OPTIONS FOR REDUCING LAND TRANSPORT FUEL USE IN TASMANIA

BY

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This thesis contains no material which has been accepted for the award of any other higher degree or graduate diploma in any tertiary institution, and to the best of the candidates knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

ABSTRACT

This thesis considers the possibility of reducing land transport fuel use in Tasmania. The consumption of petroleum products, of which the transport sector is the largest user, currently accounts for approximately 40 per cent of total energy consumed in Tasmania. The Toronto Target, which requires a reduction in emissions of greenhouse gas by 20 per cent of 1988 levels by 2005, is used as an example to consider what prospects are open for Tasmania to reduce emissions with respect to the transport sector. Other transport related pollutants are also examined.

The use of alternative transport fuels is evaluated regarding the possible contribution in aiding a reduction in greenhouse gas emissions. Transport in Tasmania is divided into sectors according to function, which includes private, public and commercial transport operations. These sectors are evaluated in terms of their contribution to total transport fuel use and their ability to yield reductions. The structure of urban form, in particular the development of low density suburban housing, is examined with regard to the way in which it contributes to transport energy use.

The thesis concludes with suggestions for a number of possible strategies aimed toward reduction of total fuel consumption over an estimated level for 2005, although the reduction is insufficient to meet the requirements of the Toronto Target.

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CHAPTER 1
TRANSPORT IN TASMANIA

The importance of transport is often under-estimated in terms of its function in our social and economic system. In relation to the daily lives of most people, transport has become second nature especially, for example, in terms of journey to work. The transport sector is also vitally important in terms of Australia's economic performance. A component cost of most commodities is associated with transportation which can effect the locational viability of an industry. The land transport sector is itself a large industry employing approximately 233 thousand and contributing $3162 million in wages and salaries Australia wide during 1983/84 (ESDWG[1] 1991). In Tasmania the significance of transport is magnified by the island nature of the State, creating a clearly recognisable barrier for many forms of transportation. During 1990/91, it is estimated that Tasmanians consumed 462 million litres of petrol, 272 million litres of diesel and 68 million litres of liquified petroleum gas for transportation and other needs (ABARE[2] 1991). The economic value of the fuel consumed during 1990/91 based on the price at the pump[3] would be in the vicinity of $550 million. Transport is a very important source of government revenue with the Federal Government raising $7034.8 million and the Tasmania Government raising almost $40 million during 1989/90 from motor fuel taxes and charges. Tasmania does not have a petroleum refinery and thus all transport fuels used in the State have to be imported. This means that Tasmanians are paying for a value added product which benefits those states which produce the refined petroleum products. Petroleum products constitute a significant proportion of total imports which affects Tasmania's trading balance. Additionally, there are the environmental and social costs involving air, visual and noise pollution which impinge on the quality of every day life associated with transport. These effects are felt differently through-out the community.

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[1]Ecologically Sustainable Development Working Groups

[2]Australian Bureau of Agricultural and Resource Economics

[3]Total fuel costs are based on the Hobart price at the pump for December 1991, petrol 71.9 c/L, diesel 69.9 c/L and LPG 39.9 c/L.

Transport activity is dominated by the road sector which accounts for approximately 90 per cent of passenger kilometres and 33 per cent of tonne kilometres travelled in Australia (ESDWG 1991). The dominance of road transport has increased over the last two decades at the cost of rail freight and passenger movements.

Reducing transport fuel use in Tasmania may be considered at at least two levels. Firstly, there is the goal of promoting energy conservation and efficiency in all sectors including transport for the direct benefit of the State. And secondly, there is the issue of an involuntary requirement which may see Tasmania forced to reduce its consumption of transport fuels in line with national or international agreements concerning carbon dioxide gas emissions.

The aims of this thesis are to:

- evaluate the contribution Tasmania's land transport sector makes to the Tasmania's total greenhouse gas emissions and general air pollution;
- outline the reasons why Tasmania will have to concentrate more closely upon reducing greenhouse gas emissions from the transport sector in order to reduce total greenhouse gas emissions by 2005, in line with the Toronto Target, compared with other Australian states;
- look at alternative forms of energy suitable for the transport sector in Tasmania;
- consider the importance city structure has on per capita energy use for transport for urban inhabitants;
- divide Tasmania's land transport system into sectors by function and mode and evaluate them in terms of their contribution to total greenhouse emissions;
- and, finally evaluate possible strategies open for Tasmania to reduce greenhouse gas emissions from the land transport sector by 2005.

For the purposes of this thesis the scope of study has been confined to land transport occurring on public roads and the commercial railways. Transport activity occurring outside these boundaries makes up only a small contribution to the overall transport picture and the availability of associated data is limited.

1.1 Motor Vehicle Emissions

Motor vehicles have become a part of everyday life for almost all Australians. Automobiles are used for a number of services including journey to work, shopping, recreation and for the transportation of commercial commodities. Increasingly people have become dependent upon the automobile, however, the costs of this dependence are often not fully realised. Automobiles are responsible for a number of airborne pollutants which contribute to the major smog problems of many large cities, as well, there are suggestions that a number of transport related pollutants may have links with health disorders (Abramson 1990).

There are a number of exhaust pollutants associated with motor vehicles including:

- nitrogen oxides,
- hydrocarbons,
- carbon monoxide,
- lead,
- particulates,
- sulphur dioxide, and,
- hydrogen sulphide (with unleaded fuel).

Nitrogen oxides include both nitric oxide (NO) and nitrogen dioxide (NO_2). Both are formed in small quantities in the vehicle engine by the high temperature combination of nitrogen and oxygen from the combustion air (Munro 1990).

Nitrogen oxide is a pollutant in its own right. Nitric oxide, while not by itself a pollutant, is claimed under particular circumstances to combine with hydrocarbons to form photochemical smog (Munro 1990). Photochemical smog has been associated with a number of adverse health effects including respiratory and eye irritations. There are guidelines suggested by the World Health Organisation (WHO) concerning the level of nitrogen oxides present in the ambient air. Motor vehicles exhaust emissions are regulated for their level of nitrogen oxides.

Hydrocarbons is a term used to describe collectively all organic species discharges (Munro 1990). Hydrocarbons are released through exhaust emissions as the result of incomplete combustion of fuel and from fuel evaporation.

There is no prescribed maximum level of hydrocarbons in the ambient air, however, the level of hydrocarbon emissions from the exhaust and from evaporation are prescribed for motor vehicles and petroleum motor vehicle fuels.

Carbon monoxide is a product of the incomplete combustion of carbon containing fuel (Munro 1990). The production of carbon monoxide in the internal combustion engine is inevitable. It is a toxic gas in sufficient concentrations. Munro (1990) claims that while in the minds of the public carbon monoxide represents the single most dangerous motor vehicle emission it is actually, at present, probably one of the least important.

Carbon monoxide has recently been implicated as having a role in the greenhouse effect. This hypothesis is related to the perceived association of carbon monoxide with the rapid rise in the atmospheric levels of methane. It is suggested that the carbon monoxide, released primarily by automobiles, is affecting the process by which methane levels are normally regulated (Munro 1990).

The World Health Organisation (WHO) recommends that ambient air carbon monoxide levels should not exceed 9 ppm during an eight hour period.

Lead compounds are emitted solely from those vehicles using leaded petrol (Munro 1990).

The result of increasing the fuel efficiency of motor vehicles has required the use of fuels with certain combustion characteristics. As a result of reducing the tolerances of automotive engine components the problems of 'knocking' and pre-ignition can occur. These problems are associated with the octane rating of the fuel which can be manipulated to gain the desired rating by either adding certain lead compounds or by severe refinery processing (NEAC[4] 1978).

The lead contained in the fuel is emitted from the motor vehicle exhaust in the form of lead salts, of which a significant proportion is in the form of air suspended particles (NEAC 1978). The toxicity of lead has resulted in regulations prescribing the maximum level of lead in the air.

Since 1986 all new motor cars registered in Australia have been required to use unleaded petrol. While these requirements aid in reducing the level of

[4]National Energy Advisory Committee

lead emissions, the elimination of lead in automotive fuel was necessary to guarantee satisfactory operation of exhaust catalysts to meet tighter exhaust emission requirements (Munro 1990).

Particulates are produced from the incomplete combustion of fuel and from the excessive combustion of lubricating oil (Munro 1990). While the majority of particulate emissions are generally perceived to originate from older vehicles with smoky exhausts, all vehicles, in fact, emit some level of particulates which contribute to the particulate loading in the urban atmosphere and may result in visibility problems.

Diesel powered vehicles are often cited as being a main contributor of particulate matter in city areas. Diesel powered vehicles can emit approximately 10 times (but up to 100 times) more particulate matter than for uncontrolled gasoline vehicles (OECD[5] 1986). Particulate pollution is a problem in many European cities where diesel powered vehicles including trucks, buses and cars constitute a significant proportion of the automotive fleet. The problem of particulate matter is less of a concern in Tasmania's urban centres, however, the contribution made by buses is certainly noticeable especially during peak traffic periods.

Sulphur dioxide is emitted from the combustion of sulphur in the fuel (Munro 1990). Currently in Australia a large proportion of the total fossil fuel demand is met from indigenous reserves which tend to be low in sulphur content and hence sulphur emissions are not a major problem. It is expected that the proportion of fuels derived from Australian sources will decline over the next decade and thus imported fuels will be required to meet the demand which may be significantly higher in sulphur content.

Hydrogen sulphide exhaust emissions are associated with unleaded petrol automobiles. The production of H_2S is suggested to occur through the storage of sulphur compounds on the catalyst which may subsequently be released in the form of H_2S during transient rich mixture operation (Martin 1990).

Sulphur emissions are regulated for and controlled at present through limits on the sulphur content of fuels (Munro 1990).

Table 1.1 outlines the findings of a study conducted by Sweden's National Environment Protection Board on motor vehicle emissions. Table 1.1 reveals a positive relationship between increasing speed and energy consumption

[5]Organisation for Economic Cooperation and Development

and all the emission compounds. The nitrogen oxides, however, appear to increase quite significantly, compared with the other pollutants.

Table 1.1
Emissions and Fuel Consumption from an Average Car[1]

Constant speed (kph)	Carbon monoxide (g/km)	Hydrocarbons (g/km)	Nitrogen oxides (g/km)	Fuel consumption (litres/100km)
70	5.94	0.54	1.04	5.8
80	5.42	0.53	1.39	5.8
90	5.56	0.56	1.87	6.2
100	6.19	0.62	2.43	7.0
110	7.57	0.71	3.09	8.3
120	9.52	0.83	3.82	10

1. average car without catalytic converter

Source: Australian Consumers' Association 1990

Australia has regulations prescribing the maximum exhaust emission levels for new cars. Table 1.2 illustrates the emissions limits for petrol automobiles in Australia, the USA and for the European Community (EC) draft recommendations to be established in 1992.

It must be remembered that table 1.2 outlines the emission guidelines for new vehicles, while vehicles which were registered prior to the introduction of these standards may exceed the current emission levels. Furthermore, unless regular testing programs are conducted and emissions guidelines are enforced many existing road vehicles may exceed the guidelines within a short period after initial operation. In order to maintain a minimum of level of pollutant emissions a motor vehicle must be maintained to specific standards including regular servicing of anti pollution equipment and, importantly, the vehicle needs to be tuned correctly.

In the United States the continued implementation of progressively tighter emission standards has resulted in substantial reductions in new car exhaust emissions. During the period from the 1960s to the late 1980s hydrocarbon and carbon monoxide emissions have improved by 96 per cent while nitrogen oxides have improved by 72 per cent (McTague 1990). These reductions are suggested to have been achieved primarily through the introduction of three way exhaust catalysts. Electronic fuel injection has been introduced to maintain engine performance in order to gain the optimum results from the exhaust catalysts (McTague 1990).

Table 1.2
Passenger Car Emission Regulations

Exhaust Emissions	Australia ADR 37	USA	EC - Draft (1989) For intro in 1992
HC g/km	0.93	0.25	-
CO g/km	9.3	2.1	2.72
NOx g/km	1.93	0.62	0.97 (HC + NOx)
Evaporative Emissions			
HC g/test	2	2	2

Proposed 1994 reductions in US, HC to 0.15 g/km, CO same, NOx to 0.25 g/km phased in over 2 years
Both US and EC required long term durability of pollution control equipment (up to 160,000 km proposed)

European test procedure is similar in severity to the US cycle but data is not directly comparable. Australia uses the US procedure.

Source: Martin 1990

1.1.1 Urban Air Quality

The effects of automobile emissions are most severe in the city which accommodates a large concentration of automobiles. The result of traffic congestion, which produces inefficient vehicle usage and higher emissions than the optimum, can be degraded air quality for the urban environment. Generally, air quality is measured in terms of the average concentration of a substance over a time period (i.e. 1, 8, or 24 hour) that is not to be exceeded more than a specified number of times (i.e. 1 or 3) a year (Munro 1990).

There has been considerable monitoring of air quality in Australian cities, especially Melbourne and Sydney. A number of conclusions about the air quality of Australian cities has been outlined by Munro (1990). These include:

- ozone levels exceed acceptable criteria levels in Melbourne and Sydney and show an increase over background levels in some cities. There is some evidence of stabilisation or decrease in the levels over recent years;

- nitrogen dioxide levels rarely exceed criteria levels but do approach them;
- carbon monoxide levels are generally below accepted levels;
- lead levels have fallen with the reduction of lead content of leaded petrol and the introduction of unleaded petrol, however at heavily trafficked sites atmospheric lead levels can be close to or above criteria levels;
- there is some evidence of a decrease in particulate levels in urban atmospheres as indicated by an improvement in visibility.

The air quality in most Australian cities is less than desirable because of the automobile; while not being the sole source of air pollutants it is a major contributor. The automobile contributes approximately;

75% nitrogen oxides,

50% hydrocarbons,

90% carbon monoxide,

95% lead,

of the detectable levels of these compounds in Australian cities (Munro 1990). The automobile is thus the single most important source of air borne pollutants in the urban area.

Table 1.3 outlines the results of carbon monoxide emission testing which has been carried out by the Department of the Environment and Planning (DEP) in Tasmania since 1978. The emission testing station is located in Liverpool Street, Hobart, which is believed to be where the highest levels of automotive atmospheric pollution is likely to occur in the city (DEP 1987). It is important to note that in Hobart the WHO eight hour goal of 9 ppm for carbon monoxide levels has been exceeded on a regular basis since 1979/80. The general perception amongst most Tasmanians would be that Tasmania has very 'clean' air and it may come as something of a shock to realise that Hobart city suffers, like other Australian cities, from automotive pollution.

The extent of carbon monoxide levels exceeding the WHO recommendations has declined since 1984/85 according to the Department of Environment and Planning (1987). It is believed that the reduction in emission levels is associated with the synchronisation of the city traffic light system introduced in 1984/85 aiding in the more efficient movement of traffic (DEP 1987). An additional factor in promoting the decline in carbon monoxide levels in the long term is attributed to the regulation of emission levels on new cars.

Table 1.3
Number of days on which the 8 hour goal of 9 ppm for the concentration of carbon monoxide[1] was exceeded in Hobart

	Days of observation (days)	Days with 8 hour average > 9 ppm (days)	Average days per complete year (days)
1979/80	161	39	88
1980/81	329	88	98
1981/82	266	97	133
1982/83	304	106	127
1983/84	285	75	96
1984/85	245	31	33
1985	353	8	8
1986	265	11	15

1. Testing is conducted at Liverpool Street, Hobart

Source: Department of the Environment (Tasmania) Annual Report 1986/87

The accuracy of the findings made by the Department of Environment and Planning in regards to the concentration of carbon monoxide in the ambient air in Hobart city have been questioned by Power (1991). Power (1991) suggests that due to problems associated with the testing equipment used by the Department of Environment and Planning the findings they have published post 1985 may have underestimated the actual carbon monoxide concentrations. While Power (1991) concedes that due to the unavailability of historical data, other than that of the Department of Environment and Planning, the observed drop in CO concentrations post 1985 may have been a real phenomenon accountable to the synchronisation of traffic lights. This hypothesis is, however, unlikely especially in light of the CO concentrations recorded by Power (1991).

Power (1991) conducted sample testing at the same site as the Department of the Environment and Planning for 23 days during July and August 1991.

Power (1991) concluded that Hobart has a definite CO pollution problem with the WHO eight hour maximum being exceed on 34.8 per cent of the days on which recordings where taken.

The effect of emission standards on average motor vehicles in the United States was examined through an on road emission testing study. The study found that about 75 per cent of vehicles tested emitted acceptable levels of carbon monoxide and only 6 per cent were classified as gross emitters (McTague 1990). The study also suggested that over 50 per cent of carbon monoxide emissions are attributable to only 10 per cent of vehicles. These figures indicate benefits of emission control legislation and also highlight the effects of vehicle ageing and renewal. Studies in the United States have also quantified the contribution that traffic congestion may have on carbon monoxide and hydrocarbon emissions. It has been estimated that in Los Angeles in 1988 traffic congestion was accountable for an increase of 46 per cent of daily carbon monoxide levels over free moving traffic. Furthermore, it has been estimated that by 2010 congestion may contribute an extra 72 per cent of carbon monoxide levels than could be expected for free flowing traffic (McTague 1990).

Motor vehicle emissions can be identified as contributing to air pollution on three levels:

- local pollution, where the emissions lead to increased levels of certain pollutants adjacent to heavily traversed roads. Carbon monoxide and lead are typical examples;
- regional pollution where the emissions contribute to reduced air quality across a city; typified by photochemical smog and reduced visibility;
- global, where the emissions add to the atmospheric burdens of gases that contribute to the depletion of stratospheric ozone and global warming.

1.2 The Greenhouse Effect - Cause for Concern

The greenhouse effect has gained considerable public interest over the last decade. There has been a growing concern due to scientific studies focusing on the accumulation of greenhouse gases in the atmosphere and the effect it may have on the earth's climate (ANZEC[6] 1990a).

The impact of greenhouse studies and the results of tests indicating the

[6]Australian and New Zealand Environment Council

accumulation of greenhouse gases in the atmosphere has encouraged the Federal Government to adopt an interim planning target for emissions of greenhouse gases not controlled by the Montreal Protocol on Ozone Depleting Substances. The target requires emissions of these gases to be stabilised at 1988 levels by 2000, and to be reduced by 20 per cent by 2005. The decision carried the proviso that the adoption of response measures should not result in adverse effects on the economy in the absence of similar action by major greenhouse gas producing countries (BTCE[7] 1991a). This interim planning target for greenhouse gas emissions has been titled the Toronto Target.

It is the hypothesis of this chapter that if Tasmania is to reduce its carbon dioxide gas emissions to meet the Toronto Target set for 2005 it will be required to focus on the transportation sector more so than other Australia states. This is proposed because of the utilisation of hydro-electricity (which releases no carbon dioxide) by sectors within Tasmania whose counterparts on the mainland consume electricity derived from fossil fuels which consequently produce carbon dioxide. This hypothesis is supported by such bodies as the Australian Minerals and Energy Council (1990) who suggest that the major opportunity for reducing carbon dioxide emissions in Tasmania would be through the transport sector.

Tasmania's contribution of greenhouse gas emissions on an international or even national level is exceedingly small. However, it is not the quantity of reduction that is important but the fact that the State is attempting to address the greenhouse problem. Furthermore, if greenhouse gas emissions can be reduced through greater efficiency, saving energy or using alternative energy sources then Tasmania may act as a role modal on which other states can draw to reduce their greenhouse gas emissions.

1.2.1 Carbon dioxide emissions

Carbon dioxide is released from a wide range of sources. Figures 1.1 and 1.2 illustrate the contribution of carbon dioxide emissions from the utilisation of fossil fuels and cement production in Australia and Tasmania during 1990.

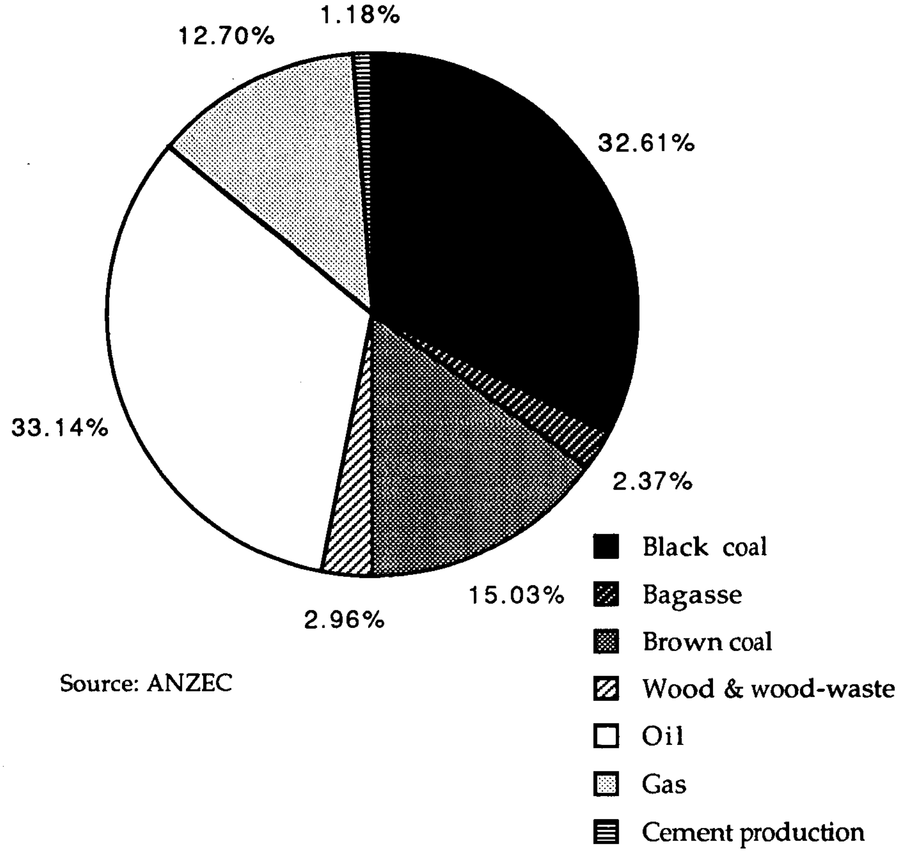
Crude oil products form the major source of carbon dioxide emissions in Australia (if black and brown coal are considered separately). Black coal, brown coal and gas are also significant sources of carbon dioxide release. Fossil fuels account for approximately 95 per cent of the total primary energy consumption (outlined in table 1.4) and as a consequence of their conversion to an energy

[7]Bureau of Transport and Communication Economics

source emit a number of by products including CO_2 (ANZEC 1990b).

Figure 1.1

Shares of Carbon Dioxide Emissions by Fuel Type, Australia 1990



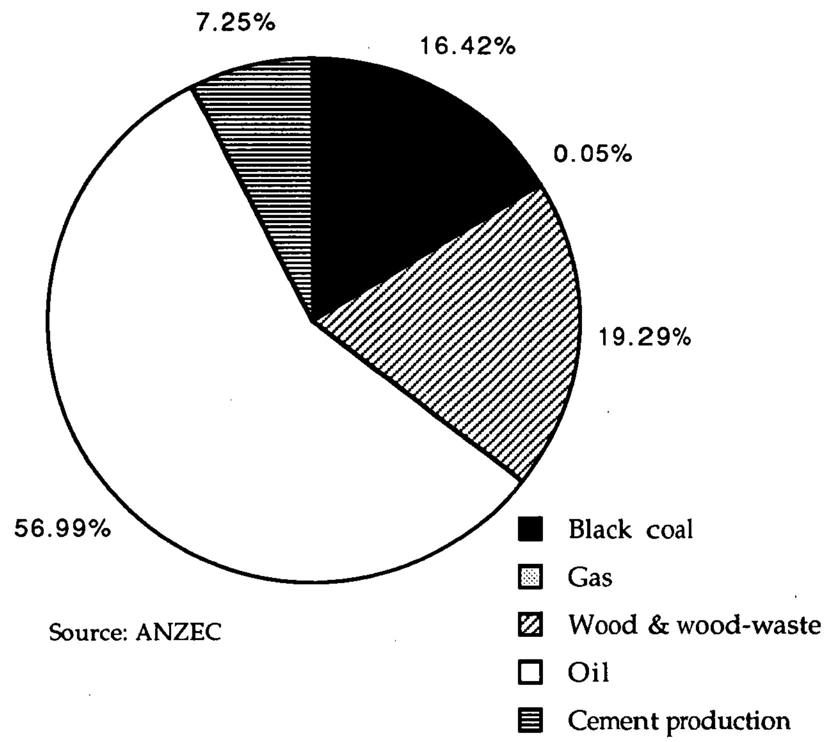
Source: ANZEC

The major source of carbon dioxide emissions generated within Tasmania are derived from the consumption of petroleum products, while black coal, wood and wood-waste, and cement production form the remaining sources of emissions. The relative shares of carbon dioxide release from the different energy sources, outlined in the figures 1.1 and 1.2, illustrate a significant difference between Tasmania and the combined total of the states and territories of Australia. The main difference in the structure of Tasmania's shares of carbon dioxide emissions is associated with the use of oil products.

The difference in the production of carbon dioxide emissions between Tasmania and the Australian average is related to the type and diversity of energy sources. Tasmania differs from other states because of the energy it acquires from hydro-electricity. Hydrological energy is one of only a few sources of energy currently being utilised which is not based on fossil fuels and thus the composition of Tasmania's carbon dioxide emissions reflects the demand for energy which is or cannot be met by hydro-electricity.

Figure 1.2

Shares of Carbon Dioxide Emissions by Fuel Type, Tasmania 1990



Source: ANZEC

Table 1.4 illustrates the total energy consumption for Australia and Tasmania for 1987/88. The difference in the totals of energy consumption for Tasmania between the ANZEC and Hydro-Electric Commission (HEC 1991), outlined in table 1.4, may be associated with the way in which the agencies record energy figures. One possibility which may account for the discrepancy between the estimates of petroleum consumption is based on the difference between origin of the sales and actual use of the products. For example, if energy figures are based on the location of the sale of petroleum products then distribution of petroleum products between states will result in discrepancies in estimates of energy use by location. Other publications have noted this difference but explanations for the differences are usually vague (HEC 1991). This study utilises figures from both these sources and indicates from where the information is derived.

Table 1.4
Total Primary Energy Consumption by Fuel Type 1987/88
(Petajoules)

	Australia	%	Tasmania[1]	%	Tasmania[2]	%
Black coal	1113.12	27.76	9.19	9.82	9.5	10.92
Brown Coal	489.31	12.20	-	-	-	
Bagasse	75.20	1.88	-	-	-	
Wood & wood-waste	94.26	2.35	10.07	10.76	10.4	11.95
Oil	1481.03	36.93	41.78	44.65	35.7	41.04
Gas	705.42	17.59	0.05	0.05	-	
Solar energy	3.94	0.10	0.01	0.01	-	
Hydro-electricity	47.52	1.19	32.46	34.69	31.4	36.09
Total	**4009.8**		**93.56**		**87**	

1. Estimation of energy consumption by ANZEC 1990b
2. Estimation of energy consumption by Hydro-Electric Commission 1991

Source: ANZEC 1990b

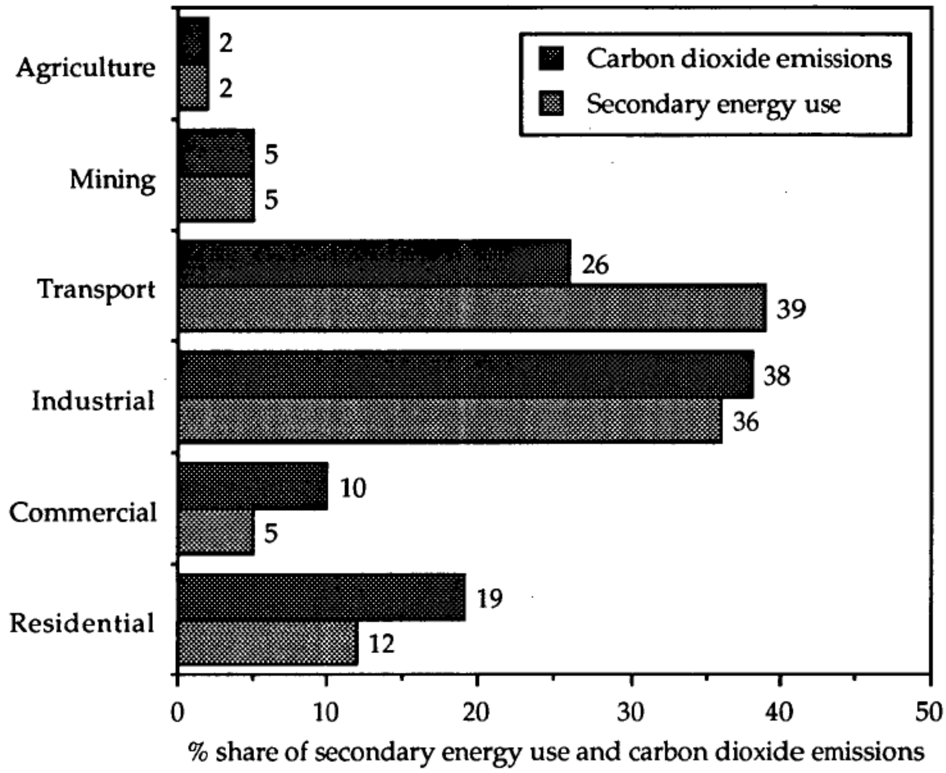
Australia extracts over 94.5 per cent of its energy requirements from non-renewable sources. While in Tasmania, over one third of the total energy consumption is met by hydro-electricity. This is almost 70 per cent of the total contribution of hydro-electricity produced in Australia. The use of hydrological energy has important implications for the energy pattern of Tasmania as it accounts for almost all the energy required for electricity generation in the State. Throughout mainland Australia coal forms the major source of energy used to generate electricity.

The use of hydrological energy in Tasmania affects for the profile of the State's carbon dioxide emissions, especially when considering final energy utilisation. One way of considering carbon dioxide emissions is by looking at energy use by sector and the source of that energy.

Figures 1.3 and 1.4 illustrate secondary energy use and carbon dioxide emissions by sector of use in Australia and Tasmania. The values are calculated by considering secondary energy use and estimating the type of fuel used (for example with electricity the fuel used in generation).

Figure 1.3

Shares of Secondary Energy Use and Carbon Dioxide Emissions by Sector, Australia 1988

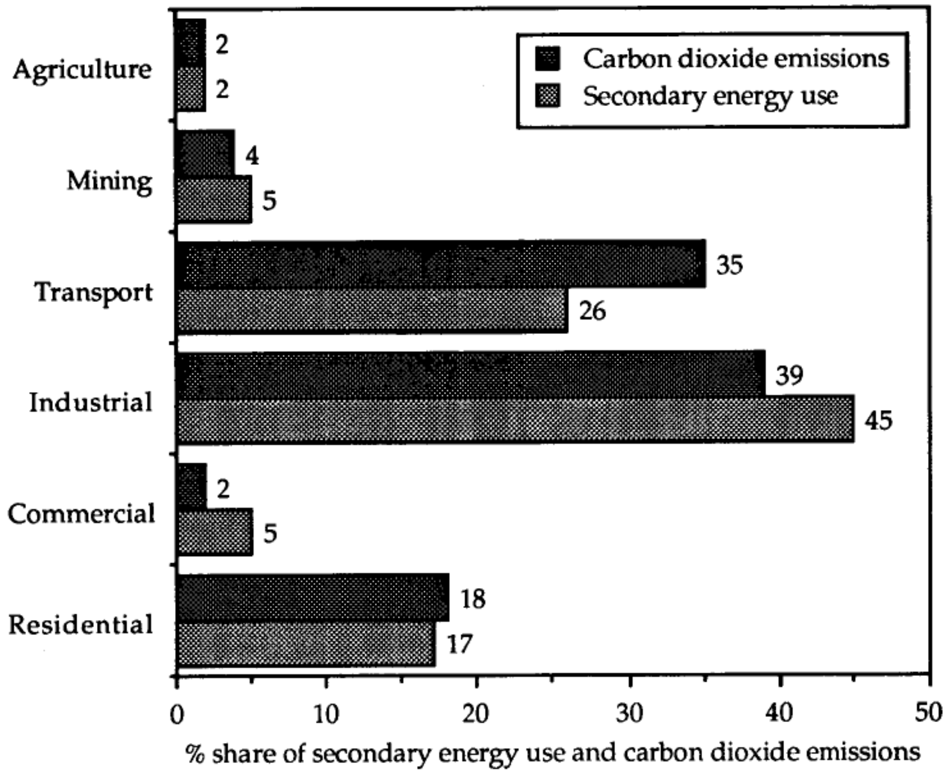


Source: ANZEC 1990b

Figures 1.3 and 1.4 provide a useful insight into the impact which different energy sources have for carbon dioxide emissions. For example, figure 1.3 shows that while the transport sector consumes 39 per cent of Australia's total secondary energy it produces only 26 per cent of total carbon dioxide emissions. By contrast the industrial, commercial and residential sectors exhibit a greater share of carbon dioxide emission than energy consumption. This phenomenon is a result of the type of fuel used to generate the secondary energy being consumed. In the case of the industrial, commercial and residential sectors a considerable amount of the energy consumed is in the form of electricity which in the main is generated from coal. The industrial sector also directly uses coal and other fossil fuels as energy sources which add to the production of carbon dioxide emissions.

Figure 1.4

Shares of Secondary Energy Use and Carbon Dioxide Emissions by Sector, Tasmania 1988



Source: ANZEC 1990b

Energy use in comparison to carbon dioxide emissions for Tasmania is dissimilar to that of the Australian average. For example, in Tasmania the industrial, commercial and mining sectors have a lower share of the total carbon dioxide emissions than for their share of secondary energy use. While for transport the share of carbon dioxide emissions is significantly higher than its energy consumption, which is the reverse of the Australian average. The explanation lies in the use of hydro-electricity, (which results in no carbon dioxide emissions) by the different sectors. The industrial sector obtains approximately half its energy requirements from hydro-electricity, while the remaining energy is derived from fossil fuels and hence it is still responsible for approximately 40 per cent of the State's carbon dioxide emissions (ANZEC 1990b). The residential sector provides an interesting case where it may be expected that the use of hydro-electricity would mean that this sector would produce a small share of the State's carbon dioxide emissions. The residential sector, however, obtains approximately 35 per cent of its energy from electricity and the remaining energy comes from fossil fuels and wood. By contrast the transport sector is limited in its ability to utilise energy other than petroleum products. Consequently when considering the shares of carbon dioxide emissions the transport sector features heavily because it is at present restricted to the use of fossil fuels.

1.3 Consumption of Petroleum Products in Tasmania

Figure 1.5 illustrates the total quantity of petroleum products consumed in Tasmania during the period 1964/65 to 1994/95[8] including fuels used for transportation as well as for other sectors, estimated by the Australian Bureau of Agricultural Resource Economics (1991). The fuels most commonly used for transport including petrol, diesel, and LPG accounted for almost 72 per cent of the consumption of total petroleum products for 1990/91 in Tasmania.

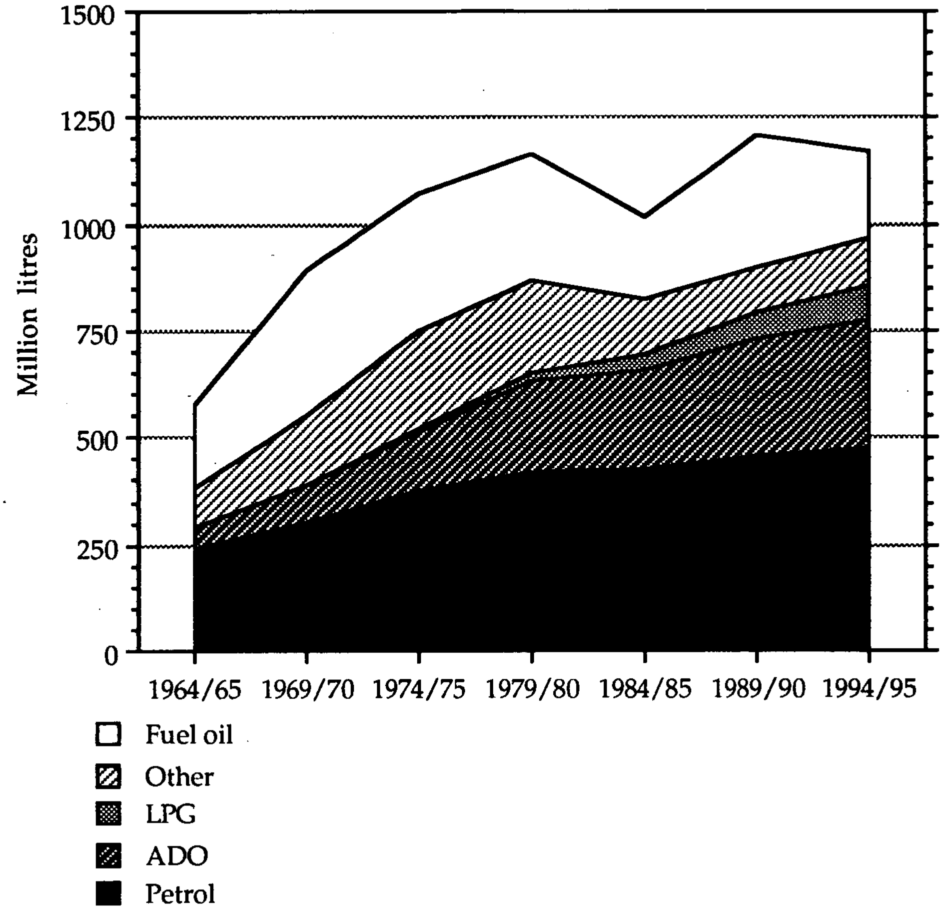
Figure 1.5 outlines total petroleum products consumed in Tasmania including those used in the industrial, commercial and residential sectors. For instance, the fuel consumed by both the industrial sector and by the Hydro-Electric Commission are included in figure 1.5.

Fuel oil is used by the HEC for the generation of electricity at the Bell Bay power station. The quantity of fuel oil consumed for the generation of electricity is associated with the capacity of the hydro system to meet the expected demand for electricity. The potential hydro energy is directly related to the volume of water contained in the hydro storage dams which is a direct function of yearly rainfall and hence the amount of fuel oil consumed each year may fluctuate due to the variation in rainfall accompanied by expected demand. For example in 1989/90 the HEC consumed over 180 ML of fuel oil for thermal power generation while the industrial sector consumed approximately 127 ML. In 1987/88, however, the HEC consumed only around 1.4 ML of fuel oil, while the industrial sector consumed over 120 ML (HEC 1991). The dramatic fluctuation of fuel oil usage by the HEC is due to the use of thermal power generation as a secondary source to hydro generation at times when the full supply cannot be met by hydro generation. The dramatic fluctuation of fuel oil usage by the HEC has resulted in the sporadic consumption of fuel oil which has had a significant influence on Tasmania's total consumption of petroleum products.

[8] ABARE provides an estimation of the consumption of petroleum products up until 2004/2005.

Figure 1.5

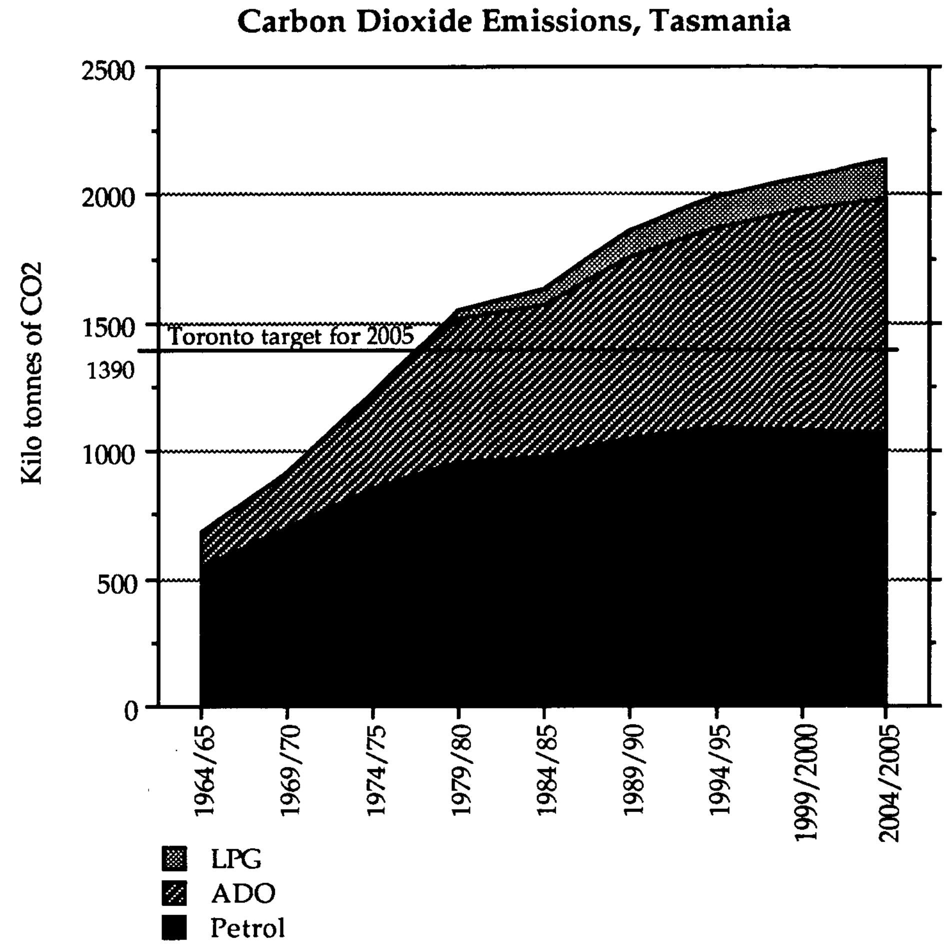
Consumption of Petroleum Products, Tasmania



Source: ABARE 1991

Figure 1.6 illustrates the contribution petrol, diesel, and LPG make to carbon dioxide emissions in Tasmania. These fuels alone contributed approximately 35 per cent of Tasmania's total carbon dioxide emissions from all sources during 1989/90 (HEC 1991 & ABARE 1991). ABARE (1991) have estimated that there will be a continued growth in consumption of petrol, diesel and LPG to at least 2005. Figure 1.6 also provides an estimation of the Toronto Target guideline for greenhouse gases from the consumption of petrol, diesel and LPG. The Toronto Target estimate relates solely to the fuels indicated in the figure and is based on a 20 per cent reduction in the total carbon dioxide emissions contributed by those fuels in 1988. The figure indicates that the estimated increase in the use of petrol, diesel and LPG will result in the failure to meet the Toronto Target for greenhouse emissions in 2005 apportioned for petrol, diesel and LPG. If Tasmania is encouraged to meet national or international agreements on greenhouse emissions the growth in the consumption of petroleum products will need to be addressed.

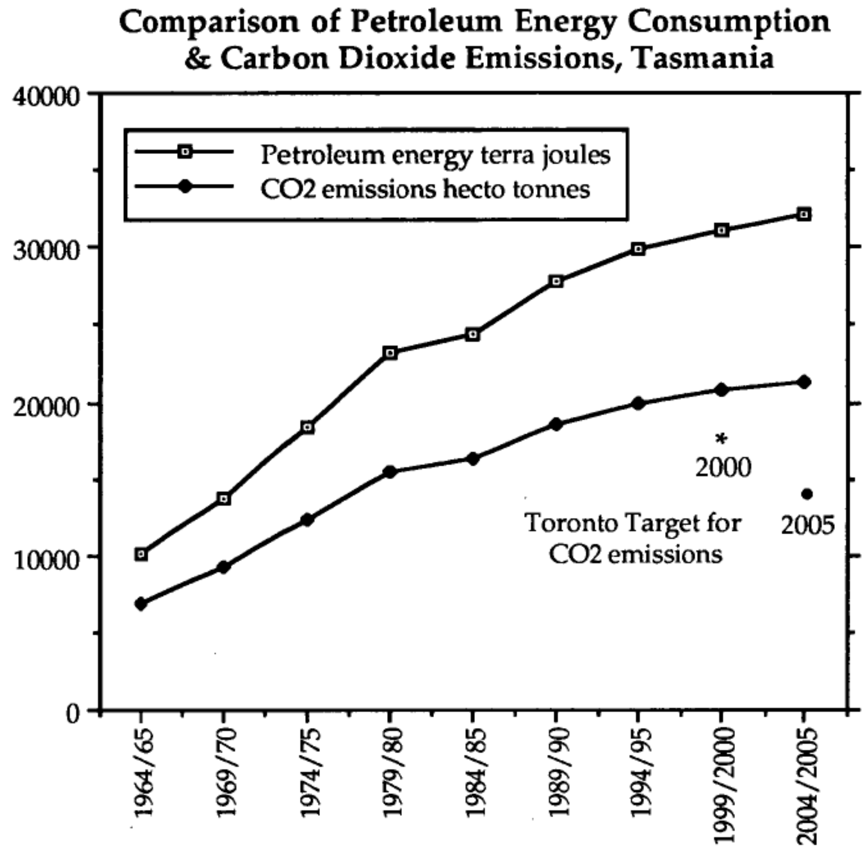
Figure 1.6



Source: ABARE 1991

An important factor to consider in terms of petroleum consumption is the effect which future changes in the composition of fuels used will produce on energy compared with carbon dioxide emissions. Carbon dioxide emissions per unit of fossil fuel consumed is based on the energy content or hydrogen to carbon ratio of the fuel. It is anticipated that petrol will decrease its dominance in terms of its contribution to total fuels consumed in Tasmania while both diesel and LPG are expected to increase their combined share. Diesel and LPG have a greater hydrogen to carbon ratio than petrol and as a result of an increase in the use of these fuels total carbon dioxide emissions will decline in relation to energy consumed. Figure 1.7 details the changes resulting from the increase in use of diesel and LPG fuels in Tasmania in relation to energy consumption and carbon dioxide emissions. The importance of substituting fuels which produce less carbon dioxide per unit of energy compared with petrol is that it allows for less change in transport behaviour in order to reduce carbon dioxide emissions.

Figure 1.7



Source: ABARE 1991

There are a number of possible scenarios open to reduce the level of carbon dioxide emissions in Tasmania by 2005 in order to meet the Toronto target. These include:

- decreasing the use of transport fuel use through regulation and pricing measures to encourage lower vehicle numbers, more efficient travel behaviour and more fuel economic vehicles;

- reducing carbon dioxide emissions without compromising the estimated energy consumption through the use of substitute fuels with lower carbon contents;

- or, introducing energy conservation programs aimed at increasing the use of more fuel economic vehicles and reducing the dependence on the automobile.

Alternative transport fuels and the possibilities of increasing motor vehicle fuel economy are discussed in following chapters.

1.4 In summary

Automobiles are part of every day life and this partnership is unlikely to diminish and, as a result, the problems associated with the widespread use of the automobile are set to continue for the foreseeable future.

Motor vehicles are responsible for a number of pollutants which contribute to the degradation of air quality especially in the larger urban areas.

The consequence of motor vehicle pollution has meant that the city of Hobart exceeds a World Health Organisation recommendation for carbon monoxide pollution during a number of days each year.

In terms of carbon dioxide, Tasmania has a different structure of the main sources of emission release with a greater release from the transportation sector compared with the Australian average profile.

In order for Tasmania to meet the Toronto target for greenhouse in 2005 there will need to be either a reduction in total energy consumed or a change in the types of fuels used to generate the required energy.

CHAPTER 2
ALTERNATIVE TRANSPORT FUELS

The aim of this chapter is to provide an overview of a number of alternative transport fuels which may be suitable replacements for gasoline and automotive diesel oil (ADO), which constitute the majority of fuel being used in the transport sector. Alternative transport fuels will be evaluated specifically in regard to Tasmania, which represents only a small fraction of the Australian petroleum market and thus has a limited ability to 'go it alone' in developing and using new technologies.

Alternative fuels may have a number of economic and environmental advantages compared with conventional fuels. Importantly if Tasmania is to reduce the contribution made by the transport sector to total carbon dioxide emissions it can either significantly change transport behaviour, use substitute transport fuels, which produce less carbon dioxide, or employ a combination of both these alternatives.

Electric vehicles

Before entering into a discussion of alternative transport fuels it is appropriate to briefly examine the alternative transport energy option of electricity. The ability to use electricity for transport requirements has important implications for Tasmania. In particular, because Tasmania derives the majority of its energy required for producing electricity from renewable sources, motor vehicles acquiring energy from the general electricity supply may have significantly less environmental problems than existing automobiles. The reduction in carbon dioxide emissions would be absolute in terms of operation of electric vehicles and there may also be substantial savings with hybrid vehicles using both a conventional engine and an electric energy source.

Until recently the high cost and relatively poor performance of electric vehicles has meant that they have not been taken as a serious substitute in the short term for conventional automobiles. At the 1990 Los Angeles Auto Show, General Motors introduced their experimental electric vehicle titled the 'Impact', produced as a viable alternative to the conventional car. The 'Impact' was designed and built as a high performance electric car capable of fulfilling the needs of many urban drivers (Ancker-Johnson & Schwochert 1990). In order to produce the high performance characteristics of the 'Impact' General Motors applied latest technologies in electronics, motor design, structural materials, aerodynamics, tires and batteries. As a result of the use of these technologies the 'Impact' can accelerate from 0 to 100 km/h in 8 seconds which makes it, in terms of performance, comparable to petrol fuelled vehicles.

One of the problems associated with electric vehicles is the limitation imposed by the use of lead-acid batteries. Currently lead-acid batteries are the only form of electricity storage medium which can be produced at a reasonable cost. The problems associated with lead-acid batteries include their weight and lengthy recharge periods. For instance, the 'Impact' uses 395 kg of batteries which provide an operating range of approximately 200 kilometres at a maximum of 90 km/h, with an overnight recharge period (Ancker-Johnson & Schwochert 1990). These factors, compared with petrol as an energy source, make electric vehicles using lead-acid significantly less convenient in operation than petrol fuelled vehicles. The development of the sodium sulphur battery may improve the viability of the electric vehicle. The sodium sulphur battery has an energy density of 70 to 80 watt hours per kilogram (Wh/kg), compared to current the lead acid battery which has about 35 Wh/kg (BTCE 1991a).

Perhaps the most important factor influencing the development of the electric vehicle is the possibility of government regulation. In the US the Californian State Government has enacted legislation requiring car manufacturers to make up 10 per cent of their total sales with 'zero emission (local air)' vehicles by 2003 (ESDWG 1991). The size of the Californian market, which has the greatest number of cars compared with any other state in the US (Los Angeles alone has about as many cars as all of Australia), will be an important factor influencing research and design decisions in many car manufacturers (ESDWG 1991). This type of commitment at a governmental level is required to ensure continued practical development of electric vehicle technology.

2.1 The Australian Petroleum Situation

The development of the Bass Strait oil fields in the late 1960s produced sufficient quantities of oil to reduce Australia's dependence on overseas oil producers. While oil production has also occurred from other sources in Australia, Bass Strait accounted for over 80 per cent of total oil production during the 1980s (AMEC[1] 1987).

The Australian crudes tend to be graded as light quality making them ideal for refining into transport fuel products including automotive gasoline (petrol) and automotive diesel oil. The light nature of Australian crudes, however, makes them unsuitable for the production of heavier petroleum products such as lubricants, bitumen and most grades of fuel oil. In order for Australia to meet the demand for heavy oil products it is dependent on imports (AMEC 1987).

The ability for Australia to maintain self sufficiency of automotive fuels will be dependent on the positive response to continuing oil orientated exploration. If no further large oil deposits are found, Australia will become increasingly dependant on the importation of oil from overseas in order to meet the demand for conventional transport fuels. The dependence on overseas supplies of petroleum products is a concern to many people who perceive the loss of petroleum fuel self sufficiency as jeopardising long term energy stability. Consequently, there has been a focusing of attention on developing suitable technologies which could be used to harness the considerable deposits of other energy sources that Australia is rich in for the substitution of conventional crude oil products.

2.2 Alternative Transport Fuels

Automotive gasoline and ADO are the two most important transport fuels presently being used and are expected to retain their dominance of consumption for the next 20 years, at least, based on the major forecasting bodies. It is therefore appropriate to limit the consideration of petroleum product replacements to alternatives for automotive gasoline and ADO. Furthermore, as both these fuels represent the majority of all transport fuel consumed in Australia any viable alternative fuel which may be substituted for either of these fuels will see the most significant impact in terms of the total consumption of transport fuels.

The substitution of alternative fuels for liquid petroleum products may be achieved by either using alternative fuels in existing or minor variants of well established internal combustion engines or by changing technology and hence the fuel used. The latter scenario would require significant changes in relation to motor vehicle manufacture and fuel support infrastructure than the present system.

[1]Australian Minerals and Energy Council

The possible alternative fuels may be divided in two groups based on the difficulty of current production. This division is based on the study conducted by the Australian Minerals and Energy Council (1987).

1) Alternatives readily available.

These fuels include existing by-products in the petroleum industry or are derived from an abundant resource using a proven and relatively simple industrial processes. The difficulty of introducing these fuels vary according to the level of engine modifications required and the cost of supply and production infrastructure necessary to retail them as compared to existing fuels.

- liquefied petroleum gas (LPG)
- natural gas for vehicles (NGV):
  - compressed form (CNG)
  - liquified form (LNG)
- alcohol fuels:
  - methanol- ethanol.

2) Alternative fuels requiring extensive production and supply infrastructure support.

These alternative liquid fuels are based on abundant energy sources but require large scale chemical or physical conversion processes in order to derive a readily usable liquid fuel replacement. Unlike a number of the fuels outlined above, these fuels would be very similar to existing petroleum products and would be unlikely to require engine modification or changes to supply infrastructure network.

The synthetic crude oil feedstocks/processes:

- gas feedstock,
- coal feedstock,
- oil from oil shale feedstock.

This chapter will limit its focus to the consideration of the first group of alternative fuels. The second group of fuels tend to be distinguished by the necessity of intensive investment in large scale production plants in order for them to become a viable alternative. Thus, these fuels would require a much larger market place than what Tasmania is able provide and consequently would need to be considered on an Australia wide basis. The processing plants required to produce these type of synthetic fuels would most likely be located in either Victoria or NSW and may in the future provide an alternative fuel import for Tasmania.

The cost and emissions of alternative fuels vary considerably from one another and from gasoline. Table 2.1 outlines the substantial differences between substitute fuels in terms of production costs and carbon dioxide emissions based on 1987 world energy prices and technology. It would appear from table 2.1, in terms of carbon dioxide emissions and costs, that compressed natural gas and methanol from gas could be viable substitute fuels for petrol. Table 2.1, however, does not indicate factors such as availability or the cost of converting existing motor vehicles to operate on the different fuels.

Table 2.1
Greenhouse Emissions and Fuel Cost of Alternative Transport Fuels

	CO2 equivalent[1]	$US per barrel equivalent 1987[2]
Coventional gasoline	..	27
Synthetic gasoline (from gas)	0 to +30	43 to 61
Synthetic diesel (from gas)	0 to +30	69
Compressed natural gas (CNG)	-19	20 to 46
Methanol from gas	-3	30 to 67
Methanol from coal	+51	63 to 109
Methanol, ethanol from biomass	-100	64 to 126
Eletric, hydrogen from non-fossil	-100	81 to 135
Electric, from caol	+26	na
Electric from natural gas	-18	na
LPG (Tasmania 1991)	-10 to -14	na

1. % change in greenhouse emissions, CO_2 equivalent
2. Overall fuel costs, 1987 $US per barrel gasoline equivalent

Source: BTCE 1991a

2.1.1 Liquified Petroleum Gas - LPG

LPG consists of a mixture of either propane or butane which are hydrocarbon gases at atmospheric temperatures and pressures but may be easily liquified at moderate pressures. In Tasmania the composition of LPG comprises not less than 98 per cent propane, 1.5 per cent butane and the remainder consists of other gases. LPG is produced in association with crude oil and natural gas (naturally occurring LPG) and from crude oil refining. Its rate of production is determined by the production of, and demand for, these other products (AMEC 1987). Australia has relatively large economically viable reserves of naturally occurring LPG which are estimated at 114 GL in 1989. During 1989/90 the total quantity of LPG produced in Australia was 3.79 GL (ABARE 1991).

In Australia LPG has been used as an alternative transport fuel since the early 1970s, with the two major users being taxis and rigid trucks. Currently (1990) almost 512 ML of LPG is used annually throughout Australia for automotive purposes representing approximately 3 per cent of the total petroleum demand for transport (Australian Institute of Petroleum 1990).

LPG is presently only an economically viable alternative for gasoline powered vehicles if they travel a relatively large number of kilometres annually, such as taxis. In Australia, gasoline engines are converted to run on LPG as there are no production LPG fuelled vehicles available. LPG has a lower energy content per unit volume with one litre of LPG providing about 20 to 25 per cent less energy per unit volume, compared with gasoline, and about one-third less energy per unit volume than ADO.

In Tasmania, the cost of converting a standard carburettor car to operate on LPG is approximately $1600 (1991$) with an additional cost if the gas storage tank is to be mounted under the car and not in the boot, which reduces storage space. Generally, for fuel injected cars the cost is slightly higher and with some fuel injected cars a specialised computer aided fuel supply monitor is recommended which adds a further $500 to the cost of conversion

Table 2.2 sets out a comparison of selected variables of vehicle performance between an average unleaded fuelled motor car and an equivalent LPG fuelled vehicle with respect to Tasmanian conversion and fuel costs. The fuel economy figure (for the unleaded car) and the average annual kilometres travelled are extracted from the ABS Survey of Motor Vehicles 1988. The Australian Liquefied Petroleum Gas Association (1986) claim that LPG powered motor vehicles use approximately 20 per cent more LPG by volume than the equivalent vehicle fuelled by petrol. This estimation of the effect on fuel economy of conversion to LPG is applied to calculate the relative performance of a LPG converted vehicle compared with the equivalent unleaded fuelled vehicle outlined in table 2.2.

The fuel cost saving using LPG as compared with gasoline in Hobart at the expiry of an average years motoring (outlined in table 2.2) may be in the order of $377. Thus considering the initial installation costs of fuel conversion, the average consumer would be unlikely to see a return on the investment for just over 4 years, without allowing for inflation.

BTCE (1991a) found that under normal operating conditions CO_2 emissions were some 10 to 14 per cent lower for the LPG fuelled vehicles when compared with similar petrol fuelled vehicles. Table 2.2 indicates a 17 per cent saving in CO_2 emissions over 13900 km for the LPG fuelled vehicle may be achievable compared with an equivalent petrol fuelled car. Although this comparison does not take into consideration that dual fuelled vehicles are required to operate on petrol for a certain percentage of their operating time. This requirement is increasingly being overcome with newer engine technologies associated with unleaded fuelled vehicles.

Table 2.2
Comparison Between an Unleaded and a LPG Fuelled Motor Car, Tasmania

	Average petrol car	LPG car
Price[1] petrol/LPG (cents/litre)	71.9	39.9
Average fuel consumption (litres/100km)	11.3	13.56[2]
Fuel consumed during an average year of motoring[3] (litres)	1570.7	1884.8
Total CO_2 emissions (tonnes)	3.58	2.98
Total annual fuel cost $	1129.3	752.1

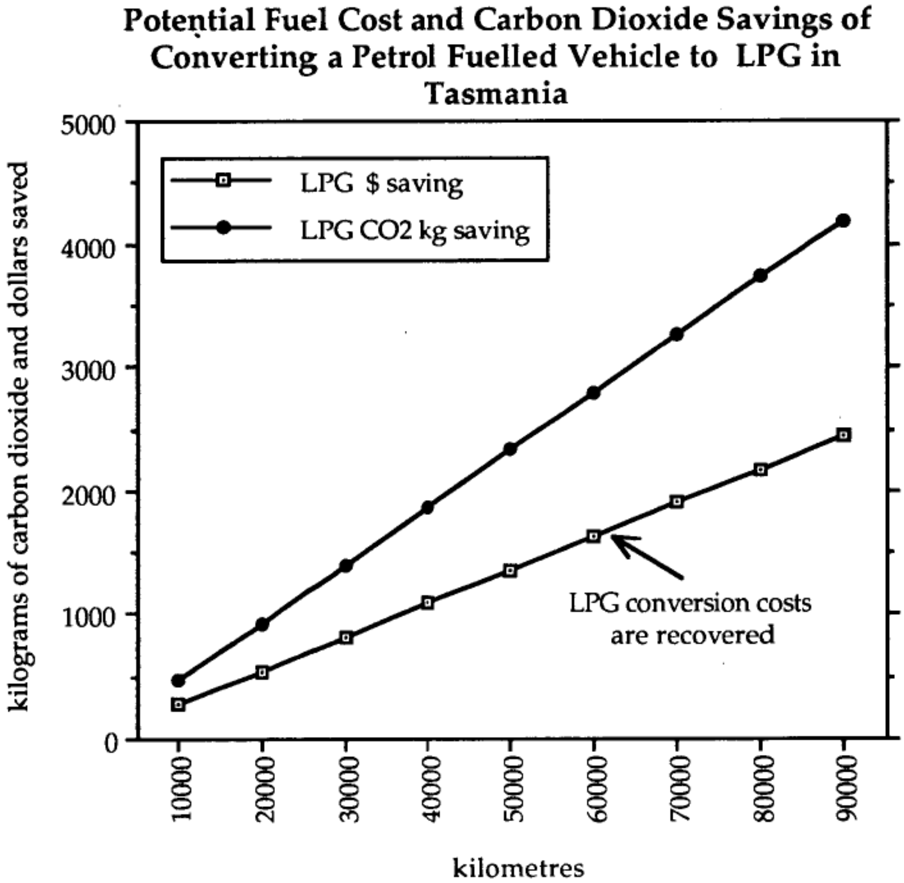
1. Price relates to price at pump in Hobart at 1/11/91.
2. Relates to the estimated rate of fuel consumptionquoted by a number of automotive and gas bodies in comparison with the petrol fuelled vehicle (based on a 20 per cent increase in fuel consumption compared with the petrol fuelled vehicle)
3. The figure used for the average kilomtres travelled was 13900 km, which was the estimated average for Tasmania in the ABS Motor Vehicle Survey 1988

Source: ABS 1989

Figure 2.1 illustrates the potential savings in both financial and carbon dioxide emissions of converting a car to LPG in respect to the current costs in Hobart.

One of the main concerns of Tasmanian motorists contemplating converting an automobile from petrol to LPG is the availability of LPG fuel. Until recently there were large distances between LPG equipped service stations in some parts of Tasmania. Supply of LPG is still restricted in the smaller rural centres where the service infrastructure is expected to expand in line with future demand. In the major urban centres there are a number of service stations supplying LPG.

Figure 2.1



Estimates are based on a LPG fuel consumption of 13.56 L/100km comapred with an equivalent petrol fuelled vehicle consumption rate of 11.3 L/100km. The price of LPG was set at 39.9 c/L and petrol at 71 c/L.

2.1.2 Natural Gas for Vehicles - Compressed Form (CNG)

Natural gas is essentially methane with small amounts of ethane, hydrocarbon gases and carbon dioxide (NEAC 1980). Australia has large economically viable reserves of natural gas which have been estimated at 114

TL in 1989 (ABARE 1991). When used as a fuel in compressed form (CNG) natural gas is stored on board vehicles in high strength cylinders at a high pressure. A limiting factor for the use of CNG as a motor vehicle fuel is the low energy content per unit volume compared with gasoline and ADO (approximately between one third and one sixth of the energy per unit volume (BTCE 1991a), which consequently may place restrictions upon operating range depending on the availability of added space to store the CNG.

CNG is as of now being used in experimental trials for commercial short-haul transport uses for buses and trucks in Australia. A large articulated truck in Victoria operating on CNG has recently produced fuel cost savings of 40 per cent compared with equivalent diesel fuelled vehicles for a number of journeys (DMID[2] 1992). It is claimed that buses and trucks powered by CNG emit between 20 to 30 per cent less carbon dioxide than equivalent petrol and diesel vehicles and 90 per cent less general air pollution (DMID 1992). Optimistic estimations predict that CNG may substitute for almost 10 per cent of diesel fuel in road transport by 2005 and that this increased penetration of CNG into the truck fleet could reduce CO_2 emissions from all trucking by about 2.5 per cent (BTCE 1991a). Trucks and buses operating on CNG are also significantly quieter than their diesel counterparts which reduces their environmental impact, especially in urban areas (ESDWG 1991).

CNG can be used in both petrol and diesel engines as either dual fuel or dedicated. The engine technology for using CNG in petrol engines is similar to that of LPG. Firstly the gas is reduced in pressure and then delivered to the combustion chamber via a gas carburettor where it is ignited by spark ignition. Similar to most LPG conversions the engine retains the ability to revert back to petrol operation which sacrifices optimal natural gas efficiency but maintains a level of convenience (Milkins 1990). If the petrol engine is converted to be dedicated to CNG fuel then engine efficiency can be improved over the equivalent dual fuel vehicles. This can be achieved by increasing the compression ratio which takes advantage of the higher octane rating of CNG compared with petrol. The major disadvantage of CNG for use as a motor fuel in domestic passenger cars is the large fuel storage tanks required because of its low energy per unit volume value.

CNG can be used as an extender in ADO engines with a ratio of up to 80 per cent CNG. The ADO engine has design characteristics which enable it to utilise the energy content of the CNG more effectively than in gasoline engines.

[2]Department of Manufacturing and Industry Development

However, the nature of the compression combustion technology used in ADO engines means that in order to produce total fuel substitution of CNG the installation of spark ignition would be required. A result of the introduction of spark ignition in ADO engines compression ratios are reduced which consequently lower operating efficiency (Milkins 1990).

In vehicles operating on conventional fuels, conversion to CNG can result in a loss of storage space which, in the example of haulage trucks, could occupy valuable space used for commodity storage space. In these situations there may need to be a compromise between CNG storage and vehicle operating range associated with economic considerations. Furthermore, CNG lacks the convenience of petrol or ADO as a motor vehicle fuel due to it being a gas requiring storage at relatively high pressures necessitating compressors and high pressure fuel tanks (Milkins 1990).

The environmental benefits, (namely CO_2 emissions benefits outlined in table 2.1) of CNG compared with gasoline are questioned by Le Cornu (1989). Le Cornu contends that because CNG is a methane gas any fugitive losses will have a negative effect on the benefits of using CNG as motor vehicle fuel. This is because methane is a potent greenhouse gas and is suggested to be equivalent to 6 times that of CO_2. Thus, Le Cornu (1989) concludes that while CNG represents a 20 per cent saving in CO_2 emissions when used in the role of a transport fuel this is negated because he believes that fugitive losses of CNG would be around 3 per cent.

2.2.2.1 CNG and Tasmania

In order to utilise the possible economic and environmental benefits of CNG (as outlined in table 2.1), natural gas may need to be piped to Tasmania from gas fields in Bass Strait. This may be economically feasible considering the debate currently being conducted into finding an appropriate energy form to provide future electricity production for the State. If natural gas becomes the preferred energy source option then it would be piped onto Tasmania. The economics of using CNG for automotive purposes would be become greatly enhanced should natural gas be piped onto Tasmania compared with transporting it by ship from gas fields or from mainland Australia.

Assuming natural gas was to be piped to Tasmania, the distribution of CNG would most likely be confined to the geographical location of the pipe line. A large CNG compression plant could be located at an appropriate point on the pipe line providing the most convenient access to users. The likely users of CNG would be large kilometre vehicles including taxis, articulated trucks and possibly trains. The most significant difficulty of state-wide CNG use would result from the economics of the pipe line construction, as the pipeline would most probably be confined to the north of the State thus reducing the convenient accessibility of natural gas to the south. This in turn may have ramifications in respect to the limited operating range of CNG vehicles reducing the viability of dedicated CNG vehicles and resulting in duel fuel vehicles which consequently are less energy efficient.

2.2.3 Natural Gas for Vehicles - Liquified Form (LNG)

Natural gas when stored in liquid form requires cryogenic storage. To date, LNG has not been widely used as a transport fuel, although boil off gas is used in LNG sea transport.

2.2.4 Alcohol Fuels - Methanol

Methanol has been described as the simplest of alcohols with early manufacture derived from the destructive distillation of hardwood and hence one of the early names for methanol was 'wood alcohol' (NEAC 1980). Methanol can be produced from either natural gas or from coal. Methanol has the advantage compared with other alternative fuels of being a stable liquid at normal operating pressures and temperatures.

Methanol can be used neat in purpose designed engines, blended directly with gasoline or converted into methyl tertiary butyl ether (MTBE) for blending with gasoline. General Motors in the US has completed considerable testing of conventional internal combustion engines performing on variable mixes of up to 85 per cent methanol and 15 per cent petrol (Ancker-Johnson & Schwochert 1990). The variable fuel vehicle was achieved by using a fuel composition sensor which adjusts the engine operating parameters based on the calculated fuel composition. Methanol can also be used an ADO substitute or supplement but the technology is not commercially available.

Methanol has a lower energy output per unit volume than petrol. Thus when methanol is used in automobiles designed to operate on petrol there is a sacrifice in operating range.

Methanol from natural gas, even if pure methane, does not offer a significant CO_2 advantage over conventional fuels and methanol from coal would involve substantially more CO_2 emissions than gasoline, as well as an additional cost penalty (BTCE 1991a). The most favourable attribute of using methanol lies in the quantity of natural gas and coal feedstocks available in Australia. It is estimated that the cost of methanol production from natural gas, coal and biomass feedstocks may be reduced considerably during the 1990s (IEA[3] 1990).

There is some concern over the health and safety aspects of methanol use, such as its high toxicity. A NSW study noted that if methanol was to be used as an automotive fuel attention will need to be paid to education, labelling and the prevention of non-vehicle methanol use (BTCE 1991a).

2.2.5 Alcohol Fuels - Ethanol

Ethanol is an alcohol fuel which can be produced by fermentation of sugars and polymers such as starch or cellulose (NEAC 1980). It can be used as an extender in existing engines without modification or by blending up to 10 per cent ethanol with automotive gasoline. It can also be used as a 100 per cent substitute for gasoline in flexible fuel vehicles or engines designed for ethanol (AMEC 1987).

A dual fuel truck operating on diesel and ethanol won the Australian 1992 Energy Challenge (DMID 1992). The competition is open to all forms of transport vehicles with contestants being evaluated on factors measuring energy consumption related to distance and mass of the load.

Ethanol can be produced from a range of crops including sugar cane, cereal grains, cassava, sweet sorghum and sugar of fodder. The technology for producing ethanol from sugar cane or hydrolysed starch using yeast is well established and large plants could be built within several years using available technology (AMEC 1987)

In 1982 a study was completed on the availability of biomass feedstocks for liquid fuel production in Tasmania. The study found that while total demand for automotive fuels in Tasmania is relatively low, compared with Australian market, there is a distinct possibility of producing alcohol fuels and using them as extenders with petrol and ADO. In particular, in the early 1980s the traditional crop feedstocks with the most potential included, sugar beet, fodder beet, Jerusalem artichoke and turnip (Todd 1982). These feedstocks were distinguished from other possible alternatives because they generally provided a high fuel yield per hectare and low feedstock prices. These types of feedstocks were considered as possibilities to be utilised on a small scale. Another

[3]International Energy Agency

form of potential feedstock, other than traditional crops, which were considered in the study included, wood, wood waste and logging residue. These feedstocks were evaluated as being of potential interest for large scale processing. All three wood products were considered to have low feedstock prices, while wood and logging residue were considered as having a high fuel yield per hectare (Todd 1982).

Research is continuing on the use of different feedstocks and improved production efficiencies.

2.3 Which Fuel For Tasmania?

Tasmania represents a petroleum market share of less than 3 per cent of the Australian total (Australian Institute of Petroleum 1990). Due to this small market size, Tasmania's ability to adopt new and largely unproven technologies is rather limited. Thus the types of alternative fuels which may be realistically considered must be limited to presently commercially available fuels. These include the wider use of ADO, LPG and CNG, all of which represent savings in both a commercial and an environmental sense. Electricity, ethanol and methanol are also distinct future transport energy possibilities, however, these types of energy sources require a much greater change in conversion for every day use than the other alternative fuels.

2.3.1 Short term fuel alternatives

Automotive diesel oil

ADO represents both savings in economic and environmental terms compared with gasoline. Le Cornu (1989) suggests that where there is the possibility of using either ADO or gasoline, ADO is a superior fuel in terms of greenhouse emissions.

LPG

The possibility of substituting LPG for gasoline as the main source of fuel in a large number of vehicles may be a short term target for Tasmania.

In order for LPG to become a more attractive alternative fuel than at the present time in Tasmania a fundamental issue must be addressed, that of, the period of time required to recover the conversion cost to LPG fuel. This may be achieved by reducing the cost of LPG in Tasmania (which incidentally is about twice the cost per litre than in Victoria with Tasmania's LPG costing 39.9 c/L while in Victoria it is approximately 19.9 c/L in November 1991) or providing a rebate to people who convert their cars from petrol to LPG fuelled.

2.3.2 Long term

CNG

The introduction of CNG as an alternative fuel may become a viable proposition if natural gas becomes the preferred energy option for future electricity production in Tasmania.

CNG may have significant economic and environmental advantages for the transport sector in Tasmania if it is piped onshore. The piped natural gas would mean a degree of state autonomy in terms of a transport fuel energy source unlike the existing fuels which are all imported from mainland states. There are also significant environmental advantages associated with CNG as a transport fuel which are primarily associated with lower carbon dioxide emissions and possibly lower carbon monoxide and hydrocarbon emissions compared with gasoline, provided fugitive emissions of methane can be controlled.

The benefits of CNG as a alternative transport fuel for Tasmania must be considered in relation to the wider energy perspective of the State. In terms of Tasmania's total fossil fuel associated emissions, the introduction of natural gas as an additional source of energy for the production of electricity may produce increased levels of emissions.

Methanol

The adoption of methanol as a substitute fuel in Tasmania will largely depend upon whether it is developed on a national level. Australia is rich in natural gas and coal which are suitable feedstocks. Methanol provides certain advantages over other substitute fuels because it is a liquid and thus is more convenient to supply than gaseous fuels.

Ethanol

The introduction of alternative fuels based on alcohol may be a long term project for Tasmania. A significant economic advantage of these types of fuels would be that the feedstock could be produced in Tasmania. However, there is certainly a significant moral question associated with using fertile land for the production of substitute fuels in Tasmania when there is such severe food shortages in other countries. This moral question is amplified when we consider the present form of opulent transport usage that may benefit from the production of fuels based on vegetative feedstocks.

Electricity

The introduction of the electric vehicles appears to be a long term possibility. The development of electric vehicle technology is being revitalised within the US at present which may result in the production of prototypes which can substitute for the conventional car within a few years. There are distinct benefits of using electric vehicles in Tasmania in terms of pollution because of the use of hydro energy for electricity generation.

CHAPTER 3
URBAN FORM AND TRANSPORTATION

The city is the focus of transport activity of all kinds. In Tasmania approximately 70 per cent of all land transport activity occurs in urban areas. As such, the structure of our urban areas and the transport options available have a significant impact upon the total fuel consumption for the State. By identifying how the urban structure influences the transport system and vice versa, possible strategies for reducing fuel consumption may be obtained.

The historical development of the different modes of transport has been inextricably linked with the changing nature of the city. The city has been spatially limited in size by the mobility of its inhabitants. Developments in transport technology has facilitated the expansion of the city. It is claimed that as early as the 1820s cities, such as New York, began to experience suburbanisation made possible by the inception of the horse-drawn omnibus (Badcock 1984). The aim of this chapter is to examine the extent to which urban form and automobile dependence are associated. It is suggested that the spatial development of most western cities during the last forty years has been facilitated by the private automobile. While the car has not been the sole factor determining the structure of the modern city, it has provided the necessary form of transport to enable the development of low density suburban housing. The private automobile has gained its popularity largely in response to its affordability and the relatively low cost of energy. In addition, the automobile has been positively embraced as the primary mode for the majority of urban transport needs which has been reflected by the provision of supporting infrastructure required to maintain its dominance compared with other forms of transport.

This chapter will firstly look at a number of the transport plans produced in order to coordinate the development of Hobart and its future urban and transport requirements. Automobile use and urban form will then be discussed in respect of a number of international cities and finally urban population density and automobile dependence will be considered specifically in respect to Hobart.

3.1 Transport Planning in Hobart

Transport planning as a discipline has a relatively brief history when compared to traditional land use planning. Since the Second World War there has been a recognition of the importance transport has on the structure of the city. The 'Transportation Study', which involved the formal recognition of the importance of transport as part of the city, emerged during the 1950s aimed at providing an appropriate planning provision for the emergent automobile city. The 'Transportation Study' was based on the ideology which considered transport patterns as an orderly response to given economic and social stimuli. Given this premise, the studies involved the measurement of a number of economic and urban variables on which predictions were calculated and planning objectives made. The studies involved modelling existing transport patterns and estimating the level of change likely to occur in the transport system in order to predict future requirements for that system.

The Transport Study may be characterised as a four-stage area wide comprehensive transportation plan, involving the collection and modelling of data based on:

1) trip generation,
2) trip distribution,
3) modal split and,
4 traffic assignment.

Collected data was used to formulate projected models of demand from which planning strategies were determined to most appropriately cope with the modelled transport system. These studies were based on an engineering supply and demand ideology which saw that any future transport problem could be solved given sufficient money required to build the necessary road infrastructure (Perry 1979).

Transportation studies generally resulted in planning documents proposing extensive engineering works designed to sculpture highways and freeways out of the city. These studies often involved prohibitively expensive public works, ineffective solutions to transport problems, were inequitable in their design and neglected to make account for the true environmental costs involved in the construction of the new transport system.

3.1.1 The 1964 Hobart Area Transportation Study[1]

The 1964 Hobart Transportation Study was conceived at the height of popularity for the 'Transportation Study' and involved an American consultancy firm, Wilbur Smith & Associates, who were engaged in a number of these studies in the United States and England. The 1964 Study entailed the prediction of future levels of transport requirements and demands, and the formulation of appropriate strategies required to accommodate the future transport system (1964 Hobart Area Transportation Study). The scope of the Study was such that it embraced all forms of transportation.

The aim of the 1964 study was to frame a comprehensive transportation plan for the Hobart area based on a 20 year forecast. In order to carry out this objective the Study examined patterns of travel behaviour and movement as well as considering factors such as population change, economic and industrial growth and physical topography.

The final recommendations of the 1964 Study involved the comprehensive reconstruction and development of Hobart's transport system. Major new arterial routes were recommended based on the predicated population growth and economic activity in the Hobart region. In order to satisfactorily accommodate the level of dispersal of population predicated by the Study, major roadworks would need to be undertaken linking northern, southern and western suburban settlements with the city centre by the year 1984.

3.1.2 The 1970 Hobart Transportation Revision[2]

The 1970 revision represented a major step in the continuation of the planned program reviewing the needs of the Hobart transportation system recommended in the 1964 study. The 1970 revision was conducted with a similar philosophical standpoint as the 1964 study and involved a revised analysis of the predictions and recommendations made in the earlier study.

[1] The 1964 Hobart Area Transportation Study was conducted by Wibur Smith & Associates. The study involved a comprehensive investigation of the expected demand for transport services for Hobart city and was prepared as a planning document providing detailed maps and diagrams of the expected future transport system for Hobart.

[2] The Hobart Transportation Revision 1970 was prepared by the Department of Works (Tasmania) in response to a provision detailed in the 1964 Transppport Study. The agenda for the 1970 Revision was as a follow up planning document comparing Hobart of 1970 with the forecast changes outlined in the 1964 Study.

The 1970 revision was not drafted to consider new road development but rather to use the existing recommendations and plans of the 1964 study as a framework for reference to which any modifications or revisions should be focused.

The 1970 revision did, however, indicate a number of policies which could have been introduced to overcome deficiencies in the transport system expected to arise unless large scale road construction was implemented to meet the predicted demand on the system. These included policies to influence land use to provide an even distribution throughout the Hobart area, control over the use of the private motor vehicle, increased controls aimed at regulating industry and population distribution.

3.1.3 The 1979 Derwent Region Transport Study[3]

The 1979 transport study involved a philosophical and methodological break form the previous transport studies and was based on transport management and traffic calming. In the 1979 study there was a recognition that the predicated population growth and subsequent transport demands predicated in the earlier studies were unlikely to reach fruition and, consequently, the planning of Hobart's transport system needed to take appropriate action. Unlike the previous studies, which provided a regional approach to transport planning, the 1979 study focused on local level issues of transportation. The study was aimed at identifying local deficiencies in the transport system and extrapolating those on a regional basis to ensure a coordinated approach to the future planning of Hobart's transportation system. There was a recognition that future funds spent on major road projects had to fulfil two roles; that of providing efficient and safe movement of vehicles on a regional level and that of providing solutions to local traffic problems (Derwent Regional Transportation Study 1979).

3.1.4 The implication of these studies for Hobart's transportation system

The 1964 Transportation Study has had a significant impact on the physical structure of urban Hobart. While the Study's recommendations were not implemented in their entirety, a number of strategies regarding northern, eastern and southern arterial corridors have resulted in major road construction

[3] The Derwent Region Transport Study 1979 was prepared by the Department of Works (Tasmania).

and corresponding housing development. Although the 1964 Study was not wholly instrumental in these road developments, the study legitimised the type of automobile led suburban development which is characteristic of Hobart and other Australian cities. The elongation of urban Hobart in a north and south manner along the River Derwent was largely due to the public commitment and investment in large capacity highways. The most important of which were the Brooker Avenue-Northern Outlet connecting the northern suburbs including Berriedale, Bridgewater and Gagebrook and the Southern Outlet connecting the southern suburbs of Kingston and Blackmans Bay to Hobart. The development of the Eastern Shore as a residential centre was facilitated by the construction of the Tasman Bridge, providing a high volume traffic link to the Clarence municipality. The effect of these road construction programmes has been to provide accessibility to large areas of land enabling it to be used for housing development. The growth in the ownership rates of the car since the late 1940s provided the personal mobility required for families to utilise these outer areas for suburban housing. The public sector has also encouraged the growth in low density outer suburb housing through housing policy. The State is responsible for almost one third of housing development in the Hobart area and has maintained a commitment since the 1940s to low density outer suburban housing (Kennedy et al. 1986).

3.2 Transport and Urban Form Characteristics

The term 'urban form' encompasses both the spatial structure and functional design of a city. Thus urban form incorporates the spatial arrangement of a city in terms of such aspects as housing, commerce and industry as well as their functional links to one another. For example, the urban form of the development of the modern 'Australian city' is characterised by a highly concentrated central business district (CBD) and low density suburban housing. This type of urban form is notably differentiated with broadly defined boundaries between housing and employment. The nature of this structural differentiation and its impact on the spatial form of the city can play an important role in relation to the level of per capita energy use for transport. Increasingly Australian cities have become more clearly differentiated in terms of housing and employment which has been expressed spatially through the expansion of the urban area via suburban housing and the maintenance of employment concentration. As the urban area has expanded at an increasingly lower population density, the average distance required to travel to work or to other services has subsequently increased.

The type of parameters which may be used to distinguish the level of automobile dependence can be divided into, firstly, features indicating the extent to which the automobile has become the primary mode of transport, which can be expressed in terms of car ownership levels, per capita energy use etc.; and secondly, automobile dependence can be identified in terms of planning parameters. Planning parameters include physical attributes of the city designed to accommodate the private car including roads and parking, and urban form characteristics. Urban form characteristics importantly include population density, which influences the use and modal split for different forms of transport.

Newman and Kenworthy (1989) have compiled a detailed comparison of a number of international cities focusing on urban form and its relationship with automobile dependence. Their work involved the collection of data from 32 cities in the United States, Australia, Europe and Asia. Not unremarkably they found that those cities which provided extensive supporting infrastructure for the private car were also the cities which were the most automobile dependent. Perhaps the single most important effect of automobile dependence is the result it has on transport energy use per capita. Cities which are highly automobile dependent use significantly higher levels of energy per capita than in less automobile dependent cities. The ramification of automobile dependence is associated with the use of fossil fuels as an energy source and the subsequent negative environmental and social effects they can have on the general welfare of a city. Furthermore, the reliance on the private automobile as the central form of transport can lead to major transport crises because of the vulnerability it places upon the constant supply of petroleum products. Automobile dependent cities tend to have a low diversification of transport options amplifying the magnitude of disruption due to unexpected fuel supply shortfalls.

Through recognising and studying the differences between cities one can gain a better understanding of urban development and the consequences it may have, in particular, for the parameter of automobile dependence. This chapter considers Hobart in relation to Newman and Kenworthy's (1989) work for a number of urban form and transport parameters.

3.2.1 Automobile dependence indicators

Table 3.1 outlines a comparison of a number of selected parameters of automobile use between cities, including Hobart. The information illustrated for those cities, other than Hobart, are obtained from Newman & Kenworthy (1989). The parameters comparing automobile use between the cities considered include gasoline consumption, vehicle ownership, public transport usage, and the modal split for the journey to work trip.

Gasoline use

Gasoline use provides a broad picture of the level automobile dependence within a city. Newman and Kenworthy (1989) found that the US per capita usage of gasoline was significantly higher than for cities in other countries. On average the US cities consumed twice as much gasoline per capita than Australian cities, four times that of the European cities and ten times that of the Asian cities. Gasoline use, however, is largely a function of the average vehicle fuel consumption and the level traffic congestion. When these factors are taken into account the difference in gasoline consumption between the cities is less exaggerated (Newman & Kenworthy 1989).

Average speed of traffic is cited by many traffic engineers as the pivotal traffic determinant influencing fuel consumption in individual vehicles. Through constructing road networks which provide free-flowing traffic the efficiency of the motor vehicle can be increased with a resultant decrease in fuel consumption. Average vehicle fuel consumption, however, should not be highlighted independently from the city in which it operates as it must be considered as part of the traffic system in which it is used. A study conducted by Newman et al. (1990), considering the impact of free flowing traffic on energy use, found that while average fuel economy rates are improved by free flow traffic road design, the total energy use for the transport system increases. The increase in energy use is associated with nature of free flow traffic road design and its influence on the spatial structure of the city. What tends to happen from the greater free flow nature of road design is that previously inaccessible land on the fringe of the urban area is made more accessible and suburban housing development follows. The city thus expands outwards at lower densities and as a result the average distance travelled to the city or employment centre increases. While the average fuel efficiency of vehicles may be improved by enhancing the free flow nature of the road network of a city it will, however, inevitably lead to greater automobile use and dependence for the city as a whole (Newman et al. 1990).

Table 3.1
Selected Indicators of Transport Use

	Gasoline use MJ per capita	Total vehicles (per 1000 people)	Car ownership (per 1000 people)	Public transport vehicle km of service per person	Public transport passenger trips per person	Proportion of workers using public transport (%)	Proportion of workers using private transport (%)	Proportion of workers using foot or bicycle (%)
Perth (1980)	32610	614	475	53	71	12	84	4
Brisbane (1980)	30653	595	458	48	79	16.6	78.1	5.3
Melbourne (1980)	29104	528	446	53	95	20.6	73.7	5.7
Adelaide (1980)	28791	568	475	51	83	16.5	77.7	5.8
Sydney (1980)	27986	489	412	77	142	29.5	65.1	5.4
Average	29829	559	453	56	94	19	75.7	5.2
Hobart (1981)	33498	—	—	54	83	13.71	78.93	7.36
Hobart (1989)	34516	625	496	52	65	12.08*	80.37*	7.55*
US (1980 average)	58541	656	533	30	27.1	11.8	82.9	5.3
European (1980 average)	13280	375	328	79	55.1	34.5	44.2	21.3
Asian (1980 average)	5493	163	88	103	37.3	60.3	14.7	25.1

* indicates data for 1986
Gasoline use per capita, total vehicles and car ownership for Hobart are based on the State figure
Hobart population comprises Hobart, Brighton, Clarence & Glenorchy
Source: (data excluding Hobart) Newman & Kenworthy; Hobart data - ABS, Hobart City Council, Department of Roads & Transport Tasmania 1990b

Vehicle ownership

The level of vehicle ownership within a city is largely related to general affluence and has a significant relationship with automobile dependence. The US cities on average dominate the vehicle ownership category, while Hobart and Perth head the Australian cities for vehicle ownership with ownership numbers exceeding a number of US cities.

Public transport

The pattern of public transport use is markedly dissimilar to the patterns of gasoline use and vehicle ownership. The Asian and European cities have the greatest levels of public transport service with the US cities indicating significantly lower usage.

In the early 1980s Hobart had a similar provision of public transport service per person and patronage to the other Australian cities with the exception of Sydney which had a significantly higher level of service and higher patronage. While the level of public transport service per person remained fairly constant between 1981 and 1989 in Hobart, the level of patronage fell considerably from 83 to 65 passenger trips per person (see Chapter 5).

Modal split

The modal split for journey to work reveals one of the most important factors influencing city design and layout, namely peak period traffic flows. The level of private car usage for journey to work provides an indication of the level of traffic surge which has to be accommodated for during the short time span of peak period traffic. Most modern cities illustrate this phenomenon with extensive road networks connecting suburbs to the city centre facilitating the movement of a large number of commuters to central city employment. A modal split for the journey to work trip which is dominated by private transport will tend to result in the development of the physical city dominated by features designed to accommodate the car i.e. large parking areas, high volume road networks etc.

US cities have the highest levels of private transport usage for journey to work with Australian cities following closely behind. European and Asian cities have a much more even modal split for journey to work between private transport, public transport and foot or bicycle.

While Hobart's modal split is consistent with other Australian cities, it does appear to be at the bottom end of the range in terms of public transport and at the top end with regard to private means for transport to work. A noteworthy feature of Hobart's modal split is that is has a higher than the Australian average proportion of workers using foot or bicycle for main mode of journey to work.

The modal split for journey to work in Hobart indicates significant features of the city structure and highlights the automobile dependent nature of our society. One of the effects of this type of modal split is the pressure it places upon accommodating the car in the city. The Hobart City Council (HCC) suggests that in 1984, 70 per cent of the demand for parking spaces in the CBD was for home based work trips, 13 per cent was for home based shopping trips and 17 per cent for other purposes (HCC 1991a). Thus the car does not only contribute to congestion problems during peak period traffic it also occupies a considerable amount for land for parking.

3.2.2 Planning parameters

Planning parameters can be divided based on variables relating to the accommodation for the automobile and how a cities population and employment structure is physically distributed.

1) Provision of transport and infrastructure - roads per capita, availability of car parking spaces, level of congestion and relative speed of the public transport modes.

2) Physical planning of the city in terms of its urban form - population and job densities.

Transport infrastructure

Table 3.2 illustrates a number of parameters relating to the provision of infrastructure for transport

Road supply and parking

US and Australian cities provide three to four times as much road per capita than European cities and seven to nine times as much as Asian cities. US cities also maintain their dominance in respect to parking, with about 80 per cent more spaces per 1000 workers than European cities and six times that of Asian cities. The extent to which car parking dominates the city centre of many western cities is exemplified by the case of Hobart which, in terms of

Table 3.2
Provision of Infrastructure for the Automobile

	Road supply (m/person)	Parking spaces (per 1000 CBD workers)	Average speed of traffic (km/h)	Total vehicles per km of road	Average speed of public transport (km/h) Bus	Average speed for all forms of public transport
Perth (1980)	13.3	562	43	46	22	35
Brisbane (1980)	6.9	268	48	94	23	37
Melbourne (1980)	7.9	270	48	67	21	33
Adelaide (1980)	9.1	380	43	64	21	45
Sydney (1980)	6.2	156	39	82	20	45
Average	8.7	327	44	71	21	39
Hobart (1981)	-	421	43	-	20	20
Hobart (1989)	10	-	-	61.3	20	20
US (1980 average)	6.6	380	43	111	20	42
European (1980 average)	2.1	211	30	205	20	43
Asian (1980 average)	1	67	24	196	15	36

Source: (data excluding Hobart) Newman & Kenworthy 1989; Hobart data- ABS, Hobart City Council, Department of Roads & Transport Tasmania

area, has around 9.5 hectares of car parking space in the CBD alone (HCC 1991a). This area incorporates the parking spaces only and does not include road access for off-street parking nor the area of the roadway on which the on street parking is situated. According to a study conducted by the Hobart City Council (1991a) in 1991 there were almost 7300 car parking places in Hobart including both on and off street sites in the CBD. The CBD as defined in the report covered an area of approximately 77 ha. In total it estimated that in the Hobart city centre there are approximately 18000 car parking places.

The growth in the area consumed by car parking and roads in the CBD has particular implications for the aesthetic nature and function of the city centre. Increasingly in modern western cities land, which has been used for various purposes, is being developed in the city centre to provide infrastructure to accommodate the car. It has been estimated that for a fully motorised city, the area occupied by bitumen could be around 30 per cent and in the CBD this may rise to 75 per cent (Newman et al. 1990). The continued development of land for car orientated infrastructure is having two important effects on the nature of the CBD, firstly it is placing increased pressure on land available for employment, which can be seen through the development of high rise buildings, and secondly it is placing pressure on public open space. Automobile dominated cities also impinge upon the viability of residential and retail activity in the city centre (Newman et al. 1990).

Congestion and public transport speeds

US and Australian cities facilitate the rapid movement of the automobile which can be expressed in terms of average travel speed. The effect of the average road network speed does not benefit road based public transport systems due to the nature of their stop start travel pattern.

In the US cities the average speed of transportation for automobiles is 43 km/h and in the Australian cities it is 44 km/h which contrasts with European and Asian cities with average speeds of 30 km/h and 24 km/h respectively. The significance of these figures is highlighted when they are compared with the average travel speeds for different forms of public transport. In the US cities which do not have rail, the average speed for bus transport is 20 km/h and in those cities with rail the average rail speed is 42 km/h. In Melbourne and Sydney, which have the most comprehensive service of rail in Australia, the average rail speed is 45 km/h and the average bus speed is 21 km/h. By contrast the European and Asian cities tend to have significantly higher average speeds for train transport than for general traffic. In Tokyo the average speed of train transport is almost twice that of the general traffic.

The speed of buses amongst all the cities observed remains fairly constant with an average speed of 19 km/h. The low level of variation of average speed amongst the cities is quite remarkable because of the diverse nature of urban conditions considered (Newman & Kenworthy 1989). *"It would thus* *appear that, in general, bus-based public transport systems seem to have an in-built limit on operating speed of no more than 25 km/h, and thus cannot be considered genuine competitors in speed to the car in any city."* (Newman & Kenworthy 1989 p.40)

Newman & Kenworthy (1989) suggest that any city seriously wishing to change the private car/public transport equilibrium in favour of public transport must move in the direction of rail-based transport infrastructure.

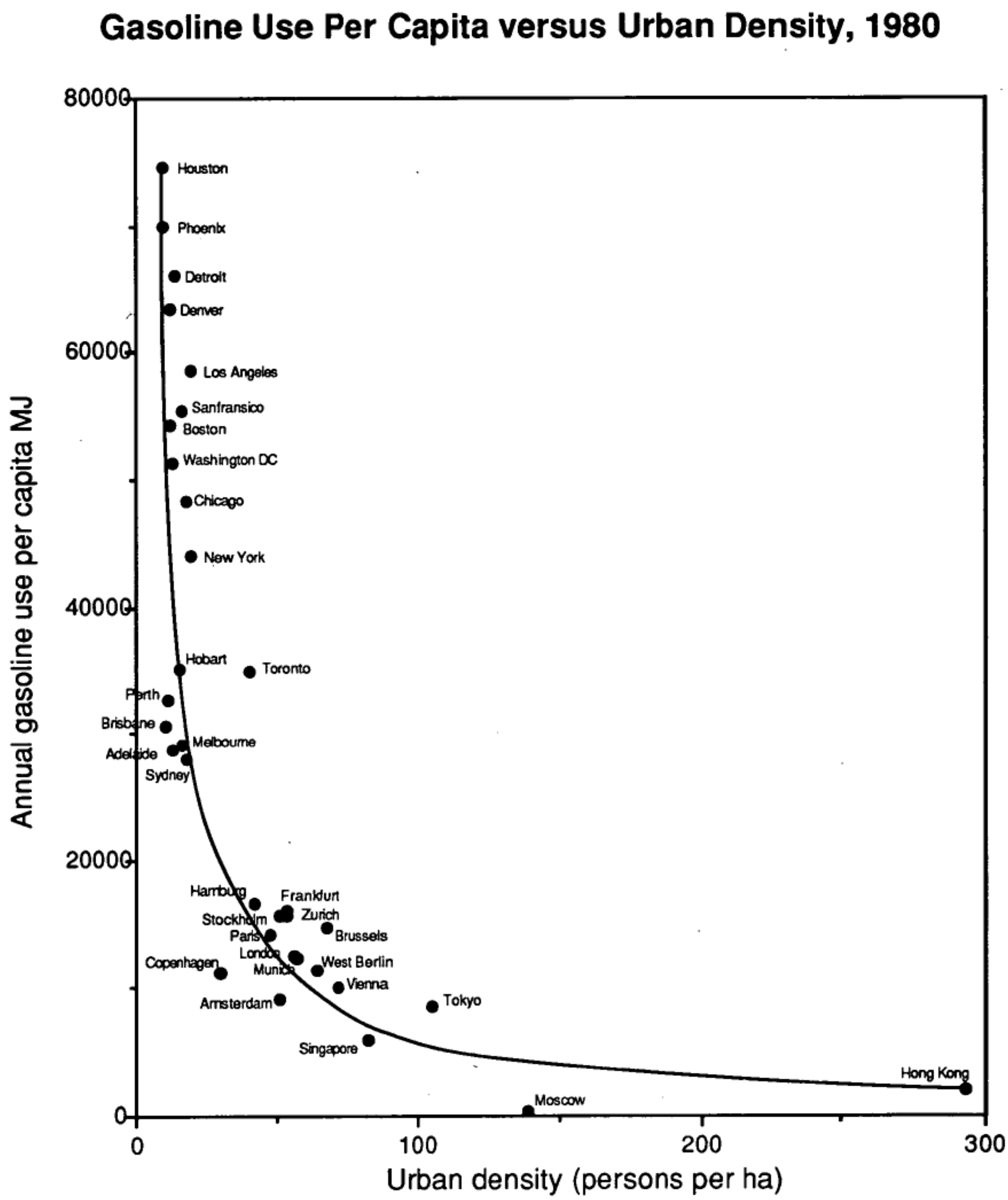
Urban form and population densities

Population density is a response to many interconnected processes not least of which is the transport system. The population density of a city has significant implications for the structure of its transport system, namely transport distances and modal split (Newman & Kenworthy 1989). On average, the US and Australian cities have much lower densities for population and jobs compared with European cities and the newer US and Australian cities have even lower densities than the older cities.

Figure 3.1 graphically illustrates the international uniformity of the association between transport energy use and urban density.

The decline in urban population density is a reflection of the changing nature of the city. Structurally US and Australian cities tend to be significantly differentiated in respect to the locational distribution of employment and housing, which can be recognised by the presence of single function sectors with clear geographical boundaries. The city centre has become the focus of high employment concentration with a low residential component. The residential suburbs housing workers in self contained houses at low densities stretch away from the city nucleus. The single most visual construct of this city form is the centrally located high rise office block, which contributes to the high employment concentration in the CBD. While the European cities also have relatively high city centre employment densities, the disparity in density between inner and outer areas of the city does not have the same contrast as in US or Australian cities. The European and Asian cities generally have a much more even distribution of employment and housing throughout the city than US or Australian cities.

Figure 3.1

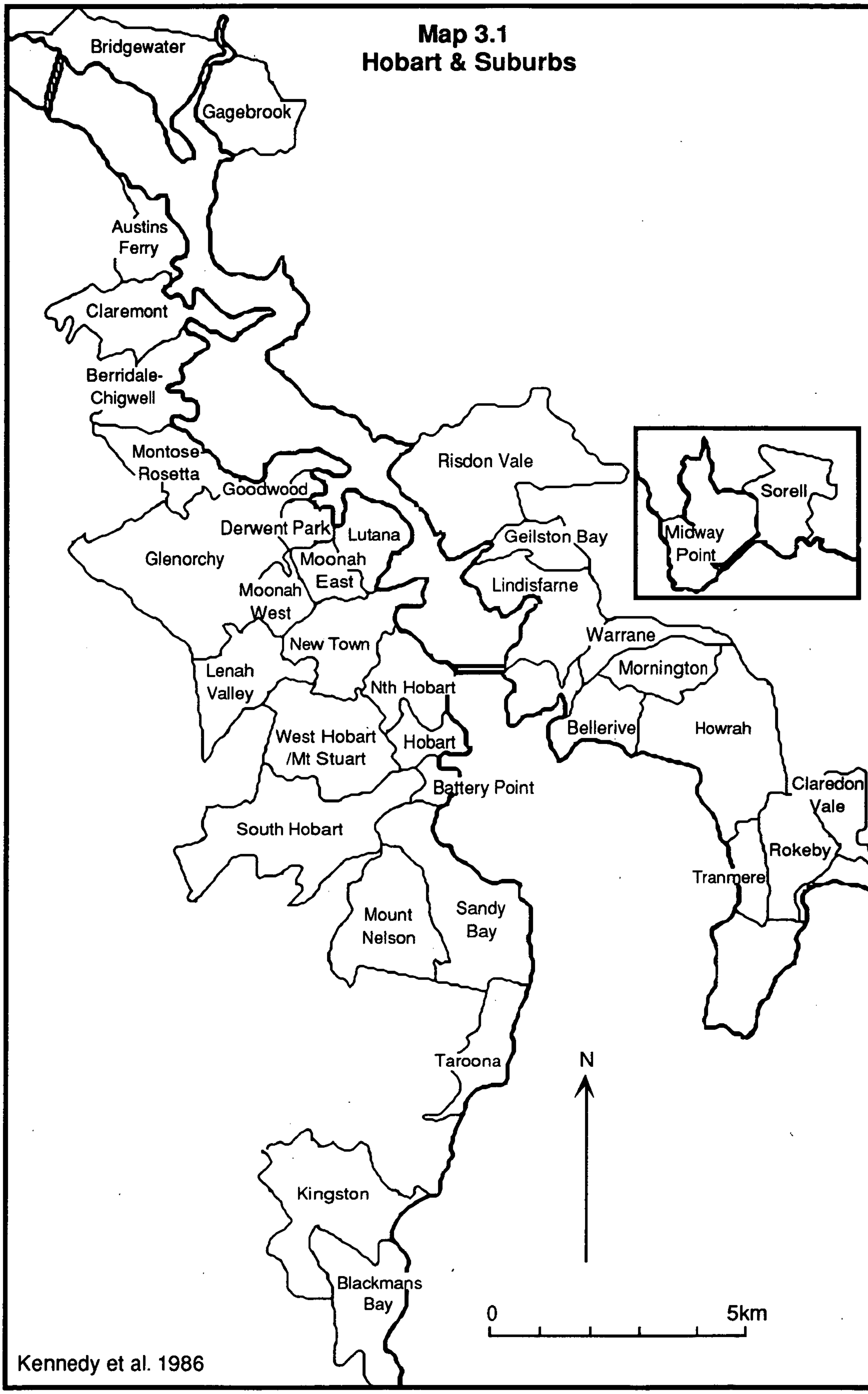


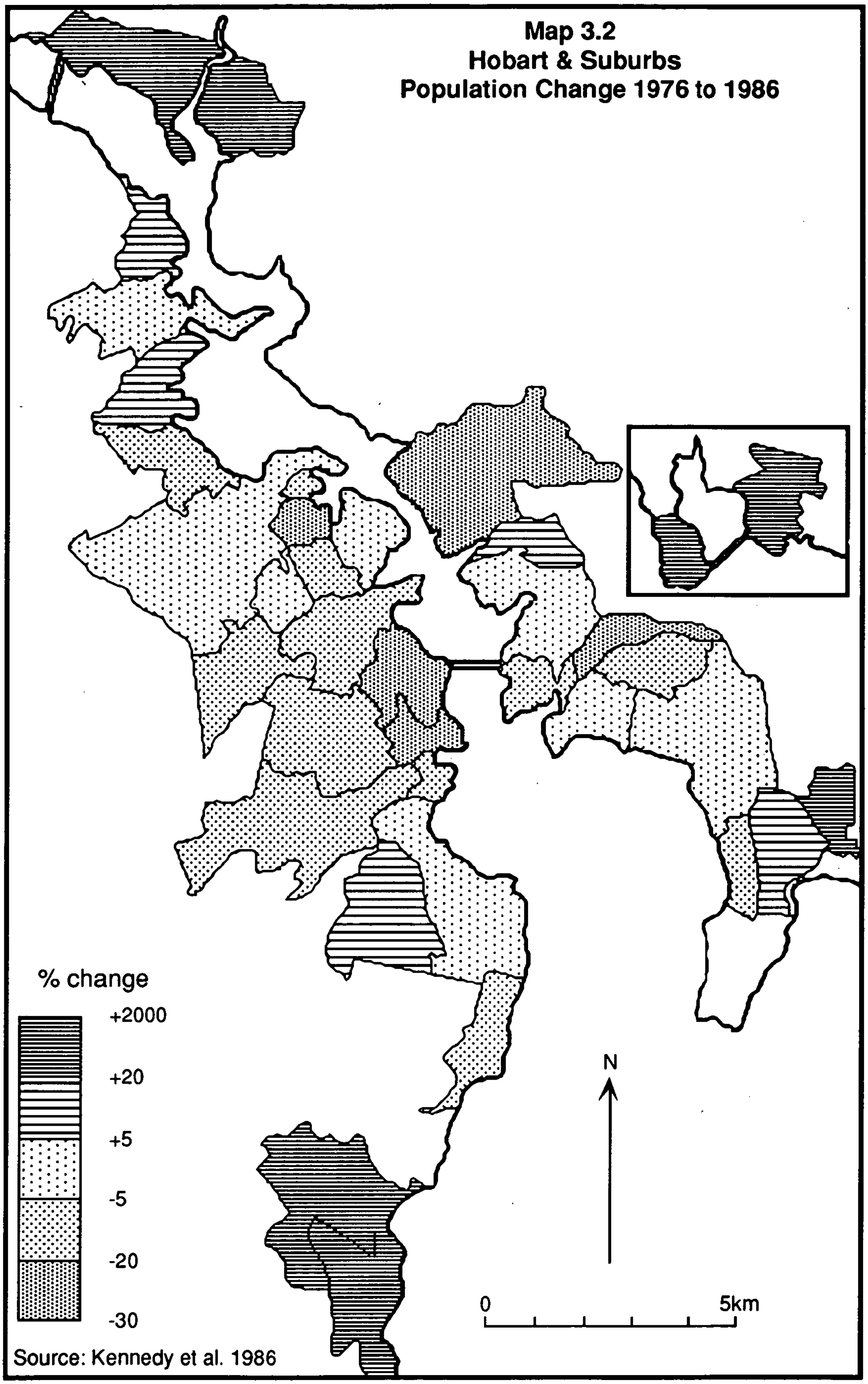
Note: gasoline and density values for Hobart refer to 1981, remaining cities values taken from Newman & Kenworthy 1989

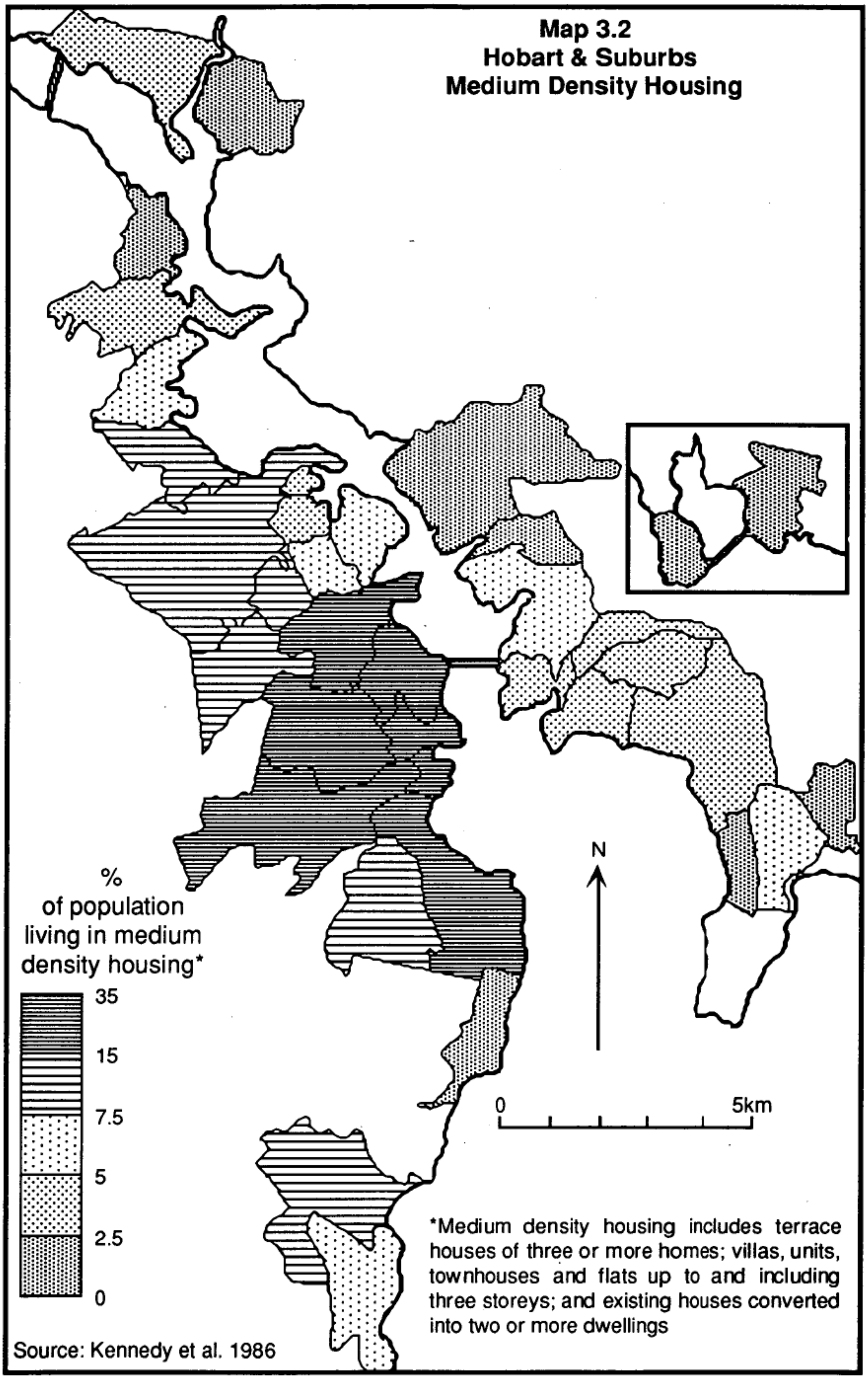
Map 3.1 outlines the suburbs which comprise Hobart. Map 3.2 illustrates population change in the Hobart suburbs between 1976 and 1986. While the overall population of Hobart grew by 4.7 per cent over the period examined, 21 of the 36 suburbs experienced a decline in population. Map 3.2 does not indicate changes in population density, however, it does provide a good example of the change in the spatial distribution of the urban population. The older suburbs, which also comprise many of the inner suburbs, including Battery Point, Hobart, North Hobart etc., have all experienced large declines in total population. Many of these suburbs have reached their residential capacity and no longer have room to accommodate development of low density housing. The factors affecting the decline in population vary between suburbs. In a number of the northern suburbs the growth in commercial and industrial activity has acted to displace parts of the existing housing stock. In other suburbs factors such as ageing, life cycle and gentrification have acted to reduce the resident population. The ageing or life cycle factors refer to the changes in household structure where a couple move into a house have children which eventually leave home leaving the original couple. When this cycle occurs in a developing suburb the homogeneity of initial residents makes the changes in population over time relatively uniform.

The outer suburbs including Bridgewater, Gagebrook, Kingston and Blackmans Bay have all experienced significant increase in population. The reasons for the increases vary considerably, with the northern suburbs of Bridgewater and Gagebrook gaining population through the development of public housing while population increases in Kingston and Blackmans Bay are accountable to private housing development.

The pattern of population growth has acted to extend the urban area of Hobart an elongated fashion along the Derwent River. The structure of housing development in the outer suburbs has been predominately low density self contained housing. The inner suburbs have developed over a much longer period and illustrate a greater variation in housing styles including terrace, semi detached, free standing and flats. The variation in housing structure is a response to many processes including local government planning regulations and policy and the effect proximity to the city centre has on the viability for different housing styles. The variation in housing is illustrated in Map 3.3 which outlines the percentage of people living in medium density housing in the different suburbs. The inner suburbs show a far greater percentage of their housing stock developed as medium density housing than for the outer newly developed suburbs. Typically these inner suburbs illustrate a greater diversity of housing styles which is attributed to the inherited housing stock and the cost of land prohibiting the development of low density housing (Westerman 1991).


Map 3.1
Hobart & Suburbs
Bridgewater
Gagebrook
Austins Ferry
Claremont
Berridale-Chigwell
Montose-Rosetta
Goodwood
Derwent Park
Lutana
Glenorchy
Moonah East
Moonah West
Risdon Vale
Geilston Bay
Lindisfarne
Midway Point
Sorell
Warrane
Mornington
New Town
Lenah Valley
Nth Hobart
Bellerive
Howrah
West Hobart /Mt Stuart
Hobart
Battery Point
Clarendon Vale
South Hobart
Rokeby
Tranmere
Mount Nelson
Sandy Bay
Taroona
N
Kingston
Blackmans Bay
0
5km
Kennedy et al. 1986


Map 3.2
Hobart & Suburbs
Population Change 1976 to 1986
% change
+2000
+20
+5
-5
-20
-30
N
0
5km
Source: Kennedy et al. 1986



Map 3.2
Hobart & Suburbs
Medium Density Housing
%
of population
living in medium
density housing*
35
15
7.5
5
2.5
0
N
0
5km
*Medium density housing includes terrace houses of three or more homes; villas, units, townhouses and flats up to and including three storeys; and existing houses converted into two or more dwellings
Source: Kennedy et al. 1986

3.3 Transport and Urban Form Correlations

The extensive data collected by Newman & Kenworthy (1989) was organised to provide a correlation analysis. The correlation analysis conducted provides an indication of the relationships between urban form and automobile dependence.

A number of important relationships highlighted by the correlation analysis conducted by Newman & Kenworthy (1989) between automobile dependence and urban form are discussed below.

Private transport and urban form

Newman & Kenworthy (1989) found that there was a strong negative correlation between private automobile ownership and use, and urban population density. However there was only a slight negative correlation between automobile use and central city job density. One would expect a strong negative correlation between these variables, as it is generally perceived that CBD job density discourages automobile use and provides a more viable situation for alternative forms of transport. This finding indicates the need to consider the whole city in terms of population and employment densities in order to gain a better understanding of automobile dependence. It appears that overall population density and dispersal may be extremely significant in relation to the transport structure of the city. This hypothesis is vindicated by the strong negative correlation between the variables of population and job density for both outer and inner areas with gasoline use. The implication for Australian cities is that while they have a concentration of employment in the CBD, the city in general is highly dispersed in terms of population and jobs which contributes to the dependence on the automobile.

Hobart provides a good example of this situation, with a high concentration of the employment in the CBD it would be expected to have an even modal split for journey to work. The modal split, however, is dominated by the automobile which may be explained by the overall density and dispersal of Hobart's population. Hobart has a highly dispersed urban area stretching in an elongated fashion along the western and to a less extent along the eastern shores of the River Derwent. While this dispersal is commonly attributed to the natural topography, Hobart's urban development is also a reflection of growth in accommodation for the private automobile. This has been reflected in urban sprawl and lowering population density of Hobart, for example Hobart

(Local Government Area) has witnessed a population decrease of 6 per cent in the 1976 to 1986 period while the urban fringe development areas of Kingborough and Brighton have experienced population increases of 60 per cent and 150 per cent respectively (ABS[4] 1986a). The implication for the transport system with a population increasingly dispersing at low densities has been the reduction in the number of transport options available for a growing number of urban residents. Increasingly the pattern of low density highly dispersed population growth produces greater dependence on the automobile which is further exacerbated in Hobart as it has retained a dominance of employment in the city centre. Unlike other cities which have dispersed employment resulting around 16 per cent of the jobs located in the CBD, Hobart has retained over 30 per cent of the jobs in its CBD (ABS 1986a). The option of alternative transport for workers travelling to the city centre is reduced as they move their residential location away from the central city. The implications for addressing the imbalance between alternative modes of transport and the automobile may not entirely lie in measures directed at discriminating against the car but at the structure of the city.

Newman and Kenworthy (1989) have suggested that there may be an exponential relationship between whole city population density and automobile dependence. Figure 3.1 (presented earlier) illustrated the relationship between population density and gasoline use, with the level of gasoline dependence increasing sharply when population densities are below 30 per ha.

Public transport and urban form

Correlation analysis indicates that the majority of public transport variables considered were positively correlated with urban employment and population density. This suggests that the overall structure and density of a city is important for the viability of public transport. This correlation is somewhat contradictory to the generally held belief that public transport requires a linear city structure to be effective. The traditional argument suggests that a city which has a concentration of employment in the city centre and a population base distributed in a linear fashion away from the centre will provide the most appropriate urban structure for a viable public transport system. While this may be the case, Newman and Kenworthy's work illustrates public transport may also be viable in cities which have a less linear structure and a greater spatial

[4]Australian Bureau of Statistics

distribution of employment centres. Additionally the existence of the strong positive correlation between the proportion of workers using public transport and all the urban density variables indicates the imbalance between automobiles and public transport may be altered with increased city density and not merely the positioning of the population in regard to the city centre (Newman & Kenworthy 1989).

Transport Infrastructure

Newman & Kenworthy (1989) found a strong positive correlation between gasoline use and the provision of transport infrastructure. Gasoline use was strongly correlated with road supply, central city parking and the average speed of traffic. These three variables indicate the level of infrastructure associated with the accommodation of the automobile in the city and it is particularly important to realise the significance of the strong correlation between gasoline use and the average speed of traffic. The average speed of traffic is also strongly correlated with the variables relating to vehicle ownership and automobile usage and is negatively correlated with all the public transport variables indicating the significance of the provision of automobile infrastructure and automobile dependence.

Unlike the positive correlation between gasoline use and the provision of transport infrastructure there is a significant negative correlation between gasoline use and all the public transport variables including walking and bicycling. The use of public transport may not be a simple relationship with the level of provision for public transport. It appears that the structure of the city plays an influential role in providing the necessary environment for the viability of public transport.

3.3.1 What is the utility of this correlation analysis for transport planning in Hobart

Newman and Kenworthy's (1989) work provides a useful tool for considering how different parameters of transport use, infrastructure and urban form are related to one another. While correlation analysis gives no indication of the processes leading to the patterns observed it does indicate the relationship between the existing patterns.

The correlation analysis indicates the importance of city population and employment density in relation to automobile dependence. Hobart has maintained a post Second World War trend toward lower population density and urban sprawl. The highest population growth centres have included the assisted housing estate areas north of the city, especially Bridgewater and Gagebrook, and the residentially attractive areas south east of the city including Blackmans Bay and Howrah. These population growth areas are largely isolated from the major employment centres and are characterised by low density self contained housing development. There is little indication to suggest that this type of housing will not continue to be the major form of housing development in Hobart in the near future (it must also be considered that the existing housing in these areas will remain in the housing stock for a number of years to come). In view of Newman and Kenworthy's work on urban density, this would indicate that the level of automobile dependence will be maintained in Hobart especially considering the dispersed nature of these developments.

3.4 Automobile Dependence and Urban Population Density - Hobart

This section examines the association of a number of variables of automobile use and dependence with the changing nature of urban population density in Hobart.

Urban form is a response to many interrelated processes including political, social, economic, cultural and historical. Urban form is also influenced by the physical environment which can affect the direction and design of a city. While many of the processes influencing the structure of a city tend to be discussed on a theoretical level, the affect of these processes can be seen in terms of particular social and economic indicators which are easily recognised as quantifiable units of measure. This section aims to explore how changes, namely increases in automobile use and ownership and the factors affecting these variables including petrol and car prices, have been related to urban density in Hobart. In order to investigate this relationship a number of statistics were collected specifically associated with urban density and automobile use over the period 1955 to 1990 in Hobart. This data was then used to form a multiple correlation matrix in order to gain some understanding of the pattern of linkages between the different variables.

The variables considered include; urban population density, car ownership per 1000 of the population, petrol consumption per capita, petrol price and car price in relation to the average weekly earnings, income and public transport trips per capita. All these variables were considered over the period 1955 to 1990, although some data are incomplete.

3.4.1 Parameters of Urban Density

Urban density

Urban population density is calculated by dividing the population by the urban area. The urban area for Hobart was derived from a periodic time series of photographic road atlases. These maps cover the period 1954 to 1990. A continuous population density figure was calculated for the years between when the atlases were published based on the assumption that the urban area increased at an average rate. The ABS population figure was then divided by the urban area for the corresponding year to calculate an urban population density value The results of this work provide a broad approximation of population density for urban Hobart.

There is a problem of accuracy with the population density figures outlined in table 3.3 which is associated with an inability to precisely correspond population statistics with the defined urban area used to calculate the urban density. Essentially the urban area defined by the atlases does not correspond exactly with the ABS population statistics. The ABS does not provide a population density figure for urban Hobart and their geographical units of population measurement for the census (collector districts) include large tracts of non-urban land. The affect of this methodology has meant that an over-estimation of population density has resulted because the population statistics are calculated for a greater area than the urban area defined by the atlases.

Car ownership

Car ownership is expressed as the number registered cars and station wagons per 1000 of the population. Car ownership is based on the state figure and was obtained from the Department of Roads and Transport (Tasmania).

Petrol consumption

Petrol consumption is calculated by considering the total number of litres of petrol consumed in Tasmania which is expressed as an energy figure consumed per capita. The quantity of petroleum products consumed in Tasmania is detailed by the Australia Bureau of Agricultural and Resource Economics (1991). Petrol consumption is also based on the state figure.

Petrol and car prices

Petrol prices were derived from ABS statistics. The ABS began publishing actual petrol prices in the early 1980s, while figures prior to this date are based on an ABS Consumer Price Index indicator calculated for petrol from 1966. The petrol price represents the number of weeks of income required to purchase 1000 litres of petrol based on the ABS calculated male average weekly earnings.

Car price

Car price was based on the price of the base model six cylinder Holden and was obtained from a number of automotive publications listing the retail prices of selected cars. This model and make of car was chosen because it best represents the typical Australian family car and provides a consistent make and model over the entire study period. The car price represents the number of weeks required to purchase the Holden car based on the ABS calculated average weekly earnings.

Income

Average weekly income is based on the ABS defined income for males. The average weekly income for males was used because it provides the only ABS continuous record of income from 1955.

Public transport

Public transport is expressed as the ratio of passenger trips per capita for the Hobart area and was obtained form the Metropolitan Transport Trust.

3.4.2 Changes in Urban Density in Hobart

Table 3.3 presents a selected range of findings indicating changes in population density and automobile use (referred to above) for the period 1955 to 1990. Population density has fallen from around 30 persons per ha in 1955 to just under 14 persons per ha. The change in population density has laregly been a response to low density fringe housing and the migration from inner city suburbs. Low density suburban housing has been facilitated by the motor car which has extended accessibility range.

Table 3.3 illustrates how automobile numbers and utility have increased dramatically over the period examined while public transport use has declined. In particular, car ownership and petrol consumption levels have both increased substantially since 1955 reflecting the growth in importance of the private car as the central form of modern transport. Furthermore, since 1960 the per-capita usage of public transport has been declining which is associated with an increased use of the private automobile providing a more convenient and flexible form of transport. These changes in the mode of transportation have occurred at a time when both petrol prices the cost of the typical private car have decreased in real terms.

Table 3.4 outlines the results of multiple regression correlation analysis of the variables. The multiple regression table formalises the relationships between the variables examined. Table 3.4 illustrates the significance of the relationships between the different variables and thus it can be used to investigate how the decline in population density in Hobart is related to changes in such variables as car use, income and public transport use.

Table 3.3
Urban Density and Automobile Dependence, Hobart

	Population[1]	Urban density (persons/ha)	Petrol consumption (MJ per capita)	Car ownership (per 1000/pop.)	Petrol price (1000 litres in terms of weekly income)	Car price (in terms of weekly income)	MTT patronage (trips per capita)
1955	106280	29.55	14381.14	143.32	2.35	-	-
1960	120750	24.87	17987.26	187.99	2.01	56.34	162.87
1965	133320	21.49	22810.24	259.65	1.68	50.61	125.87
1970	143680	18.89	27308.37	310.04	1.40	41.15	102.22
1975	155430	17.05	31777.62	386.08	1.05	37.37	95.79
1980	160630	16.04	34188.86	432.35	1.36	35.52	78.12
1985	168710	15.40	33248.64	462.11	1.45	33.34	60.57
1990	173740	13.96	34579.11	481.10	1.36	43.57	54.34

1. Population is based on the muncipalities of Hobart, Clarence, Glenorchy, Brighton and Kingborough.

Source: ABS (selected populataion statistics), ABARE 1991, Department of Environment & Planning 1990, Department of Lands & Surveys 1954, Department of Lands & Works 1962, 1966, 1969, Department of Lands 1971, 1974, 1977, Department of Lands, Parks & Wildlife 1987, Department of Roads & Transport 1990a & 1990b, MTT Annual Report (selected), Glass's Dealer Guide, Automated Data Services and Hartley et al. 1978

Table 3.4
Intercorrelations Between Urban Density and Autombile Use

	Urban density	Car ownership	Petrol use	Petrol price	Car price	Income	Public transport
Urban density	1.000						
Car ownership	-0.987	1.000					
Petrol use	-0.979	0.974	1.000				
Petrol price	0.777	-0.711	-0.829	1.000			
Car price	0.813	-0.799	-0.836	0.752	1.000		
Income	-0.827	0.871	0.750	-0.339	-0.486	1.000	
Public transport	0.976	-0.971	-0.928	0.646	0.776	-0.883	1.000

N = 26, Signicance to 0.005

3.4.3 Urban population density and other variables

One of the most significant relationships outlined in table 3.4 concerns the decline in population density with the increase in car ownership and petrol use. The decrease in population density is also significantly correlated with a decrease in public transport use. These changes in the mode of transport are particularly important to recognise and consider in terms of their relationship with urban form.

Both increasing car ownership levels and petrol usage illustrate a strong negative correlation with a decline in urban population density (this confirms the usefulness of Newman & Kenworthy's (1989) work referred in this chapter for Hobart). The relationship between urban density and car usage may be a mutually related, with decreasing population density facilitating the expansion of the urban area and thus necessitating an increase in the use of transport, which in Hobart has been via the use of the private car. As the city has expanded at a declining rate of population density the motor car has cemented its position as the major mode for transportation needs.

With a decline in urban population density there has also been a decrease in public transport use. This corresponds with Newman & Kenworthy's (1989) work outlined earlier. They found that as the overall population density of a city decreases so to the viability of public transport systems. In Hobart public transport use has declined by around 65 per cent over the period 1960 to 1990.

The financial toll of low density suburban housing in Australian cities can be exceedingly high. The costs involved in low density housing development are not only those associated with the increasing dependence it creates on the automobile but also include those costs associated with the implementation of both physical and social infrastructure. Housing development requires a significant level of supporting infrastructure including the direct physical items such as roads, water, sewerage, and electricity as well as the social items such as recreational facilities, educational, welfare and health institutions, etc. It is estimated that in 1990 in Perth the costs involved in providing infrastructure to a housing block on the urban fringe amounted to $43,000 of which $34473 may be attributable to physical infrastructure costs. In terms of the distribution of costs of providing infrastructure, 64 per cent is attributable to government sources and 36 per cent from private sources. In Melbourne it was estimated that the costs involved in developing a block at the urban fringe could exceed $40,000 (1986/87 prices) when both physical and social infrastructure as well the additional costs such as increased travel were taken into account. Table 3.5 illustrates the estimated costs of urban fringe development compared with consolidated development for Sydney in 1990. The costs for the Sydney example are based solely on the provision of physical infrastructure. This table (3.5) highlights the disparity in costs of providing infrastructure between urban fringe and consolidated housing development. Urban consolidation is defined as the process leading to the increase in density of dwellings or population, or both in an established area (Adrian et al. 1991).

It must be remembered that the costs associated with providing infrastructure are not directly accountable to each particular house but represent the average costs when the development of all the infrastructure required to service an area is taken into account. It is estimated that the savings which could occur for the development of 1000 dwellings in existing urban areas in Sydney rather than on the urban fringe range between $17 million and $31 million (Adrian et al. 1991).

Table 3.5
Costs of outer fringe development versus a consolidated area in Sydney

Outer fringe	Cost	Consolidated area	Cost
840 square metre block	$31,534	18 dwellings per ha.	$2,683
450 square metre block	$19,721	150 dwellings per ha.	$686

Source: Newman & Kenworthy 1991

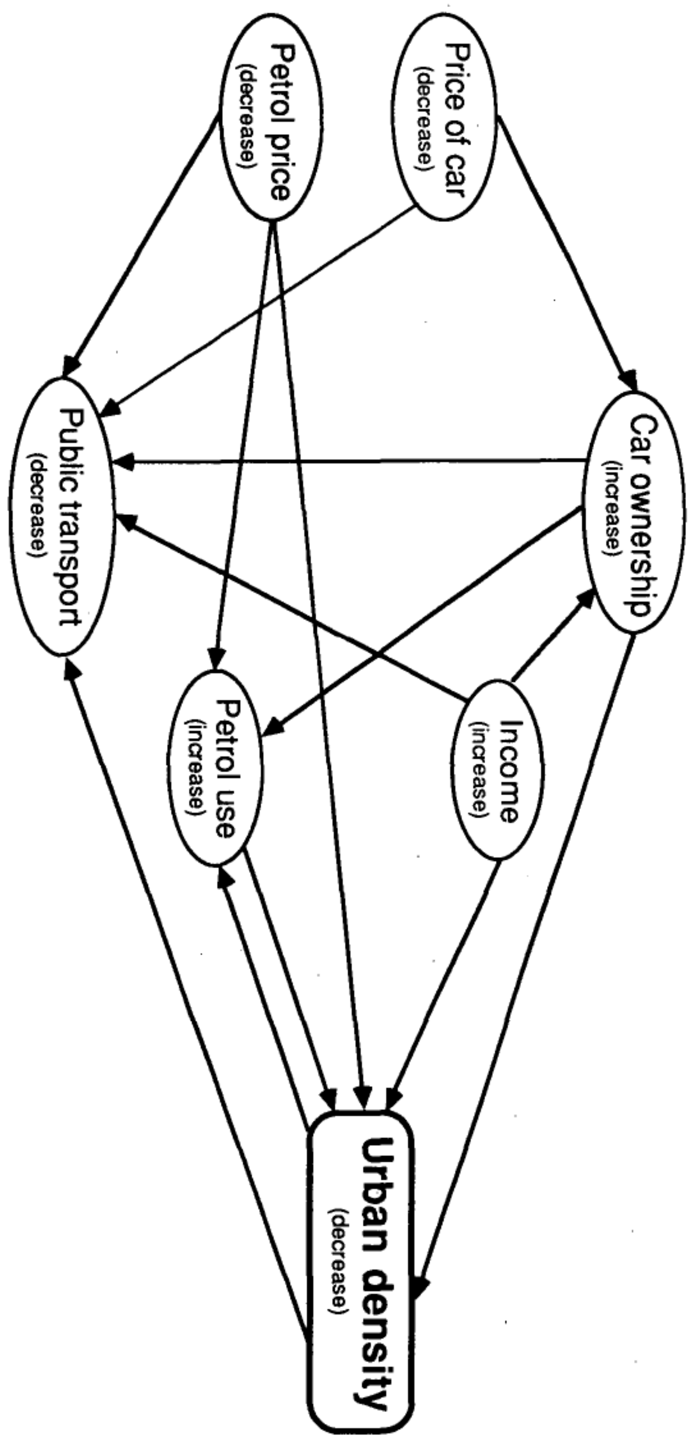
Other important relationships associated with a decrease in population density include both petrol and car prices. A decrease in the cost of petrol in relation to average weekly income is significantly correlated with a decline in urban density. This relationship highlights the changing nature of transport in the modern city. The decrease in the cost of cars in terms of average weekly earnings has meant that owning private means of transport has become more affordable. While the decrease in car prices doesn't account in full for the massive growth in car ownership it has not hindered this process.

3.4.4 Car use and energy costs

Importantly both increasing car ownership and petrol use are shown to be negatively correlated with decreasing urban density. A slightly surprising result was the relationship between petrol price and urban density which would be expected to be of higher significance. Petrol prices have in relation to income reduced in cost since the 1950s. Of particular importance is the relationship between increasing petrol usage and decreasing petrol price. This relationship raises important questions concerning energy use and price.

Figure 3.2 diagrammatically illustrates the historical relationship between the different variables and urban density which has occurred in Hobart.

Figure 3.2 Links between selected variables affecting urban density in Hobart



3.5 An example of Public Transport - Hobart

The following section outlines the functioning of public transport in Hobart and presents some of the main issues relating to the changes in urban form and how they have impacted upon public transport's share of the modal split for journey to work travel. Hobart provides a good example of public transport in Tasmania as it accounts for approximately 75 per cent of the Metropolitan Transport Trust (MTT) operations.

3.5.1 Provision of Public Transport in Hobart

The MTT provides bus services to the majority of the Hobart urban area, with the exception of Kingston which is serviced by a private bus operator. The level of service in terms of passenger trips, unduplicated route kilometres and annual bus kilometres are outlined in chapter 5.

The focus of MTT bus routes are the Hobart CBD and the Springfield Bus Interchange in Glenorchy. The timetabling of services are centred on increased frequency at peak period journey to work times and providing a comprehensive service outside of these periods.

Until November 1991 the MTT serviced eleven bus stops in the CBD catering for incoming and outbound buses. The fragmentation of central city bus stops was a result of the absence of a central city bus terminus. The development of such a bus terminus located suitably in the city centre adjacent to the city mall will undoubtedly improve the level of service provided by the Trust. The bus terminus provides a convenient interchange for patrons to board incoming and outbound buses. By centralising bus operations in the city significant advantages to the bus traveller may be realised, these include the abolition of the need to cross the entire CBD, in a number of circumstances, in order to catch connecting buses, a convenient location with easy access, and the appropriate infrastructure to provide comfortable waiting areas.

In terms of city coverage the MTT provides in excess of 100 routes which overlap to encompass the majority of Hobart's urban area. The bus routes are based on the major arterial roads and feeder streets in the suburbs. Services begin as early as 6.00 am and finish at 12.30 am.

A significant level of MTT service is directed towards journey to work travel. This type of service targets the central city where the highest concentration of employment in Hobart occurs. Journey to work data provides an indication as to the movement of people from their home to employment.

3.5.2 Journey to Work, Hobart 1986

The locational aspects of employment play an important role in shaping the layout and functioning of the city. In Hobart the central city and especially the CBD has maintained a primacy of employment which is typical of Australian cities. This creates the environment for the typical tidal movement of peak period journey to work traffic. The major corridors linking the suburbs with the central city include the Brooker Highway, the Eastern Outlet and the Southern Outlet. The dominance of the central city for employment is illustrated in figure 3.3.

Figure 3.3

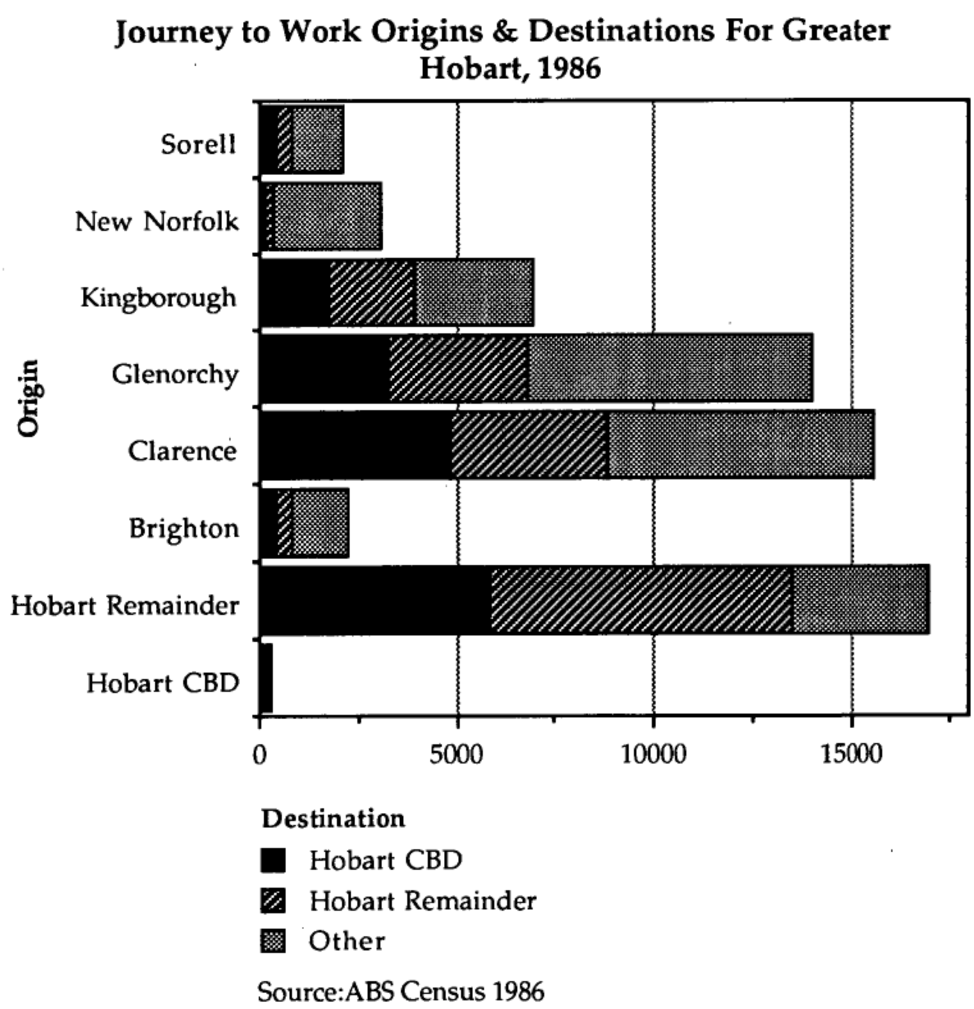


Figure 3.3 provides an indication of the movement of Hobart employees to the location of their employment. The figure illustrates that over 60 per cent or almost 40 000 people move outside of their statistical division to

travel to work. A significant proportion of these journeys are destined for the CBD and contribute to the peak period transport surge characteristic of the modern western city. Map 3.4 outlines the location of the Local Government Areas (LGAs) which comprise Hobart.

Map 3.4

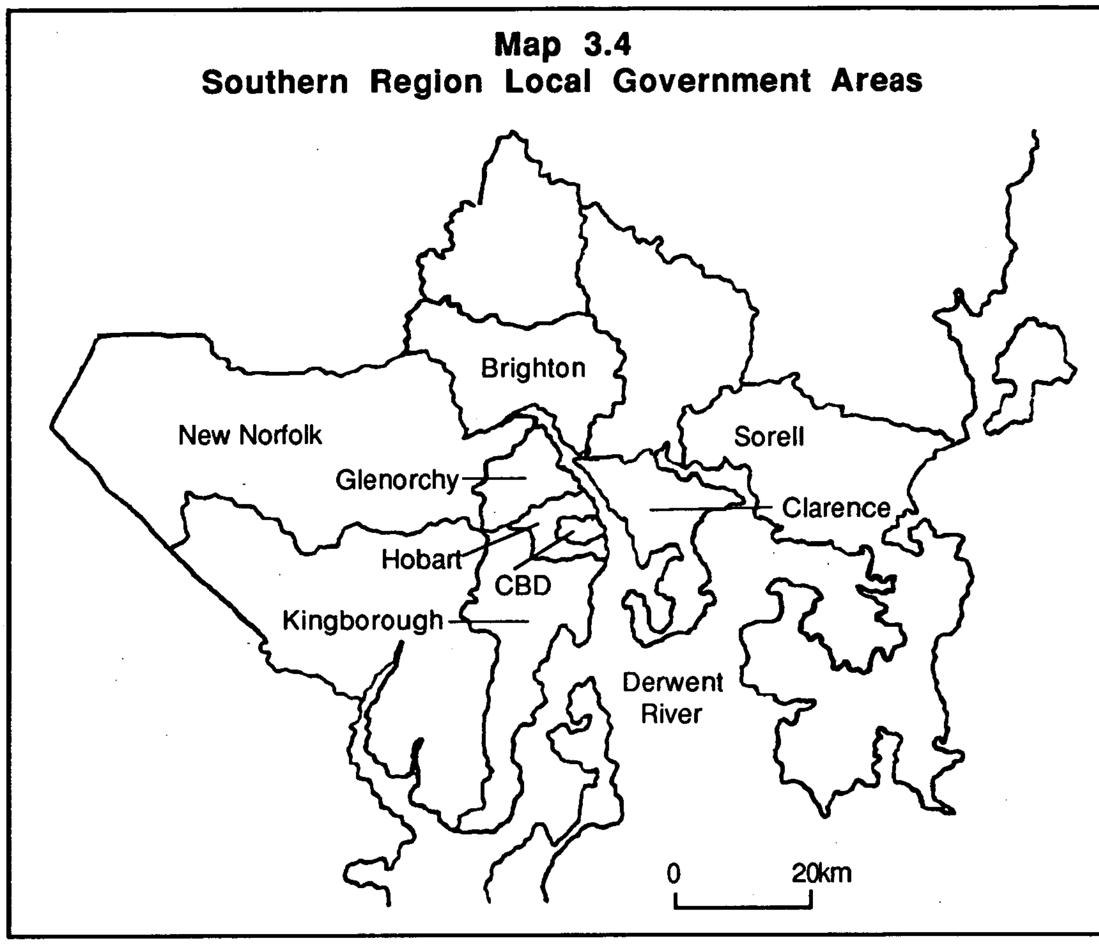
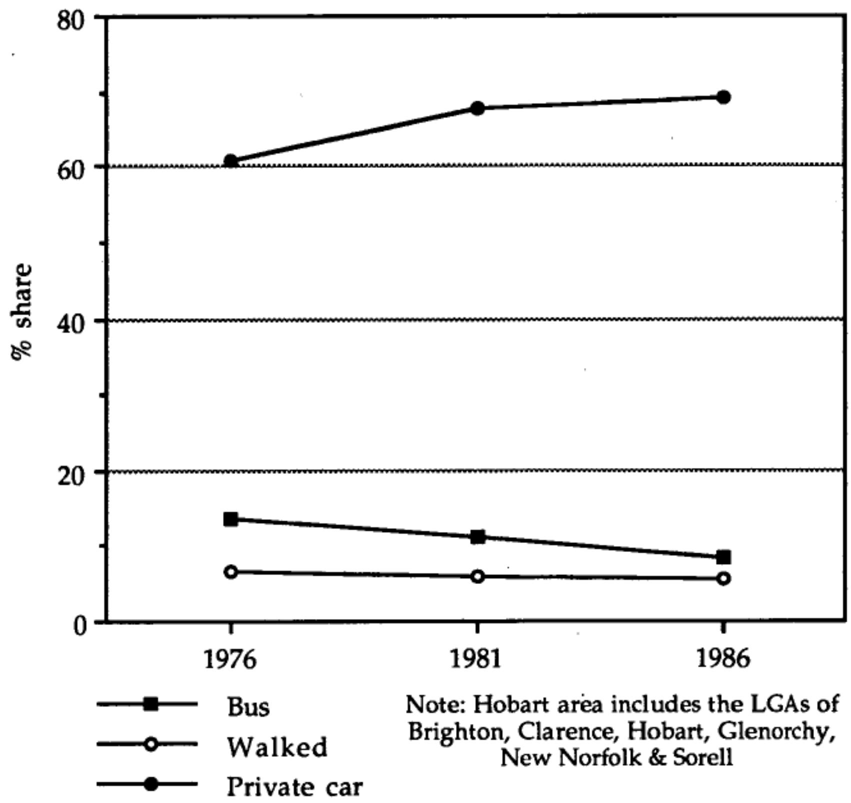


Figure 3.3 illustrates that there are large numbers of people moving from the suburbs to employment in the city centre. Journey to work travel from suburb to city centre is the type of movement which theoretically lends itself to public transport. However, the MTT has experienced a considerable decline in patronage, some of which must be accountable to a decline in the share of the journey to work travel revealed in table 3.3 (also outlined in detail in chapter 5). This can be substantiated through data collected by the ABS in relation to mode of travel for journey to work.

Figure 3.4 details the modal split for the journey to work for Hobart for the census years, 1976, 1981 and 1986 and includes the shares of journey to work travel for the private car, bus and walking, the remaining shares are distributed amongst the categories; train, taxi, ferry or tram, motorbike, bicycle, worked a home, not stated and did not go to work. Table 3.6 outlines the modal split for a number of Australia cities for 1981.

Figure 3.4

Mode of Journey to Work, Hobart Area



Source: ABS 1981, 1986a

The dominance of the private car for journey to work in Hobart is highlighted in figure 3.4 which indicates that for those people who travelled to work in the period examined around 75 per cent used private automobile transportation. As indicated in figure 3.4 the private car has increased its share of the journey to work trip, while bus transport has declined.

Table 3.6 reveals that for the Australian cities examined in 1981 the private car dominated the modal split or the journey to work trip. All the cities provide a similar profile for modal split, however, both Sydney and Melbourne have significantly higher shares of people using public transport than the other cities.

Table 3.6
Mode of Transport for Journey to Work, 1981

	Adelaide	Brisbane	Melbourne	Sydney	Hobart
	%				
Public transport	16.5	16.6	20.6	29.5	13.8
Walked / Bicycle	5.8	5.3	5.7	5.4	7.4
Private automobile	77.7	78.1	73.7	65.1	78.8

Note: the % shares are based on only those categories listed
Source: ABS Census 1981 & Newman & Kenworthy 1989

The structure of the city has been shown to play an important role in determining the nature of the urban transport system. Where public transport is based on bus transport its popularity will be adversely affected by peak period congestion. This is caused by bus transport being part of the general road traffic and hence subject to decreasing average travel speed due to the continual stop start travel pattern. This situation will be further complicated if the city's road network is allowed to develop in a cyclic nature where congestion is seen to be alleviated by better road engineering, as this has been seen to attract greater numbers of cars and hence the congestion problem re-emerges. Hobart provides a good example of this dilemma, as the level of central city employment has maintained a dominant position in terms of the employment structure of the city while the level of public transport for journey to work has decreased leading to the assumption that workers are increasingly using private cars for their journey to work. Furthermore, the quality of Hobart's urban roads has vastly improved based largely on the justification of alleviating increased congestion. The total budget for road projects currently under-construction or completed in the 1989/90 period for the Hobart metropolitan area totalled 30.087 million dollars in a state road maintenance and construction budget of 114. 235 million dollars (Department of Roads & Transport 1990a).

With the outward expansion of the city the operating viability of public transport based on buses, such as in Hobart, has declined. The inability of public transport to compete with the private car is not only compounded by the development of infrastructure designed to accommodate the car and the modal limitations of bus transport, but also through the inequity in which public transport is funded. Public transport derives revenue from services and any budgetary shortfall is provided by the State Government. Currently there are no payments made by beneficiaries of public transport, such as: car users who benefit from reduced congestion and accidents avoided; land and housing developers whose developments expand the city and require public transport services; and employers and businesses whose employees and customers travel on public transport (ESDWG 1991).

3.5.4 Hobart in Summary

The level of public transport used for journey to work in Hobart has been declining with greater numbers of people using private cars. The change in travel patterns has come about due to many factors related to city structure and car ownership. Like many Australian cities, Hobart's housing structure has been outwardly expanding decreasing the overall city population density which has two adverse effects on public transport namely, increasing travel distances and increasing the number of bus stops required as a ratio per capita. In conjunction with changes in city structure has been the increased accommodation for the private car for journey to work and for other uses which is highlighted by the improvement in roads and increased parking. While these improvements in the accommodation for the private car have taken place other forms of transport have not received similar attention. For the private car traveller there are a number of central city car parks which provide convenience at a relatively low cost, as opposed to public transport which does not have enclosed waiting areas at the suburban stops.

3.6 In summary

The structure of the city plays an important role in determining the per capita energy use for transport. The fall in Hobart's population density has occurred through two important processes; firstly, there has been the expansion of the urban area with the typical low density fringe housing and secondly, there has been the outward population migration from the older inner city suburbs. Many of these older inner suburbs reached a housing stock potential some years ago and are now experiencing gentrification and selective redevelopment for higher density housing.

The ability to increase the overall population density of Hobart, or any Australian city, is limited because of the constraints imposed by the post second world war settlement pattern. Typical housing development, which has occurred over the last forty years, has involved self contained houses constructed on 'quarter acre' blocks. This type of housing represents not only significant investment on behalf of the owners but also a desired lifestyle which has been promoted, colloquially, as the 'Great Australian Dream'. Because of this entrenched ideology in this type of settlement pattern and the cost of this form of housing the possibility of increasing the density in the existing outer suburbs, through urban consolidation, would certainly be a difficult and costly objective to achieve. However, increasing population densities or achieving a settlement pattern more conducive to energy efficient transport in the inner suburbs may be more realistic. Inner city suburbs provide a number of features making them more conducive for urban consolidation which include; their spatial proximity to the city centre, a relatively old housing stock, a considerable percentage of their housing situated on small blocks, and a mixed population structure.

The suburbs of Hobart which may be suitable for urban consolidation programs include Sandy Bay, Battery Point, Hobart, North Hobart, West Hobart/Mt. Stuart, and South Hobart. All these suburbs experienced substantial declines in total population over the period 1976 to 1986. The effect of population migration from these suburbs has been to reduce average housing occupancy rates thus creating under utilisation of the existing housing stock. The ability to promote urban consolidation will largely depend upon the commitment at federal, state and local government levels to provide incentives for medium density housing development. The Federal Government has already started investigating the possibility of encouraging different forms of housing development in Australian cities through the 'Better Cities' program. The State Government certainly has a role to play in encouraging urban consolidation through their responsibility for urban infrastructure and especially public housing programs. While local government can provide planning guidelines to facilitate medium density housing. Importantly, if medium density inner city housing is going to be viable it has to be attractive, practical and not out of place with its surrounding historical and physical environment. Furthermore, medium density housing requires a new approach to housing design to make it a desirable form of housing to those people looking to live in low density housing. The key components of attractive medium density housing include the maintenance of privacy and the maximising of space. This form of housing is architecturally possible through adequate sound insulation and creative use of open space. Perhaps most important in creating greater urban density is that development is coordinated and does not occur on a sporadic pattern across a suburb.

CHAPTER 4
PRIVATE TRANSPORT

Some form of motorised transport plays a part in the daily lives of most people. Whether it be for journey to work or for recreation, the automobile has become the single most important means for the majority of transport needs. During the last 80 years there has been a phenomenal growth in the number of automobiles throughout all Western countries including Australia. Tasmania is no different in this respect, with an exponential style increase in motor vehicle registrations since the early 1900s. This increase in vehicle numbers is directly related to an increasing dependence upon the automobile for transport. The structural change in private transportation has had significant impacts upon the nature of our society and, in particular, our cities. While the car has brought with it great advances in the quality of life for most people it has also brought significant problems. Of particular importance in urban areas are the problems associated with the disparity of mobility between those with access to a car and those without. As the modern city has developed to accommodate the car those without access to a car have become disadvantaged. People without access to a car typically include the young, elderly, disabled and those on a low income or unemployed. The problems associated with the restrained mobility are compounded in the case for those living on the fringes of the city. The widespread use of the automobile has also contributed to urban pollution, (discussed in an earlier chapter). This chapter will consider how private transport has changed in Tasmania and its importance in terms of the total energy regime for the State. Private transport will also be considered in terms of its contribution to the greenhouse emissions. In addition, there will be a discussion of a number of options for reducing the quantity of transport fuel used for private transport and the problems of implementing such changes.

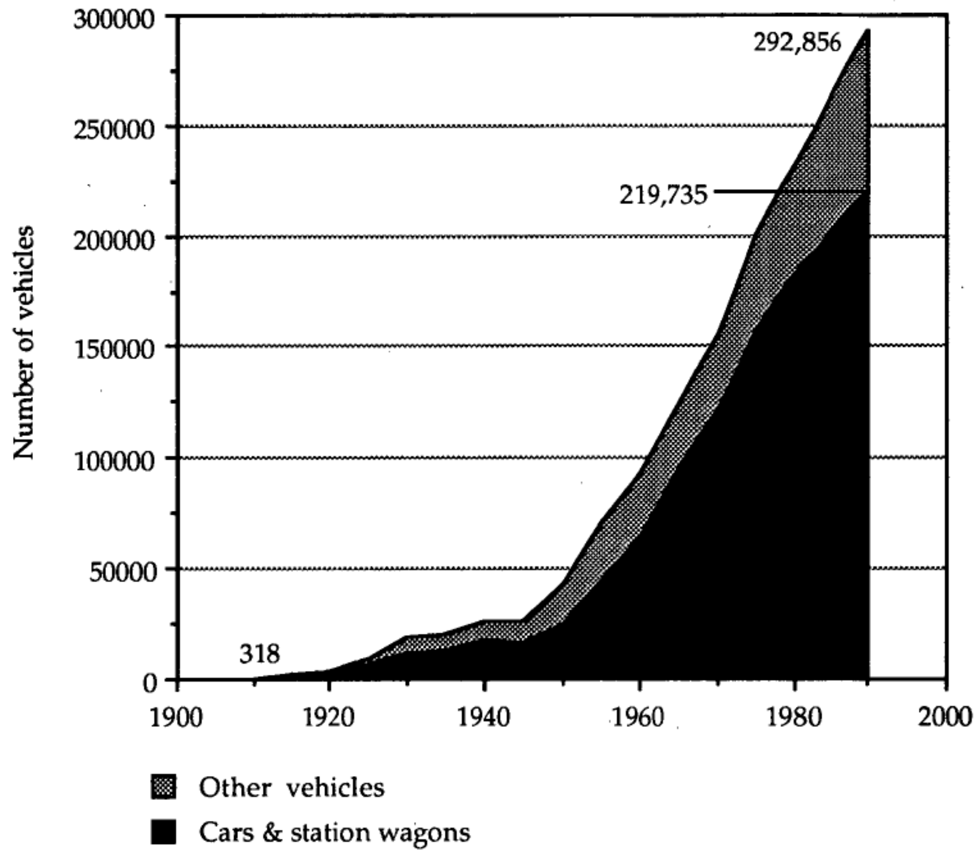
4.1 The Growth Of Motorised Transport In Tasmania

During the last one hundred years, personal transport has undergone a remarkable revolution from physical means to automotive. The most important facet of this revolution has been the growth in the availability and use of the private car. This is reflected in both an increase in car numbers and an increase in utility per vehicle.

Figure 4.1 illustrates the growth in number of motor vehicles registered in Tasmania since the early 1900s. The number of cars registered have shown a remarkable growth curve especially since the 1950s. Cars and station wagons, which represent the majority of privately owned vehicles, have maintained the dominant position in terms of total motor vehicles on register constituting approximately 75 per cent of total registrations.

Figure 4.1

Number of Vehicles Registered in Tasmania

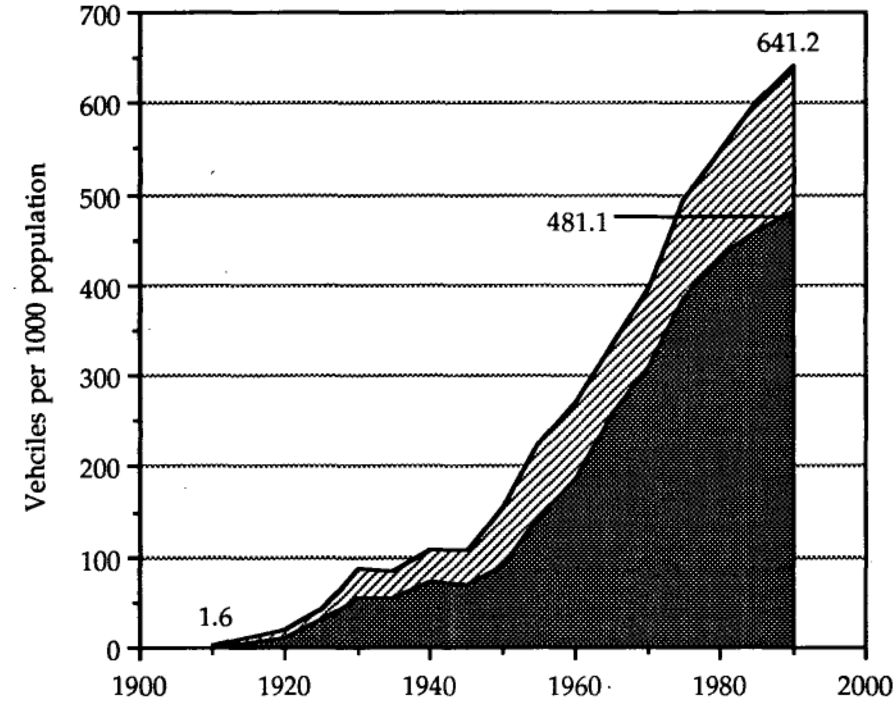


Source: DRT 1990b & ABS 1991

Vehicle registrations provide an indication of the growth in vehicles numbers in Tasmania, however, it is unrelated to other changes which may have occurred within the State including, for example, population growth. In order to obtain a more comprehensive understanding of the significance of the increase in car numbers in Tasmania, vehicle registrations can be evaluated in relation to the population change. Figure 4.2 depicts the total number of vehicles on register in respect to the total population for Tasmania.

Figure 4.2

Number of Vehicles Registered per 1000 of the Population, Tasmania



▨ Other vehicles

■ Cars & station wagons

Source: DRT 1990b

Vehicle ownership has increased steadily since the introduction of the automobile in the early 1900s, although, there was a period of moderate growth related to the depression of the 1930s and the Second World War. From the 1950s until the late 1970s the number of vehicles registered grew dramatically, tripling the number of motor vehicles on register per person in the period 1950 to 1980. During the early 1900s and up until 1920 there were less than 100 vehicles per 1000 of the population, while in 1990 there were close to 650 motor vehicles per 1000 population. In 1990 there were a greater number of registered vehicles than licensed drivers in Tasmania (DRT[1] 1990b). The dramatic increase in the number of private cars throughout Western countries has been associated with institutionalisation of the car within our society which is reflected by the provision of supporting infrastructures designed to accommodate the convenient use of the automobile (considered in chapter 3).

The decline in the rate of increase of car ownership since the early 1980s,

[1]Department of Roads and Transport (Tasmania)

outlined in figure 4.2, may indicate that the level of car ownership in Tasmania may be reaching a saturation point.

4.1.1 Vehicle Use

One method of quantifying motor vehicle use is to consider vehicle kilometres travelled. The ABS provides detailed assessments of kilometres travelled by purpose and by mode throughout Australia. Using the estimates provided in the Motor Vehicle Survey 1988 an outline can be drawn of motor vehicle use and energy consumption in Tasmania. These values provide an indication of how motor vehicles are being utilised and the modal split between the function of use.

Table 4.1 outlines the estimates made by the ABS Motor Vehicle Survey 1988 of the number of kilometres travelled by mode and purpose during 1988.

Table 4.1
Kilometres Travelled in Tasmania by Mode and Purpose 1988
(million kilometres)

	Business	Other	Total
Cars & station wagons	515.0	2491.6	3006.6
Motor cycles	3.0	26.8	30.2
Utilities & panel vans	351.1	224.9	576.0
Rigid trucks	204.5	29.8	234.3
Articulated trucks	115.9	0.3	116.2
Non-freight carrying trucks	7.7	0	7.7
Buses	45.5	0.6	46.1
Total	**1242.8**	**2774**	**4017.2**

Note: inaccuracies in totals due to rounding.

Source: ABS 1989

Table 4.1 reveals that almost 70 per cent of the total estimated kilometres travelled in Tasmania during 1988 were for other than business purposes encompassing both private and journey to work travel. In particular, while cars and station wagons accounted for almost 75 per cent of the total kilometres travelled in Tasmania, 83 per cent of these kilometres were travelled for other than business purposes which represents 62 per cent of the total kilometres travelled in Tasmania for all purposes. These figures indicate the significance of private travel and the contribution cars and station wagons make to transport activity in Tasmania. In terms of energy consumption the dominance of cars and station wagons is lessened somewhat because of varying fuel economy between the different types of vehicles, for example, trucks, in general, use considerably more fuel per kilometre than the average family car. The ABS does not, however, provide a breakdown of kilometres travelled by mode for journey to work or for private travel on a state by state basis, but it is quite obvious that cars and station wagons dominate total kilometres travelled.

Travel for the purpose of journey to work is estimated to account for almost 25 per cent of total kilometres travelled throughout Australia, while private travel is estimated to account for approximately 45 per cent of the total kilometres travelled in Tasmania during 1988 (ABS 1989). Cars and station wagons would obviously constitute a major proportion of these two figures due to their dominance of total kilometres travelled.

Estimates of vehicle kilometres and average vehicle fuel efficiency provides the necessary information to make an estimation of the total motor fuel consumed in Tasmania. The ABS provides an estimate of the relative fuel economy of the different types of vehicles based on sampling a portion of the entire transport fleet. In this way an accurate evaluation of the average efficiency can be obtained which takes into consideration the performance of the whole fleet range and is not restricted to the fuel efficiency of late model vehicles.

Table 4.2 illustrates a comparison of a number of statistics concerning transport for journey to work and private travel with the total transport operations in Tasmania during 1988. The table provides an indication of the importance of private and journey to work travel in relation to total transport in Tasmania. Transport for these purposes accounted for approximately 13.5 per cent[2] of total energy consumption in Tasmania during 1988.

[2] Energy comparison is based on the HEC estimate of 87 PJ of energy consumption for Tasmania during 1988.

Table 4.2
Journey to Work, Private and Total Transport Operations, Tasmania 1988

	Kilometres travelled (millions)	Litres of fuel consumed[1] (millions)	Energy[2] (Petajoules)	Tonnes of CO_2 emissions[3] (million)
Journey to work & private transport	2774.4	336.38	11.61	0.87
Total road transport	4017.2	576.86	20.51	1.54

Estimates are based on ABS Motor Vehicle Survey 1988.
1. Fuel consumption was based on Australian averages for the relative modes of transport and applied to the Tasmanian example.
2. In estimating energy consumption allowances were made for the use of different fuels.
3. CO_2 emissions were based the greenhouse gas coefficient of 75 kilo tonnes of CO_2 per petajoule of fuel consumed.

Source: ABS 1989

4.1.2 Automobile Use and the City

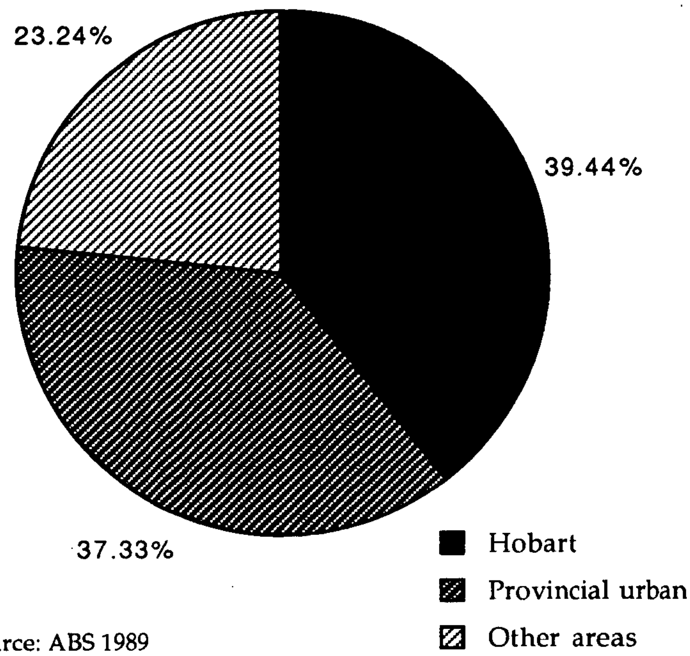
The tables and figures provided in the previous section do not indicate the spatial disparity of transport activity conducted in Tasmania. It is important to consider the use of automobiles on a spatial or regional level because it provides an indication of the pattern of transport within Tasmania.

Transport activity by area of operation is estimated by the ABS based on surveys of motor vehicle users. The dominance of urban areas for transport activity outlined in figure 4.3 is not unforeseeable as approximately 70 per cent of Tasmanians live in urban areas. What is important to consider, however, is the localised effect which arises from the concentration of the transport task in a relatively small area.

Figure 4.3 presents an important signpost for transport policy programs. For example, strategies aimed at reducing total transport fuel use will have a greater impact if they are specifically targeted at urban transport activity. Furthermore, the contribution made by cars to total fuel consumption and in particular, transport activity by cars for private and journey to work purposes, makes strategies aimed at reducing fuel use specifically at these forms of travel of greater significance than for other modes of transport.

Figure 4.3

Share of Kilometres Travelled by Area of Operation, Tasmania 1988



Source: ABS 1989

4.2 The Possibility of Reducing Motor Vehicle Fuel Consumption

This section will focus attention on strategies aimed at reducing motor fuel consumption in private transport. Should Tasmania be required to reduce its total consumption of petroleum products the private transport sector will be an important area from which reductions could be made.

One possibility of reducing carbon dioxide emissions is through the use of alternative automotive fuels which has been discussed in an earlier chapter. Two alternative ways in which total fuel consumption can be reduced in the private transport arena is through reducing vehicle fuel consumption and changing travel behaviour.

A number of possible strategies aimed at reducing motor fuel consumption are outlined below.

Vehicle fuel consumption

1. The first type of strategy aimed at reducing fuel consumption focuses on reducing the average fuel consumption of new vehicles.

Restrictive strategies

a. Influence the sales mix of new vehicles to meet fuel consumption targets based on registration charges. This strategy could be incorporated at a state level.

b. Regulate car manufactures and importers.

c. Increase the price of fuel, the royalties from which could be used to sponsor research and design of fuel efficient vehicles.

Passive

d. Encourage consumers to purchase fuel economic vehicles through advertising the benefits of those types of cars.

2. The second possible way of reducing fuel consumption is through changing private travel behaviour, i.e. reducing total private car kilometres travelled and promoting more fuel economic driving.

Restrictive

a. Provide benefits for car pooling for journey to work, i.e. special car parking allowances, specific road lanes, etc.

b. Provide disincentives for using cars for journey to work, i.e. expensive car parking.

c. Promote traffic calming through road design.

Passive

d. Promote public transport.

The problem of overlapping jurisdictions between the tiers of government may arise in instituting a number of strategies aimed at reducing fuel use. For example, car parking in the city centre is the domain of local government who obtain considerable revenue from parking by city workers and thus may be reluctant to forego on this source of revenue.

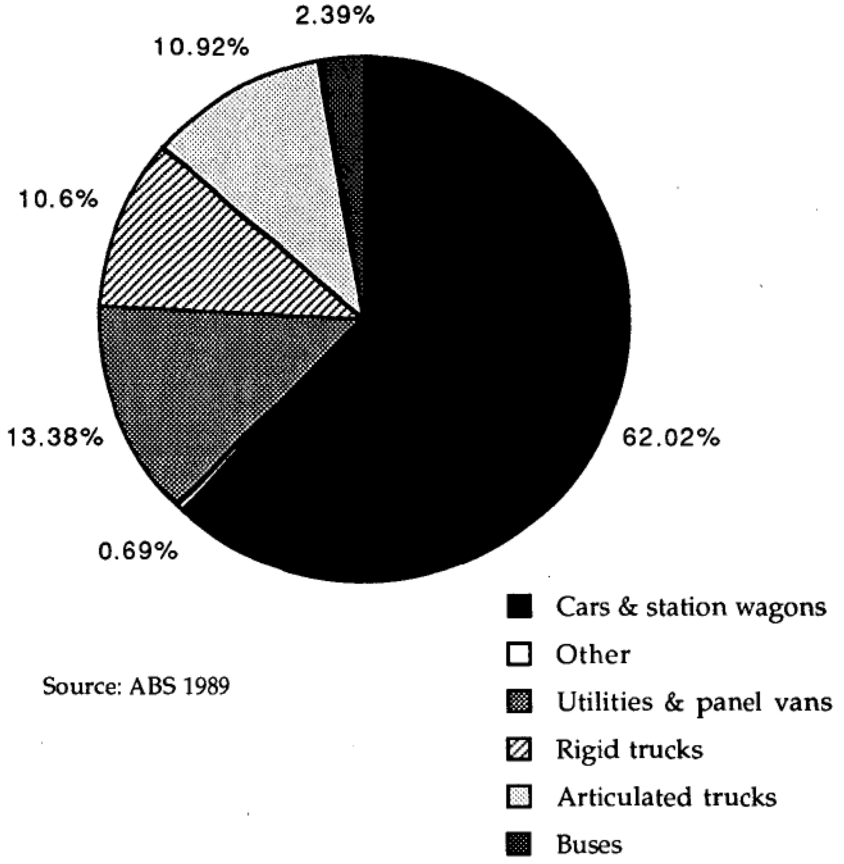
4.2.1 Motor Vehicle Fuel Consumption

One method of considering total fuel consumption is to apportion it into shares based on the relative contribution of the different types of vehicles. The utility of dividing total fuel consumption into shares is related to quantifying the significance of the contributions made by different vehicles.

Figure 4.4 illustrates the relative shares of the total motor fuel consumption for transport needs in Tasmania during 1988.

Figure 4.4

Shares of Motor Fuel Consumption by Mode, Tasmania 1988



Source: ABS 1989

Cars and station wagons, which dominate total fuel consumption with 62 per cent of the total, potentially represent an ideal target for reducing total fuel consumption. Accordingly, any reductions which can be made in either reducing the total number of kilometres travelled or by decreasing the average rate of fuel consumption of cars will have a significant impact on the State's total fuel consumption. Furthermore, cars represent a heavily traded commodity allowing for innovations in design to enter the market on a relatively short time scale. Consequently, by improving the average new car fuel economy appreciable inroads into the total amount of fuel consumed can be made.

4.2.2 Fuel Consumption of Motor Cars

In 1991 new car buyers had a large range of automobiles to choose from with an equally large range in terms of fuel economy. For instance, the least fuel economic car on the Australian market consumed an estimated 21 L/100km for a defined city cycle test while the most fuel efficient car consumed an estimated 6 L/100km for a similar test, representing a difference of 3.5 times (DPIE 1991).

Fuel economy figures are provided by the Department of Primary Industries and Energy (DPIE), who publish a guide to the fuel consumption of new cars. In Australia, tests for automobile fuel consumption are carried out following the Australian Standard AS 2877-1986. The fuel efficiency figures published by the DPIE tend to underestimate the achievements of normal driving. A survey conducted by the Society of Automotive Engineers - Australasia found that on average drivers used approximately 16 per cent more fuel than the DPIE figures for city driving and 35 per cent more for the highway driving. The Automotive Engineers' survey found that there was considerable variation around the figures disclosed in Fuel Consumption Guide. For example, the Automotive Engineers found that fuel economy figure ranged from 10 per cent below to 60 per cent above those published by the DPIE (1990). The variation in figures is claimed to be largely related to driving behaviour.

The State Government controls motor vehicle registration fees which form one possible method of influencing preference for different forms of motor vehicles. Scaling registrations fees in terms of engine capacity can play a role in influencing the preference for different motor vehicles. One limitation to the effectiveness of yearly registration fees as a means of influencing consumer choice is that the fee is a once a year payment. Thus registration fees, as they are presently structured, are unlike continuous running costs such as fuel where the consumer experiences directly the costs accountable to the fuel economy of the vehicle.

4.2.2.1 Driving behaviour and fuel consumption

Driving behaviour is an important factor influencing the rate of fuel consumption of a motor car. It has been demonstrated that the rate of fuel consumption for a motor vehicle responds quite dramatically to its operation or driving efficiency. Reducing the State's total fuel consumption through more efficient driving behaviour would require a voluntary change in behaviour on behalf of many drivers, in that it requires the conscious attention of drivers to follow driving habits which provide optimum fuel economy.

The Royal Automobile Club of Tasmania[3] (RACT 1990) compared the effect of driving style on fuel consumption within urban areas. The tests were carried out using carburettered vehicles; a 1984 six cylinder Holden Commodore Wagon and a 1983 four cylinder Mitsubishi Colt. Both vehicles were scrutinized and tuned before the tests. The fuel economy tests were conducted over a 44.7 kilometre route through Hobart city. The aims of the test were to emulate both efficient and inefficient driving behaviour. Inefficient driving behaviour is characterised by excessive acceleration and constant braking. While efficient driving behaviour is characterised by smooth acceleration, flowing with general traffic and anticipating light changes to avoid wasted energy through sharp braking.

The RACT study found that the Holden Commodore responded significantly to the different driving styles. The Commodore consumed 9.59 litres when driving inefficiently and 5.5 litres when driving efficiently, which translated to fuel economy figures of 21.45 L/100km and 12.3 L/100km for the respective driving styles. The Mitsubishi Colt consumed 4.75 litres of fuel with a consumption rate of 10.62 L/100 km during the inefficient driving test. When driven more efficiently the Colt used 3.92 litres of fuel at a consumption rate of 8.76 L/100 km. Inefficient driving affected the fuel consumption rate of the Commodore by almost 75 per cent, while the Colt was less effected by inefficient driving using an extra 20 per cent more fuel. In terms of the expected fuel savings which may be achieved over an average year's driving of 1500 km, the Commodore could be expected to save 1372.5 litres and the Colt may save 279 litres by driving more efficiently.

The above example highlights an important issue concerning motor vehicle fuel consumption, that of the ratio between best and worst performance. For example, in the above tests conducted by the RACT (1990) the Commodore exhibited a difference of 1.7 in fuel consumption between the two styles of driving while the Colt only had a difference of 1.2. This measure of fuel consumption, comparing the ratio between best and worst performance, provides a indication of potential fuel consumption. Essentially total fuel consumption is a function of the time spent driving at different levels of efficiency. Thus, while a particular car may produce a good fuel consumption figure for a particular driving style, in actuality the average total rate of fuel consumption will represent the time spent driving at varying rates of fuel consumption determined by driving behaviour and external conditions within

[3] The RACT conducted a limited fuel economy survey in 1990 in order to evaluate the effect of driving behaviour on fuel economy.

the restrictions of the cars best and worst rate of fuel consumption. A number of cars in the DPIE (1991) guide present, on the surface, quite good figures for their best driving test which presents them in a favourable light yet the ratio of best compared to worst gives an indication of the possible fuel consumption characteristics of the vehicle.

4.2.2.3 Car Fleet Fuel Economy

Average fuel economy for new cars is an important factor influencing total transport fuel consumption. Considered over time, changes in new car fuel economy indicates the trends occurring and can be used to study possible short term changes which follow through to influence fleet fuel economy and hence total fuel consumption.

Table 4.3 provides an outline of new car fuel economy figures for a number of OECD[4] countries and the relative change which has occurred over the period 1979 to 1988. Australia has shown a considerable reduction in new car fuel economy, however, both Canada and the United States have provided a greater reduction in fuel economy over the same period. Other OECD countries exhibited similar improvements in new car fuel economy as Australia, but it must be remembered that these countries started with a lower fuel economy rate in 1979.

The fuel economy figures for the various countries presented in table 4.3 are calculated using different testing procedures which need to be taken into consideration when any comparisons are made. In the case of Australia the testing standards were changed in 1986 which introduced a discrepancy of 2.75 per cent over the previous results (BTCE 1991a). Figures in table 4.3 prior to 1986 have been corrected for this factor.

Tasmania has diminutive power to influence car manufactures on the design characteristics of new cars. In terms of market share, Tasmania represents just over 2 per cent of the total Australian new car market. With this small market share it is unlikely that car manufactures would respond to pressure exerted by the State Government in terms of regulating the types of cars being sold within in the state. The State Government does, however, have certain political powers with the ability to table views and opinions at various Commonwealth and State meetings.

Changes in average new car fuel economy affects the average fuel economy

[4]Organisation for Economic Cooperation and Development

of the entire car fleet, however, the reflection is a function of car turnover or ageing of the car fleet. Table 4.4 outlines the impact which improvements in new car fuel economy has had on the entire car fleet economy in a number of OECD countries.

Table 4.3
New Car Fuel Economy
(average L/100km)

	1979	1983	1986	1988	% change 1979/1988
Australia	10.9	9.2	9.3	9.1	-16.5
Canada	11.4	8.5	8.4	8.1	-28.9
West Germany	9.6	8.1	7.5	7.9	-17.7
Italy	8.3	7.3	6.8	6.8	-18.1
Japan	8.6	7.8	8.3	8.6	0
Sweden	9.2	8.6	8.4	8.2	-10.9
U.K.	9.0	7.9	7.5	7.4	-17.8
U.S.A.	11.6	8.9	8.4	8.2	-29.2

The Australian new car fuel economy for 1990 was 8.9 L/100km

Source: BTCE 1991a

Table 4.4 shows that in Australia the total car fleet fuel economy fell from 12.7 L/100 km in 1979 to 11.8 L/100 km in 1988, a fall of 7.1 per cent which is well under the improvements made in new car fuel economy rates over the same period. Furthermore, in the United States the car fleet economy improved by 27.6 per cent to 11.8 L/100 km which made it the same as for Australia in 1988.

The moderately slow response of fleet economy to the reduction in new car fuel economy is related the ageing of Australia's car fleet. For example, in 1971 some 29 per cent of Australian cars were 3 years old or less, while in 1988 the figure changed to 13 per cent (BTCE 1991a). In addition, in 1971 approximately 25 per cent of cars were 10 years old or more, while in 1988 almost 50 per cent of cars were 10 years old or more (BTCE 1991a). These figures illustrate the ageing profile of Australia's car fleet which is related to a number of factors including; an increase in design life, increases in the real prices of cars since the late 1970s, and higher interest rates. Another important factor increasing the age profile of the Australian car fleet is associated with the size of the existing total vehicle stock and turnover rate which reduces the percentile significance of each new year's car registrations. The car pool has been continually growin, as there are more cars being registered than there are being deregistered as well as an average increase in car life. Thus, the statistical significance of new registrations is decreased when compared with total registrations. Unlike in Japan where the Government regulates the maximum life of motor vehicles and thus facilitates a continual turnover of vehicles, Australia tolerates a greater potential for vehicle life and consequently there is a comparatively longer turnover period for motor vehicles.

Table 4.4
Car Fleet Fuel Economy
(average L/100km)

	1979	1983	1986	1988	% change 1979/1988
Australia	12.7	12.5[a]	12.0[b]	11.8	-7.1
Canada	15.7	13.8	12.4	na	-24.6[d]
West Germany[c]	10.8	10.9	10.9	10.7	-0.9
Italy	9.1	8.0	7.8	7.6	-16.5
Japan	11.8	11.0	10.7	na	-9.3
Sweden	10.9	10.8	10.5	10.3	-5.5
U.K.	na	na	na	na	na
U.S.A.	16.3	13.7	12.9	11.8	-27.6

a 1982 figure
b 1985 figure
c Possibly based on erroneous data, according to IEA.
d Based on 1987 estimate of 11.84 litres per 100km

Source: BTCE 1991a

4.2.3 Future Improvements in Car Fuel Economy

The potential for further improvements in new car fuel economy has been studied by a number of people, many of whom suggest that significant improvements in new car fuel economy can be made with minimal effort. However, a number of studies suggest that over the last 10 years car manufactures have exhausted many of the low cost solutions to improve fuel economy of new cars which means that further enhancements, while technically feasible, will be much costlier to implement. For example, Difiglo et al. (1989) (in BTCE 1991a) claims that in the United States it is quite feasible that new car fuel consumption could be reduced to 6.9 L/100 km by the year 2000 using existing technology and without significantly reducing average vehicle size and performance. While McTague (1990) suggests that car manufactures have already employed most of the low cost technologies in reducing car fuel economy and that further improvements will require trade offs in terms of vehicle costs, safety, performance, comfort and convenience. Understanding the arguments concerning possible improvements in car fuel economy in the US can be useful when considering the likelihood of reducing the average fuel economy of new cars in Australia.

Car fuel economy is a function of car design characteristics and can be improved by;

- reducing weight through size reduction, more efficient design and/or lightweight materials
- reducing rolling friction (tyres bearings)
- reducing aerodynamic drag through smaller frontal area and/or reduced drag coefficient
- reducing power requirements for acceleration, and/or uphill grades (McTague 1990).

In the United States, as well as in Australia, the reduction in car fuel economy has been achieved by incorporating a mixture of the above initiatives in car design since the 1970s.

McTague (1990) argues that the initial moves toward more fuel economic cars in the US and in other countries was sparked by the OPEC crises of the early 1970s and 1980s. In particular, cars in the United States have experienced improvements in terms of fuel economy from the early 1970s through reductions in overall weight, aerodynamic design, and improved engine efficiency. However, the most significant change to aid in the improvement in fleet fuel economy in the US has been through an increased demand for smaller cars.

Table 4.5 illustrates the significant improvements which have been made in the US in terms of engine efficiency and vehicle weight, which are two important factors influencing the fuel economy of motor vehicles. The reduction in average vehicle weight indicates both the use of lightweight materials in all styles of motor cars and the demand for physically smaller vehicles. In addition, the introduction of different engine technologies provided an improvement in engine performance without necessarily increasing fuel consumption. A major advance in engine design involved the widespread introduction of single and double overhead camshaft systems increasing engine performance while maintaining relatively low fuel consumption.

Table 4.5
Selected Characteristics of New Motor Vehicles in the United States

	mid 1970s	early 1980s	late 1980s	% change 1970s/1980s
Fuel economy	15.5 L/100 km	10.5 L/100 km	8.2 L/100km	47
Engine efficiency	25 HP/L	28/30 HP/L	50-85 HP/L	100-240
Vehicle weight	1680 kg	1360 kg	1270 kg	24

HP/L - Horsepower per litre of engine capacity

Source: McTague 1990

4.2.3.1 *What is a realistic limit to fuel economy?*

The limit to continued improvement in fuel economy is difficult to determine. Using present technologies in competitions aimed at achieving the best fuel economy, an average rate of consumption of a mere 0.11 L/100 km has been achieved. These competitions are conducted under optimum operating conditions and do not reflect standard passenger car fuel economy tests. This allows competitors to take advantage of operating at efficient speed-load points and conserving energy by coasting wherever possible. The competitors, however, achieve remarkable rates of fuel economy through using fundamental fuel saving technologies including lightweight construction materials, bullet shaped body with very low frontal area and drag coefficient (<0.1), and small engine capacity (McTague 1990). The achievements of these competitions may not correlate directly with automobiles presented for general sale, but it does provide an indication of the fuel economy limits to motorised transport.

A number of prototypes made by Japanese and European car manufactures designed as suitable replacements to the conventional car have achieved outstanding fuel economy rates. In particular, Volvo has a prototype which is claimed to achieve a fuel economy rate of 3.4 L/100km for a combined city and highway test. While Toyota have suggested they have a car capable of achieving a fuel economy rate of 2.4 L/100km and Renaut has reportedly tested a prototype capable of achieving under 2L/100km (Deni Greene 1990).

McTague (1990) suggests that in the US if improvement in the average fuel economy of new cars are to be made they will be in the areas of reducing overall vehicle weight and improved engine technology. Unlike the late 1970s and 1980s where rapid improvements were made in fuel economy, McTague (1990) proposes that future improvements in fuel economy will occur at a greater cost to the consumer. This is because the major improvements in fuel economy have been achieved by relatively easy measures, namely through the use of lightweight building materials, design and down sizing. These changes in vehicle design have been aided by a receptive consumer market looking for lower vehicle running costs. McTague (1990) argues that this cycle has come to an end with vehicle size mix reaching a market equilibrium and that if further improvements in fuel economy are to occur consumers will either have to accept purchasing, on average, smaller cars or be willing to pay more for cars built with expensive lightweight materials.

The improvements in the area of vehicle weight during the 1970s and 1980s was largely a function of body design, however, the current ratio of body weight to other components means that in order for increased improvements in weight to be gained there will need to be a shift towards reducing the weight of the suspension and powertrain components which require more expensive materials to reduce their weight compared with body components. McTague (1990) is sceptical that rapid improvement can occur in these areas of vehicle design, as he suggests the history of motor vehicle production has been a lengthy process of design and testing with very few major innovations introduced on the market over a short period. In conclusion, McTague (1990) argues that over the next 10 to 15 years the rate of improvement in fuel economy will be approximately 0.8 per cent annually which would result in an average fuel economy for new cars of approximately 7.5 L/100km by 2000.

Difiglio et al. (1989) (in BTCE 1991a), suggests that in the United States it is quite feasible for the average new car fuel consumption to reach 6.9 L/100km by 2000. A more optimistic prediction of a rate of fuel consumption of 5 L/100 km may be reached by 2000 by downsizing the mix of cars, and influencing consumer choice through subsidies and taxes (BTCE 1991a). In Australia, the Federal Chamber of Automotive Industries[5] (FCAI) (in Wylie 1990) has set a target for new car fuel consumption of 8.2 L/100 km for 2000 and 8.0 L/100 km for 2005. While the fleet average car fuel economy in Australia is estimated to be approximately 10.9 L/100 km by 2005 a reduction of about 0.6 per cent per year (ABARE 1991).

It would appear that the likelihood of reducing fuel consumption lies in the path of regulation. McTague (1990), like many others, appears to advocate a free market approach to motor vehicle production, allowing consumer preference to influence motor vehicle manufactures to decide on the particular characteristics of new motor cars. The Australian Institute of Petroleum (1991b) support this ideology and suggest government regulation aimed at reducing fuel consumption of new cars may not achieve their desired results. It may, however, be up to governments to play an important role in vehicle design, which, for instance, has occurred in the case of emission standards. The remarkable improvements seen in the US in terms of emission controls have been largely in response to government regulation. It would appear that governments have the ability to play an interventionist role in car design to promote improved average fuel economy in new cars. Essentially average fuel economy can be significantly reduced by promoting cars which are fuel economic, however, this may require a shift in consumer preference away from performance characteristics.

The continued improvement in new car fuel economy will, in Tasmania as in many other places, have a gradual impact upon reducing total fuel consumption. This is due to the ageing profile of the car fleet. Unless strategies designed to increase the rate of turnover of new cars or large capacity cars are discriminated against, the impact of the continued reduction in average new car fuel economy will only have a gradual effect in reducing total fuel consumption. What is critical in terms of fuel economy is car size and capacity. If strategies can be introduced facilitating the downsizing of the car fleet then appreciable inroads may be made in total fuel consumption from the variable of car fuel economy.

[5]The Federal Chamber of Automotive Industries represents the combined Australian automotive industry.

4.2.4 Fuel pricing

One major avenue open to governments to reduce total fuel consumption is through fuel pricing measures. Pricing signals are suggested by a number of studies to be an effective means for regulating fuel consumption. The effect of fuel prices on fuel consumption was considered by the IEA (1984) for a number of OECD countries, they found that during the period 1978 to 1983 there was a decrease in the average annual fuel consumption per motor vehicle brought about by price increases. The way in which total fuel consumption is reduced through petrol pricing is largely by encouraging the use of more fuel efficient cars and reducing motor vehicle use.

Table 4.6 outlines car fleet fuel economy and corresponding fuel prices for a number of OECD countries.

Table 4.6
Car Fleet Fuel Economy & Petrol Prices
1988

	Average Car Fleet Fuel Economy	Cents/Litre
Italy	7.6	151
Japan	10.7*	135
Sweden	10.3	102
West Germany	10.7	83
Australia	11.8	56
Canada	12.4*	53
U.S.A.	11.8	42

* refer to 1986 figures
Fuel economy is equilavent to L/100km
Petrol prices in Australian cents per litre

Source: BTCE 1991a & NIEIR 1990

Table 4.6 indicates that in 1988 those countries with higher fuel prices had, on average, cars which were more fuel economic than those countries with lower fuel prices. While these figures are limited to a single year they do reflect the nature of fuel pricing for those countries which is consequently represented in the car fleet fuel economy figures.

A possible target for Tasmanian fuel pricing may be parity with European countries. In 1990 Australia had an average fuel price of 69 c/L while six prominent European countries[6] had fuel prices ranging from 103 c (Aust.)/L to 159 c (Aust.)/L (IEA 1991). It is important to consider the effect these prices have had on average fleet fuel economy and vehicle utility to consider the possible response that increasing fuel prices would have in Tasmania. In the USA in 1990 the fuel price was 40 c (Aust)/L and the annual per capita fuel consumption was 1827 L while in Italy, where the price was 159 c (Aust)/L, the annual per capita fuel cosnumption was 357 L. The average annual per capita fuel consumption for the six European countires was 476 L per capita. It is important to realise that increasing fuel prices in Tasmania to parity with European countries may not induce fuel consumption reductions to the same extent as the European countries. Increased fuel prices would be expected to encourage improvements in fleet fuel effeciency and travel behaviour. Existing constraints, namely the highly suburbanised nature of our cities, would reduce the respnse rate and hense it would be expected that per capita fuel consumption would lag behind the European countries well past 2005.

The National Institute of Economic and Industry Research (NIEIR) (1990) considered the possibility of attaining the Toronto Target in the Australian transport sector by fuel price alone. A problem outlined by the NIEIR (1990) in calculating the effect of fuel prices was the difficulty in determining the effects of price elasticity. The study suggested that past price fluctuations had neither been significant enough nor sustained for a long enough period to effectively predict long term effects on fuel consumption. The NIEIR (1990) provided two projections of meeting the Toronto Target by fuel prices alone based on their estimates of future changes in the Australian transport sector.

The NIEIR (1990) found that in order to meet the Toronto Target in Australian transport sector by fuel price alone would require fuel prices to rise by between 6 and 10 per cent annually over the period 1988 to 2005. The effect of these price increases were calculated for:

- automobile fuel economy, which was estimated to improve from a fleet average of 11.2 L/100 km to between 8.7 and 7.5 L / 100 km;
- vehicle stock, which was calculated to be reduced by between 12 to 22 per cent of the 1988 figure; and
- vehicle utilisation, which was expedected to decrease by between

[6] The European countries included: West Germany, United Kingdom and Switzerland all with a petrol price of 1.03 $ (Aust.)/L, Netherlands 1.26, France 1.27, Denmark 1.31, and Italy 1.59.

19 and 33 per cent.

The NIEIR (1990) concluded that pricing policies could be a central focus for reducing total fuel consumption and hence lowering carbon dioxide emissions. Pricing policies could be used in such a way as to reduce fuel consumption and direct the added revenue raised into providing better public transport systems. Pricing policies alone, however, bring questions of equity, with the likely result of lower income groups ending up with the less fuel economic vehicles. Thus, in conjunction with pricing policies, there needs to be the introduction of regulatory policies regarding vehicle use (NIEIR 1990).

4.3 Travel Behaviour

Travel behaviour is an important factor influencing total fuel consumption. Inefficient use of motor vehicles leads to an increase in the use of fuel.

4.3.1 Vehicle Occupancy

Increasing vehicle occupancy rates may be a particularly important factor in reducing fuel consumption in urban areas, especially during peak period traffic.

Table 4.7 illustrates that almost 60 per cent of the total kilometres travelled by cars and station wagons in urban areas during 1985 were completed with only one occupant. This indicates there may be an inappropriate use of transport vehicles when it considered that the majority of cars are designed to accommodate at least four occupants. This occupancy rate can be translated to suggest that for 60 per cent of an average cars driven life they are occupied by the driver only. This raises questions as to the possibilities for introducing motor vehicles designed accommodate single or dual occupancy which, if you consider table 4.7, would cater for almost 80 per cent of all kilometres travelled. The problem remains, however, that in general the Australian car buyer prefers large family sedans and wagons which for a great deal of their life are occupied by the driver only.

Vehicle occupancy rates have recently been considered by the Hobart City Council as part of their Central Area Strategy Plan (1991b). The council conducted a specific study focusing on vehicle occupancy rates during both am and pm peak period traffic. The council found that just under 70 per cent of vehicles were occupied by the driver only, 27 per cent had two occupants and the remainder of vehicles had three or more occupants (HCC 1991b). In addition the council surveyed vehicle occupancy rates during the afternoon (2 to 4 pm) at a central city car park and found that the percentage of single occupant vehicles had decreased to just under 50 per cent, two occupant vehicles rated 28 per cent and three or more occupant vehicles made up the remainder (HCC 1991b). These figure indicate the difference between occupancy rates for journey to work and shopping trips. Importantly, the journey to work trip provides an opportunity to increase occupancy rates through initiatives such as car pooling, especially considering the restricted nature of journey top work trip.

Table 4.7
Kilometres Travelled by the Number of Occupants for Cars and Station Wagons, Australia 1985
(% of total kilometres travelled)

	One occupant	Two occupants	Three or more occupants
Metropolitan	59.3	23.4	17.3
Non-metropolitan	43.6	31.6	24.9
Total for all areas of operation	52.5	26.9	20.6

Source: ABS 1986b

4.4 The Likelihood Of Consumer Change Based On Voluntary Behaviour

There is a certain amount of consternation concerning the extent to which changes in travel behaviour aimed at reducing fuel consumption can be initiated by non regulatory means. This section considers responses in travel behaviour by people affected by imposed mobility restraint.

4.4.1 The Tasman Bridge Collapse

Studies focusing on the effects of travel behaviour before and after the Tasman Bridge collapse in Hobart provide an insight into the possible responses people may make when confronted with imposed mobility constraints, such as increased energy costs.

A section of the Tasman Bridge collapsed in January 1975 after it was struck by an ore carrying ship. One of the effects of the bridge collapse was to isolate approximately 30 per cent of Hobart's population, who resided on the eastern shore, from the major employment, retailing and services located on the western shore. The Tasman Bridge formed one of only two road links between the two shores with the other bridge located 20 km to the north at Bridgewater. The effect of the collapse was to create what was previously a five minute road trip into a two hour journey to cross from the eastern to the western shore. The effects of the mobility restriction placed on eastern shore residents was the subject of a number surveys examining a range of household responses to the bridge collapse.

The bridge collapse provided an example of imposed mobility restriction which can be used an example, or a model, of the possible transport alternatives people may make under other possible restricted mobility scenarios, such as tighter controls on transport fuel use. The Hobart example reflects a physical break in mobility providing residents of the eastern shore with limited transport alternatives, while other scenarios would tend to use restrictive means of mobility regulation and may not be as absolute allowing a wider choice of travel options. The disruption to transportation caused by the bridge collapse can be seen to have a number of effects upon the functioning of Hobart city as individuals responded to the alternatives available to them. These responses ranged in magnitude from accepting greater travel times, through to changes in household and employment location effectively influencing the spatial structure of the city.

Of particular interest to this study was the response the bridge collapse had on eastern shore residents who continued to commute to the western shore for journey to work and private purposes. These people had a number travel options available to travel to the western shore. As a consequence of the bridge collapse alternative means for travelling between the eastern and western shores of the River Derwent were arranged including ferries and a temporary bridge (the Bailey Bridge) constructed almost twelve months after the collapse. The Bailey Bridge was constructed with two lanes and was subject to particular regulations governing speed and minimum spacing between vehicles. The Bailey Bridge was able to provide a traffic volume of 1600 vehicles per weekday compared with the Tasman Bridge prior to the collapse averaging 4400 vehicles per week day (Wood & Lee 1979). Thus, eastern shore residents had the choice of maintaining the use of private car, with the significant increase in journey time of up to 2 hours one way, or the use of public transport for all or part of the journey.

Prior to the collapse of the Tasman Bridge the modal split for the journey to work trip for residents on the eastern shore was almost 80 per cent by private car and 20 per cent by public transport (Lee & Wood 1980) The results of a survey conducted eight months after the bridge collapse found a complete reversal in the modal split for the journey to work trip with over 80 per cent of respondents claiming they used a multi-stage journey involving public transport (ferries) and only a small proportion using private transport (Lee & Wood 1980).. By August 1978, ten months after the Tasman Bridge had been reopened, the results of a survey revealed that the modal split for the journey to work trip had once again been reversed with almost 75 per cent of eastern shore workers travelling by car to the western shore (Wood & Lee 1979). In addition, the survey revealed that 22 per cent of eastern shore workers travelling to the western shore used buses and only 1 per cent used the ferries. The 1986 census data showed that public transport usage had declined even further with around only 13.5 per cent of workers living on the eastern shore using public transport for the journey to work trip (Kennedy et al. 1986).

The figures presented above indicate the possible change in travel behaviour which may result from the imposition of tighter controls on using the private car for the journey to work trip, such as higher fuel prices, restricted parking and minimum car occupancy rates. It also illustrates the imbalance in user preference between public transport and the private car under normal circumstances. The collapse of the bridge provided an opportunity to establish public transport as a credible option for the journey to work trip for eastern shore residents. Yet immediately after the bridge had been repaired two important actions took place, firstly there was a return to the private car as the dominant mode of transport for journey to work and secondly the Government responded by constructing a second multi-million dollar bridge ensuring that such a disruption to private travel would never be repeated.

While the bridge collapse provided an extreme case of imposed mobility restraint, the option of using the private car at the height of the disruption was still available, albeit with significant disadvantages over other forms of transport. Freedom of choice was exercised with a significant number of people using private cars and when the Bailey Bridge was constructed greater numbers of people returned to using cars. This case clearly highlights how people will evaluate the advantages and disadvantages of using a particular mode of transport and use what they feel is the most appropriate form. It is important to recognise the issue of perceived options and how people tend to base their decisions on no single criteria. This is due a number of reasons including the spatial structure of our cities in respect to employment and housing, the nature of our lifestyle and the availability relatively cheap, convenient, and flexible personal transport. For example, journey to work trip are often multipurpose trips incorporating shopping, visiting friends, or sports training etc. The multi purpose nature of trips presents considerable inconvenience for commuters using the linearly structured public transport system which is additionally compounded by the non linear spatial structure of our urban system.

The preference for the private car for the journey to work trip, even in the advent of adverse conditions, is important and must be considered when looking at possible ways to reduce car usage. The Tasman Bridge collapse clearly illustrates that only under the most severe restraints on mobility will commuters use public transport to any significant extent. What tends to happen to travel behaviour under mobility restraints is that essential travel, such as the journey to work trip, is continued by car while the more discretionary trips, for purposes such as shopping and leisure, are reassessed and rationalised (Wood & Lee 1980). Furthermore, the change in travel behaviour may, in fact, extend from operational changes in the use of private and public transport to structural changes in terms of household or employment location. The degree to which operational or structural changes are instituted is largely a function of the mobility constraint. As the magnitude of the restraint increases there is a greater likelihood of structural change (Wood & Lee 1980). Thus, when considering possible initiatives to reduce car usage it must be considered what sort of travel behaviour is being targeted. If there is a desire to decrease the use of the private car or change the way the private car is used for the journey to work trip particular measures are required. For example, increasing fuel changes as an initiative to reduce journey to work car usage may have a limited impact. The price of fuel is a non discriminatory action in terms of travel purpose and may not lead to a decline in the use of the private car for journey to work travel but rather reduce leisure and recreational travel. However, dencreasing the availability of long term parking in the city centre or enforcing minimum car occupancy rates during peak periods are forms of discriminatory regulations aimed at journey to work travel. Thus, it is important to recognise that travel behaviour is discretional and that regulations aimed at reducing car usage which are non-discriminatory may not extend proportionally to all types of travel purposes.

4.5 In summary

Tasmania has witnessed a phenomenal growth in car ownership since the early 1900s. There is now almost one motor vehicle per 1.5 persons and one motor car per 2 persons. In association with this increase in vehicle numbers has been the institutionalisation of the motor car as the main mode for the majority of transport activities.

In order for Tasmania to reduce its consumption of petroleum products to meet the Toronto Target it will have to consider strategies aimed at reducing the contribution cars and station wagons make to total fuel consumption. Cars dominate transport activity in Tasmania, however, because of a number of characteristics they provide the most convenient target and potentially the most significant sector for contributing to a reduction in total fuel use. Importantly cars have a number of specific characteristics which make them an ideal target from efficiency and energy conservation programs.

In terms of travel behaviour, the car is used extensively for discretional travel which could, in many instances, be replaced by other forms of transport or reduced through more efficient travel planning. Furthermore, public transport provides an existing substitute for the car for many travel purposes.

There are a number of constructive and simple things car owners can do to help reduce fuel use and the environmental impact of cars.

- Use alternative means of transport where possible including public transport, walking, or cycling. This will aid in reducing fuel consumption, traffic congestion, noise and air pollution.

- When buying a car consider size. As a general rule the smaller the car the more fuel economic and less energy was required to produce it.

- Avoid misfuelling cars designed to operate on unleaded fuel as lead fuel can damage the catalytic converter which helps reduce exhaust pollution.

- Driving style is also important as efficient driving provides optimal performance while excessive acceleration and hard braking can double fuel consumption.

- Ensure that the car is maintained including engine timing, inflation of tyres and general engine maintenance.

- Consider providing used batteries and engine oil to recycling depots.

These types of tips are derived from a number of sources including automotive bodies, consumer groups and government agencies. One possible way of promoting energy efficient driving and car maintenance could be for state governments to provide information with annual registration renewals.

CHAPTER 5
PUBLIC TRANSPORT

Should Tasmania be compelled to reduce its total consumption of petroleum products it may be required to implement strategies aimed at using more efficient or alternative forms of transport. Public transport provides an alternative form of transport to the private car for many travel purposes. Both rail and bus have been shown to be more energy efficient modes of passenger transport than the private car. A study conducted by the BTCE (1991a) found that in Australia both bus and rail transport consumed on average around 40 per cent less energy per passenger kilometre than the private car.

The importance of public transport, as an alternative transport option, is related to the form of transport for which it can act as a substitute. Chapter 4 discussed the significant contribution made by the motor car when used for private and journey to work travel to Tasmania's total transport fuel consumption. Importantly much of this travel can be easily replaced by public transport, unlike much of the commercial transport activity. Presently public transport provides an immediate alternative for many people for their journey to work trip. Thus one of the main questions which needs to be addressed concerns answering why the motor car remains the preferred transport option for many people when it is in direct competition to existing public transport.

Public transport in Tasmania is principally restricted to the larger urban areas. Tasmanian's who have access to some form of scheduled daily public transport include almost 70 per cent of the total population. In reference to environmental and economic aspects, the structure of public transport in Tasmania is quite complex. Economically, public transport directly places a severe drain on the public purse with the State Government controlled Metropolitan Transport Trust recovering one third of its operating costs (DRT 1990a). The debate concerning public transport and its future role is often reduced to economic considerations largely because of the difficulty to quantify many of the environmental and social consequences related to modal split for different transport tasks between public transport and the private car. Economic assessments, however, tend to be based on direct operating costs and do not assess the indirect social and economic benefits of public transport. In terms of environmental factors, public transport may be evaluated at many levels ranging from energy efficiency, to savings in pollution compared with the private car. Broader environmental questions regarding the structure and form of cities dependent on the private automobile may also be considered with respect to the influence public transport has on urban form. In order to consider these types of queries we need to look at Tasmania's public transport, how it operates and how it has changed historically.

Public bus transport in Tasmania is provided by the Metropolitan Transport Trust (MTT) and a number of private bus operators. This chapter will focus primarily on urban public transport and thus concentrate on the MTT as it provides the majority of urban bus services in urban Tasmania. The MTT accounts for almost 45 per cent of the total bus route kilometres travelled in Tasmania, which is very significant considering the MTT's operating area is confined to urban areas (ABS 1989).

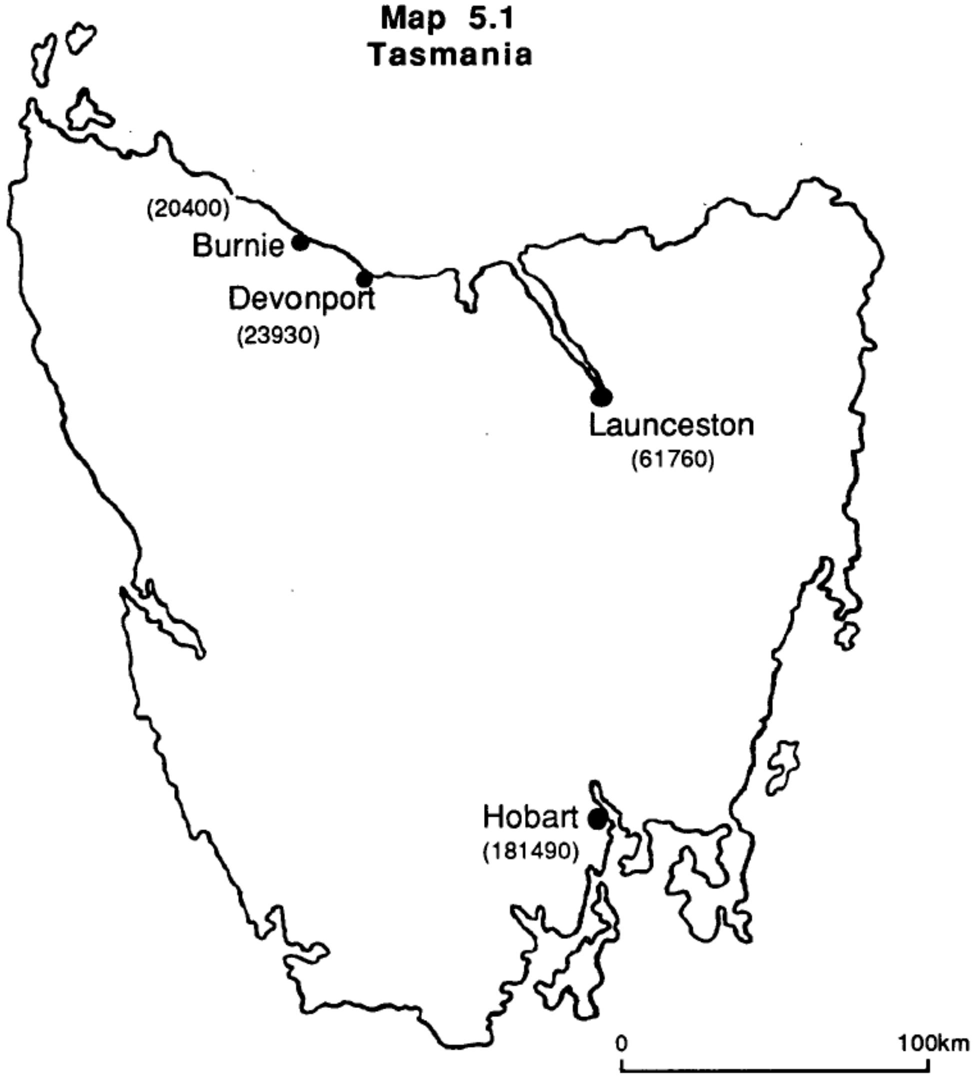
The MTT is a statutory authority established by the Tasmanian Parliament under the Metropolitan Transport Act 1954 to provide, secure or promote the provision of an efficient, adequate and properly integrated system of public transport by road within defined metropolitan areas of Hobart, Launceston and Burnie (the Burnie service area also includes Ulverstone and Wynyard) (DRT 1990a). A number of private bus operators provide services outside the operating area of the MTT. Urban areas serviced by private bus operators include; Kingston, New Norfolk, Ravenswood and Devonport. Private bus operators also service a number of inter-urban routes providing bus transport to many urban centres around the state. Tasmanian Redline Coaches and Hobart Coaches are two of the larger private bus companies providing inter-urban bus services. Map 5.1 outlines the major population centres and their geographical location in Tasmania.

5.1 The Metropolitan Transport Trust (MTT)

The MTT provides the majority of daily urban bus services in Tasmania. During 1989/90 total MTT patronage was 12.5 million passenger trips (which is equivalent to approximately 27 trips per capita), of which Hobart accounted for 75 per cent, Launceston 18 per cent and Burnie 7 per cent.

The MTT only provides bus transport. The Trust operates a total of 255 buses (as at June 30 1990) in its three operating areas. These buses vary in type and reflect the anticipated demand for different services. The Trust has a

Map 5.1
Tasmania



* estimated population 1990

The estimated population of Tasmania for 1990 was 456660
Note the population of Hobart includes the municipalities of Brighton, Clarence, Glenorchy, Hobart, Kingborough and Sorell.

number of large articulated buses which provide additional seating in peak demand and they also have been experimenting with 'midi' sized buses aimed at providing a more economical service to marginal bus routes.

The introduction of electronic ticket operation in 1988 has enabled the MTT to produce accurate passenger statistics and to provide greater flexibility in ticket structure for its patrons. Fares are structured in terms of four broad passenger groups, adult non-concession, adult concession, child concession and student concession. All these groups have access to a number of fare schemes which are based on trip distance, time of day and number of prepaid individual trips. The cost of these tickets varies depending on concession group.

The fare structure has evolved over a number of years to accommodate the different use of service and to encourage an even spread of demand outside peak period journey to work. MTT fares are derived on recovering a percentage of the total operating expenditure and, in addition, are structured to reflect a broad range of economic and social objectives of the Trust's operation. Recently, the MTT has initiated a number of fare types in order to appeal to a broad range of travellers and in doing so introduced fare incentives for travelling at particular times of the day. These types of fare structure initiatives follow similar trends adopted by public transport operators on the mainland states.

5.2.1 Policy background

Transport in Australia is regulated by all three tiers of government although the level of intervention varies both in terms of the type of transport and the form of intervention. In Australia, public transport is basically the domain of state government. Increasingly, however, the Federal Government has been taking more interest in the functioning of urban public transport which is set to continue according to a number of statements from the Federal Minister for Land Transport.

5.2.1.1 Federal Government Policy on Urban Public Transport

The Federal Government has legislated that, as part of the Federal Road Funding Schemes, state governments may use some percentage of their Federal road funding for urban transport projects (Brown 1991). This has resulted in around $30 million per annum of Federal funds being spent by state governments on capital works directed at urban public transport. In particular, the Federal Government has become interested in specifically providing additional attention to the provision of public transport services for disadvantaged groups and environmental matters such as greenhouse gas emissions. As part of a commitment made at the last Federal Government elections (1990) the Government has made available, over the period 1991 to 1994, an additional $200 million specifically for urban public transport programs. This funding arose from the Government's social justice policy and is targeted at the locationally disadvantaged in outer urban areas (Brown 1991).

Federal Government funding is restricted to capital works and may not be used to subsidise services in the form of recurrent funding of public transport operations.

The basic criteria on which funding may be granted is associated with providing a better form of transport service to the fringe of urban areas and reducing congestion on urban arterial roads. The Federal Government is also considering including funding being eligible for projects aimed at contributing to meeting the interim planning target for reducing greenhouse gas emissions by 2005.

As of June 30 1990 the MTT had not received any funding available for capital projects from the Federal Government.

5.2.1.2 Tasmanian State Government- Public Transport Policy

The MTT operates directly under the umbrella of the State Government and it is thus appropriate to consider the policy direction of the Government. In the Tasmanian State Government election, held in February 1992, the Liberal party was successful in defeating the incumbent Labor minority Government. When contacted, in April 1992, the Liberal Party did not have a specific transport policy statement available. This section will consider the State Labor Party policy on public transport as the information obtained from annual reports used corresponds to their term in Government.

The Tasmanian Labor Party has a broad policy platform which is developed in respect to Labor ideology and input from party meetings.

The Tasmanian Labor Party has a comprehensive transport policy[1] program orientated towards achieving major objectives encompassing social, economic, safety, environmental and resources areas. In terms of public transport, the Labor party policy is directed at firstly, providing a social service and secondly, addressing problems associated with the dense use of the private motor car in the urban environment. In order to achieve these policy objectives, the Labor party has outlined a number of measures encompassed within state government legislative jurisdiction. These measures include directives aimed at discouraging inner city car parking resulting from people using private motor cars for journey to work, and sweeping policy statements referring to the importance of providing public transport to disadvantaged members of society. Specifically the Labor party aims to discourage inner city traffic congestion and parking by increasing the area covered by limited time metering (with exemption stickers for residents of the areas), impose greater restrictions

[1] Policy Statement; recieved from the Australian Labor Party, Tasmanian Branch, 11/7/91

on the availability of all-day on-street parking, and to discourage 'one person-one vehicle' during peak traffic periods. At the same time the Labor party is eager to facilitate the greater use of buses (which they suggest are efficient users of road space), by placing more emphasis on the use of public transport in the central city, addressing bus time-tabling problems especially for outer urban areas, provide buses with compulsory right-of-way and provide bus services from the time of occupation of the first homes in new housing sub-divisions.

The stated Labor party policy objectives aimed at changing the way in which people utilise present transport options are evaluated against a background of preserving individuals choice of preferred lifestyle. The initiatives suggested at reducing the imbalance between the public bus and the private car are either aimed at passively discouraging the use of the private car for journey to work travel or encouraging people to utilise public transport. The initiatives do not extend past the end user with all the suggested schemes aimed at the end of the transport cycle (i.e. at the final stage of car parking) and not at the fundamental structure of transport planning. In other words, the policies tend to be stop gap remedies rather than addressing the processes leading to the present transport system.

5.2.1.3 MTT Specific Policy

There are a number of specific policy objectives outlined in the MTT Annual Report regarding social and operating objectives for the trust. The policies incorporate the fare structure as the central medium for promoting the MTT as a convenient and economical alternative to other forms of transport. The focus of the policies tends to suggest the Trust views its position as an alternative and not as the preferred option for urban travel.

The major indication of the MTT's operating policy is outlined via a number of statements regarding the structure of fares in its Annual Report. The following statements regarding the general operating policy of the MTT are outlined below.

The fares structure reflects implementation of State Government policies of:

- *concession travel for disadvantaged members of the community, school children and aged pensioners;*
- *reduced fares for residents of remote Government housing estates*

where there is a high instance of welfare dependency;

- *mobility to all groups within the community including those who do not have access to private transport;*
- *an alternative mode of passenger transport at reasonable fares and so help reduce the community's excessive reliance on the motor car.* (MTT Annual Report 1990, p.14)

These statements presented in the Annual Report 1990 bundle separate policy issues together and expresses them in terms of fare structure. For example, the third and forth statements involve quite different forms of transport requirements. Those people who do not ordinarily have access to private transport may require a different service than those who wish to substitute the private car for the bus for certain travel. By grouping these policy objectives in this way the MTT is using fare structure in an attempt to solve a number of problems which fare structure alone is incapable of resolving. A more appropriate method of achieving the stated policy objectives would be for the MTT to identify and separate the transport roles it wishes to fulfil. The Trust could subsequently form appropriate strategies which may include fare structure, timetables, bus routes and bus types in order to achieve the transport objectives. At the moment, assuming that what is stated in the Annual Report to be correct, it would appear the sole marketing strategy the MTT is employing is fare structure. This, however, is not the case, as the Trust has recently implemented a number of initiatives to provide a more efficient and comprehensive public transport service which fall outside fares.

Two of the most important steps the MTT have made toward improving the level of service they offer include, the provision of central city bus terminals in Launceston and Hobart and the development of an express bus service for the northern population areas of Hobart.

The development of central city bus terminuses in Launceston and Hobart have come about in response to the recognition of the need to centralise public transport in the central city and from general community pressure. The terminuses are situated in the CBDs of the particular cities providing a convenient geographical location to the major shopping and employment centres for commuters.

The introduction of an express bus service to the northern suburbs of Hobart has been initiated as a direct result from the recognition of the need to provide a public transport service which is comparable to the private car. Up until the introduction of the Metro Express (MX) service in July 1991, the bus travel times for the outer northern suburbs of Berriedale, Chigwell, Claremont, Bridgewater and Gagebrook to the city centre would be in excess of 50 minutes. In comparison, the private automobile could comfortably complete the same trip in around half the time with the additional convenience of sheltered car parking in the city centre. The MX service provides three separate bus routes which connect the northern suburbs with the city centre making it possible to travel from Gagebrook (one of the most distant suburbs from the city centre) to the city centre in approximately 30 minutes. The decrease in travel times have been made possible by designing bus routes which provide a minimal number of bus stops yet utilise the major population concentrations in the northern suburbs. Furthermore, the MX service includes the introduction of 'midi' buses to act as feeder transport to the bus terminuses as well as providing inter-suburban transport. The MX service also includes the provision of dedicated buses which incorporate a number of ergonomic features to enhance the travel comfort including, newly designed seats and hand rails, and the ability to lower the bus to enable easier boarding access.

The preceding section has outlined the general policy framework in which the MTT operates and provided a brief overview of recent developments in MTT service. The following sections will look more closely at the operating statistics in terms of passenger and service as well as the financial performance of the MTT in view of providing a description of how public transport performs in Tasmania.

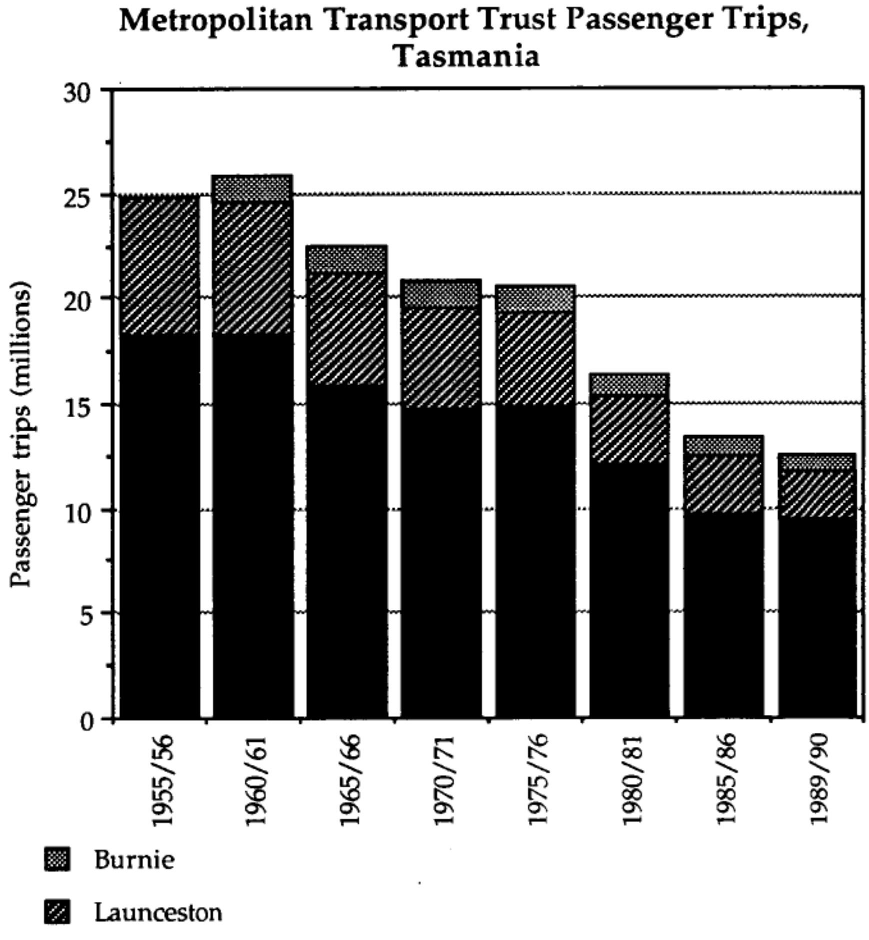
5.2.2 Operating Performance of the MTT

The MTT provides accurate operating statistics which are presented yearly in an annual report. These statistics provide invaluable information as to the yearly performance of the Trust, but perhaps more importantly they provide an indication as to the operating requirements of a public transport system in the major urban areas of Tasmania.

In order to gain an understanding of the operations of the MTT there needs to be a consideration of a number of parameters of operating performance. In particular variables such as, passenger trips, bus kilometres, length of operating routes and fare structure can be used to form a profile of public transport operations in Tasmania.

The examination of bus passenger statistics over a number of years provide a broad indication as to the performance of a bus operator. The passenger statistics for the MTT are illustrated in figure 5.1.

Figure 5.1



Source: MTT Annual Report 1990

Figure 5.1 illustrates the substantial decline in MTT bus patronage during the period 1955/56 to 1989/90. The annual number of passenger trips during the period examined has decreased from a total patronage in 1955/56 of almost 25 million to the 1989/90 figure of 12.5 million. The total decrease in passenger trips from 1979/80 to 1989/90 was 12,329,513 or almost 50 percent of the 1955/56 figure. The decline in bus patronage has been felt in all three operating areas.

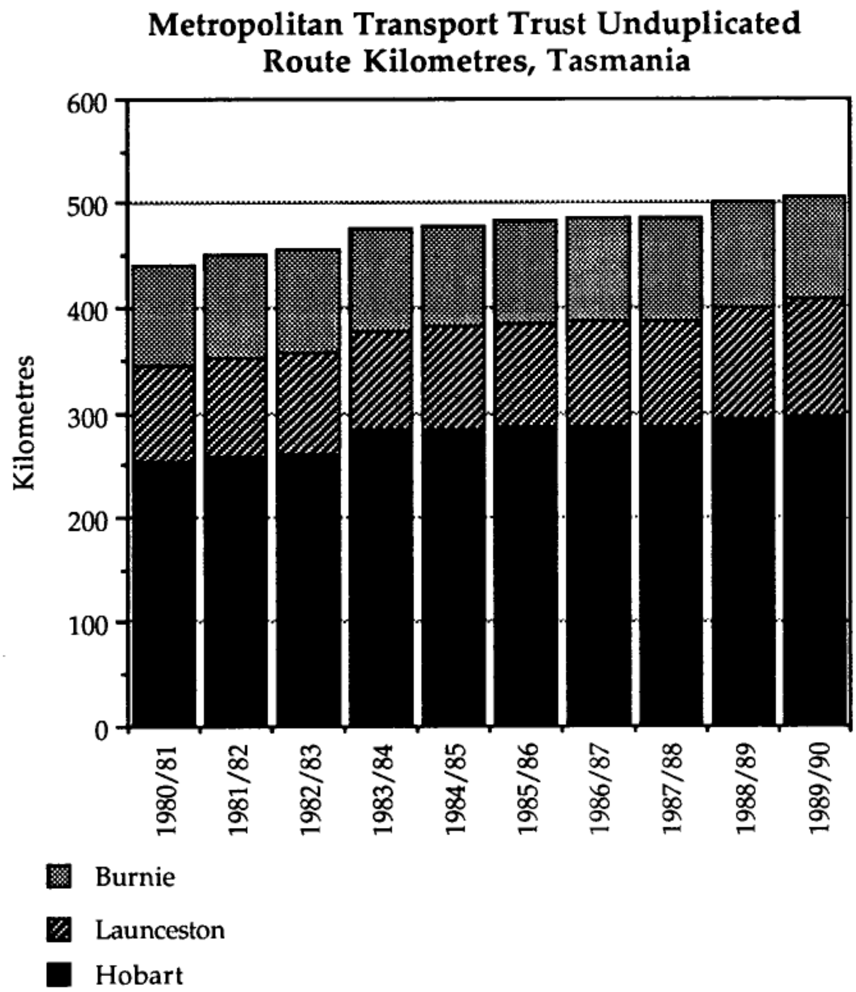
The implications of the reducing patronage of public transport in all the urban centres is complex. The decline in bus patronage is largely associated with the increase in the availability and affordability of the private car and the decline in urban population densities. This has been coupled with the provision for the private car in the city which has facilitated its dominance in terms of the majority of transportation requirements. Since the late 1940s all forms of car usage have increased quite dramatically including transport for journey to work and for other forms of urban travel which were previously the domain of public transport. Furthermore, the role of the car as the central form of urban transport has been amplified by the decline in urban population density which has had the effect of decreasing the viability of public transport. These issues have been discussed in chapter 3 in relation to the increase in automobile dependence and its relation to urban form.

While public transport patronage has been steadily declining the level of service provided by the MTT has remained fairly constant. One indicator of the level of public transport service is the number of unduplicated route kilometres serviced, outlined in figure 5.2. Unduplicated bus kilometres refer to the total number of kilometres which the MTT service and hence may be used as an indicator of the service which the MTT is imparting to the population in its operating areas. Bus routes are assessed annually and changes or additional services are incorporated where it is appropriate. During the period examined the total route kilometres has increased by almost 42 kilometres. This indicates that the MTT has expanded its operating range as the urban area has expanded.

An increase in bus route kilometres of 42 kilometres as a proportion of increase in new roads to accommodate the expansion of the urban areas of Hobart, Launceston and Burnie for the same period is difficult to quantify. The urban area has been expanding at a considerable rate with the majority of new housing being constructed on the urban fringe. While the urban areas in Tasmania have not expanded at the same rate as their counterparts on the mainland, the increase in the urban area is still significant. For example from 1977 to 1990 the urban area of Hobart expanded by approximately 2900 ha (calculated as part of the urban density study outlined in chapter 3). In order to service this expansion in urban area new roads would need to have been constructed, however, it is difficult to quantify the extra road required. Furthermore, the provision of bus services is not always immediately necessary due to a number of reasons including car ownership, age profile and density of new areas. Typically new housing areas are developed over a number of years and it is not until a justified demand is established that public transport is provided.

Figure 5.2 indicates the relative stability in the bus service provided to patrons by the MTT. The unduplicated route kilometres do not, however, provide any indication of frequency or quality of service. These variables are subject to bus timetables and route coordination.

Figure 5.2

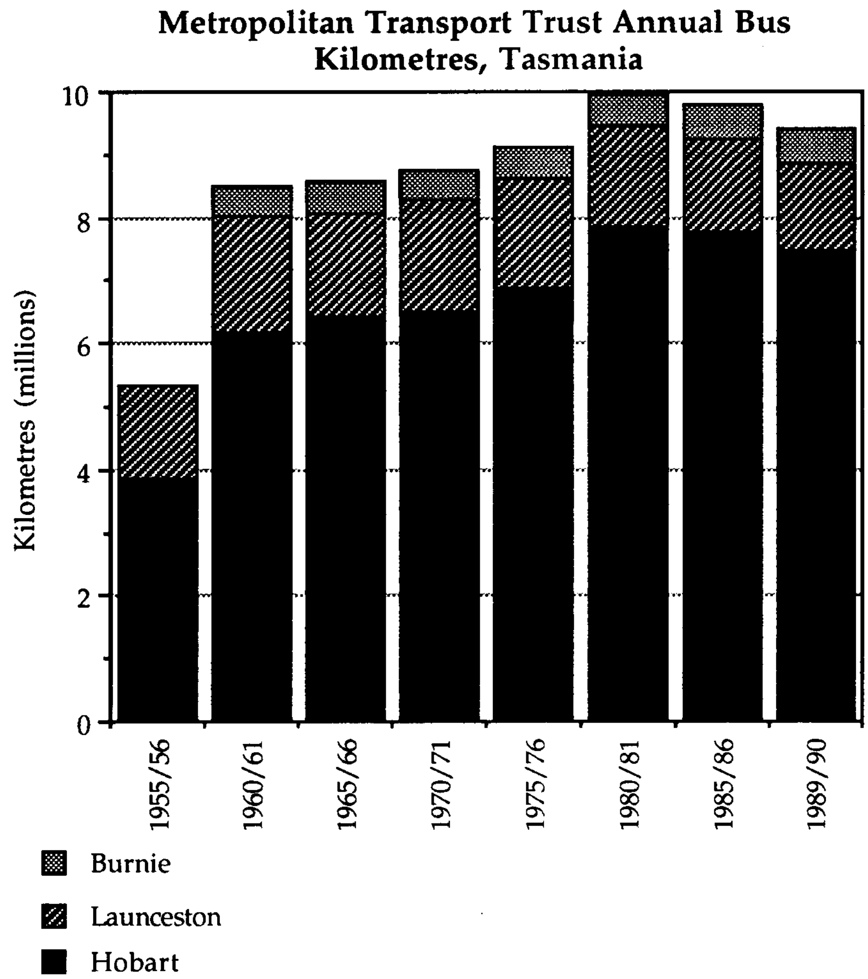


Source: MTT Annual Report 1990

The quality of the public transport service is also indicated by the total number of bus kilometres travelled annually. Bus kilometres travelled is a measure of the frequency of the public transport operations and indicates the extent to which the public transport operator is servicing the bus routes. Figure 5.3 summarizes the bus kilometres travelled by the MTT. During the period examined in figure 5.3 annual bus kilometres have remained fairly constant after the introduction of bus services to the Burnie area in 1960/61.

One of the main factors influencing patronage of public transport relates to the frequency of bus services. The private car provides a high level of convenience as travel can be spontaneous or planned with little regard for external factors. Public transport, however, provides a scheduled service and patrons therefore have to arrange their travel in accordance with the bus timetable. Increases in the number of scheduled services for a bus route increase the convenience factor of public transport compared to the private car. Furthermore, the orientation of bus routes in terms of city coverage is also important.

Figure 5.3



Source: MTT Annual Report 1990

Considering the increase in unduplicated route kilometres and the steady level of bus kilometres it appears the MTT has provided a constant level of service. It is assumed that the travel routes and the frequency of service are coordinated with demand and the fulfilment of the MTT's policy objectives.

An important observation which may be made from the above figures is that while the MTT appears to be providing a constant level of service (in terms of route coverage and bus kilometres) patronage has been declining. The change in the total number of passenger trips have already been illustrated, however, the figure failed to indicate the change in passenger trips in relation to population change. Table 5.1 sets out public transport passenger trips per person for Hobart, Launceston, Burnie, Melbourne and Sydney.

Table 5.1 clearly illustrates a sharp decline in the ratio of passenger trips to the population for all the urban areas serviced in Tasmania. During the same period, however, the level of public transport service in terms of the service provided has remained fairly constant, as outlined by the previous figure relating to bus routes and kilometres travelled. Table 5.1 indicates that there has been a decline in the proportion of the population using public transport or that there has been a decline in the frequency of use.

Table 5.1
Public Transport Passenger Trips per Capita

	1971	1981	1989
Hobart	110.1	83.4	65.1
Launceston	78.7	53.5	37.2
Burnie	31.7	22.1	16.2
Melbourne (1980)	-	95	-
Sydney (1980)	-	142	-

Source: MTT Annual Reports, ABS, & Newman & Kenworthy 1989

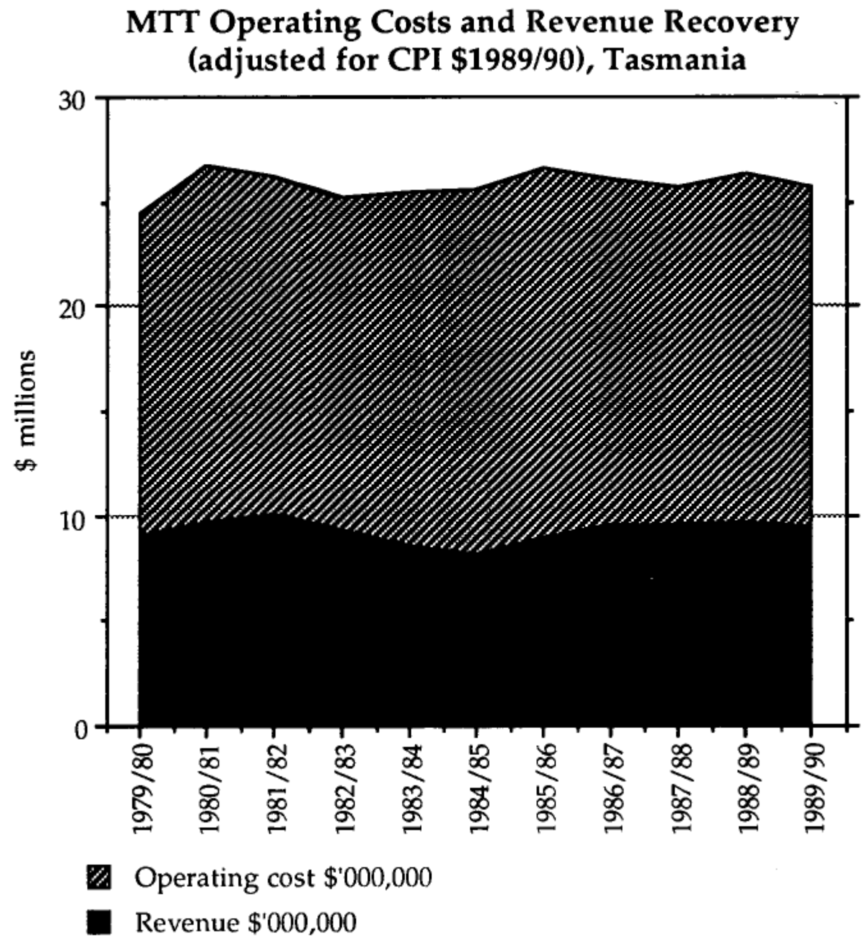
5.2.3 Financial Operating Results

This section will examine the financial operating results of the MTT. The financial operating results of the MTT provide an indication of the costs involved in providing public transport in Tasmania.

The MTT provides a transport service which is subsidised by the State Government who finance the difference between the revenue raised by the MTT and the total yearly expenditure. The Government maintains a close alliance with the functioning of the MTT and inspects the annual report which is tabled in Parliament.

The annual operating expenditure of the MTT may be expressed in terms of revenue and operating cost, which is summarised in figure 5.4.

Figure 5.4



Source: MTT Annual Reports

Figure 5.4 illustrates the relative stability in the ratio between operating expenditure and revenue for the MTT during the period 1979/80 to 1989/90. Both revenue and operating costs have remained fairly stable throughout the period examined in figure 5.4. The MTT has maintained a level revenue which is approximately one third of total operating costs. As the majority of revenue is achieved through scheduled passenger services, the MTT has been able to offset the loss of revenue from the decreasing patronage by increasing fares. In comparison in South Australia the revenue versus expenditure ratio for urban public transport for 1989/90 was approximately 38 per cent (State Transport Authority 1990).

During the 1989/90 the cost recovery for MTT operations was approximately one third of the total operating budget. The State Government funds the difference between revenue earned and total expenditure. Government subsidies are thus a major influence upon fare structure, and are expressed in terms of:

- *the difference between the full adult fare and a concession fare;*
- *the difference between the full adult fare and that necessary to recover all costs;*
- *the subsidy for operating uneconomic low-patronage services to provide what is considered an essential public transport services* (MTT Annual Report 1990 p.14)

The ability of the MTT to structure fares which they feel are responsive to users is restricted by budgetary constraints. While the Trust attempts to maintain a level of revenue of approximately one third of total operating costs with a declining patronage its freedom to structure fares according to social policies is severely encumbered. Unless the MTT is able to increase the level of patronage, attract additional sources of revenue or the Government is willing to further subsidise public transport, the MTT will be forced to continually increase fares at a greater rate than the Consumer Price Index (CPI).

In 1979/80 fares were structured in respect to the number of geographical sections a trip would cover. The cost of adult non-concession fares began at 20 cents (≈ 43.3 when adjusted for CPI $1989/90) and confined travel to within section one. The maximum fare for adult non-concession was 45 (97.4) cents, which entitled travel for the maximum number of sections. Concession fares cost 15 (32.5) cents and entitled travel to all sections.

The fare structure for 1989/90 included a number of additional fare types to enable users to purchase single trip or multiple trip tickets. For single trip fares the minimum adult fare cost 90 cents and $2.00 for the maximum number of sections. The structure of concession fares remained similar to the 1979/80 situation, although the student concession category was spilt to separate tertiary students, who only gained concession fares on multiple trip tickets.

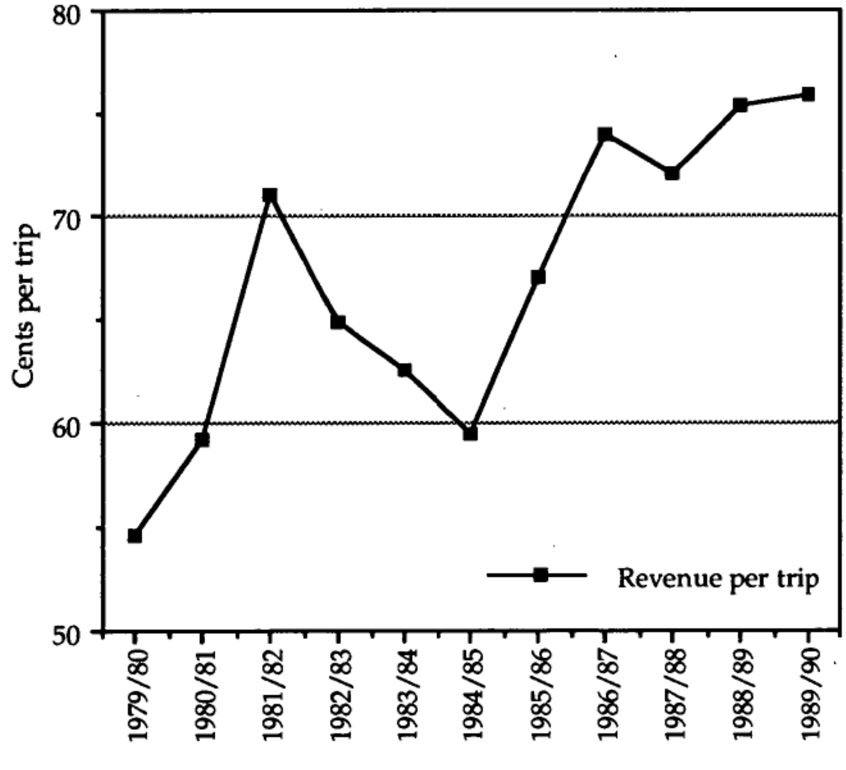
Prepaid multiple trip tickets became available to all concession categories during the late 1980s and provided considerable savings compared with single trip fares. The MTT provides a 'Metro 10' which entitles the traveller to 10 separate trips and a 'Metro Month' ticket enabling the traveller to unlimited travel for a month period. For the adult category the multiple ticket is purchased for a prescribed route, as the multiple trip ticket replicates the section fare system. While for concession categories the multiple trip tickets are not bound by section restrictions.

Savings which may be achieved through the metro 10 ticket system range from 25 per cent to 36 per cent of single fare tickets. While the savings for the Metro Month are associated with individual use, as monthly system entitles the user to unlimited trips during the prescribed period.

Fares have increased during the period since 1979/80, however it is difficult to make simple cost comparisons over time as fare structures have changed considerably, especially with the introduction of electronic ticketing. The increase in the real cost of fares is associated with declining patronage. The effect of maintaining a constant level of annual revenue while passenger numbers have been declining has been to increase the real cost of public transport to users. This is indicated by considering the change in the revenue raised per passenger trip, outlined in figure 5.5.

Figure 5.5

MTT Average Amount of Revenue Raised per Passenger Trip (adjusted for CPI $1989/90), Tasmania



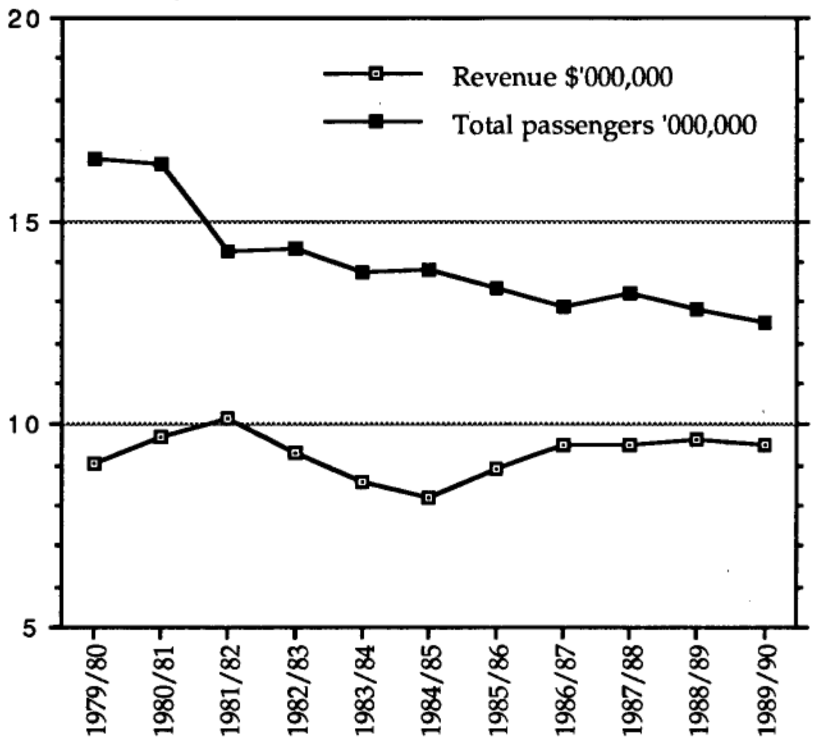
Source: MTT Annual Reports

Since 1979/80 revenue raised per passenger trip has been increasing as indicated in figure 5.5. In order for this to occur the real cost of public transport fares have had to increase. The sharp deviations in revenue per passenger trip outlined in figure 5.5 are accountable to the fact that the MTT does not increase fares in a uniform manner and thus when the changes in passenger numbers are compared to revenue over a number years the yearly results fluctuate.

Comparing the revenue raised with passenger trips provides a good indication of the changes to the costs of public transport. Figure 5.6 outlines both total passenger numbers and MTT operating revenue.

Figure 5.6

Total Passenger Trips Compared with Revenue (adjusted for CPI $1989/90), Tasmania



Source: MTT Annual Reports

The MTT has maintained its revenue base (in real terms) during the period illustrated in the figure. The majority of the revenue is raised from scheduled timetabled services (almost 80%) while other services, including leasing of advertising space on buses and charter work make up the remainder. In order to maintain a constant level of revenue while passenger trips have steadily decreased the MTT has initiated a number of programs aimed at providing a more cost efficient service as well as adjusting its fare structure. An interesting feature of MTT operating statistics is illustrated in figure 5.6; while revenue has been steadily increasing passenger trips have just as steadily been decreasing. This highlights the problem of maintaining a constant level of revenue when the source of that revenue, namely passengers, is declining.

One factor which may have led to this situation could be that the MTT is caught in a revenue recovery versus fares policy trap. On the one hand the MTT wants to maintain its passenger numbers but on the other it wishes to recover a certain percentage of its operating budget which is affecting the MTTs attractiveness as a cheap alternative means of transport.

5.2.4 Public Transport in summary

Tasmania has a public transport service which has maintained its level of service in terms of operating range yet has seen a large decline in patronage. It would appear that while the cost of fares have increased in real terms it is not fares which are turning passengers away. Without studying in detail the reasons why people do not prefer to travel by bus it would appear that the MTT is part of a wider pattern of decreasing usage of public transport. Of particular importance to public transport viability has been the continued development of infrastructure to accommodate the car in urban areas.

Increasingly public transport is taking on the role of a social service providing transport for those without access to a private car. While this is a vitally important role it does not necessarily provide any benefit in terms of reducing transport fuel in Tasmania. In order for public transport to aide in this quest it will be required to replace the private car for a number of transport purposes. An initial indication of the extent to which public transport displaces the private car can be identified by the percentage of total trips completed by adult fare passengers. During 1989/90 adult full fare passengers accounted for approximately 35 per cent of total MTT patronage, while child and student concession accounted for approximately 40 per cent and the remainder comprised adult concession (MTT 1990). In comparison in South Australia, during 1989/90, the adult passenger fare category comprised approximately 41 per cent of total patronage while child and student concession accounted for approximately 36 per cent (State Transport Authority 1990).

5.2.5 Future of Public Transport in Tasmania

The future of public transport in Tasmania is dependant upon the roles it is going to fulfil. Currently the MTT operates a transport service which provides several different functions including; journey to work travel, a means of transport for those who do not otherwise have access to other forms of transport, transport for shopping trips, private travel etc. In terms of operating structure, however, the MTT is largely orientated towards the journey to work service. The implication for this orientation in service is a transport system structured to accommodate the rapid movement of people during two periods of the day. The service is equipped with the appropriate buses and operational organisation to meet the demands of journey to work travel which does not necessarily provide the best possible service for other transport roles. This situation is changing with the introduction of 'midi' buses and buses designed ergonomically (a number of new buses are able to provide a lower entry point aiding people with impaired movement to board the bus) to provide a more appropriate service outside the traditional journey to work travel.

One of the central problems of traditional public transport is that of flexibility. The private car provides unparalleled freedom of travel and convenience. At any one time a bus may be fulfilling a number of transport roles for any number of passengers and this is where a number flexibility problems arise. In order to provide a convenient and flexible service the MTT needs to identify travel needs in the community and respond to those needs. This form of service may not, however, be any more cost effective as the present system but it would provide a superior social service. Presently the bus operation is focused upon providing services to the city centre which certainly caters for the majority of travellers, however, it exposes the public transport's greatest weakness compared to the private car, that of flexibility.

5.3 In summary

There are a number of factors which can be identified as being a key part of providing a public transport system as an alternative to the private car.

Convenience, i.e. the ability to move people quickly and efficiently as opposed to other forms of transport. For Hobart the MTT has shown a clear recognition of this point with the introduction of its MX service providing a fast service from the outer suburbs and secondly with the central city bus terminus.

Flexibility. An ability for travellers to move in directions other than towards the city centre. The MTT incorporates this initiative with buses catering for movements from suburb to shopping complex without moving via the city centre and will be enhancing this service with the 'midi' buses.

Cost. The cost opposed to other forms of transport. Increasingly the private car will become less attractive for certain journeys due to spiralling costs in terms of fuel and parking, however, at present the costs are relatively low for the form of transport which is obtained.

Government intervention. Each tier of government can play a role in increasing the use of public transport. Local government can reduce the supply of car parking in the central city. The State government can play an important role through traffic laws, for example, compulsory give way to buses which would allow buses to return to the traffic flow from bus stops and designated bus lanes to provide decreased travel times for buses etc.

CHAPTER 6
ROAD AND RAIL FREIGHT TRANSPORT

This chapter will focus on commercial transport in Tasmania with regard to general transport statistics, energy consumption, and finally a discussion of the issues regarding the modal split for bulk freight transport. Commercial or business related transport accounts for a considerable proportion of the State's total transport related fuel use. If inefficiencies can be identified in this sector of transport then savings in total fuel consumption may be able to be accomplished.

Tasmania's situation in regards to freight transport is unique compared with other Australian states because of its island nature. All freight must be either shipped or flown into Tasmania and then distributed from these entry points by either rail or road. This tightly bound transport system provides an ideal example for examining various transport statistics.

6.1 Road Transport in Perspective

This section will outline general statistics concerning commercial transport users. The following section will consider broader issues of the road/rail debate.

There is continual debate between individuals and representative bodies of the various road users concerning their rights in using the existing road network. This debate ranges over a wide agenda involving the perceived safety of mixing the various modes of road transport users on the existing road network, the relative damage to roads caused by the different road users (specifically articulated trucks), and issues of modal split for the transport of freight between road and rail.

6.1.1 Commercial Road Transport

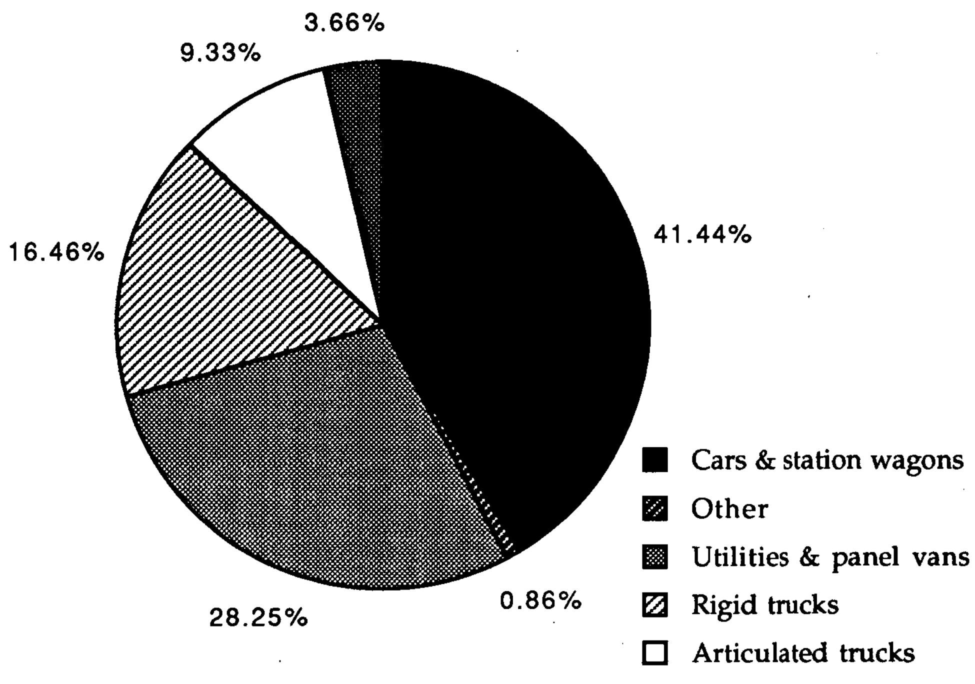
In 1990 the clearly recognisable commercial transport vehicles including trucks, buses, utilities and vans registered in Tasmania, represented approximately 25 per cent of all registered vehicles. During the period 1970 to 1990 the number of these types of vehicles have more than doubled from 30665 to 66937 units, however, their position relative to total registered vehicles has only increased 4 per cent (DRT 1991b). Cars and stations wagons dominate registered vehicles with 220 thousand registrations while utilities and panel vans, trucks, and buses combined account for 67 thousand.

A more conventional statistic associated with the study of commercial transport is business kilometres travelled. The ABS (1989) estimates total kilometres travelled by type of vehicle and makes estimations as to the particular function of travel, for example business kilometres. Business kilometres can be divided into the total number of kilometres travelled by the type of vehicle and the average annual kilometres travelled per individual vehicle. Business kilometres provides an indication of the frequency of road use for particular modes of transport. Business kilometres can be useful when examining the function of the transport fleet and the relative benefits particular road users gain from road infrastructure.

Figure 6.1 illustrates the relative proportion of the total kilometres travelled in Tasmania for business purposes according to the type of vehicle used.

Figure 6.1

Shares of Business Kilometres Travelled in Tasmania by Mode, 1988



Source: ABS 1989

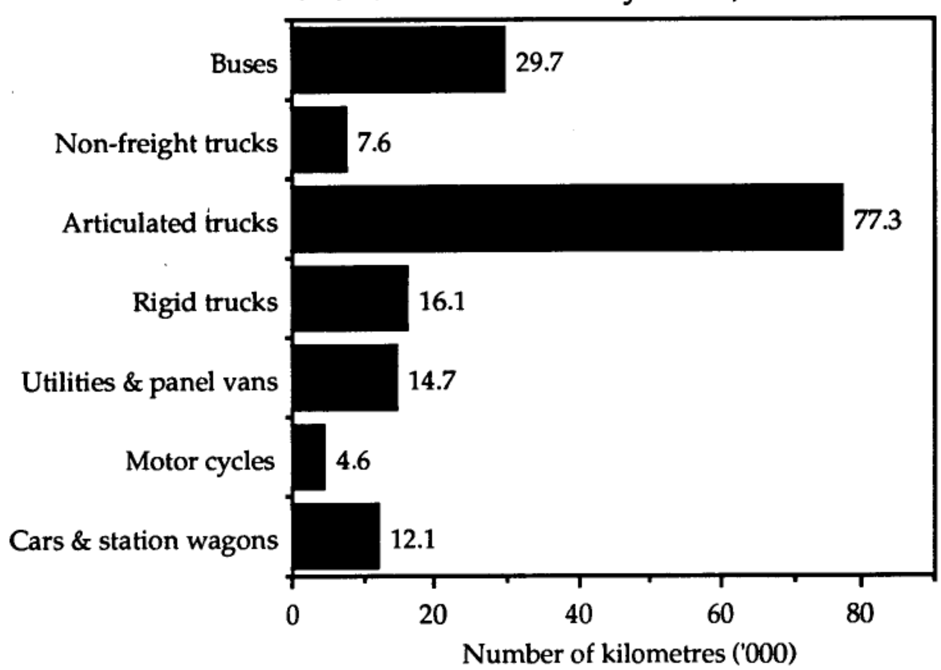
An important aspect of the transport industry illustrated in figure 6.1 is the dominance of business kilometres travelled by cars and station wagons.

Cars and station wagons tend be inconspicuous as to their purpose of travel and thus it is often not realised the extent to which the car serves as a business vehicle. Rigid and articulated trucks account for around 25 per cent of the total business kilometres travelled in Tasmania.

Figure 6.2 indicates the estimated average kilometres travelled for business purposes per vehicle during 1988, or vehicle utility. Articulated trucks are clearly heavily utilised by their operators. This is an indication of a number of factors including the purpose built nature of these vehicles, the types of commodities being transported, government regulations and the capital invested in large trucks.

Figure 6.2

Annual Average Number of Business Kilometres Travelled in Tasmania by Mode, 1988



Source: ABS 1989

Comparing figures 6.1 and 6.2 in respect to the utilisation of cars and station wagons for business purposes, it appears that while a large component of total business kilometres are travelled by cars and station wagons these kilometres are dispersed over a large fleet. The average business kilometres may reflect the flexibility of the different vehicles to preform different tasks, for example large articulated trucks are specific built for commodity haulage, while cars and stations wagons can easily double as a vehicle for the journey to work trip as well as a vehicle suitable for business purposes.

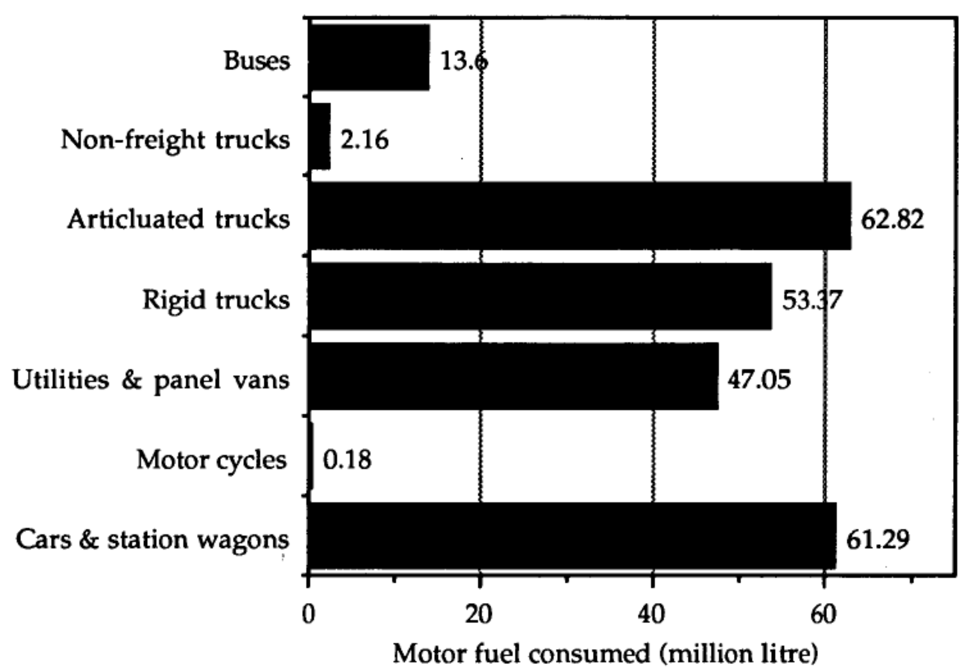
In summary it would appear that the utility of particular vehicles used for business purposes varies considerably, articulated trucks, while being relatively low in numbers are heavily utilised and cars and station wagons are large in number but are moderately used.

6.1.2 Energy Consumption

There are significant levels of fossil fuels consumed for business transport in Tasmania. During 1987/88 vehicles used for business purposes consumed an estimated 240 million litres of motor fuel which represented approximately 40 per cent of total fuel consumed for road transport. Figure 6.3 illustrates the estimated total fuel consumed for business related transport based on calculations made from information presented in the ABS Motor Vehicle Survey 1988. Total fuel consumption estimates presented in figure 6.3 were calculated by multiplying total kilometres travelled by purpose in Tasmania by the fuel economy for the different vehicles based on Australian averages. Figure 6.3 represents a broad approximation of fuel consumption for business purposes in Tasmania for 1988. The estimated total fuel consumed provides a good indication of the energy used by the commercial transport sector.

Figure 6.3

Fuel Consumed for Business Purposes, Tasmania 1988



Source: ABS 1989

Figure 6.3 indicates there is a relatively even distribution of fuel consumed for the types of vehicles used for business purposes. In figure 6.1 the proportion of kilometres travelled for business purposes was dominated by cars and station wagons, yet when total fuel consumed is considered there is a much more even distribution between all the types of vehicles. This may be explained in respect to how fuel intensive the different transport tasks are and the type of vehicles being utilised. While cars and station wagons account for over 40 per cent of total business kilometres and articulated trucks account for less than 10 per cent (figure 6.1) they both use a similar amount of fuel in completing those total kilometres.

Business transport operations form a large part of the total road transport system in Tasmania. Table 6.1 provides a summary of a number of important statistics comparing business transport with the total transport operations in Tasmania.

Table 6.1
Commercial Transport and Total Transport Operations, Tasmania 1988

	Kilomtres travelled (millions)	Litres of fuel consumed[1] (millions)	Energy[2] (Peta joules)	Tonnes of CO_2 emissions[3] (millions)
Business	1242.8	240.47	8.91	0.67
Total road transport	4017.2	576.86	20.51	1.54

Estimates are based on ABS 1988 Motor Vehicle Survey.
1. Fuel consumption was based on Australian averages for the relative modes of transport applied to the Tasmanian example.
2. In estimating energy consumption allowances were made for the use of different fuels.
3. CO_2 emissions were based the greenhouse gas coefficient of 75 kilo tonnes of CO2 per Peta -joule of fuel consumed.

Source: ABS 1989

6.2 The Road/Rail Debate

This section will discuss some of the major issues of the road/rail debate in Tasmania including the relative energy efficiency of the modes of freight transport, social costs, and pollution (including visual, air and noise). Other aspects of the debate such as Tasrail's operating and financial performance and the real costs of road based freight transport will also be considered.

The transportation of bulk freight in Tasmania is divided between rail and road based transport. Increasingly during the last decade the modal split between road and based freight transport has shifted toward road based operators. This trend is occurring on a nationwide basis (Webber 1990). During the period 1961/62 and 1985/86 the Government operated railways experienced a drop of 14 per cent in terms of the total Australian freight task while road transport increased its real share by 43 per cent (Andrews & Gray 1990). The decline in rail's share of the freight task has been despite considerable productivity increases by the railway. There appears to be an ongoing debate regarding the future of Tasrail's operation in Tasmania, largely due to its doubtful viability. The closure of Tasrail would result in the transfer of the rail freight task to road which would have a number of implications for the Tasmania's transport industry.

6.2.1 Rail Transport

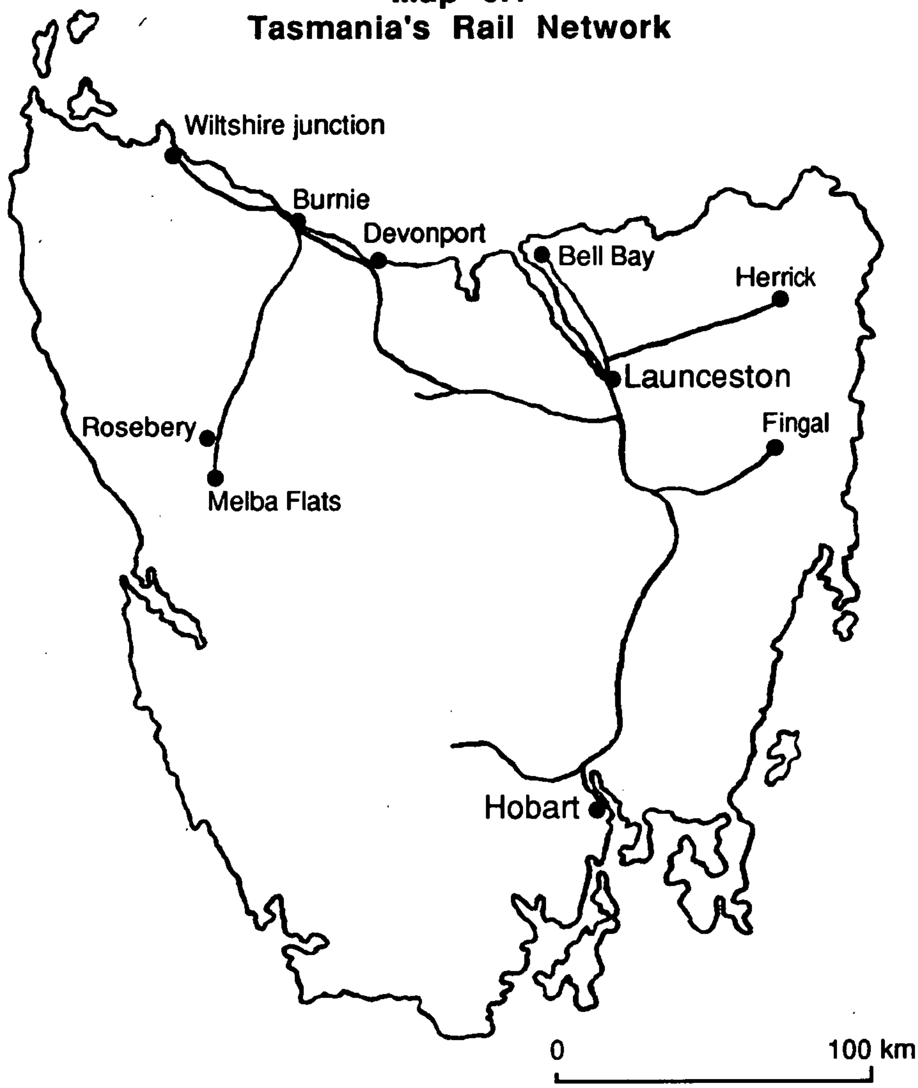
Rail transport has had a long history in Tasmania with the first lines laid in 1871 linking Launceston with Deloraine. Hobart was connected to Launceston by the mid 1870s and by the 1890s Tasmania had a comprehensive rail network connecting the major northern ports with the south of the State.

Rail network in operation in Tasmania (1991) totalled 804.8 km with an additional 130 km included in the Emu Bay Railway. The Emu Bay Railway is the only private commercial line linking the mining town of Rosebery and the port of Burnie. The remaining rail network connects the major northern ports including Burnie, Devonport and Bell Bay with the major population and industrial centres of Launceston and Hobart. There is also rail connecting Wiltshire Junction in the north-west, Herrick in the far north east and Fingal on the east coast. Tasmania's rail network is duplicated by a number of highways including the Midland, Bass and Tasman highways.

Map 6.1 illustrates the rail network in Tasmania.

In 1975 the Tasmanian Government Railways were taken over by the Commonwealth Government and in 1978 the railway became under the direct control of the Australian National Railways Commission (ANRC). Up until the acquisition the railway had been subject to a continual decline in operating viability and was in need of major capital investment in operational equipment and restructuring of operations management. Following the findings of the report conducted by Joy et al. (1976) on the Tasmanian Rail System, the Commonwealth Government set upon subsidising the full operating deficit of the railway and funded a redevelopment plan to aid in the modernising of the railway. The annual subsidy provided by the Commonwealth remained at approximately $20M in 1989/90 dollars from 1975-76 to 1984-85 (BTCE 1991b).

Map 6.1
Tasmania's Rail Network



Source: BTCE 1991b

In 1985 a revision was made to the form of subsidy arrangements, with the Federal Government agreeing to provide a set supplement consisting of a single financial package totalling $52M. In 1988, at the expiry of the financial package, the Federal Government commissioned a study into Tasrail operations and following the findings of this report agreed to finance the railway for a further 5 year period (BTCE 1991b). The change in funding arrangements initiated by the Federal Government included a five year financing program aimed at: providing short term financial security for Tasrail, reviewing and implementing suitable operating strategies, and increasing its operating efficiency. The Federal Government's intention of the fixed term funding on the basis of commissioned assessment was aimed at encouraging the continual improvement in Tasrail's operating performance.

6.2.1.1 Tasrail's financial performance

Tasrail's financial performance is influenced by a number of factors including: the limited scale of operation, Tasmania's difficult topography, the small population and industrial base, and the inheritance of inadequate infrastructure requiring a significant level of economic resources to improve its condition.

The financial operating performance of Tasrail for the period 1978 to 1990 is indicated in table 6.2. The figures presented in table 6.2 relate to overall performance and do not include the direct government subsidies received by Tasrail.

Table 6.2
Selected Financial Indicators, Tasrail
($ millions)

	1978	1984	1990	%change 1978-90
Operating revenue	23.166	23.724	28.859	25
Total expenditure	64.613	53.697	45.389	-30
Operating loss	41.447	29.973	16.530	-60

All figures expressed in $1989/90
Source: ANRC Annual Report 1989/90

In order to comprehend the relevance of the figures in table 6.2, selected operating statistics need to be taken into consideration, illustrated in table 6.3.

Since 1977/78, when the Tasmanian railways fell under new management, there has been an overall reduction in the annual operating loss. The operating loss has fallen by 60 per cent which has largely been attributable to a reduction in total operating expenditure. Importantly the improvement in the operating deficit has occurred at a time when the actual revenue recovery per net tonne-kilometre (NTK) has decreased (table 6.3). The decrease in revenue per NTK up until 1984 was accountable to freight rates which did not increase at the same rate as inflation largely due to a number of major contracts which had fixed rates (BTCE 1991b). The revenue recovery has steadied since 1988 to be just under 7.0 cents per NTK which represents an almost 20 per cent increase over the low of 1984 of 5.7 cents. The effect of the decrease in revenue per NTK has been reflected in the overall operating revenue which, although it has improved by 25 per cent, has, in actual dollars, only resulted in an increase of $5.7M. In comparison there has been a massive turnaround in terms of expenditure of 30 per cent or almost $20 million. The major problem, however, confronting Tasrail is the magnitude of the relation between operating revenue and expenditure which results in an operating loss of over half that of the operating revenue. In order for Tasrail to improve its viability it will need to increase annual freight tonnage transported, and maintain an annual decrease in expenditure through whatever means, otherwise it will have to increase its rates for NTKs in order to improve revenue.

Table 6.3
Selected Operating Performance Indicators, Tasrail

	1978	1984	1990	% change 1978-90
NTKs (million)	246	412	413	68
Freight tonnes (000's)	1604	2192	2025	26
NTK/Average employee	145907	346218	511455	251
NTK/Wagon	119825	352137	563438	370
Freight revenue/NTK (cents)	9.24	5.76	6.99	-24

NTK - Net Tonne Kilometres
Source: ANRC Annual Report 1989/90

While the operating deficit points to the overall commercial performance of the railways it does not give any indication to the profitability of individual commodities transported. D'Este (1989) found that the estimated cost recovery for particular commodities varied considerably. The transportation of pulpwood, cement and coal provided almost total cost recovery while the remaining commodities (outlined in table 6.4) generally recovered less than 50 per cent of their costs of transportation. The result of these figures raises the questions of how the pricing mechanisms for commodity transportation are arrived at and why they are not priced to recover the costs of transportation. The answer to this question is associated with two factors, the fixed cost of operating a rail network and the price of transporting goods by road based operators (D'Este 1989). There are considerable fixed costs involved in operating railways and can only be minimised by the high utilisation of the system making these costs a small component of individual commodity transportation. This, however, does not answer the question as to why these costs are not transferred onto pricing which would be expected to reflect all the component costs associated with the operation. D'Este (1989) suggests that Tasrail's pricing structure is a response to the competition it receives from road based transport operators.

In terms of general operating performance, Tasrail has achieved a remarkable increase in overall productivity. In 1977/78 Tasrail's freight task was 246 million net tonne-kilometres and by 1989/90 this had improved to 412.9 million net tonne-kilometres, however, the 1990 figure was slightly down on the previous several years. The areas of employee and rolling stock productivity have shown the greatest improvement in productivity for Tasrail. Employee productivity has improved largely because the work force has been halved since 1977/78 yet the freight levels have improved. Importantly for Tasrail there has been an improvement in rolling stock productivity which has been the implementation of improved management initiatives and more efficient operating practices. Although there was a decrease in the free-weight task for 1990, Tasrail's overall operating performance appears to be steadily increasing and it is hoped that by 1995-96 the railway will be at a break even point (BTCE 1991b).

Table 6.4 details Tasrail's freight task during 1989/90 and 1990/91.

Tasrail's freight task is dominated by 3 commodities, timber products, coal and cement which comprise almost 75 per cent of the total freight task (table 6.4). Other bulk freight commodities constitute around 15 per cent and containers, which provide the major non bulk commodity, contributes just over 10 per cent of Tasrail's total freight task. The low diversification of commodities which are transported is replicated in terms of the small number of companies which form the major customers of Tasrail. Six firms, namely, Australian Pulp and Paper Mills, Australian Newsprint Mills, Forest Resources, Goliath Cement, Cornwall Coal, and the Pasminco E. Z. either received or dispatched about 90 per cent of Tasrail's freight task during 1989/90 (BTCE 1991b).

Table 6.4 illustrates the importance of logs as a transport commodity for Tasrail. The future of the timber industry may significantly affect the continued viability of Tasrail and hence its future operating viability (based on the present structure of commodity freight transport) may be dependant on the expansion of the Tasmanian timber industry. The limiting factor facing Tasrail to benefit from the expansion of the timber industry is the fact that its operating area is limited to the existing rail network.

Table 6.4
Tasrail Freight Task, ('000 Tonnes)

	1989/90	%	1990/91	%
Woodchip logs	635	31.37	696	32.08
Pulpwood	214	10.57	173	7.79
Cement	326	16.11	358	16.50
Sulphuric acid	126	6.23	157	7.24
Containers	198	9.78	221	10.19
Coal	369	18.23	392	18.07
Fertiliser	91	4.50	89	4.10
Timber - sawn	0.5	0.02	5	0.23
Other goods	64	3.16	78	3.60
Total	**2024**		**2169**	

Source: BTCE 1991b

6.2.3 Infrastructure and equipment

The Joy et al. (1976) report evaluated track condition and concluded that only 6 per cent could be considered to be of 'high standard', the remainder of the track ranged in its rating from fair to very poor. Since acquisition of the railway by AN in 1978 there has been an ongoing programme of track improvement. This programme has been aided by the financial assistance from the Federal Government. The improvement to track condition has involved the replacement of wooden sleepers with steel sleepers, and the continuous welding of track lines. At 30 June 1990 assessment of the track rated 38 per cent of track as being in 'very good' condition, 38 per cent in 'good condition', 16.1 per cent in 'fair' condition and the remaining 9.1 per cent of the track which is used infrequently as being in 'poor' condition. There has also been a steady reduction in the percentage of the track subject to speed restrictions.

Since 1975 additional infrastructure improvements have included the construction of container terminals in Launceston and Hobart, the modification of track routes in a number of localities, the construction of a number of bridges, reconstruction of rail yards and the development of a new 'one spot' wagon repair centre (BTCE 1991b).

The locomotive fleet has also been upgraded since 1975 with an operating fleet in 1991 of 49 locomotives which includes 33 locomotives purchased from Queensland Railways since 1987. The current rolling stock fleet consists of 728 wagons of which 400 (55 per cent) are log wagons, reflecting the importance of woodchip and pulpwood logs to Tasrail (BTCE 1991b).

6.2.4 Rail Protection Levies

The *Tasmanian Traffic Act 1925* delegates authority to the Tasmanian Transport Commission to impose Rail Protection Fees (RPFs) to be levied upon road freight carrying vehicles. RPFs were designed to enable the Transport Commission to influence the structure the freight carrying transport system and were primarily designed to increase the viability of rail transport over long distance freight movements.

RPFs currently apply to:

- vehicles with a gross vehicle mass (GVM) or gross carrying mass (GCM) exceeding 12 tonnes;
- loads of more than 7 tonnes of the following commodities: bulk cement, bulk fertilisers, logs, timber, coal or acid;
- journeys exceeding 100 km in competition with rail.

If a transport operator meets any of the criteria making them liable for payment of the protection fees they are subsequently required to pay 1.4 cents per tonne GVM or GCM per kilometre which must be paid in advance to the Transport Commission. Exemption from the fees may be granted if the carrier can show that rail transport is unsuitable for the transport task and there are also a number of bulk products which have been provided with an exemption from RPFs.

The revenue collected from RPFs has fluctuated over recent years as illustrated in table 6.5. It is interesting to note the variation of revenue received by the different commodities over the short time span considered in the table. The variations may be explained because of the inclusion of some products into exemption scheme and commodity specific changes (DRT 1991).

Table 6.5
Revenue Derived from Rail Protection Fees

	1986/87	1987/88	1988/89	1989/90	1990/91
Logs	4062	1355	482	17739	16696
Timber	11675	13871	71319	62765	901
Coal	115	1109	374	36745	134288
Cement	142	38989	49455	47914	55275
Sulphuric acid	4829	2771	-	-	-
Limestone	3010	678	1131	-	1228
Fertilisers	141180	176317	66750	6398	12525
Total	**$165013**	**$235090**	**$189510**	**$171561**	**$220913**

Source: DRT 1991

In real terms the annual revenue received from RPFs has been declining. The scheme has not been maintained in accordance with the original intentions for which it was designed. Most significantly the levy has not increased in line with inflation which in effect means the fee is now worth less than a sixth of its real value in 1964 when the rates were last revised (BTCE 1991b). Furthermore, the number of commodities receiving exemptions has increased.

It is hard to determine to what extent the revenue collected from the RPF scheme represents the true total NTK of commodities transported in competition with rail. It is suggested by most reports into transport of commodities in Tasmania that there is considerable avoidance of RPFs through both conscious and unconscious means.

Table 6.6 outlines a comparison between road and rail in relation to the transportation of a number of commodities. In addition table 6.6 provides an estimate of the contribution road transport operators made in terms of rail protection levies.

Column 1 in table 6.6 illustrates the ABS (1989) estimated road NTKs for the period 1987/88. The GVM tonne kilometres (shown in column 2) are calculated in relation to the total revenue raised by the RPF scheme for 1987/88 and subsequently converted to a tonne kilometre value. This value is greater than the NTK because the GVM tonne kilometre includes the weight of the commodities being hauled and in addition the weight of the truck. Thus the GVM tonne kilometres is calculated by multiplying the total mass of the truck including its load with the kilometres travelled. The GVM tonne kilometre value will be greater than the equivalent NTK but it does provide an indication of the truck freight attracting RPFs in relation to the total freight task.

Table 6.6
Comaprison of the Road/Rail[1] Tonne Kilometres Transported
(millions)

	Total Road NTK	GVM TKs (attracting RPFs[2])	Total Rail NTK
Logs & timber	595.1	1.08	199.3
Coal	2.6	0.08	83.4
Cement	6.5	2.78	14.7
Sulphuric acid		0.19	18
Fertiliser	12	12.5	30.1
Other		0.05	

NTK Net Tonne Kilomtre
GVM TK - Gross Vehicle Mass Tonne Kilomtres
RPF - Rail Protection Fee. RPF is set at 1.4 cents per NTK of road transport in competition to rail transport

1. NTK figures for road refer to 1987/88 while rail refer to 1989/90
2.GVM TKs refer to the total Road TKs which attracted RPFs 1987/88

Source: DRT 1991

Theoretically, the GVM tonne kilometres can be used as a broad approximation of the modal split for the different commodities which are deemed under the RPF scheme to be in competition with Tasrail. As discussed above, the level of non payment of RPFs is hard to calculate and thus making any reliable comparisons based on table 6.6 is rather questionable. Table 6.6 does, however, raise some important question as to the extent to which RPFs are making an impact on the modal split. For example, it is estimated for logs and timber the total road task is almost 600 million NTK of which only about 1 NTK (representing less than 0.2 per cent) is subject to RPFs. While the RPF scheme provides exemptions for timber products, it would appear that timber may potentially be a commodity of greater benefit to rail as a transportable commodity.

6.3 Road freight transport

It is estimated that the road transport freight task for 1990 was 1988 million NTK (BTCE 1991b). The Bureau of Transport Economics (BTE 1987) report considering the Tasmanian Road Freight Transport Industry found that road haulage in Tasmania was generally a profitable business, and that the transportation of logs and livestock was more profitable than the haulage of general freight. In addition, the report suggested that due to the restrictions placed on the entry of operators into the road transport industry and the indexation of freight stifled any incentive for road haulers to purchase the most efficient trucks.

In the event of Tasrails closure the freight task would be transferred to large articulated trucks with a GVM over 30 tonnes. At 30 June 1990 the number of registered trucks with a GVM over 30 tonnes totalled 1794 which represented approximately 9.1% of the total truck fleet in Tasmania.

There would be an expected increase in the level of traffic volume based on the transfer of the 1990 rail freight task of just under 413 NTK to road based operators. The transfer of the 413 NTK from the railway would convert to between 300 and 330 NTK for road based operators due to the existing road distances being shorter when compared to the rail equivalents (BTCE 1991b). An increase of 330 NTK for the road freight industry would represents a 16.5 per cent increase over the estimated 1990 road freight task of 1988 million NTK.

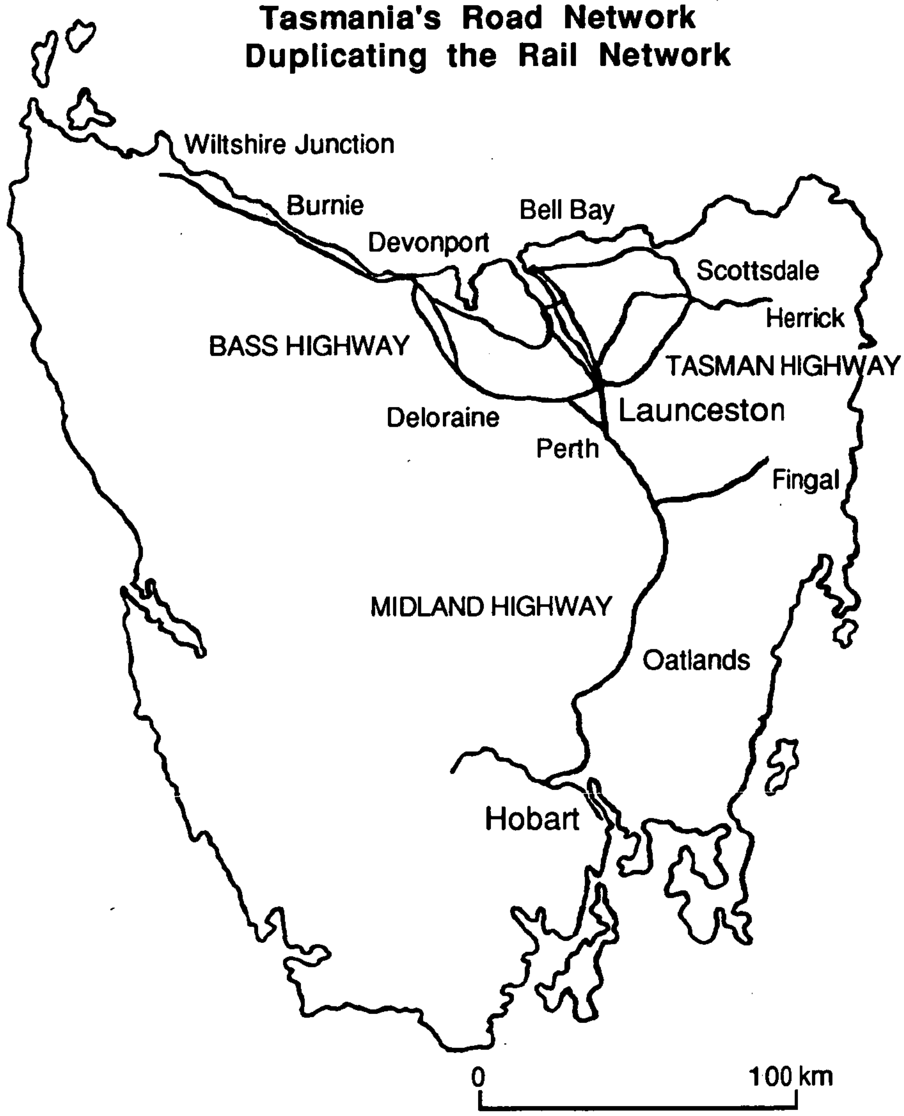
Recently there has been a proposal to introduce B doubles onto Tasmanian roads by road freight transport lobbyists. The term B double describes a truck form which consists of a prime mover hauling two semi trailers, each shorter than a typical semi trailer. The advantage of attaching two or more trailers to a prime mover is the increased load which may be hauled. For instance in South Australia the maximum gross mass of a truck and freight combination permissible is 115.5 t while in Tasmania the present maximum gross mass of a articulated truck is 41 t. The Tasmania road freight lobbyists are not at present contemplating the introduction of road trains, however, the introduction of B doubles would allow trucks to operate with a gross combination mass of around 60 t. It has been suggested that using B doubles will improve transport efficiency by approximately 20 per cent (ISC[1] 1987).

[1]Inter-State Commission

The main objections to the introduction of B doubles in Tasmanian stem from the claims that the present roads are inadequate to safely accommodate these vehicles in association with general traffic. Essentially, it is claimed that there are insufficient overtaking lanes on the highways and that the extra length of B doubles will jeopardise the safety of motorists attempting to overtake these vehicles outside the multi lane zones.

Map 6.2 illustrates the major road networks which duplicate the rail network in Tasmania.

Map 6.2
Tasmania's Road Network Duplicating the Rail Network



6.3.1 Road cost recovery

6.3.1.1 Road funding

Table 6.7 outlines the classification and the relative road lengths in Tasmania.

Table 6.7
Tasmania's Road Network 1990

	Sealed km	Unsealed km	Total km
Proclaimed State Roads	3,567.7	239.2	3,806.9
Council Roads	5,461.1	7,791.4	13,252.5
Other Subsidised Roads			5,680
Total Roads			**22,839**

Source: DRT 1990b

Unlike Tasrail, who as an operating body are responsible for the maintenance and upgrading of the rail network, road transport operators do not directly pay for the maintenance of the road network they operate upon. Road transport operators pay taxes and levies which contribute to a pool from which monies for road construction and maintenance is taken. The form of taxes road users pay include registrations fees and motor fuel tax.

The Commonwealth, State and Local Governments all contribute to the funding of Tasmania's road infrastructure.

The Commonwealth raises revenue from excise and custom duty on motor spirit and diesel fuel (Feb. 1991, 25.767 c/L for both petrol and diesel). During 1989/90 the Commonwealth raised $7.03 billion from excise and duties on petroleum products, of which $4.02 billion was raised from petrol and $1.57 billion from diesel fuels (Australian Institute of Petroleum 1991b). The Commonwealth allocates money for the construction and upgrading of roads in the states and territories on the basis of priorities determined by the Government.

The State Government collects taxes from transport users from a variety of sources including both fuel taxes, registration fees, road tolls and levies. Revenue collected goes into Consolidated Revenue and it is then up to Treasury to determine the amount to be spent on road infrastructure. The revenue collected by the State from road users does not necessarily reflect the amount spent by the government on road infrastructure.

Local classified roads represent a large section of the total road network in Tasmania. Local government is responsible for the maintenance of roads which are funded by receipts received from the Commonwealth and from rates and tolls charged within their municipal boundaries. The State Government also contributes to the maintenance and construction of local roads on behalf of local government. Table 6.8 provides an estimate of the revenue raised within Tasmania by the different tiers of government.

Table 6.8
Revenue Raised from Tasmanian Road Users 1989/90
($ million)

	Revenue from fuel taxes	Revenue from other sources (registration fees, etc.)
Federal	146	not applicable
State	39.4	53.7
Local	not applicable	0.8
Total	185.4	54.5
Net Total		**240**

Sources: DRT 1990a & 1991, Tasmanian State Government 1991 & Australian Government 1991

6.3.1.2 Road Spending

During 1989/90 the State Government received approximately $52.3 million from the Commonwealth for road infrastructure, in addition to this the State Government spent approximately $60 million on its road network (DRT 1990a & Australian Government 1991). In total there was around $76.5 million spent on new pavement construction and almost $36 million spent on road maintenance (DRT 1990a). Table 6.9 provides an outline of the money spent on the different types of roads in Tasmania as well as the financial contributions the Federal Government made to road construction and maintenance.

Tasrail does not receive financial support from government sources targeted for rail maintenance or construction. The responsibility for the upkeep of the rail network comes directly from Tasrail's operating budget. Furthermore, Tasrail is not exempt from paying Commonwealth motor fuel excise fees. It is estimated that during 1989/90 Tasrail contributed approximately $2.2 million of which $0.5 million may be hypothecated to have been contributed to road funding (DRT 1991). From January 1990 Tasrail has been compelled to pay the State Government's petroleum franchise fees which are estimated to cost Tasrail a further $0.5 million annually.

An important factor which may be partly responsible for the disparity of funding between road and rail infrastructure is related to the beneficiaries of the money spent on the infrastructure. With road construction and maintenance, not only do road freight operators benefit, but so to the general road user who can see where their taxes are being spent. With rail transport, any infrastructure improvements only directly benefit the rail users. While in the long term the general road user may be better off with a larger share of freight transport being transported by rail, in the short terms the benefits of an improved road network are far more tangible.

Table 6.9
Total Expenditure and Federal Funding of Tasmania's Roads 1989/90
($ million)

	Expenditure	Federal Grants
National Roads	21.75	23.8
Arterial Roads	69.92	13.8
Local Roads	20.67	14.7
Other	1.05	-
Total	113.77	52.3

Sources: DRT 1990a & Australian Government 1991

6.3.1 Road Cost Recovery - specific

In principal, road user charges should be levied so that the beneficiary pays. As outlined above the road infrastructure budget comprises an assortment of taxes and levies placed upon all road users. While the Commonwealth raises the majority of its revenue in the form of a direct tax based on fuel use the State Government uses a series of levies and taxes which may not be reflected in the benefits received by the individual road user. The Inter-State Commission 1990 (ISC) on a National Road Pricing and Funding Scheme concluded that the present manner in which funds are raised by State and Local Governments does not match road revenue or expenditure to the actual use made of roads in an equitable manner. The ISC (1990) suggested that a more appropriate form of revenue recovery should include the use of fuel charges and in the case of heavy vehicles, a mass distance charge. The mass distance charge for heavy vehicles should be based on the total number of kilometres travelled and the gross vehicle mass (ISC 1990).

Particular concern in relation to road maintenance and construction costs is associated with the disparity between the contributions made by the various road users to the road budget. A study conducted by the BTCE (1988) apportioned road damage by mode of transport vehicle with respect to the contribution the mode of vehicle made to the total road budget. The study found a considerable disparity between the average contribution made by the different road users to the road budget. The study suggested that cars contributed approximately $664, while articulated trucks contributed between -$2532 for less than 5 axle trucks, -$18 417 for 6 axle trucks and -$48734 for trucks with more than 6 axles, on average per vehicle to the balance of road expenditure (BTCE 1988). The significant disparity between the contributions made by the different road users to road expenditure suggests that large articulated trucks are provided with a considerable operating subsidy compared with the average car.

The ISC (1990) suggested that road damage is directly attributable to vehicle mass and that any revision made to road user charges should incorporate taxes based on vehicle mass. Furthermore, the ISC (1990) concluded that there should be some form of road classification scheme outlining the expected use of roads. A road classification scheme could be used to construct and maintain roads to specific standards depending upon its intended purpose. For example, major freight transport routes could be built to particular standards and users of the particular roads could pay accordingly.

The ISC (1990) proposed a new form of road user charges levelled at recovering road construction and maintenance costs primarily through fuel taxes and mass distance charges. It is proposed that all vehicles should incur charges in the form of fuel taxes and articulated trucks should be charged for their trailers on the basis of the mass and distance travelled (BTCE 1991b). Currently in Tasmania articulated trucks pay set registration fees and incur mass distance charges. The structure of these fees does not discriminate between the mass of the truck expressed at the axle. It was felt by the ISC (1990) that vehicle charges should reflect the mass at the axle because it is the best reflection of the potential damage the truck may cause to the road network.

The nationwide enforcement of the proposed ISC scheme would result in the recovery of road user charges from far fewer sources than the ad hoc levies and taxes presently in existence and would reflect an equitable, user pays system. The new charges would be directly reflected in road freight rates and thus, in general, should lead to a shift in demand from road haulage to rail (Webber 1990).

The application of the ISC (1990) recommendations for articulated trucks in Tasmania would be varied. The major determinants affecting a trucks operating cost are the GVM and number of axles. The cost ratios recommended by the ISC (1990) would mean under the present scheme operating in Tasmania, some operators would be better off while others would incur greater charges depending on the type of truck and the loads they carrying. Basically the type of trucks which will benefit from the adoption of the ISC (1990) recommendations would be those with the greatest axle to weight ratio. It must be remembered that the ISC (1990) proposed scheme is aimed at recovering road user charges directly from the user in relation to the potential damage which the operator may be causing.

6.4 Closure of Tasrail

If Tasrail were to close it would be expected that its freight task would be entirely transferred to road transport operators. This would inevitably lead to an increased level of road freight traffic which in turn may pose problems for Tasmania's road network. The possible closure of Tasrail has been considered by a number of studies which have focused upon the various implications that such a closure would have on Tasmania and its road network. In general the conclusion amongst these studies was that up to 1000 kilometres of road would be affected by rail closure and that up to 470 kilometres of road would require extensive upgrading to meet an acceptable standard for the increased traffic volume. There was, however, little consensus as to the extent and cost of road reconstruction and expected annual maintenance which would be required in the event of increased traffic levels. At a minimum, it would be expected that $20M would be required to upgrade the affected road network to an acceptable standard and annual road maintenance would remain unchanged.

6.4.1 Environmental Aspects

The environmental aspects of a Tasrail closure may be measured in terms of the balance between the possible benefits of the rail closure and the effect of an increased level of heavy vehicles.

One effect of a Tasrail closure may be measured in terms of an estimated increase in traffic volume of trucks on the major transport corridors around the Tasmania. Table 6.10 outlines the estimated increase in the number of six axle trucks which may result from the closure of Tasrail. The estimates are expressed in terms of the average annual daily traffic (AADT) which provide an indication as to the number of truck trips on the particular highways. The figures presented in the table are based on the average at a number of points on the highway which AADTs were recorded. Table 6.10 does not provide an indication whether there would be a natural increase in truck traffic, without the influence of the closure of Tasrail, due to normal economic growth.

Table 6.10
Increase in Truck Traffic on Tasmanian Roads as a Result of the Closure of Tasrail

	AADTs 1991	Estimated AADTs 1995	% increase 1991-1995
Bass	213	347	63
Midland	164	265	62
Tasman	51	66	29

AADT - average annual daily traffic
Note: AADTs relate to six-axle trucks only

Source: BTCE 1991b

The consequence for truck traffic volume on the Midland and Bass Highways as a result of the closure of Tasrail may be quite significant according to table 6.10. While the costs of this increased traffic volume in respect to road construction and maintenance has already been addressed there may be additional costs in terms of environmental and social outcomes.

In addition to the increase in noise levels there may also be problems associated with the passing of additional trucks in terms of vibration and deposition of commodities, especially coal and cement dust. While many of the historic townships have been bypassed on the major highways there are still a number of significant historical buildings which would be subject to increased level of vibrations with additional truck traffic.

6.4.2 Pollution

The effect of transferring the rail freight task to road based operators would result in an increased level of carbon dioxide and other pollutants released by the transport sector. The increased level of carbon dioxide emissions is associated with the relative efficiency of freight transport between road and rail. It is generally accepted that rail transport is a more energy efficient mode than road based systems for the transportation of freight. There is, however, some contention as to the relative energy efficiency of rail as compared with road transport. The Draft Industry Commission report 1991 on Rail Transport suggested that for the transportation of freight, rail may be twice as energy efficient as road transport per net tonne kilometre and consequently produces far less carbon dioxide (DRT 1991).

Table 6.11 outlines a number of features associated with road and rail freight transport in relation to energy efficiency and carbon dioxide emissions.

Table 6.11
Comparison of Energy and Carbon Dioxide Emissions between Rail and Road Freight Transport

	Tonne kilomtres (billions)	Energy consumption (PJ)	Energy consumption (MJ/TK)	Rate of CO_2 emissions (g/TK)	Total CO_2 emssions (Mt)
Tasmania					
Rail	0.455	0.36	0.79	52.84	0.024
Road	1.514	2.41	1.60	107.5	0.163
Australia					
Bulk rail	37.1	15	0.4	29	1.1
Non-bulk rail	13.1	11	0.8	60	0.8
Road	40.9	63	1.4	104	4.6

TK - tonne kilometres
Road statistics relate to articulated trucks only
Australian rail statistics relate to Government railways

Sources: BTCEa 1991, ABS 1989 & Tasrail (per. com.)

The figures refer to fuel energy and are calculated in terms of total fuel consumed for all purposes for articulated trucks and Tasrail. It appears that for the Tasmanian example, rail it a much more energy efficient mode of freight transport than road based systems.

The expected increase in carbon dioxide in 1993-94 in the advent of a Tasrail closure are calculated by attributing the expected rail freight to road based transport operators. Thus the net impact of a Tasrail closure, as illustrated in the table 6.12, is in addition to the total CO_2 emissions from existing road transport operators.

Table 6.12
Greenhouse Effect From Tasrail Closure in 1993-94 by Mode
(tonnes CO2 per annum)

Mode	1993-94 Estimated CO2
Rail	-24 132
Road	+37 408
Net impact	+13 276

Soure: BTCE 1991b

6.4.3 Noise Pollution

An increase in noise pollution would be expected due the larger volume of trucks as a result of a Tasrail closure. The level of expected truck volumes is indicated in earlier section of this chapter. The most noticeable increase in noise pollution would occur in the towns which are situated on the Midland, Bass and Tasman highways. It is suggested that on a dBA scale, a heavy truck at 7 metres distance travelling at 40 kilometres per hour produces a noise level of 90 dBA, which is injurious to hearing with continuous exposure (BTCE 1991b). In order to maintain a constant level of 90 dBA trucks would need to pass a given point continuously which tends not to happen in actuality. It is felt that even in the towns most subject to increased traffic levels the noise pollution would be below 68 dBA. However, this level of noise pollution, while not injurious, could prove to be exceedingly uncomfortable to those people subjected to it.

While the incidental noise level of trains can be significant, the low frequency of travel tends to reduce problems of noise pollution.

6.4.4 Social Costs

In a move to increase employee productivity AN Tasrail embarked on a redundancy scheme which has seen a number employees drop from 1686 to 790 between 1979/80 to 1990. Furthermore in October 1991 an additional 160 employees were given redundancy notices.

The major social cost which would occur as the result of a Tasrail closure would be in the form of lost employment. The effect of redundancies follows through to dependants and to the wider community. Importantly at a time of when the unemployment rate in Tasmania is nearing 11 per cent (September quarter 1991, ABS) many workers made redundant may have difficulty finding alternative employment.

The loss of employment from the closure of Tasrail would be offset to some degree as increased employment would be generated by the transfer of freight to the road transport industry. Road transport is, however, generally less employment intensive compared with rail (BTCE 1991b).

6.4.5 Effects on Road Accidents

The effect of an increased level of truck usage on highways could lead to an increased level of road accidents. The effect of road accidents are felt by the immediate friends and family of the injured party and by the wider community through the subsequent cost of health care and associated costs involved in accidents.

It is estimated that the railways are associated with, on average, three level crossing accidents per year resulting in one fatality and 2.4 injuries in Tasmania (BTCE 1991b). The BTCE (1991b) study suggests that should Tasrail rail close the number of road accidents would rise with two additional fatalities, 4.3 additional serious and 7.3 minor injuries resulting from road accidents.

6.5 Conclusions

The costs of shutting down Tasrail are primarily those associated with carrying the rail freight traffic by road, namely truck costs, road pavement damage and additional accidents (BTCE 1991b). It would appear that Tasrail provides a more energy efficient form of freight transport compared with the present road based systems. Rail has, however, a number of disadvantages compared with road in terms of speed and flexibility. In Tasmania, (as with the rest of Australia) road based freight transport has been increasing its share of the total freight task, largely because of the favourable treatment road transport has received from the various levels of Government. For example in Tasmania the RPF scheme which was initiated to encourage freight transport by rail has been allowed to become largely ineffective. If rail is to gain a greater share of the freight task it will require Government action to provide the necessary incentives to encourage users to favour rail transport.

The BTCE 1991b study conducted a number of cost and social benefit analysis of which the majority of the results were significantly negative indicating that society would be worse off if the railway was disconnected. The more Tasrail is able to improve its efficiency, the greater would be the lose to the Tasmanian community of its closure (BTCE 1991b).

6.6 In summary

Commercial road transport accounts for approximately 10 per cent of Tasmania's total energy consumption and contributes a significant amount to total carbon dioxide emissions.

Large articulated trucks, while consuming a large volume of fuel, are heavily utilised.

Rail transport appears to be significantly more energy efficient than road based freight transport.

The RPF scheme appears to be unsatisfactory in terms of its initial agenda. If the Government intends to manipulate the road/rail modal split then the scheme should be directed more energetically towards its objectives.

Trail has made a remarkable improvement in all levels of operating performance and productivity, however, because freight cost recovery has not been maintained at real dollars the improvements in productivity have not been reflected in the financial results.

In respect to environmental and social costs Tasrail should be maintained.

Trucks do not currently pay a true measure of attributable road damage.

A road cost recovery scheme should be established to recover the real damage costs of large articulated trucks.

CHAPTER 7
CONCLUSIONS

The aim of this chapter is to outline strategies which might be used to reduce land transport fuel consumption and/or reduce greenhouse gas emissions in Tasmania by 2005, in accordance with the guidelines of the Toronto Target.

To date the only strategies proposed by government to reduce fuel consumption are those of the Federal Government involving the 'Better Cities' program. The 'Better Cities' program is designed to consider alternatives to the present suburban settlement pattern of Australian cities. As part of the this program one of the options proposed includes urban consolidation which aims to create higher density housing. This in turn may impact upon per capita energy use for transport. Apart from the 'Better Cities' program government does not have projects in place to reduce transport fuel consumption by 2005, which is now less than 15 years away. It is unlikely at present that Tasmania will reduce its emission of greenhouse gases in line with the Toronto Target.

7.1 Baseline Predictions of the Changes in Fuel Consumed by the Transport Sector to 2005 based on a Continue as Normal Scenario

This section will examine the possible contribution cars and station wagons and other transport modes will make to total fuel consumption in Tasmania to the year 2005.

Cars and station wagons have been separated from other transport modes because they presently account for approximately 75 per cent of road vehicle kilometres travelled and consume over 60 per cent of the total fuel consumed in Tasmania (ABS 1989). The dominance of cars, in terms of transport activity within Tasmania, means that any changes in relation to average annual fuel use will have a significant impact upon the State's total transport fuel consumption. In addition, the availability of information concerning future changes in fleet fuel economy and other variables is far more detailed for cars than for other modes.

Making predictions about the future with any degree of accuracy is a difficult thing to do. The following section details a scenario of change in the structure of vehicle numbers and use of the Tasmanian fleet and looks at the effects of changes in different variables upon total fuel consumption up until 2005. Predictions of future fuel consumption are based on estimates concerning average annual vehicle utility, number of vehicles, and average vehicle fuel consumption.

The following information outlines the premises on which estimates about the future of cars in Tasmania were made.

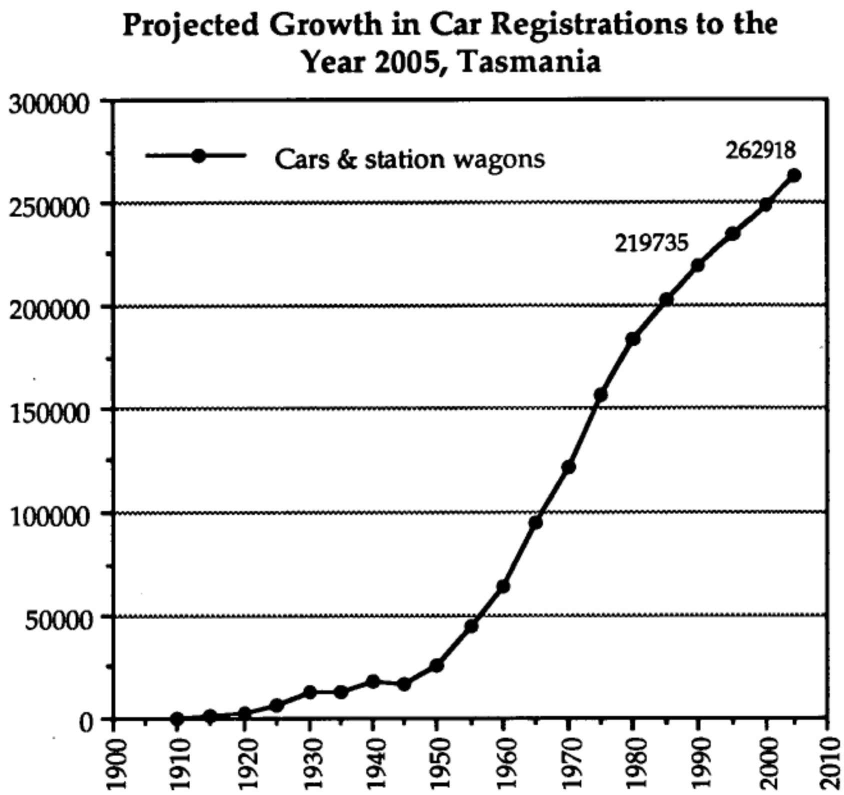
Number of cars and station wagons

It is likely that the number of cars and station wagons registered in Tasmania will increase annually to at least the year 2005, considering the historical profile of vehicle registrations up until 1990. The methodology used to quantify the increase in vehicle numbers was based on the historical change in vehicle registrations. To calculate future vehicle numbers it was assumed that cars and station wagons would continue to increase but at a declining rate. This assumption was made because the historical incline of the profile of registrations has been progressively less acute since the early 1970s and furthermore, it is assumed that cars represent a commodity which will inevitably reach a saturation point. The projected rate of increase was based on the yearly average rate of increase for the years 1985 to 1990 corrected at five yearly intervals according to the average decline between 1980 and 1990. The method of extrapolation for predicting future car registrations based on the historical changes in registrations provides a broad estimation of the possible growth in car numbers.

Figure 7.1 illustrates the growth in vehicle numbers up until the year 2005 based the historical growth in car registrations.

Estimating the future growth in car numbers by considering the historical profile of registrations ignores two important determinants of car ownership, namely population change and the saturation point of car numbers. In order to evaluate the change in car ownership levels in light of the estimates of car numbers outlined in figure 7.1, predictions of future population may be used. The Tasmanian Statistical Advisory Committee 1988 projected population change at five yearly intervals from 1988 to 2013. Table 7.1 outlines the projected population change and the corresponding ratio of cars to 1000 of the population based on the change in car numbers indicated in figure 7.1.

Figure 7.1



Note: car registrations prior to 1990 were derived from DRT 1990b. Car registrations from 1990 to 2005 were extrapolated from the historical profile.

Table 7.1
Estimations of Future Population and Car Ownership Rates for Tasmania

	Population	Vehicle numbers	Vehicles per 1000 population
1988	448457	209635	467
1993	463793	228542	493
1998	478343	243018	508
2003	490857	257173	524
2008	501137	271490	542

Source of population data: Tasmanian Statistical Advisory Commitee 1988

Table 7.1 illustrates that based on both estimates of future population and car numbers, the ratio of cars and station wagons to total population would increase by just over 16 per cent from 1988 to 2008. This rate of increase is relatively moderate in terms of the increase in car numbers as a ratio of total population between 1970 to 1990 which increased by approximately 55 per cent (DRT 1990b). Furthermore, Newman & Kenworthy (1991) found that in a number of US cities in 1981 the rate of car ownership was over 600 per 1000 of the population and the average for the 10 cities which they studied was 533 per 1000 population.

Average annual kilometres

Average annual kilometres travelled in Tasmania is assumed to remain at a constant level for the purpose of these predictions. The ABS has made estimates of annual average kilometres travelled since 1971 as part of the Motor Vehicle Surveys which have shown that vehicle utility has remained relatively stable. Table 7.2 outlines the estimated average annual kilometres travelled by cars and stations wagons made by the ABS.

Table 7.2
Average Annual Kilometres Travelled by Cars and Station Wagons
(thousand kilometres)

	Australia	Tasmania
1971	15.9	-
1976	15.4	-
1979	15.1	-
1982	15.3	-
1985	15.5	14.2
1988	15.8	13.9
% change	**1971-88**	**1985-88**
	-0.6	**-2.1**

Source: ABS 1986b, 1989

Table 7.2 reveals the relatively moderate fluctuation in average annual kilometres travelled in Australia during the period 1971 to 1988. In Tasmania there has been a greater change in average annual kilometres between 1985 and 1988 than for Australia. Based on table 7.2, it would be difficult to substantiate any predictions concerning future changes, either up or down, in average annual kilometres travelled thus for the purpose of this study the rate will be set at 13900 km. It is, however, probable that vehicle utility will decrease with the expected increase in the ratio of automobiles to the population with more sharing of transport tasks than replication.

Average fleet fuel consumption

Expected changes in average fleet fuel consumption are estimated by ABARE (1991). It is suggested that average fuel economy for 1990 was 11.8 L/100 km which is expected to decrease to 10.9 L/100 km in the year 2005 which equates to annual decrease of approximately 0.5 per cent from the 1990 figure.

7.1.1 Estimates of Future Fuel Consumption in Tasmania

Table 7.3 outlines the expected changes in total fuel consumption based on the estimates of future vehicle numbers, average kilometres travelled and average vehicle fuel consumption. The estimates contained in table 7.3 consider the possible future changes in relation to car registrations which may occur under a 'continue as normal' scenario. Importantly this scenario illustrates a continual growth in car numbers, total kilometres travelled and fuel consumed.

Table 7.3 may be regarded as a base case which can be used to consider the effect of possible strategies aimed at reducing fuel consumption may have on the particular variables outlined.

The Toronto Target for greenhouse gas emissions provides a goal at which Tasmania can aim for and requires that CO_2 emissions be reduced to an equivalent of 20 per cent of the 1988 levels by the year 2005. Thus, given the parameters for the Toronto Target, Tasmania would have to reduce its total fuel consumption, from cars and station wagons, from an anticipated 398 ML to 286 ML by 2005. This target assumes the same mix of fuels for 2005 compared with 1988, as fuel substitution may achieve a net reduction in CO_2 emissions without reducing total fuel consumption.

Table 7.3
Estimated Changes in the Number, Distance Travelled and Fuel Consumed for Cars and Station Wagons, Tasmania

	Cars & station wagons	Fuel economy L/100km	Average annual kilometres travelled	Total kilomtres (million)	Litres of Fuel consumed (million)
1988[1]	216302	11.9	13900	3006.6	357.79
1990	219735[2]	11.8[3]	13900[4]	3054.32	360.41
1995	234609	11.5	13900	3261.07	375.02
2000	248790	11.2	13900	3458.18	387.31
2005	262918	10.9	13900	3654.56	398.35
% change 1988-2005	21.55	-8.4	-	21.55	11.34

1. The figures for 1988 are derived from the ABS Survey of Motor Vehicles and calculated for 30 September of 1988.
2. Car registration for 1990 are for 30 June of that year. The estimation of car registrations for the following years are based on the average rate of increase in car registrations from 1985 to 1990 accounting for the decline in the rate increase from 1980 to 1990.
3.Fuel economy is based on the estimations of change in the car fleet outlined in ABARE 1991, (approximately 0.5 per cent decrease per year from the 1990 figure).
4. Annual average kilometres travelled for Tasmania has been maintained at 13900 km because of the small variation in this variable outlined in previous ABS Motor Vehicle Surveys.

Source: ABS 1899, ABARE 1991 & DRT 1990b

Estimating the future consumption of fuels for other modes is more difficult than for cars and station wagons. For example, the number of articulated trucks operating in Tasmania is more responsive to both government policies and economic activity than cars. Furthermore, the amount of data available to make predictions is limited compared with that available for cars and station wagons.

Predictions of the expected fuel consumption for motor cycles, light commercial vehicles, trucks, articulated trucks and buses is set out in table 7.4. The estimations are based on information obtained from a study conducted by the NIEIR (1990). The NIEIR (1990) considered the possibility of reducing greenhouse gas emissions from the Australian transport sector. As part of this study the NIEIR (1990) calculated a base case scenario of the expected transport task for Australia up to 2005. The calculations assume varying increases in both vehicle numbers and utility and a decrease in average fuel consumption for all the modes from 1988 to 2005. The use of the NIEIR (1990) predictions for any transport sector will inevitably provide a growth scenario. The application of these assumptions to the transport fleet in Tasmanian ignores the particularities of the State and is unable to account for the regional variations throughout Australia.

Table 7.4
Estimated Change in Total Fuel Consumption for Tasmania to 2005: For Modes Other-than Cars & Station Wagons
(million litres)

	Motor cycles	Utilities & panel vans	Trucks	Articulated trucks	Buses	Total
1988	2	77	63	63	14	219
2005	2	91	94	96	17	300

Note: 1988 figures are derived from the ABS 1989. The figures for 2005 are based on estimates outlined in NIEIR (1990) pertaining to expected changes in average fleet fuel economy, vehicle numbers and vehicle utility. These figures relate to the Austraian average and provide a broad approximate of the possible change in fuel consumption for these modes in Tasmania.

Sources: NIEIR 1990 & ABS 1989

Table 7.4 reveals that, in terms of a base case scenario, it is likely that Tasmania's total fuel consumed by registered vehicles will rise from approximately 577 ML in 1988 to 698 ML by 2005; a rise of almost 21 per cent compared with the 1988 figure. Based on the estimates outlined in table 7.3 and 7.4 Tasmania would be required to reduce its total fuel consumption to 461 ML by 2005 in order to meet the Toronto Target.

To attain the Toronto Target will require a series of strategies which can act jointly to reduce fuel consumption. Considering the relatively short time scale and the fact that there are no coordinated strategies already in place to reduce emissions the choice is somewhat constrained. It is, however, important to outline a framework of priorities from which strategies can be preferentially selected. The most important criteria for selecting strategies is to target inefficiencies throughout the transport sector.

7.2 Strategies for reducing total transport fuel consumption

7.2.1 Cars and Station Wagons

It is likely that the number of cars and station wagons will continue to grow based on the historical profile of car registrations in Tasmania. The rate of increase, however, may change and estimating this change to any great accuracy is relatively difficult. For simplicity, the following strategies aimed at reducing fuel consumption are based on estimations of cars already outlined in table 7.3. The estimation of future growth in car numbers is relatively moderate.

Table 7.5 outlines a number of strategies aimed at reducing total fuel consumption from cars and station wagons by the year 2005.

1. Vehicle fuel consumption

Reducing average fleet fuel consumption is one possible way of lowering total fuel consumption. Optimistic projections suggest that in the US it may be possible to reduce average new car fuel consumption to between 7.5 and 6.9 L/100 km by 2005 (BTCE 1991a). While in Australia the FCAI (1990) (in Wylie 1990) have set targets of 8.2 L/100 km by the year 2000 and 8 L/100 km by the year 2005 for average new car fuel economy. The translation of these improvements into the fleet fuel economy is hindered by the ageing profile of the Australian car fleet

In order to achieve the Toronto Target through average fleet fuel economy alone would require a consumption rate of 7.83 L/100 km to be achieved by 2005 based on the estimates of car numbers and vehicle utilisation outlined in table 7.3. It is generally accepted that under normal circumstances the average fleet fuel economy will reach 10.9 L/100 km by 2005 thus to lower this to 7.83 L/100 km will require regulative strategies to encourage car buyers to the purchase vehicles which have a better fuel economy. An average rate of between 9 and 10 L/100 km may be an achievable target for the Tasmanian car fleet by 2005. For instance, an average rate of 9.5 L/100 km would reduce the estimated fuel consumed by cars and station wagons to 347.2 ML, which would be equivalent to an approximate saving of 13 per cent.

Table 7.5
Options for Reducing the Contribution Cars make to Total Fuel Consumption in Tasmania

	Objectives	Strategies	Continue as normal	Desired Impact
1. Vehicle fuel consumption	• down size vehicle feet • promote fuel economic cars	- introduce a sliding sales tax for new cars based on engine capacity & a similar scale for stamp duty - scale car registration fees according to engine capacity - fuel price would also effect this component - educate consumers as to the benefits of fuel economic cars	10.9 L/100km	-achieve an average fuel consumption of between 9 & 10 L/100km
2. Alternative energy	• promote alternative fuels i.e. LPG & CNG • introduce electric vehicles (EVs)	-reduce taxes on alternative fuels -promote EVs via lower sales tax & stamp duty, preferential parking, electricity rebates	3.4% of total fuel consumed comprised of LPG	-10 percent or greater of transport fuel made up by LPG & alternatives -EVs commercially available
3. Travel behaviour i.e. journey to work	• decrease private car's share of modal split for journey to work • increase availability of alternative modes of transport • encourage fuel economic driving behaviour	- promote car pooling by providing incentives such as preferential parking, designated traffic lanes & congestion taxes - onboard eletronic detection and information systems which can provide information about congestion and ca: be used as a charging system for road users - reduce availability of long term parking in the central city - provide information to drivers concering fuel economic driving behaviour and vehicle maitenance	- dominant use of private cars for journey to work - low occupancy rates	- reduce private cars share of modal split for journey to work - increase average occupancy rates for private cars for journey to work
4. Fuel price	• set fuel price target at parity with Eurpoean countries • use fuel price as a transport use tax	- use pricing measures to gradually increase fuel prices inline with Europe - use increased royalties from fuel taxes to fund public tranport services and other transport programs	- among the lowest fuel prices in the world	- pressure on total kms travelled thus act to reduce total fuel consumed - pressure on average vehicle fuel economy

State governments have little power to influence car manufactures on decisions concerning the fuel economy of new cars. State governments do, however, have powers in respect to registration fees and sales taxes which can be used to discourage the ownership of large capacity vehicles. Registration fees and sales taxes could be scaled to reflect the engine capacity of the vehicle. Currently in Tasmania registration fees are structured in terms of engine size based on the number of cylinders. Engine capacity is only one component of registration fees. The major component of registration fees is the contribution to motor vehicle insurance.

Stamp duty may be used as means to encourage the ownership of smaller cars. Currently stamp duty in Tasmania is set at a flat rate of 3.5 per cent of the purchase price for all motor cars. This could be altered to incorporate a sliding scale based on engine capacity.

It is difficult to determine at what level registrations fees or sales taxes would need to be set to effect a change in consumer preference in engine capacity. Currently registrations fees for private cars range from $200 to $300 which represents less than a third of average annual fuel costs. A problem with using registration fees and sales taxes, as means for reducing fuel consumption, is that they represent infrequent payments which tends not to be as an effective deterrent as recurring costs, such as fuel. Furthermore, registration fees and sales taxes act more as ownership taxes rather than vehicle use taxes. It is important to realise that the car provides many benefits and that it is more preferable to influence travel behaviour rather than limit accessibility to car ownership.

2. Alternative transport fuels

The impact of the use of alternative fuels such as LPG, CNG, Methanol and Ethanol may be to increase total fuel consumption but lower total CO_2 emissions. This is because these alternative fuels have a lower energy content per unit volume than petrol and ADO. The impact for greenhouse gases will, however, be reduced to varying degrees depending on the composition and quantity of the substitute fuels used.

The ABS (1989) found that in 1988 LPG accounted for approximately 3.4 per cent of total fuel consumed nationally for cars and station wagons which had increased from 2.1 per cent in 1985.

Table 7.6 outlines three profiles of total fuel consumption and carbon dioxide emissions for Tasmania. The 1988 composition of fuel consumption estimate for Tasmania is based on national average. The first of the 2005 estimates is calculated from the predictions concerning kilometres travelled and average fuel consumption outlined in table 7.3 assuming that the composition of the fuels consumed is similar to the 1988 estimate. The second 2005 is calculated similarly to the first 2005 estimate but assumes that 10 per cent of total fuel consumed is LPG.

Table 7.6
Potential Saving in Carbon Dioxide Gas Emissions in Tasmania based on LPG Assuming a 10 per cent Share in Fuel Consumed by Cars & Station Wagons by 2005

	Petrol	ADO	LPG	Total
1988				
Mega litres consumed	339.48	6.28	12.02	357.78
CO_2 kilo tonnes	774.79	16.36	18.74	809.89
a 2005				
ML	377.97	6.99	13.39	398.35
CO_2 kt	862.63	18.21	20.86	901.7
b 2005				
ML	351.52	6.99	39.84	398.35
CO_2 kt	802.26	18.21	62.08	882.56
CO_2 saving between a & b				**2.12%**

1988 profile of fuel consumed in Tasmania by fuel type is based on the ABS estimation of the composition of total fuel consumed in Australia.
a 2005 reflects the profile of total fuel consumed based on a similar composition as that of 1988
b 2005 is based on LPG assuming a 10 per cent share of total fuel consumed with ADO remaining the same as 1988 and a subsequent reduction in the share of petrol.

Source: ABS 1989 & ABARE 1991

Table 7.6 illustrates that in order for LPG to make an impact upon reducing carbon dioxide emissions in the transport sector it will need to assume a significant share of total fuel consumed. Currently there are no production vehicles designed to operate on fuels other than petrol or ADO.

The promotion of other transport energy sources such as CNG and electricity would benefit reductions in CO_2 emissions. Tasmania, with its unique position in terms of hydro-electricity, could gain considerable savings in CO_2 emissions by promoting the use of electric vehicles (EVs). The State Government could help promote the use of EVs by reducing registration fees, stamp duty and providing electricity rebates.

A target of 1000 electric vehicles could be set for 2005 which would relate to 0.4 per cent of the expected total car registrations (table 7.3). If the EVs were dedicated electric vehicles, rather than hybrids, a reduction of 1.5 ML could be achieved.

3. Travel behaviour

Vehicle utility is an important variable affecting total fuel consumption. The NIEIR (1990) suggest that the average rate of automobile utilisation could increase by 2.7 per cent over the period 1990 to 2005. Should this occur in Tasmania, without changes in the other variables in table 7.3, the estimated total fuel consumed by cars and station wagons would increase from 398.35 to 409.1 million litres by the year 2005.

The likelihood of an increase in the utilisation of the average motor vehicle in Tasmania is low. During the last 20 years in Australia, vehicle utility has remained fairly constant and it would appear that the increase in motor vehicles is being absorbed in terms of convenience use. The increase in vehicle numbers, in effect, are sharing the expansion of the transport task rather than replicating it.

Travel behaviour is one area which can have a significant impact upon total fuel consumption. Considering travel behaviour alone would require average vehicle utility to be reduced from 13900 km to 9988 km by 2005 in order to meet the Toronto Target for Greenhouse Gases without changes in vehicle numbers or average rate of fuel consumption as outlined in table 7.3.

A reduction in average vehicle utility by 28 per cent over the period 1990 to 2005 could only be achieved by introducing fuel pricing measures and regulating travel behaviour.

Journey to work is a major area in which changes in travel behaviour could be targeted with regulations governing central city parking and vehicle occupancy rates. A central feature of journey to work is the inefficient use of vehicles which is illustrated by low vehicle occupancy rates. Local government has the ability to limit long term car parking available in the city centre. Sole occupant vehicles could also be restricted to certain lanes on the roads during peak period traffic to encourage car pooling. The type of action required to change travel behaviour, without using fuel pricing, is to use regulatory measures rather than passive measures such as education programs. The Tasman Bridge collapse (outlined in chapter 4) provided an example of the extent to which the private car is preferred over public transport.

A target to aim for in terms of journey to work travel would be to reduce private car travel by between 10 to 20 per cent. This may be achieved by shifting the modal split for journey to work travel away from the private car with increased utilisation of alternative transport options including public transport, walking, bicycling or shared car.

In Australia during 1988 journey to work travel accounted for approximately 25 per cent of total kilometres travelled by cars and station wagons. In the case of Tasmania, assuming the Australian average, fuel consumed for journey to work travel by motor cars would have been approximately 90 ML during 1988. If journey to work travel continued to account for 25 per cent of total kilometres travelled by 2005 it would account for approximately 100 ML of the total fuel consumed.

By reducing the number of cars used for journey to work travel by between 10 to 20 per cent, a saving of almost 20 ML may be achieved with a 20 per cent reduction, which would translate to approximately 5 per cent of the expected total fuel consumed for 2005.

It would be envisioned that travel behaviour would respond to changes in other variables particularly changes in city structure.

4. Fuel prices

One of the major factors influencing vehicle utility relate to operating costs, of which fuel costs account for the greatest share. The price of fuel is one area open for governments to directly influence vehicle utility and thus total fuel consumption. Fuel pricing, as discussed in chapter 5, is a non-discriminatory measure in terms of vehicle utility which can be used to reduce total fuel consumption. Using fuel price signals as a means of reducing total fuel consumption has the benefit of acting directly upon vehicle use and hopefully encouraging users to become more efficient in their travel behaviour.

It is difficult to determine at what rate fuel prices should be set to evoke a sustained change in vehicle preference to more fuel efficient cars and to change travel behaviour. The NIEIR (1990) suggest that to meet the Toronto Target by fuel price signals alone would require prices to increase by between 6 and 10 per cent annually from 1988 to 2005. In the case of Tasmania this would result in the price of petrol rising from 61.97 c/L in 1988 to between 166.87 c/L and 313.22 c/L by 2005. Alternatively, fuel prices could be increased to provide parity with European countries.

Table 7.7 outlines a comparison of fuel prices and per capita consumption between a number of countries and Australia for 1990. Table 7.7 reveals that almost all the European countries consume approximately 50 per cent less fuel per capita than Australians while the price of fuel ranges between 150 to 230 per cent more per litre. These figures tend to verify the NIEIR (1990) estimations of the response fuel prices may have on the consumption of transport fuels.

Table 7.7
Comparsion of Petrol Prices and Petrol Consumption for Selected Countries with Australia 1990

	Cost of petrol (c/L compared with Australia)	Petrol consumption (L per capita per annum compared with Australia)
Italy	2.30	0.32
Denmark	1.90	0.40
France	1.84	0.42
Netherlands	1.83	0.30
Switzerland	1.49	0.73
UK	1.49	0.54
(West) Germany	1.49	0.57
Canada	0.97	1.24
USA	0.58	1.63

Comparisons based on the Australian price of petrol of 69 c/L and and an annual consumption rate of 1120 L per capita. Price are based on $Aust/L.

Source: IEA 1991

Another important issue of greater government regulation of fuel prices relates to its ability to influence the viability of alternative fuels.

7.2.2 Other Modes

The ability of reducing fuel consumed by modes other than cars and station wagons will be limited primarily because of their function of use. Unlike cars and station wagons many of the other transport modes are specifically designed and utilised for commercial purposes, thus, the ability to easily influence factors affecting fuel use will be restricted. Furthermore, using price signals as means of reducing fuel use for these modes may also have a lesser effect because of the limited availability of alternative modes of transport. In addition, the effect of increasing fuel prices would, to some degree, be absorbed by increased fuel costs being passed on. Many of the price measures which can be directed at cars and station wagons effect the end user and are thus likely to be more effective determinants of travel behaviour.

Utilities and panel vans (light commercial vehicles)

Utilities and panel vans would be expected to be more susceptible to reductions in fuel use in response to changes in travel behaviour, fuel pricing and fuel economy improvements compared with other commercial transport modes. In terms of kilometres travelled for particular purposes, utilities and panel vans travelled almost 40 per cent of total kilometres for journey to work and private purposes. While in comparison, articulated trucks travelled less than 1 per cent of total kilometres travelled for journey to work and private purposes. If a 10 per cent reduction in travel for other than business purposes can be achieved by 2005, assuming this form of travel continues to occupy 40 per cent, then a saving of 3.6 ML may be achieved.

Utilities and panel vans also share modal similarities with cars and station wagons allowing them to respond similarly to technological improvements in fuel efficiency. It is anticipated that there will be a continued improvement in the average fuel economy for these light commercial vehicles, which has been accounted for in table 7.4. If the average fleet fuel economy can be improved by an extra 10 per cent of the expected value then a reduction of 9.1 ML may be achieved.

Trucks

It is unlikely that significant reductions in fuel use by this mode can be achieved by either technological improvements in efficiency or by travel behaviour. Reductions, however, may be achieved by this mode by employing fuel conservation programs. For example, many of these trucks are left idling while being unused.

Articulated trucks

A number of reductions in fuel consumption may be achieved by this mode by employing similar operational improvements as general trucks such as idling. A reduction of 10 per cent may be an achievable target for the combined truck sector through operational efficiency programs. If a 10 per cent saving could be made through operation efficiency a total saving of 19 ML may be achieved.

Articulated trucks may also increase their efficiency through using B-doubles, which have been claimed to improve fuel efficiency by up to 20 per cent. B-doubles, however, are restricted to particular road standards and thus would be confined to the Midland highway and, depending on upgrades, the Bass highway.

Freight which can be transferred from road to rail will produce a fuel saving as rail is approximately 50 per cent more efficient than road transport (although the consumption of fuel by rail has not been indicated in table 7.4). If a 10 per cent shift from road to rail could be achieved by 2005 then a saving of 4.8 ML may be achieved.

Potential also exists in the articulated transport fleet to utilise CNG. CNG produces approximately 15 per cent less carbon dioxide per unit of energy than ADO, allowing for fugitive loses (NIEIR 1990). Thus, if CNG could displace 5 per cent of the total energy consumed by the articulated transport sector by 2005 the equivalent saving, expressed in litres of ADO, would be 7.2 ML.

Buses

Unlike the other modes buses would be encouraged to increase total fuel consumption due to the implementation of programs designed to encourage people to utilise public transport.

Similar to articulated trucks, there is potential for buses to utilise alternative energy including CNG and electricity. Anticipated increases in the fuel consumed through the greater utilisation of buses may be offset by subsidising the utilisation of alternative energy forms through the increase in government revenue obtained from raising fuel costs for other modes.

7.2.3 Conclusion

Table 7.8 outlines a number of potential savings in fuel consumption for the Tasmanian land transport sector for 2005.

Table 7.8
Potential Savings in Total Fuel Consumption for 2005, Tasmania
(million litres)

Strategies	Saving
Cars and Station Wagons	
Reduce average car fuel economy to 9.5 L/100 km	51.2
10 % LPG of fuel consumed	≈8.4
1000 electric vehicles	1.5
10 % reduction in journey to work	10
Other modes	
10 % reduction in average fuel economy for utilities and panel vans	9.1
10 % reduction in journey to work and private travel travel for utilities and panel vans	3.6
10 % improvement in operational efficiency for all trucks	19
5 % of energy replaced by CNG in articulated trucks	≈7.2
10 % shift in freight transport from road to rail	4.8
Total savings	**111**

Note: savings are based on the expected totals outlined in table 7.3 & 7.4

Table 7.8 reveals that even with the moderate strategies outlined, Tasmania will be unable to reduce its total fuel consumption to reach the Toronto Target of 461 ML. The table 7.8 also highlights the significance of increasing average vehicle efficiency for reducing total fuel consumption. Fuel pricing measures have not been included in the table as it is difficult to quantify reductions in fuel consumption that different price increases may have. In order to reach the Toronto Target by fuel price signals alone would require a three fold increase in fuel prices by 2005 (NIEIR 1990).

The ability to realise the reductions in fuel consumption outlined in table 7.8 will rely heavily upon government intervention beginning immediately. Furthermore, many of the strategies would meet with considerable objection from various interest groups, although the nature of the reductions are fairly moderate. The more extreme measures including fuel pricing would be electorally unpopular and would require a government committed to transport reform to initiate them.

Table 7.8 includes only moderate estimates of reductions in fuel use possible through changing transport behaviour. Transport behaviour would be expected to respond significantly to changes in urban form, however, it would be unlikely that a response to urban consolidation programmes would appear within the time scale to meet the Toronto target over that accounted for in the table.

7.3 Structural Strategies Aimed at Improving Transport Efficiency

This section outlines structural initiatives which will aid in providing a more efficient transport system.

7.3.1 City structure

With 70 per cent of Tasmania's transport activity conducted within urban areas, the possibility of producing a city structure which is more energy efficient may have significant implications for total fuel consumption in Tasmania. The speed at which reductions in transport fuel use per capita can be achieved through urban planning strategies including urban consolidation is difficult to quantify. However, strategies aimed at producing a more transport energy efficient city may be considered as long term objectives.

Table 7.9 outlines a number of strategies targeting the reduction of transport energy use per capita by changing features of urban form. The likelihood for these strategies to contribute to a reduction in total fuel consumption in Tasmania by 2005 is rather limited. The inertia already built into the housing market means that any changes will take a considerable time to reach fruition.

Table 7.9
Options for Reducing Transport Energy Use Per Capita in Urban Areas

	Objectives	Strategies	Continue as normal	Desired impact
Urban density **-urban consolidation** **-Changing the 'Great Australian Dream'**	• increase urban density (improves viability of public transport) • greater mix of land uses (reduces travel distances) • transit corridors for bicycling and walking • change the perception that low density housing is the most desirable form of housing • promote medium density housing and mixed land use • re-urbanisation • to make medium density housing affordable	- encourage redevelopment of urban land at medium density - new development should be contained within the existing urban boundaries - reduce subsidies to fringe development - education & information programs targeted at planners and governemnt agencies involved in housing development concerning the advantages of higher density housing - review lending and taxation systems to assist urban consoldiation	-low residential density, high per capita energy use for transport - the house on a 'quarter acre' block remains the dominate housing form	- increase overall city density to 20 or more perosns/ha -create a network of transit corridors for bicycling and walking - new urban development planned in coordination with desirable and affordable medium density housing
City centre	• reduce availability of long term parking in CBD • encourage bicycling and walking • provide environment for greater diversity of activity in the CBD • increase availability of inner city residential accomodation	- increase cost of existing city centre parking - limit availability of free on street parking within walking distance of the city centre (excluding residents) - limit the development of new private car parks - allocate land corridors for alternative transport - encourage redevelopment of existing buildings and promote building utility for other than office space purposes	- city centres dominated by the private car - increasing specialisation of the CBD i.e. office work - increasing specialisation of shopping - CBD only active during office hours	- an active inner city, characterised by a diversity of commercial, social and residential activity - the CBD organised to accomodate public transport, walking and bicycling - a network of transit corridors for bicycling and walking

The main areas open to the Federal, State and Local governments to reduce automobile dependence in the urban areas is through encouraging greater urban density or urban consolidation, increasing the diversity of activity in the inner city and re-orientating transport priorities.

Newman et al. (1990) suggest that an urban population density of 20 or preferably 30 to 40 people per ha provides the type of population settlement capable of sustaining the significant use of public, walking and bicycle transport. These forms of transport become more viable as population density increases because of a number of factors including; shorter transit distances, a greater concentration for public transport collection and higher levels of congestion for cars. Indiscriminately increasing population density, however, may not necessarily achieve significant reductions in per capita transport energy use. Of particular importance to urban planning, which is more conducive to energy efficient transport, is the coordination of development which improves accessibility for transport options other than the private car. Medium density housing needs to be suitably located in relation to other facilities, such as, employment and retailing, in order to discourage the use of the private car.

The example of a number of European cities illustrates how city structure and the provision of alternative modes of transport promotes considerably less per capita fuel consumption. For example, the average per capita consumption of petrol for 12 European countries during 1980 was 13280 MJ while for Hobart it was over double that figure (Newman & Kenworthy 1989). Through greater urban densities and the provision of alternative forms of transport the European countries achieved a modal split for journey to work of 34.5 per cent using public transport and 44.2 per cent using private cars, while for Hobart the figures were 13.7 and 78.9 respectively.

In addition to increasing population density there also needs to be a commitment aimed at re-orientating the transport system. In particular, the re-orientation of transport priorities include, parking limitations, upgraded and extended public transport, pedestrianisation and bicyclisation and focus on congestion (Newman et al. 1990). As an example in Stockholm planners believe that the majority of houses should be situated within 500-900 metres of a rail station; train services should run at least every 12 minutes; and people should not need more than 30 minutes to get to the city centre (Australian Consumers' Association 1991).

In 1981 the CBD of Hobart contained the second highest provision of car parking places per CBD worker compared with other Australian capital cities.

The amount of space allocated to the car in the city centre in most Australian cities is enormous and tends to occupy space which could be utilised for other purposes. One of the most important ways to increase the utilisation of the city centre by the general public is to provide an environment which caters for people rather than for motor cars. Importantly the objective of utilising space previously occupied by parked cars is to provide a greater diversity of activity to encourage people to the city centre.

As part of changing the nature of the central city, provision needs to be made for cycling and pedestrian ways. Presently Hobart lacks integrated cycle ways and pedestrians are required to walk beside busy streets which do not provide the most conducive environment. Ideally provision could be made for special corridors linking inner suburban housing with the city centre providing pleasant transit routes for inner city residents to walk or cycle to the city centre.

If programmes aimed at changing the urban structure of Hobart can be initiated then the 10 per cent reduction in journey to work outlined in table 7.8 may be able to be surpassed. Furthermore, greater improvements in reducing per capita energy use may be achieved through shorter transit distances and alternatives transport, reducing private and commercial travel.

7.3.2 Public Transport

Table 7.10 outlines a number of strategies aimed at making public transport a more attractive form of alternative transport.

The viability of public transport as an alternative to the private car is largely dependant upon changing the structure of the city detailed in the previous section. However, it would inappropriate to rely on increasing public transport patronage through solely relying on people forced from using the private car. Public transport service needs to be improved to increase the attractiveness of it as an alternative.

The introduction of a light rail network in Hobart as an alternative to buses may reduce some of the modal disadvantages of buses. Light rail, however, would be unlikely to be financially successful in Hobart unless the urban population density could be increased in a corridor fashion and the private car is discriminated against. Bus transport presently suffers in performance compared with the private car as an alternative means of transport. The fundamental problem of bus transport is that it is part of the road transport system and is thus subject to increased delays compared with the private car because of passenger boardings, which is inversely proportional to the level of traffic congestion. In Amsterdam they have attempted to overcome this modal

Table 7.10
Option for Increasing the Viability of Public Transport

	Objectives	Strategies	Continue as normal	Desired Impact
Public transport as an alternative to the private car	• increase flexibility and convienence of public transport	- introduce different size buses to cater for differences in demand - provide a bus timetable by phone - introduce shuttle bus services from designated parking areas on the fringe of the central city	- continued decline in public transport patronage - decline in the use of public trnsport by those with access to private cars	- make public transport a more convienent alternative to the private car
Public transport transit speed	• increase transit speeds for public transport	- give buses right-of-way when pulling out from bus stops -install electronic detectors to manipulate traffic lights - provide specific road lanes for buses and car pooling during peak period traffic	- the transit speed of public bus transport will decrease in response to greater levels of traffic congestion	- improve the speed of service throughout the urban area
Public transport funding	• recover infrastructure costs from beneficiaries	- developers should make direct contributions to public transport proportional to the costs of providing a service - road vehicle users should be charged for contribution public transport makes to lessen traffic congestion and road accidents	- inequity of operating costs recovery, i.e. all tax payers contribute to the deficit of the MTT yet some gain a disproportional benefit	- organise a system of funding which takes account of the beneficiaries of public transport

shortfall by installing a system that provides trams with right of way on the roads. Trams are able to gain right of way through the use of electronic detectors allowing the manipulation of traffic lights providing free flow movement for the trams. While in Hamburg this system is being trialed with buses. The aim of this system is to increase average transit speeds and thus make these forms of public transport comparable to the private car. This form of positive discrimination for public transport may be the type of initiative required to encourage people to utilise public transport for a number of travel requirements. A boost in the use of public transport will not provide a complete solution to the problems associated with automobile dependence, as the decline in public transport has acted as an indicator of a much more entrenched situation of decreasing population density. Increasing overall population density will require a long term commitment by all levels of government towards urban consolidation. One of the first measures to encourage greater density would be to make fringe developers pay the real social and physical infrastructure costs of fringe development. It has been estimated that each block on the urban fringe is subsidised by around $40,000. Part of this subsidy involves the cost of providing public transport. This type of regulation of the housing market, however, needs to be coordinated because of the flow on effect will decrease housing affordability. For example, if there is an attempt to recover the real costs of fringe development then it is unavoidable that the costs of inner city housing will also rise.

7.3.3 Freight transport and the Road/Rail Debate

Table 7.11 outlines a number of strategies aimed at producing a more efficient system of freight transportation in Tasmania.

On the basis of environmental criteria, rail transport in Australia, and in Tasmania, has been shown to be more energy efficient and consequently produces less greenhouse gas emissions per unit of bulk freight transported than the equivalent for road transport. Rail is also a safer mode for freight transport, produces less congestion, noise and visual pollution.

The modal split for bulk freight transport in Tasmania is influenced by an adhoc arrangement of political and market forces. The road /rail debate is in a state of flux with many commentators suggesting that rail is uneconomical in Tasmania and that road transport can provide a superior service. However, it is the particular mix of government subsidies and regulations which has created a situation where road freight operators receive considerable indirect subsidises while Tasrail is expected to operate at a financial break even point

Table 7.11
Options for Improving the Efficiency of Freight Transport in Tasmania

	Objectives	Strategies	Continue as normal	Desired Impact
Modal split for freight transport	• increase rails share of line haul freight • reduce energy use in freight transport	- increase infrastructure investment in rail network especially with reagrd to enhancing transit speed - use rail where possible because of its superior energy effeciency compared with road transport	- continued decline rail's share of freight transported in Tasmania	- remove much of the non-time sensitive freight from road transport operators - produce an effecient line haul rail transport system
Road safety	• increase the safety on Tasmanian roads	- remove as much freight as possible to rail - limit the introduction of B-doubles until the road network is of sufficient standard	- the incidence of road accidents set to increase in line with the increase in vehicle kilomtres travelled by freight trucks	- lower incident of road accidents and improve general road safety
Uniform road freight laws	• provision of an equitable system of road funding recovery • implementation of national standards regarding road freight vehicles	- adopt a national road user scheme and a vehicle use tax which incorporates a road damage levy -introduce a national registration scheme to control licensing and truck specifications	- inequiatble road user charges (trucks effectively recieve subsidies form other road users) - adhoc arrangement of standards across Australian states	- road user scheme based on beneficiary pays - reduce operating ineffeciencies - improve road freight saftey

The State Government has asseverated to encourage the use of the railways in the instances where road and rail directly compete, this is exemplified by rail protection levies and specific legislation covering the modal transportation of particular commodities. The rail protection levies, however, have declined in real value through the failure to index them to the CPI. In addition, exemptions and failure to enforce the levies has meant that the revenue recovered from the scheme has declined in real terms over the past 10 years and their effectiveness as a means to influence the modal split has decreased substantially. Furthermore, it appears remarkable that Tasrail will not receive ongoing government funding for infrastructure improvements while it is required to contribute to road funding through fuel tax levies. It may be argued that this situation, where rail is required to fund its own operations yet trucks receive considerable subsidies, has arisen because of the present structure of revenue recovery for road funding.

The main advantages which trucks provide as a means of freight transport compared with rail is their speed, flexibility and their relatively unrestricted area of operation. Road transport provides a superior freight service compared with rail for a number of time sensitive commodities. The extent to which road based freight transport operators are able to provide a superior service to rail is, in large, due to the subsidies they receive in the from of the non recoupment of the road pavement damage they cause. Currently there is a net surplus of monies raised by the Federal and State Governments from road users compared with road funding (DRT 1990a & Australian Government 1991). Thus, the various tiers of government have little need to itemise the contributions made by mode compared with road damage while there are sufficient funds available for road maintenance and construction. Whether the financial contribution the government receives from trucks is proportional to the damage they cause is not a high priority consideration while cars contribute to the deficit. Several studies, conducted by the Bureau of Transport Economics and the Inter State Commission (1990), have found that large articulated trucks contribution to the road budget through registration fees and fuel taxes is not proportional to the attributable road pavement damage. Based on the economics of road construction and maintenance in Australia, cars are required to contribute disproportionately to road funding compared with trucks (BTCE 1987). Rail, however, as a single operating body is unable to offset any loses through revenue raised from other users of the existing infrastructure, apart from the occasional recreational use by private rail operators. The government can calculate direct costs in running Tasrail, thus any reduction in subsidies will appear as cost savings at the end of the day to the government.

It is unlikely that any definite moves will be made by the State Government to orientate the modal split for bulk freight transport towards rail, however, if agreements are made on a national road user charges then it is likely that road freight transport will be required to contribute more in taxes. The effect of a greater imposition on road freight transport would be to make rail more competitive.

7.4 Conclusion

The ability of Tasmania to reduce transport fuel consumption is contingent upon the commitment by all levels of government and the public to promote transport energy efficiency. The reduction of transport fuel consumption can be achieved through the adoption of many interrelated transport reforms including technological, behavioural and pricing. But, the likelihood of Tasmania's transport sector achieving a reduction in fuel use in line with the Toronto Target is remote, especially given the time scale and lack of existing strategies designed to reduce fuel use.

Reducing transport fuel use can provide positive incentives for the economic, environmental and social well being of Tasmania.

While many of the strategies proposed to reduce transport fuel use involve the impost of pricing signals the benefits of reducing fuel imports may be considerable. For example, savings made through transport efficiency programs may provide particular economic benefits by reducing the transport cost component of commodities. Furthermore, the dependence on fuel imports reduces Tasmania autonomy in relation to energy supply and makes the state more vulnerable to external disruptions in supply.

The dominance of road transport and the dependence on petroleum fuels consequently produces distinct pollution problems. The city, in particular, suffers from carbon monoxide levels exceeding WHO guidelines, while other pollutants such as noise, visual and odour reduce the quality of the city centre. On a global scale Tasmania's high use of petroleum products makes the state's contribution to greenhouse gas emission on a world wide per capita basis an important area of concern.

Problems associated with the existing structure of transport extend beyond pollution problems and involve the social inequities characteristic of urban development designed to accommodate the car. The post Second World War city has expanded through low density suburban development facilitated by the automobile. Public transport, however, has failed to provide a comparable form of alternative transport. Consequently, those people forced to the city fringes in search for cheaper housing and who are without access to a private car can suffer from restrained mobility.

The pattern of energy use in Tasmania's transport sector, like other sectors, is symptomatic of the availability of abundant and relatively cheap sources of energy and a dominate ideology which supports consumption. Little incentive exists for individuals to invest in energy conservation, especially when energy remains so cheap and there are few institutional restraints guiding behaviour. Adoption of strategies designed to reduce transport fuel use which are planned and coordinated to effect structural reform can provide considerable benefits for the quality of life of Tasmanians.

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