

## Valuing Transport Externalities – A Mechanism to Promote Sustainable Development

Caroline Evans<sup>1</sup>  
<sup>1</sup>ARRB Group Ltd

### 1 Introduction

The abatement of environmental externalities has received significant international, political and community attention over recent times. Evidence suggests that the effects of externalities are diverse and potentially very large, and are likely to have significant economic, social and environmental costs associated with damage to health and the environment (BIC 2001). Strategies to substantially diminish the impact of the transport sector, in particular, on the environment have been proffered over the last 20 years. Notwithstanding the prevalence of good-will and ideas to increase emphasis on the issue of sustainable development, the reality is that the environmental impact of transport is a direct outcome of the demand and reliance on transport for passenger and freight sectors.

The objective of this paper is to assess the valuation of externalities as a mechanism to promote sustainable development and focuses primarily on environmental transport externalities (mainly for road). This paper does not estimate the external costs related to transport, rather it explores recent progress and trends in developing externality values in Australia, and the challenges in applying these values in policy development, providing correct pricing signals and project appraisal.

### 2 Sustainable development

Sustainable development is considered to be both a local and global challenge. It seeks to ensure that ongoing transport investment meets the needs of the community without compromising the ability of future generations to achieve their own standards for a sustainable outcome.

Agenda 21, an action plan at the 1992 Rio Earth Summit, in Brazil stated that in order to protect the environment, a precautionary approach should be widely applied by States according to their capabilities (Raffensperger and Tickner 1999). According to OECD (2002) titled *Working Together Towards Sustainable Development*, OECD countries have made progress towards sustainable development since this Summit. At the OECD Ministerial Council Meeting in May 2001, OECD Finance and Environment Ministers undertook a commitment to shape globalisation for the benefit of all, and improve the balance between economic, social and environmental dimensions—the essence of sustainable development (OECD 2002).

Current world's best practice recommends that public and private agencies extend the scope of traditional management and reporting, to include social, environmental and economic performance. Therefore, both private and public sectors have steered away from the traditional focus on financial objectives of economic development, and have added dimensions of social and environmental accountability. The consideration of these three dimensions is commonly known as the 'triple bottom line' (TBL) approach to decision-making. This incorporates a framework for measuring and reporting corporate performance in a way that is more orientated towards community values and seeks to minimise negative externalities and create economic, social and environmental value (ATC 2004; Elkington 1997).

### 3 External costs

According to Delucchi (2000), there is no 'right' definition of 'externality'. In spite of the number of sources which define externalities two conditions are apparent: one party affects the other (A affects B); but; does not recognise or account for the effects (Baumol and Oates 1998 in Delucchi 2000). Accordingly, transport externalities refer to situations in which transport users either do not pay for the full costs of their transport activity or do not receive the full benefits. In the case of a negative externality, this creates a divergence between marginal private cost (MPC) and marginal social cost (MSC) where the MSC is greater than MPC<sup>1</sup>. In an economic sense, it is necessary to correct for externalities, as in a market economy, when resources are not priced at their MSC it results in a deadweight loss to society compared with optimal resource allocation. This is demonstrated in Figure 1. In response to this condition, the valuation of externalities provides an essential tool for correcting this disutility and promoting sustainable development.

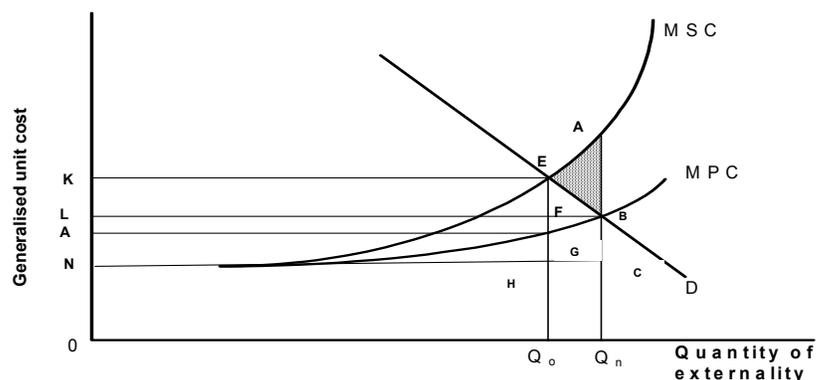


Figure 1: Economic theory of externalities

#### 3.1 Types of externalities

In the production and consumption of goods and services, externalities may occur in the forms of litter on streets and in public places, vandalism of public property, negative externalities arising from crime, or externalities associated with the transport sector. Four main categories of transport externalities exist: congestion, accidents, environmental costs and pavement and bridge wear (more commonly known as road/pavement damage).

##### 3.1.1 Pavement and bridge wear externalities

The Australian Rail Track Corporation (ARTC) (2001) notes that the damage to the road pavement is caused from the number of axle loads across a section of highway, and is associated with the mass of the axle load, freight vehicle type and the proportion of vehicles operating. It is suggested that the impact of heavy vehicle axle loads cause more damage to

<sup>1</sup> Figure 1 may be described as a situation whereby social cost = private costs plus the externality.

the pavement than light axle loads. Some pavement and bridge wear costs are considered to be external, whereby the increased proportion of freight vehicles on roads may result in increased pavement damage, in turn adding significantly to increased costs associated with maintenance expenditure in the long-term. These costs are also often influenced by factors such as weather conditions which account for a large share of road deterioration (WALGA 2006). This creates an externality with increased repair cost of the road, borne by the road infrastructure provider, and the increased vehicle operating costs for the other road users (Mayeres 2002). Alternatively, the National Transport Commission (NTC) (2006a) defines so called road damage as *'the higher vehicle operating costs that all other road users will experience due to the road now being a little rougher due to the truck having passed over it'* (p.17)<sup>2</sup>.

### 3.1.2 Environmental and other externalities

Whilst a number of externalities associated with the transport sector have been identified, the focus of this paper is on valuing and applying environmental externalities to assist in integrating sustainable development concepts into practice. Major environmental externalities include noise, local air pollution, greenhouse gas emissions (GHG), water pollution, nature and landscape and urban separation.

It is acknowledged that other externalities such as accidents and congestion are considered to be more contentious than others and may not be as straightforward to define. For example, Martin (2005) states that the estimation of external accident costs is very complex and raises both conceptual and measurement problems. Popular measures of accident include the share of total accident costs, the difference between total accident costs and total insurance premiums, costs imposed on non-road users (system costs being the main ones) and costs arising from the disparate vulnerability of road users (Martin 2005, p.10).

Similarly, estimation of congestion is also a challenging task. The economic approach to valuing congestion argues that to eliminate congestion to the point where traffic flows freely would not be desirable because road infrastructure would then not be utilised efficiently and economic activity would also be constrained (Naude et al. 2006). The economic approach argues that there is an 'optimal' level of congestion that needs to be reached (through marginal cost pricing) where some road users either do not travel at all, postpone their trips to another day, travel at different times of the day (off-peak) or travel on other modes (public transport) or with other users (ridesharing) (Naude et al. 2006; VCEC 2006). This in turn influences the external value assigned, the optimal economic cost and the ability to internalise these costs.

Another externality associated with road transport is the disposal of end-of-life tyres. This refers to the extent of any market failures applying to the management of end-of-life tyres in Australia (i.e. whether there has been a failure of the market to efficiently allocate the resource value contained in end-of-life tyres) (WALGA 2006). Illegal dumping of end-of-life tyres is of concern to local communities whereby it has been associated with environmental and human health risks (WALGA 2006).

---

<sup>2</sup> Load associated pavement and bridge wear can be expressed as a cost that is attributable to heavy vehicles. It is often defined as an externality and is usually recovered in Australasia by charging heavy vehicles according to distance and the type of pavement travelled and load carrying capacity per vehicle axle or set of axles. For a critique of methods used in the estimation of pavement and bridge wear costs see Martin (2000).

### 3.1.3 Interrelationships between externalities

When investigating externalities, it is also important to recognise that externalities are highly interrelated. A causal relationship exists between externalities and often one cannot be considered independent of the other. For example, congestion is considered to impose relatively high costs to the transport system, and affects the level of other externalities, such as accidents, noise and noxious emissions (BTCE 1993; WALGA 2006). Feed-back loops are therefore created where the level of traffic and its impacts, gives rise to congestion, however congestion in turn directly influences the traffic patterns.

Although externalities are highly interrelated, they are not perfectly correlated. The marginal external costs vary widely in respect of the network considered, the volume of traffic, vehicle type and other factors (Mayeres 2002; WALGA 2006). Therefore, when designing the policy instruments, account should be taken of the interactions between all externalities, and a range of instruments will therefore be needed to tackle them (Mayeres 2002). Additionally, externalities vary significantly by location and time of day and other dimension such as by vehicle class, mass, distance travelled, type of road and extent of vehicle use (BTRE 2004; WALGA 2006). Establishing the external costs of transport externalities is an essential component towards understanding the complex interrelationship between social and private costs and benefits associated with transport, and accounting for these estimates in order to promote sustainable transport systems.

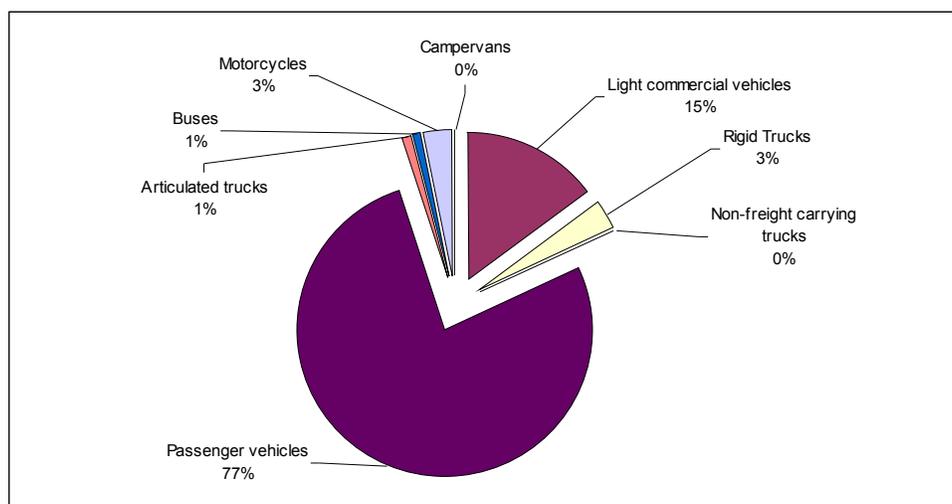
## **4 Externalities in the context of sustainable development**

The relationship between transport and sustainable development has been researched with varying degrees of intensity, and assessment of environmental impacts has perhaps been at the forefront of this research. In developing an understanding of the full impacts of transport on the environment and sustainable development into the longer-term, the economic, social, demographic and energy related aspects are important. This section briefly discusses each of these, and provides a link between negative environmental externalities imposed by transport and sustainable development.

### **4.1 Economic**

At an economic level, the provision of efficient and effective road assets are fundamental components for the economic function of cities. According to the Bureau of Transport and Regional Economics (BTRE) (2006b), Australia's land freight transport task is forecast to double from 2000 to 2020, placing significant demands on road assets and the environment. Additionally, passenger vehicles also contribute to environmental impacts. The key factors underlying the growth in passenger and freight transport are population growth, increases in household income, growth in economic activity (demand and supply of transport services, and GDP), trends in passenger and freight transport costs, increasing consumer spending power, increasing urbanisation and geographical spread of cities, and increases in resource demand for minerals and agricultural production (NTC 2006b; OECD 1996).

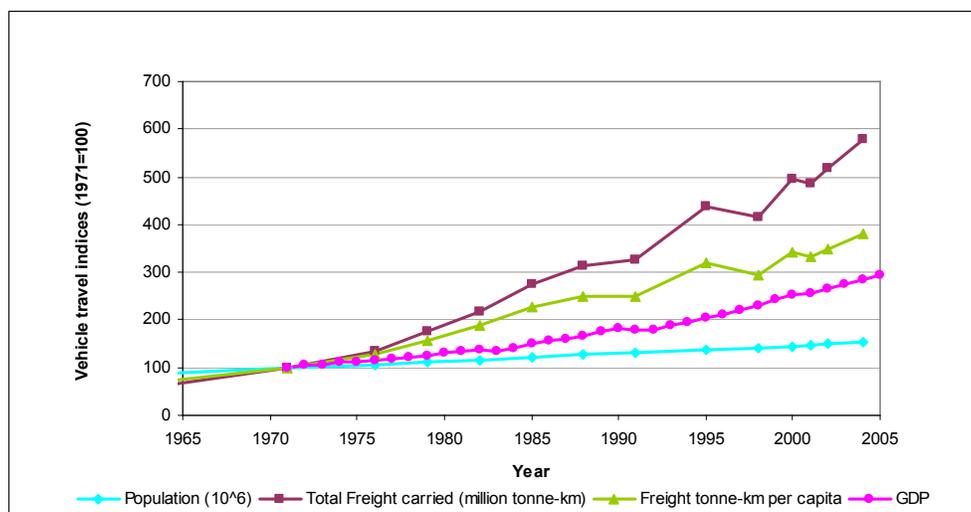
Over the past three decades, vehicle numbers in Australia have grown by about 2% a year (Austroads 2003). In 2005 there were 13.9 million vehicles registered, an increase of 11.6% from 2001 (or an average growth rate of 2.8% per annum) (ABS 2005). The breakdown of the registered vehicle population per vehicle type is shown in Figure 2.



Source: (ABS 2005)

**Figure 2: Registered vehicle population per vehicle type**

Literature suggests that Australia transports more road freight per unit of GDP than any other country in the world (Austroads 2003). This is due to a combination of low population densities, large distances between major economic centres and the low cost of transporting freight by road. According to the BTRE (2006a), total road freight tonnages are projected to grow by 3% per annum over 1999-2025. This trend is also shown in Figure 3, where the total freight task (along with population and GDP) has grown by 415% from 1971-1998 (extrapolated from 1998 onwards). The growth continues to be stronger than GDP with 1.7 times the rise in GDP over 1971-1998 (Austroads 2003). In a recent report by Sinclair Knight Merz and Meyrick and Associates for the NTC (2006b) it is reported that historically, transport activity has grown approximately 30% faster than overall economic growth. The shares of the road freight task has also changed significantly by vehicle type, with increases in smaller and larger vehicle (B-Double) sizes on roads (NTC 2006b).



Source: (Austroads 2003; ABS 1998; 2005)

**Figure 3: Freight task trends compared with population and GDP changes**

However, with this growth there is a flow-on effect of increased degrees of environmental degradation and associated negative externalities. As a procyclical trend exists between increases in transport movements (freight and passenger), environmental impacts and economic growth, it is a challenging task for governments to both maximise returns on investments within a growing economy and reduce environmental impacts. Research suggests that environmental impacts are directly associated with the increasing demand and reliance on transport within the economy. As a result, any gains in diminishing these negative impacts of transport, whilst maintaining economic growth, are dependent on the ability to value and account for these in sustainable development decisions for the future.

However, notwithstanding these observations, it is essential to note that environmental impacts are not solely affected by increases in the passenger and freight task (whether it be for road or rail) or other areas identified above, and are dependent on a complex array of interrelated factors.

#### **4.2 Social needs**

There is growing evidence that the community would like the social costs of growing the economic pie to be taken into account whilst ensuring that it is benefiting the broader community. Striking the right balance between the economic, social and environmental values is essential for satisfying TBL objectives and achieving sustainable development. Recent studies identify a strong link between negative environmental impacts and adverse health effects imposed on society as a result of transport (Pratt 2002). However, it is important to note that transport does not solely influence these effects.

According to the BTRE (2005), the total economic cost of air pollution-related mortality associated with motor vehicles is in the order of \$1.8 billion. In addition to health costs imposed on society, air pollution can also contribute to a number of environmental problems. These include smog, degraded visibility, loss of biodiversity, and damage to infrastructure such as discolouration of stone, erosion and building soiling (BIC 2001; WALGA 2006). Additionally, other externalities such as localised noise pollution, and the increasingly noticeable issue of climate change are areas of significant concern to society. Valuation of externalities therefore provides a necessary step in ameliorating these negative effects and provides a mechanism for improving the health, liveability of cities and quality of life for individuals in the future.

#### **4.3 Demographic aspects**

Most environmental externalities are directly correlated with demographic and location aspects. Analysis of impacts such as air pollution and noise pollution, requires identification of the dispersion of pollutants to different locations and how they have been transformed (Kahn 1998; WALGA 2006). GHG emissions are not discussed in this section because they are global in nature and are hence not location specific. When considering local pollutants, it is important to identify the exposure of society to the pollutant e.g. what population (human and non-human) are exposed to the pollution, and what is the level of exposure? Analysis of externalities also requires consideration of how the exposure to the pollution gives rise to physical effects (e.g. health impacts), known as 'dose-response' relationships, and/or in the case of noise pollution, to changes in property values (for hedonic pricing, see section 5). Additionally, many externalities are highly location specific and vary in intensity according to population density in urban and rural locations. These demographical aspects and linkages to externalities are further discussed in section 6.4.1.

#### 4.4 Energy

The analysis of environmental impacts and long-term sustainability requires a distinction between different vehicle types, mass, fuel types, technology, and vehicle movement. This strong interrelationship exists particularly in urban areas where freight and passenger movements are more pronounced. For example, according to Watkiss (2002) petrol vehicles have lower particulate emissions than diesel vehicles. However, it has been noted recently that diesel cars, due to the high efficiency of their combustion, produce less carbon dioxide per kilometre than petrol cars. A trade-off exists between the level of emissions produced, fuel type and technology e.g. level of euro-standard. As a result of engines becoming more fuel efficient (e.g. introduction of catalysts and stricter emission policies, Euro IV and Euro V between 2005-2008), progress has been made in reducing major noxious emissions such as lead, sulphur dioxide, nitrogen oxides and hydrocarbons (Hafkamp 2006 unpublished).

Additionally, the type of vehicle influences levels of pollutant generated. For example, passenger vehicles in Australia are largely run on unleaded petrol, whereas diesel is more common for freight vehicles. In spite of progress that has been made addressing emissions, with the projected increases in passenger travel due to urbanisation (growth in total inter-regional passenger trips of 2.6% per annum between 1999 and 2025), and estimated doubling of freight movements (growth in the total domestic freight task of 2.75% per annum between 1999 and 2025), levels of all pollutants will need to be carefully monitored (BTRE 2006a). Hence, this is a major issue for decision-makers in ensuring sustainable development.

The availability of alternative fuels has been viewed as a possible solution to reducing the pollution and health problems imposed on society. CSIRO et al. (2003) reports the appropriateness of a 350 ML biofuels target in terms of net environmental benefits, net economic and regional benefits and industry viability. Environmental benefits were estimated for GHG emissions, where under the target scenario, GHG emissions are projected to be 268,000 tonnes lower in 2010 (about 0.3% of transport GHG emissions). Whilst there are environmental benefits associated with alternative fuels, it is highly dependent on technology developments, effects on industry, world oil prices, exchange rates, and the prices of biofuel feedstocks. This is the topic of ongoing research and discussion within Australia.

#### 5 Valuing externalities

In order for governments and industries to take account of the economic, social, demographic and energy-related effects associated with externalities, it is necessary to provide a framework to encourage the consideration of externalities within decision-making processes. According to *the Land Transport Pricing Study* (Ministry of Transport 1996), it is noted that '*identifying and costing environmental externalities is essential for the promotion of sustainable management...*' (p.7). Therefore, in addition to recognising these environmental implications, the valuation of externalities can provide an effective mechanism to assist in quantifying these environmental impacts. In turn, these values can be used to assist in the implementation of mitigation strategies into government and industry practice.

The estimation of externality values broadly involves three steps. The first is to estimate the physical quantity of the externalities (such as urban and rural locations), type of vehicle, using estimation techniques ranging from the application of default parameters to the use of more sophisticated transport models. Secondly, valuation requires the user to estimate the monetary impacts by applying valuation parameters to these quantity changes, and finally the user is required to multiply quantity by dollars to estimate the stream of benefits and

hence the key appraisal indicators e.g. for values disaggregated by cents/vehicle kilometre, first estimate the kilometres and multiply this with the parameter value (ATC 2004).

A range of techniques exist to derive estimated values, and their application and interpretation varies for each externality. These methods include revealed preference approaches, such as hedonic pricing, hedonic wage studies or the travel cost method, and stated preference e.g. contingent valuation and conjoint analysis (Kahn 1998). A number of other methodologies such as dose response relationships, willingness to pay (WTP), demand/supply analysis, market shadow prices, willingness to accept, production function approach, and control costs (mitigation costs) are also useful to quantify externalities (Spaninks and Van Beukering 1997).

In order to ascertain the benefits of environmental policy and the costs of obtaining these goals, these measurement techniques can assist by providing a link between externalities and their impact on society, the environment and economy. For example, hedonic pricing is used to measure the value of noise pollution through revealing society's WTP to avoid noise pollution, and comparing this to society's demand for houses in quieter areas e.g. how the market price of the house varies with changes in noise levels can reveal the value of noise (Kahn 1998). In the US, Pearce and Markandya (1989) found that property values fell by between 0.01% and 0.22% for a 1% increase in noise pollution (Sinclair Knight Merz 2001).

Although, hedonic pricing is flexible in taking into account case-specific details such as the actual levels of noise, durations and times of the noise, density of the housing, and (perhaps more controversially) the incomes of the people affected as reflected in house prices, it is reliant on availability of data and resources. Like any economic methodology, there is widespread debate around which is the most appropriate for estimating a particular externality type. In the case of noise externalities, it is questionable as to whether hedonic pricing provides a more complete estimate of the cost effectiveness of noise mitigation measures than using other methodologies such as WTP.

## **6 Current practice in applying externality values**

In accordance with a world-wide shift to more sustainable development and TBL initiatives, the valuation of externalities for transport has become increasingly important for informing broad policy objectives, pricing, and project appraisal.

### **6.1 Externalities within a policy framework**

Whether it is entrenched within the Government's strategic framework in meeting high-level social, economic and environmental outcomes, valuation is of critical importance in setting priority actions and promoting sustainable development. Examples of recent government strategies include Melbourne 2030: Planning for Sustainable Growth (State of Victoria 2002), the Integrated Transport Planning Framework (Queensland Government 2003), Western Australia's Network City (State of Western Australia 2005), the Sydney Metropolitan Strategy (State of New South Wales 2005), and the Strategic Infrastructure Plan (State of South Australia 2005) for South Australia. These strategies reflect the current trend across governments in Australia to provide collaborative, consistent and sustainable approaches to transport planning. This includes supporting economic activity and growth, improved quality of access, provision and promotion of more sustainable travel options, a safer community and a cleaner environment. From a policy setting perspective, the valuation of externalities provides a useful component in informing the principles of sustainable development, and enables long-term strategic approaches to infrastructure to be pursued by government, industry and the broader community.

### 6.1.1 Challenges of applying externality values in policy

The application of externalities is often influenced by government initiatives in place, coupled with the need for decision-makers to meet the requirements of stakeholders and the community. An example of this is in the valuation of climate change and selection of an appropriate dollar per tonne (\$/tonne) value for GHG emissions. International carbon-credit trading mechanisms (designed to equalise the costs and benefits of emitting or sequestering a tonne of CO<sub>2</sub>-e) are yet to be formalised amongst all greenhouse gas emitting countries. However, in 2005 the European Union Greenhouse Gas Emitting Trading Scheme commenced operation as the largest multi-country, multi-sector greenhouse gas emission trading scheme world-wide. In a report undertaken by CSIRO, ABARE and BTRE (2003), it is noted that *'in the absence, at the present time, of an international market value for carbon dioxide equivalent emissions, the Australian Greenhouse Office has suggested use, on an illustrative basis, of the values contained in the 1999 publication, Discussion Paper 2 – Issuing the Permits (AGO 1999). The discussion paper postulated a permit price range of \$10 to \$50 a tonne CO<sub>2</sub>-e. The lower value of \$10 a tonne CO<sub>2</sub>-e is consistent with the upper bound of the cost to government of abatement purchased under round 1 of the Greenhouse Gas Abatement Program (GGAP)'* (p.26).

As a formal market trading system is yet to be established in Australia, the application of CO<sub>2</sub> values to address greenhouse is therefore complex. This is also influenced largely by the wide-range of externality parameters that are now available for this area.

### 6.1.2 Range of greenhouse values available

Tsolakis et al. (2003) discusses two main approaches to estimating climate change. These include the Infrac/IWW study (based on a control cost approach or calculates the marginal avoidance cost to reach the specified target) and the ExternE study (based on a damage cost approach). The Infrac/IWW 2000 study used the average avoidance cost of reducing transport emissions by 50% in accordance with an IPCC scientific determination of sustainable CO<sub>2</sub> emissions, and arrived at a value of approximately A\$205 per tonne CO<sub>2</sub>. ExternE (European Commission 1999) considered a range of climate change impacts (based on sea level rise, climate change, desertification, loss of habitat, species, coral reefs, arable land etc.<sup>3</sup>) and estimated the unit cost at approximately A\$48 per tonne CO<sub>2</sub>. Tsolakis et al. (2003) also reports ranges from other literature sources, such as EnValue (developed by the NSW EPA), which presents values of A<sub>1999</sub>\$4 to A<sub>1999</sub>\$10 per tonne CO<sub>2</sub> (adjusting these values to Australian dollars using a CPI and Purchasing Power Parity adjustment factor). Similarly, Laird (2005) advises \$25 per tonne of CO<sub>2</sub>-e, whilst the BIC (2001) recommendation was for a tax of \$40 per tonne of carbon dioxide, with their view that this estimate may prove to be conservative (Laird 2005). Additionally, Pratt (2002) notes overall unit prices in a range of \$10 to \$90 per tonne, and selected \$40 per tonne as an initial estimate. Finally, recent literature contained in ATC (2004) suggests the lower value of \$10 per tonne CO<sub>2</sub>-e which is consistent with CSIRO et al. (2003).

---

<sup>3</sup> Within the ExternE (European Commission 1999) report values represent an 'equity weighting' and make allowance for greater effects in some countries than on others. Selection of a discount rate considers whether there are viable alternatives (relocation of human populations, shift of habitat of flora and fauna), and if effects are irreversible, to what extent is it appropriate to discount costs in the light of the principle of inter-generational equity. By contrast, the Infrac/IWW does not use an 'equity weighting approach. Rather it assumes a uniform per-unit value applied across countries based on the reasoning that differentiated values for otherwise identical goods is not consistent with the notion of equity. It includes Purchasing Power Parity in its correction (Tsolakis et al. 2003).

---

Therefore, there exists a considerable amount of literature each providing suggested dollar per tonne of CO<sub>2</sub> values, and these are important components in calculating cents per vehicle or net tonne kilometre parameters for GHGs. A question may however be raised as to whether a \$/tonne value for GHG emissions should be included in decision-making techniques at all in the absence of an agreed market-trading value in Australia. Though this may be valid, this is perhaps politically undesirable given the high degree of pressure already being placed on road authorities and governments to account for GHG emissions directly as a result of community influence and the increasing need for governments and industries alike to bring about significant change and ensure sustainability for future generations. NTC (2006a) notes that any recommendation of an appropriate value should be a whole of government decision and is the source of ongoing consideration within Australia.

It is important to note that the above discussion does not negate the wide range of other measures aimed at reducing GHG emissions such as enhancing public transport, parking policies, personalised journey planning techniques, high occupancy vehicle lanes, road user charging, park and ride, intelligent transport systems, travel demand management and many others. These options are also associated with challenges in a policy framework (see section 6.4.1), and like these the valuation of externalities for use in policy is merely one piece of a complex puzzle. In essence the integration of sustainable development into policies and practice, is driving the need to invest more resources into mitigating these negative externalities.

## **6.2 Incorporating externalities into pricing**

### **6.2.1 Current progress**

Significant progress is currently taking place within Australia into the pricing of transport. COAG has recently agreed to a Productivity Commission inquiry to be completed by 2006 to assist in the implementation of efficient pricing of road and rail freight infrastructure through consistent and competitively neutral pricing regimes, in a manner that optimises efficiency and productivity in the freight transport task and maximises net benefits to the community (Productivity Commission 2006). This inquiry raises the question of whether externalities should be incorporated when charging for road and rail modes. Currently, within Australia there is no charging of environmental externalities in road or rail. BTRE (2004) notes that while externalities are lower for rail freight than for road freight, it would generally not be appropriate to charge heavy road vehicles (and/or freight trains) and exclude light vehicles (and/or passenger trains). Additionally, from the road-rail competition perspective, externalities are suggested to be less significant over the non-urban routes, where this competition primarily occurs, than in urban areas (BTRE 2004). For example, Meyrick (1994) estimates that the charge that would be required to cover the average cost of externalities, for all vehicles, was 7.15 c/vkt in urban areas and 0.92 c/vkt in rural areas.

### **6.2.2 Complexities**

BTRE (2004) notes that two main approaches exist in addressing externalities. These are charging users for external costs or limiting externalities by regulating activity. There are a number of challenges relating to each approach, such as whether externality charges are to take the place of, or supplement regulatory approaches (BTRE 2004), availability of adequate parameters, and whether externality charges would make a genuine contribution to the efficient reduction of these costs in freight transport (ALC 2006).

If externalities are to be charged, questions are raised as to how environmental externalities are to be mechanically incorporated into a pricing mechanism, which operating environment

is appropriate, if some or all vehicle types will be charged (including which fuel types because externalities vary according to diesel or petrol), which location is appropriate (urban or rural), and at what level of government should these charges be administered (e.g. at the federal or state/territory level). Inherent in the charging of environmental externalities is the need to have a well designed charging system (BTRE 2004), with access to values, and fully monetised externalities wherever possible.

Similarly on the regulation side, an important consideration is the role that transport reform can play in internalising externalities through mechanisms such as amendments to legislation, fiscal incentives associated with accelerated scrappage of older freight and passenger vehicles, and technology improvements that are consistent with contemporary practice e.g. the Australian Design Rules and the *Fuel Quality Standards Act*<sup>4</sup>. Other considerations include, identification of which negative externalities will be reduced (e.g. whether an approach will focus on noise pollution, air pollution or GHG emission reduction), and if there is sufficient regulation within the market, is it necessary to charge for externalities at all?

### 6.3 Progress in developing externality values for project appraisal

Increasingly, current practice in Australia is to apply externality values within project appraisal processes. Two common approaches currently used within some Australian governments and road authorities include the use of default values and/or modelling techniques.

Default values are particularly useful where information is limited or where analysis of environmental effects is resource intensive and costly. Default values can therefore be used in initially scoping the extent of environmental damage before modelling is undertaken. They also have an advantage in that they can be applied directly into a BCA e.g. through a rapid BCA<sup>5</sup> and provide a rough indication of whether it is necessary to undertake further analysis. The current trend within Australia has been to derive these values for use in BCA, rather than describe externalities solely on a qualitative basis. As an alternative or in addition to the use of default values, modelling techniques which evaluate externalities may be used in project appraisal which are specific to some jurisdictions. These are perhaps more useful for undertaking detailed analysis of environmental impacts. Where further analysis is warranted for specific externalities, these models can be used.

Although the valuation of externalities is an emerging area requiring further refinement, in recent years, considerable progress has been made within Australia in developing more defined parameter or default values. These are for:

- air pollution
- GHG emissions

---

<sup>4</sup> The ADRs and Fuel Quality Standards were announced by the Federal Government in 1999 to reduce the levels of vehicle emissions (DOTARS 2001). The ADRs control and facilitate the adoption of enhanced engine technologies in motor vehicles, and require manufacturers to adopt new emission standards that align with the European Union fuel standards, e.g. Euro I to Euro V (DieselNet 1997).

<sup>5</sup> The rapid BCA step is a BCA that includes only the main benefits and costs, estimated with less accuracy than would be expected for a detailed BCA. The rapid BCA is intended to be a cost-effective way of gauging whether a project is likely to pass a detailed BCA (ATC 2004).

- noise pollution
- water pollution (e.g. water run-off from roads)
- nature and landscape
- urban separation.

Numerous studies have contributed to this area of research. Some of these include, Tasman Asia Pacific (2000), ACIL (2001), Affleck (2002), Booz.Allen and Hamilton (ARTC 2001), BTRE (2004), BIC (2001), BTE (1999), Meyrick (1994), the EPA Victoria (1994), Watkiss (2002), Port Jackson Partners (2005), and Maunsell Australia Pty Ltd (NTC 2006a). A number of Australian jurisdictions have developed values for application in project appraisal, which are state specific or reflect nationally based values.

### 6.3.1 State parameter values

At the state level values have been calculated for the Queensland Government by Laird (2003; 2005), and represent recommended Queensland externality costs. According to Laird (2005) these estimates were used in a Brisbane – Townsville corridor report (The Straight Track Study), and were used by the NSW Department of Transport (2004) in a study of grain transport options, and by Laird and Mitchell (2004) in analysis of Sydney – Melbourne rail upgrading options.

Values have also been calculated by the author of this paper for the Victorian Department of Infrastructure (DOI) as a framework for consistently evaluating the effectiveness and viability of projects across the Department (Pratt 2002). This study aimed to provide a series of default environmental externality values for use in project appraisal and evaluation (by vehicle and externality type).

Externality parameter values have also been considered for the Department of Planning and Infrastructure Western Australia, Department for Transport, Energy and Infrastructure, South Australia and the NSW EPA. The EnValue environmental valuation database, developed by the NSW EPA and first released in 1995, provides a systematic collection of environmental valuation studies presented in an on-line database. This can be used to assist in decision-making through valuation of changes in environmental quality.

Whilst many jurisdictions are continuing to consider externalities on a state-by-state basis, externality values are perhaps more commonly reported as total Australian (national) environmental externality values (rather than calculated for a specific jurisdiction).

### 6.3.2 National values

National values have also been determined within a number of Australian sources. The author of this paper extended the work previously undertaken in Pratt (2002) to derive default externality values reported in the ATC National Guidelines for Transport System Management in Australia (NGTSM) (ATC 2004). These values have been calculated from a combination of Australian and overseas data, and were selected after undertaking detailed research into factors such as the source of the data, methodology used for measurement, and the method of conversion from overseas literature. Externality values provided in the NGTSM include air pollution, GHG emissions and water pollution are derived from Pratt (2002) using more recent data, whilst values for noise, nature and landscape and urban separation have been sourced from Tsolakakis et al. (2003; 2004).

The NGTSM in Australia provide separate default environmental externality values expressed in common \$A units of 'dollar values per vehicle kilometre travelled' (cents/vkt) for passenger vehicles, and cents per net tonne kilometre (cents/ntk) for road and rail freight transport. Values are disaggregated by passenger vehicle, freight vehicle type, and some are further divided by location such as urban and rural (all rail freight values represent urban values).

Values applicable to a national context are also available through the *Austroads Guide to Project Evaluation* (Tsolakis et al. 2004) and the *Austroads Valuing Environmental and Other Externalities* (Tsolakis et al. 2003). A key objective of this project was to provide a series of look-up-tables with ranges of dollar estimates for selected external costs. It uses a consistent approach to valuing externalities based on two international studies that examined environmental valuation. The first is the Infrac/IWW study completed in 2000 which was undertaken by the Infrac Consulting Group based in Zurich and the Institute for Economic Policy and Research (IWW) at the University of Karlsruhe, Germany. The second is the ExternE project initiated by the European Commission in 1999 which provides estimates of climate change damage costs (as well as other environmental externalities) (Tsolakis et al. 2003).

Recently, Port Jackson Partners (PJP) (2005) conducted an analysis of externalities and provided ranges of suggested national values. Following this study, Maunsell Australia Pty Ltd prepared a report for NTC (2006a) which included a review of PJP (2005) externality values.

#### **6.4 Trends in valuation in Australia**

There are three trends that exist in the valuation of environmental externalities within Australia. First, there is an inter-relationship between reported Australian values and overseas studies whereby unadjusted values are converted for application within Australia, sometimes via an exchange rate alone and extrapolated over the required number of years. Alternatively, overseas values may be converted with adjustments to population or other factors specific to Australia. The second situation that has become apparent is where values are obtained from studies in Australia (based on previously converted overseas values) and are modified. In many cases the data in Australian studies are interrelated and often trace back to the same source. For example, the ARTC (2001), and Laird (2003) refer to BTE Working Paper 40 (1999) within some calculations for their recommended values. In turn, PJP (2005) then refer to these same studies.

The final trend in valuation that has emerged is the calculation of values independent of other studies (containing full parameters for various externality types) using a combination of overseas and Australian data. In other words, rather than converting/adjusting total externality values to Australian conditions from overseas studies or modifying previously converted total values as in the two above approaches. These values are intended to reflect Australian conditions as closely as possible. However, the calculation of these values is challenging due to the high reliance on data availability, funding and resources.

An example of this third approach is shown in the work conducted for DOI and for the NGTSM (see sections 6.3.1-6.3.2). In the case of air pollution, values have been determined by identifying pollutants relevant to Australia such as carbon monoxide (CO), oxides of nitrogen (NOx), particulate matter (PM<sub>10</sub>) and total hydrocarbons (THC). Emission estimates (\$/tonne) are determined as approximate costs (health costs) imposed on society per tonne of gas emitted. In the NGTSM the analysis draws on \$/tonne health costs from Watkiss (2002). Cost per tonne values have been transferred by Watkiss (2002) to Australian values

according to population, and population densities in various types of areas in Australia and have been compared against the site types reported in ExternE, based on a regression analysis (ATC 2004). In order to obtain national air pollution values for urban and rural locations, a population weighted average was taken of these \$/tonne health costs for Australian cities and passenger and freight vehicle values were calculated using SMVU data, and recent emission factors for each chemical type developed by Cosgrove (2003). It is noted that total air pollution values in the NGTSM are higher than other sources as these values include larger health costs for each chemical type. For example, Pratt (2002) reports particulate matter as A\$14,362/tonne, sourced from Sinclair Knight Merz (2001), whereas Watkiss (2002) provides values in the range of \$1,240 to \$341,650/tonne for particulate matter.

#### 6.4.1 The need for more location specific values

BTRE (2004) notes that externalities vary on many dimensions, including by location and time of day (congestion, local pollution and noise), weather conditions (pollution), engine efficiency (local pollution and climate change) and fuel use (climate change). Additionally, environmental impacts are exacerbated in urban areas compared to regional areas of Australia. This is due to higher populations in these areas, increased levels of travel, mobility, and congestion. The OECD (1996) notes that localised noise pollution is generally perceived by society to be the first and foremost problem associated with road traffic.

Another localised pollutant of concern in urban areas is air pollution. As a result of the link between health impacts and certain chemical compounds present in air pollution, urban areas experience larger adverse effects, compared to rural areas, where populations are lower. Watkiss (2002) notes that Australian conditions are perhaps more unique than other regions, such as Europe, where, due to lower more dispersed populations (urban areas are spread over larger areas) than in Europe, secondary air pollution levels are considerably lower in Australia.

Although there is widespread evidence that environmental externality values are available for use in Australia to assist in promoting sustainable development, there is a need for further research into determining more location specific values. This is linked to the fact that policy tools such as modal shift from cars to public transport or spatial planning<sup>6</sup> are common options for addressing the number of kilometres travelled by vehicles, energy use, and transport emissions, however may lead to outcomes which are different for local and global environmental quality. This is because the effects at the local level (noise, odour), metropolitan (smog, particulate matter) and global level (climate change) are different (Hafkamp 2006 unpublished).

Hafkamp (2006 unpublished) suggests that for environmental effects at the global scale, spatial planning instruments are perhaps not an effective tool and are more effective at the local or metropolitan level. For example, it is argued that spatial planning may only affect new construction of housing and other infrastructure assuming that newly built stock does not come with a radically higher number of trips/distances for its users, and that it is difficult to control peoples lifestyles, motivations to make trips, destinations and behaviour (Hafkamp 2006 unpublished). Additionally, it is noted that spatial planning is useful in addressing 'a sprawling agglomeration around a dense core', and may have an effect on local

---

<sup>6</sup> The concept of the compact city lies at the heart of urban *spatial planning* policies. It aims to discourage ownership and use of cars, and facilitate people to make their trips by public transport (Hafkamp 2006 unpublished).

environmental quality in core areas along main arteries, however may not affect the aggregate performance of the car fleet in kilometres per year (Hafkamp 2006 unpublished). As a result, this gives rise to the need to differentiate some environmental effects by location, and in turn when evaluating these effects, consideration needs to be given to the availability of more location specific environmental externality values.

## **6.5 Too many options for practitioners?**

In addition to the need for more location specific values, there are a number of other issues which researchers and practitioners should consider in applying external values with the aim of addressing sustainable development. It has already been noted that there are increasing numbers of values which are becoming available through research, and over time these will become more and more reflective of actual conditions. However, as a result of having increasing numbers of values available, it can become a complex task for practitioners to select the most appropriate to meet their specific requirement. In selecting the appropriate source of default values for application in policy decisions, it is essential for the practitioner to acknowledge that it is not a simple case of comparing 'apples with apples'. Values calculated across a range of sources have each been estimated using different data, economic methodologies, assumptions, and calculation methods.

Notwithstanding the valuable contribution of recent science in placing monetary values on major externalities associated with the transport sector, significant uncertainty still exists in the determination of appropriate values. Valuation is dependent on data and its availability, and although a number of Australian papers have been identified above, there have been few related studies conducted in Australia based entirely on local Australian conditions. Australia is therefore heavily reliant on overseas data, where the estimation of values stems largely from comparing these studies as seen in section 6.4.

Analysis of overseas parameters therefore requires consideration of many factors, and these should be noted by practitioners when selecting appropriate values to apply. These include evaluation of when the study was conducted, how and when the values have been converted, extrapolated or calibrated to the Australian context, where the study was conducted, which methodologies were used, and which components have been used in the calculation of other parameters.

### **6.5.1 Timing of the study and where the study was conducted**

Practitioners should be conscious of the timing in which the study was conducted, if/when the study was converted for application in Australia, and where it was conducted. For example, values used in BTE (1999) are based on values quoted in the Inter-State Commission (ISC) (1990), which in turn are from an earlier US Federal Highway Cost Allocation Study from the 1980s. As these values are from the early 1980's they may not reflect changes that have since occurred in environmental conditions, however for the purpose of the study, they were selected from the US as a basis for reflecting Australian conditions as closely as possible.

### **6.5.2 Economic methodologies applied**

As noted in section 5, environmental externalities can be derived using a number of different methodologies and techniques. The type of methodology applied can lead to results of different proportions, which is an important consideration when comparing values across sources. For example, values obtained using damage costs would yield a different result to mitigation costs e.g. one study may value water pollution by considering the damage or opportunity costs for the community that is suffering from associated impacts, whereas other

sources reflect the cost of prevention or mitigation measures to avoid the environmental damage (Tsolakis et al. 2003). Similarly, the use of hedonic pricing or WTP for noise valuation, or assessing the difference between insurance premiums and total accident costs as opposed to other methodologies discussed in section 3.1 may result in different values. This is an important factor for practitioners to consider and can also explain differences in the order of magnitude between values and literature sources.

Practitioners should also determine if values represent total costs, marginal or average costs. The marginal cost may be above or below the average cost for externalities, and there can be a significant difference between the marginal and the average costs, particularly for accident externalities. The benefit of reducing an activity that gives rise to the externality is equal to the reduction in the marginal external cost. In other words, it is the equalisation of marginal costs and marginal benefits which ensures an efficient outcome (Tinch 1995). It is argued that marginal valuation is perhaps a preferred approach, because small changes from the current position are generally easier to value than large changes (or value of entire effects). Additionally, it is suggested that small changes usually represent a more realistic scenario, making the valuation of small changes of more direct relevance to policy (Tinch 1995).

### 6.5.3 Assumptions behind the values

Externality values across sources may also differ due to the components considered within calculations and assumptions applied. It is important for a practitioner to consider if the most appropriate components have been selected for Australia and whether some sources reflect a more complete use of these within calculations than others e.g. whether air pollution values are based on particulate matter or other pollutants.

The importance of providing assumptions and an explanation of how the values have been derived is also critical to the practitioner. For example, within Pratt (2002) preliminary estimates of congestion costs are provided. However, caution should be applied when using these values as they should only be used for projects where road traffic is removed as a result of a public transport improvement project. It is therefore the benefit to remaining road users resulting from a reduction of road traffic e.g. diversion of road passengers to rail.

There is a risk that values may be used for the wrong purposes hence, it is essential to consider how the values have been derived, before application. Practitioners should be mindful of these issues, when considering environmental externalities, and often it is useful for the assumptions and economic methodologies behind the values to be reviewed to ensure that they are the most appropriate to apply. Within some sources, such as ATC (2004), assumptions behind the values and steps for application are provided. This is to assist practitioners in determining whether the right externalities are used for the right circumstance.

It is therefore noted that there is no one technique for quantifying environmental transport externalities, as service delivery, transport infrastructure and environmental implications (direct or indirect) are diverse. Valuation is therefore dependent on the information available, interpretation of methodologies and purpose for application.

## **7 Conclusion**

It is acknowledged that assessment of environmental externality costs and estimating their value in monetary terms is an emerging area of expertise. Valuation is dependent on many factors such as consideration of health impacts (e.g. hospital admissions), location,

population densities, fuel consumption, and vehicle type. Additionally, values are difficult to estimate given the absence of sufficient data pertaining to Australian conditions and scientific uncertainty regarding effects on human health, social well-being and environmental ecosystems in the long-term. Research is therefore highly dependent on the conditions set, measurement techniques used, where the studies were undertaken, and how these values are converted to the Australian context.

In spite of these difficulties, through increased research and attention attributed to valuing externalities both within Australia and internationally, more opportunities exist for implementing externality values into policy development, providing correct pricing signals and project appraisal. Although practitioners are faced with more externality values than a decade ago, there remain significant challenges in derivation and application processes, and this paper raises areas for further research. This paper also identifies the progress in developing these externalities, from the existence of default values and modelling techniques, to the estimation of state and national parameter values and the trends that have emerged in the way values are presented in Australian sources.

There is a clear link between economic, social, safety and environmental aspects and sustainable development, and this paper shows that valuation of externalities provides a way of internalising these negative impacts (where appropriate) and achieving an optimal result (where possible). It is therefore considered to be an important mechanism that will assist, not only in mitigating negative impacts, but will also assist in ensuring long-term sustainable development for all generations.

## 8 References

ABS (1998), *Survey of Motor Vehicle Use Catalogue 9208.0* Canberra: Australian Bureau of Statistics

ABS (2005) *Motor Vehicle Census Catalogue 9309.0* Canberra: Australian Bureau of Statistics

ACIL (2001) *Rail in Sustainable Transport* report to the Rail Group of the Standing Committee on Transport

Affleck, F (2002) *Comparison of Greenhouse Gas Emissions by Australian Intermodal Rail and Road Transport* Brisbane: QR Network Access

ALC (2006) *Productivity Commission Submission: Review of Transport Infrastructure Pricing*, Australian Logistics Council, Prepared by Meyrick and Associates, May 2006

ARTC (2001) *Interstate Rail Network Audit: Final Report*, prepared by Booz Allen Hamilton for the Australian Rail Track Corporation, Appendix A, Melbourne

ATC (2004) *National Guidelines for Transport System Management in Australia*, Canberra: Department of Transport and Regional Services

Austrroads (2003) *The Outlook for Road Related Revenues and Road Transport Demand AP-R215* Sydney: Austrroads

BIC (2001) *Getting the Prices Right: Policy for More Sustainable Fuel Taxation for Road Transport in Australia*, submission by Mr John Stanley to the Commonwealth Fuel Taxation Inquiry

BTCE (1993) Goods and bads in urban transport, *Transport and Communications Indicators, Bulletin 42 1*, 1-19

- BTE (1999) *Competitive Neutrality Between Road and Rail* Working Paper 40 Canberra: Bureau of Transport Economics
- BTRE (2004) *Land Transport Infrastructure Pricing: An Introduction*. Bureau of Transport Economics Working Paper 57. Canberra.
- BTRE (2005) *Health Impacts of Transport Emissions in Australia: Economic Costs* Working Paper 63 Canberra: Bureau of Transport and Regional Economics
- BTRE (2006a) *Demand Projections for Auslink Non-Urban Corridors: Methodology and Projections* Working Paper 66 Canberra: Bureau of Transport and Regional Economics
- BTRE (2006b) *Freight Measurement and Modelling in Australia Report* 112 Canberra: Bureau of Transport and Regional Economics
- Cosgrove (2003), *Urban Pollutant Emissions from Motor vehicles: Australian Trends to 2020*, BTRE Consultancy Report for Environment Australia
- CSIRO, BTRE & ABARE (2003) *Appropriateness of a 350 ML Biofuels Target, Report to the Australian Government* Canberra: Department of Industry, Tourism and Resources
- Delucchi, M A (2000) Environmental externalities of motor-vehicle use in the US *Journal of Transport Economics and Policy*, 34 (2), 135-168
- DieselNet (1997) *Emission Standards: Australia: On-Road Vehicles and Engines*, viewed 28 April 2006 <http://www.dieselnet.com/standards/au/>
- DOTARS (2001) *Land Transport Vehicle Emission Australian Design Rules (ADRs)* Canberra: Department of Transport and Regional Services
- Elkington, J (1997) *Cannibals with Fork, the Triple Bottom Line of 21st Century Business* Oxford: Capstone Publishing
- Environment Protection Authority Victoria (1994) *Victorian Transport Externalities Study, Volumes 1-4* Melbourne: EPA
- European Commission (1999), *ExternE' Project. Volume 7 to 10: Methodology Update* Brussels: DGXII, Science, Research and Development, JOULE, Externalities of Energy, EU
- Hafkamp, W (2006 unpublished)
- Infras/IWW (2000) *External Costs of Transport – Accident, Environmental and Congestion Costs in Western Europe* Paris: International Union of Railways
- ISC (1990) *Road Use Charges and Vehicle Registration: A National Scheme* Canberra: AGPS
- Kahn, J (1998) *The Economic Approach to Environmental and Natural Resources* USA: Harcourt Brace College Publishers
- Laird P (2003) *Rail Studies: Land Freight External Costs in Queensland* Brisbane: Queensland Transport
- Laird P and Michell M (2004) *Interstate rail track upgrading options to 2014*, Australasian Transport Research Forum, Adelaide
- Laird P, (2005) Revised land freight external costs Australia, CD ROM *Papers of the 28th Australasian Transport Research Forum*
- Martin, T C (2000) *Assessment of Additional Infrastructure Costs Due to Increased Axle Mass Limits* Research Report ARR 329, Vermont South, Victoria: ARRB Transport Research
- Martin, L (2005) External accident costs of motor vehicles revisited, CD ROM *Papers of the 28th Australasian Transport Research Forum*

- Mayeres, I (2002) *Taxes and Transport Externalities* Working Paper Series 2002-11, Leuven, Belgium: Katholieke University Energy Transport and Environment
- Meyrick S (1994) Objectives of road pricing, in Cox, J (ed), *Refocusing Road Reform*, Melbourne: Business Council of Australia
- Ministry of Transport (1996) *Land Transport Pricing Study, Environmental Externalities, Summary Report* Wellington, New Zealand: Ministry of Transport
- Naude C, Tsolakis D and Anson G (2006) *Defining Transport Congestion*. ARRB Contract Report VC71854 prepared for Victorian Competition and Efficiency Commission Inquiry into Managing Transport Congestion. January.
- New South Wales Department of Transport (2004) Grain Infrastructure Advisory Council Report
- NTC (2006a), *Freight and mode share forecasts: a review of "The Future of Freight"* prepared by Maunsell Australia Pty Ltd for the National Transport Commission
- NTC (2006b) *Twice the Task: A Review of Australia's Freight Transport Tasks*, prepared by Sinclair Knight Merz Pty Ltd and Meyrick and Associates for the National Transport Commission
- OECD (1996) *Transport and Environment: Background Report and Survey of OECD, IEA and ECMT work*, Paris: Organisation for Cooperation and Development
- OECD (2002) *Working Together Towards Sustainable Development* viewed 28 April 2006, [http://www.oecd.org/document/8/0,2340,en\\_2649\\_34589\\_2757192\\_1\\_1\\_1\\_1,00.html](http://www.oecd.org/document/8/0,2340,en_2649_34589_2757192_1_1_1_1,00.html)
- Port Jackson Partners Ltd (2005) *The Future of Freight*, report for Australasian Railway Association Inc.
- Pratt (Evans) C (2002) Estimation and valuation of environmental and social externalities for the transport sector, *CD ROM Paper of the 25th Australasian Transport Research Forum 25* Canberra: ATRF
- Productivity Commission (2006) *Road and Rail Freight Infrastructure Pricing: a Public Enquiry into the Economic Costs of Freight Infrastructure and Efficient Approaches to Transport Pricing*, Canberra: Australian Government viewed 28 April 2006, <http://www.pc.gov.au/inquiry/freight/index.html>
- Queensland Government (2003) *Integrated Transport Planning Framework for Queensland: a Guide for Transport Planning* Brisbane: State of Queensland and the Local Government Association of Queensland
- Raffensperger, C and Tickner J, (1999) *Implementing the Precautionary Principle*, Eco-Compass, Island Press
- Sinclair Knight Merz (2001) *Emissions Australia State of the Art*, Internal Review for Department of Infrastructure, Victoria
- Spaninks, F and Van Beukering, P (1997) *Economic Valuation of Mangrove Ecosystems: Potential and Limitations* Creed Working Paper Series 14 London: Collaborative Research in the Economics of Environment and Development
- State of New South Wales (2005) *Sydney Metropolitan Strategy, City of Cities: a Plan for Sydney's Future*, viewed 28 March 2006, <http://www.metrostrategy.nsw.gov.au/dev/ViewPage.action?siteNodeId=28&languageId=1&contentId=-1>

State of South Australia (2005) *The Strategic Infrastructure Plan for South Australia 2005/6 - 2014/15: Building South Australia*, viewed 28 March 2006, <http://www.infrastructure.sa.gov.au/strategicinfo.asp>

State of Victoria (2002) *Melbourne 2030: Planning for Sustainable Growth*, viewed 28 March 2006, [http://www.dse.vic.gov.au/melbourne2030online/downloads/2030\\_complete.pdf](http://www.dse.vic.gov.au/melbourne2030online/downloads/2030_complete.pdf)

State of Western Australia (2005) *Network City - a Milestone in Metropolitan Planning (Draft)*, viewed 28 March 2006, <http://www.wapc.wa.gov.au/Publications/734.aspx>

Tasman Asia Pacific (2000) *Competitively Neutral Freight Rates for Road and Rail*, report prepared for the Australian Trucking Association

Tinch, R (1995) *The Valuation of Environmental Externalities: Executive Summary* London: Department of Transport

Tsolakis, D Houghton, N Lester, C and Seethaler, R (2003) *Valuing Environmental and Other Externalities AP-R229/03*, Austroads, Sydney.

Tsolakis, D Patrick, S and Thoresen, T (2004) *Guide to Project Evaluation – Part 4: Project Evaluation Data AP-G82-04* Sydney: Austroads

WALGA (2006) *Inquiry into Road and Rail Freight Infrastructure Pricing, Submission to Productivity Commission* Perth: Western Australia Local Government Association

Watkiss P (2002) *Fuel Taxation Inquiry: the Air Pollution Costs of Transport in Australia*, report ED44525 Oxford, UK: AEA Technology Environment