Submission to Senate Rural and Regional Affairs and Transport Legislation Committee re

Inquiry into Australia's future oil supply and alternative transport fuels

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Introduction

1. This submission will draw on research conducted at the University of Wollongong and supported, in part, by the CRC in Railway Engineering and Technologies (Rail CRC). However, it does not necessarily reflect the views of either organisation. The submission draws various publications of the writer and on earlier submissions to the Federal Government, including to the Productivity Commission in its inquiry into Energy Efficiency.

2. Given the rapidly changing world scene in regards to oil supply and demand, the Committee's inquiry is timely.

General comments on oil use

3. The use of oil goes hand in hand with greenhouse gas emissions. The Bureau of Transport and Regional Economics has more than once examined reducing energy use and greenhouse gas emission from transport, including in 2002 with *Greenhouse policy options for transport - Australian trends to 2020*, with some 11 groups of measures. These include reduce vehicle kilometres travelled (VKT), nine measures to reduce emissions per VKT, four road pricing measures (mass-distance charges for heavy trucks, tolls, internalising transport externalities and emission charging), carbon taxes and tradable permits. Optimal road pricing was held to offer the best way forward.

The Senate Committee on Environment, Communications, Information Technology and the Arts Reference Committee in its 2000 report 'The Heat is On' and its recommendations, and the limited Government response to these recommendations is of note.

Of the 106 recommendations made by the majority of the Committee, no fewer than 21 addressed transport greenhouse gas emissions (GHG) and solutions. However, only four of these 21 transport recommendations received the full support of the Federal Government (Australian Greenhouse Office, 2001), with a further 11 recommendations being considered, already being supported, or addressed through existing measures. The remaining six recommendations, coupled with a minority party recommendation to replace road funds by transport funds, were noted as not being supported by the Government.

A new approach is required to address the heavy bias to oil-based road transport in Australia. This is a major challenge for the Committee.

4. The difficulties of getting a movement from 'business as usual' to a more sustainable approach should not be underestimated. Over the years, many related inquiries have been held that touch on reducing oil use in transport, and these are in part addressed in Appendix A. These inquiries are listed in Table 1.

TABLE 1 SOME GOVERNMENT INQUIRIES AND REPORTS RELEVANT TO REDUCING OIL USE IN TRANSPORT (including improving road pricing)

During the 1970s

1979 Australian Transport Advisory Council *Transport and Energy Overview.*

During the 1980s

1980 Sydney - Melbourne rail electrification study
1984 National Road Freight Industry Inquiry
1986 Federal Department of Energy, Inter-State Commission
1987 Inter-State Commission

During the 1990s

1991 Senate Standing Committee on Industry, Science and Technology *Rescue the Future: reducing the impact of the greenhouse effect*
1991 Industry Commission Rail Transport, and Greenhouse Gases (two inquiries)
1991 Ecologically Sustainable Development (ESD) Working Group on Transport
1994 Industry Commission Urban Transport
1994 National Transport Planning Taskforce
1996 Bureau of Transport and Communications Economics in its 2002 Report No 105 *Greenhouse policy options for transport 2020*
1997 Australian Academy of Technological Sciences and Engineering re urban air pollution
1997 House of Representatives Standing Committee on Communications, Transport and Microeconomic Reform (the Neville Committee) Planning not patching
1998 The Neville Committee Tracking Australlia
1999 Productivity Commission Progress in rail reform
1999 Prime Ministers Rail Projects Task Force 'Revitalising Rail'

During the present decade

2000 Senate Environment, Communications, Information Technology and the Arts Reference Committee *The heat is on: Australia's greenhouse future*
2001 Australian Rail Track Corporation Interstate Track Audit
2001 Fuel taxation inquiry commences
2002 Fuel taxation inquiry report is rejected by Federal Government
2002 Bureau of Transport and Regional Economics in its 2002 Report No 105 *Greenhouse policy options for transport 2020*
2002 AusLink Green Paper
2003 Many submissions to AusLink Green Paper supporting transport reform
2003 Parry Inquiry (NSW Ministry for Transport) Sustainable Transport
2004 AusLink White Paper
2005 House of Representatives Standing Committee on Environment and Heritage Sustainable Cities
2005 Senate Rural and Regional Affairs and Transport Legislation Committee re AusLink

Appendix B also notes some comment from various Non-Government organizations re the need for a new approach. The AusLink White paper released in June 2004 does in effect replace road funds by transport funds from a land freight perspective. However, the fact remains that as recognized by both the Senate Committee AusLink 2005 report and the House of

Representatives Committee that produced the report *Sustainable Cities*, a new program is also required to shift more people from single occupant cars to urban transport in our cities and regions.

This writer suggests that government at a federal and state level will need to do more to assist Australia to adjust to a regime of higher international oil prices in a manner that encourages improved energy efficiency in transport. This would also reduce transport GHG emissions.

5. It is submitted that more disclosure of timely information on oil use, by both government and industry would be in the national interest. One way to achieve this would simply be for government, through legislation, to require disclosure in the relevant annual reports. This should go further than disclosing the cost of any emission trading costs and ideally include the quantities of oil (petrol, diesel etc) used each year. It would also be helpful to include the energy equivalents used in both Full Fuel Cycle (FFC or primary) energy and end-use energy in terms of Megajoules.

Put simply, if you are not measuring oil use, or the cost of oil is perceived to be cheap, or at least affordable, then there is little or no incentive for oil conservation.

6. It is a good question as to how much Government should fund research and development into reducing dependence on oil.

This question was canvassed by the Productivity Commission in its inquiry into Energy Efficiency. Its finding 7.2 as follows is of concern: *The need for special energy efficiency research and development funds has not been substantiated. Sourcing funds from existing more general research and development programs enables contestability between proposals and selection of those yielding the greatest net benefit.*

This negative view of supporting energy efficiency research and development stands in contrast with the Productivity Commission's strong support of the generous *Automotive Competitiveness and Investment Scheme (ACIS)* worth over $4 billion over 10 years. This includes the ACIS Stage 2 *Motor Vehicle Producer Research and Development Scheme* (*MVP R&D Scheme*) which is directed to encourage Australian motor vehicle producers to invest in high-end R&D technologies, offering up to $150 million in R&D assistance from 2006 to 2010. This assistance commenced on 1 January 2006.

Appendix C notes has some notes about the former Energy Research and Development Corporation (ERDC).

7. The Committee is invited to explore the proposition that Australia should reduce its oil use per capita, and, ways of achieving this. Achieving such a target could well require support of research on a range of topics.

8. Canada has a One-Tonne Challenge (www.climatechange.gc.ca) which calls on all Canadians to reduce their annual greenhouse gas emissions by one tonne per annum. Canada has also ratified the Kyoto Protocol. Even if Australia, as yet, has not ratified the Kyoto Protocol, it could at least support a similar challenge for all Australian's to reduce their annual greenhouse gas emissions by one tonne per annum.

The Canadian Federal Government (like the US Government) also funds urban public transport. Canada's Federal Transport agency, Transport Canada (2004) is involved in funding urban transportation, has a program Moving on Sustainable Transportation or MOST, and a *Sustainable Development Strategy 2004-2006.*

9. The New Zealand Parliament has also ratified the Kyoto Protocol, and approved in February 2002 a Land Transport Package called Moving Forward. Along with increasing petrol tax by 4.7 cents per litre in 2002 and a further 5 cents per litre in 2005 with proceeds going to alternatives to roads and replacing of road funds with transport funds, the package aims for a transport system that *is 'affordable, integrated, safe, responsive and sustainable.'* Further initiatives have since been announced.

Transport

10. The main part, of this submission will focus on oil use in land transport. This will draw on a Project 'Energy efficiency and rail sustainability' of the Rail CRC. A summary of this Project is attached as Appendix D.

A literature survey completed for this project in May 2003 appears in Appendix E of this submission. The main findings are on average, buses and trains are more energy efficient than cars and aeroplanes in moving people; also rail and road freight had increased their energy efficiency during the 1990s, and that rail is more energy efficient than road in moving freight.

11. From the Survey of Motor Vehicle Usage now conducted annually by the Australian Bureau of Statistics (with usage for 12 months ended 31 October) the following information is provided of fuel use in billions of litres for all road vehicles.

TABLE 2 FUEL USE BY ALL ROAD VEHICLES - billion litres

	Petrol	Diesel	LPG etc	Total
1991	15.4	4.8	1.1	21.3
2001	17.2	7.0	1.7	25.9
2004	17.6	8.2	1.6	27.5

Of interest is total fuel consumption. As noted by ABARE (Sales of Petroleum Products, Australia (Source: Department of Industry, Tourism and Resources: Australian Petroleum Statistics), during 2003-04, Australia used 19.96 billion litres of petrol, 14.49 litres of automotive diesel oil, 4.34 billion litres of aviation fuel (mostly Avtur).

By way of contrast to fuel use by road vehicles, during 2003-04, rail used some 0.69 billion litres of diesel, 1860 GigaWatt hours of electricity and a modest 250 tonnes of coal (Australasian Railway Association, 2005, the 2004 rail productivity report). This modest energy use was for both rail passengers and freight.

12. The greatest potential for saving liquid fuel in Australia is in moving people in its major cities in a more energy efficient manner. This will need reducing excessive automobile dependence. In turn, this will require better urban public transport (upgraded infrastructure and as well in some cities (particularly Sydney) improved service delivery) along with improved road pricing.

Urban Passenger Transport

13. As argued by the Industry Commission (IC) in its 1994 report on Urban Transport (see Appendix A), the way people then moved themselves around Australia's larger cities was in need of reform. Ten years later, the need for reform is even greater in order to reduce high economic, environmental and social costs imposed by excessive automotive dependence.

14. The difficulty in introducing reform in this area was outlined by this and other writers in the book *Back on Track-rethinking transport policy in Australia and New Zealand* (UNSW Press 2001, pp96-98). In brief, the IC in 1994 gave a good appreciation of major problems in major cities and gave a carefully considered way of moving forward. The IC also recognised the complexity of the problem and that the important thing **was to start the reform process.**

15. However, between 1994 and 2006, passenger vehicle kilometres in our major cities have significantly increased (for example, in the order of 25 per cent in Sydney from 1991 to 2001). Moreover, major Australian cities (with the notable exception of Perth) have seen very modest growth in urban public transport passenger numbers.

16. There are many factors resulting from much increased car use and little growth in public transport usage. One factor is a vigorous roll out over the last 10 years of freeways and tollways in major cities, with modest and variable investment in urban rail and bus systems. Further factors include road pricing for the most part going backwards at a national level (freezing of fuel excise indexation in 2001) and in at least two states (NSW with toll rebates, and Queensland with its Fuel Subsidy Scheme). Moreover, the pragmatic recommendations of the Fuel Taxation Inquiry were set aside in the 2002 Federal Budget.

By design or accident, measures introduced by the New Tax System making cars cheaper and placing GST on public transport in the new tax system further increased oil dependence. In addition, the move to shuttle reduces and then freeze indexation of fuel exercise gave further incentives not to conserve fuel. It also impacted on federal finances, with estimates cited in the 2001 Budget Papers (No 2, p 40) as follows:

2001-02	$150m
2002-03	$425m
2003-04	$785m
2004-05	$1135m

The Committee may care to gain updated estimates, and also an estimate of foregone revenue for 2005-06. This is all money that could have gone to making a modest federal contribution to improving urban public transport, and more into rail, with a view to reducing dependence on oil.

17. With the exception of fuel excise, which is offset by generous taxation deductions for motor vehicle expenses (over $3 billion per year is given back to taxpayers who as individuals, companies, partnerships or trusts claim over $12 billion per year) Federal funds for roads (now at record levels) and the Queensland Fuel Subsidy Scheme, there is a very limited effort to recover external costs from motor vehicle use.

18. The Bureau of Transport and Regional Economics (BTRE) in a 2005 Working paper *Health Impacts of transport emissions in Australia: Economic costs* gives a mid-range estimate

of the annual health related costs from air pollution from motor vehicles in Australia's capital cities at $2.33 billion for the year 2000. This comprises $1596 million from the estimated cost of mortality (premature death as a result of air pollution), and $735 million for morbidity (quality of life and/or productive capacity of victims impaired or reduced as a result of air pollution; and, this estimate is appreciably lower than a 2003 BTRE estimate). Following a European approach (Kunzli N, Kaiser R and Medina S, Public health impact of outdoor and traffic related air pollution: a European assessment, *Lancet* Vol 356, Sept 2 2000) the BTRE effectively attributes air pollution costs to PM10 (particulate matter of size less than 10 microns) levels.

In a further 2003 BTRE paper (*Urban pollutant emissions from motor vehicles: Australian trends to 2020)* estimates are given of both PM10 emissions in Australia's capital cities and the kilometres driven for various types of motor vehicles. Analysis of this data shows (Laird, *Revised Land Freight External Costs In Australia,* Australasian Transport Research Forum 2005), in part, that the average health cost of air pollution from operations of cars (and other small passenger vehicles) in Australia's capital cities is 1.3 cents per vehicle kilometre. The average health unit cost for within Australia's mainland State capital cities range from 0.7 cents per vehicle kilometre (Perth) to 1.6 cents per vehicle kilometre (Sydney).

To recover an average cost of 1.3 cents per car kilometre in capital cities through fuel taxes would require, assuming an average fuel use of 11.4 litres per 100 km (ABS SMVU 2001 estimate), a **fuel levy of about 12 cents per litre.**

19. An outline of some external costs of motor vehicle use and 'road deficits' follows. This suggests a 'road deficit' of about $11 billion per annum.

i. Road crash costs were estimated by the BTRE (2000) at $15 billion in 1996. Less congestion costs it was $13.5 bn. Only about $8 covered by insurance in 1997-98 (Laird et al 2001); leaving about $5.5 bn being a cost to the wider community.

ii. Road congestion costs in major cities of about $12.8 billion in 1995 (BTRE, 1999);

iii. Health related costs from the effects of air pollution from motor vehicles with mid-range estimates for the year 2000 of the BTRE as $2.6 billion (regions plus capital cities);

iiii. The cost of noise from all motor vehicles in urban areas as $0.7 billion, as per a low range estimate of the Bus Industry Confederation (2001);

v. Net taxation refunds for motor vehicle use of $2.8 billion in 1997-98 (Laird et al 2001);

vi. A $1.7 bn greenhouse gas cost in 2000-01 (at $25 per tonne - Laird, 2003);

vii. An annual $0.8 bn non-tariff automobile industry assistance programme;

viii. An estimated increased health cost of lack of physical activity due to excessive car use of about $0.8 b per annum in Australia (Mason, C (2003) Personal communication, also *Transport and health: en route to a healthier Australia?* Medical Journal of Australia Vol 172, 6 March 2000 pp230-232)

ix. A Queensland Fuel Subsidy Scheme payment now costing the Qld Government over $0.5 bn per year, and the NSW Government about $40m per year; and,

x. Toll rebates in Western Sydney costing about $60m per year.

These approximate cost estimates add up to some $28.3 billion per year. Road system costs in 2001-02 were about $8 billion a year (more recently, NTC 2005, over $10 bn a year). The total is $36.3 billion per year. Road vehicle specific revenues to Government in 1997-98 were about $12.6 bn in 1997-98 (and only $12.7 bn in 2001-02 - BTRE, 2004). Hence, excluding congestion costs, a case can be made that there is a 'road deficit' that is now about $11 billion per year.

In regards to the costs of accidents involving motor vehicles it can be argued that some, but not all of these costs fall on other road users (see, for example, a 2005 ATRF - BTRE paper by Ms L Martin). Thus, the percentage of road crash costs that should be regarded as an external cost is open to question. Hence, the estimate of 'road deficit' of about $11 billion per year is also open to question. However, treating external costs as zero is not a satisfactory policy option.

20. It is submitted that Government should support a move to a "polluter pays" principle, plus ensure internalisation of all current external costs. It is submitted it would be desirable to put some cost for greenhouse gas emissions.

21. As well, transport policy and taxation measures should be reformulated to be *"consistent with our obligation to current and future generations to sustain the environment"* (as per the AusLink Green Paper). This paper recognises that (p19) [transport] *"greenhouse gas emissions in 2010 are projected to be almost 47 per cent above 1990 levels."*

22. In a similar way, government could well give more support to the National Strategy for Lowering Emissions from Urban Traffic with a National Action Plan, as approved by the Australian Transport Council in August 2002.

To quote from the communique for this meeting: *The Strategy and Action Plan developed by the National Transport Secretariat in collaboration with all states, territories and the Commonwealth government provides a groundbreaking national approach to reducing greenhouse emissions from the transport sector.*

Ministers noted that the National Strategy is the first agreed national approach driven by the transport sector to reducing greenhouse emissions, creating greater momentum than can be achieved via a fragmented approach.

The National Action Plan builds on the large range of activities already underway in each state and territory. The positions are, within the next 5-10 years:

a fully integrated transport system that allows for timely, reliable, accessible and safe travel will be operational.

programs that encourage people to take fewer trips by car will be operational in each jurisdiction and a nationally cooperative approach between jurisdictions will have been developed.

transport costs will have moved from predominantly fixed to predominantly variable costs. This outcome will address cost variations in transport modes and ensure that transport users experience more of the true cost of their travel choices.

a significant improvement in the emissions efficiency of urban vehicles will have been achieved.

nationally developed policy and benchmarking tools for the integration of transport and land use planning will have been implemented. Well-planned urban development reduces the need for car trips and improves the 'liveability' of towns and cities.

a nationally developed transport investment framework for investment decisions across all transport modes of travel will have been trialled and implemented.

23. As noted above, the Productivity Commission reported in 2005 on its inquiry into energy efficiency. Its final report includes a chapter (one of 14) on energy efficiency in transport. It is submitted that the approach adopted by the Productivity Commission on this occasion was disappointing in its negative recommendations re a national energy efficiency target in general, and, as above, its attitude to special energy efficiency research and development funds despite the excellent job done by the former ERDC and its support of the *Automotive Competitiveness and Investment Scheme*). The Commission's approach to transport taxation reform, and compulsory fleet wide fuel consumption targets (finding 11.2) is also considered in need of review. Thus, the report's sole recommendation on transport, as below, is of interest.

Australian governments should investigate the feasibility of introducing congestion pricing where it is likely to improve the economic efficiency of road use (including greater energy efficiency). It may be appropriate for such a study to be incorporated in a wider examination of efficient road pricing or in a review of passenger transport reform as a whole.

24. The large payments made under *Automotive Competitiveness and Investment Scheme* could be better targeted at those companies who would be prepared to make in Australia small cars and the so called hybrid cars. The idea is not original as it has been suggested elsewhere.

It is even possible that some of these funds could be directed into making buses and passenger rail carriages.

25. Support is given for the views of the Committee in its 2005 report re AusLink as follows.

a. the need for efficient charges for use of infrastructure, including for heavy trucks *"…that compete directly with rail [and] affirms the need to confirm working towards efficient pricing of access to infrastructure…"* (p28).
b. public transport issues "*are still on the table"*. Moreover (p30) "*there may be a case for Commonwealth assistance to major projects such as rail extensions which are unlikely to happen, or unlikely to happen soon enough, without the involvement of the bigger budget which the Commonwealth commands."*
c. support for a forum such as a National Transport Advisory Council (NTAC) for "*co-ordinating policy"* in "*investment policies modal integration and access pricing"*.
d. The need for research and better data was noted, including protocols in the case of rail to allow "*information gathering of industry-wide importance"*.

26. Support is also extended for the seven transport recommendations of the House of Representatives Standing Committee on Environment and Heritage 2005 report Sustainable Cities

 # 5 The committee recommends that the Department of Transport and Regional Services, in consultation with the Department of the Environment and Heritage, investigate options to extend the Roads to Recovery programme to include other modes of transport as a step towards including sustainability in the funding criteria.

 # 6 The committee recommends that:
transport infrastructure planning decisions be benchmarked against the recommended Australian Sustainability Charter; and
the Australian Government significantly boost its funding commitment for public transport systems, particularly light and heavy rail, in the major cities.

 # 7 The committee recommends that the provision of Australian Government transport infrastructure funds include provision of funding specifically for sustainable public transport infrastructure for suburbs and developments on the outer fringes of our cities.

 # 8 The committee recommends that the Australian Government review the current FBT concessions for car use with a view to removing incentives for greater car use and extending incentives to other modes of transport.

 # 9 The committee recommends that the Australian Government review the tariff policy on four wheel drive vehicles with a view to increasing the tariff rate on four wheel drive vehicles, except for primary producers and others who have a legitimate need for four wheel drive capability.

 # 10 The committee recommends that the Australian Government provide adequate funding to develop new programmes and support existing programmes, such as TravelSmart and the National Cycling Strategy, that promote and facilitate public and active transport options.

 # 11 The committee recommends that the Department of Transport and Regional Services investigate developing emission standards for older vehicles and work with the States and Territories with a view to instituting mandatory testing and reporting at point of sale.

27. It is expected that the Government will release in Autumn 2006 its response to the recommendations of the Sustainable Cities report. Given the relevance of the above recommendations to reducing oil use in Australia, the Committee may wish to examine this response and provide appropriate comment.

28. A good approach to energy use in transport was given 27 years ago in a government Australian Transport Advisory Council 1979 publication *Transport and Energy Overview*. This report was prepared, following the second major world oil price shock during the late 1970s. Although the data used in this report is now dated, the approach is commended, as are the conclusions. In part: *"... rail is relatively energy efficient compared to road for long distance freight ... (and) ... does have fuel substitute options, such as coal-oil slurries or electrification ..... As far as possible pricing and cost recovery policies should be consistent across the modes so as to encourage use of modes appropriate to particular tasks. Appropriateness may be defined broadly as minimising the total social cost of transport services, including externalities.*

This 1979 ATAC report notes (p83) that private cars which operate with an average load factor of about 25 per cent (corresponding to occupancies between about 1.2 and 1.4) yield

about 0.25 passenger kilometres (pkm) per MegaJoule (MJ), whilst buses and trains operating at average load factors of 2 pkm per MJ, at 100 per cent load factor yield in the order of 6 pkm per MJ. The report also notes *"Rail does have fuel substitute options, such as coal-oil slurries or electrification that afford a degree of long-term flexibility in the event of large scale price increases for liquid petroleum fuels"*.

29. Since the 1970s, most cars, buses and passenger trains have improved their energy efficiency. Offsetting features leading to lower energy efficiency for cars include increased use of air conditioning, a trend by some to purchase larger cars and 4WDs for urban use, and increased road congestion. Plus heavier occupants. For rail and buses, lower occupancy factors in some services has also lowered energy efficiency.

Based on 2001-02 ARA/ ACG FFC estimates, passenger rail had an average energy efficiency of 0.65 passenger km (pkm) per Megajoule (MJ) as compared with 0.36 pkm per MJ for passenger road vehicles, 0.71 pkm per MJ for buses and 0.40 pkm per MJ for domestic airlines.

30. Suppose that the present urban transport bus and train services were completely withdrawn and that 90 per cent of the passenger movement was replaced by cars. How much extra petrol would be required, and how much diesel from bus use would be saved?

We start with recent estimates of urban rail and bus passenger kilometres (pkms). For rail (ARA/ACG data) they were 8.5 billion pkm in 2002-03. The Bus Industry Confederation (2003) notes that in urban areas, buses have passenger tasks of about 8 billion pkm. Assume that say 90 per cent of this combined task then moves by car, giving 14.85 billion pkm. Assume also that with no buses and trains that there would be an occupancy rate of 1.2 passengers per car (higher than the BTRE's estimate of the average vehicle occupancy rate in Australia of around 1.1 persons cited on page 11 of *Greenhouse policy options for transport 2020* Report 105, 2002). This would result in an extra 12.375 billion car km per year. On an ABS average petrol use of 11.0 litres/100km (ABS SMVU data for 2003, Table 5) this results in an extra 1.36 billion litres of petrol used per year.

The decrease in diesel use for the 8 billion pkm urban bus task is broadly estimated (at 0.71 pkm/MJ and 38.6 MJ per litre) at about 290 million litres. The net oil savings is then about 1 billion litres per year. There would also be a decrease in electricity use for the trains.

The closure of bus and train services would increase external health costs due to the extra air pollution from more car use. With the unit cost of 1.6 cents per passenger vehicle km (item 18 above) this cost is some $198 million per year, with a modest offset with less diesel use. There would undoubtedly be an increase in road trauma as well.

Conversely, if the urban public transport task were to double (still leaving lots of room for cars on city roads), Australia would save over one billion litres of oil a year. Moreover electric trains have many advantages in people moving and reducing both road congestion and air pollution. To achieve this will need upgraded public transport infrastructure and improved road pricing.

Other savings would follow by more encouragement of 'active transport' including walking and cycling. However, as well as improved footpaths and cycleways (better connectivity) and programs like 'Travel Smart', improved road pricing is needed.

More on land freight transport

31 Land freight transport is an increasingly important topic. The growing rail and road freight tasks in Australia are shown in Table 3.

TABLE 3 AUSTRALIAN LAND FREIGHT TASKS (and tonnages for 2003-04)

	Billion tonne kilometres				***(million tonnes)***
	1994-95	1998-99	2002-03	2003-04	*2003-04*
Rail					
'Govt.' rail *	62	67	41±		
Non-Govt. **	48	60±	117		
Total	**110**	**127** ±	**158**	**168**	*(594)*
Coal	28	33±	44	46	*(239)*
Iron Ore	47	50±	66	72	*(220)*
Other Intrastate	18	24±	21	23	*(119)*
Interstate	17	20±	26	27	*(16)*

	Billion tonne kilometres				***(million tonnes)***
	1994-95	1998-99	2002-03	2003-04	*2003-04*
Road					
B-Doubles	9	19	35	38.2	-
Road trains	15	20	19	25.2	-
Artic. trucks	89	99	116	121.3	*769*
Interstate	26	30 ±	37 ±	?	?
Total	**119**	**127**	**153**	**157.7**	***1696***

* Includes former State and Federal Government operated systems in 1994-95, Queensland Rail (QR) only in 2002/03
** Excludes Government operated systems, all except QR in 2002/03
Note coal and iron ore includes relatively small domestic movements
References include: For rail, Steering Committee on National Performance Monitoring (1996), Bureau of Transport and Regional Economics (BTRE - 1999), various Annual Reports, Australasian Railway Association (ARA, 2004a, 2005a) and some estimates (indicated by ±).
For road. ABS (2004) Note various data caveats as there are severe limitations on the quality and quantity of data publicly available on land freight in Australia.

Under National Competition Policy, much attention has been given to rail - rail competition for freight, but until recently, little attention has been given to competitive neutrality affecting land freight. For example, in the 30 years to 2004, in 2004 dollars, the Federal Government outlaid some $58 billion for roads and only approximately $2.2 billion for upgrading the entire rail system. During this time, the National Highway System has been substantially upgraded ($24.5 bn over 30 years) while the state of the national rail system has disintegrated to the point where Engineers Australia gave an “F” rating to the rail lines linking Australia’s three largest cities.

34. Work on the South Sydney Freight Bypass along with other basic track work recommended in a 2001 National Track Audit is only now about to commence under a $1.8 billion investment over 2004-2009 for tracks used by freight trains. However, there is a need for

advanced planning for further track upgrades. This includes track straightening, and in places, heavier rails and/or increased clearances.

Intermodal freight terminals need attention. In addition, there needs to be harmonisation between the states regarding access arrangements and rail safety regulation.

35. The issue of road pricing for heavy trucks in Australia has long been contentious with inquiries going back to the 1970s and a BTRE (1988) study found during 1985-86, articulated truck operations had a resultant under-recovery of road system costs of $1283 million. Using different methodology to the BTRE, a hidden subsidy was calculated (Laird et al, 2001) of $1235m in 1997-98. The BTRE (1999, page xi) noted *"Under the current road user charging system, trucks overall are undercharged for their use of the road system. Moreover, larger more heavily laden vehicles and those travelling larger distances are charged the least (per tonne kilometre) while smaller, less heavily laden vehicles and those travelling shorter distances cross-subsidise them."* The BTRE (loc.cit, p 58) suggested that *"Mass-distance based road use charges offer greater scope to reflect the avoidable cost of heavy vehicle road use."*

Transport access pricing is now subject to a Productivity Commission hearing for CoAG.

36. Assuming unit external costs of accident involvement, air pollution, noise pollution, greenhouse gases ($A25 per tonne)) of 0.98 cents per net tonne km in non-urban areas and 1.65 cents per ntkm for haulage in urban areas (Laird, 2005) with an articulated truck freight task of 121 btkm (Table 3) including about 25 btkm in urban areas (from ABS (2004) data), the social and environmental costs for 2003-04 were about $1350m. Under present rebates for diesel use, this amount is not being recovered.

Rail freight operations generate external costs (accidents, air pollution, noise and greenhouse gases with estimates of unit costs of 0.17 cents per net tonne km (ntkm) plus an additional 0.26 cents per ntkm for haulage in urban areas (Laird 2005). With a non iron - ore rail task of 96 btkm in 2003-04 (Table 3) and assuming say 10 btkm of this freight task is in urban areas, an external cost of about $190m results. Again, in the absence of any diesel fuel excise being levied on rail, these external costs are not being recovered.

The costs to Government and the community of effectively encouraging both line haul and some bulk freight to road transport (via substandard national track and 'highway subsidization') include extra fuel use along with external costs are appreciable. These impacts affect not only quality of life, but also impose a monetary cost that could be considerably reduced by comparatively modest investment in rail track and improved road pricing.

34. A recent NTC publication 'Twice the task' gives a somewhat business as usual approach to a growing freight task, but is very light on both road pricing for heavy trucks and mainline track straightening and strengthening. This is despite track straightening proposals being noted in the 2001 ARTC Track Audit, the 2004 Federal budget speech, the 2004 AusLink White Paper, and the 2004 AusLink National Guidelines for Transport System Management in Australia (AusLink Plus proposals as noted on page 248 of Vol 3)

A speech given by NTC Acting Chairman on 14 February notes that "only 10-20 % of the road freight task is contestible." Accepting that only 10 per cent of the articulated truck task of 121 billion tonne km moved to road would reduce diesel use by trucks, at 2004 fuel use

(ABS SMVU of 36.7 tonne km per litre), by about 330 million litres (per year). The diesel needed by rail would be about 110 million litres. Even allowing for some road pick up and delivery, this would result in a net saving of over 200 million litres per year. There would also be an appreciable reduction in external costs.

If 20 per cent of the articulated truck task was to move to rail, then the new savings would be over 400 million litres per year. Elsewhere (Productivity Commission, energy efficiency inquiry, submissions, and report page 265) this writer has estimated that at least 8 per cent of the 2002-03 road freight task could conditionally be transferred to rail, however, road could win some traffics currently moved by rail if rail was not upgraded etc.

35. There has been at least one period during the 1990s, as noted by the Apelbaum Consulting Group (Australian Transport Task, Vol B, 1997, p120) where the private rail freight task increased (by 8 per cent - p 44) and the energy use actually declined by 4 per cent from 1990-91 to 1994-95.

A further example from the 1990s in reducing diesel use in rail freight is with National Rail's then new fleet of 4000 HP Dash 8 locomotives. This investment coupled with upgraded wagons and incentives for drivers to save fuel allowed National Rail to obtain significant fuel savings. A September 2001 brochure issued by National Rail (pre-sale and to note the advent of a profit in 2001-01) **stated an average fuel use of 4.0 litres per 000 gtkm for 1999-00-01 as against 7.4 litres per 000 gtkm for 1992-93-94.**

As per Appendix D, Australia has the most energy efficient trains in the world and these are the iron ore trains in the Pilbara region of WA. Queensland Rail's Central Queensland's electric coal train operations are also world class, and are estimated to be saving over 170 million litres of diesel each year. Although other examples of world best practice can be found in Australia, there is potential to further increase diesel savings in Australian rail freight.

36. **A ten point transport pricing plan**

Improved road pricing to remove large hidden subsidies from motor vehicle operations (cars in major cities during peak hours and articulated truck operations) is necessary to improve demand management. One approach is given by the Railway Technical Society of Australasia (Submission #186 to the House of Representatives Environment and Heritage Committee's inquiry into Sustainable Cities) which proposed a ten point transport pricing plan along the following lines.

i. Re tolls

A. remove toll rebates in Western Sydney, which is a costly scheme to administer.

B. reinstate tolls at Berowra and Waterfall, with the proceeds being used to expedite long-overdue improvements of both the Pacific and Princes Highways.

C. ensure that the Mitcham - Frankston motorway is built as a toll way.

ii. Remove the Queensland Fuel Subsidy Scheme, at least from South East Queensland.

iii. Impose a congestion charge for access to the Sydney and Melbourne CBDs. It works well in London. And/or impose an environmental fuel levy for motor vehicle use in the Greater Metropolitan Areas of state capital cities and Canberra.

iiii. Restore fuel excise indexation, with the additional revenue going into improved transport infrastructure. To ensure best use of funds, replace road funds (as enjoyed by the NSW Roads and Traffic Authority) by transport funds (as per Western Australia, New Zealand and as proposed under AusLink).

v. Ensure that the further determinations of heavy vehicle road user charges by the National Transport Commission recovers - at least the populous zone - the full road System costs from heavy articulated trucks, B-Doubles and road trains. At present, these vehicles are cross-subsidised by other road users. Ensure that additional revenue is directed towards not only National Highway System maintenance (to compensate for changes under AusLink), but rail track and improved intermodal facilities.

vi. Increase annual registration fees for the heavier four wheel drive vehicles.

vii. Support the recommendation of the Productivity Commission from its 1999 Inquiry into Progress in Rail Reform into an inquiry into road provision, funding and pricing. Also have the Productivity Commission examine urban transport.

viii. Increase rail fares, with all proceeds going into a better rail system.

ix. Improved land transport data, with publication of accurate, comprehensive and up-to-date information on all modes of transport, with details of energy use and greenhouse gas emissions.

x. Ensure that major airports and seaports are not in receipt of hidden subsidies.

37. The 1979 report of the Australian Transport Advisory Council *Transport and Energy Overview* also gives a discussion of future oil supplies, both domestic and imported. In addition, it also discusses factors relevant to Australia maintaining a capacity to refine oil products. By the end of the 20th century, Australian's oil refineries were old and small by world standards. The committee may care to examine their suitability for the 21st century.

APPENDIX A GOVERNMENT ACTION AND OR INQUIRIES RELEVANT TO REDUCING OIL USE IN TRANSPORT

During the 1980s

Some measures to reduce oil dependency flowed through from the move to full parity pricing introduced in the late 1970s by the Fraser Government. However, as international oil prices eased during the early 1980s, some of the incentive to conserve oil was lost. The Federal Department of Energy (1986) produced a series of reports, including one on transport which noted, inter alia *'...potential energy savings from more use of the less energy intensive sea and rail freight transport modes, and, that such greater use would be more likely with improved road cost recovery from heavy truck operations'*.

Some progress was made with road cost recovery from heavy vehicle operations, which had exercised numerous Government inquiries and was the subject of many reports in the 1980s including the BTCE (1984, 1988), the National Road Freight Industry Inquiry (May et al, 1984), and the Inter-State Commission (1986, 1987, 1990) with the increasing use of Federal fuel excises and State franchise fees, introduction of the Federal Interstate Registration Scheme in January 1987 and the introduction by NSW and Victoria in 1987 of permit fees for vehicles operating at increased Gross Vehicle Mass (GVM) limits.

Across Australia, there was during the 1980s significant variation in both the level of state franchise fees for diesel fuel and annual registration charges for articulated trucks. By 1 July 1996, National Road Transport Commission uniform charges had been implemented on a national basis. However, these charges failed over all to address agreed 'user pay' requirements and did not include the option of mass distance pricing. This situtation has continued to this date, with yet another inquiry due to be held during 2006 by the Productivity Commission with a view to moving towards a more economically efficient and refined charging regime.

Meantime, the views of the Industry Commission (1992), in commenting on the NRTC initial charges, are of note *"...Annual fixed charges are not efficient because costs vary with the distance travelled and the mass of the vehicle. The result is that some vehicles - the heaviest travelling long annual distances - will meet less than 20 per cent of their attributed costs... Differences between the recommended charges and road-related costs are greatest for vehicles competing with rail. The charges, as recommended, will therefore potentially distort the long-haul freight market as rail reforms take effect...."*

During the 1980s, Queensland Railways upgraded, extended and electrified their central lines serving ports at Gladstone and Mackay to handle increasing tonnages of export coal. This resulted in reduced costs for locomotive maintenance and along with reduced wagon turn around times. The use of electric traction at 25,000 volts AC was initially in the Brisbane suburban network (as opposed to the older 1500 volt DC system used in Melbourne and Sydney) and then the coal lines resulting in an estimated saving of 128 million litres of liquid fuel a year (Read and Drake (1989) Queensland Railways Main Line Electrification Project, Proceedings, Fourth International Heavy Haul Railway Conference, Brisbane).

Inquiries during the 1990s

A Senate Standing Committee on Industry, Science and Technology in 1991 report *Rescue the Future: reducing the impact of the greenhouse effect* addressed, inter alia, transport. Noting

that transport contributed over a quarter of Australia's Carbon dioxide emissions, the Committee made six specific transport recommendations. These comprised:

- an integrated national transport strategy within two years.
- a national action plan for urban public transport
- minimum fuel economy of 8 litres per 100 km for all new vehicles sold in Australia reducing to 6 litres per 100 km by 2005.
- incentives for fuel efficient vehicles, mode shifting to public transport, and replacing high standing charges (registration and insurance) by those proportional to vehicle use.
- favouring LPG and natural gas
- research re use of lower carbon fuels.
-

The 1991 Senate Committee report also noted that ***"already much has been written and said, including strategies and recommendations that would greatly reduce greenhouse gas emissions. The element that is missing is not information but action."***

Reducing greenhouse emissions from transport goes hand in hand with reducing dependence on imported oil, and conserving Australia's limited domestic resources. The present Committee may well reach the same conclusion as the 1991 Committee did.

In 1991, a detailed report from an Ecologically Sustainable Development (ESD) Working Group on Transport was released. This report was one of nine reports on ESD sponsored by the Federal Government. The ESD transport final report gave a careful examination of the issues, and made some 30 recommendations. These addressed concerns about concessions within the Fringe Benefits Tax system that encouraged the provision of company cars, the need to encourage the use of public transport as part of salary packages, better vehicle pollution control measures, effective schemes to improve fuel efficiency with labelling, the removal of subsidies to encourage greenfield suburbanisation, road pricing mechanisms, priority for high-occupancy vehicles, bicycling etc. Many of these recommendations were ignored by Government when formulating budgets, although some influenced 1992 Government policies on ESD, and a National Greenhouse Reduction Strategy. These 1992 recommendations included reducing

'...total energy consumption in transport through improved technical and economic efficiency of urban and non-urban transportation and switching to alternative transport technologies or modes where this reduces greenhouse emissions per passenger or unit of freight'.

'

...Government funding of interurban road and rail infrastructure development, including the National Highway system and the National Rail Corporation's network, should be brought onto an even-handed basis that incorporates ESD principles, by assessing both road and rail projects according to a single set of criteria covering national and local economic, social and environmental benefits and costs' (finally achieved in part with AusLink in 2004, some 12 years later).

However, throughout the 1990s, the annual reports of the Federal Department of Transport made little or no reference to energy efficiency. In contrast, annual reports from this Department in the late 1970s did address the issue. Moreover, the 'Vision Statement and Objectives' of the Australian Transport Council (ATC) released in 1994 did not even bother to mention energy efficiency. This was in marked contrast to one goal of the United States Intermodal Surface Transportation Efficiency Act 1991 which was to: *'... develop a National Intermodal Transportation System which is economically efficient and environmentally sound,*

provides [sic] the foundation for the nation to compete in the global economy and will move people and goods in an energy efficient manner.'

In 1993 the Keating Government established a National Transport Planning Taskforce (NTPT). The aim was '... to develop a truly nationally integrated transport system.' Three Taskforce members were appointed with a small staff and a budget of about $1 million. The main conclusion of the summary NTPT (1994) report was that ***'Significant changes are needed in the way Australia makes and implements transport decisions.'***

The changes are still needed. The NTPT report gave 16 recommendations, including the following:

- 'Commonwealth, State and Territory Governments negotiate and seek endorsements of the Council of Australian Governments to establish a framework for national strategic transport planning in Australia – a National Transport Infrastructure Network....'
- 'That road, rail, port and airport infrastructure investments and their funding arrangements should be considered within a framework that allows intermodal, network and corridor considerations to be evaluated transparently.' The rationale was that '...more flexible funding mechanisms should be negotiated so funds can be channelled into corridors and modes of highest priority.'
- 'All governments ensure transparency in setting of taxes and charges on freight transport. In setting taxes, governments should consider the consequences for competition between modes. ...'
- 'All governments ensure development mechanisms for pricing for the use of transport infrastructure which reflects the costs of efficient provision of that infrastructure and take into account congestion and environmental factors in a transparent way.

The first NTPT recommendation was yet another call for integrated transport planning whilst the second one urged a more balanced approach to transport infrastructure investments.

The NTPT recommendation regarding transparency in taxes and charges was a discrete acknowledgment that Australian road pricing for heavy trucks could be distorting modal competition. The last recommendation cited was in recognition (NTPT, 1994, p52) that: ***'...Investing in better roads will not necessarily achieve reduced congestion; in fact, it could prove counter productive in some circumstances, attracting more users onto the roads as travel times temporarily decrease.'***

The NTPT reports provided a strategy to improve Australia's transport network and to assist international competitiveness.

A major effort by the Federal Government towards urban transport reform was an inquiry conducted by the Industry Commission (IC, 1994). Some quotes follow: *"Australia's urban transport systems are falling far short of their potential contribution to the economic and social wellbeing of our cities. There are no 'quick fixes' available: rather a mutually reinforcing package of policies is needed. … 'Transport is vital to making our cities work. Many believe that the financial, economic, social, and environmental consequences of the way we build and operate our urban transport systems cannot be sustained.*

"In Australia in recent years, significant reform has occurred in other areas of transport such as long distance road transport, and domestic and international aviation. Urban transport lags behind, although there have been some notable improvements in several States in recent times..."

The BTRE (1996) recommended no fewer than 16 measures (including five 'no regrets' measures of which four were concerned with urban transport and one to transfer more freight to rail) to reduce greenhouse gas emissions, and hence liquid fuel use in transport.

The BTE report was followed by an inquiry into urban air pollution by the Australian Academy of Technological Sciences and Engineering (AATSE, 1997). This report recommended that land transport reform on several familiar fronts be undertaken.

The need for integrated transport planning was again reiterated by the House of Representatives Standing Committee on Communications, Transport and Microeconomic Reform (1997, 1998). The Committee, chaired by Mr Paul Neville MP, in its 1997 report on roads recommended, *'...that the Commonwealth consult widely, develop and publish an integrated national transport strategic plan by 1 July 1999.'*

Further support for integrated transport planning had been given by the Neville Committee's August 1998 report on rail, and, in a report called 'Revitalising Rail' by a Rail Projects Task Force (1999) established by the Prime Minister. This Task Force found that the lack of an integrated national transport strategy and 'substandard national track' were the two major barriers to improved rail performance. Their first recommendation was that: *'The Commonwealth Government takes the lead in developing an economically-driven National Transport Strategy that will secure a seamless domestic transport system embracing road, rail, sea and air transport, and provide for the entry and exit of people and goods by sea and air at world competitive standards.'*

This recommendation of the Rail Projects Task Force was yet another variation of the long sought after National Transport Strategy recommended in 1991 by the ESD Working Party, the NTPT report in 1994, and the two Neville Committee reports of 1997 and 1998.

In addition, the Productivity Commission held an inquiry into Progress into rail reform. A key recommendation, not accepted by the Government, was an inquiry into road provision, funding and pricing.

During the 1990s, with the exception of indexation of fuel excise, road pricing mechanisms to induce modal shifts had gone backwards. The regressive measures included (following lifting of tolls at Berowa on the Sydney - Newcastle highway in December 1988) the following:

* The Queensland Government converting Sunshine Coast tollways to freeways
* The Federal Government abandoning plans to construct the upgraded Federal highway as a tollway
* The NSW and Federal Governments abandoning plans during the 1990s for a major upgrade of the Pacific Highway using tolls (the Motorway Pacific proposal of early 1993)
* NSW, after a change of Government in 1995 introducing a costly cash back scheme for private motorists using certain Sydney tollroads
* The failure to require the Queensland Government not to introduce a Queensland Fuel Subsidy Scheme on the imposition of additional fuel excise to replace state based fuel franchise schemes following a High Court decision in 1997.

Inquiries during the present decade

In its 2000 report *The heat is on: Australia's greenhouse future* the Senate Environment, Communications, Information Technology and the Arts Reference Committee (2000) addressed transport. Of the 106 recommendations made by the majority of the Committee, no fewer than 21 addressed transport greenhouse gas emissions and solutions.

However, only four of these 21 transport recommendations received the full support of the Federal Government (Australian Greenhouse Office, 2001), with a further 11 recommendations being considered to already being supported, or addressed, through existing measures. The remaining six recommendations, coupled with a minority party recommendation to replace road funds by transport funds, were noted as not being supported by the Government.

In May 2001, the Australian Rail Track Corporation (ARTC) released a detailed Track Audit outlining an economic case for upgrading interstate mainline track. It took three further years for NSW to agree to lease its mainline track to the ARTC.

In 2001, the Federal Government commenced a Fuel taxation inquiry. Despite the pragmatic approach taken by the three inquiry members (assisted by Treasury staff), the Fuel taxation inquiry report was rejected at the time of the May 2002 budget by the Federal Government.

The Bureau of Transport and Regional Economics (BTRE) in its 2002 Report No 105 *Greenhouse policy options for transport 2020* again considered land transport,, with some 11 groups of measures to reduce vehicle kilometres travelled (VKT), nine measures to reduce emissions per VKT, four road pricing measures (mass-distance charges for heavy trucks, tolls, internalising transport externalities and emission charging), carbon taxes and tradable permits. Optimal road pricing was held to offer the best way forward.

This view was shared by the Parry Inquiry (NSW Ministry for Transport, 2003) that noted, inter alia (p72) *"The thinking underlying the support for road use pricing is that road access is currently 'too cheap' (as distinct from the general cost of motor vehicle use), as motorists are not directly bearing all of the costs associated with their decision to make a journey. For example, driving a vehicle is associated with costs such as congestion, road wear and tear, pollution and accidents."*

The Parry Inquiry (loc.cit, p 74) also noted *"Currently, public transport is disadvantaged compared with private transport by a range of taxation (for example, the fringe benefits tax), expenditure and other policies that encourage private transport use. As a separate issue, and irrespective of the decision made regarding road use pricing, those policies that distort decision making in favour of private transport should be reviewed to ensure that public transport is not disadvantaged."*

When the AusLink Green Paper was released in late 2002, it received many submissions with wide support for the Federal Government to assist urban public transport. As noted above, this issue was addressed by both the House of Representatives Standing Committee on Environment and Heritage in its inquiry into Sustainable Cities, and, the Senate Rural and Regional Affairs and Transport Legislation Committee in its inquiry into AusLink.

APPENDIX B OTHER EXPRESSIONS OF CONCERN

Various Non-Governmental organisations in Australia have expressed some concern about transport policy. One example in the early 1990s follows

Australian National Report to the United Nations Conference on Environment and Development, 1991 P189, 1991 **Non-Government Organisation Views**

The policies of the Federal and most State Governments have been to favour increasing road capacity and road transport efficiency whilst leaving significant parts of the interstate mainline rail network in South East Australia with steep grades, sharp curves and tight clearances. This, coupled with three different gauges, has resulted in a modal shift since 1972 for interstate freight in Eastern Australia from rail transport to the more energy intensive road transport. Whilst the formation of a National Rail Corporation in 1991 will improve management and terminal operations, Government commitment is needed to upgrade mainline interstate track from nineteenth century standards so as to allow for modern intermodal freight operations.

Progress in removing large hidden subsidies for heavy truck operations through inadequate road pricing has been slow. Although an inter-governmental commitment was made in 1991 (Special Premiers Conference) to form a National Road Transport Commission, it will not be until 1995 that charges that reflect much improved road cost recovery will be attained.

Transport of people within and between cities is dominated by cars and in part reflects Government bias to car use and road funding. Planning and development of light rail transit in most Australian major cities is generally ten years behind that of North America, Europe and many Asian cities.

(Consumers' Transport Council, Comments on National Report, 26.8.91, p2)

Fifteen years later, one can ask what has changed. The main advances would appear to be Adelaide - Melbourne gauge standardization and related works in the early 1990s, good progress made during the mid 1990s by Queensland in upgrading mainline track, and more recently by the WA Government in expending urban rail in Perth. On the other hand, as argued in the main submission, the 'user pays' promised in 1991 in road pricing for heavy trucks is yet to be delivered. So also is interstate mainline track straightening and strengthening.

During the late 1990s, two notable contributions were made. One was from the Chartered Institute of Transport in Australia found it necessary to issue a sternly worded statement at its 1998 National Symposium about the oil situation: *"Our greatest ever source of cheap energy may soon contract and the 'Petroleum Age' in which we live now can be seen to be approaching an eventual end.*

"The Symposium heard that a clear consensus is emerging that cheap oil production outside the Middle East will begin permanent decline around the year 2000, to be followed by permanent world decline within 15 years. … 'More of the same' in our current transport plans and ways of thinking is no longer tenable. ..."

Also, as found by the Institution of Engineers, Australia (1999) we have major problems

in major cities, and, there is a need to respond to the challenges. In brief:

A Taxation and fiscal policy instruments should encourage sustainable transport. At present, these measures encourage car and truck use.
B There is a strong case for increased investment in transport infrastructure that is more sustainable and less greenhouse gas intensive. Where market forces fail, government should intervene.
C More holistic approaches to transport decisions are needed that integrate considerations of impacts on health, sustainability and greenhouse gas emissions.
D There is a need for research to support cleaner transport fuels and technologies, along with transport pricing, economics and demand management technologies.

In a new decade, with recent international events and oil prices, the warnings and remedy of these two conservative bodies are even more relevant. The challenge for Australia is to reverse the long standing transport policies that act so as to increase oil dependence.

APPENDIX C ENERGY RESEARCH AND DEVELOPMENT

The Energy Research and Development Corporation (ERDC) was formed in 1990 to increase commercialisation and the effectiveness of a long standing National Energy Research, Development and Demonstration Council. It was regretfully abolished about 1997. To quote Senator Meg Lees (Hansard, Wed 25th March 1998) in speaking to a disallowance motion after the Government had moved to close down ERDC. *"The Energy Research and Development Corporation was set up to manage the federal government's direct investment in energy innovation and research in energy supply and use. The way this works is that it invests in energy projects right from concept through to commercialisation, focusing on traditional energy supply, alternative and renewable energy sources and systems, and sustainable energy use. It covers a range of things, including gas and liquid fuels, electricity generation, distribution and application of energy use in Australian industry, manufacturing, transport, the built environment, appliances, processing and agriculture-in other words, the full gamut.*

"The ERDC selects projects and then funds them to meet these priorities. Therefore, it supplies support to the private research sector. It is a big injector of funds in research and development--indeed, the major injector of funds--and was about ensuring that Australia had a leg-up in the new technology field, that we actually got into the sunrise industries and really made a contribution to the future of energy trends and use. "

"It has in its short time developed a very good reputation, a good name in the industry and research institutions, and it was helping to create a lot of jobs, not just jobs directly in the specific research areas but, as processes and procedures came on stream and as products were developed, further jobs down the line. As an Australian it was very good to see the Australian stamp on much of this marketed technology. "

With a modest Federal outlay of about $12.5 million a year, and a small dedicated professional staff, ERDC supported projects that were mainly funded by industry with the strong prospect of saving energy. The scope of its later projects was wide ranging. One was improved control of electric motors with big power savings, and applications including a sawmill in Tumbarumba, Queensland Rail's Brisbane-Rockhampton electric tilt train that started running in 1998, and exports to Hong Kong's Mass Transit Railway. Solar heating and

solar power cell development was supported along with energy efficient housing. So also was the use of methane gas drained from NSW coal mines to run bulk haulage trucks, and compressed natural gas to run quieter cleaner garbage trucks for Waverley Council. Another ERDC project (Weekend Australian 17-18 May, 1997 p42) was to make drink vending machines more power efficient with a saving each year for each new machine of $350. The electricity saved meant less carbon dioxide emissions to the greenhouse and less air pollution in our cities.

In short, ERDC actively supported measures to save energy, increase Australia's international competitiveness and to reduce greenhouse gas emissions. There is a clear need for Australia to improve its performance in these areas.

The 1996 State of the Environment Australia report noted that Australia's average energy consumption per head (at 16.2 gigajoules per head in 1993-94) had increased in recent years, and, is a little higher than the OECD average. In a warm country, we should be using below the OECD average. This report also notes that Australia has a high fuel use per capita which is some 20 per cent higher than the OECD urban average, and the relatively poor average fuel efficiency of our car fleet.

Australia also has the highest road freight activity per capita in the world, and road transport uses much more fuel than rail or sea for a given long distance or bulk freight task. Clearly, there is ongoing need for improvement in energy efficiency, and we cannot be 'relaxed and comfortable' about market forces delivering, on their own, the necessary gains.

6. In place of ERDC, other arrangements were made, including an increased reliance on State Governments and private sector, along with Universities working with reduced resources, to advance essential energy research of national significance.

In one sense, the Australian Greenhouse Office (AGO) became the Federal Government's lead agency in energy efficiency. However, issues of energy efficiency and conservation appear to have been subordinated to suggestions that somehow Australia is meeting its agreed Kyoto targets for greenhouse gas emissions.

APPENDIX D Rail CRC Project 24 – Rail Transport Energy Efficiency and Sustainability

Sources of data re energy use in transport operations in Australia include the Australian Bureau of Statistics (ABS), the Bureau of Transport and Regional Economics (BTRE), the Apelbaum Consulting Group (ACG), the Australasian Railway Association (ARA-Australian Rail Industry Report 2004) and this writer. A common theme is that rail transport is more energy efficient than road transport.

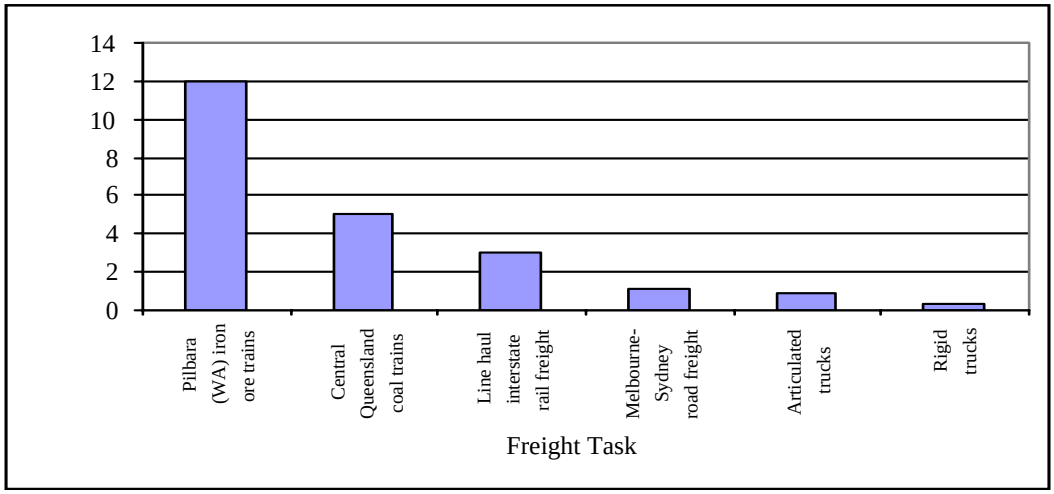
Rail freight In Australia, fuel use per tonne for BHP Iron Ore operations has decreased by 43 per cent between 1980 and 2000 to about 0.75 litres per tonne of iron ore (Darby, 2001 *Technology for profit*, Proceedings 7th International Heavy Haul Conference). This gives a world record energy efficiency of at least 12 net tonne per Megajoule (net tkm/MJ) on a Full Fuel Cycle (FFC) basis where 1 litre of diesel is equivalent to 41.77 MJ.

Queensland Rail (QR) and former government rail systems had an average FFC energy efficiency in rail freight of 2.98 net tkm/MJ in 1997-98 (ACG). This includes the use of electric power for QR where 1 KWh is equivalent to 12 MJ on a FFC basis giving Central Queensland

coal trains an energy efficiency of at least 5 net tkm/MJ. CRC project 24 data for 2001-02 suggests an average for non iron ore freight trains of 3.3 net tkm/MJ.

By 2002, US Class I railroads had gained an average energy efficiency of 3.7 net tkm/MJ (primary energy). The Canadian Pacific Railway 2004 Annual Report publishes data implying an impressive energy efficiency of 4 net tkm/MJ (FFC). There are problems in gaining accurate and up to date land transport data within Australia.

Driving techniques, equipment, train mass, terrain and track alignment all influence rail fuel consumption. With 4000 HP locomotives, upgraded wagons, and incentives for drivers to save fuel, Melbourne - Sydney - Brisbane standard superfreighter average energy efficiency now appears about 2.7 net tkm/MJ on the existing track. Computer simulation from an earlier project for the Rail Infrastructure Corporation has shown that for the entire Sydney - Melbourne track, a major track upgrade (with three major deviations outlined in the ARTC Track Audit and the 2002 ATRF paper cited below) would increase rail freight energy efficiency by 12 per cent. Further Rail CRC work in this area is now underway by the Project for these and other rail deviation sites within NSW and Queensland.



Rail passengers Rail CRC project 24 aggregate data from individual Australian rail passenger operators is given in Table 1. Based on 2001-02 ARA/ ACG FFC estimates, passenger rail had an average energy efficiency of 0.65 passenger (pax) km per Megajoule (MJ) as compared with 0.36 pax km per MJ for passenger road vehicles, 0.71 pax km per MJ for buses and 0.40 pax km per MJ for domestic airlines.

TABLE D 1 RAIL PASSENGER ENERGY EFFICIENCIES
Passenger km per MJ (Full fuel cycle)

	Light Rail	Urban Rail	Non-Urban Rail
2000-01	0.60	0.69	1.09
2001-02	0.60	0.68	1.13
2002-03	0.61	0.64	0.99
2003-04		0.67	

APPENDIX E LITERATURE SURVEY RE ENERGY USE IN AUSTRALIAN LAND TRANSPORT (to 2003)

1 INTRODUCTION

The subject of fuel use in transport operations in Australia has received limited attention from a number of writers over the last 25 years. This includes the Australian Transport Advisory Council (1979), Bureau of Transport (and Communications/Regional) Economics (BTE - 1980, 1981, 1991, 1996, 1999), Railways of Australia (1980), Gentle (1983), Senate Standing Committees (on Industry Science and Technology - 1990 and Environment, Communications, Information Technology and the Arts - 2000), Laird (1990, 1995, 1996, 1998, 2003), the Industry Commission (1991a, 1991b), Laird and Adorni-Braccesi (1993), Moon (1994), Bureau of Industry Economics (1996), Australian Bureau of Statistics (1997), the Australian Bureau of Agricultural and Resource Economics (ABARE - 2001), and, the Apelbaum Consulting Group (ACG-1991, 1993, 1997, 2001). Overseas interest in Australian transport energy use includes that of the International Energy Agency (2001).

A common theme of much of this work, when touching on freight transport, is that sea and rail transport are generally more energy efficient than road transport. More attention has been given to freight than passenger transport in the above references. Further discussion on land freight is given in Section 2 of this report.

More recent publications on energy use in transport include Affleck (2002) and Laird (2003). In addition, attention has been given to the related topic of greenhouse gas emissions transport, including the BTE (1991, 1996, 2002, 2003) and the Australian Greenhouse Office (AGO -see www.greenhouse.gov.au). In addition, the AGO has introduced a 'Greenhouse Challenge' which has received support from sections of the road freight industry, and Queensland Rail (Ramsden and Mack, 2003) which reports a reduction in greenhouse gases in QR rail freight operations of 4.8 per cent per gross tonne -km between 2000-01 and 2001-02.

In regards to passenger transport, we note from earlier data (see for example, Institution of Engineers, Australia (1999*)* or Back on Track, Appendix B); based on 1997-98 ACG estimates, urban rail had an average energy efficiency of 0.68 passenger (pax) km per Megajoule (MJ) as compared with 0.35 pax km per MJ for urban passenger road vehicles, and 0.63 pax km per MJ for urban buses. Non-urban rail had an average energy efficiency of 0.86 pax km per Megajoule (MJ) as compared with 0.45 pax km per MJ for non-urban passenger vehicles, 0.34 pax km per MJ for domestic airlines, and 1.06 pax km per MJ for non-urban buses (ACG, 2001).

The data on the public record shows that each mode of passenger transport has generally shown increasing energy efficiency over time with the exception during the period from 1994-95 to 1997-98. This was attributed by ACG (2001, page 16) in the case of light rail due to a decline in passenger loadings. Passenger trains with good load factors would have a higher energy efficiency than buses.

It is necessary to note increasing problems in gaining accurate and up to date transport data within Australia. Here, the Australian Bureau of Statistics (ABS) has had problems with its both road and rail data in the late 1990s (Laird et al, 2001).

Other Government agencies analysing land transport data have either effectively been abolished (the Inter-State Commission 1990, the Bureau of Industry Economics in 1996, and

the Energy Research and Development Corporation in 1997) or, been down sized (Bureau of Transport Economics and Universities in 1996). A Steering Committee on National Performance Monitoring produced valuable data in the 1990s, but this too was disbanded. Rail privatisation has also made it more difficult to obtain rail transport data in Australia, in part due to the disappearance of Annual Reports. Even such basic annual outputs as freight tasks measured in tonne kilometres have all but disappeared over the last few years. Fuel use data has also become more elusive.

The situation in Australia is in contrast with larger private rail freight operations in both the United States and Canada. Each year, the Association of American Railroads (AAR) publishes the freight tasks of each Class I railroad, and their aggregate fuel use. US Class I railroads by 2001 had gained an average energy efficiency of 3.72 net tkm/MJ (primary energy). North American railroad companies also release useful data.

By way of example, the Canadian Pacific Railway 2002 Annual Report gives no fewer than 12 performance indicators, that note or imply a 207.81 billion tonne gross km (btkm) freight task, a 173 net btkm freight task, and fuel use of 260 million US gallons (or 983 million litres) giving an impressive energy efficiency of 4.2 net km/MJ.

From recent Annual Report data, the Tokaido Shinkansen operated by JR Central has an energy efficiency exceeding 2 pax km per MJ.

2 RAIL FREIGHT

An analysis of energy use - either diesel or electricity - for each Government rail system has shown increased energy efficiency in rail freight from 1990-91 to 1994-95 (Laird, 1998) with Queensland Rail and Westrail as the better performers at nearly 3.0 net tonne km per MJ by 1994-95. The data in Appendix A also shows that "Government" (excluding the iron ore railways) rail freight transport in Australia has shown increasing energy efficiency to 1997-98 at 2.98 net tkm/MJ.

The total diesel use for all government rail freight operations in 1994-95 was some 420 million litres (Laird, 1998) and the total use for private rail was 103.7 million litres (ABARE, 1997, pers. comm.). As noted by ACG (1997), Australian railways used 40.6 PJ of energy in 1994 -95 for their growing freight and mixed passenger tasks and this was less than the 42.1 PJ used in 1990-91. The 1997-98 primary energy use by rail was 44.1 PJ (ACG, 2001).

Energy efficiency in rail freight, like road freight, depends on driving techniques. For rail, these can be assisted by computers (see, for example, Howlett and Pudney, 1995).

2.1 Bulk rail haulage

The average energy efficiency of BHP iron ore trains in the Pilbara was noted as about 10 net tonne km per MJ in 1991 (Laird and Adorni-Braccesi, 1993) and is understood to have since attained 12 net tonne per MJ. As noted by Darby (2001), fuel use per tonne for BHP Iron Ore operations has decreased by 43 per cent between 1980 and 2000. This was assisted by heavier axle loads using well built and maintained track with heavy rails, top class maintenance of locos and wagons, and increasing use of aerodynamically designed wagons and new

generation locomotives with AC traction motors. Their standard train consists of four locos and 224 wagons with two locos in the middle. On average, it takes just under one litre of diesel to move one tonne of iron ore 426 km and bring the empty wagons back. Although gravity helps the loaded ore trains, its contribution is relatively small.

Queensland Rail is understood during the mid 1990s to have achieved an energy efficiency of about 5 net tonne km per MJ (of primary energy) with use of its 25 000 volt AC electric locomotives in its Central Queensland coal train operations

2.2 Interstate rail freight - existing track

Citations of actual energy efficiency on Australian mainline interstate freight operations are few and far between. The Industry Commission (1991a, Vol II, p.62) noted that Sydney - Melbourne line haul rail freight energy efficiency in the late 1980s was between 1.5 and 2 net tkm/MJ, whilst trains moved freight between Sydney and Adelaide with an energy efficiency of nearly 3 net tkm/MJ. Sydney - Melbourne line haul rail freight energy efficiency in the early 1990s was noted (Laird and Adorni-Braccesi, 1993) at about 2.0 net tkm per MJ for superfreighters using 81 class 3000HP locomotives.

The Bureau of Industry Economics (BIE -1995, p97) gives a discussion on fuel use by freight trains, noting inter alia, a variation from just over 3 litres per thousand gross tonne km (L/000 gtk)"... *for 4000 tonne freight trains hauled by modern locomotives, to over 10 L/000 gtk (for trains crossing the Great Divide"* (eg. Sydney Melbourne). A similar ratio was noted by Railways of Australia (1980). Fuel use in freight train operations in Australia was also examined by Quarterman (BTE, 1981) who, like the BIE (1995), noted energy efficiency increasing with train mass.

However, whereas the BIE (1995, p97) noted that *"...Terrain is the major physical influence on fuel consumption"*, Quarterman (BTE, 1981, p xii) found that *"... The disparity between the efficiencies of different parts of the railway system suggests that there is also considerable potential for lifting the maximum attainable efficiency of some railways by improvements to grading and alignment ..."*.

With their new 4000 HP locomotives, upgraded wagons, and incentives for drivers to save fuel, National Rail were able to obtain significant fuel savings. By 1998, overall National Rail fuel use had been reduced to the range of 4.0 to 4.15 litres per 000 gtkm (Ernst and Young, 1998 ver 2, p 29). A September 2001 brochure issued by National Rail to note the advent of a profit in 2001-01 **stated an average fuel use of 4.0 litres per 000 gtkm for 1999-00-01 as against 7.4 litres per 000 gtkm for 1992-93-94.**

It is understood that the east - west operations (where 1800 metre trains with double stacked containers are possible between Adelaide and Perth) had a target fuel use of 3.5 litres per 000 gtkm as against 4.5 litres per 000 gtkm for north-south train operations The ARTC in its 2000 Annual Report noted (p 6) 26.60 gross btkm and 12.35 net btkm over its network in 1999-2000. This gives a ratio of 2.15. At 4.5 litres per 000 gtkm and 38.6 MJ per litre, with this gross to net tonnes ratio, *an average energy efficiency of 2.68 net tkm/MJ results*.

To assist a Mathematics in Industry Study Group project (Benjamin and Laird, 2001) National Rail advised that one NR locomotive hauling a 1280 tonne maximum trailing load over the *existing* Dynon - Acacia Ridge track (1912 km) would be expected to use *at least*

11,500 litres of diesel. This gives an energy efficiency of 2.84 ntkm/MJ and is an upper limit for freight trains operations on the existing corridor.

On the basis of the above information, Melbourne - Sydney - Brisbane **standard superfreighter average energy efficiency appears to be about 2.7 ntkm/MJ on the existing track.** This is a 35 per cent increase on the above cited 2.0 net tkm/MJ. However, as per trucks, there can be appreciable variations from the average.

In comparing the energy use of intercity land freight using rail or road line haul, it is necessary to include in rail line haul an allowance for road pick up and delivery. One assumption (Laird et al 2002) of this energy use is 77 MJ (about 2 litres) per tonne in pick up and delivery. It should be noted that road line haul using B-Doubles may also require road pick up and delivery using smaller trucks.

In a recent study, Affleck (2002) noted intermodal fuel use by NR locomotives ranging between 0.003 and 0.005 litres per gtkm (ie 3 and 5 litres per 000 gtkm), whilst corridor specific fuel use per ntk and gtk was confidential.

2.3 Interstate rail freight - upgraded track

The Australian Rail Track Corporation (ARTC) National Track Audit reviewed the Australian Transport Council's speed weight targets, examined minimum market improvements (the S1 scenario), significant track improvements (the S2 "stretch" target scenario), and after economic analysis, recommended optimised investment of $507 million with a combined benefit cost ratio of 3.2. The Track Audit also outlined three major deviations (Wentworth, Centennial and Hoare) on the Sydney Melbourne track with a combined length of new construction at about 195 km.

Computer simulation for an ARC - RIC project (Laird et al, 2002) showed that the running time for a standard superfreighter with 2600 tonnes trailing load hauled by two 4000 HP locomotives moving over the existing 940 km Dynon - Chullora track was nearly 12 hours, but that the same train moving over an upgraded route would take about 10 hours. Moreover, the fuel used for this freight task would reduce from about 13, 200 litres on the existing track to some 11,900 litres on the upgraded track, a saving of about 10 per cent. The data shows that for the entire Sydney - Melbourne track, the fuel saving due to the major track upgrade is 12 per cent. This is due to a 6.3 per cent reduction in point to point distance, and a 6 per cent reduction in fuel use per 000 gtkm. The rail deviation offering the largest fuel saving (and time saving) is for the Yass - Cootamundra section with a fuel saving of 32 per cent. This is due to a 20 per cent reduction in point to point distance, and a 15 per cent reduction in fuel use per 000 gtkm.

Improved and straightened track with its easier ruling grades would also allow a heavier load behind each locomotive, with further fuel savings, plus appreciably lower train transit times. This would improve the competitiveness of intermodal land freight, giving further fuel savings.

It is suggested that superfreighter average energy efficiency could be taken at 3.0 ntkm/MJ on fully upgraded track, with 2.7 ntkm/MJ on existing track, 2.8 ntkm/MJ on track upgraded to S1 standards and 2.9 ntkm/MJ on track upgraded to S2 standards.

Innovations in use, or tried in the Pilbara iron ore railways, but yet to be introduced for interstate rail freight operations, include the use of AC traction diesel electric locomotives,

aerodynamically designed wagons, and electronically applied braking. The uptake, over time, of such technology will improve the energy efficiency of rail freight operations. The use of modern high voltage electrification, with regenerative braking, has the capacity to give even higher energy efficiency. A Canadian study (Environment Canada, 2000) found that from 1975 to 1990, the fuel consumption rate per gross ton mile was declining at 1.9 per cent per annum and suggested that it would decline at about 1 per cent per annum to 2005.

3 ROAD FREIGHT

The fuel efficiency of articulated trucks has improved during the 1990s. In 1990-91, the ABS SMVU indicated all articulated trucks used 1997 million litres (ML) of diesel for a 62.9 billion net tkm (btkm) freight task. Thus, the average energy efficiency (at one litre = 38.6 MJ) was 0.82 ntkm/MJ. By 1998-99, the aggregate freight task for articulated trucks had risen to 99.1 btkm, using 2709 ML of diesel, giving an average fuel efficiency of 0.95 ntkm/MJ (end use energy). *This is a 16 per cent increase in the average energy efficiency of all articulated trucks.*

Increases in heavy truck energy efficiency have followed from upgraded roads, improvements in truck technology (including on board truck monitors recording fuel use, braking applications and speed), and the relaxation of mass and dimension limits for heavy trucks. These included raising the GVM of six axle articulated trucks from 38 to 42.5 tonnes by 1988, with some of these heavier trucks showing impressive energy efficiencies. By way of example, ABS 1991 SMVU data showed 47 per cent of six axle articulated trucks with a gross vehicle mass of 41 tonnes or more used fuel at a rate of less than 50 litres per 100 km (Laird and Adorni-Braccesi, 1993, p179) when the average fuel use in 1991 for all six axle articulated trucks was 51.7 litres per 100km, and six - axle articulated trucks in the 1991 SMVU showed a wide range of fuel use in litres per 100 km that did not always relate to Gross Vehicle Mass. More recently Truck and Bus (July 1998) noted one such truck hauling a 27 tonne payload of orange juice with a back load of general freight with a fuel use at 2.18 km per litre: assuming say a 70 per cent back load (by weight) gives an energy efficiency of nearly 1.30 net tonne km per MJ (net tkm/MJ).

Road freight fuel use depends very much on the way a truck is driven, with an older reference (Victoria Department of Minerals and Energy, 1981) giving data showing a 25% increase in speed (from 80 to 100 km per hour) resulted in a 44% increase in fuel usage.

The wider use of B-Double and road trains has also increased overall road freight energy efficiency, and it is of note that ABS (1996) SMVU data shows the freight tasks of these classes of vehicles as 9.1 and 14.9 btkm respectively. However, for the 12 months ended 30 Oct 2000 (ABS, 2001), the B-Double freight task had shown strong growth to 22.1 btkm, road trains had grown to 18.3 btkm, whilst the six axle articulated truck freight task had fallen to 50.4 btkm.

3.1 Road Line Haul Energy Efficiency

The energy efficiency of good line haul articulated truck operations is higher than the above cited averages. This is mainly due to relatively less haulage in congested urban areas, and the larger scope to use B - Doubles on most interstate operations, with the potential to use Road Trains on some corridors such as Adelaide - Perth.

After retaining a company to consult several truck operators for vehicle performance, the ARC-RIC project (Laird et al, 2002) assumed an average of 1.15 net tkm/MJ for current line haul truck operations. With better roads, better trucks and more use of B -Doubles and road trains, offset by more road congestion, an improvement to say 1.25 net tkm/MJ by 2010 could be expected. Like rail, it would be reasonable to assume an annual average increase in energy efficiency of 1 per cent per annum between 2000 and 2020. The BTRE (2002, p 129 and 131) suggests articulated trucks are likely to increase their average loads between 1995 and 2020 by 1.64 per cent per annum (from 17.6 to 26.6 tonnes, with fuel use in litres per truck km remaining constant.

Affleck (2002) notes, after industry consultation, truck fuel consumption rates for six axle articulated trucks, 9 axle B - Doubles, and 11 axle road trains hauling steel and general freight as respectively 0.0224, 0.0173 and 0.0092 litres per net tkm. At 38.6 MJ (end use) per litre of diesel, this gives respective energy efficiencies of 1.16, 1.60 and 2.82 net tkm/MJ. This report also discusses the findings of a European study, and notes for eight Australian corridors on a two way basis, that carbon dioxide emissions for intermodal freight vary from 10 grams to 17 grams of carbon dioxide per ntk; whilst six axle articulated truck emissions range from 31 to 39 grams per ntk and B-Double emissions are between 24 to 30 grams per ntk. Overall, intermodal transport was found to produce 31 to 54 per cent of the emissions of six axle articulated trucks, and 41 to 70 per cent of the emissions of B-Doubles.

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REFERENCES

Affleck Consulting (2002) *Comparison of Greenhouse Gas Emissions by Australian Intermodal Rail and Road Transport* (see qr.com.au via track access publications)

Apelbaum Consulting Group Pty Ltd (ACG)
- (1991) *Primary Energy Consumed by Australian Transport - the 1987/88 Review*
- (1993) *The Australian Transport Task and the Primary Energy Consumed; The 1990-91 Compendium* (Commonwealth Dept of Primary Industries and Energy: Canberra)
- (1997) *The Australian Transport Task , Primary Energy Consumed; and Greenhouse Gas Emissions* (DPIE, Canberra)
- (2001) *Australian Transport Facts 1998* (with DPIE, Canberra)

Association of American Railroads (2002) *Railroad Facts* 2002 Edition, Washington

Australasian Railway Association (2001, 2002)

Australian Bureau of Agricultural and Resource Economics (2001) *Australian Energy: Projections to 2019-2020*

Australian Bureau of Statistics
- (1996) *Survey of Motor Vehicle Usage for 1995*, preliminary
- (1997) *Australian Transport and the Environment* Cat. No 9 4605.0
- (2001) *Survey of Motor Vehicle Usage for 12 months ended 31 Oct 2000*

Australian Rail Track Corporation - (2000) Annual Report (p3)
- (2001) National Track Audit

Australian Transport Advisory Council (1979) *Transport and Energy Use*

Association of American Railroads (2002) *Railroad Facts.*

Benjamin B and Laird P (2001), *Comparison of AC and DC locomotives,* Proceedings of the 2000 Mathematics in Industry Study Group, Edited by J Hewitt, p 133-147

Bureau of Industry Economics (1995) *International Performance Indicators - Rail Freight 1995* Canberra: AGPS

Bureau of Transport (and Communications/Regional) Economics
- (1980) *Consumption of transport energy in Australia 1975-76*
- (1981) *Freight Transport Energy Consumption*
- (1991) *Greenhouse Gas Emissions in Australian Transport*
- (1996) *Transport and Greenhouse: Costs and options for reducing emissions*
- (1999) *Competitive neutrality between road and rail*, Working Paper No 40
- (2002) *Greenhouse policy options for transport*
- (2003) *Greenhouse emissions from transport - Australian trends to 2020* Report 107,

Darby (2001) *Technology for profit,* Proceedings 7th International Heavy Haul Conference
Ernst and Young, (1998) *Benchmarking review of operating costs for National Rail*

Environment Canada (2000) *Locomotive Emissions Monitoring Programme 1998*

Gentle, N F (1983) *Energy Use - Transport,* Energy 83 Conference, The Institution of Engineers, Australia, National Conference Publication No 83/2.

Howlett P G and Pudney P J (1995) *Energy -efficient train control,* Springer, London

Industry Commission
- (1991a) Rail Transport Inquiry, Final Report
- (1991b) Costs and Benefits of Reducing Greenhouse Gas Emissions, Final Report

Institution of Engineers, Australia (1999*) Sustainable Transport: Responding to the Challenges*

International Energy Agency (2001) *Saving oil and reducing CO2 emissions in transport*, OECD, Paris

Laird, PG
- (1990) The potential for liquid fuel savings in Australian land freight transport, *Greenhouse and Energy*, edited by D. Swaine, p 304-314, CSIRO Australia
- (1995) Increasing Energy Efficiency in Australian Land Freight Transport, *Transport Engineering in Australia* , Institution of Engineers, Australia, Vol 1, No 1, p15-26.
- (1996) *Intercity land freight transport in Eastern Australia,* Working Paper, Centre for Resource and Environmental Studies, Australian National University
- (1998) Rail freight efficiency and competitiveness in Australia, *Transport Reviews*, Taylor and Francis, London, Vol 18, No 3, p241 - 256
- (2003) *Australian transport and greenhouse gas reduction targets,* Australasian Transport Research Forum,

Laird, PG and Adorni-Braccesi, GA (1993) *Land Freight Transport Energy Evaluation*, Main Report - Part One Energy Research and Development Corporation, Canberra

Laird, PG Michell, M and Adorni-Braccesi, GA (2002) Sydney–Canberra–Melbourne High Speed Train Options, Australasian Transport Research Forum, Canberra, Papers, Volume 25

Laird, PG Newman, PWE Bachels, M and Kenworthy, J (2001) *Back on Track: Rethinking transport policy in Australia and New Zealand* UNSW Press, Sydney

Laird, PG and Newman, PWE (2003 book chapter) *Back on Track? Will Australia return to rail?* World Transport Policy and Practice, Earthscan Press, England, pages 99 -104

Moon, B (1994) Transport energy in Australia, *Energy Policy,* Vol 22, p331-344

Railways of Australia (1980) *Saving liquid fuels during a national emergency by diversion of freight from road to rail transport.*

Ramsden T and Mack A (2003) *Queensland Rail cuts greenhouse gas emissions*, International Railway Journal, April 2003, p 23 - 24.

Senate Standing Committee on Industry, Science and Technology (1990) *Rescue the future - reducing the impact of the Greenhouse effect* Canberra: AGPS

Senate Environment, Communications, Information Technology and the Arts Reference Committee (2000) *The Heat is on: Australia's Greenhouse Future*

Steering Committee on National Performance Monitoring, Melbourne, (1995 through to 1997) *Government Trading Enterprises Performance Indicators 1989-90 to …to 1995-96.*

Victoria Department of Minerals and Energy (1981) *Saving Road Transport Fuels*