Deloitte Access Economics

The true value of rail

The Australasian Railway Association

3 June 2011

Deloitte.

Deloitte Access Economics Pty Ltd
ACN: 149 633 116

Level 1, 9 Sydney Ave
Barton ACT 2600
PO Box 6334
Kingston ACT 2604

Tel: +61 2 6175 2000
Fax: +61 2 6175 2001
www.deloitte.com.au

Bryan Nye
Chief Executive Officer
Australasian Railway Association

Suite 4, Level 4
Plaza Offices (East)
Canberra Airport Terminal Complex
ACT 2609

3 June 2011

Dear Bryan

The true value of rail

I am pleased to attach our report examining the true value of rail in Australia. The analysis identifies and quantifies, where possible, the benefits from rail transport that are not captured in prices and which accrue to the community at large. The level and type of investments needed to help rail achieve its potential are also considered and compared to the benefits that could flow from increased rail use.

We hope this report will add to the policy debate around where and how to invest in Australia's transport infrastructure.

Yours sincerely,

Ric Simes
Partner
Deloitte Access Economics

General use restriction

This advice is prepared for the use of the Australasian Railway Association. The advice is not intended to and should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. The advice has been prepared for the purpose of estimating the externalities associated with rail travel. You should not refer to or use our name or the advice for any other purpose.

Contents

Charts

Tables

Figures

Glossary

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ACF	Australian Conservation Foundation
ACG	Applebaum Consulting Group
ARA	Australasian Railway Association
ARTC	Australian Rail Track Corporation
ATC	Australian Transport Council
ATSB	Australian Transport Safety Bureau
BITRE	Bureau of Infrastructure, Transport and Regional Economics
BTE	Bureau of Transport Economics
BTRE	Bureau of Transport and Regional Economics
CNG	Compressed natural gas
COAG	Council of Australian Governments
CPI	Consumer price index
CPRS	Carbon pollution reduction scheme
CRAI	Charles River Associates International
CRC	Cooperative Research Centre
CRRP	COAG Road Reform Plan
DFAT	Department of Foreign Affairs and Trade
DRET	Department of Resources, Energy and Tourism
FIRS	Federal Interstate Registration Scheme
IPART	Independent Pricing and Regulatory Tribunal
ITLS	Institute of Transport and Logistics Studies
NSW	New South Wales
NTC	National Transport Commission
OECD	Organisation for Economic Cooperation and Development
PWC	PricewaterhouseCoopers
QR	Queensland Rail
RIS	Regulatory Impact Statement
RTA	Roads and Traffic Authority

SPC	Sydney Ports Corporation
TRESIS	Transport and Environmental Strategy Impact Simulator
USA	United States of America
VFT	Very fast train
VSL	Value of statistical life

Executive Summary

Understanding the true value of rail in Australia requires that the benefits from rail transport which are not captured in prices and which accrue to the community at large are identified and quantified. In this report some of these social, environment and economic impacts of rail transport are identified and quantified.

The analysis indicates that, for passenger journeys, every trip made on rail rather than road can reduce costs to society by between $3 and $8.50, depending on the city. For freight the savings are estimated to be around 95 cents for every tonne kilometre (this translates to around $150 for a normal container transported between Melbourne and Brisbane).

These estimates are based on congestion, accident and carbon emission costs and so benefits from social inclusion, reduced infrastructure maintenance costs and fuel security could also be added.

The situation today

Australia's approach to the planning of cities, land use and transport has changed dramatically over the last half century as a result of population growth. Our major cities have expanded and their centres have grown denser. Demand for passenger and freight transport services have steadily grown, both within and between urban centres. The pressure on transport infrastructure is set to progressively intensify over the coming years as Australia's population increases to a forecast 30.5 million by 2030 (ABS 2008). In this environment, decisions must be made about how much and where to invest in transport infrastructure. These decisions must be informed by the true value of rail or the wrong investments will be made.

Historically, much of the increased demand for transport services has been met by road. For example, the share of interstate, non-bulk freight met by road transport has risen from around 22% in 1970 to around 70% today, while that met by rail has fallen from around 45% to under 30% over the same period (BTE 1999 and Port Jackson Partners 2005). Similar trends can be observed in passenger services within cities.

Indeed, Australia is now the most intensive user of road freight in the world[1] and has the least energy efficient road passenger transport among members of the International Energy Association (DFAT 2008 and Prime Minister's task group on energy efficiency 2010).

These trends cannot continue if our freight systems are to be managed efficiently and our passenger networks are to not be overburdened by congestion as populations grow.

In order to meet the land transport challenges confronting the nation, a suite of complementary measures will be needed; involving:

[1] When measured on a tonne-kilometre per person basis.

- effectively integrating investment in transport infrastructure in all metropolitan strategies;
- reforming pricing to encourage efficient choices between different transport modes; and
- taking a long-term view of the benefits that accrue from investment in core transport infrastructure.

Policy-makers have been engaged in developing elements in each of these three areas for action but progress has been slow. Congestion, carbon emissions and inefficiencies in supply chains have continued to worsen. A greater sense of urgency is required.

As is evident from international experience, an increased use of rail will be vital to meeting these challenges as the population, and population densities, increase. Rail provides many benefits over road transport which are not incorporated into costs and prices. These benefits include:

- improved land use and urban densification;
- lower carbon emissions;
- reduced congestion;
- fewer accidents;
- removing barriers to social inclusion;
- improving land values; and
- enhanced energy security.

Rail is already price competitive with road in some areas of the transport network, particularly freight, and would become more competitive with improved infrastructure and/or suitable pricing signals. These benefits should grow as the population increases and rail infrastructure can be more fully utilised allowing the infrastructure costs to be spread between more users.

Benefits of rail

A key part of ensuring correct investment decisions are made is to recognise the true value of rail. This report provides evidence on the level of the benefits not captured in prices or costs that arise from shifting passengers or freight from road to rail. The benefits identified are:

- Passenger transport:
  - Road travel produces more than 40% more carbon pollution than rail travel per passenger kilometre.
  - Road transport generates almost eight times the amount of accident costs as rail transport does.
  - In the longer term, high speed rail provides the potential to alleviate pressures that will emerge to move people between major cities and along east coast corridors as Australia’s population grows.
- Urban passenger transport:
  - An additional commuter journey by rail reduces congestion costs alone by between around $2 and $7.

    - For every passenger journey made on rail rather than road in Australia's four largest cities, between $3 and $8.50 can be saved in congestion, safety and carbon emission costs.
    - In Sydney, for example, if rail absorbed 30% of the forecast increase in urban travel then congestion, safety and carbon emission costs could be reduced by around $1 billion a year by 2025.
- Interstate freight transport:
    - Heavy vehicle road freight users do not face the full maintenance costs that they cause. Under-recovery of these costs has been estimated at between $7,000 and $10,500 per truck each year (Productivity Commission 2006 and NTC 2006). The National Transport Commission (NTC) has recommended changes which seek to address this issue.
    - Freight moved between Melbourne and Brisbane by rail instead of road reduces carbon costs by around $56 per container and reduces accident costs by around $92 per container.
    - Along the North-South freight corridor, for example, if rail was to achieve a 40% share of the market then savings, in terms of carbon pollution and accidents, would currently be around $300m a year or $630m a year by 2030.
- Freight transport within urban centres:
    - Along with the use of the mass transit of people, a greater use of rail for freight within, especially, Sydney and Melbourne will be needed to alleviate the increasing congestion on road networks. Environmental and safety benefits would also accrue.
    - The NSW and Victorian Governments have recognised the need to develop more effective rail freight services within their cities and have set targets accordingly. These goals aim to ease congestion on arterial roads and improve use of existing rail infrastructure and port land.

These costs have tangible effects on the lives of all Australian's and the economy. Congestion eats away at leisure time and reduces economic productivity as workers and goods take longer to reach their destination and cost more to transport. Carbon pollution creates social costs to be borne by future generations who will face the duel costs of a changed climate and the need to reduce emissions. In addition to deaths caused by vehicle accidents, injuries create ongoing effects in terms of pain, reduced ability to work and the need for care.

Investing in infrastructure

The costs in terms of congestion, carbon emissions and safety that have been outlined above will increase in coming years. Increases in congestion costs are set to outpace the increase in either the size of the economy, the size of our cities or the size of our population. Policy makers are, therefore, faced with difficult decisions. Investment which recognises the value of rail could lead to significant benefits for Australia but these investments are large and can be administratively difficult.

For example, to meet the needs of this growing population, there is a choice between investing in mass transit now or building road or rail networks through already developed urban areas in the future. The high cost of retro-fitting road networks is already reflected in Sydney's M4 East expansion, which is expected to amount to more than $500 million per km (NRMA 2011). In contrast, Brisbane is looking to invest in Cross River Rail to prepare for a denser population.

There are currently some key bottlenecks holding back the efficient use of rail in Australia. Freight movements between Melbourne and Brisbane are constrained by congestion in northern Sydney. The North Sydney Freight Corridor would go a long way to addressing this issue. Fixing this key point of infrastructure is estimated to cost around $4.4 billion today. A number of other projects on this route such as modern intermodal facilities in Sydney and Melbourne and many minor adjustments to the track might also be needed.

These investments are costly but will help drive a modal shift towards rail freight which creates benefits from reduced carbon pollution and accidents. If rail was to achieve a 40% market share then by 2030 the savings from accidents and carbon pollution could be worth well over $600 million a year.

The key choke point for freight is intimately linked with Sydney's metropolitan network. The metropolitan network is currently constrained by capacity through the city. Expanding capacity in the city, through the Western Express project, would currently cost around $4.5 billion. Again, there are large savings in carbon pollution, accident and congestion costs which work to offset the initial infrastructure investment. If a congestion charge and carbon tax were introduced, this could result in around 150 million extra rail journeys a year. All these extra passengers would reduce carbon pollution, congestion and accident costs on the roads by around $1.2 billion a year.

Projects to relieve current bottlenecks should be put through a rigorous cost benefit analysis before being committed to and the full benefits of rail should be included in this analysis.

The policy challenge

Rail has a central role to play in meeting this transport challenge; it can provide mass transport and links across cities, reducing congestion, accidents and pollution. It can also play a key role in transporting freight efficiently between and through population centres. Rail, therefore, should be a focus of policymakers when considering how best to support and accommodate future transport and economic growth.

Investment in rail should be made through a mix of public, private and public-private partnership (PPP) funding. No matter which method of funding is used investment should be made in a coordinated manner with reference to longer term transportation goals and incorporating the full costs of different modes of transport.

The most prominent involvement of State governments has been in metropolitan rail. State governments, through their metropolitan plans, therefore have an essential role to play in ensuring investments in rail infrastructure are made which keep pace with their growing cities and capture the full range of benefits that rail offers (including social inclusion, reduced congestion, reduced road accidents and reduced pollution). Rail will play a key role under any reasonable transport plan.

In addition to making investments in rail, state governments can also focus on addressing existing inefficiencies in the pricing of road transport. First through ensuring that heavy freight vehicles cover the costs they impose and then by moving towards mass-distance pricing.

The Australian Government, by being less focused on the operation and maintenance of rail networks themselves, can take on a coordination and leadership role as well as their central funding role. Leadership can be made through continued investigation of new rail developments and planning strategies which place an emphasis on rail.

In terms of funding, ideally, the benefits of rail (such as reducing congestion, carbon emissions and accidents) would be directly internalised using policy options such as carbon pricing, congestion charges and accurate vehicle registration fees. This is a long term goal, however, and, in the shorter term, a second best approach is for the Australian Government to take into account the full benefits of rail when considering which investments to support.

Funding from the Australian Government is also important in overcoming myopic investments. Given the past pattern of transport investment in Australia it is often the case that an incremental investment in road seems more appealing than an investment in rail. Following along this path will only lock Australia in more closely with road transport and will miss the opportunities presented by making use rail transport.

A series of bold and innovative policy options should be considered. Over the very short term, the CRRP process should be strongly pursued and supported with a goal of more closely tying truck operating costs to the actual costs they create.

In the medium term, allocating some of the funds from a carbon tax to the development of public transport networks could present a particularly appealing policy.

In the longer term, introducing congestion charging in Australia's capital cities and levying a per tonne charge on road freight transport within cities should be seen as overall policy goals.

Effective action along these lines would result in very large gains to the national economy. Indeed, the potential gains would result in improvements in national productivity of a scale that would compare favourably with some of the major microeconomic reforms delivered over the past few decades.

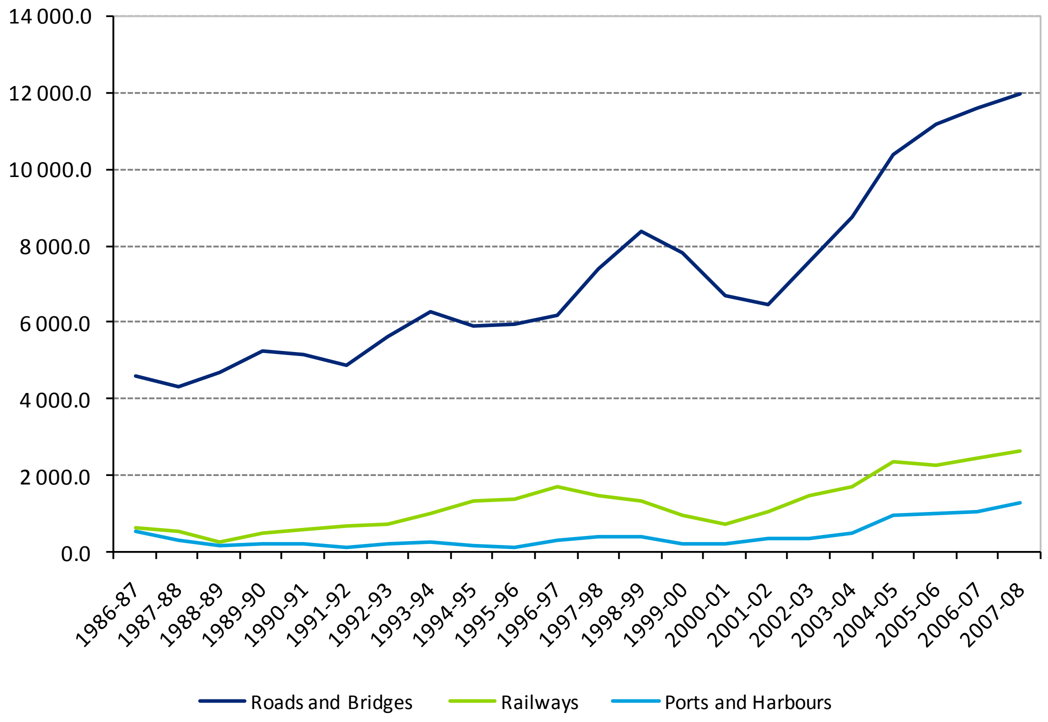
Deloitte Access Economics

1 The policy setting

> The increasing demand for transport associated with the expansion of our major cities has been predominantly met by building roads. Governments have played a key role in guiding these investment choices. With a movement towards integrated planning of transport investments across modes and jurisdictions supported by a number of key policy documents, there is an opportunity for a fresh approach to investment planning.
>
> To make appropriate policy decisions, decision makers must take into account all the costs for each different transport mode.

Australia's approach to the planning of cities, land use and transport has changed dramatically over the last half century as a result of population growth. Our major cities have expanded, leading to greater demand for the transport of both passengers and freight, within and between cities. The expansion of our cities reflects a change in land use, from a relatively dense hub-and-spoke configuration, to a low density suburban sprawl, supported by an expanding road network (BTRE 2007). Over the last few decades, this increasing transport need has typically been met by investment in roads, with little relative investment in rail (see Chart 1.1 below).

Chart 1.1: Value of major transport infrastructure engineering construction, $ million



Source: BTRE (2009c)

Government policy plays a significant role in guiding investment choices in Australia's transport infrastructure. Looking ahead, it will continue to play a coordinating role for infrastructure development because, while many transport operators are private entities or government corporations, the planning of cities and major infrastructure investments remain, largely, the purview of government, as does control of transport's regulatory environment.

A program of microeconomic reform in the 1990s, as part of the National Competition Policy Review, led to changes in the operating environment of the transport industry. For example, restructuring occurred in the rail industry, where below and above rail infrastructure was vertically separated and a number of rail access regimes were created (Everett 2006). It is arguable that in the decades since, however, reform and investment in infrastructure have stagnated. That attention is now shifting back, with freight and transport policy both firmly in the spotlight (BCA 2009).

In the freight sector, government policy towards freight transport has recently shifted towards an integrated planning model, in contrast to the previous parallel planning model where transport modes were planned separately and state and territory regulations did not align. The Australian Government and the Council of Australian Governments (COAG)'s reform agenda has been a driving force behind this shift. Several steps have already been taken towards an approach to transport policy that is integrated across jurisdictions and across modes, some recent highlights include:

- The release of a draft National Land Freight Strategy (Infrastructure Australia 2011)
- The National Ports Strategy (Infrastructure Australia 2010a)
- The Road Reform Plan (ATC 2009)
- A report commissioned by the National Transport Commission (NTC) looking at the development of an inter-modal supply chain (Booz & Company 2009)
- A Regulatory Impact Statement (RIS) recommending the implementation of a national framework for the regulation, registration and licensing of heavy vehicles (Department of Infrastructure, Transport, Regional Development and Local Government 2009)
- A RIS recommending the creation of a national safety investigator across all transport modes (NTC 2009)
- Dedicated transport infrastructure spending, with the creation of Building Australian Fund and the Nation Building Program, both under the jurisdiction of Infrastructure Australia

The role of rail freight within Australia's cities has also been recognised with, for example, renewed efforts for the integration of rail into the Port of Melbourne and Port Botany and planning for investments into intermodal terminals.

Similarly, there has been increased attention on urban transport planning at both a Federal and State level. Recent examples include:

- Initial Federal movement into urban infrastructure planning, with the development of a Major Cities Unit within Infrastructure Australia.
- A Discussion Paper looking at Sydney's Metropolitan Strategy for 2036 (NSW Planning 2009)

- A call for submissions regarding Sydney's proposed M5 corridor expansion (RTA 2009a)
- The Victorian Transport Plan (Department of Transport 2008)
- A draft Integrated Transport Plan for South East Queensland (Department of Transport and Main Roads 2010)
- An Infrastructure Plan and Program for South East Queensland (Department of Infrastructure and Planning 2010)
- A research report into 'Population growth, jobs growth and commuting flows in Perth' (BITRE 2010b).

Australia's population is forecast to increase to 30.5 million by 2030 (ABS 2008). As such, both the population and freight task are likewise forecast to continue growing in the decades to come. The policy shift towards an integrated planning model bodes well for the task ahead, as it has been found that multiple regulatory systems are inherently unstable (BTRE 2006). A more populous Australia will inevitably further change the landscape of our cities and infrastructure requirements. This will require significant investment in transport infrastructure for the efficient movement of more people and more goods. A focus on improving Australia's transport infrastructure is integral to continuing to build on the productivity gains that began with economic reform and competition policy in earlier decades (BCA 2009). Efficient transport is a key input to the production of goods and services in Australia and, as such, designing the right transport policy for both freight and passengers is integral to achieving future productivity growth. Without addressing efficiency and capacity constraints, there will be significant negative implications for the national economy (IPA and PWC 2009).

This begs the question; how best to grow as a nation? To sufficiently answer this question, it is important to understand the full implications of different investment choices. The question then becomes what is the best approach to the provision of funding of infrastructure, services and pricing to ensure that the most efficient modal mix is achieved.

Policy architecture that lends itself to the efficient development of the transport sector must ensure that stakeholders take into account all the costs for each different transport mode. Hence, one important consideration for transport planning decisions is an appreciation of the externalities associated with each mode. It is not the only consideration, but a failure to include it in the decision making process will likely lead to an outcome with a distortionary effect.

This report seeks to outline the potential advantages of investment in rail and its potential to best meet the challenges of a growing population and freight task. Issues affecting the policy decision making process are discussed further in this report. Background is given in Section 2, the current state of road and rail in Australia, including their economic characteristics, is discussed in Section 3, transportation costs are addressed in Section 4 and other considerations are discussed in Section 6. Finally, implications for public policy are addressed in Section 7.

2 Transport background

> Rail is well suited to meeting the needs of Australia's future population growth whether this be as mass transit in Australia's increasingly large and dense cities, interstate passenger transport or freight transport (both within and between cities).
>
> Rail presents benefits of enabling increased density, reducing congestion and accidents, being less fossil fuel dependent and negating the need for investment in airport and road expansions.
>
> Rail has been held back by historical underinvestment, especially when compared to other modes of transport, which has led to an unnecessary reputation of poor performance. With sufficient infrastructure rail could significantly increase its share of the transport task.

As Australia's population grows over the coming decades, the potential value of rail will likewise grow. A more populous country is better able to tap into the efficiencies and benefits of rail, as its advantages lie in mass transportation, whether that be of people or of goods.

For the transport of passengers, rail has particular advantages at an intra-city, or metro, level. Australia has, for a long time, had a highly urbanised population and a growing population is likely to result in larger, denser cities. Investment in passenger rail networks offers one way of addressing how Australia's cities will be organised.

The ability of our major cities' footprints to expand is limited by geographic barriers to what are already sprawling suburbs. As a result, cities accommodating larger populations will inevitably become denser. This increased density and increased numbers of people make investment in rail an attractive option. Rail is able to move people in mass, resulting in a more efficient use of capital and transport corridors, and a reduction in congestion. Other notable benefits accrue from increased safety, partly as a result of reduced congestion. Environmental benefits are also derived from the economies of scale achieved through the mass transit of people and because rail is a less fossil fuel-dependent mode of transport than road.

Rail also potentially offers advantages for the transport of passengers at an inter-city level. In addition to the population growth of major cities, regional centres are also growing and sizeable population corridors are beginning to take shape. This trend is particularly strong along the East coast of Australia between Sydney and Brisbane, but is also becoming apparent to the South of Perth and around Melbourne.

With sufficient population density and with more nodes along potential routes in the future, the option of a very fast train (VFT) for passenger transport along the east coast of Australia may be increasingly attractive. The BITRE reports that, as a general rule, a viable high speed train line should connect cities with over one million residents that are at around three hours apart, and requires 6 to 12 million passengers a year (BITRE 2010c). In a similar manner to intra-city metro services, inter-city rail has potential advantages for addressing congestion and environmental issues.

The most important transport mode in this space is currently air. However, in the future, a reliance on air transport among a larger population may lead to congestion problems at airports. Air travel also has higher negative environmental costs than both rail and road (BITRE 2010), as well as fuel security concerns, both of which may reduce its relative appeal over time. Research in this area asserts that an east coast high speed rail corridor achieving speeds of 350km/h could compete with air travel (IPA and AECOM 2010).

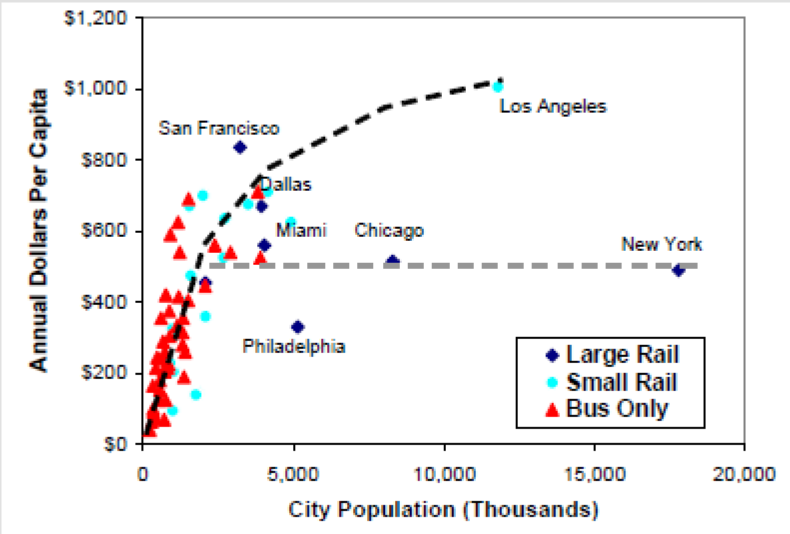
Case study: Rail passenger transport in America

Those American cities with 'large rail' systems are found to receive economic, social and environmental benefits from their public transport system relative to cities with 'small rail' or a 'bus only' public transport system.

A large, well-established rail public transport system is found to significantly increase per capita public transport use through two mechanisms. First, with access to rail transportation, more people choose to commute by public transport rather than by car (also called 'discretionary riders'), reducing total vehicle mileage. Secondly, people change their car ownership patterns, thereby reducing levels of car ownership.

Through a higher per capita use of public transport, these large rail systems are found to achieve expected benefits, relative to comparably sized 'small rail' and 'bus only' cities. These include less traffic congestion and lower traffic death rates, as well as lower consumer expenditure on transport and higher public transport service cost recovery. Chart Box.1 below shows that American cities with large rail transport systems have far lower congestion costs than cities of comparable size with a small rail or bus only transport system.

Chart Box.1: Estimated congestion cost in American cities



Source: Litman (201)

New York, Boston, San Francisco and Chicago are examples of American cities with successful established rail transport systems. However, Portland has a relatively new rail system and has achieved similar outcomes in neighbourhoods with access to rail transport, such as increasing public transport patronage and a reduction of private car use. This suggests that new rail systems can affect transport and land use patterns at a fast enough rate to be considered worthwhile investments.

Source: Litman (2010)

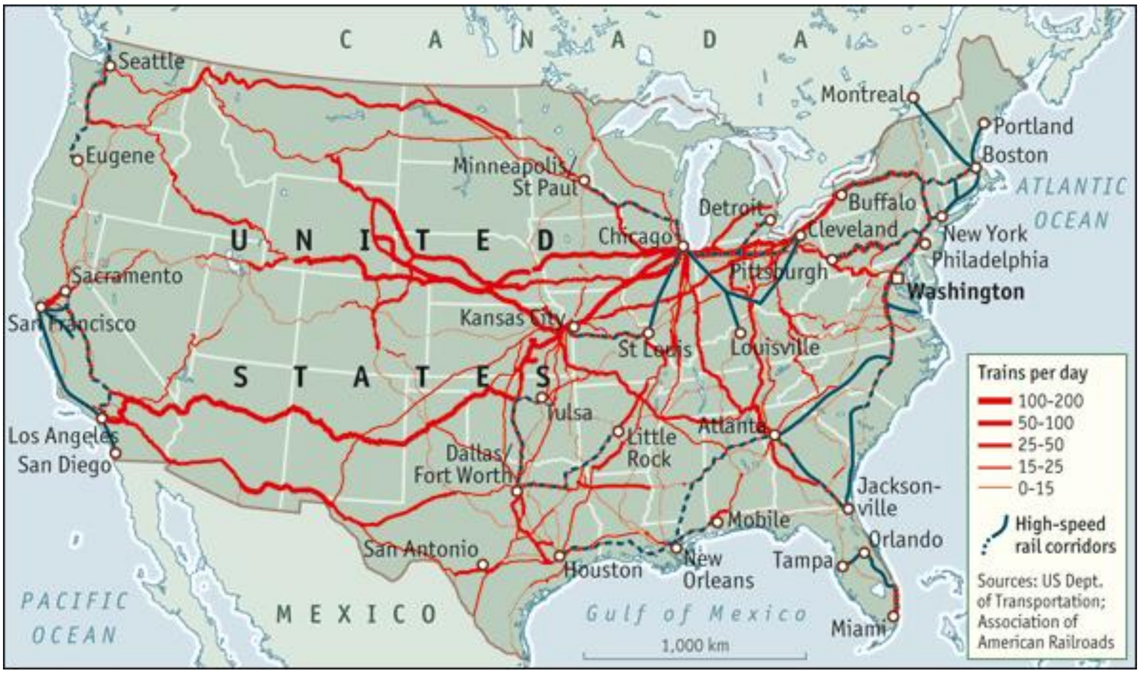
By 2020, Australia's freight task is forecast to double in size (PWC and IPA 2009). Like for the movement of passengers, rail has advantages for the movement of large quantities of goods. Rail has a particular advantage over very long distances moving from point to point where economies of scale can be achieved (BITRE 2009d) but can also play a key role over shorter distances, particularly within cities where rail offers ways to manage congestion and staffing concerns. For example, rail already performs very well in the movement of freight between the West and East coasts of Australia. As Australia's population grows and the freight task between major population centres also grows, rail may be the most efficient transport mode for the movement of goods between cities. Like in the case of metro passenger transport, it offers benefits in terms of congestion, safety, health and environmental costs.

It is arguable that historical under-investment in capital along rail corridors in east coast hubs and along the North-South corridor between Melbourne and Brisbane has affected line haul performance and limited the demand for rail services along these tracks. With increased capital investment, it is estimated that rail could increase its modal share. Some estimates place the potential for rail share to be between 30 and 40% for freight movements between Melbourne and Sydney, and up to 80% for freight movements between Melbourne and Brisbane (Booz & Co 2009).

The US, particularly along the West coast with the Alameda Corridor and in the mid-West, provides a best practice example for the use of rail for the movement of freight. Figure 2.1 shows the main rail corridors in the US and the average daily patronage of each route. Long-distance routes along East-West corridors receive the highest number of trains per day, while the populous West coast supports high-speed rail corridors.

An OECD (2006) study finds that the US has a fairly balanced modal share for freight, with rail taking on the highest share at 39%, followed by road at 31% and pipelines/inland navigation/short-sea shipping at between 7 and 8%. This is relative to both Europe and Japan, where rail does not hold a significant modal share and road and short-sea shipping dominate. In Japan 41% of the freight task is undertaken by short-sea shipping and 55% by road. In the EU-15 countries 44% is done by road and 39% by short-sea shipping. Given its geographic similarities and similar requirement to navigate a federal system, this bodes well for the potential of rail to take on a similar role for the movement of freight in Australia.

Figure 2.1: Freight Rail Movements in the United States of America



Source: The Economist (2010)

Moving forward, rail may also play a greater role in connecting regional and metro areas to Australia's major ports. Rail already facilitates the transport of many bulk commodities to Australia's ports for export. Furthermore, several significant Australian ports have flagged a goal to improve rail's modal share of their respective port trades, particularly in containerised exports (Sydney Ports Corporation 2008; Port of Melbourne Corporation 2009a; Port of Hastings Corporation 2009). An increase in rail's modal share of this task would aim to relieve road congestion, improve port land use and improve linkages with the interstate rail freight network (BITRE 2009d). Booz & Co (2009) predict that in the absence of landside logistics reform to better favour rail, an additional 1.3 million truck trips will occur each year adding to the congestion problems for ports.

A better understanding of the potential benefits of rail is important when considering Australia's future transport infrastructure planning. The development of rail infrastructure in the certain areas of the transport network where its benefits are clearest has the potential to efficiently and productively meet Australia's growing passenger and freight transport tasks.

3 The state of transport in Australia

The potential role for rail in Australia should be compared to its current state. There are extensive road and rail networks both within and between Australia's major cities. There is, however, a clear difference in outcomes. The share of interstate non-bulk freight met by road transportation has risen from around 22% in 1970 to around 70% today, while the share met by rail has fallen from around 45% to under 30% over the same period (BTE 1999 and Port Jackson Partners 2005). In an environment where the total transport task has been growing, rail, although showing recent gains, has been largely confined to areas such as the transport of bulk minerals, very long freight hauls and for mass transit in Australia's largest cities.

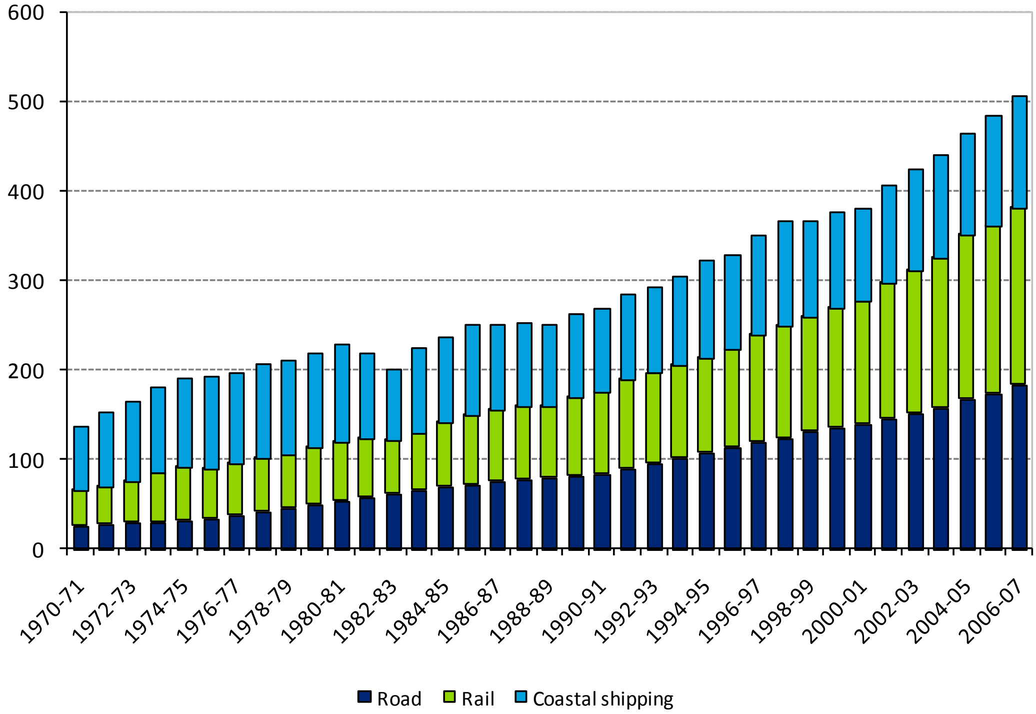
Part of the explanation for this outcome is the different infrastructure investments made in both networks. Historical trends have shown greater investment by government in road than rail infrastructure. Given the economics of infrastructure networks, such as the increasing returns to scale due to network effects and high fixed costs, these past supply decisions have driven current demand outcomes.

3.1 Road in Australia

Transport in Australia is highly reliant on its road network, which is vast. In 2007 Australia had a total 815,074 kms of roads (BITRE 2009c). Australia is the most intensive user of road freight in the world on a tonne-kilometre per person basis (DFAT 2008) while a survey of members of the international energy association has also shown that Australia has the least energy efficient road passenger transport and one of the lowest levels of new passenger vehicle fuel efficiency (Prime Minister's task group on energy efficiency 2010).

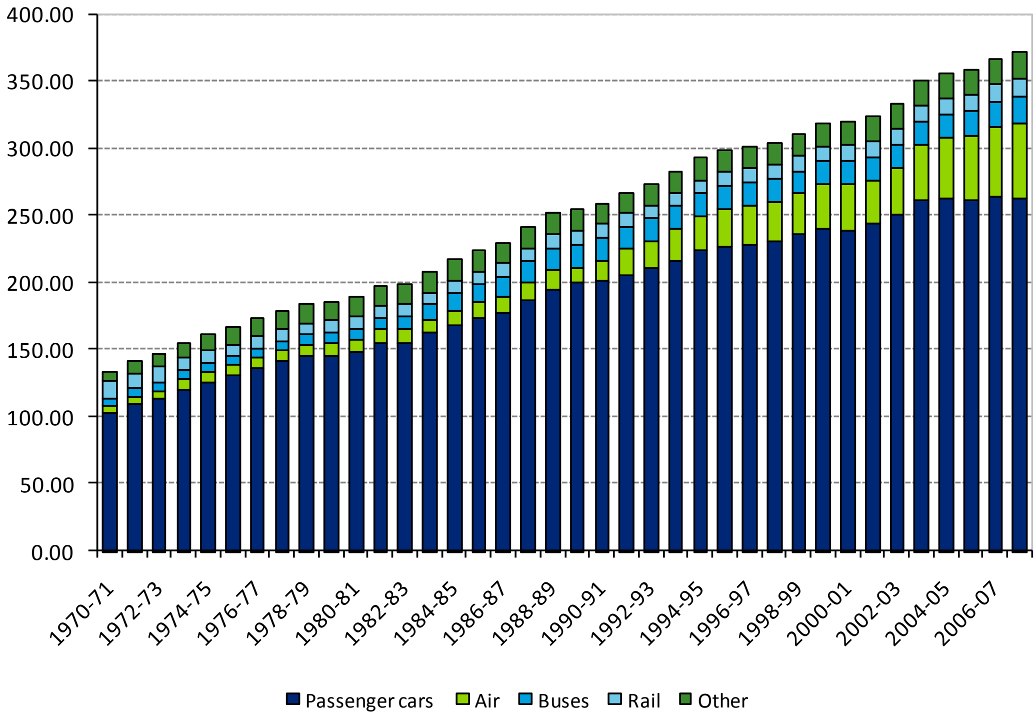
Australia's reliance on its road network has been increasing over recent decades; both for the movement of passengers and of freight (see Chart 3.1 and Chart 3.2). In terms of the freight task, in 1970-71 road moved 19% of goods, measured in tonne-kms and by 2006-07 this had increased to 36%. Total passenger-kms travelled by passenger cars increased by 256% over the same timeframe; however passenger cars' share of total passenger travel did not increase. The steady role of passenger road travel, as a proportion of total passenger travel, is due to the rise of air passenger travel, which has increased its passenger kms almost ten-fold over this time and is the only transport mode to have increased its share of passenger travel from 1970-71 to 2006-07.

Chart 3.1: Total domestic freight task by transport mode, billion tonne-kms



Source: BITRE (2009c)

Chart 3.2: Total passenger travel by transport mode, billion passenger-kms



Source: BITRE (2009c)

Most road infrastructure in Australia is provided by government, with all three levels of government contributing in different ways. State, territory and local governments have ownership and control over Australia's road networks, with the former responsible for major roads and the latter responsible for smaller local roads. The Australian government is responsible for funding of the interstate highway network (formerly known as Auslink), shown in Figure 3.1. The Australian government also has some influence over the governance of roads, through its distribution of funding and through its role in negotiating COAG reforms.

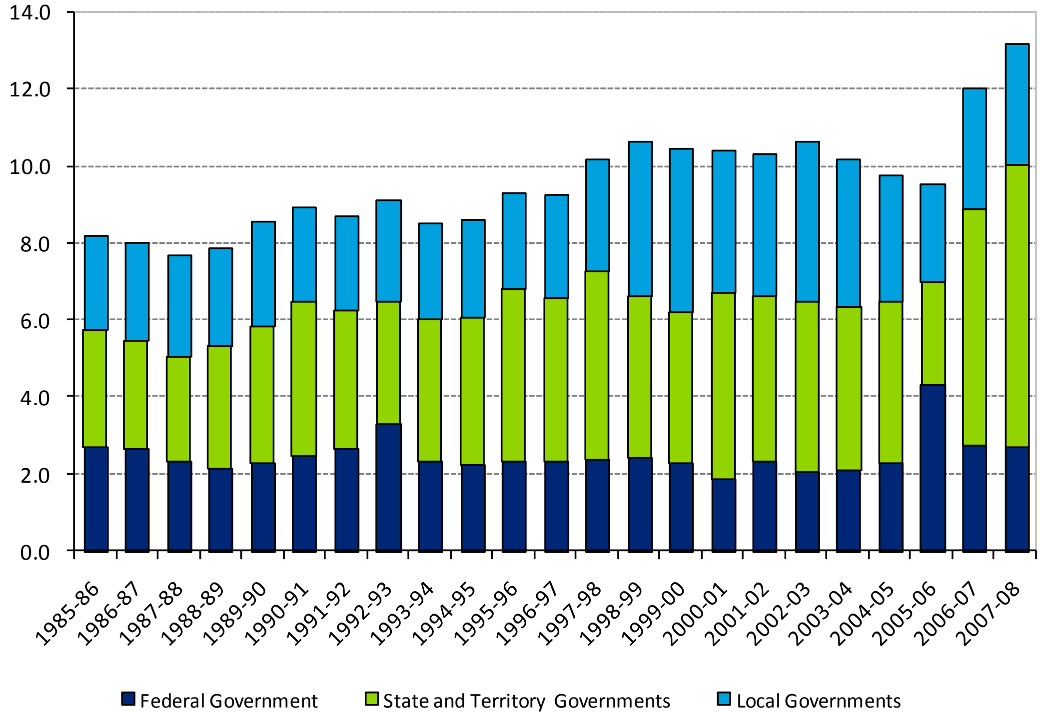
At a state and territory level, each jurisdiction's respective transport department is responsible for distributing funding for roads, registration and licensing of vehicles, managing road networks and for transport safety. Local councils are responsible for managing local roads.

Figure 3.1: Auslink national road network

Source: BITRE (2009c)

Generally speaking, state and territory government make the largest funding contributions to Australian roads, followed by local governments and the Australian government, respectively (see Chart 3.3). A limited proportion of road infrastructure is also provided by private sector transfers. Private sector transfers refer to roads that are constructed by the private sector and are then transferred to local government, for example, roads in new housing developments (BITRE 2009d). According to the BITRE's most recent figures, road related expenditure by all levels of Australian governments totalled \$13.9 billion in 2007-08, including transfers from the private sector.

Chart 3.3: Road-related expenditure by jurisdiction, $billion (2006-07 prices)



Source: BITRE (2009c)

However, since 2008 the Australian Government has taken on a greater role in the funding of roads. Major new programs for funding road infrastructure by the Australian government include:

- The Nation Building Program, which distributes Australian Government funding for roads. Funding under this program will average of $4.6 billion per year between 2008-09 and 2013-14. This is a significant increase in funding compared to the previous total federal spending level of $2.7 million in 2007-08 (BITRE 2009d).
- The Building Australia Fund contributes to critical infrastructure projects, including road projects. Funding is distributed based on an Infrastructure Priority List (Department of Infrastructure and Transport 2010a).
- The Roads to Recovery program contributes federal funding to local councils and to state and territory government for local roads in unincorporated areas. $1.75 billion will be distributed between 2009-10 and 2013-14 (Department of Infrastructure and Transport 2010b).
- The Black Spots Program provides funding to high-risk road locations around Australia. It will provide $59.5 million per year until 2013-14.

The pricing of road use is generally managed by state and territory governments. For passenger road transport, the price of road use consists of a vehicle registration fee, a license fee and toll charges for the use of privately constructed roadways. In the first two cases, these are fixed cost compulsory fees where vehicle registration is an annual charge and the term of vehicle licenses varies. Toll charges are marginal costs to road users, but are discretionary to the extent that they can be avoided.

For freight road transport, road use prices consist of charges to heavy vehicles, which in turn include a diesel fuel excise and heavy vehicle registration fees. The diesel fuel excise is a marginal cost for heavy vehicle users and varies with the amount of fuel consumed and, therefore, with distance travelled. It is charged at 38.14 cents per litre. However, most heavy vehicles (those over 4.5 tonnes) are eligible for a fuel tax credit if they meet a minimum one of four environmental criteria under the *Fuel Tax Act 2006.* Heavy vehicles meeting this condition receive a fuel tax credit of 18.51 cents per litre, leaving a net diesel fuel excise of 19.63 cents per litre (Productivity Commission 2006).

The interstate registration of heavy vehicles is called the Federal Interstate Registration Scheme (FIRS) and provides national registration for heavy vehicles over 4.5 tonnes operating solely in interstate transport. The National Transport Commission (NTC) recommends the level of interstate heavy vehicle registration charges. These recommendations are then taken into account by the Australian Transport Council (ATC), an element of COAG, when it forms its decisions. Over the past few years there has been a tendency for the ATC to not implement recommendations from the NTC, this was noted in a 2009 review of the NTC which found that its "impact on transport outcomes has fallen short of what should be expected" (NTC Review Steering Committee 2009). The relevant State and Territory transport authorities administer these charges on behalf of the Australian government. Each jurisdiction also administers registration of heavy vehicles that are registered to that State or Territory. Both systems, individual State and Territory, and FIRS, have registration fees that vary by vehicle type.

There has been debate in Australia recently about whether road freight has been subsidised relative to rail. In 2006 the Productivity Commission released a report into *Road and Rail Freight Infrastructure Pricing* which found that there was no compelling case that heavy vehicles are subsidised relative to rail, there was some indication that there may be cross-subsidisation within vehicle classes (Productivity Commission 2006). The conclusions of this report should be tempered by the persistent data problems identified by the Productivity commission. At various points in the report the lack of data for both road and rail infrastructure is highlighted as a problem which restricted the commission's ability to fully analyse the issues:

- "A lack of reliable data in relation to some issues has affected both the emphasis and approach [to the terms of reference]."
- "Data on the expenditure within each jurisdiction that is attributable to heavy vehicles is needed to test this claim [of under-compensation to local government], but these data are not available."
- "Data on State and Territory rail expenditure do not identify expenditure on capital works or new assets, nor are they comparable across jurisdictions due to significant differences in accounting policies."
- "there is considerable uncertainty about the accuracy of the road capital stock data"

In addition, advocates of rail have argued that because heavy vehicle road user charges have been capped at CPI since 2002, and steep increases in road infrastructure investment have been made over this time, that road freight operators have been subsidised (CRC for Rail Innovation 2009). The outcome of this debate is, as yet, unclear.

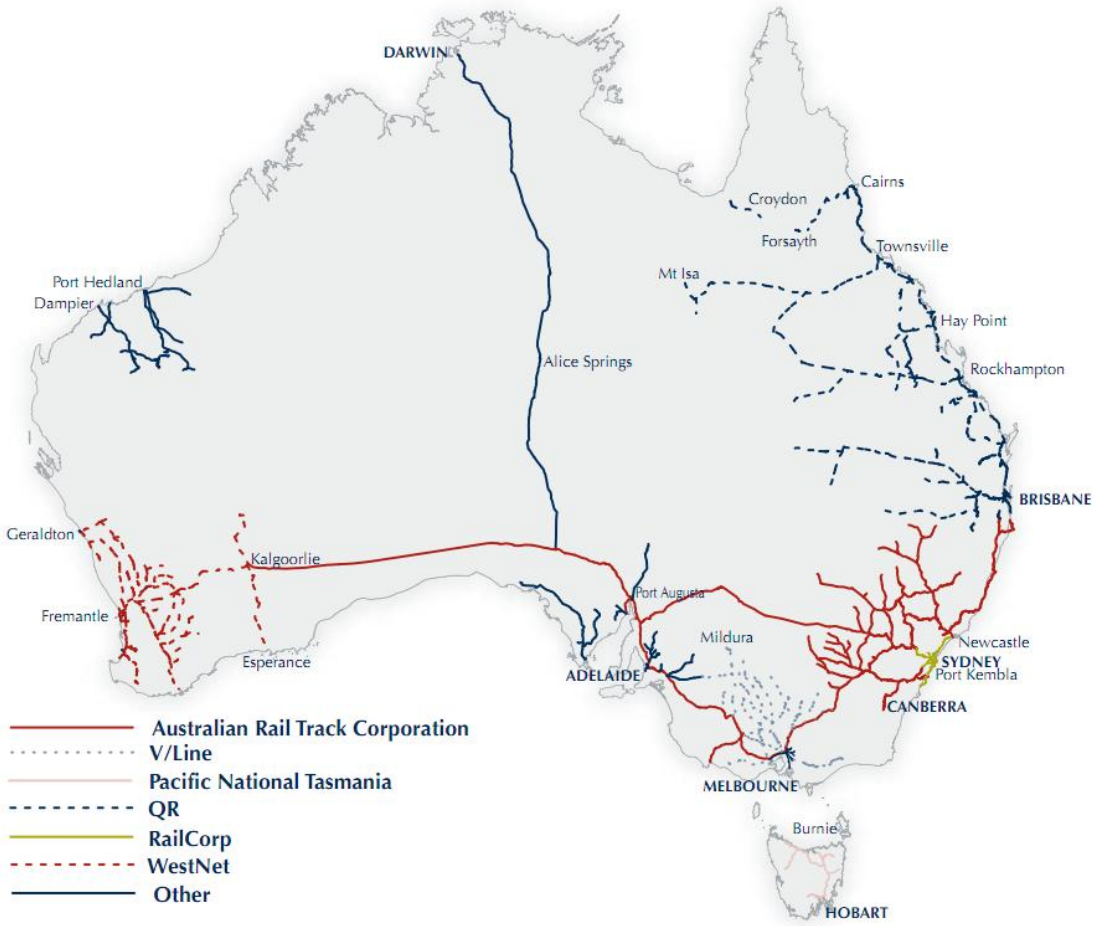
Following on from the Productivity Commission report, over the past few years COAG has been proceeding along its road reform plan. The COAG road reform plan (CRRP) has focussed on the finding that prices for larger road vehicles were highly averaged and did not always reflect the distance travelled, vehicle mass and the maintenance costs of different road types. This is a somewhat narrow target for reform and CRRP has explicitly stated that it does not intend to include social costs such as congestion, air pollution, greenhouse gas emissions and accidents in the pricing reform process (CRRP 2010).

COAG is therefore interested in implementing a pricing structure which more closely reflects mass, distance and location. One likely element of this would be to increase registration charges for larger heavy vehicles making long journeys (such as road trains or b-doubles) when compared to smaller heavy vehicles making shorter journeys. These changes are currently expected to be implemented no earlier than 2014. This variety of externality, cross subsidisation between road users, is further investigated later in this report.

3.2 Rail in Australia

Australia has an extensive, complex, rail network covering the major capital cities. Australia's rail infrastructure can broadly be broken down into interstate railways, intrastate railways and metropolitan passenger networks, some of the major links are shown in Figure 3.2 below.

Figure 3.2: Major rail links in Australia



Source: BITRE 2009c

Interstate railways join Perth to Adelaide; Adelaide to Melbourne, Sydney and Darwin and Sydney, Melbourne and Brisbane along the east coast. These interstate connections, all standard gauge, carry passengers and freight.

Within states there are many different types of rail infrastructure including:

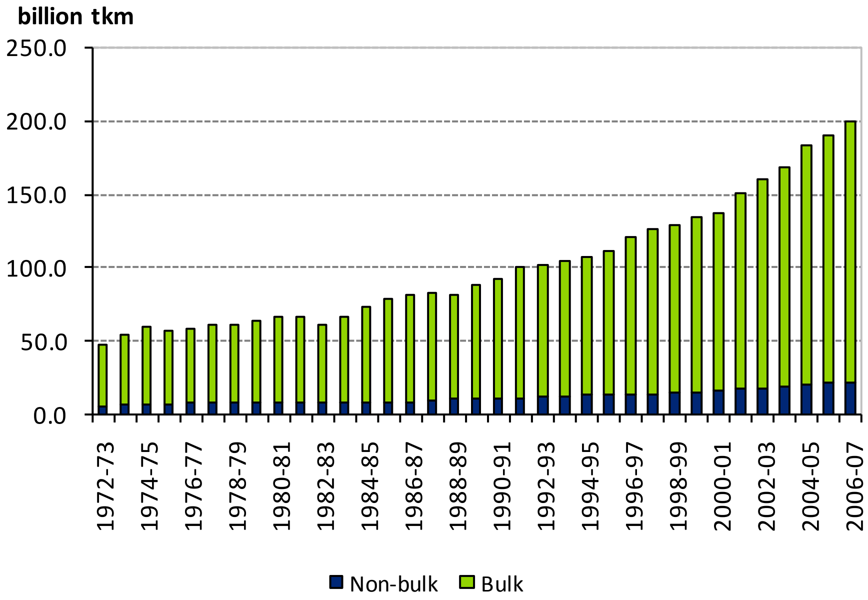
- networks such as the Goonyella system in Queensland or the Hunter Valley Coal network in NSW which primarily connect mines to the port;
- intercity rail networks such as that operated North of Brisbane by Queensland Rail (QR);
- regional freight networks, often used to transport grain; and
- private railways used to transport cane, timber and ore.

Looking to metropolitan passenger networks, there are electrified heavy rail networks in Sydney, Melbourne, Brisbane and Perth and a non-electrified network in Adelaide.

The volume of freight moved by rail, measured in billion tonne kilometres has been growing strongly over recent years from around 136.9 billion tonne kilometres in 2000-01 to around

198.7 billion tonne kilometres in 2006-07, accounting for around 39% of total freight transported in 2006-07. This is an average growth rate of around 5.8% a year. Bulk transport has been growing faster than non-bulk transport, around 5.9% a year for bulk freight compared to 5.5% a year for non-bulk freight. This compares to a growth rate in total road freight of around 4.5% a year over the same period and in costal shipping of around 3.1% a year (BITRE 2009c).

Chart 3.4: Estimated rail freight task



Source: BITRE 2009c, Access Economics calculations

Rail has not performed quite as well when measurements are made in millions of tonnes. Rail has grown at an average rate of 3.4% a year between 2003-04 and 2006-07 as compared to road's 8.4% a year average growth. By this measurement, rail transport makes up around 23% of the freight task. The better performance of rail when measured in tonne kilometres, rather than just kilometres, indicates that rail has performed well in long haul markets (BITRE 2009c).

As Chart 3.4 shows, bulk commodity transport currently makes up the majority of net tonne kilometres transported by rail. In 2006-07, the latest year for which there are comprehensive statistics available, bulk transport made up around 87% of freight net tonne kilometres transported by rail (BITRE 2009c, BITRE 2010a).The major bulk commodities transported by rail in terms of tonnage are iron ore and coal which together make up around 75% of net tonne kilometres of bulk goods transported by rail (ACG 2008). Bulk goods transported by rail are predominantly moved within, not between states (BITRE 2010a).

In terms of passenger transport, rail makes up a very small portion of passenger kilometres, around 3.8% in 2007-08 but has been growing at an average rate of around 3.8% a year since 2000-01, this is a faster growth rate than either road (1.1% a year) or bus transport (1.2% a year) since 2000-01 (BITRE 2009c).

In the past, many of the above rail networks were provided by government in an integrated fashion, having a single entity operate both the above rail services and below rail infrastructure. With the focus on microeconomic reform throughout the last few decades there has been a consistent trend towards corporatisation and structural separation.

Corporatisation involves the transformation of ownership structures to put greater emphasis on profitability and response to market signals rather than political factors. An example of corporatisation has been the transformation of Victorian Railways, originally chaired by government commissioners, into V/Line.

Structural separation involved splitting ownership of rail infrastructure from ownership of rail services. The most prominent example of this was the establishment of the Australian Rail Track Corporation (ARTC) which now controls the interstate rail infrastructure (through either ownership, leasing or having the right to sell access) in Western Australia, South Australia, Victoria and NSW. ARTC also operates the Hunter Valley network and will soon assume responsibility for the freight network within Sydney. ARTC then provides open access to rail operators, such as Great Southern Rail or Pacific National, to operate rail services. Access to rail infrastructure is normally covered by access arrangements overseen by competition regulators in order to prevent the infrastructure operator from misusing its monopoly position.

The structural separation of rail operators and infrastructure providers has also encouraged specialisation among rail operators. There are very few rail operators servicing multiple markets with specialisation clearly apparent between freight and passenger operators and even within these categories between luxury and budget passenger journeys and even somewhat between operators transporting intermodal and bulk freight.

This specialisation has highlighted areas where rail has a comparative advantage over other forms of transport. Rail has a clear cost advantage in high volume passenger markets, such as metropolitan areas, in transportation of bulk minerals and along longer hauls for freight. For example, rail is frequently used in transporting intermodal freight between Perth, Adelaide and Melbourne but is less frequently used to transport similar freight along the shorter routes between Melbourne, Sydney and Brisbane. This is mirrored in the transport of bulk grain where rail is generally preferred to road in Western Australia while road transport dominates in Victoria.

Corporatisation and structural separation have significantly reduced the direct role of government in the provision of rail infrastructure. A corporatised rail infrastructure provider, such as ARTC, must operate in a commercially viable manner and recover infrastructure costs from the users of its network.

Government’s role in the provision of rail services has therefore shifted from operational concerns to strategic concerns. Governments have taken on the role of long term planning and vision setting for rail, such as the NSW government’s goal of 40% of freight from Port Botany being transported by rail. Long term planning and strategy requires a focus by government on factors such as:

- planning zoning and city growth in a way which makes efficient use of transport options;
- securing rights-of-way for future rail developments;

- ensuring coordination in investments by different infrastructure providers; and
- managing the interaction of parties along rail supply chains.

Some of the areas where government still makes more direct interventions into rail including funding for large investments of national significance, overseen by Infrastructure Australia, and through competition policy. Competition policy is normally enforced by regulation which aims to ensure open access to rail infrastructure at fair prices, an example of this is the regulation of ARTC by the Australian Competition and Consumer Commission (ACCC).

There are also cases of ongoing subsidies from government, for example Sydney's metropolitan network received $1.9 billion in subsidies from the state government in 2007-08 (IPART 2008). A substantial portion of this, however, is used to subsidise concession fares such as seniors' concessions and student concessions (Transport NSW 2003). These subsidies may be justified in terms of the benefits generated by rail transport, which are analysed in section 4 of this report.

Overall, rail currently plays a specialised role in servicing Australia's transport task. It currently excels over long hauls, in the transport of bulk minerals and for mass passenger transport. Rail transport has been growing steadily and at a higher rate than other forms of transport over the past ten years. This strong growth may reflect benefits coming from more commercially focussed, corporatised organisations. The corporatisation of rail organisations in Australia presents an opportunity for government to focus on broader strategic goals of transport in Australia and to take into account the true value of rail when considering infrastructure investments.

3.3 Economic characteristics of road and rail transport and infrastructure

Turning from the state of transport as it currently stands in Australia and towards conceptual issues; there are a number of economic concepts which should be considered by decision makers when weighing up transport investments. Primary among these are network effects, economies of scale and supply led demand.

Transport networks

Road and rail infrastructure can both be thought of as networks which connect geographic locations. These networks connect the nodes of cities, homes and workplaces with the links of roads or railway track.

There is a balance between competition and complementarity of rail and road networks. In some cases the two networks are in direct competition with each other, an example is when a commuter deciding whether to drive to work or catch the train. Another area of direct competition is in the movement of grain and other minor mineral commodities to Port (BITRE 2009d).

However, even in cases where it appears as if the networks are in competition with each other, interstate transport for example, there is a degree of complementarity as containers moved between cities using rail must still be delivered to its final destination by road (BITRE 2009d). Even in metro areas road and rail can act as complements with bus transport and train transport providing redundancy and resilience to failure of a single mode of transport on critical routes (Munger 2008).

There are, of course, differences in the infrastructure for road and rail networks. One key difference is that the interdependence of technology between road and rail infrastructure and the vehicles that operate on them is quite different. For rail infrastructure, choices of gauge width, axle load and electrification have a significant influence on the types of locomotives and wagons run on track. The choice of above-rail technology in turn has an influence on the performance and availability of infrastructure, poorly maintained wheels, for example, can cause serious damage to rails. In contrast to rail, road infrastructure and vehicles are not so intimately linked.

Increasing returns to scale

Road and rail both show increasing returns to scale from network effects and from reduced average costs.

As with other networks, the value of a transport network increases at an increasing pace with the number of nodes that are connected. An additional train station not only increases the value to people near the station but also increases the value to consumers near all the other train stations, as they can now more easily travel to a new location.

Transport also incurs large fixed costs. For both road and rail there are extremely large fixed costs in the initial construction, or subsequent expansion, of infrastructure and then there are additional fixed costs for trucks, trailers, locomotives and rollingstock. These fixed costs must be incurred before the first tonne of freight or the first passenger can be transported.

As the volume of freight or number of passenger journeys increase, these large fixed costs can be shared between more users. This causes the average cost per tonne or per passenger to decrease as volumes increase. In this case rail transport is likely to have greater returns to scale than road transport as not only can the fixed infrastructure be used more efficiently at higher volumes but train lengths can also be increased. This is in contrast to road transport where the number of trailers or seats per vehicles is essentially fixed.

These two effects are also cumulative, a new connection in a rail or road network will raise the value of that network to all its users which will lead to more use of the network which will lead to reduced costs for all users.

Supply-led demand and path dependence

Both the network effects and the increasing returns to scale felt by transport users mean that current decisions about which mode of transport to select are strongly led by past decisions about the supply of infrastructure.

A good example of supply led demand is comparing port infrastructure in Sydney and Melbourne. In Melbourne some trains are loaded at a facility separate from the Port itself while in Sydney rail is fully integrated into port activities. This means that, in Melbourne, an intermediate step is often made where trucks move containers from the dock to the train. This supply decision, about where to locate train tracks, has influenced different outcomes for rail transport in the two cities. In Sydney around 20% of all containers are moved by rail while in Melbourne this is around 14% (SPC 2010, Port of Melbourne Corporation 2009b)

In this case rail infrastructure is somewhat at a disadvantage to road infrastructure. Investments in road infrastructure can often be made in smaller increments than rail infrastructure. Road infrastructure has the advantage of servicing smaller, more spread out units (cars and trucks) rather than larger, more concentrated users (rail operators) which require special additional infrastructure (such as intermodal terminals and or passenger stations) to actually make use of the infrastructure. This makes organising and planning extensions of road infrastructure easier and less risky.

Over time, decisions which select between relatively easy expansions of road infrastructure and relatively difficult and costly expansions of rail infrastructure may lead to over investment in roads. Given the supply led demand situation that exists in transport, this may lead to overconsumption of road transport at the expense of rail transport.

Capacity, congestion and network expansion

Investment in transport infrastructure is not all about connecting new nodes but is often about ensuring capacity for existing connections. This is particularly the case when congestion begins to arise.

Road and rail transport experience congestion in different ways. When trains consume rail infrastructure they consume a train path, a location and time pair which secures unencumbered movement through the rail network. To ensure movement through the network, this train path must be mutually exclusive; no other train can consume that portion of track infrastructure. Train paths are allocated by a central network planner.

In contrast, planning for paths through the road network is completely decentralised. Each vehicle operator decides when they are going to leave and how they are going to pass through the network. This creates the possibility that certain roads will reach capacity and become congested.

Trains, therefore, experience a different kind of congestion than road users. Congestion for road users is experienced through increased travel times. On rail networks congestion is experiences through planning problems for network coordinators. In Australia it is most common for this planning problem to be managed by giving passenger rail priority, and sometimes excluding freight at certain times of the day. Congestion for passengers is then managed by the network planner ensuring that sufficient infrastructure is available and creating a timetable which best achieves the transport task. For freight services this congestion, caused by passenger transit during peak times, most often manifests as delays in entering the network or being held on a loop to allow a passenger train to pass.

In Australia, in various geographic locations, rail and road are experiencing congestion – bottlenecks and pinch points for rail and peak hour congestion on roads in metro areas. In deciding how to best respond to this congestion, governments who still play the role of strategic planners in rail and road, must weigh up the factors outlined above (network effects, economies of scale and supply led demand) to arrive at a vision for how they want Australian cities to function in the future.

The following chapters of the report discuss and analyse specific phenomena that policy decision makers ought to consider when planning and facilitating investment.

4 Transport costs to society

Both road and rail transport generate costs that are not taken into account in prices. These costs, known as externalities, must be borne by society. These costs should be taken into account in order to make correct investment decisions.

Importantly, rail transport creates less of these external costs than does road transport.

Modelling indicates that a passenger journey made by rail and not road transport can reduce costs relating to congestion, carbon pollution and accidents by around $3.11 in Brisbane or up to around $8.41 in Sydney. On the freight side, moving from road to rail can decrease these costs by around $0.95 for every tonne kilometre; this translates to around $150 for a single container transported between Melbourne and Brisbane.

Road freight transport also creates costs for other road users as larger trucks tend to under-pay for access compared to the costs that they create. Rail also generates benefits by allowing for greater social inclusion.

These costs have tangible effects on the lives of all Australian's and the economy. Congestion eats away at leisure time and reduces economic productivity as workers and goods take longer to reach their destination and cost more to transport. Carbon pollution creates social costs to be borne by future generations who will face the duel costs of a changed climate and the need to reduce emissions. In addition to deaths caused by vehicle accidents, injuries create ongoing effects in terms of pain, reduced ability to work and the need for care.

Rail transport is used to move passengers and various types of freight. In a number of markets rail has a strong comparative advantage. Rail is the preferred transport mode for many bulk commodities and long-distance haulage tasks (in some instances, rail networks are used almost solely for the transportation of minerals). For other tasks such as passenger transport (e.g. metropolitan public transport and intra-state services) and other freight tasks (e.g. containerised freight, intra-city freight and grain) rail faces strong competition from transport by road.

Current decisions about choosing between road and rail transport are distorted because the price users' face does not reflect the true costs they create. There are two reasons for this:

- the existence of a number of costs that are not captured in prices which disproportionately advantage road transport (i.e. road transport is underpriced); and
- the existence of pricing distortions because of cross subsidisation between different classes of road users.

The true value of rail includes the benefit of avoiding incurring these costs and must be considered when determining pricing and investment decisions if the right decision is going be made. In addition, investment decisions should consider the long term ability to expand road and rail networks in terms of resource availability in order to ensure that the transport system evolves to suit both short term and long term needs. For example, land and development constraints may prevent future expansions of important roads.

4.1 Passenger

The largest difference in costs imposed by road and rail that are not included in prices is through congestion. Other major costs investigated in this paper are carbon emissions and costs related to accidents.

4.1.1 Passenger - carbon emissions

Carbon emitted from burning fuel to power road vehicles and trains imposes a cost on society through its impact on the atmosphere and climate. Both road and rail generate costs from the emission of carbon but the true value of rail is in its relatively lower emissions per passenger journey than road.

In Australia, passenger transport is mostly made by road. In 2010, passengers travelled 182.0 billion kilometres (km) by road compared to 13.6 billion km by rail (BITRE, 2009a). BITRE (2009a) estimated that 48.3 million tonnes of CO_2 equivalent was emitted due to road vehicles transporting passengers. Emissions from rail were less; only 14.8 million tonnes of CO_2 equivalent.

Adjusting for distance travelled and passengers carried, emissions from road users were 0.16 kilograms of CO_2 equivalent per passenger kilometre travelled. In comparison, rail emissions were 0.11 kilograms of CO_2 equivalent per passenger kilometre. This means that every kilometre travelled by a passenger in a road vehicle rather than by rail resulted in an additional 0.05 kg of CO_2 equivalent being emitted. These calculations are set out in Table 4.1.

Table 4.1: Carbon emissions from passenger transport, 2006

	Total emissions	Total distance travelled	Emissions/km travelled
	Million tonnes of CO_2 equivalent	Billions of passenger km	kilograms of CO_2 equivalent per passenger km
Road			
Cars	46.6	287.5	0.16
Buses	1.4	21.9	0.06
Motorcycles	0.3	2.1	0.13
Total	48.3	311.5	0.16
Rail[a]			
Total	1.5[b]	13.6[c]	0.11
Difference			
			0.05

Notes: (a) Estimate includes emission from power generation for electric rail. (b) Sum of electric and non-electric. (c) Sum of passenger km for urban heavy, non-urban and urban light.
Source: BITRE (2009a) and Access Economics calculations.

Road travel produces more than 40% more carbon pollution than rail travel for each kilometre travelled by a passenger.

Converting carbon emissions into a dollar savings is difficult because there is currently no price on carbon emissions. Since the cost imposed on society will occur in the future and is highly uncertain it is difficult to determine the potential size of the cost. In this report a price of $26.70 per tonne of CO_2 equivalent is used. This price is based on the price that was proposed for the beginning of the CPRS-5 in 2010 (converted from 2005 dollars to 2010 dollars using consumer price inflation) (Treasury, 2008). This price reflects the expected cost of carbon required to induce a certain reduction in emissions rather than the expected net present value of future social costs.

At a carbon cost of $26.70 per tonne, every kilometre of transport moved from road to rail transport results in a reduction in negative carbon pollution costs of 0.12 cents.

This reduction can be put in context by looking at average commute distances in some of Australia's major cities. Data on actual average commute lengths is difficult to find and so information from a number of sources has been drawn together to give estimates of average travel distances. Table 4.2, below, shows the potential reduction in carbon costs if the average trip being made by car was moved onto rail.

Table 4.2: Carbon pollution costs per commuter trip

City	Average trip (km)	Potential cost saving (cents)
Sydney	16.8	2.1
Melbourne	17.8	2.2
Brisbane	15.3	1.9
Perth	17.0	2.1

Note: average trip distances were available for Sydney and Brisbane (Sanderson 2010; Xu and Milthorpe 2010) while average straight line distances were available for Sydney, Melbourne and Perth (BITRE 2010b). The ratio between the two measures for Sydney was used to estimate actual travel distances in Melbourne and Perth.

Every additional rail journey reduces carbon emission costs by around 2 cents.

These results are based on the current energy mix used to power road and rail transport. In Australia rail transport is predominantly powered by diesel fuel and electricity. The electricity is most often generated from coal fired power plants. The emissions from rail transport could therefore be reduced significantly by increased electrification of rail networks and substitution into less emissions intensive sources of electricity.

These results indicate that if 1000 commuters switched the mode of transport for their daily commute from road to rail, this would reduce costs from carbon emissions by roughly between $10,000 and $11,000 a year (depending on the city).

The assumed carbon price of $26.70 a tonne is not necessarily representative of the price that would emerge under a carbon trading scheme. As there are currently ongoing negotiations over the mechanics of an emissions reduction scheme, it is difficult to accurately estimate the carbon price that may emerge. A range of other carbon prices are considered in Table 4.3.

Table 4.3: Carbon emissions costs at different carbon prices

Carbon price ($/tonne)	Emissions cost (c/passenger km)
10	0.05
26.7	0.12
50	0.23
75	0.35
100	0.46

4.1.2 Passenger - congestion

As Australia's cities continue to grow and the pressure on arterial roads mounts, avoiding congestion is likely to be the largest benefit to be gained from transporting passengers by rail rather than road.

Congestion occurs when infrastructure is being used above capacity — the amount of use that allows free flow of traffic. This tends to be more of an issue on roads rather than rail and is more likely to occur in densely populated areas.

Once roads reach their capacity, each additional user imposes a cost on existing road users in terms of increasing their travel time, uncertainty about travel time, fuel usage, and reducing the amenity of driving. Congestion also increases fuel consumption, air pollution and green house gas emissions, all of which impose a cost on society. Congestion is, at its heart, caused by a combination of an underpricing of access to roads at peak times and places and an undersupply of the infrastructure necessary to accommodate demand. A direct approach to managing congestion could be to introduce peak period pricing; this would force road users to face the true cost of their decisions.

Rail is much less subject to congestion. While increased numbers of rail users can cause over-crowding on trains, which reduces the amenity of the trip for the passenger, this does not impose the other costs that occur as a result of road congestion. The centralised scheduling of train services makes it easier to avoid congestion on the train lines — although increasing the number of services operating will make this coordination more difficult and could increase the risk or severity of a delay.

Determining the value of congestion costs is challenging. This is because the level of congestions depends on features such as:

- the origin and destination of commuter journeys;
- the time of day that journeys are made;
- the capacity and layout of the road network;
- the placement of railway stations;

- the frequency of rail services; and
- available alternatives such as buses, walking or cycling.

These factors differ from city to city and over time. As such, congestion costs are best dealt with using a model which simulates the transport network and its use in a particular area (such as a city).

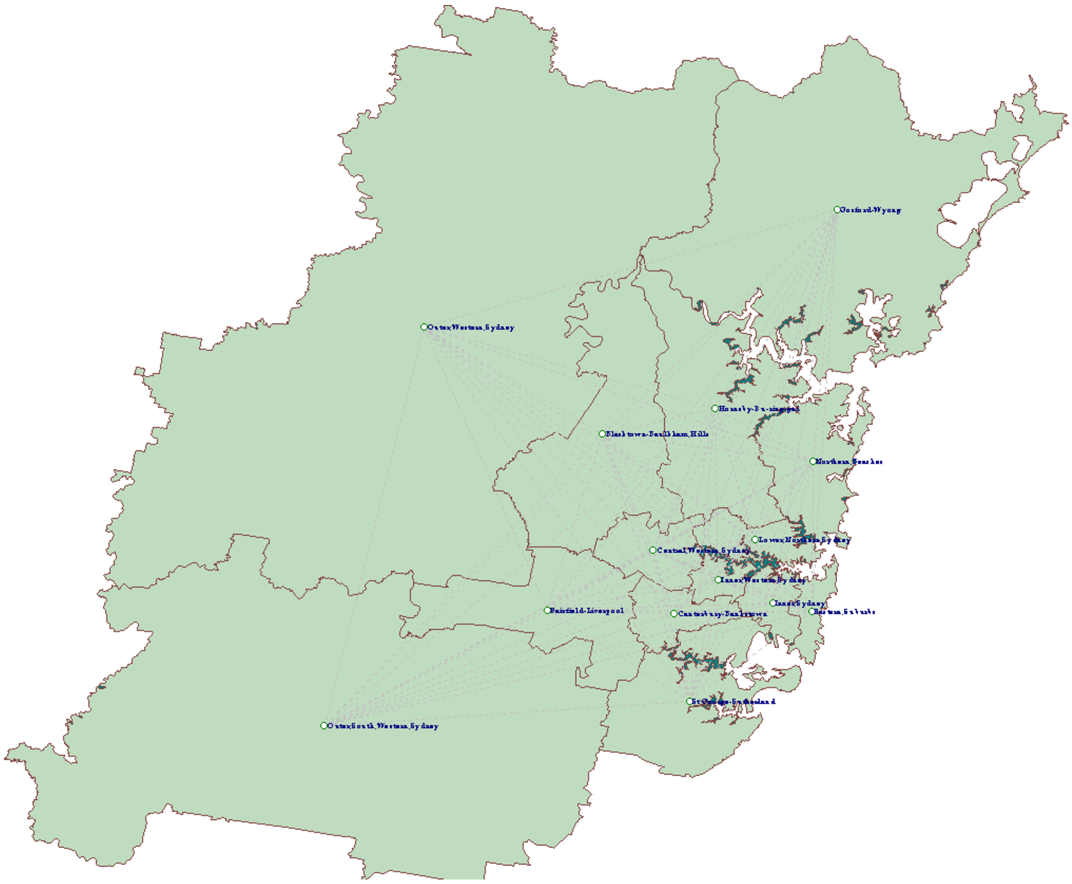
This report relies on a model, the Transport and Environmental Strategy Impact Simulator (TRESIS), developed at the Institute of Transport and Logistics Studies at the University of Sydney. TRESIS combines information on the behavioural responses of individuals (gathered through experiments, surveys and data), road networks, public transport options and demographic information. It contains a set of choice models for:

- commuting — includes choice of working hours, departure time, mode of transport and workplace location;
- automobile choice — type of vehicle and number of vehicles per household;
- residential — location and dwelling type; and
- automobile use — annual vehicle and kilometres travelled by the household and the spatial composition of this travel.

This input is combined to create a model where households select their home and work locations as well as their transport decisions, including whether to own a car or not. The model is more fully described in Appendix A. TRESIS has been used to analyse diverse situations including the benefits that could flow from increased bus use in Melbourne (Stanley 2007), an improved road connection in north east Sydney (Hensher *et al* 2004) and from congestion pricing on Sydney's roads (Hensher 2008).

One key advantage of TRESIS is that it allows modelling to be targeted to each major Australian city. This report focuses on congestion costs for Sydney, Melbourne, Perth and Brisbane. Each city is represented by a number of regions with each region having road, rail and bus links to other regions. Sydney, for example, is made up of 14 regions, as is shown in Figure 4.1.

Figure 4.1: TRESIS regions in Sydney



Source: TRESIS

The key outputs from TRESIS that will be used to estimate the congestion costs are the total travel time and the number of journeys by bus, car and train. TRESIS also provides information on carbon emissions.

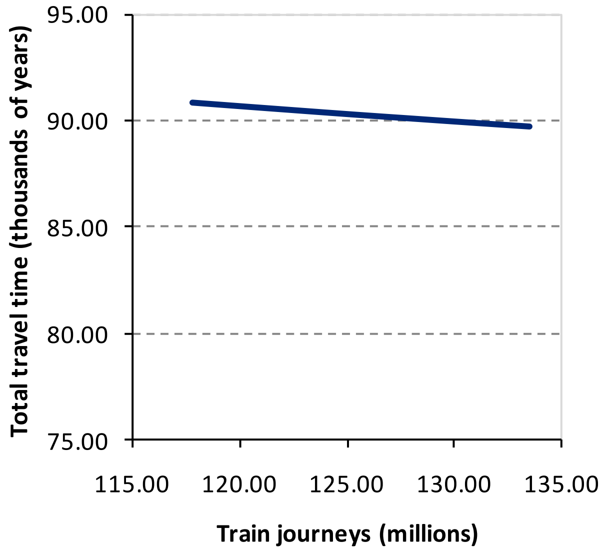
Following an approach used in papers developed for the NSW government (CRAI 2008, LECG 2009) congestion costs will be measured in terms of the increase in minutes of travel time and carbon emissions that an extra road user adds to all the existing road users.

To take a stylised example, consider a situation where 100 road users currently make the same commute which takes them each 45 minutes. If another road user is added the commute time might increase to 50 minutes each. In this case the congestion cost created is the additional 5 minutes added to each existing road user's journey but does not include any of the travel time of the 101st road user. The 101st user's own travel time is excluded as it is a cost taken into account and borne by that user. The same basic approach can be used to look at the effect of congestion on carbon emissions (just replace minutes of travel time with kilograms of carbon emitted).

As TRESIS models the behavioural response of individuals to factors such as travel time and cost, the effect of moving a person from road transport to rail transport can be mimicked by varying the cost of a train fare. An increase in the train fare will drive some people away from rail and towards road transport. This will increase congestion on the roads and lead to an increase in total travel time and carbon emissions.[2]

The output from this stage of the modelling was to establish a relationship between the number of train journeys and travel time.[3] An example of this relationship is shown in Chart 4.1 below. This figure shows a negative relationship between total travel time and the number of train journeys in Sydney in 2011, that is, each additional passenger journey that is moved from road to rail decreases total travel time by reducing the effect of congestion on other road users.

Chart 4.1: Modelled relationship between rail journeys and total travel time in Sydney 2011



Source: TRESIS, Access Economics

The next step in the modelling is to extract the effect of moving a single person from road to rail transport. As the impact of increasing (or decreasing) train fares by 10% moves a large number of commuters between modes, the effect of moving a single commuter must be drawn out. This was done using regression analysis, described in detail in Appendix B.

Making the necessary calculations for each of the cities we are considering gives the following results for average congestion externalities in the city:

[2] This approach was used to establish a high level relationship between number of rail journeys and total travel time, not to identify the characteristics of specific users who would change travel decisions based on fare changes.

[3] Total travel time includes travel time for ride-share for each person in car and all components of time of public transport users (Bain and Hensher 2008).

Table 4.4: Congestion costs, travel time

City	Change in travel time for existing road users (minutes)
Sydney	-22.5
Melbourne	-17.1
Brisbane	-5.9
Perth	-9.2

Source: TRESIS, Access Economics estimates

Every additional rail journey reduces time spent waiting in traffic by between around 6 and 23 minutes.

These results mean that, for example, in Sydney, a single journey moved from road transport to rail transport reduces total travel time for existing road users by 22.5 minutes; each individual road user therefore only benefits by a fraction of a second.

More intuitive comparisons could be made by considering actual real world passenger volumes. For example, if a Melbournian's daily commute for a normal working year was moved from road to rail that would result in a time saving of 5 days and 17 hours for other road users. If this was extended to 1000 people, the time saving would be in the order of 15 years and 8 months.

These changes in travel time can also be used to calculate the effect on CO_2 emissions. The NSW Roads and Traffic Authority (RTA) estimate that idling engines emit around 1.15 kilograms of CO_2 per hour (RTA 2009). This rate of emissions can be applied to the amount of extra time spent in congested traffic to give the results are in Table 4.5.

Table 4.5: Congestion costs, carbon emissions

City	Change in CO_2 emissions for existing road users (kg)
Sydney	-0.4
Melbourne	-0.3
Brisbane	-0.1
Perth	-0.2

The next step in estimating the costs of congestion is to bring the measurements from disparate figures of minutes and kilograms of CO_2 into a comparable dollar value.

For travel time, a certain percentage of the wage is normally used to calculate a dollar value for time spent travelling. A paper reviewing a wide range of research indicates a range of percentages have been used in various papers (BTE 1982). Although now rather old, the estimates established in this paper have been frequently used and have formed the basis of previous, recent studies of transport externalities in Australia such as CRAI (2008) and LECG (2009). Drawing on the 98 references in the paper which are not assumed values, the following results are obtained:

Table 4.6: Ranges for value of travel time as percent of wage

	Mean	Median	Standard deviation
Business	83.8%	76%	62.7%
Commuter	43.5%	35%	25.8%
Average	63.65%	55.5%	

Source: BTE 1982

The average of the above medians is then applied to the wage to obtain dollar values for the cost of congestion. This approach has been used in previous studies of transport externalities in Australia such as CRAI (2008) and LECG (2009).

Data from the ABS indicates the average weekly earnings in each Australian state; this is set out in Table 4.7. Earnings in Western Australia are higher than in other cities due to the influence of mining on the local economy. It is reasonable to use this higher than average figure as it remains a genuine reflection of the opportunity cost of time, and hence congestion, in Western Australia.

Table 4.7: Average weekly earnings around Australia, August 2010

City	Average weekly earnings	Average hourly earnings	Value of travel time (per hour)
Sydney	1347.10	33.68	18.69
Melbourne	1305.00	32.63	18.11
Brisbane	1335.30	33.38	18.53
Perth	1503.70	37.59	20.86

For carbon emissions, as described above, a cost per tonne of CO_2 of \$26.70 can be attributed based on modelling by Treasury (2008).

This then allows the conversion of travel time from minutes to dollars and carbon emissions from kilograms to dollars. The different components of the congestion costs can then be added together to give an estimate of the total congestion costs, this is set out in Table 4.8 below.

Table 4.8: Congestion costs per journey, dollars (2010)

City	Travel time (\$)	Carbon emissions (cents)	Total (\$)
Sydney	7.00	1.15	7.01
Melbourne	5.17	0.88	5.18
Brisbane	1.83	0.30	1.84
Perth	3.19	0.47	3.20

Every additional rail journey reduces congestion costs by between $1.80 and $7.01.

These results indicate that if 1000 commuters switched their mode of transport from road to rail, this would reduce costs from congestion by between around $959,000 and $3,700,000 a year (depending on the city).

There are other options for the value of time that could be used to calculate a dollar value for congestion costs. Table 4.9 sets out a sensitivity analysis for the value of time, in the above analysis 55% of average hourly earnings was used, but this percentage can be varied.

Table 4.9: Congestion cost sensitivity analysis, dollars (2010)

	Value of time, percentage of average hourly wage					
City	25%	33%	55%	66%	75%	100%
Sydney	3.16	4.17	7.01	8.33	9.47	12.62
Melbourne	2.34	3.08	5.18	6.16	7.00	9.33
Brisbane	0.83	1.09	1.84	2.18	2.48	3.31
Perth	1.44	1.90	3.20	3.80	4.32	5.76

4.1.3 Passenger - accidents

Accidents impose a significant cost on society in terms of Medical care, disability care, support services and the cost of emergency services. These costs are predominantly publically provided and so accidents create costs borne by the community at large. There are also losses in productivity from death or disablement, quality of life and damage to property. Some of these costs are included in costs faced by those making transport decisions. This is done through insurance and road user charges. However, much of the cost of an accident is borne by society and the people involved in the accident.

Many costs associated with accidents are similar for road and rail (such as the cost of a loss of life) while others, such as property costs, differ substantially. The costs of rail and road accidents are taken from estimates made by the BITRE (formally the BTRE) for 1999 and 2006 respectively. The methodologies differ because less detailed data is available on rail accidents.[4]

It is assumed in this report that the cost of road and rail accidents have grown in line with the CPI between 1999 and 2010. This has been done because of the lack of publicly available data on accident cost changes.[5] Although many of the accident costs for road and rail transport are similar, there are many more road accidents each year than there are rail accidents. In 2006, there were 1,602 fatalities, 31,204 injuries and 438,700 accidents

[4] The BITRE may have developed its methodology in the period between these reports. Changes made between the costing of road accidents in 1996 and 2006 account for around 1% of total 2006 costs (BITRE, 2009b).

[5] This is unlikely to be a problematic assumption as it is the relative accident costs between road and rail which are of most interest and, as similar treatments are required for both road and rail accidents, it is unlikely that the cost relativity has changed significantly.

involving property damage on roads (BITRE, 2009b). In 2006, there were only 38 rail fatalities and 135 injuries Australia wide (ATSB, 2010).

Table 4.10: Number of accidents by severity for road and rail

	Road (2006)	Rail (1999)	Rail (2006)
Fatalities[(a)] (number of people)	1,602	48	38
Injuries[(a)] (number of people)	31,204	170[(b)]	135
Property damage only (number of crashes)	438,700	214	NA

Note: (a) Suicides are excluded for road (2006) and rail (1999), unknown for rail (2006) injury (b) This number is atypical due to 57 minor injuries that occurred in the Glenbrook accident in 1999.
Source: Access Economics calculations and ATSB (2010).

The total social cost of road accidents in 2006 was $17.85 billion (BITRE, 2009b). Rail accidents cost $143 million in 1999 (BTRE, 2003). Of the road accidents, passenger vehicle crashes made up around $17.2 billion. Rail costs were not split by passenger and freight. Laird (2005) suggests a 30% share for freight, which would imply an accident cost of around $100.1 million for rail passenger transport.

The cost per passenger km travelled in 2006 was 8.4 cents for road and in 1999 was 0.87 cents for rail (Table 4.11). Converted to 2010 dollars using CPI inflation the cost per km for road was 9.38 cents and for rail was 1.20 cents. Road transport therefore generates 8.19 cents extra in accident costs per km than rail.

Table 4.11: Accident costs from passenger travel

Unit	Road	Rail
Total cost ($ million)	17,249	100
km travelled (billion)	205.7	11.51
Cost per km (cents)	8.4	0.87
Cost per km (cents) in 2010	9.38	1.20
Difference (cents per km)		8.19

Note: These figures are based on 2006 for road and 1999 for rail.
Source: Access Economics calculations.

> Road transport generates almost eight times more accident costs than rail transport.

The reduction in accident costs can be highlighted by looking at average commute distances in some of Australia's major cities. Table 4.2, below, shows the potential reduction in accident costs if the average commuter trip being made by car was moved onto rail.

Table 4.12: Accident costs per trip

City	Average trip (km)	Potential cost saving ($)
Sydney	16.8	1.38
Melbourne	17.8	1.46
Brisbane	15.3	1.25
Perth	17.0	1.39

Every additional rail journey reduces accident costs by between $1.25 and $1.46.

These results indicate that if 1000 commuters switched their mode of transport road to rail, this would reduce costs from accidents by between around $650,000 and $760,000 a year (depending on the city).

A recent study (Tooth 2011) makes use of a similar approach to estimating accident costs to that used by BITRE but updates the value of statistical life (VSL). The VSL used reflects recent research which identified a VSL in Australia of around $6 million (Hensher *et al* 2009). This estimate is far higher than the $2.4 million used by BITRE in its analysis. Incorporating this estimate of VSL into BITRE's framework results in an estimate of road accident costs of around $28 billion in 2006.

Unfortunately these updated calculations do not provide enough detailed information to update the BITRE estimates for the purposes of this paper. Rough calculations indicate that the revised difference in passenger accident costs based on these updated figures would be around 12.8 cents per kilometer; a 56% increase above the BITRE based estimates. This gives an indication of the sensitivity of the above results to the VSL.

4.1.4 Passenger - social inclusion

Social inclusion involves the lowering of barriers which make it difficult for people to participate fully in society. Social exclusion is usually measured from five different angles:

- Employment status: whether a person is or is not in a job
- Political activity: whether a person is engaged in any committees or groups
- Social support: whether a person can access help from friends, family or neighbours
- Participation: whether a person can participate in any hobbies, events, or organised recreational activities

Mobility is a key aspect of social inclusion as, without it, individuals are likely to have difficulty finding work, travelling to places of education, accessing health services, buying affordable groceries or even participating in social activities. That is, without mobility a person will have difficulty doing well on any of the measures of social exclusion.

More extensive rail networks that provide more frequent services have the ability to enhance social inclusion. For an individual, travel by rail does not require the large fixed costs of vehicle ownership, registration, insurance and licensing that travel by road does.

The availability of rail transport options may therefore increase the mobility of those unable to afford the large fixed costs of cars.

The role for rail here is further enhanced by its ability to move relatively quickly over long distances. The recent Infrastructure Australia report, State of Australian Cities 2010, found social inequality to be most significant in large metropolitan areas. The role for rail is further illustrated by a joint study funded by the University of Western Sydney and the Western Sydney Community Forum (2006) which found that widening the diversity of rail network coverage, improving accessibility and network effects was seen as a means of improving social benefit and productivity.

Until recently, there has been little focus on quantifying the value of social inclusion in Australia. This has reflected the difficulty in estimating the value from significantly expanded transport services. A forthcoming paper has attempted to address this lack of research by estimating the willingness to pay for additional trips that enhance mobility and improve social inclusion (Stanley *et al* 2011).

The approach is based on a series of face-to-face interviews across Melbourne with 443 adults. Selection of participants was designed to ensure representative geographic coverage and variability in access to transport, income and age. The results of the survey indicated that those at higher risk of social exclusion made fewer journeys per day. The results of the survey can be used to calculate willingness to pay for trips; this depends on the household's income.

At the average level of household income, the willingness to pay for an additional journey, among those included in the survey, is up to $19.30. This valuation declines as income increases. This is because higher income individuals tend to already make a large number of trips while lower income individuals make a small number of trips and so stand to benefit significantly from increased mobility.

This estimate, based on willingness to pay, can be compared to other sources, based on costs of transport, which indicate an implied value of $7.07 for an additional car trip and $9.56 for a public transport journey (Department of Infrastructure 2005; Australian Transport Council 2006), a difference of $2.49 between private and public transport.

4.1.5 Passenger - other

An important issue to consider is that in major cities it is difficult to expand the road network due to land constraints. These constraints apply both when attempting to retrofit existing roads to higher volumes and when expanding the road network into new areas (as there are natural constraints to the footprint of many of Australia's cities).

As such, rail is potentially more valuable on a transport per land area used basis. This aspect of rail transport could be looked at in two ways:

- For a given amount of land, the number of people or volume of freight that can be carried by rail transport is likely to be higher than what could be carried by road transport.
- For a given transport task, the amount of land required when using rail transport is smaller than the amount of land required when using road transport.

Some attempts have been made in past papers to estimate this value. A rail transport system, operating efficiently, may use around 1.25m^2 of land per person per kilometre travelled while a highway may use up to 20m^2 per person per kilometre travelled (ARA 2000 in ACF 2009).

This potential land use benefit arising from the use of rail transport is often taken into account in current prices, as the land must be paid for. However, additional benefits arise from other potential uses of the land. Land that could be freed up by relying more heavily on rail transport could be put to other uses such as housing, industry, warehouses, or for community and recreation areas. All of these uses may create additional benefits.

4.1.6 Summary on passenger transport

Costs created by passenger travel but not included in prices come from a number of different areas including: carbon emissions, congestion, accidents, social inclusion, land use and from funding arrangements.

Some of these are amenable to quantification in dollar terms and some are even comparable to one another, this allows for the calculation of a total costs, shown in Table 4.13.

Table 4.13: Total costs per average commuter trip (2010$)

City	Carbon emissions	Congestion	Accidents	Total
Sydney	0.02	7.01	1.38	8.41
Melbourne	0.02	5.18	1.46	6.66
Brisbane	0.02	1.84	1.25	3.11
Perth	0.02	3.20	1.39	4.61

> Each passenger journey made by rail instead of road reduces congestion, accident and carbon costs by around $6.45 in total.[6]

4.2 Freight

The focus of this report, and the calculations below, is on interstate freight transport. This is a key, and growing, market for freight transport in Australia. Having said this, the role of intra-city and inter-regional rail transport should not be overlooked. Inter-regional transport shows the same benefits outlined below, but simply on a smaller scale. Intra-city rail transport is somewhat different, offering opportunities to relieve congestion, as was analysed above, in addition to the carbon and accident benefits estimated below.

The largest cost associated with freight that is not covered in prices is the difference in infrastructure maintenance costs. Rail lines used for freight are required to earn a return, while roads are publically owned and can operate at a loss. The public ownership of roads makes it difficult to accurately price the share of the damage inflicted and the share of

[6] Using a weighted average based on population

common costs (construction and services such as street lights) that should be attributed to each vehicle.

Similar to passenger services, there are also differences in carbon emissions and accident costs. However, congestion is less of a problem as freight routes tend to bypass city centres.

4.2.1 Freight - carbon emissions

Rail plays a larger role in freight transport than it does in passenger transport, accounting for over half of land based freight, when measured in tonne kilometres. In 2010, 249 billion tonne kilometres were transported by freight trains and 207.4 billion by road vehicles. Despite the similarity in total distance travelled, road transport emits ten times as much CO_2 equivalent as rail transport (30.4 million tonnes of CO_2 equivalent for road compared with 3.1 for rail). The difference in road and rail carbon emissions from freight transport per tonne km travelled is 0.13 kilograms of CO_2 equivalent per tonne kilometre (see Table 4.14).

Table 4.14: Carbon emissions from freight, 2010

	Total emissions	Total vehicle distance travelled	Emissions/tonne km travelled
	Million tonnes of CO_2 equivalent	Billion tonne km	kilograms of CO_2 equivalent per tonne km
Road			
Light commercial vehicles	12.5	8.2	1.53
Rigid trucks	7.1	36.9	0.19
Articulated trucks	10.8	162.3	0.07
Total	30.4	207.4	0.15
Rail[a]			
Total	3.1	249.0	0.01
Difference			
			0.13

Notes: (a) Estimate includes emission from power generation for electric rail. (b) Sum of electric and non-electric. (c) Sum of tonne billion km for ancillary freight, hire and reward bulk and hire and reward non-bulk.
Source: BITRE (2009a) and Access Economics calculations.

Road freight produces more than ten times as much carbon pollution as rail freight per tonne kilometre.

As with the analysis of carbon emissions for passenger transport, these emission figures can be converted to dollar figures by applying a carbon price. A price of $26.70 per tonne of CO_2 equivalent is chosen based on the price that was proposed for the beginning of the CPRS-5 in 2010 (converted from 2005 dollars to 2010 dollars using consumer price inflation) (Treasury, 2008).

Every tonne kilometre of freight moved from road to rail results in a reduction in carbon pollution costs of around 0.36 cents.

These results are based on the current energy mix used to power road and rail transport. In Australia rail transport is predominantly powered by diesel fuel and electricity, freight transport relying heavily on diesel. The emissions from rail transport could therefore be reduced by increased electrification of rail networks and substitution into less emissions intensive sources of electricity.

To put this figure into context we can look at the overall effect if a single container, weighing around 9 tonnes and being transported between some Australian cities, was moved by rail transport instead of road transport. The total costs saved for various city combinations are given in Table 4.15.

Table 4.15: Example carbon costs for intercity freight ($)

	Sydney	Melbourne	Brisbane
Sydney			
Melbourne	27.83		
Brisbane	30.08	55.81	
Perth	127.85	110.24	142.23

Note: distances are taken from BITRE (2009c) and using an assumed 9 tonne container of freight.

The assumed carbon price of $26.70 a tonne is not necessarily representative of the price that would emerge under a carbon trading scheme. As there are currently ongoing negotiations over the mechanics of an emissions reduction scheme, it is difficult to accurately estimate the carbon price that may emerge. A range of other carbon prices are considered in Table 4.16.

Table 4.16: Carbon emissions costs at different carbon prices

Carbon price ($/tonne)	cost (c/tkm)
10	0.13
26.7	0.36
50	0.67
75	1.00
100	1.34

4.2.2 Freight - accidents

Following the same approach as set out for passenger transport related accidents (see section 4.1.3) the accident cost for freight transport was 0.58 cents per tonne km in 2006 for road and 0.04 cents per tonne km for rail in 1999. In 2010 prices this would be 0.65 cents for road and 0.06 cents for rail. This means that the accident cost associated with road freight transport is ten times that for rail freight transport on a per tonne km basis. These calculations are set out in Table 4.17.

Table 4.17: Accident costs from freight transport

Unit	Road	Rail
Total cost ($ million)	999.2	100.1
Tonnes km (billion)	173.30	106.2
Cost per tonne km (cents)	0.58	0.04
Cost per tonne km (cents) in 2010	0.65	0.06
Externality (cents per tonne km)		0.59

Note: These figures are based on 2006 for road and 1999

> Every tonne kilometre of freight moved from road to rail results in a reduction in accident costs of around 0.59 cents.

To put this figure into context we can look at the overall effect if a single container, weighing around 9 tonnes and being transported between some Australian cities, was moved by rail transport instead of road transport. The total accident cost saved for various city combinations is given in Table 4.18.

Table 4.18: Example accident costs for intercity freight ($)

	Sydney	Melbourne	Brisbane
Sydney			
Melbourne	45.83		
Brisbane	49.54	91.92	
Perth	210.54	181.55	234.22

Note: distances are taken from BITRE (2009c)

As discussed above, a recent study (Tooth 2011) makes use of new estimates of the value of statistical life in Australia to update BITRE's total accident cost estimates. Unfortunately these updated calculations do not provide enough detailed information to update the BITRE estimates for the purposes of this paper. Rough calculations indicate that the revised difference in freight accident costs based on these updated figures would be around 0.82 cents per kilometer; a 39% increase above the BITRE based estimates. This gives an indication of the sensitivity of the above results to the VSL.

4.2.3 Freight - infrastructure maintenance

Heavy vehicles, the transporters of freight, are required to pay both a registration fee and a fuel excise to help recover the cost of damages made to the road, if this fee accurately reflected the costs created by each vehicle type then prices would reflect costs and there would be no advantage for road or rail transport. When prices depart from costs, this can distort transport decisions.

In practice prices faced by individual users do not necessarily reflect their actual damage. For example, the Productivity Commission (2006) found that B-Doubles under recover the costs that they generate when compared to other classes of trucks. This cost is being borne by the smaller rigid and articulated trucks. As such, the price signal sent to operators may not be correct, distorting the choice between using rail or road to transport freight.

The fact that it is the largest road vehicles which receive the cross subsidisation from smaller vehicles is critical as it is these larger vehicles which are the closest substitutes for rail transport.

The current basis for calculating heavy vehicle charges is to apportion the expected expenditure on roads. This is based on the average of seven years of budget data and is updated annually. This total cost is then apportioned across vehicle classes based on average:

- vehicle kilometres travelled;
- Equivalent Standard Axle kilometres travelled, which is a measure of deep pavement wear;
- Passenger Car Unit kilometres travelled, which is a measure of relative road space requirements based on the size of the vehicle;
- Average Gross Mass kilometres travelled, which is a measure of the mass impacts on the road pavement in general; and
- Heavy vehicle kilometres travelled, which is a measure of the relative amount of heavy vehicle travel.

The principle of this pricing system is that, on average, each class of heavy vehicle pays its own share of allocated road expenditure, minimising under and over-recovery. This only ensures that costs are recovered on average in each vehicle class and so the pricing structure might not be the most efficient possible.

Another difficulty with the current pricing structure is that it is based on current expenditure needs, not future needs. Heavy vehicles today are paying for road damage that occurred in the past rather than paying to repair the damage they are causing today. Since heavy vehicle use has been growing steadily, road charges today are not sufficiently high to recover the actual cost of today's road use.

There are different estimates of the precise level of this cross subsidisation. The Productivity Commission estimated that on a per truck basis, under-recovery was in the order of $7000 a year (Productivity Commission 2006) while the NTC has estimated a value of around $10,500 (NTC 2006). The NTC has made recommendations for pricing reforms which would address some of these issues, but this is an ongoing issue as the COAG Road Reform Plan is currently conducting a review process which will identify ways to address the current cross-subsidisation but have not, as yet, calculated a dollar figure for its level.

4.2.4 Summary on freight transport

The carbon pollution and accident costs quantified above lend themselves to adding together to give a total cost, Table 4.19.

Table 4.19: Total freight costs

Type	Cost (c/tkm)
Carbon emissions	0.36
Accidents	0.59
Total	0.95

This per tonne kilometre measure can be put into context by considering some of Australia's intercity freight journeys

Table 4.20: Example total costs for intercity freight ($)

	Sydney	Melbourne	Brisbane
Sydney			
Melbourne	73.65		
Brisbane	79.63	147.73	
Perth	338.39	291.79	376.45

Note: distances are taken from BITRE (2009c)

5 Impact of modal shift and investment in rail

To achieve the potential benefits of rail identified above, investment will be needed. Two good examples of current bottlenecks can be found in Sydney. For freight transport along the North-South corridor, there is currently a bottleneck in Northern Sydney while for passenger transport within Sydney there is a bottleneck at key city stations.

If rail was to take a 40% share in North-South freight movements there would, today, be a reduction in accident and carbon costs of around $300m a year. This is expected to grow to around $630m by 2030.

On the passenger side, if rail was to absorb 30% of the forecast increase in transport demand in Sydney, this could create benefits of over $1 billion a year by 2025.

This section will consider two main case studies where infrastructure investment is required to achieve the true value of rail:

- Freight transport on the north-south corridor; and
- Passenger transport in Sydney.

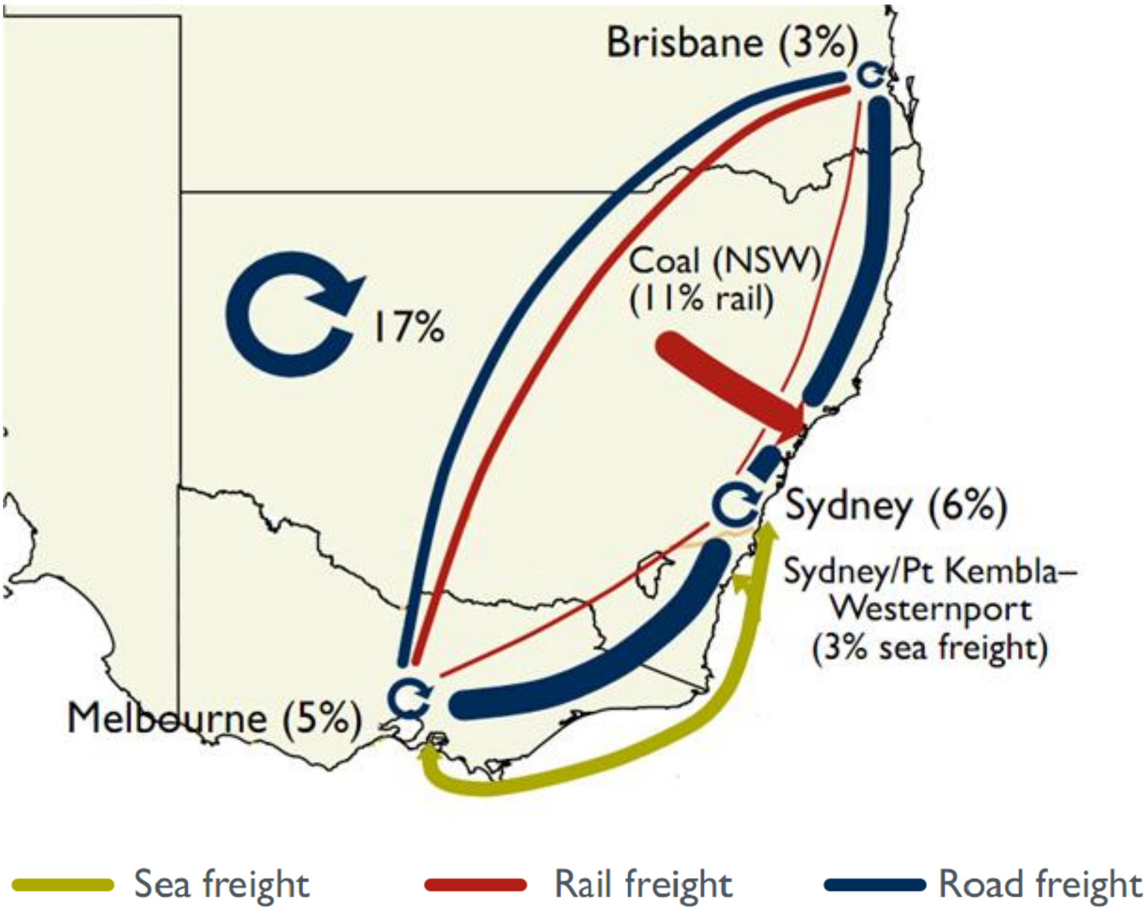
These case studies have been selected as there are clear gains to be made, even in the short term, from specific infrastructure investments. However, these are not the only investment options in Australia, Cross River Rail in Brisbane, an inland freight route and a very fast passenger train are other possibilities each with different investments and timeframes.

5.1 The north-south corridor

5.1.1 The corridor today

The north-south transport corridor connects Melbourne to Brisbane via Sydney. It is one of Australia's key transport corridors. In 2006-07, trade along this corridor in goods originating from these states accounted for around 30% of the total domestic non-bulk freight task (BITRE 2010a). Of this, rail made up well under 15% and likely in the region of 9-12% (BITRE 2009c and BTRE 2006). As a percentage of the market, rail tended to perform best on the northbound NSW to Brisbane leg of the journey (BITRE 2010a).

Figure 5.1: The north-south corridor



Note: Percentages are the share of total modal freight task, measured in tonne kilometres.

Source: BITRE 2009d

In terms of the infrastructure used by road along this journey, trucks will take alternative routes if they are travelling between Melbourne or Brisbane and Sydney or if they are travelling between Melbourne and Brisbane. The Melbourne to Brisbane route runs inland along the Hume, Goulburn Valley, Newell, Cunningham, Leichhardt, Gore and Warrego Highways. The Sydney to Melbourne corridor runs via the Hume Highway, more toward the coast, while the Sydney to Brisbane corridor runs mainly along the Pacific or New England Highways (Department of Infrastructure and Transport 2007a, 2007b, 2007c). Of course, there are variations possible. The road infrastructure is able to accommodate B-Doubles along its entirety and road trains along sections of the Newell Highway (Department of Infrastructure and Transport 2007c).

The inland corridor is generally not affected by capacity constraints at the moment, excepting congestion when passing through population centres and areas where speeds are affected due to steep climbs (Department of Infrastructure and Transport 2007c). The more coastal routes, servicing Sydney, are more heavily affected by congestion than the inland route. This is mostly in areas of population such as around Albury/Wadonga, between Sydney and Newcastle and between the Gold Coast and Brisbane but also includes infrastructure constraints such as bridges around Scone and Maitland (Department of Infrastructure and Transport 2007a, 2007b).

The heavy use of road transport along this corridor leads to heavy vehicles making up a high proportion of total traffic on many legs of the journey. The proportion often exceeds 30 per cent for lengths of the corridor between Jerilderie and Forbes as well as between Narrabri and Toowoomba (Department of Infrastructure and Transport 2007c). .

In terms of rail infrastructure, a single line runs between Melbourne and Sydney and another between Sydney and Brisbane, the Sydney metropolitan network links these two interstate lines.

Between Melbourne and Sydney, the track generally runs in parallel with the Hume highway but deviates through Wagga Wagga. On the Sydney to Brisbane leg the track generally follows the Pacific Highway but deviates inland via Maitland, Taree, Grafton and Casino (Department of Infrastructure and Transport 2007c). The interstate track is owned (or leased) by the ARTC while the Sydney metropolitan network is owned and operated by RailCorp.

Some sections of the track still maintain the original alignment set out for steam trains. These sections include tight curves and steep grades (particularly between Macarthur and Goulburn and between the Hunter Valley and Grafton) as well as being only a single track in places. This legacy infrastructure can be compared to the highways servicing the same routes which have seen significant re-alignment to reduce curves and climbs as well as the introduction of multiple lanes.

At the moment, the critical constraint on the North-South rail corridor is the Sydney metropolitan network. This arises from the fact that interstate freight trains must share the metropolitan network with passenger trains. Passenger and freight trains move at different speeds and have different stopping patterns. Passenger trains are given preference over freight trains on the network; this effect is most clear during peak periods in the Sydney network, roughly from 6:00 to 9:30 in the morning and from 4:00 to 6:00 in the evening, where there are virtually no freight train movements on the network.[7]

A freight train journeying from Melbourne to Brisbane via Sydney must enter the RailCorp network, pass through the southern part of the network to arrive at an intermodal terminal then navigate through the northern section of the metropolitan network. An example of a typical run from Melbourne to Sydney would be a train that leaves Dynon in Melbourne at around 3pm to arrive in Sydney at around 3am the following morning. The train then enters an intermodal terminal to exchange containers, before heading off at around 5:30am. This train can pass northward through the passenger network as it is heading against the flow of the peak traffic.

5.1.2 The need for and benefits of investment in rail

Investment in rail infrastructure could, generally, be motivated by two factors: increasing capacity or improving service standards. In the case where capacity is currently constrained, investment becomes a pressing issue which requires addressing if volumes are to be allowed to grow.

[7] Some counter-peak movements are possible such as moving north from Hornsby.

On the north-south rail corridor, capacity is generally constrained by the need to mix passenger and freight trains which move at different speeds and have different stopping patterns. Issues raised by the presence of passenger trains can either be managed by segregation of freight from passenger traffic or by enabling more flexible management of traffic by incorporating loops which allow for holding and passing. Loops to allow holding and passing help manage the different speeds at which passenger and freight trains move.

The Southern Sydney Freight Line (SSFL), running between Macarthur and Sefton, is due to be completed sometime in the next two years and will effectively allow for complete separation of freight and passenger trains in Sydney's south.

The presence of the SSFL leaves Sydney's north as the key bottleneck for trains looking to traverse the metropolitan network. The main north line currently has capacity for around 16 freight trains each day in each direction. Of these there is capacity for seven in the period from 5:00am to 10pm. This period is a key time as it allows trains to arrive in Brisbane at a time which end customers' desire. There is currently only space for one extra train in either direction during this core period. Demand forecasting by Transport NSW indicates that this single remaining path will probably be consumed by 2013 (Department of Transport 2010a). For example, if a single large customer, such as Woolworths, was to shift its interstate transport from road to rail (a distinct possibility), it would be difficult to meet the extra demand given the current network constraint in north Sydney. The Melbourne to Sydney leg of the journey could be accommodated with current infrastructure but the Sydney to Brisbane leg could not be accommodated in an efficient manner leading to undesirable arrival and departure times from the major cities.

The problems with the line heading north out of Sydney are partially related to the lack of places where freight trains can be held to allow passenger trains to pass. The different speeds at which the two train types travel make this a necessity. The lack of these facilities has been driven by increases in train length (ARTC 2008). Increases in the length of trains in recent years have grown ahead of increases in the number of long loops in the RailCorp network which can accommodate these trains. For example, there is a long loop available at Cowan but nothing further until Broadmeadow, much further north.

In addition to the need to invest to maintain capacity for natural growth in transport volumes, there are also large benefits to investing in rail. As identified earlier in the report, moving a single tkm of freight from road to rail transport reduces negative carbon and accident costs by around one cent. Given that the Melbourne to Sydney journey is around 863km and Sydney to Brisbane is around 933km, this implies that a single tonne of freight moved by rail instead of road could reduce carbon emission and accident costs by around $16.50-$17, depending on the route taken.

Using BITRE estimates of current freight volumes on the corridor, rail is already contributing around $92m of benefits each year. Looking at forecast freight volumes, which only see modest increases in rail's modal share, by 2030 rail is forecast to contribute around $227m in today's dollars. Some more scenarios are provided in the table below.

Table 5.1: Potential yearly rail benefits on the north-south corridor ($m)

Year	Base case	20% rail modal share	30% rail modal share	40% rail modal share
2011	92.0	148.9	223.3	297.8
2020	159.3	233.5	350.2	466.9
2030	226.6	314.6	472.0	629.3

However, the realisation of these potential benefits cannot be achieved with today's infrastructure. Today's north-south corridor infrastructure faces an immediate capacity constrain in the north of Sydney and ongoing constraints in the years beyond. The investments required to allow growth in rail, both natural and in the event of a modal shift, are outlined below.

These investments are large in both scale and dollars but should be compared to investments which attempt to expand the existing road network in populated areas. It is these urban areas which constrain road capacity along the same route. Retrofitting a major urban highway is an extremely costly exercise, as exemplified by the M5 and M4 expansions in Sydney. These major investments could also start Australia down a path towards more reliance on rail and break away from the current situation where past investment in road infrastructure has determined current preferences for road transport.

5.1.3 Required investments

The initial investment required to free up capacity on the north-south corridor is to establish the northern Sydney freight corridor (NSFC). A project outline for the NSFC has recently been made by Transport NSW (2010a). The proposed NSFC is not a separate freight line but is, instead, a series of augmentations to the existing shared network which would allow passenger and freight trains to interoperate more freely and would therefore create additional freight train paths. The proposed NSFC would operate in three stages, initially increasing the daily number of train paths from 16 to 26 in both directions while stage two would increase this to at least 33 paths in both directions. Stage three would transition towards a dedicated freight line

The NSFC is forecast to cost around $1.2bn for stage one, $3.4bn for stage two and $3.2bn for stage three, for a total of around $7.8bn. This expenditure would be spread over the next 12 years and so, in present value terms the capital cost is around $5.2bn. Of this, $0.8bn has already been allocated under the Nation Building program. This leaves an unfunded capital cost of around $4.4bn in present value terms.

Another infrastructure investment likely to be required is that of intermodal terminals in Sydney and Melbourne. In Sydney, the most likely candidate is for a terminal at Moorebank (ARTC 2008). This terminal has recently been estimated to have a capital cost of around $700m but would likely be privately funded. In Melbourne, a new intermodal terminal would likely be located to the west of the city. Both of these new terminals would be located closer to the current industrial centres of the cities, as compared to the older terminals at Chullora and Dynon which are now not at the industrial heart of the city, and could also be configured to allow for double stacking.

The introduction of double stacking on the north-south corridor would likely follow on from the introduction of double stacking on the east-west corridor. Allowing double stacking on the east-west corridor would require significant works on the stretch of track from Cootamundra to Sydney, estimated to be around $214m. Introduction of double stacking on the north-south corridor could, potentially, follow on from this initial investment by making incremental investments to the track between Cootamundra and Melbourne, estimated at around $107m (ARTC 2008).

A number of other projects including deviations, passing lanes and duplications are also considered necessary by ARTC in order to meet demand growth that would occur in the presence of a modal shift to rail. These other projects could amount to around $2.4bn in the period to 2020 (ARTC 2008).

A somewhat separate, but interconnected, issue is the treatment of freight within Sydney. These two issues are interconnected as internal freight takes up train paths which could be dedicated to interstate freight. Key issues here are the potential expansion of Port Kembla, which could lead to more trains travelling into Sydney. This could be offset by improvements to the Illawarra line, or potentially by re-construction of the Maldon-Dombarton line. The Maldon-Dombarton line was partially completed in the 1980s and would currently cost around $0.55bn to complete (Connell Hatch 2009). Other potential future freight issues within the Sydney network are the movement of coal from a new coal mine at Warnervale to Port Waratah, possibly costing around $150m, and the movement of thermal coal to the power stations at Lake Macquarie.

5.2 Sydney's passenger network

5.2.1 The network today

Sydney's metropolitan network extends from the Hunter south to the Southern Highlands and west to the Blue Mountains. The Sydney metropolitan network is highly complex, connecting 307 stations and averaging around one million passenger trips each weekday. Some of the complexity of the Sydney network arises from the fact that it combines a metro-style system, which serves underground stations at frequencies up to 20 trains per hour in the city, with a suburban rail system. This means that the same trains and track must fulfill dual purposes. This complexity is increased as trains serving different routes share common infrastructure and so delays on one route can easily spread across the network.

During the one hour peak of morning travel around 100,000 people are transported by train in Sydney, a single train operating on the RailCorp network moves around 875 people on average (on some routes an average train can moves up to 1280 people).

5.2.2 The need for and benefits of investment in rail

The Sydney passenger network is a radial network, spreading out from the key city stations of Central, Town Hall. Wynyard and North Sydney. It is these stations, and the flow of passengers towards the city, which currently constrains capacity. Capacity through the CBD theoretically allows for the passage of 20 trains an hour. Currently the number of paths used ranges from 14 to 19 and is constrained by factors such as the mix of stopping patterns, congestion at key junctions and rollingstock availability. There is an additional line which terminates at Central Station, theoretically capable of carrying 24 trains an hour, but which does not enter the city itself and so currently only carries up to 14 trains an hour.

The rail clearways program seeks to obtain the full 20 trains per hour capacity through the six lines at Town Hall station. This program is essentially aimed at getting the most out of the existing available infrastructure. The extra capacity delivered by the rail clearways program will require extra rollingstock. Although there is currently a program to acquire extra carriages, which will also allow all suburban trains to be built up to eight cars long, there will not be sufficient rollingstock to fully utilise the available capacity.

The city stations themselves are also constrained by their ability to physically accommodate passengers and move passengers into and out of trains. The mix of suburban style carriages and multiple destinations being serviced from single platforms do not allow for the complete clearing of platforms or the efficient unloading and reloading of trains. This constraint reflects the fact that the major city stations were designed and constructed in the 1920s and 30s and that redevelopment is difficult due to the need to also redevelop surrounding areas of the city to accommodate larger stations.

Putting these two effects together, the Sydney metropolitan network is currently constrained by capacity, both in terms of rail paths and platform space, in the city itself.

Even though the network is currently approaching capacity, there would be large benefits to be gained from inducing a further shift towards rail. Modelling using TRESIS, further discussed in Appendix A, indicates that if a congestion charge and a carbon tax were introduced the number of passengers travelling via rail could immediately increase by around 146 million journeys a year or by up to 212 million journeys a year by 2025. This would represent an almost doubling of passenger journeys compared to the base case for 2025.

Using the costs estimated earlier, this modal shift would lead to around a $1.2 billion a year reduction in costs in 2011 or almost $25bn in the period to 2025. These savings in accidents, carbon emissions and congestion costs would also have to be added to the revenue raised for government from a carbon tax and a congestion charge.

Using the current average number of passengers per train, this modal shift caused by policies that align prices and costs, would require an extra 95 trains to be running per hour of the peak, on average. This number of trains would not be able to be accommodated given the current available infrastructure.

Instead of looking at the effect on modal choice that would result from a radical policy shift, we could also consider how the Sydney metropolitan network might expand under natural growth conditions. Considering the increase in population and other key variables that might occur within Sydney by 2015, in the absence of any policy interventions, TRESIS provides the following estimates:

Table 5.2: Change in key transport indicators in Sydney from 2010 to 2025

Indicator	Change by 2025
Population	767,240
Annual rail passenger journeys	27,417,000
Annual road vehicle journeys	491,525,000
Vehicle Kilometres	5,343,500,000
CO_2 emissions (tonnes)	105,930
Average car journey length (metres)	140

In this base case, it is clear that road transport plays a dominant role in accommodating the increased number of journeys demanded. If rail was to play a larger role in accommodating this increase then there would be significant benefits. Estimates of these benefits are given in Table 5.3. This table gives scenarios where the base case of only 5% of additional trips being serviced by rail increases to 10%, 20% and 30%.

Table 5.3: Cost savings from increased rail usage in Sydney in 2025 ($2010 million)

	Base Case	Scenario 1	Scenario 2	Scenario 3
Road/rail share of extra journeys	95/5	90/10	80/20	70/30
Accident costs saved	0	25.6	77.4	129.1
Congestion costs saved	0	179.8	542.7	905.5
CO_2 emissions costs saved	0	0.6	1.9	3.1
Total	**0**	**206.1**	**622.0**	**1,037.8**

Different infrastructure investments would be required by these different levels of rail modal share. The precise cost of the investments would depend on how intensely different parts of Sydney experience the modal shift. However, as the average journey length for cars is forecast to increase by 2025 this indicates that there is likely to be strong growth in outer lying areas of Sydney (such as the north-west and south-west growth regions). This indicates the potential need for extensions of motorways into these new areas. Extensions of train networks into these areas are considered in the following section.

5.2.3 Required investments

Planning for investment in commuter rail should be made in an integrated way. That is, rail planning should align with bus and light rail planning. Bus and light rail can work as complements to rail travel by providing a feed in mechanism or by providing redundancy and overflow ability. Having said this, there are a number of stand-alone infrastructure investments that need to be made in rail in order to accommodate natural growth in passenger numbers and any modal shift that could be induced.

The most immediate infrastructure investment that is required, and is currently planned with a funding guarantee as part of Sydney's metropolitan transport plan, is the Western Express project. The main element of this project is the construction of the City Relief Line which will extend a new line, and new platforms, from Redfern to Wynyard (these are key city stations). This new line will enable to full utilisation of an existing line which currently terminates at Central. The project will also allow the introduction of 10 and 12 car trains along the western line. Overall the project will increase the total number of available seats on the western line by 5000 per hour during the peak, an almost 60% increase in capacity. This could provide for around 19 million extra passenger journeys per year.

The Western express project is currently estimated to cost around $4.5bn (NSW Government 2010). If fully utilised at around 19 million journeys a year this would imply a benefit of around $161m a year or around 3.6% of the initial cost each year.

The other main project which is covered in the metropolitan transport plan is the northwest rail links. The northwest rail link would involve the construction of 23km of rail and 6 new stations in Sydney's northwest; this would bring passengers onto the existing RailCorp network at Epping. This link would serve one of Sydney's key current growth areas. Transport NSW estimates that currently only 7% of trips made by travelers who live in the northwest of Sydney are made public transport and that by 2021 road congestion in the area is expected to increase travel times by 50-70% (Transport NSW 2010b).

To be fully effective, and to avoid the capacity choke point of the Harbour Bridge, an integrated approach to the northwest link and the Western Express project would need to be implemented. This would see a second rail harbour crossing linked to the existing North Shore and proposed North West corridor.

The northwest rail link is estimated to cost around $3.8bn, excluding the second harbor crossing, and would allow for around 23.6 million passenger journeys per year (Transport NSW 2010b). This level of patronage would generate around $200m a year in benefits, this equates to 5% of the construction costs each year.

To accommodate the natural growth in Sydney, and rail transport, by 2030 it is envisioned that the RailCorp network would require the projects discussed above and would also include the South West Rail Link and the Parramatta to Epping Link. However, in order to accommodate a modal shift leading to the doubling of rail volumes there would also likely have to be additional investments, these could include projects such as:

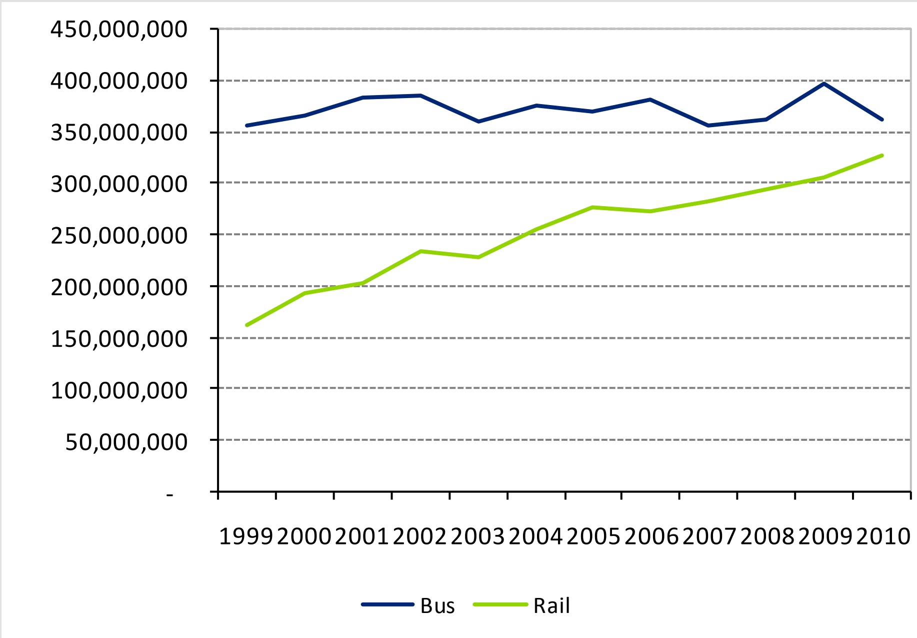
- track amplifications throughout the network:
    - north to Chatswood; and
    - west to Strathfield, Granville and Parramatta.
- Upgrading of Town Hall and Wynyard stations;
- two additional rail lines into the city; and
- grade separation at remaining flat junctions;

In addition to these expansions there would also, likely, need to be increases in other public transport facilities, such as bus and light rail, consideration of the introduction of more metro style trains, improved interchange locations, adequate maintenance and stabling facilities and altered land use policy to employments centres in areas such as Parramatta, Penrith and Liverpool.

Case study: Light rail in Portland, Oregon

The city of Portland, Oregon in the US is largely viewed to have implemented a successful light rail system, coupled with 'transit oriented neighbourhoods'. The investment in light rail has successfully led to the take-up of rail transport by commuters, as rail ridership in Portland over the last decade has grown much more strongly than has bus ridership (shown in 0 below). Residents living in these neighbourhoods have been found to own fewer cars, drive less and use public transport more than they otherwise would (Litman 2010). Specifically, 30% of residents moving into these neighbourhoods reduce their vehicle ownership, while 69% increase their use of public transport. This trend may explain Portland's success in curbing congestion delays. Between 1998 and 2003, Portland's population grew by 14%, however per capita congestion delays did not increase (Litman 2010).

Chart Box.2: Passenger kms travelled in Portland by bus and train, kms



Source: Trimet (2010), Access Economics calculations

The introduction of metro style trains could be achieved on the existing RailCorp infrastructure, by the addition of new metro only lines or, most likely, by some combination of the two. Metro trains may help to overcome problems of boarding and alighting trains as metro trains have more and larger doors but introduce other problems relating to increased rolling stock requirements, signalling needs and stabling facilities.

5.3 Elsewhere in Australia

Although these two case studies have been selected, there are critical bottleneck and infrastructure projects all around Australia.

At the top of the list is likely to be the Cross River Rail project in Brisbane. This project would provide an alternate path for trains to cross the Brisbane River, currently trains running on the Gold Coast, Beenleigh, Cleveland, Ferny Grove, Airport and Doomben lines must travel across the Merivale Bridge. This bottleneck presents a capacity constraint to the Brisbane network. There is currently a detailed feasibility report being prepared but the recent natural disasters in Queensland have led to a delay in the project timeline.

Other significant infrastructure projects, with longer time horizons for investment, would include:

- An inland rail route between Melbourne and Brisbane. This route would allow for faster movement of freight by creating a modern infrastructure and allowing for the problems raised by the Sydney network to be avoided.
- A high speed rail network in Australia's southeast. This network could potentially connect Brisbane, Melbourne, Sydney and Canberra as well as some regional cities in the area. This network would reduce air and road congestion, allow for regional development, defer the construction of a second airport in Sydney and reduce costs arising from carbon pollution and accidents.

6 Other considerations

Rail transport also has other benefits, not identified above.

Rail transport can be powered by electricity generated by many different sources. The use of electricity is a key advantage for rail as both domestic fossil fuels, such as natural gas and coal, or even renewable energy sources can be used to generate electricity

This should be compared to Australia's current oil intensive approach to fuelling transport. Unleaded gasoline and diesel oil contributed 94% of road transport's energy consumption in 2008-09. Investment in rail transport would therefore provide some insurance against an increased scarcity, and price, of oil.

An effective rail based passenger transport system can improve economic productivity and create wider benefits for the economy. This is created through more efficient land use patterns (such as higher density and clustering) as well as enhanced land values.

Future investment in the rail network has the potential to play a wider role in achieving long term government objectives. It has the capacity to contribute towards social benefit, through society-level outcomes associated with a rail network, such as moving the economy towards a less oil-reliant logistics chain and through an increase in the value of land in proximity to future rail network investments. These broader benefits should be additional considerations for government policy in decisions affecting modal choice and planning.

6.1 Fuel security

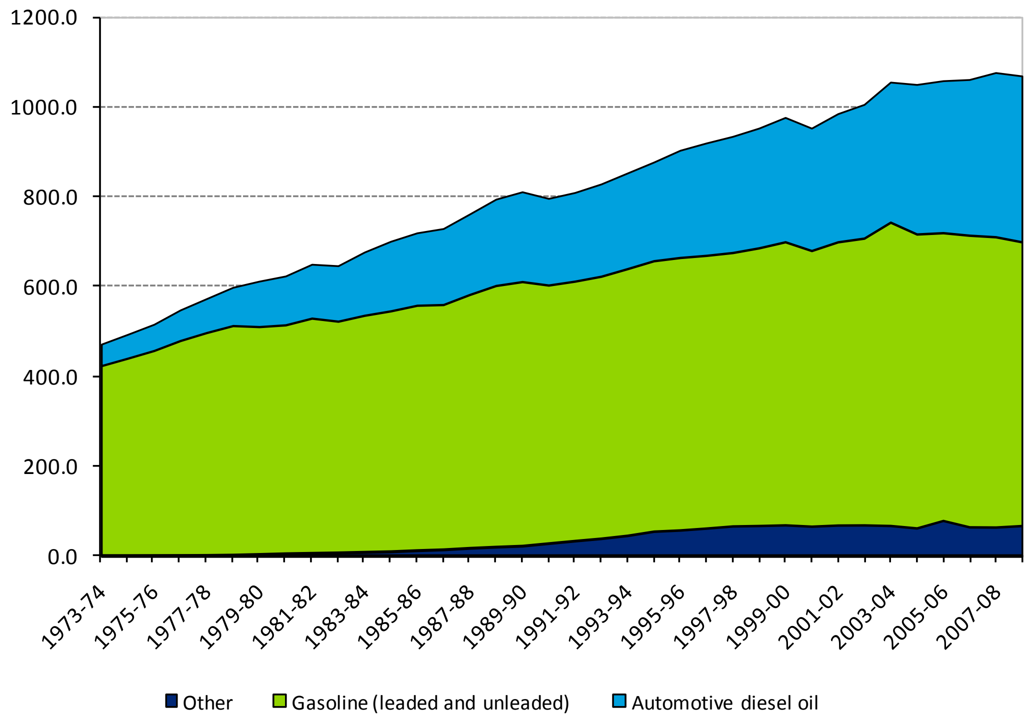
Planning for a less oil-dependent economy and future is a visible concern of the Australian Government. This goes back to 2007 when the Senate Rural and Regional Affairs and Transport Committee Inquiry stated that 'corridor strategy planning [should] take into account the goal of reducing oil dependence' (quoted in Laird 2007). The Department of Resources, Energy and Tourism (DRET) is currently working on producing an Energy White Paper in order to set policy directions for Australia's long term energy security, with the aim or reducing reliance on fossil fuel related greenhouse gas emissions. DRET has also released a report into Australia's liquid fuel vulnerability (ACIL Tasman 2008) and a National Energy Security Assessment (DRET 2009), noting that energy security is a priority of the government.

A member of the board of Infrastructure Australia, Professor Peter Newman, has brought attention to the symbiotic relationship between urban planning and oil dependency, with a strong focus on the role of transport. He has recently contributed to a Planning Institute of Australia study that recommends an overhaul of transport and urban policies to limit urban sprawl in the face of increased reliance on oil imports. Professor Newman is also reported to have recommended that every State should duplicate a Queensland law requiring an 'oil dependence test' for new developments (West 2010).

The current transport task in Australia is oil intensive as most of the energy consumed in this industry is by road transport, which is dependent on fossil fuels for its energy. Chart 6.1 shows that in Australia, road's total energy consumption has more than doubled over the last three decades. It is also highly reliant on fossil fuels, with unleaded gasoline and diesel oil contributing 94% of road transport's energy consumption in 2008-09. In addition, there are next to no renewable energy sources available to power energy consumption for vehicles; in 2008-09 bio-fuels contributed a meagre 0.005% of total energy consumption for road transport.

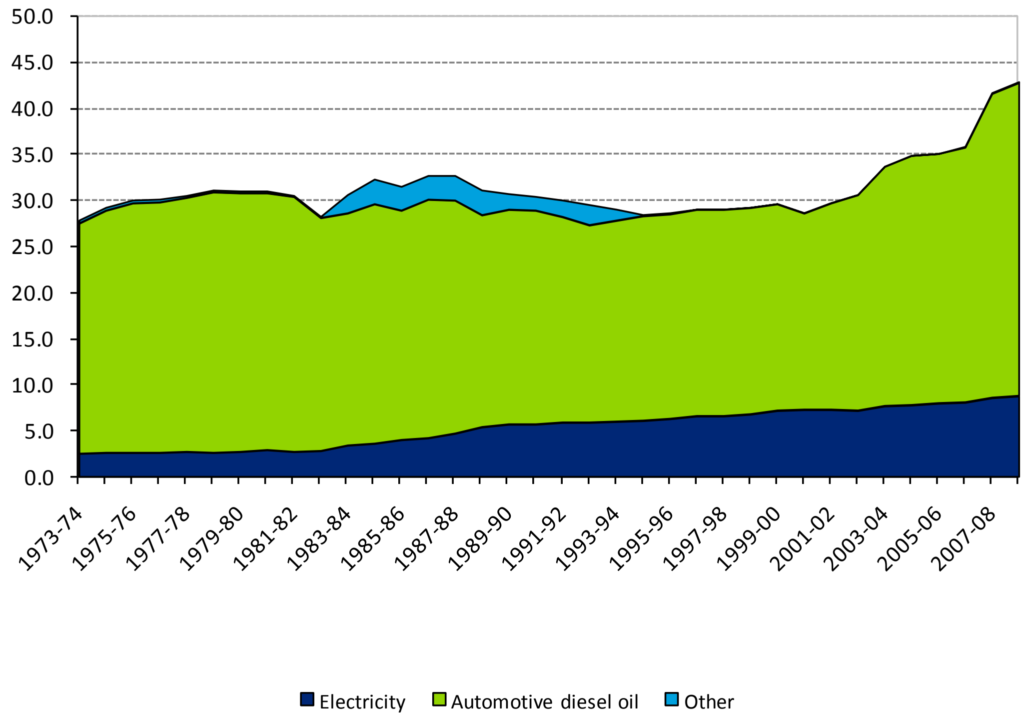
Rail's total energy consumption has remained fairly steady over the same three decades and its total energy consumption is on a much smaller scale than that of road. In 2008-09, rail transport consumed only 4% of the amount of energy consumed by road. Rail is also reliant on a more diverse range of fuels for its power, including electricity which contributed 20% of rail energy consumption in 2008-09. The use of electricity is a key advantage for rail as both domestic fossil fuels, such as natural gas and coal, or even renewable energy sources can be used to generate electricity. The use of electricity therefore makes rail transport far more resilient to fuel security concerns than road transport.

Chart 6.1: Total road transport energy consumption by fuel type, energy units



Source: ABARE (2009)

Chart 6.2: Total rail transport energy consumption by fuel type, energy units



Source: ABARE (2009)

The OECD sees a potential role for rail transport in decoupling economic growth from greenhouse gas emissions and for meeting future growth in freight transport. In relation to the transport of passengers, they suggest that measures involving low investment costs and short implementation periods, such as improving rail service quality or the accessibility of rail and public transport, are an important first step in any effort to decouple economic growth from transport-related CO_2 emissions (OECD 2006). Rail is also viewed favourably as an option for freight transport. The OECD (2010) finds that there is considerable scope for improved rail efficiency through shorter transit times and reduced costs, in the face of expanding global demand for the transport of freight. This is in contrast to other modes of transport that have limited scope for improved transit times and are unlikely to curtail their levels of CO_2 emissions.

The Prime Minister's task group on energy efficiency has also found that Australian energy efficiency strategies have not dealt with the improvements that could be achieved by greater use of public transport. The task group has found that the result of this has been to lock in high emissions, high energy transport networks for decades to come. It recommends explicit linking of Australian Government transport infrastructure funding to energy efficiency outcomes (2010).

Given that rail has less reliance on oil than road and that it currently has greater potential to diversify away from fossil fuel consumption, investment in a rail network would provide some insurance against a future scarcity of oil supply. Such a change in both urban and inter-state transport and freight planning would help to address the concerns raised by DRET and the Planning Institute of Australia.

6.2 Broader economic benefits

An effective rail based passenger transport system can improve economic productivity and create wider benefits for the economy. Essentially, having a rail network, whether it is a metropolitan system or an inter-state system, increases the value of being in proximity to that network.

There is evidence that both households and firms change their behaviour in response to a change in transport infrastructure (OECD 2008) and this can lead to a changing approach to land use, with wider flow-on economic benefits. Examples of such benefits include increased productivity, agglomeration, competition and the thickening of the labour market (OECD 2008), as well as increases to the value of land proximate to a public transport network (Litman 2010).

Litman (2010) finds that rail passenger transport systems encourage more efficient land use patterns, where multiple metropolitan areas of business activity arise, centred on important stations. Improved land use through increased density and clustering then provide agglomeration benefits, which increase productivity through improved accessibility and network effects.

Similarly, the improved accessibility and inter-connectedness provided by a rail network may create increases in property values. A summary review of various studies into the effect of proximity to rail lines in European and American cities finds that properties located near railway stations can have up to a 50% increase in property values (Hass-Klau et al 2004 referenced in Litman 2010).

These effects are possible as a result of investments in metropolitan and regional rail networks. At the metropolitan level, investments in passenger rail infrastructure will be beneficial for Australia's major cities as populations become denser and the need for mass transit increases. These benefits would also be expected to increase over time due to the increasing returns to scale and network effects that should arise as rail networks expand. Benefits would also increase through a system based on optimising the complementarities between bus and rail passenger transport, whereby rail lines form the backbone of the network but may work with bus networks to increase the reach of the public transport system (Kenworthy 2008).

At the regional level, if a very fast train (VFT) network eventuates, similar benefits would be derived from regional centres that are nodes along this network. For example, high speed rail has been associated with the economic and social recovery of regional centres in Europe (Infrastructure Partnerships Australia and AECOM 2010). There is, however, a trade off in the planning for a VFT route whereby more stops will lead to more areas where land values increase, but more stops also reduce the speed of the train, limiting the benefits of the service.

Case study: High speed rail in China

China already has the world's largest network of dedicated high speed railways and is currently investing to expand this further. This comprises 3,400km of track that was built between 2003 and 2010, and an additional 6,700km that was under construction in 2010 (BITRE 2010). By 2012, 42 high speed lines in China are scheduled to be operational (Bradsher 2010). 0 below shows China's high speed rail network, including routes under construction or planned for the future.

Chart Box.3: China's high-speed railways

Source: BITRE 2010

The use of high speed rail suits China's geographical spread, dense population centres, system of central planning and ability to gain from economies of scale. As such, it has pioneered advances in high speed rail technology. For example, certain routes, such as that between Beijing and Tianjin, achieve the highest possible speeds, travelling at 350km/hour (BITRE 2010). The Chinese bullet train, travelling from the coastal industrial centre in Guangzhou to the inland city of Wuhan covers just over 1,000km in little more than three hours (Bradsher 2010). The line being built between Shanghai and Beijing will cover 1,318kms and is the most expensive engineering project in Chinese history (Forsythe 2009). The Chinese experience demonstrates that, as high speed rail becomes more common, the technology becomes easier to access, cheaper and less risky (IPA and AECOM 2010).

From 1990 to 2008, the average distance travelled by passengers on China's national railway system doubled from 275km to 534km, demonstrating the increased mobility of the population (Amos et al 2010). China also aims to achieve long-term benefits from its substantial investment in its high speed railways. This includes a slowing of China's dependence on private vehicles and imported oil, a reduction in air pollution and relief for annual shortages of seats during Chinese New Year (Bradsher 2009). It is also part of an asserted effort to free up existing track for the transport of freight (Schulz 2007).

It is difficult for rail infrastructure providers to capture these broader economic benefits. That is, these positive property value and city planning benefits are a positive externality which accrues to society at large. As such, private investment alone in rail infrastructure is unlikely to result in an efficient network size being achieved. There is a key role for government to play in ensuring that the broader economic benefits that rail provides for city planning are captured and the necessary infrastructure investment is made.

7 Implications for public policy

Australia is currently in a situation where the most desirable mix of transportation modes may be changing and if the right investments in infrastructure are to be made then decision makers must consider the true value of rail.

Considering a future with larger, denser cities the benefits associated with moving passengers from road to rail transport are likely to grow. This indicates that the benefits of rail calculated in this report, which are based on current levels of emissions, accidents and transport choices, may be conservative when thinking over longer time horizons.

For freight, when the benefits for each container shipped by rail and not road are multiplied up by the distances freight moves within Australia then the benefits are sizable.

There is a need for policy action to overcome current network constraints and realise the true value of rail to the Australian economy. Bold policy decisions, such as redirecting funds from a carbon tax towards public transport, should be considered. Failure to act will tie Australia further in to road based transport and would not allow the realisation of increasing returns to scale, environmental, productivity and social gains that could be seen if rail networks were encouraged to grow.

The main role for public policy in transportation is for making decisions related to infrastructure investments. These decisions include both the amount of funding to be delivered from government sources as well as other issues such as zoning and density decisions and protection of right-of-way for future rail and road corridors. In this sense, the role of government is forward looking. It must envision a likely and socially acceptable future and plan for the according infrastructure investments.

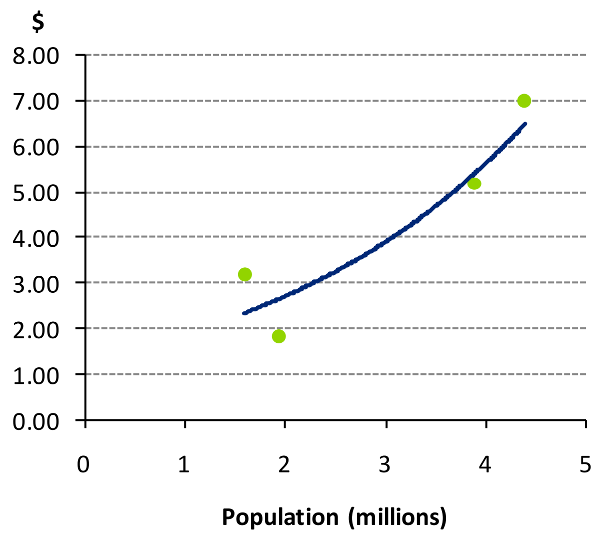
Australia is currently in a situation where the most desirable mix of transportation modes may be changing. If the right investments in infrastructure are to be made then decision makers must consider the true value of rail. The true value of rail includes issues identified in this report such as:

- Improved land use and urban densification;
- reduced carbon emissions;
- reduced congestion;
- reduced accidents;
- removing barriers to social inclusion;
- improving land values; and
- enhanced energy security.

Many of these factors flow from decisions about how we want our cities to function. Over time, increasing populations mean that there will either be a continued spread of our cities or increased densification (or likely some combination of both). Under both scenarios there is a key role for rail to play, either through mass transport within dense metro areas or by connecting far flung suburbs. The costs of investment in rail must also be compared to the costs of retrofitting road networks to meet population growth. Consider, for example, the recent estimate that the M4 east expansion in Sydney could amount to around $4.7-5.6 billion; this is well above $500m per km (NRMA 2011).

Considering a future with larger, denser cities the benefits associated with moving passengers from road to rail transport are likely to grow. It was shown earlier that congestion costs are currently the largest components investigated in this report. When comparing different Australian cities we find a strong and ever increasing relationship between a city's population and the congestion cost that was identified, this is shown in Chart 7.1.

Chart 7.1: Relationship of congestion costs ($) to city population



This indicates that the externality calculations made in this report, which are based on current levels of emissions, accidents and transport choices, may be conservative when thinking over longer time horizons.

For policy decision makers, thought must be put towards how rail infrastructure will be integrated into a transportation system which can adapt and respond to changes in urban sprawl and density over time. The transport system must be both able to cope with moving large numbers of people to a few areas during peaks and moving smaller numbers of people across a large city.

A similar story applies for regional and interstate passenger transport. Australia is in a somewhat unique international situation with a relatively small number of quite large cities separated by long distances. This is, however, changing. There is a growing belt of regional centres arising along the eastern coast and, over the next 30 to 50 years, the prospects for rail passenger transport along Australia's eastern coast will improve. For the benefits of rail in connecting these regional centres to Australia’s main cities, high level planning must commence soon.

For freight, the true value of rail far exceeds its nominal value. When the benefits for each container shipped by rail and not road are multiplied up by the distances freight moves within Australia then the benefits are sizable and compare to the internal costs of transport itself.

On the north-south corridor, where there is significant room for rail to grow its market share, it is currently being held back by inefficient network infrastructure which leads to reliability issues. The main constraint on the north-south corridor is currently in the Sydney metropolitan network. Trains attempting to move through the network must avoid peak passenger periods. This is complicated by a lack of necessary infrastructure in the north of Sydney. There is currently only a single extra freight train path available each day heading north out of Sydney and this path is likely to be used up within the next year or two. The north-south corridor is therefore facing imminent capacity constraints which will hamper any growth in rail freight along the east coast. This constraint could be alleviated with investment in the north Sydney rail freight corridor, which has been proposed to Infrastructure Australia but is currently only partially funded.

The Sydney metropolitan network itself is also facing constraints; this is caused by the radial nature of network, where capacity in the CBD limits capacity throughout the entire network. The rail clearways program is attempting to extract as much as can be from the existing infrastructure but is quickly approaching the limits of what is possible. Investment will soon be needed, and is planned, to add a new rail line through the CBD and to increase capacity on the western line. Looking further out, there is also a need to supply rail to Sydney’s growth areas in the north and south west regions.

Overall, there is a need for policy action. Rail is a sector where today’s policy decisions will seriously affect the future. The long lived nature of transport assets effectively locks consumers’ choices into whatever infrastructure has been provided to them. In the face of increasing population, more congestion, climate concerns, the need to retrofit existing arterial roads and energy supply issues, there is a key role for rail.

There is a place for multiple approaches to achieving investment and development of rail in Australia. This could be through public, private or PPP funding and at either a state government or Australian Government level. No matter what the investment approach taken is, coordination is highly desirable and a national approach to rail is warranted.

The most prominent involvement of State governments has been in metropolitan rail. Metropolitan rail networks play a vital role in moving people and goods through Australia’s largest cities and are the point where most Australian’s directly feel the benefits of rail transport. State governments, through their metropolitan plans, therefore have an essential role to play in ensuring investments in rail infrastructure are made which keep pace with their growing cities and capture the full range of benefits that rail offers (including social inclusion, reduced congestion, reduced road accidents and reduced pollution).

In addition to making investments in rail, state governments can also focus on addressing existing inefficiencies in the pricing of road transport. This process is beginning with the

CRRP and attempts to ensure that heavy road freight vehicles are covering the costs they create. Following on from this, further reforms could be made to charge a per container levy on freight movements, to reflect the external costs such as congestion, created by road transport. This could then transition towards charging freight movements based on the use of arterial roads and finally towards mass-distance charging. Analogously in passenger transport would be movements towards congestion charging by initially having time of day tolls on arterial roads.

The Australian Government has a critical role to play in determining the future of rail in Australia. Being less focused on the operation and maintenance of rail networks themselves frees the Australian Government to take on a coordination and leadership role as well as their central funding role.

In terms of leadership, the Australian government can focus its own policies on rail and drive states towards a focus on rail through, for example, continued investigation of new rail developments and planning strategies, such as the national urban policy, which give rail a central role in meeting transport demand. The Australian Government is already playing a strong role here, with recent support for rail voiced in the national port strategy and a forthcoming land freight strategy as well as work being undertaken by CRRP. A greater sense of urgency is, however, required as Australia is currently at a point where well selected policy decisions could lead to rail playing a far larger role in meeting Australia's transport task.

In terms of funding, ideally, the benefits of rail (such as reducing congestion, carbon emissions and accidents) would be directly internalised using policy options such as carbon pricing, congestion charges and accurate vehicle registration fees. This approach is unlikely to be fully implemented in the short term and so a second best approach is for the Australian Government to take into account the full benefits of rail when considering which investments to support. This would involve fully accounting for all the benefits of rail when comparing investments in different modes of transport. This is, to a certain extent, already done but could be made more central to government considerations and more rigorous. A more straightforward version of this is to ensure that transport infrastructure investments are compared on a consistent basis. That is, the full costs of one investment should be weighed against the full costs of the alternative. For example, an investment in road based transport, such as buses, should account for ongoing road infrastructure and maintenance costs.

Funding from the Australian Government is also important in overcoming myopic investments. Given the past pattern of transport investment in Australia it is often the case that an incremental investment in road seems more appealing than an investment in rail. Following along this path will only lock Australia in more closely with road transport and will miss the opportunities presented by making use rail transport.

A series of bold and innovative policy options should be considered. Over the very short term, the CRRP process should be strongly pursued and supported with a goal of more closely tying truck operating costs to the actual costs they create (including damage to road infrastructure, emissions, accidents and noise).

In the coming years, allocating some of the funds from a carbon tax to the development of public transport networks could present a particularly appealing policy. Using funds from a carbon tax to invest in sustainable transport infrastructure would not only help to reduce the carbon emissions from transport, and hence reduce its costs, but, by creating more useful public transport options, would also help to reduce congestion and accident costs. Funds raised through a carbon tax also create fewer economic distortions than funds raised through other taxes. This is because a carbon tax affects economic activity by reducing a damaging behaviour (polluting) while other taxes tend to affect the economy by reducing a beneficial behaviour (production, employment, consumption). It has been proposed that a 'double dividend' could be achieved by using the funds raised from a carbon tax to reduce other, less efficient, taxes. However, a 'double dividend' could also be achieved by investing in rail infrastructure which reduces costs related to accidents and congestion.

In the longer term, introducing congestion charging in Australia's capital cities and levying a per tonne charge on road freight transport within cities should be seen as overall policy goals. A congestion charge has similar goals to a carbon tax, making those who create costs bear them. Congestion charging would work by having a charge for the use of a road which varies based on how congested the road is. Ideally the price would be set to equal the additional time costs that each driver entering the road creates for other drivers using the road. Although a large departure from how roads are currently priced in Australia, much of the infrastructure required for congestion pricing is already established. Many cars are already equipped for electronic tolling and many arterial roads already being toll roads. There is also rudimentary congestion pricing in effect with time of day tolling on the Harbour Bridge. Implementation of congestion charging is therefore more likely to be a question of political will and whether the benefits outweigh the costs of implementation rather than technical feasibility.

Levying a per tonne charge on road transport within cities is a move towards a long term goal of mass-distance pricing for road freight. Mass-distance pricing is the most desirable method to more closely tie truck operating costs to the true costs they create. A per tonne charge would account for mass while confining the charge to arterial toll roads would allow for distances to be estimated. Implementation of mass-distance pricing is hampered by a lack of data (and data gathering methods) for both road freight distance and weight. If implemented, a per tonne charge on road transport could be used to both internalise the damage that heavy road vehicles cause to the road as well as other externalities associated with road transport, such as carbon pollution, accidents and noise.

Overall, there is a key role for rail to play in the future of Australia's transport system. This role will be growing over time as the size and density of our cities as well as the amount of freight moved around the country increases. Policy makers will have a decisive role in determining the success of rail transport due to decisions about the future of our cities' density and sprawl, reserving right-of-way and providing funding for infrastructure investment. Policy makers must focus on the true value of rail. If the true value of rail is not taken into consideration then there will be underinvestment in Australia's rail infrastructure and underdevelopment of the rail network. This would tie Australia further in to road based transport and would not allow the realisation of increasing returns to scale, environmental, productivity and social gains that could be seen if rail networks were encouraged to grow.

References

ABARE 2009, *Australian energy consumption, by industry and fuel type – energy units*, http://adl.brs.gov.au/data/warehouse/pe_abarebrs99001693/energyUpdateTableF2008-09.xls, accessed 21 February 2011.

ABS 2008, *Population Projections,* http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/0E09CCC14E4C94F6CA2574B9001626FE/$File/32220_2006%20to%202101.pdf

ACG (Apelbaum Consulting Group), 2008. *Australian Rail Industry Report*.

ACIL Tasman 2008, *An assessment of Australia's liquid fuel vulnerability*, http://www.ret.gov.au/energy/Documents/Energy%20Security/Liquid%20Fuel%20Vulnerability%20Assessment.pdf, accessed 16 February 2011.

Amos, P, Bullock, D and Sondhi, J 2010, *High-speed rail: The fast track to economic development?*, http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2010/07/26/000334955_20100726032714/Rendered/PDF/558560WP0Box341SR1v08121jul101final.pdf, accessed 10 March 2011.

Australian Conservation Foundation 2009, *Investing in sustainable transport*, http://qccqld.org.au/docs/Campaigns/ClimateChange/Transport%20Report%20V9-LOW.pdf

Australian Rail Track Corporation (ARTC) 2008, *2008-2024 Interstate and Hunter Valley Rail Infrastructure Strategy*, http://www.artc.com.au/Content.aspx?p=186

Australian Transport Council 2006, *National Guidelines for Transport System Management in Australia – 4: Urban Transport*, Commonwealth of Australia, http://www.atcouncil.gov.au/documents/ngtsm.aspx

Australian Transport Council 2009, *COAG Road Reform Plan: Phase I Report*, http://www.atcouncil.gov.au/documents/files/COAG_road_reform_plan.pdf, accessed 14 February 2011.

Australian Transport Safety Bureau (ATSB) 2010, *Australian Rail Safety Occurrence Data 1 January 2001 to 30 June 2010,* ATSB Transport Safety Report RR-2010-008.

Bain, S and Hensher, D. A 2008, *TRESIS 1.4M: Policy Assessments for Melbourne with special reference to fuel prices.*

Booz & Company 2009, *Final Report – Towards Co-modalism*, http://www.ntc.gov.au/filemedia/Reports/IntermodalSupplyChainFinMar09.pdf.

Bradsher, K 2009, 'China's route forward', *The New York Times*, 22 January: B1, http://www.nytimes.com/2009/12/23/world/asia/23iht-letter.html, accessed 10 March 2011.

2010, ‘China sees growth engine in a web of fast trains’, *The New York Times*, 12 February: B1, http://www.nytimes.com/2010/02/13/business/global/13rail.html?_r=2&pagewanted=all, accessed 10 March 2011.

Bureau of Infrastructure, Transport and Regional Economics (BITRE) 2009a, *Greenhouse gas emissions from Australian transport: projections to 2020*, working paper 73, Canberra ACT.

-2009b, *Cost of road crashes in Australia 2006*, Research Report 118.

-2009c. *Australian Transport Statistics Yearbook*, BITRE, Canberra, Australia.

-2009d *Information sheet 34 - Road and rail freight: competitors or complements?,* http://www.bitre.gov.au/publications/23/Files/IS34_RoadRailFreight.pdf

-2010a. *Australian rail freight performance indicators 2007–08*, BITRE, Canberra, Australia.

-2010b. *Population growth, jobs growth and commuting flows in Perth*, http://www.bitre.gov.au/publications/75/Files/perth.pdf

-2010c, *Internal brief: A profile of high-speed railways*, http://www.bitre.gov.au/publications/77/Files/A_profile_of_high-speed_railways.pdf, accessed 17 December 2010.

Bureau of Transport Economics 1999, *Competitive Neutrality Between Road and Rail*, http://www.bitre.gov.au/publications/74/Files/wp40.pdf

Bureau of Transport and Regional Economics (BTRE) 2003, *Rail accident costs in Australia*, Report 108.

-2006, *Demand projections for AusLink Non-Urban Corridors: Methodology and Projections*, http://www.btre.gov.au/publications/72/Files/AusLinkDP_FullReport.pdf

Business Council of Australia 2009, *Groundwork for growth: Building infrastructure that Australia needs*, http://www.bca.com.au/Content/101615.aspx, accessed 7 December 2010.

Connell Hatch 2009, *Maldon-Dombarton Rail Line Pre-Feasibility Study For Port Kembla Port Corporation*, http://www.nationbuildingprogram.gov.au/publications/reports/pdf/Maldon_Dombarton_Freight_Rail_Line_Pre_feasibility_Study_Final_Report.pdf.

Council of Australian Governments Road Reform Program (CRRP) 2010, *Heavy Vehicle Pricing Options: Development and assessment framework*, http://www.roadreform.gov.au/DesktopModules/Bring2mind/DMX/Download.aspx?TabID=81&Command=Core_Download&EntryId=756&PortalId=0&TabId=81

CRAI, 2008, *Value of CityRail externalities and optimal government subsidy*, http://www.ipart.nsw.gov.au/files/CRAI%20report%20-%20CityRail%20Externalities%20-%206%20June%202008.PDF

CRC for Rail Innovation 2009, *Paper 5: The Transport Operators*, http://www.railcrc.net.au/sites/default/files/managed/files/r1106-paper-5-transport-operators.pdf, accessed 28 January 2011.

Department of Foreign Affairs and Trade 2008, 'Land transport in Australia', http://www.dfat.gov.au/facts/land_transport.html, accessed 16 February 2011.

Department of Infrastructure 2005, *Guideline on Economic, Social and Environmental Cost-benefit Analysis,* Melbourne, Australia, Planning and Policy Division, Department of Infrastructure.

Department of Infrastructure and Planning 2010, *South East Queensland: Infrastructure plan and program 2010-2031*, http://www.dip.qld.gov.au/resources/plan/SEQIPP/dip-seqipp-10.pdf, 17 December 2010.

Department of Infrastructure and Transport 2007a, Sydney-Brisbane corridor strategy, http://www.infrastructure.gov.au/transport/publications/files/Sydney_Brisbane_Corridor_Strategy.pdf.

- 2007b, Sydney-Melbourne corridor strategy, http://southernhighlandsbusiness.com/documents/Sydney_Melborne_Corridor_Strategy.pdf.

-2007c, Melbourne-Brisbane corridor strategy, http://www.infrastructure.gov.au/transport/publications/files/Melbourne_Brisbane_Corridor_Strategy.pdf.

-2010a, 'Building Australia Fund projects', http://www.infrastructure.gov.au/infrastructure/baf/baf_projects.aspx, accessed 16 February 2011.

-2010b, 'Road to Recovery program funding allocations 2009-2014', http://www.nationbuildingprogram.gov.au/funding/r2r/, accessed 16 February 2011.

Department of Infrastructure, Transport, Regional Development and Local Government 2009, *A national framework for regulation, registration and licensing of heavy vehicles: Regulatory impact statement*, http://www.infrastructure.gov.au/roads/vehicle_regulation/ris/files/HV_RIS_8May2009.pdf, accessed 15 December 2010.

Department of Resources, Energy and Tourism 2009, *National Energy Security Assessment*, http://www.ret.gov.au/energy/Documents/Energy%20Security/National-Energy-Security-Assessment-2009.pdf, accessed 16 February 2011.

Department of Transport 2008, *The Victorian Transport Plan*, http://www4.transport.vic.gov.au/vtp/pdfs/vtp.pdf, accessed 15 December 2010.

Department of Transport and Main Roads 2010, *Draft Connecting SEQ 2031: An integrated regional transport plan for South East Queensland*, http://www.connectingseq.qld.gov.au/Libraries/Publications/Draft_Connecting_SEQ_2031.pdf, accessed 17 December 2010.

The Economist, 2010, *High-speed rail-roading*, http://www.economist.com/node/16636101

Everett, S 2006, 'Deregulation and reform of rail in Australia: Some emerging constraints', *Transport Policy*, 13: 74-84.

Forsythe, M 2009, 'Is China's economy speeding off the rails?', *The New York Times*, 22 December, http://www.nytimes.com/2009/12/23/world/asia/23iht-letter.html, accessed 10 March 2011.

Hensher, D.A., 2008, *Climate change, enhanced greenhouse gas emissions and passenger transport- what can we do to make a difference?* Transportation Research D 13 (2), 95-111.

Hensher, D.A., Stopher, P.R., Bullock, P. and Ton, T, 2004, *TRESIS (Transport and Environmental Strategy Impact Simulator): Application to a Case Study in NE Sydney*, Transportation Research Record 1898, 114-123.

Hensher, D. A., Rose, J. M., de Dios Ortúzar, J., Rizzi, L. I., 2009, *Estimating the willingness to pay and value of risk reduction for car occupants in the road environment*, Transportation Research Part A 4, pp.692-707.

Hurni, A. 2006, *Transport and social disadvantage in Western Sydney, a partnership research project*, http://www.wscf.org.au/uploads/File/Transport_disadvantage_report_web.pdf

Independent Pricing and Regulatory Tribunal (IPART) 2008, Review of CityRail fares, 2009-2012, http://www.ipart.nsw.gov.au/files/Review%20of%20CityRail%20fares%202009-2012%20-%20Draft%20Report%20and%20Draft%20Determinations%20-%20October%202008.PDF

Infrastructure Australia 2010, State of Australian Cities, http://www.infrastructure.gov.au/infrastructure/mcu/soac.aspx

- 2011, *National Land Freight Strategy*, http://www.infrastructureaustralia.gov.au/national_freight/files/NLFS_220211.pdf, accessed 23 February 2011.

Infrastructure Australia and National Transport Commission 2010, *National ports strategy: Infrastructure for an economically, socially, and environmentally sustainable future*, http://www.infrastructureaustralia.gov.au/national_ports/files/National_Ports_Strategy_DEC2010_v2.pdf, accessed 10 January 2011.

Infrastructure Partnerships Australia (IPA) and AECOM 2010, *East coast high capacity infrastructure corridors: A realistic pathway to very fast trains*, www.infrastructure.org.au/DisplayFile.aspx?FileID=433, accessed 17 February 2011.

Infrastructure Partnerships Australia (IPA) and Price Waterhouse Coopers (PWC) 2009, *Meeting the 2050 freight challenge*, http://www.roadreform.gov.au/DesktopModules/Bring2mind/DMX/Download.aspx?TabID=82&EntryId=186&Command=Core_Download&PortalId=0&TabId=82, accessed 7 December 2010.

Kenworthy, J 2008, 'An international review of the significance of rail in developing more sustainable urban transport systems in higher income cities', *World Transport Policy & Practice*, 14 (2): 21-37.

Laird, P. 2005, *Revised Land Freight External Costs in Australia*, Paper presented to the 28th Australasian Transport Research Forum, Sydney, September.

Laird, P 2007, *Melbourne – Sydney – Brisbane rail options for 2014*, paper presented to AusRAIL PLUS 2007, Sydney, December 2007.

LECG 2009, *Value of Sydney bus externalities and optimal government subsidy*, http://www.ipart.nsw.gov.au/files/Consultancy%20Report%20-%20LECG%20Draft%20report%20on%20Value%20of%20Sydney%20bus%20externalities%20and%20optimal%20Government%20Subsidy%20-%2012%20May%202009.PDF

Litman, T 2010, *Rail transit in America: A comprehensive evaluation of benefits*, Victoria Transport Policy Institute.

Munger 2008, *Planning Order, Causing Chaos: Transantiago*, http://www.econlib.org/library/Columns/y2008/Mungerbus.html

National Road and Motorists Association (NRMA) 2011, M4 East Extension – Road to the future, http://www.mynrma.com.au/assets/About-PDF/M4-Report-NRMA.pdf.

National Transport Commission (NTC) 2006, Productivity Commission Inquiry Into Freight Infrastructure Pricing Submission, http://www.pc.gov.au/__data/assets/pdf_file/0004/47848/sub017.pdf

National Transport Commission 2009, *Single, national rail safety regulatory and investigation framework: Regulatory impact statement volume 1*, http://www.ntc.gov.au/filemedia/Reports/SingleNatRailRegInvRisVol1Jul09.pdf, accessed 7 January 2011.

NSW Government 2010, *The metropolitan transport plan*, http://www.nsw.gov.au/metropolitantransportplan

NSW Planning 2009, *Metropolitan Strategy Review: Sydney towards 2036*, http://www.metrostrategy.nsw.gov.au/LinkClick.aspx?fileticket=K3OvHZ6LP-I%3d&tabid=286&language=en-AU, accessed 7 January 2011.

NTC Review Steering Committee 2009, *Review of the National Transport Commission*, http://www.infrastructure.gov.au/transport/australia/ntc/files/NTC_Review_Report.pdf

Organisation for Economic Co-operation and Development 2010, *Globalisation, transport and the environment*, http://www.oecd.org/document/40/0,3746,en_2649_34363_44342184_1_1_1_1,00.html, accessed 16 February 2011.

-2008, *The wider economic benefits of transport: Macro-, meso and micro transport planning and investment tools*, Discussion paper no. 2008-6 at the Joint Transport Research Centre Round Table, Boston, October 2007.

-2006, *Decoupling the environmental impacts of transport from economic growth*, http://www.oecd.org/document/7/0,3746,en_2649_34363_37676487_1_1_1_1,00.html, accessed 16 February 2011.

Port of Hastings Corporation 2009, *Port of Hastings: Land use & transport stategy*, http://www.transport.vic.gov.au/DOI/DOIElect.nsf/$UNIDS+for+Web+Display/AC2341887EF73617CA25761F007F73DC/$FILE/PortofHastingsLandUseTransportStrategy.pdf, accessed 15 December 2010.

Port of Melbourne Corporation 2009a, *Port development strategy: 2035 vision*, http://www.transport.vic.gov.au/DOI/DOIElect.nsf/$UNIDS+for+Web+Display/070ED6E3108EBACFCA25761F007F5F86/$FILE/PortofMelbPortDevelopmentStrategy.pdf, accessed 15 December 2010.

2009 Container Logistics Chain Study, http://www.portofmelbourne.com/global/docs/CLCS-Summary-PoM-2009.pdf

Port Jackson Partners 2005, *The Future of Freight,* http://www.pjpl.com.au/media/553/futureoffreight.pdf

Prime Minister's task group on energy efficiency 2010, *Report of the Prime Minister's task group on energy efficiency 2010*, http://www.climatechange.gov.au/~/media/submissions/pm-taskforce/report-prime-minister-task-group-energy-efficiency.pdf

Productivity Commission 2006, Road and Rail Freight Infrastructure Pricing, http://www.pc.gov.au/__data/assets/pdf_file/0003/47532/freight.pdf

Roads and Traffic Authority (RTA) 2009, *Reducing petrol emissions*, http://www.rta.nsw.gov.au/environment/vehicleemissions/reducingpetrolemissions.html, accessed 16 February 2011.

- 2009, *M5 corridor expansion: Moving goods, people and the economy*, http://buildingsydneymotorways.com.au/attachments/099_M5%20corridor%20expansion%20overview.pdf, accessed 10 December 2010.

Sanderson, S. 2010, *The 30 Minute City*, http://www.planning.org.au/documents/item/2193

Schulz, G 2007, 'Passenger dedicated lines will spearhead CR's inter-city speed-up', http://www.railwaygazette.com/news/single-view/view/passenger-dedicated-lines-will-spearhead-crs-inter-city-speed-up.html, accessed 10 March 2011.

Stanley, J., 2007, Sustainability in land transport: the big picture, http://www.busvic.asn.au/database/files/JStanley-TheBigPicture.pdf

Stanley, J., Hensher, D., Stanley, J., Currie, G., Greene, W., Vella-Brodrick, D., 2011, *Social Exclusion and the Value of Mobility*, Journal of Transport Economics and Policy (JTEP), Volume 45, Number 2, May 2011 , pp. 197-222(26).

Sydney Ports Corporation (SPC) 2008, *Port freight logistics plan: A framework to improve road and rail performance at Port Botany*, http://www.sydneyports.com.au/__data/assets/pdf_file/0008/9998/Port_Freight_Logistics_Plan.pdf, accessed 15 December 2010.

- 2010, Annual report 2009/10, http://www.sydneyports.com.au/__data/assets/pdf_file/0019/14338/SPC_Annual_Report_2010.pdf

Transport NSW 2003, *Ministerial Inquiry into Sustainable Transport in New South Wales - Final Report*, http://www.transport.nsw.gov.au/sites/default/file/inquiries/parry-final-report.pdf

Transport NSW 2010a, *Northern Sydney Freight Corridor,* http://www.transport.nsw.gov.au/sites/default/files/publications/ia_submission_full_web.pdf

Transport NSW 2010b, *North West Rail Line,* http://www.transport.nsw.gov.au/sites/default/files/publications/ia_submission_full_web.pdf

Treasury 2008, *Australia's Low Pollution Future: The Economics of Climate Change Mitigation,* http://www.treasury.gov.au/lowpollutionfuture/report/html/00_Executive_Summary.asp,accessed 12 January 2011.

Trimet 2010, ‘Trimet service and ridership information’, http://trimet.org/pdfs/publications/trimetridership.pdf, accessed 10 March 2011.

West 2010, ‘Report warns of oil woes’, *The Age*, 28 December, http://www.theage.com.au/national/report-warns-of-oil-woes-20101227-198k2.html, accessed 16 February 2011.

Xu, B. and Milthorpe, F. 2010, *Analysis of Journey to Work Patterns in Sydney*, http://www.bts.nsw.gov.au/ArticleDocuments/82/CP2010-1-Analysis-of-Journey-to-Work-Patterns-in-Sydney.pdf.aspx

Appendix A: Overview of TRESIS

This appendix is derived from Hensher (2004).

The Transport and Environmental Strategic Impact Simulator (TRESIS) is a microsimulation package, developed at the Institute of Transport and Logistics Studies (ITLS), part of the University of Sydney. It is designed as a policy advisory tool to evaluate, at a strategic level, the affect of policy instruments on urban passenger travel behaviour and the environment. Versions of TRESIS have been developed which can be applied to Canberra, Sydney, Melbourne, Brisbane, Adelaide, and Perth.

As an integrated model of many aspects of household decision making such as location of home and work as well as vehicle stock, TRESIS offers users the ability to analyse and evaluate a variety of land use, transport, and environmental policy strategies or scenarios for urban areas.

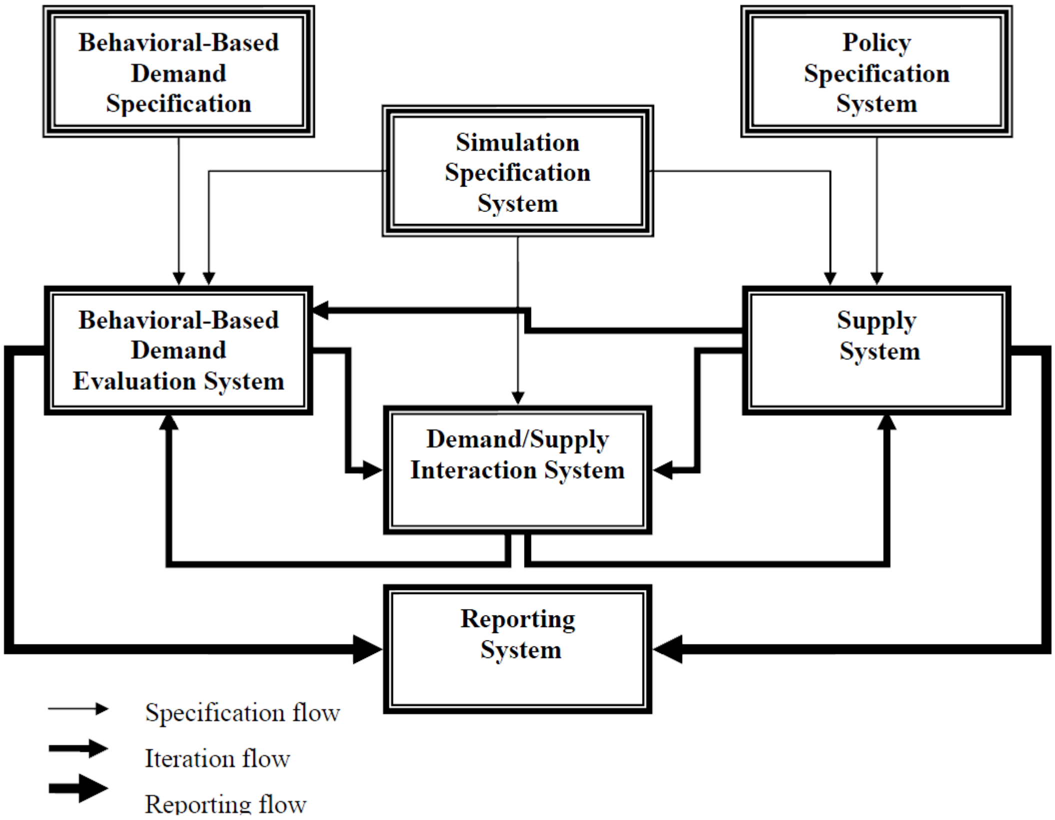
The behavioural engine of TRESIS encompasses key household, individual, and vehicle-related decisions; in particular:

- where a household chooses to locate;
- the type of dwelling to live in;
- where the workers from that household will work;
- the household's number and type of vehicles;
- the means of travel; and
- the time of travel.

From this a range of economic and environmental impacts are estimated on a year by year basis. The results of a base case scenario are used as references to compare with those of the policies and projects to be tested. The system generates a number of performance indicators to evaluate these effects in terms of economic, social, environmental and energy impacts.

TRESIS is structured around seven key systems, set out in the diagram below.

Figure A.1: TRESIS' component systems



Source: Hensher (2004)

Simulation specification system

This system provides a means for users of TRESIS to control factors such as:

- the types, sources, and locations of input and output from TRESIS;
- the heuristic rule for accommodating the temporal adjustment process;
- the number of future years to be simulated from the present year; and
- the specification to control the calibration and iteration process of TRESIS run.

The heuristic rule for accommodating the temporal adjustment process needs to be clarified. The model system in TRESIS is static and hence produces an instantaneous fully adjusted response to a policy application. In reality, choice responses take time to fully adjust, with the amount of time varying by specific decision. We expect that it would take longer for the full effect of the change in residential location to occur and much less time for departure time and even choice of transport mode. TRESIS allows users to impose a discount factor that establishes the amount of a change in choice probability that is likely to be taken up in the first year of a policy. It removes the rest of the change and uses the new one-year adjustment as the starting position for the next year.

Behavioural demand specification system

This system provides the household characteristics data and model formulation for the behavioural demand evaluation system of TRESIS. It contains a module for constructing a synthetic household database as well as a suite of utility expressions representing the behavioural system of choice models for individuals and households. These models are based on mixtures of revealed and stated preference data. Each synthetic household carries a weight that represents its contribution to the total population of households. Through time TRESIS carries forward the base year weights or, alternatively, modifies the weights to represent the changing composition of households in the population.

Households adjust their residential location in response to changes in the transport system and for other reasons. Consequently any one of a number of strategies can influence the probability of a household both living in a particular location and the type of dwelling they choose to occupy. At any point in time there will be a total demand for dwelling types in each residential location. Excess demand will result in an increase in location rents and dwelling prices; excess supply will result in a reduction in the respective rents and prices. In TRESIS, dwelling prices are used to clear both the market for dwelling types and location.

Disequilibrium is allowed for when an injection of new dwellings creates excess supply given the number of households. Any additional dwellings will be left vacant in the particular year as an indication that property developers may have created too much stock at that time. In future years as households grow the take up rate increases without creating increases in dwelling prices until the market is cleared.

Supply system

This system contains four key databases:

- the transport network database (with different levels of service for each time of day for each of six main modes of transport including drive alone, ride share, train, bus, light rail and busway)
- the land-use zone database (with attributes such as number of different dwelling types and associated prices, number of jobs, etc.);
- automobile technology or vehicle database (number of different vehicle types and associated performance and energy indicators); and
- the policy and environment parameters database (carbon contents in petrol, diesel, CNG and electric vehicles and others).

Key attributes (such as travel times for different times of the day, demand level and associated prices of housing) of transport network and zone databases are updated dynamically at run time during the calibration process to reflect the impact of the demand system on the supply system. In return, the newly updated attributes of the supply system will have an impact on the behavioural demand evaluation system. The iterative control process is handled by the demand/supply interaction system.

Policy specification system

A rich array of policy instruments is supported in TRESIS, such as new public transport, new toll roads, congestion pricing, gas guzzler or greenhouse gas taxes, changing residential densities, introducing designated bus lanes, implementing fare changes, altering parking policy, introducing more flexible work practices, and the introduction of more fuel efficient vehicles.

The policy specification system employs a graphical and map-based (Map Objects) user interface to translate a single or mixture of policy instruments into changes in the supply system.

Behavioural demand evaluation system

Given the input from the behavioural demand specification system and the supply system, the characteristics of each synthetic household are used to derive the full set of behavioural choice probabilities for the set of travel, location and vehicle choices and predictions of vehicle use.

Demand/Supply interaction system

This system contains three key procedures to control or equilibrate the three different types of interactions between demand and supply. The key mechanism for driving these three procedures is the level of interaction between demand and supply.

The three procedures are:

- Equilibration in the residential location and dwelling type market involves establishing total demand for different dwelling types in each residential location calculated at any point in time. Excess demand will result in an increase in location rents and dwelling prices. In TRESIS, prices for different dwelling types are used to clear the markets for dwelling types and locations, in the absence of data on location rents.
- For equilibration in the automobile market: a vehicle price relative model is used to determine the demand for new vehicles each year. This model controls the relativities of vehicle prices by vintage via given exogenous new vehicle prices. A vehicle scrappage model is used only to identify the loss of used vehicles consequent on vintage and used vehicle prices, where the latter are fixed by new vehicle prices in a given year. The supply of new vehicles is determined as the difference between the total household demand for vehicles and the supply of used vehicles after application of the scrappage model based on used vehicle prices.
- For equilibration in the travel market: households might adjust their route choices between origin and destination, or trip timing and/or mode choice in response to changes in the transport system, particularly the travel time and cost values between different origins and destinations. In other words, different households can have different choices in responding to changes in different levels of service at different times of day.

Output

TRESIS provides a comprehensive set of outputs representing performance indicators such as impacts on greenhouse gas emissions, accessibility, equity, air quality and household consumer surplus. The output is in the format of summary tables cross-tabulated by household types, household incomes and residential zones and in more detailed format by origin and destination, by different times of day and by different simulation years.

Appendix B: Approach to identifying congestion externalities

The most useful data available from TRESIS for attempting to estimate rail transport externalities is:

- total travel time; and
- annual number of journeys by each mode.

Generally we can say that travel time is an increasing function of journeys by both road and rail. Considering congestion, there should be a quadratic relationship between the number of journeys and total travel time; this is because each additional road user will generate congestion externalities which increase the average travel time for all other road users. In contrast, the relationship between total travel time and the number of train journeys should be linear as the central organisation of the train system should be able to manage additional journeys.

This leads to the following functional form for a relationship between the number of journeys and total travel time:

$$\text{Total travel time} = \beta_1\text{*(rail journeys)} + \beta_2\text{*(road journeys)} + \beta_3\text{*(road journeys)}^2$$

This parameterisation allows the identification of average journey time for the different modes of transport. For rail, the average journey time is given by β_1 while for road the average journey time is:

$$(\beta_2\text{*(road journeys)} + \beta_3\text{*(road journeys)}^2)/\text{(road journeys)}$$

Here, average road travel time depends on the number of road journeys, this reflects the congestion externality.

Using output from TRESIS on how people change their transportation decisions when the train fare is increased or decreased, the parameters (β_1, β_2 and β_3) can be extracted using ordinary least squares regression.

Once these parameters have been extracted, we can then carry out the thought experiment of moving one person from road to rail transport

$$\text{Total travel time}_{base} = \beta_1\text{*(rail journeys)} + \beta_2\text{*(road journeys)} + \beta_3\text{*(road journeys)}^2$$

$$\text{Total travel time}_{experiment} = \beta_1\text{*(rail journeys+1)} + \beta_2\text{*(road journeys-1)} + \beta_3\text{*(road journeys-1)}^2$$

We can then find the different in total travel time

$$\text{Total travel time}_{experiment} - \text{Total travel time}_{base}$$

This difference is made up of three components, the increase in rail travel time for the passenger that has been shifted, the decrease in their road travel time and the decrease in other people's road travel times. We can identify these three components as:

$$\text{Average increase due to own shift to rail} = \beta_3$$

$$\text{Average decrease due to own shift from road} = -(\beta_1 * x + \beta_2 * x^2)/x$$

This leaves an amount which is unaccounted for, the externality on other road users.

This approach gives the following results

Table B.1: Congestion externality modelling results

City	β_1	β_2	β_3
Sydney	56.56	54.26	4.27×10^{-8}
Melbourne	71.69	32.59	3.68×10^{-8}
Brisbane	67.22	26.53	2.89×10^{-8}
Perth	57.94	21.94	4.59×10^{-8}

Note: All βs are statistically significant at the 1% level of significance

Limitation of our work

General use restriction

This report is prepared solely for the use of the Australasian Railway Association. This report is not intended to and should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. The report has been prepared for the purpose of estimating the externalities associated with rail travel. You should not refer to or use our name or the advice for any other purpose.

Contact us

Deloitte Access Economics
ACN: 49 633 116

Level 1
9 Sydney Avenue
Barton ACT 2600
PO Box 6334
Kingston ACT 2604 Australia

Tel: +61 2 6175 2000
Fax: +61 2 6175 2001

www.deloitte.com/au/economics