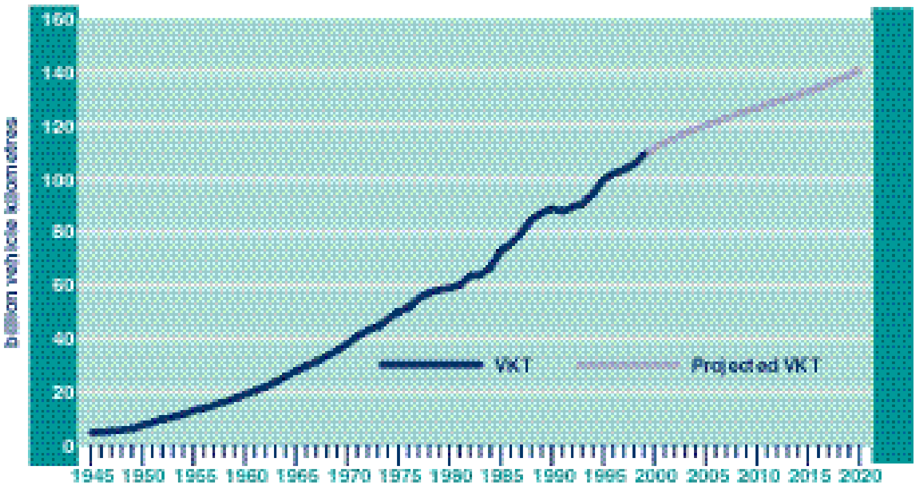
bte

Urban Congestion – the Implications for Greenhouse Gas Emissions

Congestion to increase at a significant rate

Over the last 50 years, motor vehicle travel within Australian cities has grown immensely. As can be seen from figure 1, between the 1950s and now, kilometres travelled by passenger cars in Australian urban areas have expanded by something like a factor of 15.

FIGURE 1 HISTORICAL AND PROJECTED VEHICLE KILOMETRES BY PASSENGER CARS IN AUSTRALIAN URBAN AREAS



Source BTE estimates, BTE Working Paper 38.

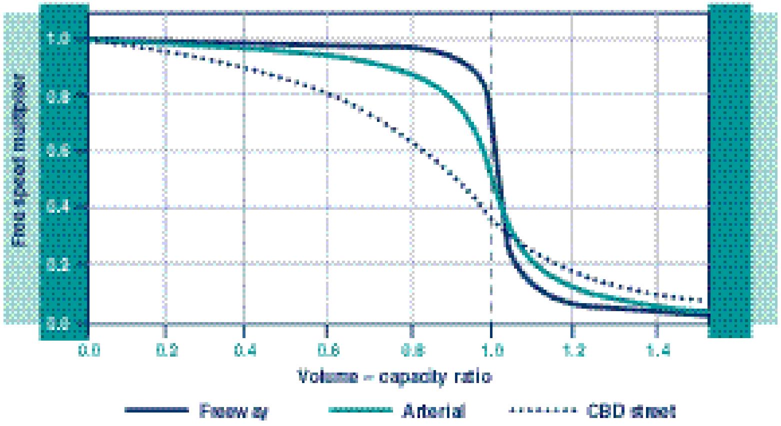
Also shown in figure 1, urban car travel in Australia is expected to continue to grow appreciably over the next 20 years (by close to 30 per cent)—though at a somewhat slower rate of growth than for the last few decades. Total traffic volumes are forecast to increase more rapidly than the car growth shown in figure 1 (of around 1.2 per cent per annum), because the growth trend in the commercial road sector is stronger than for private travel. Inclusion of commercial vehicles results in a projected growth in total vehicle travel (in passenger car equivalents) of around 1.4 per cent per annum to 2020.

The roads in Australian cities are becoming increasingly crowded. A large proportion of Australian urban car trips occurs during the morning and evening peak times. In addition, significant portions of the road networks of the major Australian cities (particularly Sydney) increasingly experience heavy traffic volumes throughout much of the day. Consequently, approximately half of total urban vehicle kilometres travelled (VKT) are currently performed under congested traffic conditions (BTCE Report 94, p. 312). That is, the travel is typically done on roads with either heavy congestion (involving average traffic speeds of less than a third of that possible on those roads under free-flow traffic conditions) or interrupted flow (where traffic is moving at around half that of free-flow or unimpeded speeds).

The costs of congestion

Congestion, as an economic externality, imposes significant costs on society. Road users incur higher private costs when joining a congested traffic stream, through increased vehicle operating costs and trip travel times. Furthermore, road users do not typically take account of the fact that their decisions to travel serve to increase congestion, and therefore impose additional delays and (public) costs on other road users. Depending on how close the traffic volume is to a road's designed traffic capacity, increases in overall delays can rise sharply as traffic increases. To demonstrate, figure 2 shows the typical shape of the relationship between average vehicle speed and the traffic density, for various urban road types. Note how low the 'congested' speeds are, relative to the free flow speed of the road.

FIGURE 2 NORMALISED SPEED-FLOW RELATIONSHIPS FOR SELECTED ROAD TYPES



Source BTE calculations, BTCE Report 92.

Rough (order of magnitude) social costs due to urban traffic congestion were presented in BTE Information Sheet 14. The BTE estimates a total cost of approximately 12.8 billion dollars per year due to traffic congestion in major Australian cities (with Sydney currently experiencing costs of around 6.0 billion dollars per annum, Melbourne 2.7, Brisbane 2.6, Adelaide 0.8, Perth 0.6 and Canberra 0.05). If nothing is done, the total cost of Australian urban congestion could rise to about 29.7 billion dollars per year by 2015 (table 1, BTE Information Sheet 14).

This 'cost of congestion' is the estimated value of the excess travel time and other resource costs (such as extra fuel use) incurred by the actual traffic over those that would have been incurred had that traffic volume operated under completely free-flow conditions. It should be noted that for actual road systems, such conditions are, of course, an unrealisable hypothetical situation. Therefore, the cost of congestion, so defined, is primarily a measure of the scale of the problem, rather than a measure of the actual savings that can be made. A policy response to congestion can serve to reduce this cost, but it will not be possible (nor desirable on economic grounds) to eliminate it altogether.

Congestion is a major contributor to vehicle emissions

Fuel consumption per vehicle (eg. litres/100km) under congested traffic conditions is approximately twice that under free-flow conditions. Therefore, congestion has the potential to double the output of greenhouse gas emissions from a stream of vehicle traffic. Emission rates of noxious pollutants (eg carbon monoxide, volatile organic compounds, particulates) also tend to be approximately twice as high under congested conditions.

BTE estimates, based on the Bureau's modelling of urban network congestion (detailed in BTCE Report 92 and BTCE Report 94, Chapter 18), suggest that as much as 40 per cent of the fuel used by road vehicles in Australia's major cities is the result of interruptions to the traffic flow. Estimates of the emission levels *attributable to congestion* can be made on a basis consistent with the costs of congestion detailed above. That is, the extra emissions generated by the actual traffic flow over and above the emission levels of traffic operating under hypothetical free-flow conditions.

In terms of global warming, traffic delays and interruptions to traffic flow in Australia's six major cities would account for around 13 million tonnes of greenhouse gas emissions per annum–comprising about 10.5 million tonnes of CO_2 emissions and emissions of other gases (such as methane, nitrous oxide and ozone precursors) having a possible warming contribution equivalent to a further 2.5 million tonnes of CO_2. This level of emissions is equivalent to around 17 per cent of the annual greenhouse gas emissions due to Australian domestic transport, or about 3 per cent of net Australian greenhouse emissions from all sectors. BTE estimates (based on BTE Information Sheet 14) imply that, of the approximately 10.5 million tonnes of CO_2 emitted per year as the result of congestion, Sydney contributes around 4.0 million tonnes per annum, Melbourne 2.9, Brisbane 1.3, Adelaide 0.9, Perth 1.1 and Canberra 0.2. Order of magnitude estimates for the noxious air pollution due to urban congestion within these six major cities total 780 thousand tonnes per annum of carbon monoxide, 75 thousand tonnes of nitrogen oxides, 115 thousand tonnes of volatile organic compounds, and 5 thousand tonnes of particulate matter.

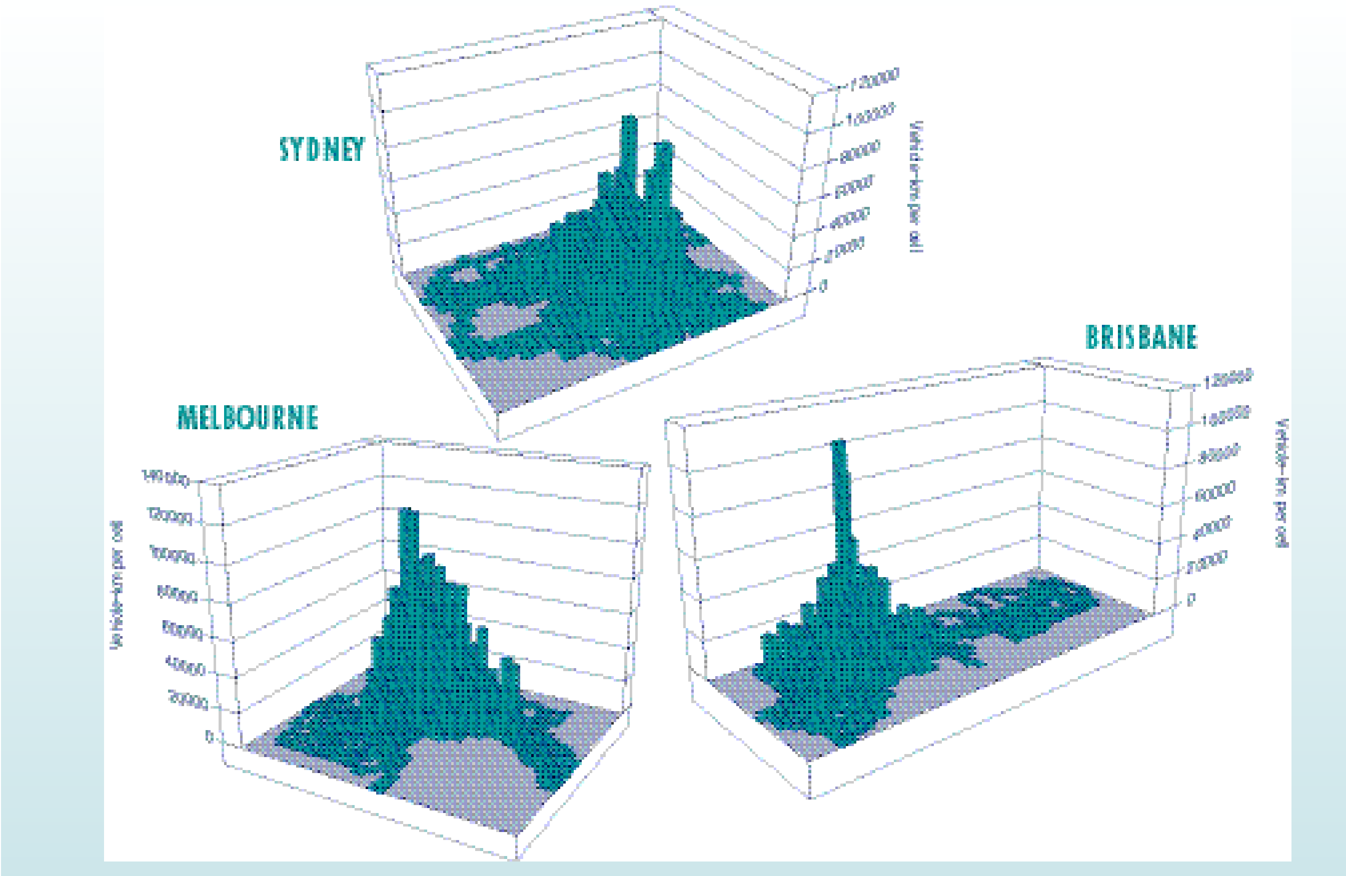
In the future, increasing vehicle travel will tend to cause congestion to spread across wider areas of our cities than currently. Future vehicle fleets will be more fuel efficient and have better emission performance than the current fleet, but this will be more than offset by the increasing trends in overall VKT and in the amount of traffic congestion. BTE projections imply that annual greenhouse emissions due to urban congestion could grow to roughly 16 million tonnes (of CO_2 equivalent) by 2015.

Policy options

As mentioned before, it would be impossible for urban traffic to flow completely free from interruption and delays. However, congestion levels can be reduced, and traffic flows improved, by a variety of measures including congestion pricing, parking policies, improved public transport, and the use of technology such as Intelligent Transport Systems (ITS).

For many Australian cities, the highest congestion levels tend to be concentrated around the city centres, and are worst during the morning and evening peak periods. For example, figure 3 shows the typical geographic distribution of current vehicle travel (graphed by subdividing the urban areas using a grid of 3-kilometre square cells) for our most congested cities–Sydney, Melbourne and Brisbane.

FIGURE 3 ROAD VEHICLE TRAVEL IN THE MORNING PEAK HOUR FOR SYDNEY, MELBOURNE AND BRISBANE



Source *BTE modelling results, BTCE Report 92.*

Note *The graph of Melbourne is drawn as the city would appear from the south-west. Sydney and Brisbane are drawn as they would appear from the south-east.*

Since congestion is typically such a widely varying problem, the most effective policies aimed at reducing it will tend to be those that can target particular city areas and particular times of travel. Examples of such options include parking surcharges, freeway tolls, cordon charges for entering the CBD, and continuous electronic road pricing.

For example, BTCE Report 92 estimated that levying optimal road user charges within the major Australian cities could reduce peak hour travel by the order of 20 per cent, while reducing overall travel time by close to 40 per cent, and total traffic fuel consumption by close to 30 per cent. ('Optimal' here refers to the charges being structured to vary between different parts of the city, being highest in the most congested areas and lower in less congested areas and being set at levels that maximise the net economic gains.) Such optimal congestion charges could reduce greenhouse gas emissions, from road vehicles within the six major Australian cities, by around 5 million tonnes per annum (BTCE Report 94, BTCE Report 92).

Whichever methods are chosen to tackle the problem of urban road congestion, they will have to contend with the growing demand for vehicle travel and the necessity to engage community awareness by linking the congestion abatement policies directly with their benefits–that is, reductions in trip delays, fuel consumption, noise levels, noxious air pollution and greenhouse gas emissions.

References

BTE (1999), *Urban Transport–Looking Ahead*, BTE Information Sheet 14.

BTE (1998), *Forecasting Light Vehicle Traffic,* BTE Working Paper 38.

BTCE (1996a), *Transport and Greenhouse: Costs and options for reducing emissions*, BTCE Report 94, AGPS.

BTCE (1996b), *Traffic Congestion and Road user charges in Australian capital cities*, BTCE Report 92, AGPS.

Abbreviations

BTE	Bureau of Transport Economics
BTCE	Bureau of Transport and Communications Economics (note BTCE is now BTE)
CBD	central business district
vkt	vehicle kilometres travelled

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ISSN 1440-9593