Climate Change and the Transport Sector:
Are we travelling in the right direction?

November 2010

Maddocks in collaboration with HASSELL and Hyder
Table of contents

Introduction 1
A framework to assess the impact of climate change on the transport sector 1

Adaptation 2

Roads 2
Profile of roads infrastructure in Australia 2
The impact of climate change on road infrastructure 5
Regulatory framework 5
Case study - Upgrading the Pacific Highway - Iluka Road to Woodburn 7
Assessing climate change induced flood risk 7

Rail 9
Profile of rail infrastructure in Australia 9
The impact of climate change on rail infrastructure 11
Regulatory framework 11

Ports 13
Profile of port infrastructure in Australia 13
The impact of climate change on port infrastructure 13
Case study - Sea level rise guidance on the Townsville Port Berth 8 project 14
Regulatory framework 14

Air 17
Profile of air infrastructure in Australia 17
The impact of climate change on air infrastructure 17
Regulatory framework 18

Liability 20
Liability for road authorities 21
Liability in relation to port infrastructure 22

Summary 22
Entities responsible for climate change 22
Regulatory tools to address the effects of climate change 23

Mitigation 23
The contribution of transport to climate change 23
Mitigation opportunities for particular transport modes 24
Road 24
Shipping 32
Rail 32
Case study - Maldon to Dombarton rail link 33
Air 33
Climate Change and the Transport Sector: 
Are we travelling in the right direction?

Introduction

Transport plays a fundamental role in our society. It consists of the infrastructure used to move people and goods, such as roads, railways, ports and airports as well as the vehicles within which people and goods are moved, including cars, trains, ships and airplanes. By enabling the physical movement of individuals and goods from one place to another, transport facilitates production and trade, provides customers with access to goods and enhances labour mobility.

When the challenges associated with meeting society’s transport needs are identified, the most common themes that emerge are increasing demand, congestion and the burgeoning cost of building and upgrading transport infrastructure.

Climate change has not been a high profile issue in this regard despite the significant implications of climate change for the transport sector. In particular, the transport sector makes a substantial contribution to Australia’s greenhouse gas emissions. Furthermore, the physical consequences associated with climate change can pose important risks for transport infrastructure. Nevertheless, there are also significant opportunities within the sector to reduce emissions, including a range of regulatory mechanisms, financial incentives and voluntary programs.

In this paper, we:

- establish a framework for examining the implications of climate change for the transport sector
- explain the impacts that climate change may have on transport infrastructure and identify the extent to which practical responses to these impacts on transport structure are accommodated within existing regulatory regimes
- explain transport’s contribution to climate change and identify the ways in which the emissions caused by transport can be reduced, including particular policies and regulations that encourage emissions reductions in this sector.

A framework to assess the impact of climate change on the transport sector

There is now an overwhelming view that human activities have resulted in the emission of high concentrations of greenhouse gases into the atmosphere. These gases have been associated with global warming and other physical phenomena linked to climate change. It is predicted that continued growth in the emission of greenhouse gases will increase the already significant risk of dangerous climate change.

The 2008 Garnaut Report states that Australia’s per capita emissions are the highest in the OECD and among the highest in the world. The majority of Australia’s emissions are the result of electricity and other stationary energy generation, which relies heavily on the burning of fossil fuels. However, a substantial volume of emissions also emanate from the transport sector, particularly through the combustion of fuels for road transport.
Higher concentrations of greenhouse gases have been linked to a range of physical phenomena associated with climate change, including higher temperatures, sea level rise and flooding, lower rainfall and drought in some areas (for example, southern and eastern Australia), increased intensity of storms and bushfires.

There are two main implications of climate change for the transport sector:

- **Risks for transport infrastructure** - Climate change poses risks for transport infrastructure. The physical effects of climate change that could pose particular challenges for transport infrastructure include higher temperatures and increased solar radiation, rising sea levels, increasing prevalence of bushfire events and storm surges and increases in storm severity, including lightning strikes, extreme winds and heavy rainfall. While the impact of climate change on transport infrastructure may vary depending upon a variety of factors, including the particular type of infrastructure in question, its location, design, age and relative usage, there will be consequences for most regulators, owners, operators and users of transport infrastructure throughout the country.

- **Contribution to greenhouse gas emissions** - Transport contributes approximately 14% of Australia's total greenhouse gas emissions. Around 90% is attributable to the combustion of fuel for road transport, with the remainder linked to rail, domestic aviation and shipping. Moving forward, the challenge for transport providers and users will be to reduce the contribution that transport makes to Australia's emissions problem.

The types of responses that are available to address these implications can generally be characterised as:

- **Adaptation** - Adaptation to climate change involves actions to help reduce vulnerability to the effects of climate change. In relation to transport infrastructure, adaptation involves actions that ensure that the infrastructure can better withstand the physical impacts of climate change.

- **Mitigation** - Climate change mitigation involves action to reduce the concentration of greenhouse gases by limiting their sources (or by increasing carbon sinks). Mitigation action in the transport sector involves action to reduce the volume of emissions resulting from the use of road, rail, shipping and air transport.

We discuss both categories of responses in the context of the transport sector below.

**Adaptation**

In this section of our paper, we consider the extent to which regimes that regulate the ownership, management and use of transport infrastructure in Australia include tools to help address the challenges that climate change presents. We illustrate how existing tools could be used to combat the effects of climate change. Given that there are differences between the regulatory regimes applicable to the various modes of transport, we address each of these regimes in turn.

**Roads**

**Profile of road infrastructure in Australia**

Australia has a vast road network, which extends across the country's states and territories. There are four main categories of road infrastructure, namely:

- **Municipal roads** - Municipal roads provide access to homes, businesses, health and community service buildings and recreational facilities located within the relevant municipalities.
- **Arterial roads** - Arterial roads are main routes for the carriage of traffic, with moderate or high capacity. They carry large volumes of traffic within and between urban centres and may link freeways. Commercial buildings, shopping centres and petrol stations are located on these types of roads.

- **Freeways** - Freeways allow for the high-speed operation of vehicles. Cross traffic from other roads and rail tracks as well as access to and from adjacent properties is usually not possible on freeways.

- **Tollways** - Tollways are roads for which users pay a toll for access and use.

While traffic volumes are generally greatest on arterial roads, the overall length of the municipal roads, as a proportion of the Australian road network, is greater. Freeways and tollways often form important links in the broader road network.

In considering the impact of climate change, it is necessary to consider the type, usage, location, ownership and management structure for the components of road infrastructure that make up this network.

Generally speaking, ownership and responsibility for the management of road infrastructure lies with the public sector. More specifically, most road infrastructure in Australia is publicly owned and managed by state or territory governments through statutory authorities (in the case of arterial roads) and by local governments (in the case of municipal roads). A relatively limited proportion of road infrastructure – particularly, tollways and bridges (if they are part of a tollroad) – is owned and managed privately. The federal government also has a stake in the ‘National Land Transport Network’ (consisting only of national roads), which is co-funded by federal and the relevant state and territory governments.

The location of road infrastructure will also be particularly relevant in assessing the likely impact of climate change. For example, roads in low lying or coastal areas will be most susceptible to the effects of sea level rise and flooding, whereas roads located in hot climate zones will be particularly vulnerable to the effects of increased temperature and solar radiation.
The impact of climate change on road infrastructure

The Table below summarises the main impacts of climate change that are likely to affect road infrastructure. It also identifies the possible consequences of climate change for owners, managers and users of road infrastructure.

<table>
<thead>
<tr>
<th>Climate change effect</th>
<th>Direct impact on road infrastructure</th>
<th>Consequences for road infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased temperatures and solar radiation</td>
<td>Embrittlement and cracking of bitumen</td>
<td>Temporary or permanent blocked road access</td>
</tr>
<tr>
<td>Increased rainfall</td>
<td>Loss of water seal causing potholing</td>
<td>Interruption to commercial activities that depend upon road transport</td>
</tr>
<tr>
<td>Rising sea levels</td>
<td>Low lying roads may be submerged</td>
<td>Increased maintenance costs to increase resilience</td>
</tr>
<tr>
<td>Flooding</td>
<td>Damage to road foundations as a result of prolonged drought and low rainfall</td>
<td>Re-routing to avoid climate change affected roads</td>
</tr>
<tr>
<td>Bushfires</td>
<td></td>
<td>Increased risk of liability resulting from road damage</td>
</tr>
<tr>
<td>Salinity effects</td>
<td></td>
<td>Higher insurance costs</td>
</tr>
</tbody>
</table>

There have been some recent illustrations, both in Australia and elsewhere, of the damage to road infrastructure that might result from physical phenomena that have been associated with climate change. For example, Cyclone Ului, which hit northern Queensland in March 2010, resulted in damage to the road network by exposing the road bed. In addition, trees and power lines that were felled as a result of the cyclone hindered road access. These consequences were exacerbated by subsequent flooding.

Regulatory framework

Regulatory frameworks for road infrastructure are typically aimed at promoting safe and efficient roads. Among other things, the relevant legislative instruments:

- identify the entities that are responsible for the management of road infrastructure
- set out the role, functions and powers of road authorities
- establish the general principles that apply to road management.

We examine some aspects of these regulatory frameworks to illustrate how the powers and tools they include could be utilised to address the effects of climate change.

(a) Functions and powers of road authorities

In the jurisdictions considered, there are two main categories of road authorities, namely:

- state government bodies that are dedicated to the management of the larger arterial roads, such as VicRoads in Victoria and the Road Traffic Authority in New South Wales
The functions and powers of road authorities imposed under road management legislation typically include:

- to provide and maintain roads for use by the community
- to design, construct, inspect, repair and maintain roads and related road infrastructure.

In performing these functions, road authorities must take all steps that are reasonably practicable to ensure the structural integrity and safety of public roads.

Assuming that adequate funding is available, these functions and powers of road authorities could be viewed as broad enough to accommodate efforts to address the effects of climate change, although they have not as yet been specifically invoked and applied in this context. In addition, some regimes contain specific functions and powers that could prove particularly useful in assessing and, potentially, addressing climate change. These regimes, including the functions and powers that might be useful in combating climate change, are discussed below.

(b) Obligation to account for climate change

In addition to the above mentioned functions that are imposed on road authorities under road management legislation, planning legislation around Australia requires assessment of potential environmental impacts, including climate change, in planning for the design, construction and operation of road infrastructure (for example, the NSW Environmental Planning and Assessment Act 1979).

Statutory state-owned corporations in NSW, such as the Road Traffic Authority (RTA), have an express obligation to 'conduct ... operations in compliance with the principles of ecologically sustainable development' under the NSW State Corporations Act 1989. This necessitates an appropriate level of planning to identify practical measures to assess and manage the effects of climate change. The RTA has prepared guidelines to reduce greenhouse gas emissions and plan for physical consequences posed by climate change – namely, the 'RTA Environmental Impact Assessment Procedure – Preparing a greenhouse assessment report'.
Upgrading the Pacific Highway – Iluka Road to Woodburn Assessing climate change induced flood risk (Case study by Hyder)

The Pacific Highway is the major transport link between Sydney and Brisbane, and serves the growing population of the mid north and far north coast of NSW. The proposed upgrading of the Devils Pulpit section of the Pacific Highway aims to provide substantial benefits for local and regional safety.

A key aspect of the environmental assessment for this project involved assessing risks posed by climate change induced flood risk to the design, construction and operation of the highway. This was included within Director General’s requirements (DGRs), issued under the NSW Environmental Planning and Assessment Act 1979, to assess flood risk posed by climate change.

CSIRO climate change projection scenarios were analysed for northern NSW where it was found a projected 10 per cent increase in rainfall intensity was projected for 2070. An additional margin of 10 per cent was applied as a conservative measure, and the highway upgrade design was assessed against projected climate change increases in rainfall intensity of 20 per cent.

Flood modelling was undertaken by Hyder for standard design events and climate change intense rainfall events. It was found that rainfall intensity due to climate change was likely to result in increased flood levels and velocities throughout the study area. Nevertheless, the modelling found that existing flood mitigation structures had the capacity to cater for additional impacts posed by increased rainfall intensity under projected climate change.
(c) Road management plans

Two of the jurisdictions considered – namely, Victoria and Queensland – provide for the development of road management plans, which could prove an important tool in addressing climate change.

Victoria’s Road Management Act 2004 empowers – but does not oblige – road authorities to develop a ‘road management plan’. The primary purpose of road management plans is to establish good asset management practices focused on delivering the optimal outcomes for the available resources, having regard to the applicable policies and priorities. Through road management plans, individual road authorities may determine standards and policies for managing public roads that are under their control.

Under Queensland’s Transport Infrastructure Act 1994, a ‘roads implementation program’ must be developed and must include performance targets for road transport infrastructure. In the most recent roads implementation program for the period 2009/2010 to 2013/2014, reference was made to environmental management initiatives adopted by Queensland’s state government, which formed the context for prospective road works. Such environmental management initiatives included conservation of ecologically significant areas, conservation of heritage listed sites (including protecting significant trees) and road landscaping and amenity activities.

It is conceivable that, in the jurisdictions where road management and implementation programs are currently provided for, in the future, they will expand beyond standards and performance targets that are aimed at minimising the impact of road infrastructure on the environment to include those that accommodate the impact of climate change on road infrastructure.

(d) Codes of road practice

Codes of road practice could also prove a useful mechanism to accommodate the effects of climate change and could be a useful complement to road management plans.

Victoria is the only jurisdiction considered that provides for such codes. In particular, the Victorian Road Management Act 2004 empowers the Minister to make a Code of Practice for a road authority or class of road authorities. Among other things, a Code of Practice may establish benchmarks of good practice in relation to the performance of road management functions by road authorities, those that develop new road infrastructure as well as providers of public transport services. However, it is notable that a Code of Practice cannot impose obligations on these parties nor can they direct how any matter or thing is to be done.

A Code of Practice for Road Management Plans was issued in 2004 in Victoria. It provides that road management plans may establish the standard or target condition to be achieved in the maintenance and repair of different types of road infrastructure. The Code of Practice further provides that the road management plan may set out details of the applicable management system, the purpose of which is to discharge the relevant entity’s duty to inspect, maintain and repair.
In determining appropriate standards for road management, the Code states that a road authority should consider a range of factors, including:

- environmental factors and any other relevant risk factors
- the type of road infrastructure, the volume and nature of public road usage
- community expectations
- the resources available, and the competing demands for these resources.

Depending upon the type, location and usage of road infrastructure, ‘relevant risk factors’ could include the physical effects of climate change. Moreover, accounting for ‘community expectations’ may involve consideration of and response to such effects to ensure that road infrastructure is capable of withstanding these effects and is fit for purpose.

**Rail**

*Profile of rail infrastructure in Australia*

Rail infrastructure includes railway tracks, rolling stock, over and under-track structures, signalling and communication systems and related buildings, plant and equipment. The rail networks in Australia’s states and territories include metropolitan, intrastate and interstate sub-networks, which are used for both passenger and freight transport services.

While rail networks are usually owned by the relevant state and territory governments through governmental instrumentalities such as VicTrack in Victoria and RailCorp in New South Wales, these entities are empowered to lease rail infrastructure to other statutory or private bodies that provide rail services pursuant to access arrangements, which are overseen by the relevant jurisdictional regulator. Furthermore, each of the states and territories has arrangements with the federal government for the provision of interstate and national rail services using rail infrastructure that is managed by the federal government. The Australian Competition and Consumer Commission (ACCC) regulates access by private operators to that part of Australia’s rail track which is owned and operated by the Australian Rail Track Corporation (a federal government entity).

As in the case of road infrastructure, the location of rail infrastructure (among other things) will also be relevant in assessing the likely impact of climate change. The relevant parts of rail networks that are used to support ports and port infrastructure by connecting ports to the hinterland are likely to be susceptible to the effects of sea level rise, flooding and storm surges. Similarly, rail networks located in hot climate zones are most likely to suffer from train delays resulting from heat-affected swollen rail tracks.
The impact of climate change on rail infrastructure

The Table below summarises the main impacts of climate change that are likely to affect rail infrastructure. It illustrates the possible consequences of climate change for owners, managers and users of rail infrastructure.

<table>
<thead>
<tr>
<th>Climate change effect</th>
<th>Direct impact on rail infrastructure</th>
<th>Consequences for rail infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased temperatures</td>
<td>Buckling of tracks</td>
<td>Interruption to commercial activities that depend upon rail transport</td>
</tr>
<tr>
<td>Flooding</td>
<td>Low lying rail tracks and those tracks which service ports may be submerged</td>
<td>Increased maintenance and replacement costs</td>
</tr>
<tr>
<td>Sea level rise</td>
<td>Signal and other electrical damage</td>
<td>Increased risk of liability resulting from rail damage</td>
</tr>
<tr>
<td>Increased intensity and frequency of storms</td>
<td>Damage to rail foundations as a result of prolonged drought and low rainfall</td>
<td>Higher insurance costs</td>
</tr>
</tbody>
</table>

The intense heat experienced in Melbourne during the 2008 – 2009 summer illustrates the consequences of climate change for rail infrastructure. Soaring temperatures caused the Melbourne metropolitan railway network to swell which, in turn, resulted in significant disruptions to passenger train services for extended periods of time. Cyclone Ului also illustrates the possible consequences of extreme weather events. In addition to the impact on road infrastructure, this cyclone created disruption to Queensland’s rail network, particularly that part of the network, which supports the Hay Point Dalrymple Bay coal terminals.

Regulatory framework

Regulatory frameworks for rail infrastructure in the states and territories typically include the following core elements:

- identification of rail transport corporations, which own and manage Australia’s rail networks
- establishment of regimes for access to rail infrastructure by transport service providers
- obligations to ensure safe rail and reliable rail transport services.

Aspects of these regulatory frameworks that may be relevant to assess the extent to which they can be utilised to address the effects of climate change are discussed below.

(a) Rail maintenance and repair obligations

In most jurisdictions, statutory rail corporations have been established to own, manage and operate rail infrastructure, particularly for passenger services. The responsibility for undertaking repair and maintenance work on rail infrastructure is generally governed by lease arrangements between the government owners of such infrastructure and the public or private lessees. Consequently, it is probable that we will see leases being used as a vehicle to ensure repair and maintenance work to address the effects of climate change in the future.
For example, the Transport Service Contract (Rail Infrastructure) Agreement between the Queensland Government and Queensland Rail (a government corporation established to provide rail transport services) provides a useful example of one such lease arrangement. Under that agreement, Queensland Rail was obliged to provide services and maintain the performance of rail tracks to standards specified in the agreement. In addition, the Yarra Trams Infrastructure Sublease between the Director of Public Transport and Metrolink Victoria Pty Ltd (among others) required that the latter maintain the infrastructure such that it may be used for its intended purpose and comply with ‘environmental laws’. Under the Sublease, ‘environmental laws’ included laws relating to climate.

In the future, it is possible that the performance obligations included in lease agreements of this kind will explicitly require lessees to address the effects of climate change in the management and operation of rail infrastructure. These agreements could also be used to allocate responsibility for climate change risks resulting in injury and damage to property arising from disrepair or infrastructure deterioration to the manager or operator of the rail infrastructure.

(b) Safety accreditation

By way of complement to obligations that may be contained in bilateral lease arrangements between owners and operators of rail infrastructure, two of the jurisdictions considered also impose statutory obligations on rail infrastructure operators to ensure that such infrastructure is safe and reliable through safety accreditation.

In particular, the Victorian Rail Safety Act 2006 requires accreditation of owners and managers of rail infrastructure and rolling stock by Public Transport Safety Victoria (PTSV). The PTSV is responsible for, among other things, the safety accreditation of rail operators in Victoria and monitoring the compliance of infrastructure (through inspections) with statutory requirements. The purpose of accreditation is to ensure that operators have the competence and capacity to manage safety risks associated with rail operations.

Similarly, Queensland’s Transport Infrastructure Act 1994 establishes as a pre-requisite to accreditation, a requirement that the railway manager or operator has an appropriate safety management system in place.

Depending upon the type, location and age of rail infrastructure, safety and reliability of rail services may be compromised if the effects of climate change are not adequately accounted for. Accordingly, in the future, safety accreditation may be used to ensure that climate change risks are accounted for in the context of the management and operation of rail infrastructure.

(c) Safety and fitness for purpose obligations

The statutory regime could also include specific obligations requiring those involved in the design, supply and installation of rail infrastructure to ensure that the infrastructure is safe and fit for purpose, including in the context of physical conditions arising as a result of climate change.

For example, the New South Wales Rail Safety Act 2008 requires any person who designs, commissions, manufactures, supplies, installs or erects rail infrastructure or rolling stock must ensure, so far as is reasonably practicable, that the infrastructure is safe if it used for a purpose for which it was designed, commissioned, manufactured, supplied, installed or erected.
These types of provisions could be invoked in cases where newly installed rail infrastructure does not account for the effects of climate change and thereby renders the infrastructure unsafe and/or unfit for purpose when climate change events occur.

**Ports**

*Profile of port infrastructure in Australia*

Port infrastructure exists in each of Australia's states and territories, including a mix of major commercial ports, which are used for domestic and international trade, and smaller local or community ports. The larger commercial ports are either publicly owned and operated through statutory corporations and authorities or privately owned and operated. The smaller, community ports are generally owned and operated by local councils or by private entities.

Unlike local ports, the larger commercial ports are usually subject to access and price regulation.

Regimes for the regulation of port infrastructure typically relate to a broad range of onshore and offshore port facilities and assets, including:

- wharfs and port marine operational areas
- shipping channels
- bulk loading and unloading facilities
- boat harbours and boat ramps
- vehicle and railway ferry terminals
- access roads and rail corridors
- car parking facilities.

*The impact of climate change on port infrastructure*

The Table below summarises the main impacts of climate change that are likely to affect port infrastructure. It illustrates the possible consequences of climate change for owners, managers and users of port infrastructure.

<table>
<thead>
<tr>
<th>Climate change effect</th>
<th>Direct impact on port infrastructure</th>
<th>Consequences for port infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased severity of weather events (including rainfall, wind, cyclones and sea storms)</td>
<td>Corrosion</td>
<td>Increased frequency and duration of port closures</td>
</tr>
<tr>
<td>Sea level rise</td>
<td>Infrastructure damage and deterioration resulting from heavy storm activity</td>
<td>Shipping delays</td>
</tr>
<tr>
<td>Increased ocean swell</td>
<td>Inundation of infrastructure</td>
<td>Damage to cargo and goods</td>
</tr>
<tr>
<td>Ocean acidification</td>
<td></td>
<td>Increased costs of sea trade and shipped goods</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased maintenance and replacement costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased risk of liability resulting from port damage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Higher insurance costs</td>
</tr>
</tbody>
</table>
The degree to which port infrastructure is likely to be affected by climate change depends on the port type, construction and location. The effects of climate change are likely to be more serious and damaging in areas that are already prone to tropical cyclones, including northwest Western Australia, the Northern Territory and the Queensland coast. Nevertheless, as sea levels continue to rise and the incidence of extreme weather events becomes more widespread, it is possible that port infrastructure located in other areas will also be affected.

**Sea Level Rise Guidance on the Townsville Port Berth 8 project (Case study by Hyder)**

Hyder consulting was commissioned to provide guidance on the projected impacts of sea level rise and storm surge on the design upgrade for Townsville Port Berth 8.

The key outcome from this study was to adapt the upgrade design to ensure continuity of operations with regard climate change. More specifically, it was recommended that consideration was given to a projected mean sea level rise of 0.7m by 2070, additional storm surge events (over and above 0.3m for current 1 in 100 year events) and further catchment flood modelling to understand potential impacts of extreme rainfall on local sea level rise.

**Regulatory framework**

The regulatory frameworks applicable to Australia’s ports typically:

- establish port authorities, which are responsible for the management of port infrastructure
- provide for the effective management and operation of ports.

Aspects of these regulatory frameworks that may be relevant to assess the extent to which they can be utilised to address the effects of climate change are discussed below.
(a) Functions and powers of port authorities

In general terms, there are two main categories of port authorities – namely, those that are responsible respectively for commercial trading ports and local or community ports. The obligations imposed on the former are usually more onerous than those imposed on the latter.

Under the Victorian *Port Services Act* 2004, port corporations, which are responsible for commercial trading ports must, among other things:

- manage and develop ports in an economically, socially and environmentally sustainable manner
- facilitate the integration of infrastructure and logistics systems in the port with systems in place outside the port in a manner which is commercially sound and environmentally sustainable.

The Victorian regime is unique in that it expressly requires that account be taken of environmental considerations by port authorities in the management of port infrastructure, although the impact of climate change is not specifically identified. We discuss other more specific examples of requirements regarding the account that must be taken of environmental factors below.

(b) Environment management plans

Part 6A of the Victorian *Port Services Act* 2004 contains another tool that could be useful in combating climate change. Specifically, it requires port authorities to prepare environment management plans. They must also ensure that reasonable steps are taken to implement these plans.

The Act sets out in some detail what is required in environmental management plans. Among other things, these plans must identify the nature and extent of environmental hazards, specify the measures and strategies to prevent the hazards and set out how tenants, licensees and service providers will be involved in the implementation of the environment management plan. In addition, the relevant Minister can provide guidance or direct port authorities on how the environment management plans should be developed, as well as the content and implementation of such plans.

The Act also provides for regular audits of the management plans to ensure they are adequate. The plans need to be certified by an environmental auditor and may be the subject of audits to ensure that they are adequate and meet the Act’s requirements.

(c) Port management plans

More generic port management plans could also be used to ensure that account is taken of the impact of climate change on port infrastructure, such as those provided for in the context of the Queensland regime.

Under Queensland’s *Transport Infrastructure Act* 1994, certain port authorities must prepare and submit to the Minister a port land use plan, which sets out the uses and intended uses of port land. A port land use plan must specify, among other things, the desired environmental outcomes for the land, including measures that will assist in achieving the desired environmental outcomes. Plans of this kind could be extended to include reference to measures that are needed to respond to the effects of climate change.
Context for assessment of the impact of climate change on port infrastructure

A tool for assessing climate change impacts on port developments that could provide useful context for adaptation of port management plans are coastal management plans, such as the Draft State Coastal Management Plan in Queensland. This provides direction for addressing potential impacts posed by climate change in Queensland’s coastal region. The plan contains policy requirements for assessing risks posed by climate change and includes measures for adapting to potential impacts – for example, adoption of the 0.8m benchmark for projected sea level rise by 2100.

Australian Standard 4997-2005 Guidelines for the Design of Maritime Structures also provides useful context for the assessment of climate change on port infrastructure. It includes a requirement for maritime structure design to account for sea level rise factors in accordance with design life. For example, a 0.4 metre sea level rise factor is proposed for structures with a 100 year design life. However, these factors are likely to be conservative given that they are based on mid-range emission scenarios from the 2001 UN IPCC Assessment Report.

Air

Profile of air infrastructure in Australia

In 1997, the Commonwealth Government commenced a process of privatising its 22 federal airports, including the major commercial and passenger airports in each of the capital cities. This was accomplished by granting long-term leases over the airport sites to private sector operators. Since 1997, there has been substantial investment in Australia’s airports following privatisation to keep pace with growing demands for air travel. However, most regional airports are owned by local councils and are subject to state and local government planning controls.

Regimes for the regulation of airports typically relate to a range of infrastructure types, including:

- airport buildings and terminals
- runways and taxiways
- roads and other vehicular access
- railways and rail handling facilities.

The impact of climate change on air infrastructure

To date, the effects of climate change in the context of the air industry have focused predominantly on emissions from airplanes. In comparison, the impact of climate change on airport infrastructure has received limited attention.
The Table below summarises the main impacts of climate change that are likely to affect airport infrastructure. It illustrates the possible consequences of climate change for owners, managers and users of airport infrastructure.

<table>
<thead>
<tr>
<th>Climate change effect</th>
<th>Direct impact on air infrastructure</th>
<th>Consequences for air infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased rainfall and storm events</td>
<td>Damage to terminals</td>
<td>Disruption to airline operations</td>
</tr>
<tr>
<td>Increased severity and speed of winds</td>
<td>Expansion of joints, protective cladding, coatings and sealants on aerobridges and other airport infrastructure</td>
<td>Increased maintenance and replacement costs</td>
</tr>
<tr>
<td>Increased intensity and frequency of storms</td>
<td>Flooding of runways and access roads</td>
<td>Need to construct longer runways to compensate for reduced airlift</td>
</tr>
<tr>
<td>Increased temperature and solar radiation</td>
<td>Reduced life of asphalt on airport tarmacs</td>
<td>Need for ground cooling mechanisms</td>
</tr>
<tr>
<td>Bushfires</td>
<td>Reduced airlift</td>
<td>Increased risk of liability resulting from air infrastructure damage</td>
</tr>
<tr>
<td></td>
<td>Reduced visibility</td>
<td>Higher insurance costs</td>
</tr>
</tbody>
</table>

Regulatory framework

The leased federal airports are regulated under the Commonwealth Airports Act 1996. Among other things, the Airports Act 1996 regulates planning and development on federal airport sites. In particular, the Act:

- imposes foreign and cross-ownership ownership restrictions on airport operator companies
- requires:
  - preparation of an Airport Master Plan, which is intended to reflect a 20 year strategic vision for the airport site, including future land uses, types of permitted development, and noise and environmental impacts
  - preparation of Major Development Plans for significant developments
  - development of an Environment Strategy, which is aimed at ensuring that all operations at the airport are undertaken in accordance with relevant environmental legislation and standards and to promote the continual improvement of environmental management at the airport.

Some airports are also subject to price and quality monitoring and access regulation under the Trade Practices Act 1974.

The Airports Act 1996 is complemented by a range of regulations, including the Airports (Environment Protection) Regulations 1997, whose object is to regulate noise and pollution emanating from airports as well as to promote the improvement of environmental management practices for activities carried out at airports.
(a) Master Plans

Under the *Airports Act* 1996, a Master Plan must be prepared for each airport and updated every five years. The purposes of these plans include to:

- establish the strategic direction for efficient and economic development at the airport over the planning period of the plan
- reduce potential conflicts between uses of the airport site, and to ensure that uses of the airport site are compatible with the areas surrounding the airport.

The Act further provides that a Master Plan must contain an assessment of environmental issues that might reasonably be expected to be associated with the implementation of the Plan.

Climate change was specifically identified in the list of environmental issues that might reasonably be expected to be associated with project implementation in the 2008 Master Plan for Melbourne Airport. However, the assessment focused exclusively on mitigation of greenhouse gases through energy efficiency at airports rather than addressing the physical impacts of climate change on airport infrastructure and the need to adapt to those physical impacts.

Ideally, in the future, Master Plans should specifically identify and assess the impact of climate change on airport infrastructure and include an adaptation strategy to respond to these impacts.

(b) Environment Strategies

The primary purpose of an Environment Strategy for an airport is to ensure that all operations at the airport are undertaken in accordance with relevant environmental legislation and standards.

The *Airports Act* 1996 requires the Environment Strategy to identify sources of environmental impact associated with airport operations. Recent plans have included targets to reduce energy and water consumption. However, these strategies have not, as yet, been used to anticipate and respond to the impact of climate change. Like the Master Plans, in the future, it would be desirable to identify and assess the impact of climate change on airport infrastructure in the Environment Strategy for airports.

**Liability**

Failure to account for climate change in the construction, management and operation of transport infrastructure could potentially result in liability in negligence for responsible entities. Whether or not liability can be established will depend upon a number of factors including whether the responsible entity took all reasonable care to address foreseeable climate change risks and whether a causal link can be established between the responsible entity’s acts/omissions and any loss or damage that may have been suffered as a result of the effects of climate change.

Specific provisions addressing liability in relation to road and port infrastructure exist in Victoria and Queensland respectively.
Liability for road authorities

While most road regulatory regimes do not explicitly outline the liability consequences of road authorities’ acts or omissions that may cause loss or damage, the Victorian regime does provide guidance as to how this issue will be addressed.

Specifically, the Victorian Road Management Act 2004 addresses civil liability that might be imposed on road authorities for acts and omissions relating to the development and upkeep of road infrastructure.

The Act sets out factors that must be considered by a court of law in determining whether a duty of care exists or the duty of care has been breached. These factors include:

- the character of the road and the type of traffic that could reasonably be expected to use the road
- the standard of maintenance and repair appropriate for a road of that character used by traffic of that type
- the state of repair in which a reasonable person would have expected to find a road or infrastructure of that character
- whether the road authority knew, or could reasonably be expected to have known, the condition of the road or infrastructure at the time of the relevant incident
- in the case where the road authority could not have reasonably been expected to repair the road or infrastructure or take other preventative measures before the relevant incident, whether the road authority did display, or could be reasonably expected to have displayed, appropriate warnings.

Despite the foregoing, the Act does contain limits on the liability that might be imposed upon road authorities. Specifically, it provides that a road authority is not liable in any proceeding for damages in respect of any alleged failure by the road authority to remove a hazard or to repair a defect or deterioration in a road or to give warning of a hazard, defect or deterioration in a road unless the road authority had actual knowledge of the particular risk the materialisation of which resulted in the harm. Accordingly, a road authority must respond to deterioration and damage to road infrastructure, whatever its cause, to the extent that the authority is aware of the deterioration or damage.

The Act also establishes a ‘policy’ defence for road authorities and infrastructure and works managers. In practical terms, this means that, where a road authority acts in accordance with established policy (including a road management plan), it will not be liable for losses suffered by third parties as a result unless the policy is completely unreasonable — in other words, a reasonable road authority would not have acted in accordance with the policy.

In essence, these liability provisions suggest that road authorities need to ensure that they account for and reasonably respond to foreseeable climate change related risks that might otherwise cause loss or damage to users of road infrastructure. This approach would also be prudent in jurisdictions where explicit liability provisions of the kind found in the Victorian Road Management Act 2004 do not exist.
Liability in relation to port infrastructure

Queensland’s Transport Infrastructure Act 1994 envisages the possibility that port owners and operators could be held liable in negligence for failing to maintain a port in ‘good condition to a standard appropriate to its use’. The Act provides that a [port] facility is taken, for the purposes of all adverse civil proceedings in relation to death, injury, damage or loss, to be solely owned, occupied and under the management, control and responsibility of the manager. This emphasises the importance of accounting for the possible effects of climate change in operating and managing port facilities.

Summary

Climate change is likely to pose significant challenges for owners, managers and users of Australia’s transport infrastructure, including roads, rail, ports and airports. At a minimum, the effects of climate change may require additional maintenance and repair. At worst, some types of infrastructure may become permanently unusable and will need to be replaced. The collective consequences of a climate change event could wreak havoc for the logistics supply chain if each type of infrastructure is concurrently affected. Cyclone Ului is a compelling example in this regard.

Apart from the practical difficulties that climate change presents, it may also lead to considerable additional costs for owners and operators of transport infrastructure. It may also lead to liability if the risks of climate change are foreseeable but have not been addressed.

Entities responsible for climate change

In this paper, we have examined the profile of transport infrastructure in various jurisdictions in Australia, including the entities that own and manage the various types of transport infrastructure considered. The ownership and management structure is important because it determines which entity will bear primary responsibility for addressing the effects of climate change.

It is notable that the ownership and management structure differs between each type of transport infrastructure considered. In general terms:

- Roads - Public entities – including state government authorities and local government bodies – will bear primary responsibility for responding to the effects of climate change in respect of road infrastructure.
- Rail - While state governments typically retain ownership of rail infrastructure, lease arrangements with statutory and private operators may have the effect of transferring responsibility for responding to the effects of climate change from owners to operators.
- Ports - Ports are owned and operated by a range of public and private entities, which will respectively bear responsibility for responding to the effects of climate change.
- Air - Most of the major commercial and passenger airports are subject to long-term leases with the Commonwealth Government, although several regional airports are owned by local councils. At the first instance, these entities will need to devise ways to respond to the physical impacts of climate change on airport infrastructure.

These entities need to be prepared for fully assuming or delegating responsibility (for example, to other statutory or private entities) as the effects of climate change become more frequent and pronounced.
Regulatory tools to address the effects of climate change

In this paper, we have also considered the regulatory regimes applicable to road, rail and port infrastructure. We noted a range of existing regulatory tools that could be utilised to manage the risks of climate change, including:

- infrastructure management and implementation plans
- codes of practice
- accreditation
- safety and fitness for purpose obligations.

These tools could provide the context within which an assessment of the physical risks posed by climate change could be undertaken. They could also allow for the formulation of responses to these risks that are suited to the infrastructure in question to ensure that any response adequately accounts for, among other things, the type, usage and location of the infrastructure. As previously noted, these factors could heighten or reduce the relative risks associated with climate change for the particular type of infrastructure.

There is clearly scope within existing infrastructure regulatory regimes for the effects of climate change to be addressed. Indeed, this paper has demonstrated that there are a number of useful tools in existing transport regimes that can be used to assist transport infrastructure in adapting to the effects of climate change.

Mitigation

In this section of our paper, we identify the opportunities that exist to facilitate the reduction of greenhouse gas emissions from the transport sector.

The contribution of transport to climate change

Demand for transport is increasing over time for each of the transport modes – road, rail, shipping and air. Growing demand is driven by a combination of factors, including:

- **Increasing population** - As populations rise, the greater the demand for transport services to move people and goods.
- **City sprawl** - Population growth is usually accompanied by city sprawl. As cities spread outwards to low-density areas, residents will necessarily become more dependent upon transport to access places of work, shopping centres and educational and recreational facilities.
- **Rising incomes** - Studies demonstrate that rising incomes result in greater car ownership and, consequently, car dependence. Rising incomes are also likely to lead to increased use of air transport.
Rising demand for transport services results in a corresponding increase in the volume of transport emissions, which is illustrated in the diagram below.

**Total Transport Emissions 1990 – 2008**

Transport emissions arise predominantly from the fuel that is used to drive the various types of transport. Road transport – particularly, the use of passenger cars – has been the main source of transport emissions up until now. It accounted for 86.3% (69.2 MtCO$_2$e) of transport emissions in 2008. Other transport sources were smaller contributors – aviation contributed 7.4% (6.0 MtCO$_2$e), domestic shipping 3.7% (2.9 MtCO$_2$e), and rail 2.5% (2.0 MtCO$_2$e). Total emissions are predicted to rise from 75 MtCO$_2$e in 2000 to 96 MtCO$_2$e in 2020.

**Mitigation opportunities for particular transport modes**

While the growing contribution of transport to the climate change problem presents many challenges for the sector, there are also various opportunities to mitigate (or reduce) transport emissions. Most measures and actions that are available to drive mitigation within the sector are specific to particular transport modes. However, others relate more generally to the way in which we use transport services and the impact of design of transport and the associated infrastructure on such usage. We discuss the main measures and actions below.

**Road**

Of the four main transport modes, road transport is by far the most significant contributor of greenhouse gas emissions. Accordingly, most of the mitigation initiatives that have been developed are directed at road transport. The initiatives consist of a mix of regulatory measures, financial incentives and voluntary programs.

(a) **Regulatory measures**

A range of regulatory measures have been introduced in Australia at the federal and state levels that mandate action to reduce greenhouse gas emissions from road transport.

*Mandatory vehicle emissions standards*

A regulatory mechanism that is likely to prove particularly effective in reducing greenhouse gas emissions is the introduction of mandatory vehicle emissions standards.
Australia has had vehicle emission standards in place since the early 1970s. Over the years, these standards have been progressively tightened. The current standards reflect Australia’s commitment to harmonise its vehicle standards with those developed by the UN Economic Commission for Europe, wherever possible. However, up until now, the standards have focused on air pollution and noise.

One of the Labor Government’s promises during the 2010 election campaign was to introduce new mandatory carbon dioxide emission standards for all new light vehicles, including cars, from 2015. It is expected that these standards could save 2.6 million tonnes of carbon dioxide annually. The proposed legislation will require all car companies to reduce emission levels from vehicles they sell in Australia by introducing better technologies and changing the fleet mix. A four-year transition period will apply to help ensure the industry properly prepares and plans for the new standards.

Fue consumption labelling

Mandatory fuel consumption labelling already exists in Australia. Specifically, standards for fuel consumption labelling are specified in Australian Design Rule 81/02 Fuel Consumption Labelling for Light Vehicles.

Under the standard, a model-specific fuel consumption label must be placed on the windscreens of all new vehicles up to 3.5 tonne gross vehicle mass. The label indicates how many litres of fuel a vehicle will use to travel 100 kilometres and how many grams of carbon dioxide the vehicle would emit for each kilometre. The rating on the label is based on a standard test procedure, which allows the performance of different models to be compared under identical conditions.

The rationale for this initiative was to encourage consumers to factor in fuel efficiency and greenhouse gas emissions into their car purchase decisions.

(b) Incentives

The regulatory measures that have been implemented to reduce emissions from the transport sector are complemented by various federal and state-based incentives that are directed predominantly at the car manufacturing industry, although incentives for vehicle users also exist in some States.

Green Car Innovation

The aim of the Federal Government’s Green Car Innovation Fund, to which $1.1 billion has now been allocated, is to foster innovation in passenger motor vehicles to significantly improve fuel-efficiency and greenhouse gas emissions. The fund will provide assistance over ten years, commencing 2009-10, to Australian companies for projects that enhance the research, development and commercialisation of Australian technologies that significantly reduce fuel consumption and/or greenhouse gas emissions of passenger motor vehicles. The Government has made it clear that it supports improvements to existing oil-based technology over subsidies for electric vehicles.

In 2009, the NSW Government established an Electric Vehicles Task Force to explore opportunities and barriers to uptake of electric vehicles in NSW. The Task Force is currently reviewing the technology, infrastructure, policy, and legislation to support the uptake of electric vehicles by NSW motorists.
As part of its exploratory work, a report was commissioned to investigate the economic viability of electric vehicles in the Sydney Greater Metropolitan Region. The report, prepared by AECOM, dated 4 September 2009, found that the plug-in electric vehicle market in NSW is both economically and financially viable, even though the economic and financial returns accrue over the longer term. The move towards a plug-in electric vehicle market also generates large savings in greenhouse gas and air pollution emissions. The report also found that higher levels of charging infrastructure significantly increase the take-up of plug-in electric vehicles and, thereby, increases the viability of the market. Other key factors that were identified as affecting both the take-up and viability of the market include the vehicle cost and rate at which it converges with conventional internal combustion engine vehicles, fuel prices, vehicle range and the existence of local supply constraints.

AECOM concluded that vehicle costs and vehicle range are expected to converge over time as technology improves and production increases. Therefore, if the uptake of electric vehicles is to be encouraged, emphasis should be placed on the removal of supply constraints and the provision of charging infrastructure.

Building on the Victorian Transport Plan, the Victorian Government has recently pledged in its 2010 Climate Change White Paper to provide additional support to encourage local design and manufacture of innovative electric and low-emissions vehicle technologies and to continue working with Standards Australia to develop nationally consistent technical, regulatory and safety standards for electric vehicles and recharging infrastructure.

Cleaner Car Rebate

The Labor Government’s promises during the 2010 election campaign also included the Cleaner Car Rebate which will entitle car owners who trade-in their pre-1995 vehicles for new fuel-efficient vehicles to a $2,000 rebate once that car is scrapped (that is, it cannot be re-sold). The objective of the program is to encourage owners of older cars that are less fuel-efficient and, therefore, more carbon-intensive, to replace those cars with more fuel-efficient models.

Around 200,000 cars are expected to be taken off the road over a 4 year period from 1 January 2011 as a result of the scheme. It is also hoped that the $395 million that has been committed to the program will help boost the automotive industry.

Alternative fuels

Alternative transport fuels to petrol and diesel can reduce vehicle emissions as well as improving air quality and reducing reliance on imported fuel. Alternatives include biofuels, which are sourced from agricultural and forestry residues and municipal waste.

Through its Second Generation Biofuels Research and Development Program (Gen2), the Federal Government has sought to encourage the development of biofuel technologies and a biofuels industry in Australia. Under this program, funding of $12.617 million was allocated to six projects over three years from 2009-10 to 2011-12 as part of the Australian Government’s expanded $5.1 billion Clean Energy Initiative.
The Victorian Government is also trying to encourage biofuels investment. As part of Victoria’s Action Plan for Green Jobs, the Government announced that it will:

- invest $2.5 million in biofuels infrastructure in Victoria over the next 12 months
- trial the use of biofuels on V-Line trains to reduce Victoria’s emissions
- provide $350,000 towards a Regional Biodiesel Distribution initiative to establish biofuel tanks and improve access to biofuels in regional Victoria
- give consideration to a mandated target on biofuels directly linked to industry investment in Victoria.

Regarding targets for biofuels, in 2007, the New South Wales Government imposed a requirement that 2% of the total volume of petrol sold in NSW is ethanol, a biofuel that is attracting increasing attention in Australia because of its environmental benefits and the role it could play in helping farmers and reducing reliance on imported fuel. Under the 2% ethanol mandate, petrol wholesalers were required to ensure that ethanol made up a minimum of 2% of the total volume of NSW sales.

Since inception of the scheme, the NSW Government has increased the ethanol mandate and added a new biodiesel mandate. In particular, in 2009, the NSW Government:

- increased the volumetric ethanol mandate to 4% (from 1 January 2010) and later 6%
- introduced a volumetric biodiesel mandate, initially 2% (from 1 January 2010), increasing later to 5%
- broadened the volumetric mandate obligations to apply to major retailers as well as primary wholesalers
- established a sustainability standard for biofuels.

The New South Wales Government intends to develop a 10-year biofuels strategy to build on these mandates to enable the sustainable production of much greater volumes of biofuels.

*Greening the Taxi Fleet*

In 2009, the Queensland Government introduced the 15% Preference Rule for Green Taxis, pursuant to which prospective taxi operators are provided with a financial incentive to purchase low emission vehicles for use as taxis. More specifically, tenders for taxi licences that will use green vehicles will be valued at 15% higher than the amount bid.

The objective of this policy is to reduce the level of greenhouse gas emissions produced by the Queensland taxi fleet. This is considered a priority because Queensland taxis travel an average of 135,000 km annually, which is approximately nine times the distance travelled by the average motorist. The replacement of a single taxi with a green vehicle will produce a significantly higher greenhouse gas reduction than would occur for the replacement of a single, private vehicle.
Higher car occupancy

Vehicle occupancy rates in Australia are low and are decreasing over time. By providing incentives for more people to travel per car, emissions would be substantially reduced and congestion cut. Shifting vehicle occupancy rates from 1.4 to 1.6 persons per car could save 2.8 million tonnes of CO$_2$ per year by 2020.

Opportunities to increase vehicle occupancy include transit lanes that give priority to multi-person vehicles and employer based car-pooling schemes. Awareness campaigns to inform people of the substantial savings in greenhouse gas emissions, fuel costs and congestions may also assist.

(c) Voluntary measures

Finally, a variety of voluntary mechanisms have been established that seek to encourage car users and others in the road transport industry to reduce their carbon footprint.

Vehicle Offset Program

In its 2010 Climate Change White Paper, the Victorian Government committed to establish a new voluntary program that provides the opportunity for road users to offset their vehicle emissions as part of the vehicle registration process. It is hoped that the offset program will counterbalance emissions from the transport sector as well as raising consumer awareness of the environmental impact of vehicles.

Cleaner Fleets

A number of governments have introduced cleaner fleet programs. For example, NSW FleetWise Partnership is a voluntary program that aims to reduce emissions of greenhouse gases and other air pollutants from business, non-for-profit organisations and council fleet vehicles in New South Wales.

The program seeks to assist organisations to reduce their fleet emissions by providing information about:

- low emissions fleet management practices
- vehicle procurement and emerging vehicle technologies
- options to reduce vehicle travel
- online tools to measure emissions and model the impact of altering various aspects of a fleet
- advice on how to develop a low emissions fleet strategy.

Since 2001, the Victorian Government has purchased carbon offsets for its vehicle fleet emissions. These offsets cover the residual emissions that remain after minimising kilometres driven, and using more efficient vehicles and cleaner fuels. In addition, in its 2010 Climate Change White Paper, the Victorian Government announced that it will introduce a target of reducing its overall fleet emissions by 20% by 2015, starting with the purchase of 2,000 Camry Hybrids built in Melbourne.
Fuel Efficiency Targets

Australia has had in place various targets for fuel efficiency since 1978. For example, the 2000 target was 8.2 litres per 100 km. These targets have been voluntary, and have not delivered the environmental outcomes sought, nor provided investment certainty for the Australian car industry.

However, in its 2010 Climate Change White Paper, the Victorian Government announced that it would work with the Commonwealth Government and the automotive industry to develop a national vehicle fuel efficiency target that reduces transport emissions. It is hoped that such a target will prove more effective than those adopted in the past.

Improving traffic flow

The Queensland Government has announced that it will invest $39.3 million in state-of-the-art computer-based transport systems to reduce emissions and ease congestion on key roads and motorways in South East Queensland. Traffic flow on major roads will be improved by installing new technologies to coordinate traffic signals and on-ramps, vary speed limits, control lanes and monitor traffic. The systems will also collect traffic data, assist with future network planning and allow problem areas to be diagnosed more quickly allowing better responses to traffic incidents that lead to unexpected congestion.

Improving freight efficiency is another important way to reduce travel demand. This can be achieved in a number of ways. Higher capacity vehicles can reduce the total number of trucks on the roads. Better scheduling of trucks reduces unproductive trips. Land-use planning that takes account of the need to maximise freight efficiency can reduce the length and number of trips.

Information

The Federal Government’s Green Vehicle Guide website provides information about the environmental performance of new light vehicles sold in Australia since mid-2004. It is regularly reviewed and updated as new models come onto the market and contains information to help consumers compare the level of emissions of different vehicles and consequently their relative impact on the environment.

The information includes:

- a Greenhouse Rating derived from a vehicles CO₂ emissions value.
- an Air Pollution Rating based on the level of air pollutant emissions allowable under the standard to which the particular vehicle has been successfully tested to for supply to the Australian market
- an Overall Rating based on the sum of the air pollution and greenhouse ratings
- fuel consumption figures quoted in litres/100km derived from ADR81/02 Fuel Consumption Labelling for Light Vehicles.
Shipping

As yet, regulatory measures have not been adopted in the domestic shipping sector to encourage or assist with the reduction of greenhouse gases produced by this sector. This is also the case with respect to international shipping, although the International Maritime Organization is currently examining possibilities for the development of technical, operational and financial measures to regulate greenhouse gas emissions from shipping.

As shipping trade grows in scale and volume, so too will the sector’s share of emissions. Regulatory responses to mitigate these emissions may, therefore, be needed in the future. However, in the meantime, there are practical measures that ship owners and operators can implement to reduce their emissions:

- retrofit for existing vessels, including the introduction of energy efficiency measures, can significantly reduce energy consumption
- technical innovation, such as improved hull and propeller designs, can also reduce emissions by replacing older, less energy-efficient or higher-polluting equipment and engines
- operational strategies, such as use of optimal vessel speeds (‘slow steaming’) and optimising vehicle usage, might potentially reduce fuel use and, therefore, emissions
- alternative fuels that produce fewer emissions (such as biofuels) could also provide options for emissions reductions in the future.

Rail

Rail has the smallest carbon impact of the four modes of transport considered. Increased investment in rail infrastructure would decrease carbon emissions and could have additional benefits, such as driving growth in regional areas that were previously not easily accessible.

During the 2010 election campaign, the Federal Government announced two commitments to enhance rail transport in eastern Australia. In particular:

- Fast-speed rail link - $20 million will be committed to study the feasibility of a fast-speed rail link between Sydney and Newcastle. It would commence later in 2010 and be completed within 18 months.
- Inland rail link - An inland rail link will be built between Brisbane and Melbourne via the New South Wales central west region. The rail line would stretch 1,700 kilometres through three states. The project, which will cost $4.7 billion over 8 years, would become economically viable by 2030.

Apart from investment in rail infrastructure as an alternative to other modes of transport, there are a range of solutions that could improve the energy efficiency of rail transport and thereby reduce emissions. These include:

- technical solutions aimed at achieving optimum train mass
- operational changes, including energy efficient driving
- better matching rail stock to demand
- investment in emerging technologies, including hybrid drives and hydrogen fuel cells.
Maldon to Dombarton Rail Link (Case study by Hyder)

Hyder has been commissioned to undertake the preliminary environmental assessment (PEA) for the design of a rail link between Maldon and Dombarton in NSW. A greenhouse gas assessment has been undertaken as part of the PEA to estimate the greenhouse gas emissions from construction activities associated with the rail line and the estimated savings from switching transport of freight from road to rail.

The PEA will be submitted to the NSW Department of Planning for assessment and will inform the development of the Environmental Assessment Requirements as part of an assessment under the Environmental Planning and Assessment Act 1979.

Air

In its National Aviation Policy White Paper, which was released in December 2009, the Federal Government acknowledged that the proportion of global carbon dioxide emissions from the aviation sector is growing.

The White Paper notes that, as part of the Government's broader response to the issue of climate change, Australia ratified the Kyoto Protocol and proposed a Carbon Pollution Reduction Scheme, which would have included domestic aviation to meet carbon dioxide reduction targets. The White Paper notes that the Government will continue to work through the International Civil Aviation Organization to establish a framework for the treatment of international aviation emissions that can reduce emissions without unfairly disadvantaging Australia's international airlines.
In the meantime, there are a number of measures that the aviation sector can adopt to mitigate emissions, including:

- more fuel efficient aircraft, such as through advanced propulsion systems, utilization of lightweight materials, and improved aerodynamics and airframe designs
- use of lower carbon fuels
- navigation systems and air traffic control techniques that minimise fuel use and idling
- improved operating procedures, including single-engine taxi to and from the runway and the use of a Continuous Descent Approach, which can reduce emissions significantly during operations in and around an airport.

Switching transport modes

A variety of factors, including relatively low fuel prices and patterns of urban development, have led to heavy dependence on road transport. Given the significant contribution that road transport makes to greenhouse gas emissions, measures are needed to encourage road transport users to switch to less carbon-intensive modes.
Lower Hunter Transport Needs Study (Case study by Hyder)

Hyder Consulting was commissioned by the Department of Infrastructure and the NSW Road Traffic Authority to identify land transport networks to meet the long and short term transport needs of the Lower Hunter in NSW. The overall objective of this project was to assess the relative benefits of a number of proposed road options based on strategic engineering, environmental, economic and cost criteria in meeting the transport needs of the study area. As part of the environmental assessment, Hyder conducted a greenhouse gas assessment of the emissions generated by traffic for each of the proposed options.

Each transport option had a unique greenhouse gas emissions profile based on operational efficiency and construction requirements. Assessments were carried out based on traffic volumes and transport modes. Road route options were considered against the following government policy objectives:

- NSW State Plan – 60% cut in greenhouse gas emissions by 2050 and a return to 2000 emissions by 2025
- The National Ecologically Sustainable Development Strategy – To improve the technical and economic efficiency of urban and non-urban transportation; encourage switching to alternative transport technologies or modes where this reduced greenhouse gas emissions per passenger or unit of freight, and to optimise the modal mix of transport to achieve greater economic, environmental and social benefits.

It was found there were only slight differences in operational efficiency between the different route options. Any reductions in greenhouse gas emissions between the proposed route options and the current road were a result of reduced delays and improved traffic conditions being offset by longer distances generated by new roads in the transport network. Estimated emissions released during construction of the road options were also calculated.

Land-use planning can reduce the need for travel and, hence, travel demand. More compact cities and developments that place employment, shopping and recreation near where people live reduce the need for travel. Australian cities have much lower densities than their European counterparts and, consequently, generate more car kilometres per person. Urban sprawl means that new households on the fringe of major Australian cities are forced to travel substantial distances for work, shopping and recreation.
Modern rail infrastructure in burgeoning cities (Case study by HASSELL)

Strategic planning, design and construction for new underground rail infrastructure and surface light rail systems is developing at an increasing pace in capital cities around Australia. This is a reaction to population growth, public transport demand, increased urban density and growing road traffic congestion problems.

Epping to Chatswood Rail Link (ECRL), Sydney NSW

Prior to its opening, the new Epping to Chatswood underground rail line and underground stations were virtually unknown to the public, with the majority of construction being completed underground.

This underground rail line, as an insertion into an existing city, provides not only increased transport amenity, but also opportunities for urban densification, regeneration and flexibility. The Macquarie Park Station, for example, is located close to a university, shopping centre and large office and industrial park, in an area that was previously isolated with limited parking and bus transport options. With the opening of the rail link, it now offers development and business opportunities, which attracts staff and students to the university, and assists in decreasing the reliance on private vehicles.

Signature entry pavilions for the stations establish the project’s civic identity. Covered in glass louvres they welcome, shelter and direct passengers, capturing light by day and illuminating at night. The stations breathe via a naturally ventilated building design that reduces energy, minimises costs and enhances amenity.

The design of the underground stations achieve a sense of calm, clarity and timelessness befitting the station’s importance as contemporary public buildings through:

- creation of local identity
- natural light and ventilation,
- unambiguous circulation and wayfinding.

Epping to Chatswood Rail Link, Macquarie Park Station NSW
Reduced dependence on cars can be achieved in a number of ways, including:

- intermodal transport efficiencies
- transit-oriented design
- investing in alternative transport infrastructure
- raising awareness about the benefits of using alternative modes.

We consider examples of each of these options below.

**Transport-oriented design**

Activity centres and transit-oriented development can make a significant contribution to mitigating the effects of climate change.

An activity centre is an area in which a variety of activities are concentrated such as shopping, working, studying, socialising and recreational activities. Activity centres are characterised by high density residential buildings and other facilities clustered around public transport nodes rather than being widely dispersed.

Activity centres are increasingly being advocated for the environmental benefits that they generate. In particular, activity centres reduce dependence on cars which, in turn, reduces fuel emissions. In addition, mixed use activity centres are considered to have significant social advantages because they are more interesting and dynamic than single use areas. Moreover, synergies may develop as a result of the co-location of businesses within an activity centre.

Planning helps to support activity centres through transit-oriented development, which is a mixed-use residential or commercial area designed to maximise access to public transport. More specifically, rather than segregating uses, planning may aggregate uses in a defined area or zone, by indicating which particular uses can be carried out in that zone.

**Melbourne 2030 - Melbourne @ 5 million**

The Victorian Government's long-term planning framework for managing Melbourne's growth is set out in a recent series of framework and policy documents. Melbourne @ 5 million provides policy initiatives that are complementary to the directions of Melbourne 2030. It outlines the implications of the Victoria in Future 2008 growth projections for Melbourne, which indicate that the city’s population is likely to reach 5 million before 2030. Actively managing this growth and change is an important part of Melbourne's future liveability. The framework seeks to implement the principles of transit-oriented development through the Transit Cities program.

The elements of the Transit Cities program include the:

- development of urban cities around central public transport services
- integration of private and public investment and development
- appointment of an agency to coordinate development within the Transit City
- encouragement of high density development
- increase in public transport use.
Intermodal terminal facility design (Case study by Hyder)

Hyder Consulting is currently undertaking concept planning design for a proposed intermodal facility located in Sydney. This project will contribute to the NSW government’s objective to achieve a 40 per cent rail mode share of containers to and from Port Botany. The project aims to significantly reduce greenhouse gas emissions in the Sydney Basin.

Hyder undertook a climate change risk assessment (supported by climate change modelling) with regard to potential impacts posed by flooding in response to projected increases in rainfall intensity and bushfire impacts. The following adaptation strategies were recommended for adoption in the detailed design stages of the project:

- selection of building materials to withstand storm intensity
- structural design for increased wind intensities
- warehouse ventilation for improved heat removal
- provision of building setbacks and strategic fire management zones
- design of stormwater detention on site to accommodate increased rainfall
- design of rail line to withstand flooding posed by increased frequency of extreme rainfall events

A greenhouse gas assessment was also undertaken to identify potential impacts and inform the identification of mitigation strategies for the design, construction and operational phases of the project.
Transit Oriented Development – in existing urban areas (Case study by HASSELL)

Parramatta Transport Interchange, Sydney NSW

The new Parramatta Transport Interchange, designed by HASSELL, will accommodate an expected 50% growth in rail patronage by 2021, to 35,000 passengers each morning peak period. In addition, the building provides ease of movement and connection for the complex modal interchange requirements of the fifth largest public transport station on the Sydney metropolitan network. The interchange connects the primary modes of public and personal transport clearly and efficiently to delight rather than confuse the passenger.

‘It is important that all stations and stops are designed to reduce the walk time and distance for passengers accessing and interchanging between services. Parramatta Transport Interchange is a good example of integrated transport with rail, bus, long distance coach, taxis, cycling and key destinations all within close proximity to each other.’ Parramatta City Centre Integrated Transport Plan.

The station design achieves connectivity through permeable screens and vistas including:
- north and south facades that provide visual connection, weather-protection and security
- a large single span station roof providing a recognisable signature of the Parramatta Transport Interchange and a singular presence
- a sculptural wall titled ‘Movement Through Landscape’ which provides a symbolic articulation and connection of transport modes.

Parramatta Station Precinct

The rail line in and out of Parramatta Station has historically divided the City of Parramatta, north to south. The new station provides improved pedestrian permeability from north to south and reinvigorates commercial and public opportunities, connections to retail zones and future Parramatta Civic Place urban development.

The NSW Government’s $200 million public transport infrastructure investment was an important first step for the city development. The next steps will be to increase density, build mixed use buildings, public plazas and increased business opportunities, all centred on the Parramatta Transport Interchange.
Transport

Investment in alternative infrastructure

The Queensland Government will invest $2.9 million to accelerate the planning and development of key walking and cycling infrastructure in South East Queensland as part of its Faster, Better, Safer Walking and Cycling initiative. The infrastructure will focus on closing gaps linking key destinations, such as the Brisbane CBD, the University of Queensland and Fortitude Valley. The initiative is part of the South East Queensland Principal Cycle Network Plan, released in late 2007, which defines a network of cycle routes and corridors across Brisbane.

The desired outcomes of the Faster, Better, Safer Walking and Cycling initiative are:

- reduced greenhouse gas emissions from the transport sector
- getting people out of cars and walking and cycling more
- higher numbers of people walking and cycling
- improved personal health and air quality
- reduced vulnerability to peak oil.
Transport infrastructure – Innovation in Bio-diversity and energy generation
(Case study by HASSELL)

Transport infrastructure projects have a unique ability to improve and enhance the surrounding natural habitat whilst minimising environmental impacts in design and construction. Innovative transport projects take a holistic approach by incorporating mixed transport modes with energy generation and water minimisation, recycling waste and protecting eco-systems.

TrackStar Alliance – Sunshine Coast QLD

TrackStar Rail is part of the Queensland Government’s $134 billion South East Queensland Infrastructure Plan 2010-2031. The program aims to build capacity of the suburban rail network.

The design and construction of the new rail corridor and five rail stations connecting Robina to Varsity Lakes provided opportunities for the mitigation of environment and climate change impacts, such as:

- integrated innovative building energy conservation features, passive solar design, open ventilation spaces and large pitched roofs
- integrated water conservation features and a rain water collection system connected to the toilets and garden irrigation
- solar electricity generation with photovoltaic cells embedded into skylights in platform roofs. The solar cells are designed as features in the skylight glazing, visible from the platform and concourse
- a rehabilitation plan at Beerburrum Creek Bridge area on the Sunshine Coast which has reconnected a locally significant biodiversity corridor and increased creek bank stability
- an innovative fauna crossing design implemented in ecologically sensitive areas throughout the rail corridor.
**Raising awareness**

Travel demand can also be reduced through behaviour change programs. These programs encourage households to examine their travel behaviour and reduce motor vehicle trips. Successful programs have reduced vehicle kilometres by up to twenty per cent.

TravelSmart Australia is a program that is jointly run by the Commonwealth, State and Territory Governments. In essence, TravelSmart is a tool that seeks to inform and motivate people to change their travel behaviour through personal choice. TravelSmart identifies the many community and government based programs that are aimed at encouraging using alternatives to car travel.

TravelSmart asks you to think about your travel needs in the following ways:

- Use alternative transport to the car, for example using walking, cycling and public transport.
- Reduce the negative impacts of the car on traffic congestion and air pollution.
- Recognise the health benefits of incidental exercise such as walking or cycling.
- Choose shops and facilities that are near you to reduce the need to travel and to support your local businesses.

**Summary and conclusions**

This paper has highlighted the risks and the opportunities that climate change presents for the transport sector.

More specifically, the physical consequences associated with climate change can pose important risks for transport infrastructure if adaptation of climate change effects does not occur. While there is scope within existing infrastructure regulatory regimes for the effects of climate change to be addressed, it is fair to say that these regimes do not tackle climate change head on. Indeed, none of the regimes considered expressly recognise the risks posed by climate change. Explicit recognition of the impact of climate change in the relevant statutory instruments will clarify and, thereby, facilitate the use of existing tools to address the effects of climate change.

In conjunction with a review of the regulatory regimes, consideration needs to be given to how climate change can be more effectively accounted for to reduce the risks for transport infrastructure. Some options include:

- mandatory assessments of climate change risks by infrastructure owners and operators
- review of the standards for transport infrastructure development to ensure that the infrastructure can withstand the effects of climate change – now and in the future
- the imposition of a use-based tax to support additional maintenance and repair measures that may be needed to address the effects of climate change
- establishing a direct link between revenues collected from road users and the allocation of funding for infrastructure construction and maintenance to ensure adequate funding exists to address the effects of climate change.

With respect to mitigation, there are a range of mitigation measures aimed at reducing greenhouse gas emissions from the transport sector, including mode-specific measures as well as more general actions regarding design of transport and transport usage.
Most of the mode-specific mitigation measures relate to road transport. Uptake of these measures, particularly the voluntary measures, may be limited until a carbon price is introduced. In the meantime, greater emphasis is needed on making transit-oriented design the norm and changing individual’s habits regarding their transportation choices. Improving less carbon-intensive transport choices – particularly, rail transport – will help to achieve this.

Broader consideration also needs to be given to mitigation options for the other modes, particular air and shipping transport. However, adoption of measures for these modes may be delayed until global responses have been developed.
Our contact details

This paper was prepared by Dariel De Sousa and Rebecca Dickson, with assistance from John Thwaites.

For further information about the issues raised in this paper, please contact a member of our team.

www.maddocks.com.au

Case studies were prepared by HASSELL and Hyder Consulting

Contacts details for HASSELL are:

Ross de la Motte
Director
Architecture
rdelamotte@hassell.com.au

Rodney Uren
Principal
Architecture
ruren@hassell.com.au

Contacts details for Hyder Consulting are:

Jason van Paassen
Regional Director
Transport Planning and ITS - Australasia
Jason.VanPaaassen@hyderconsulting.com

www.hyderconsulting.com

Brad Searle
NRM Team Leader
Brad.Searle@hyderconsulting.com