# Emissions and energy use by road freight vehicles under alternative freight land use development options

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## 1 Introduction

The success and sustainability of an urban environment is in part dependent on having an efficient freight distribution network which provides for consolidation, movement and storage of goods. The locations at which these freight-related activities occur throughout a large city have a large effect on the efficiency of those activities, as well as the externalities associated with them.

The Victorian Freight Network Strategy, *Freight Futures*, released by the Department of Transport (DOT 2008a), proposed land use policies leading to consolidation of freight-related activities around a number of freight "Activity Centres" connected by high capacity freight links. This is similar to the land use and transport strategy *Melbourne 2030* (DOI 2002), which lead to the development of Principal, Major and Specialised Activity Centres, supported by high quality public transport services.

This paper presents material supporting the premise that a consolidation of freight activities within a limited number of locations in Metropolitan Melbourne would lead to considerable efficiency benefits together with lower fuel and energy usage and an associated reduction in emissions. It reviews the past and expected continuing growth in transport activity and measures which have been proposed to reduce the associated emissions. Acknowledging that land use development is only one factor in reducing emissions, it describes a research project that examined the effects of alternative future freight land use development scenarios on predicted freight traffic generation and the associated energy usage and emissions.

## 2 Background

### 2.1 Freight-related land use

Melbourne is currently one of Australia's most rapidly growing cities, with *Victoria In Future 2008* (DPCD 2008a) projecting that Melbourne's population will increase from the 3.7 million recorded in the 2006 Census to over 5 million by 2026. To address this, the planning update *Melbourne@5million* (DPCD 2008b) proposed a number of strategies based on *Melbourne 2030,* including the direction of development towards seven Central Activities Districts, leading towards a more compact city with better management of urban growth.

Analysis of transport-related emissions under alternative land use scenarios (Alford and Whiteman 2008, 2009) confirmed that encouragement of development around a small number of large central activities districts throughout the urban area resulted in lower travel demand and emissions than most of the other scenarios examined.

Associated with this continuing growth in population and urban size is a greater need to move more freight a greater distance. *Freight Futures* noted that the number of kilometres travelled by road freight vehicles in Victoria is forecast to increase by 70 per cent by 2025, requiring 60 per cent more freight vehicles. Further, freight transport and logistics activities are an important part of the economy, directly contributing an estimated 14.7 per cent of Victoria's Gross State Product freight, and facilitating a much larger component. In developing *Freight Futures*, the Department of Transport recognised the need to provide efficient movement of freight while minimising adverse externalities such as congestion and emissions.

A number of strategic directions were adopted to respond to these challenges. These include identification and development of Freight Activity Centres (FACs), connected by a principal freight network (PFN). Figure 1 shows the FACs and PFN around Melbourne that were identified in *Freight Futures*.

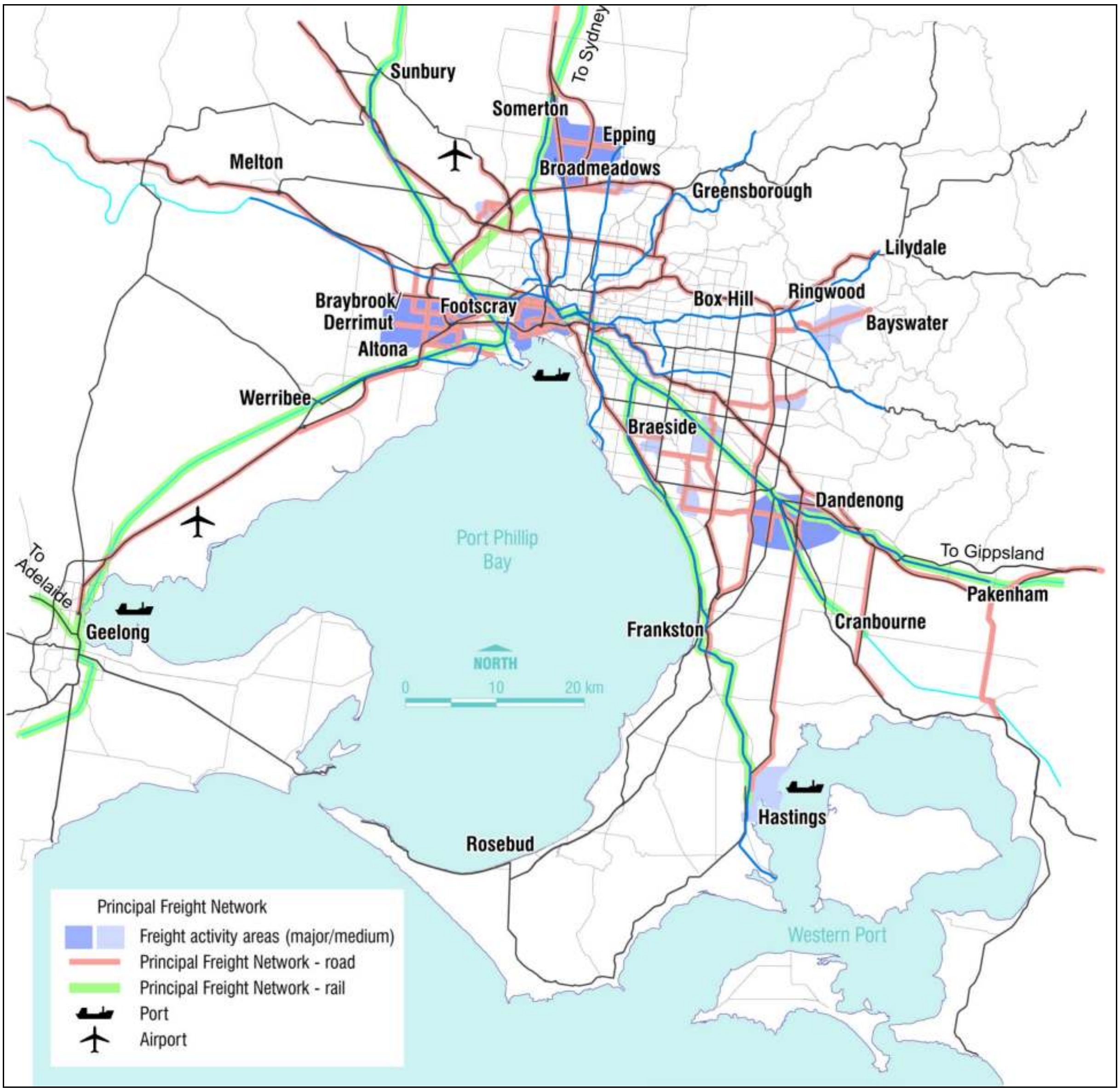


**Figure 1 – Freight activity areas and the Principal Freight Network around Melbourne (DOT 2008a, Figure 6)**

The four major freight activity areas are located at the Port of Melbourne / Dynon rail yards, South West Industrial Area (Laverton / Derrimut), Northern Industrial Area (Somerton), and South East Industrial Area (Dandenong). These locations are based on current freight-intensive industrial areas, which have developed historically to serve Melbourne's needs. Infrastructure developments that serve these areas attract further freight-related development due to the reduced distribution costs and benefits of co-locating with similar activities.

A further eight medium freight activity areas were also identified at Altona, Deer Park, Airport West, Donnybrook, Bayswater, Clayton, Port of Hastings, and Pakenham. These are also based on existing industrial areas, located between the major freight activity areas, and tend to provide more for local freight tasks.

Wilson (2008) conducted a theoretical approach to optimising logistics locations, without considering existing land use and transport network conditions. He used a simple set covering model to identify the number and location of freight hubs required to service Melbourne's 31 Local Government Areas (LGAs) for a range of freight trip length limits. A total of three freight hubs would be able to service the LGAs keeping the maximum trip length below 30 kilometres, while a total of 10 freight hubs would be required if the maximum trip length was limited to 10 kilometres.

The proposed FAC locations in *Freight Futures* considers (1) the current distribution of demands for freight activities and (2) the existing distribution network of road and rail links that has developed historically as Melbourne has grown. A detailed analysis of the effectiveness of these locations for future freight development needs to take these important factors into account.

### 2.2 Freight-related emissions

According to the National Greenhouse Gas Inventory (DCC 2008a), transport in Australia accounted for 13.7% of Australia's net greenhouse gas (GHG) emissions in 2006. Of that, transport in Victoria accounted for 25.2% of the total transport-related emissions in Australia. Road transport was the main source of transport emissions in 2006, responsible for 87.1% of transport emissions, and 12.0% of national emissions across all sectors. Emissions from road transport represented one of the fastest growing sources of $CO_2$-e emissions in the inventory, increasing by 26.7% between 1990 and 2006. After domestic air transport, emissions from light commercial vehicles, trucks and buses had the highest growth rates within the transport category.

Total Environment Centre (2008) notes that "*Tail pipe emissions from freight transport alone are predicted to increase by almost 100% between 1990 and 2020. This growth is not only inconsistent with the deep cuts required if Australia is to play its part in avoiding dangerous climate change but is also inconsistent with the modest targets established by the first stage of the Kyoto Protocol*". Measures proposed to manage the climate exposures of logistics included: improving operational efficiencies (maximising vehicle efficiency, optimising freight loading and driving behaviour), as well as switching to more efficient transport modes and greater use of low emissions fuels. No analysis was provided on quantifying the effectiveness of each of these measures, or how they could be implemented.

## 2.3 Modelling of transport emissions

BTRE (2004) Working Paper 62 reports on a CSIRO study that examined the response of urban freight patterns to greenhouse gas abatement scenarios. A model of the Sydney transport network was used as the basis of an analysis that considered seven alternative scenarios – one of which included land use changes in combination with infrastructure improvements.

Their analysis suggested that relocation of some freight-generating employment from inner areas to Western Sydney would lead to an increase in commercial vehicle activity and hence GHG emissions from freight vehicles. Figure 2 shows that, of the seven alternative scenarios examined, gaseous emissions (including Carbon Dioxide) were greatest under the “Industry + Infrastructure Relocation” scenario.

This may seem counterintuitive; however the model retained the Sydney docks and industrial areas as the destination for many trips to and from the relocated industrial areas. This resulted in generally longer trip lengths, particularly for articulated trucks. The report suggested that greater development within these designated freight areas, rather than simply relocation of existing activity to remote locations, would prevent these longer trip lengths and associated GHG increases. The GHG responses of this development were not included in their analysis.

The greatest reductions in GHG emissions occurred through increasing load factors (either through larger vehicle sizes or efficient use of existing vehicles), and through adoption of best fuel technology (i.e. more modern vehicles that conform to stricter emission requirements). These offer further avenues for improving efficiencies and reducing emissions above those examined in the current project.

BTRE also calculated the GHG emissions from all vehicles, including passenger vehicles under each scenario. All alternative scenarios gave reduced GHG emissions across all vehicles compared to the base scenario. This included the “Infrastructure + Industry Relocation” scenario which had higher emissions from freight vehicles, offset by lower emissions from passenger vehicles. It is important to consider the effects on emissions from other vehicles when aiming to reduce freight vehicle emissions.

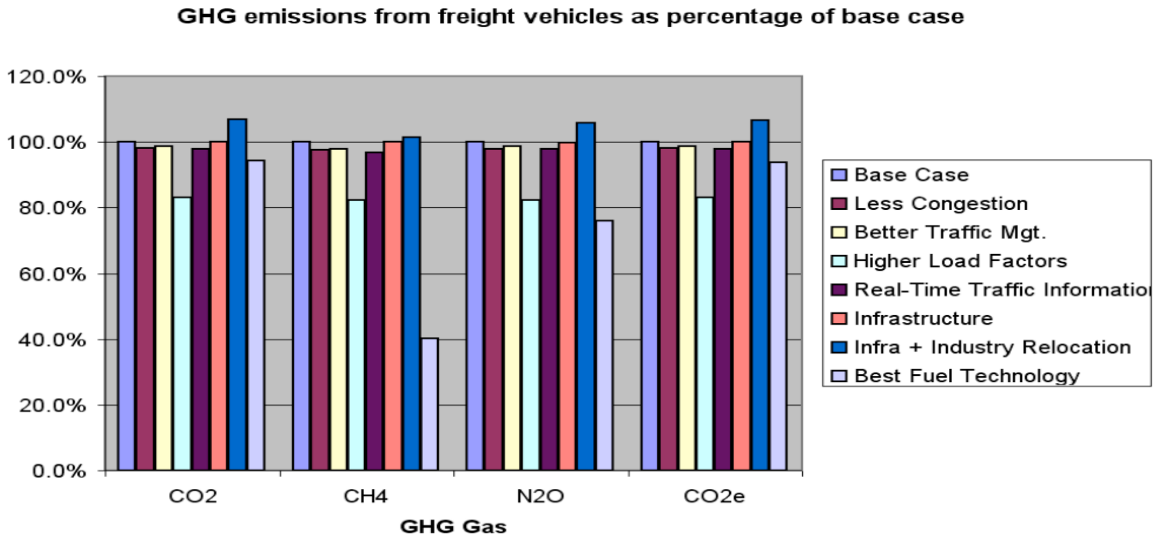


**Figure 2 – Greenhouse gas emissions from freight vehicles by scenario (BTRE 2004, Figure 6.1)**

Alford and Whiteman (2008, 2009) provide an analysis of macro urban form impacts on transport energy consumption and greenhouse gas emissions for private vehicle and public transport. They sought to help understand the spatial correlations between urban form and transport energy / greenhouse gas emissions in Melbourne, to determine which urban form and transport investment scenario of future development might show the best transport GHG emissions and transport energy outcomes.

Their study applied spatially-integrated techniques, including small area modelling and analysis. This approach is particularly useful for transport agencies as it means that the potential impacts of investments in transport infrastructure and services can be assessed at the route level, in addition to be re-assessed the cumulative subregional and regional level. Additionally, land use planning agencies can use this information on the effectiveness that different urban consolidation policies can have on influencing greenhouse gas emissions and transport energy consumption.

The same outcomes can be sought from this current study for freight related travel. The Alford and Whiteman study only covers travel by private vehicle and public transport, which means that while trips generated by residential, recreational, retail, commercial and industrial activities are captured within the study, the freight trips generated by these activities are not. This study seeks to build on the previous work by filling in the freight gap so that now the impact of the entire transport task on GHG emissions and urban form can be considered.

# 3 Study Approach

## 3.1 Methodology

The methodology used in this study is an application of that used by Alford and Whiteman, in this study specifically applied to freight traffic. A strategic network-level model was used to determine the flows of freight and non-freight traffic on all major road links across the entire Melbourne urban area. Several alternative freight land use scenarios were considered, for each the traffic flows were converted into equivalent fuel and energy usage and corresponding GHG emissions.

It was important to be able to relate the emissions to the actual origins of the individual freight trips, rather than to where the emissions actually occurred. The project was primarily concerned with the effect of freight terminal locations on GHG emissions, irrespective of the location that the actual emissions occurred.

## 3.2 Freight Movement Model

The Department of Infrastructure (now Department of Transport) commissioned the consultant firm IMIS in November 2005 to develop a Freight Movement Model (FMM) as a practical and operational freight movement modelling and forecasting tool. This has been used to assist the strategic policy development and planning of freight movements as a component of the total metropolitan Melbourne travel (DOI 2007).

The FMM is based on the Melbourne Integrated Transport Model. MITM contains over 42,000 links between over 18,000 nodes. There are 2272 centroids between which freight and non-freight trips are made. Although the model contains data for the metropolitan rail and tram networks, these links were disabled for the current analyses. MITM has been used widely within the Department of Transport for strategic-level analyses of the metropolitan transport network, for example in forecasting traffic patterns for various transport proposals.

### 3.3 Scenarios and time periods

*Freight Futures* identified four major freight activity areas and eight medium freight activity areas (Figure 1) in which development of freight and logistics operations are to be encouraged in response to the growing freight task forecast through to 2031.

In addition to the current baseline case, which has been calibrated against freight and non-freight traffic conditions in 2006, three alternative land use scenarios for 2031 were considered:

- 2031 scenario 1 (Business-As-Usual): Applying the growth predictions to freight and non-freight traffic through to 2031, and including several major transport infrastructure projects.

- 2031 scenario 2 (Four major FACs): As for scenario 1, but concentrating much of the growth in freight traffic to the four major FACs proposed in *Freight Futures*.

- 2031 scenario 3 (Twelve major and medium FACs): As for scenario 1, but concentrating much of the growth in freight traffic to the four major and eight medium FACs proposed in *Freight Futures*.

Several network improvements were added between the 2006 base case and the three 2031 scenarios. These include the EastLink tollway between Ringwood and Frankston in the outer eastern suburbs, and the Deer Park bypass in the western suburbs. Several major transport projects and proposals announced in the *Victorian Transport Plan* (DOT 2008b) had not been finalised when the analysis was conducted, so were not included. Longer term freight land use plans announced in *Freight Futures*, such as the interstate rail terminal at Donnybrook/Beveridge in the outer northern suburbs of Melbourne and the potential Stage 2 terminals in the outer west and outer south-east, were not included in the current analysis. These latter terminals make greater use of intermodal (road/rail) freight transfers, whereas the current analysis assumes the majority of freight around metropolitan Melbourne continues to be moved on road using similar vehicles to those currently in use.

The network of FACs, interconnected by high capacity freight routes, would facilitate the introduction of higher productivity vehicles to move freight more efficiently between FACs, combined with innovative local distribution solutions for ‘last mile’ freight distribution. Additional benefits which are facilitated by these land use changes (such as a greater use of higher productivity vehicles), or associated with new vehicle and engine technologies, could be analysed separately.

Each of these scenarios was simulated in three time periods.

- AM Peak: 7:00 am – 9:00 am
- Interpeak: 10:00 am – 3:00 pm
- PM Peak: 4:00 pm – 6:00 pm

Traffic volume profiles for trucks generally do not exhibit the two peaks associated with commuting traffic. Volumes of trucks are highest in the daytime interpeak period, when overall traffic volumes are relatively low and travel speeds are relatively high. Freight traffic would have different travel speed characteristics, and hence different fuel consumption, energy and emission rates in these three time periods, necessitating the use of three separate time periods in the analysis.

### 3.4 Fuel consumption and emissions

The fuel consumed by freight vehicles on the network was estimated using the Austroads Fuel Consumption Model (Austroads 2006). This is the same model as used for road project evaluation purposes in Australia. It is calibrated against current-technology vehicles in use on Australian roads, but does not differentiate between different freight vehicle types. A revised version of the fuel consumption model (Austroads 2008) includes different coefficients for rigid and articulated vehicles. This model was considered to be less appropriate to estimation fuel consumption across the network since it required estimation of the proportions of those two vehicle types. The FMM assumes that all freight is carried by heavy commercial vehicles (rigid trucks and articulated trucks), with light commercial vehicles only contributing a small proportion of the overall metropolitan freight task. It is assumed that all freight vehicles use diesel fuel, with the Survey of Motor Vehicle Use (ABS 2008) showing that diesel represents 99.3% of all fuel consumed by freight-carrying trucks.

A full fuel cycle conversion factor of 2.9 kg $CO_2$-e per litre of diesel fuel (DCC, 2008b) was used to account for both the actual combustion of the fuel and the emissions associated with the fuel extraction processes.

## 4 Discussion of Results

### 4.1 Freight task

Appendix 1 shows that the total number of freight trips in all time periods is much higher in all of the three scenarios for 2031 as compared to the 2006 base case. This is solely a function of the trip matrix used as input to the FMM, and represents the predicted growth in the freight task over this period.

The total vehicle kilometres travelled (VKT) and tonne-kilometres carried both show differences between the three scenarios for 2031, with scenario 2 (encouraging freight development around the four major freight activity areas) having approximately 95 per cent of the VKT and 93 per cent of the tonne-kilometres carried, as compared to the business-as-usual scenario 1.

### 4.2 Trip lengths

This lower VKT and tonne-kilometres is attributed to a greater proportion of short distance freight trips associated with the consolidation of freight activity. To confirm this, Figure 3 shows the distribution of trip lengths under each of the three scenarios examined for 2031.

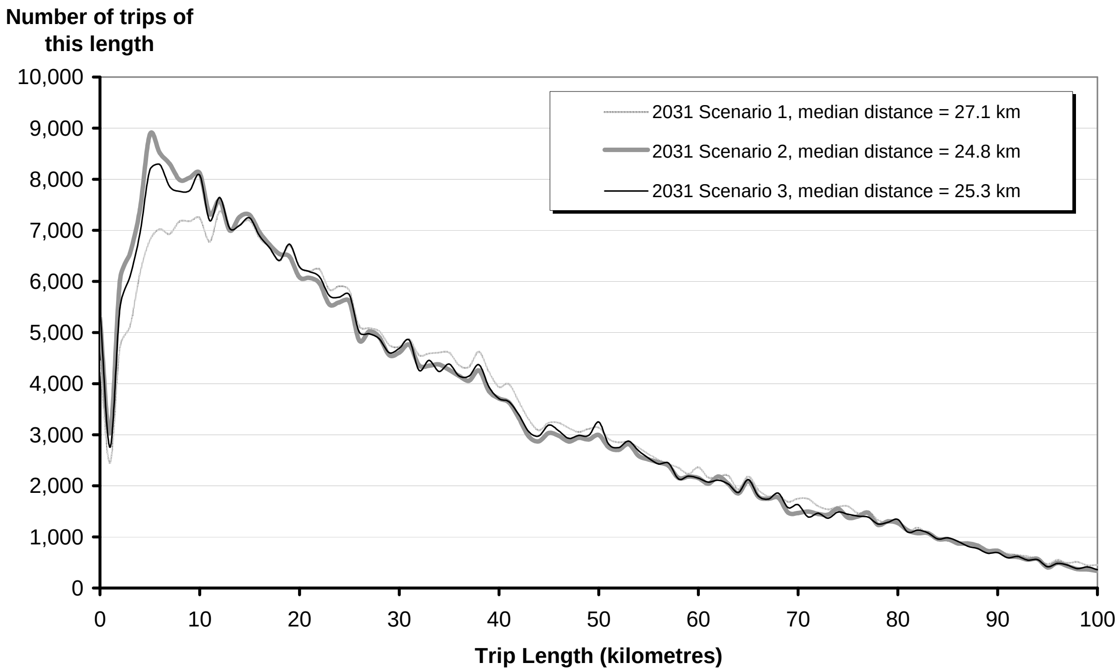


**Figure 3 – Distribution of trip lengths by distance**

There is a greater number of very short trips (less than 10 kilometres in length) in scenarios 2 and 3 compared to scenario 1, and a lower number of medium length trips (25 kilometres to 50 kilometres) in these scenarios. This shows that encouragement of freight-related activities in a limited number of locations leads to a greater number of freight trips in the immediate vicinity of those locations, with a reduction of longer trips outside those freight locations. Scenario 3 has fewer very short trips (less than 10 kilometres) compared to scenario 2, a greater number of medium length trips (20 to 50 kilometres), and a similar number of trips over 50 kilometres in length. That is, increasing the number of freight areas from 4 to 12 encourages a greater number of medium length trips that would otherwise be conducted within the locale of the major freight areas.

Although the numbers of long-distance trips are lower in scenarios 2 and 3, there are still a significant number of longer trips. These longer trips contribute more to the external impacts of freight movements than shorter trips, so it is important to reduce their number in order to reduce freight-related emissions. Encouragement of development in specific freight areas, with suitable intermodal and transhipment facilities, and connected by an appropriate standard network, would facilitate the movement of freight in bulk by more efficient means between these freight areas.

## 4.3 Fuel consumption, energy usage and emissions

Appendix 1 also shows the total fuel used (in litres) by freight vehicle trips in each scenario and time period. Fuel usage is lower in scenarios 2 and 3 than in scenario 1, this is attributed to the shorter trip distances in these scenarios.

Fuel consumption rates were found to be similar across all scenarios, but did vary between different time periods. The more-congested AM Peak period has consistently higher fuel consumption rates than for the interpeak and PM peak periods for all scenarios. Note that average fuel consumption rates would be expected to decrease from 2006 and 2031 due to engine technology improvements.

The total $CO_2$-e emissions are calculated directly from the fuel used. As such, the conclusions would be expected to be identical to those for fuel and energy usage. Scenario 2 has 95 per cent of the $CO_2$-e emissions of scenario 1, while scenario 3 has 97 per cent of the $CO_2$-e emissions of scenario 1.

Figure 4 compares each of the performance measures under each scenario, relative to the 2031 Business-As-Usual scenario. Most evident is the large growth in all performance measures between the 2006 base case and all of the 2031 scenarios. This is part of the underlying assumptions used as input to the modelling for this report, and is associated with the general growth in the economy over this period. A comparison of the scenarios for 2031 shows that Scenario 2, encouragement of freight development around four freight activity areas, offers some savings in freight task, fuel usage and GHG emissions.

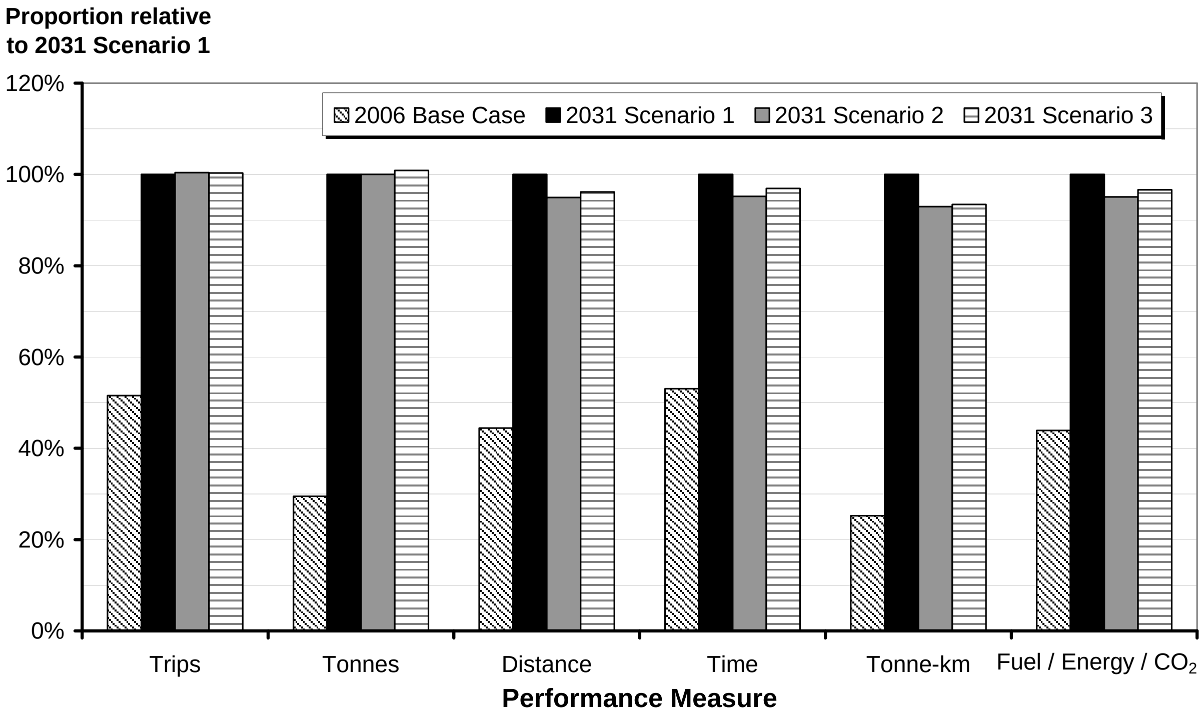


**Figure 4 – Comparison of relative performance measures for each scenario**

## 4.4 Measures of Productivity

To enable a better comparison between the different land use scenarios, the productivity of the freight task was evaluated in terms of the number of freight trips that can be undertaken for a given amount of energy (trip energy productivity), and the tonne kilometres that can be carried for a given amount of energy (freight energy productivity). These are tabulated in Appendix 1 for each scenario and time period.

Across the entire network, freight trips are more productive (having a greater number of trips for the same energy usage) in scenarios 2 and 3. This is attributed to the same number of trips being conducted and the lower overall energy usage under these scenarios. Trip energy productivity is closely related to the average trip length, with longer trip lengths requiring greater energy input and producing greater emissions.

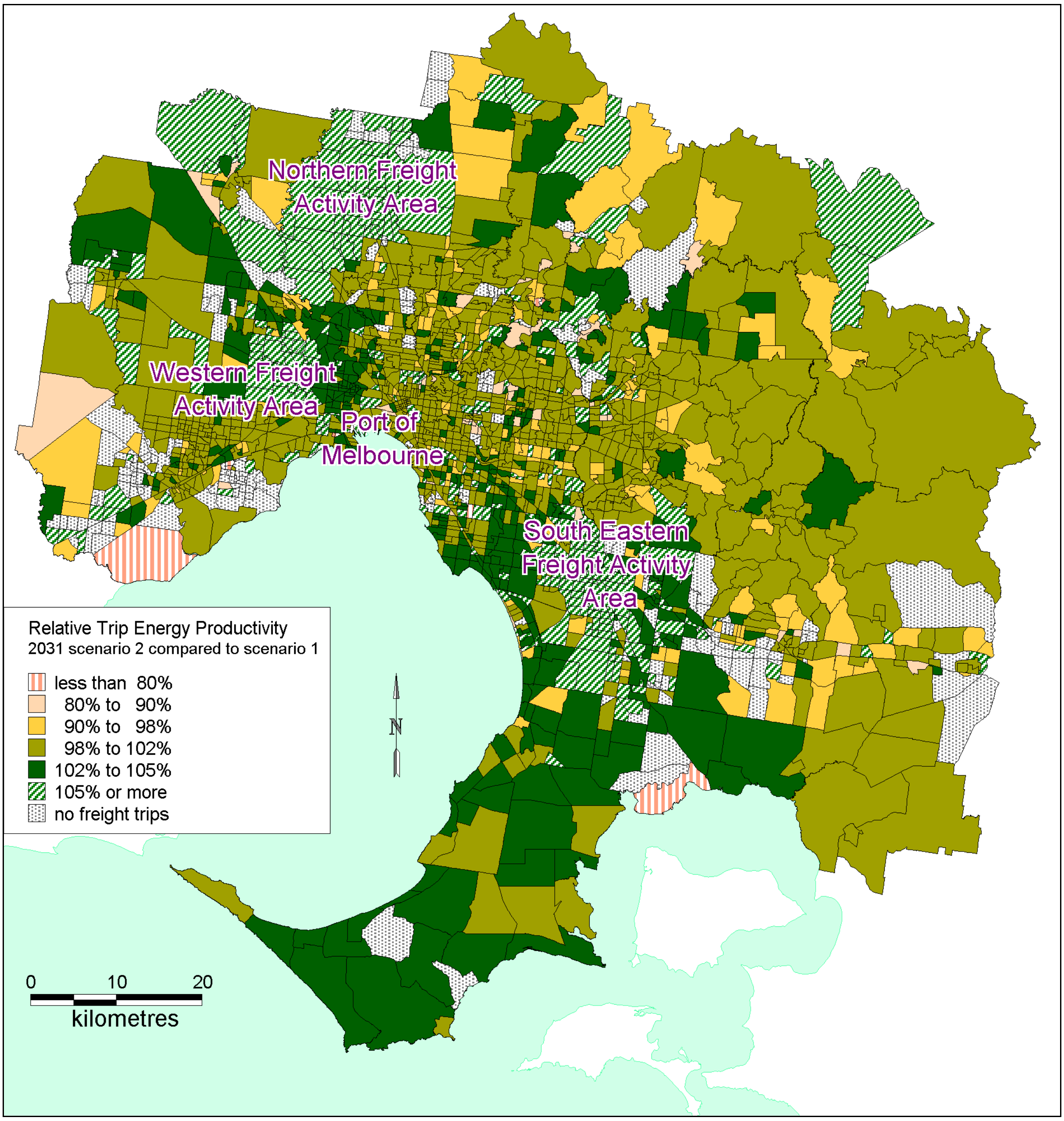


**Figure 5 – Relative trip energy productivity – 2031 scenario 2 compared to 2031 scenario 1**

Figure 5 shows the relative trip energy productivity by freight trip origin for 2031 scenario 2 (four major freight areas) compared to 2031 scenario 1 (business-as-usual). Trip energy productivities tend to be generally higher (more than 100 per cent of scenario 1) across the entire metropolitan area in scenario 2, and are particularly higher (more than 105 per cent of scenario 1) around the freight activity areas in scenario 2. Similar results were found when comparing scenario 3 (twelve freight areas) to scenario 1. These are attributed to generally shorter freight trip lengths across the entire metropolitan area and particularly around the freight activity areas in scenarios 2 and 3.

In order to enable an objective comparison of results from different networks and transport modes, a measure of productivity is required that is independent of trip length. Freight energy productivity is defined as the freight task output in tonne-kilometres divided by the energy required in order to conduct that task.

Referring to Appendix 1, freight energy productivity is lower in scenarios 2 and 3; this is attributed to the reductions in tonne-kilometres generally being greater across the network than the corresponding reductions in energy usage. Short trips are generally more energy intensive than longer trips.

Figure 6 shows the comparison of relative productivity measures under the different scenarios. Scenario 2 (having four freight activity areas) is the most efficient of the three scenarios for 2031, resulting from reducing the length of freight trips across the network – and hence their emissions and energy usage. However, this leads to a greater amount of freight moving between the freight hubs, the impacts of which may be able to be alleviated by increasing vehicle efficiencies through improved logistics and a greater use of more freight-efficient vehicles.

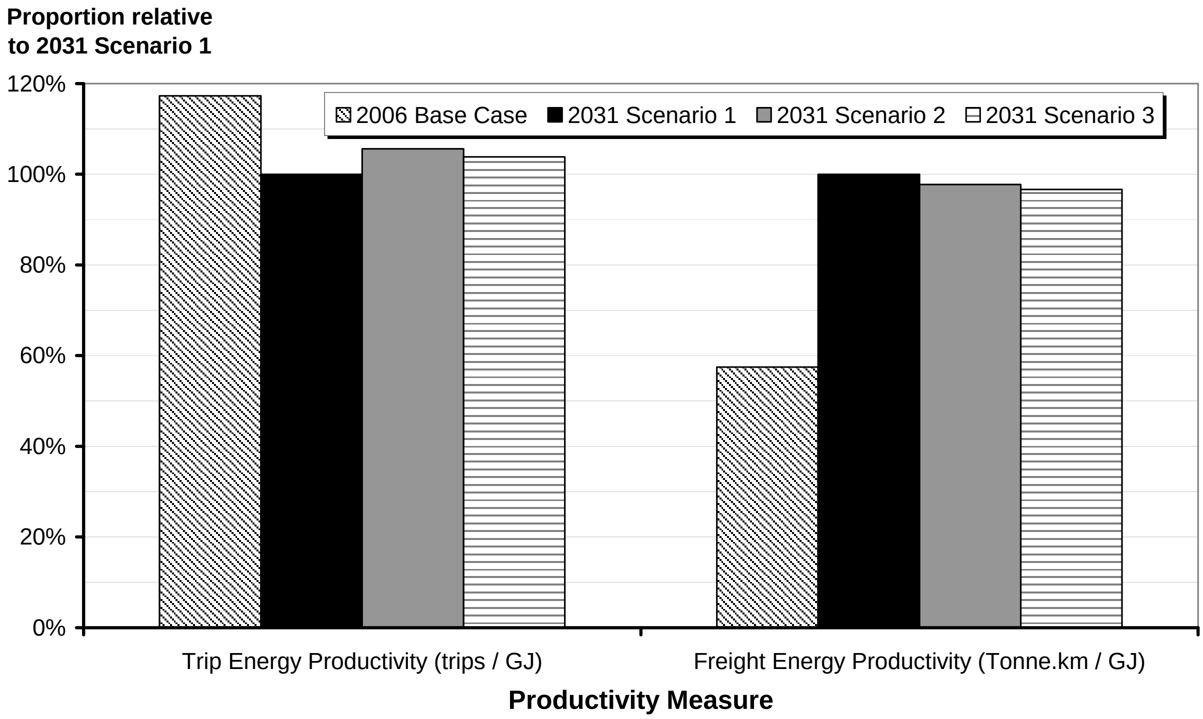


**Figure 6 – Comparison of relative productivity measures for each scenario**

The average freight energy productivity of 0.18 net tonne-kilometres per megajoule for road freight transport in an urban network is lower than for other freight modes and other operational areas. Laird (2003) reports that examples of average full-fuel-cycle energy efficiencies for various road and rail freight tasks include:

- 0.36 tkm/MJ for rigid trucks (smaller trucks used in urban goods movement)
- 0.93 tkm/MJ for articulated trucks
  (mostly single articulated, also includes B-Doubles and road trains)
- 3.0 tkm/MJ for Line haul interstate rail freight
- 5.0 tkm/MJ for Central Queensland coal trains
- 12.0 tkm/MJ for Pilbara (WA) iron ore trains

The relatively low freight efficiencies found in the current study are attributed to the low average speeds across the congested metropolitan road network and associated higher fuel consumption rates, in combination with the relatively low average payloads being carried by vehicles compared to long distance transport.

# 5 Discussion and Conclusions

This analysis shows that land use development policies directly contribute to the efficiency of freight operations. The strategies outlined in Freight Futures would be expected to lead to energy and emissions savings of the order of five per cent, solely based on the reduction in trip lengths associated with the consolidation of freight activities around a small number of freight activity areas. This is similar to the findings of Alford and Whiteman that appropriate consolidation of development within an urban area leads to reductions in non-freight transport energy usage.

This freight consolidation also facilitates the greater use of more productive vehicles to more freight between centres along a high standard arterial road network. The benefits associated with improvements in vehicle and engine productivity should be evaluated and considered in addition to those outlined in this report.

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# Appendix 1 – Performance and productivity measures for freight vehicle trips in each time period and each scenario

| *Time Period* | *2006 Base Case* | *2031 Scenarios* | | |
|---|---|---|---|---|
| | | *2031 Scenario 1* | *2031 Scenario 2* | *2031 Scenario 3* |
| **Number of freight trips** | | | | |
| AM Peak | 62,000 (52%) | 121,000 | 121,000 (100%) | 121,000 (100%) |
| Interpeak | 73,000 (51%) | 141,000 | 142,000 (101%) | 142,000 (100%) |
| PM Peak | 44,000 (52%) | 86,000 | 86,000 (100%) | 86,000 (100%) |
| All-Day | 179,000 (52%) | 348,000 | 349,000 (100%) | 349,000 (100%) |
| **Total vehicle kilometres travelled by freight vehicle trips** | | | | |
| AM Peak | 1,851,000 (44%) | 4,205,000 | 3,983,000 (95%) | 4,027,000 (96%) |
| Interpeak | 2,165,000 (45%) | 4,849,000 | 4,618,000 (95%) | 4,687,000 (97%) |
| PM Peak | 1,311,000 (45%) | 2,933,000 | 2,780,000 (95%) | 2,811,000 (96%) |
| All-Day | 5,326,000 (44%) | 11,988,000 | 11,381,000 (95%) | 11,525,000 (96%) |
| **Total tonne-kilometres moved by freight vehicles** | | | | |
| AM Peak | 4,873,000 (25%) | 19,479,000 | 17,979,000 (92%) | 18,020,000 (93%) |
| Interpeak | 5,687,000 (25%) | 22,370,000 | 20,981,000 (94%) | 21,182,000 (95%) |
| PM Peak | 3,426,000 (25%) | 13,541,000 | 12,517,000 (92%) | 12,537,000 (93%) |
| All-Day | 13,986,000 (25%) | 55,390,000 | 51,477,000 (93%) | 51,739,000 (93%) |
| **Average trip length for freight vehicle trips (km)** | | | | |
| AM Peak | 29.7 (85%) | 34.8 | 32.9 (94%) | 33.3 (96%) |
| Interpeak | 29.8 (87%) | 34.4 | 32.5 (95%) | 33.0 (96%) |
| PM Peak | 29.6 (87%) | 34.2 | 32.4 (95%) | 32.8 (96%) |
| All-Day | 29.7 (86%) | 34.5 | 32.6 (95%) | 33.0 (96%) |
| **Total fuel used by freight vehicle trips (litres)** | | | | |
| AM Peak | 1,260,000 (41%) | 3,101,000 | 2,947,000 (95%) | 2,982,000 (96%) |
| Interpeak | 1,369,000 (47%) | 2,932,000 | 2,788,000 (95%) | 2,842,000 (97%) |
| PM Peak | 829,000 (45%) | 1,837,000 | 1,748,000 (95%) | 1,781,000 (97%) |
| All-Day | 1,260,000 (41%) | 3,101,000 | 2,947,000 (95%) | 2,982,000 (96%) |
| **Average specific fuel consumption rate (litres per net tonne kilometre)** | | | | |
| AM Peak | 0.259 (162%) | 0.159 | 0.164 (103%) | 0.165 (104%) |
| Interpeak | 0.241 (184%) | 0.131 | 0.133 (101%) | 0.134 (102%) |
| PM Peak | 0.242 (178%) | 0.136 | 0.140 (103%) | 0.142 (105%) |
| All-Day | 0.247 (174%) | 0.142 | 0.145 (102%) | 0.147 (103%) |
| **Trip energy productivity for freight vehicle trips (trips / GJ)** | | | | |
| AM Peak | 1.28 (127%) | 1.01 | 1.07 (106%) | 1.05 (104%) |
| Interpeak | 1.37 (110%) | 1.25 | 1.32 (106%) | 1.29 (104%) |
| PM Peak | 1.38 (114%) | 1.21 | 1.27 (105%) | 1.25 (103%) |
| All-Day | 1.34 (117%) | 1.14 | 1.21 (106%) | 1.19 (104%) |
| **Freight energy productivity for freight vehicle trips (net tonne-kilometres / GJ)** | | | | |
| AM Peak | 100 (62%) | 163 | 158 (97%) | 157 (96%) |
| Interpeak | 108 (54%) | 198 | 195 (99%) | 193 (98%) |
| PM Peak | 107 (56%) | 191 | 186 (97%) | 182 (96%) |
| All-Day | 105 (57%) | 182 | 178 (98%) | 176 (97%) |

*Note: Percentages are relative to the same time period in 2031 scenario 1*