Community Travel Mode Shift Scenarios to Achieve Toward Zero Transport Strategy Targets

Final Report

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SKM

Contents

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Executive Summary

Sinclair Knight Merz (SKM) was commissioned by the City of Port Phillip to develop mode share scenarios to achieve a 50% per capita reduction in transport greenhouse gas emissions by 2020 (relative to 2007 levels). This target, established as part of the *Toward Zero* strategy adopted by Council in 2009, applies to transport emissions directly related to the community. The purpose of this study was threefold:

1) identify what magnitude of mode shift would be required to achieve the target,
2) suggest travel behaviour changes that may be required for 'typical' households, and
3) identify what types of monitoring could be undertaken.

The study suggests general means by which the mode shifts may be obtained, but does not seek to quantify the impact of the various policies. Rather, the study had the objective of identifying the magnitude of mode shifts that would be required to achieve the *Toward* Zero target.

In addition to mode shifts, the benefits that could accrue from converting electrified public transport to fully renewable energy (i.e. reducing public transport emissions intensity to zero) and increasing the proportion of low emission private cars in the municipality were examined.

Only travel that starts or finishes in the municipality, and only travel by residents of the community (trips to or from the municipality, or through the municipality, by non-residents are neglected) is considered in the analysis. Private transport contributes around 38% of overall transport emissions, and the proportion contributed by residents will be somewhat less than this. As such, the analysis necessarily reflects only about a third of transport emissions in the municipality.

The Victorian Integrated Survey of Travel and Activity (VISTA) was used to develop a picture of travel by residents of the City of Port Phillip. The 2007/08 wave of this survey interviewed 493 individuals across 243 households in the municipality, providing a total of 1,898 trip stages. Emissions intensity factors developed by the Department of Transport were used to estimate the marginal greenhouse gas emissions from this travel. 55% of all trip stages by residents were as a vehicle driver or passenger, equating to 78% of all kilometres travelled. These private vehicle trips contribute 86% of all community transport emissions in 2007.

Population forecasts for the municipality imply a growth in population of 12.9% between 2007 and 2020, with a shift towards lone person households. Person kilometres travelled are forecast to increase at a slightly lower rate of 11.8%. Vehicle emissions intensities are forecast to improve by around 12% over the same time period, which will tend to cancel out the additional vehicle travel that would be forecast to occur. In addition, shifts towards less greenhouse intensive electricity generation are forecast to improve electricity emissions intensity by around 8% over the period. The net result is a forecast 13.9% reduction in per capita emissions over the period (although net emissions would remain essentially stable).

To achieve a 50% reduction in per capita emissions a package of measures would be required that would (a) increase the mode share of active transport for short trips, (b) increase the mode share of public transport and reduce its' emissions intensity (through a shift to renewable energy), and (c) accelerate the shift towards lower emissions motor vehicles.

In order to achieve the target the following would need to occur (Scenario 5 in Section 5):

- For trips under 5 km there would need to be a 50% increase in active transport person kilometres, combined with a 15% increase in public transport kilometres.
- For trips between 5 km and 15 km there would need to be a 15% increase in active transport kilometres and a 30% increase in public transport kilometres.
- For trips longer than 15 km to adjacent municipalities there would need to be an increase of public transport person kilometres of 20% and for other municipalities with good public transport links there would need to be a 10% increase in public transport kilometres.
- 100% of electricity used by public transport would need to come from renewable sources by 2020.

Scenario testing indicated that achieving the target without mode shifts, i.e. only through encouraging lower emissions vehicles and using renewable energy for public transport, would not enable the goal to be reached. Only through very rapid changes in fuel prices (which would of themselves drive a mode shift), improvements in vehicle technology, consumer preferences and Council and Government policies could such a scenario in itself achieve the target.

1 Introduction

Sinclair Knight Merz (SKM) was commissioned by the City of Port Phillip to develop mode share scenarios to achieve significant reductions in transport greenhouse gas emissions (GHG) within the municipality. The target for the community was set in the *Towards Zero Strategy* at a 50% per capita reduction over 2007 levels by 2020.

The key objective of this study was to help Council understand what types of changes in private transport choices would need to occur for this target to be achieved. The objective was not to model policy impacts *per se*, but rather to set plausible (but stretch) targets by mode and travel segment to develop a better understanding of the likely contribution of various measures.

1.1 Background

In 2005 Victoria generated over 120 million tonnes of anthropogenic GHG emissions[1]. Of these emissions transport contributed approximately 17% and was the second largest contributor behind the stationary energy sector. In 2007 the City of Port Phillip developed the *Towards Zero Strategy* which set out a strategy to improve environmental outcomes for the council and community. Transport was one of the nine environmental challenges identified in this strategy. Within the transport sector ambitious targets were set for the Council and community separately. The greenhouse gas target for the community was set at a 50% per capita reduction over 2007 levels by 2020.

In 2009 the City of Port Phillip commissioned ARUP to undertake a greenhouse gas audit of the municipality[2]. This study found that within Port Phillip 26.5% of emissions came from transport. Of these transport emissions 33.3% were attributed to private vehicle travel emissions and a further 4.8% were attributed to public transport emissions[3].

1.2 Methodology

The methodology adopted for this study was to work up from observed current travel behaviours and choices of residents of the municipality. Using data gathered from the Victorian Integrated Survey of Travel and Activity a bottom-up analysis of observed travel behaviour has been conducted for the residents of the City of Port Phillip. This analysis has been performed taking a representative sample of households and individuals who characterise the private travel behaviours of residents across the municipality. This information has been used to develop an understanding of current travel patterns throughout Port Phillip, including trip purposes, distances travelled, trip origins and destinations and the mode choices used for the commute. Forecasts have then been

[1] CES (2007), Public Transport's role in reducing greenhouse emissions, Commissioner for Environmental Sustainability Victoria.

[2] ARUP (2009), Carbon Footprint of Community Emissions for the City of Port Phillip.

[3] Most of the remainder were due to light and heavy goods vehicle (truck) movements.

applied to the VISTA data to determine likely changes in private transport based greenhouse gas emissions and to predict baseline mode shares to 2020.

Based on these forecasts a series of scenarios have been developed which attempt to reduce per capita greenhouse emissions by 50% from 2007 levels by 2020 and show how these reductions translate into different mode shares. The assessment also includes information pertaining to strategies council could consider to achieve these changes, financial implications associated with these scenarios and methods of monitoring performance within the municipality.

2 Baseline data

2.1 VISTA

The Victorian Integrated Survey of Travel and Activity (VISTA) database is a biennial travel diary conducted for the Department of Transport. The survey is a one day travel diary of residents of metropolitan Melbourne and regional centres, covering all purposes and modes of travel on the survey day. The survey provides for an understanding of current transport demand by different demographics, household structures and household locations within Melbourne. This allows for a more detailed analysis to be undertaken of current and potential travel patterns, and how significant changes in travel (motivated in part by the *Toward Zero* target) will impact upon households and individuals within the municipality.

In this analysis we have used the trip stages, or ‘stops’, dataset with all-day stop weights Trip stages are individual trip legs, so for example, provide information on a walk to a tram stop, a tram journey, and then the walk at the destination end of the trip. Weights provide an expansion of the survey sample to be representative of the population. All-day stop weights, developed by the VISTA survey team, have been used in this analysis. These all-day weights expand the sample to be representative of an average day of travel for all residents each municipality.

Forecasts for travel patterns out to 2020, based on VISTA and forecast changes in population and demography are described in Section 3.

2.2 Inclusion and exclusions

Limitations in the datasets, combined with limitations of the City of Port Phillip to influence some types of travel, meant that only certain travel has been included in this analysis:

- Only trips made by residents of the City of Port Phillip are considered.
- Only trip stages that originate and/or terminate within the municipality are considered (Table 2.1).

Conversely, the following exclusions have been made in the analysis performed in this report.

- Trips made by non residents of the City of Port Phillip which originate or terminate within the municipality have not been included in this analysis; this is due to the difficulty in capturing these trips and also the reduced likelihood that the council will be able to influence these trips.
- Trips which pass through the municipality without having an origin or destination within council boundaries have not been captured, this is due to the inability to accurately determine which routes these trips have taken and also the fact that council would have minimal influence on these trips (e.g. trips along Queens Road between the Princes Highway and Kings Way)

- Trips by residents by aircraft (civil aviation contributes approximately 6% of transport based GHG emissions in Australia[4]), While aviation is likely to be a major contributor to GHG emissions produced by Port Phillip residents (both directly in terms of passenger travel, and indirectly through the consumption of goods transported by aircraft) there is only very limited data available on this travel, and Council have very limited ability to influence these emissions.
- Freight (which contribute around 60% of all transport emissions in the municipality).

  Freight movements have not been considered as e the majority of these would be associated with travel to and from the Port of Melbourne and as such lay outside of the Councils jurisdiction;
- Light commercial vehicles (which contribute around 20% of transport emissions according to the ARUP study). While light commercial vehicle movements are more likely to be associated with residents through their consumption of goods and services, there is very little detailed data available on their movements.
- 'Embedded' emissions that result from the manufacture and transport of vehicles are excluded. For example, around 10% of lifecycle emissions of a car come from its manufacture, with most of the remainder coming from its' use. Policies which encourage the early scrappage of a vehicle, and replacement with a more fuel efficient vehicle, may not result in net emissions savings – at least in the short term.

2.3 Trip Analysis

The 2007/08 VISTA survey interviewed approximately 43,800 individuals across 17,100 households. Of this sample 493 individuals across 243 households were residents of the City of Port Phillip. Each respondent provide information on a day's travel, resulting in 1,898 trip stages[5] by residents that started and/or finished in the municipality.

Around half of all trips (by all modes and for all purposes) by residents of the municipality start and finish within the municipality (Table 2.1). These trips only account for 15% of all person kilometres travelled.

▪ Table 2.1: Average daily trips by location using weighted VISTA data (all modes)

Trip type	No. of trip stages		Person kilometres	
Internal Trips	152,749	50.7%	249,025	15.0%
Internal to External	74,344	24.7%	724,214	43.7%
External to Internal	74,008	24.6%	685,458	41.3%

[4] CES (2007), Public Transport's role in reducing greenhouse emissions, Commissioner for Environmental Sustainability Victoria

[5] A *trip stage* is a journey with a single purpose and single mode. A *trip* may consist of multiple *trip stages*; for example, a tram trip from a home in St Kilda to the CBD would consist of three trip stages (walk to tram stop, tram journey, walk to destination in CBD).

The distribution of all trips included in the VISTA dataset is shown in Figure 2.1. The majority of trips by Port Phillip residents occur either entirely within Port Phillip (50.7%) or to the neighbouring municipalities of Melbourne, Stonnington, Yarra, Glen Eira and Bayside (38.4%).

- Figure 2.1: Trips by Port Phillip residents based on destination municipality

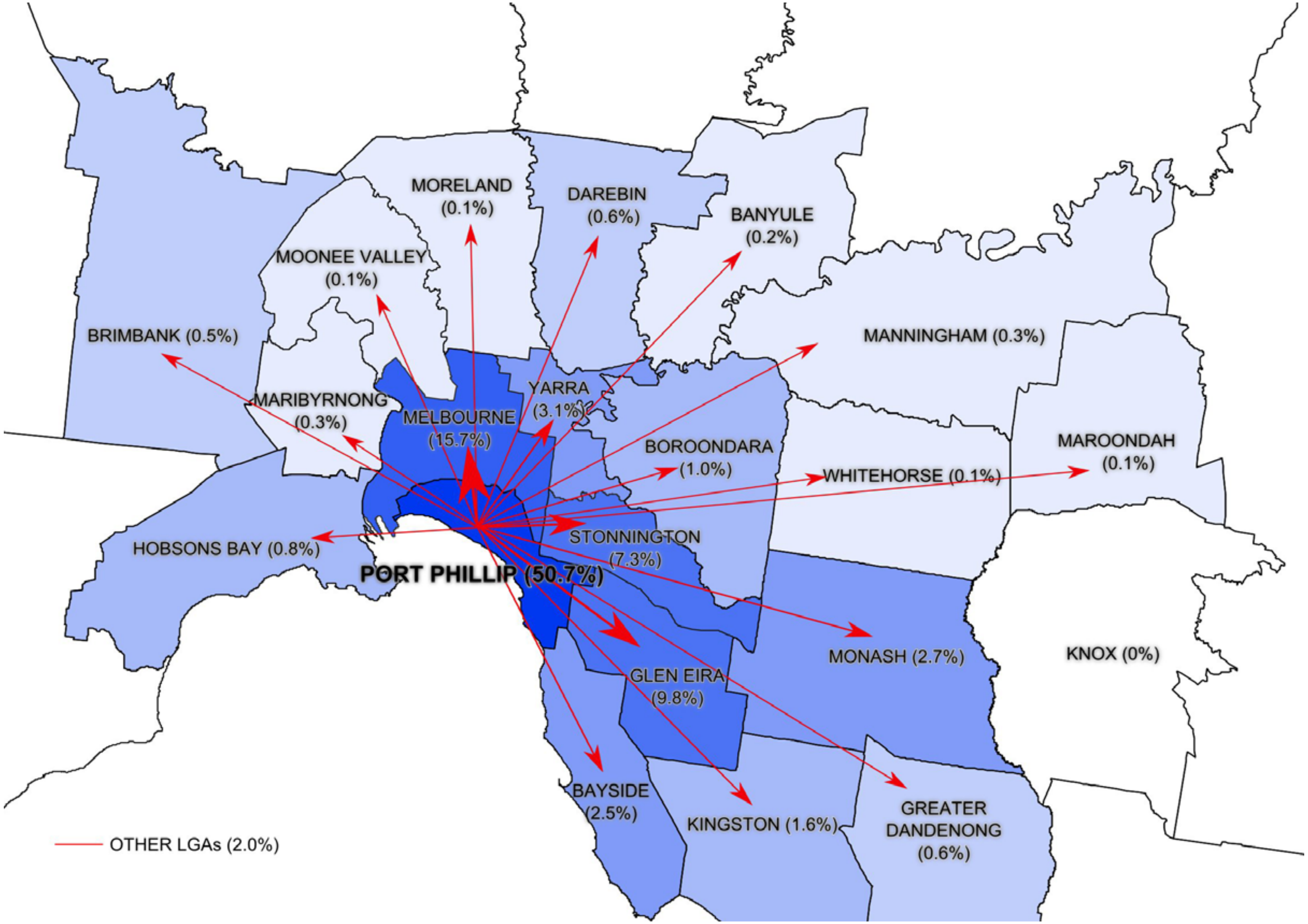


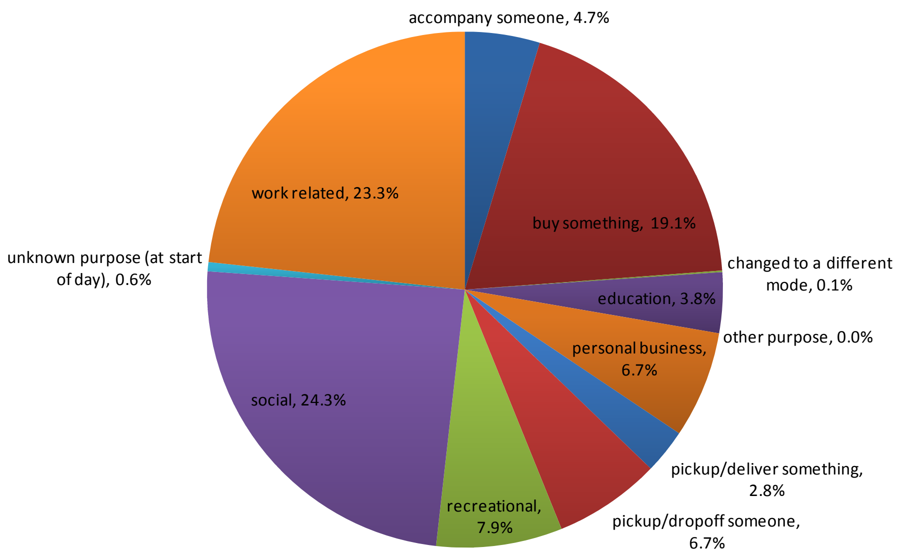
Table 2.2 shows that two thirds of trip stages are less than 5 kilometres in length. Only 9.3% of trip stages are over 15km, however this segment does equate to 43.1% of kilometres travelled.

■ Table 2.2: Trips by distance using weighted VISTA data (per day)

Distance	No. of trip stages		Person kilometres	
<1km	93,967	31.2%	47,014	2.8%
1-2km	38,932	12.9%	57,705	3.5%
2-5km	67,984	22.6%	217,639	13.1%
5-10km	59,994	19.9%	427,975	25.8%
10-15km	15,876	5.3%	192.088	11.5%
>15km	24,346	8.1%	716,274	43.1%

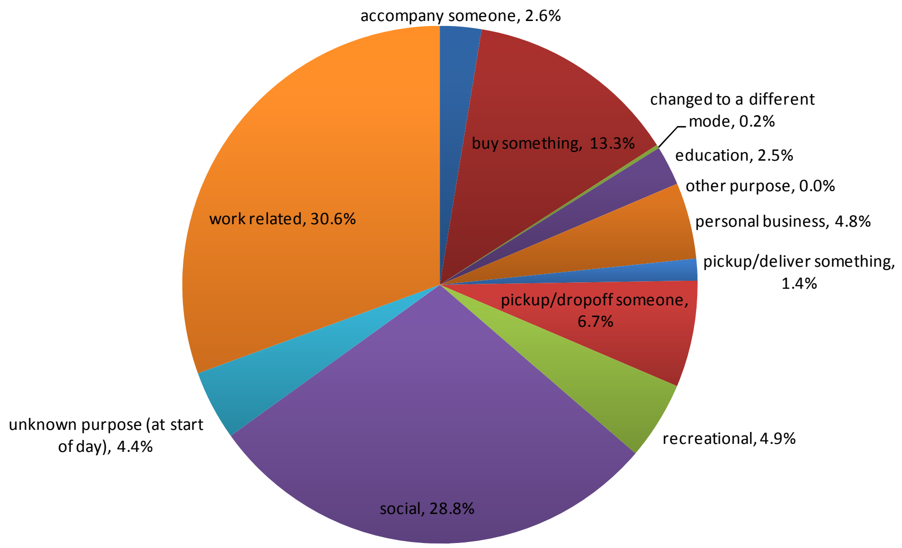
While commuting travel contributes disproportionately to congestion it still only represents about a quarter of all travel, this can be seen in Figure 2.2 and Figure 2.3 which show the trips and kilometres travelled by purpose[6]. From these graphs it can be seen that social trips and shopping trips contribute significantly to both the trips made and kilometres travelled by residents of Port Phillip. Recreational trips also form a significant proportion of shorter trips made by residents.

■ Figure 2.2: Trips by purpose



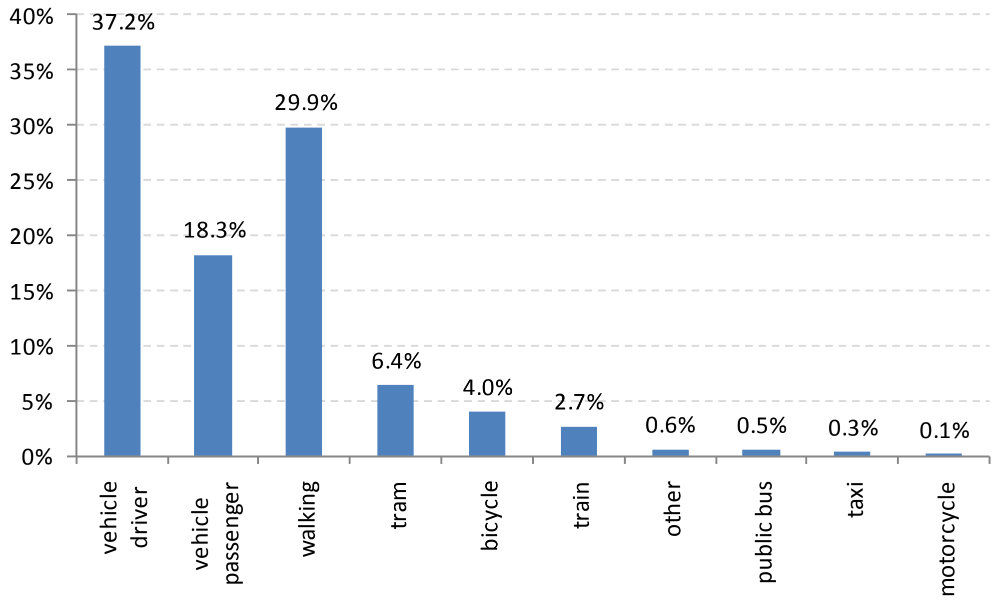
[6] The trip purpose used here is for the overall trip, not the trip stage. So, for example, a walk to a tram stop, tram journey and then a walk to a workplace would have each of the three trip stages classified as 'work related'.

■ Figure 2.3: Trip kilometres by purpose

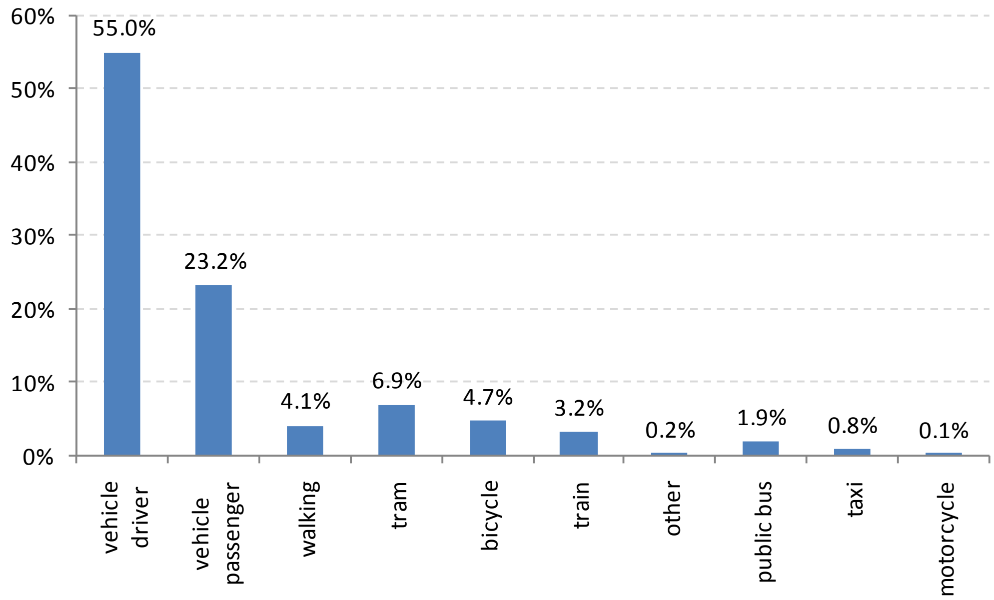


Analysis of the trip mode share for all trips by Port Phillip residents is shown in Figure 2.4. Although private car travel represents the most commonly used mode of transport (55.5%), walking (29.9%), cycling (4.0%) and travel by tram (6.4%) make up significant proportions of travel by residents of the municipality. However, Figure 2.5 shows that when the length of each trip is considered private car travel represents 78.1% of kilometres travelled by residents. This equates to over 1.3 million private vehicle kilometres travelled by Port Phillip residents daily or almost 14 km per capita per day.

■ Figure 2.4: Trip stages by mode of transport

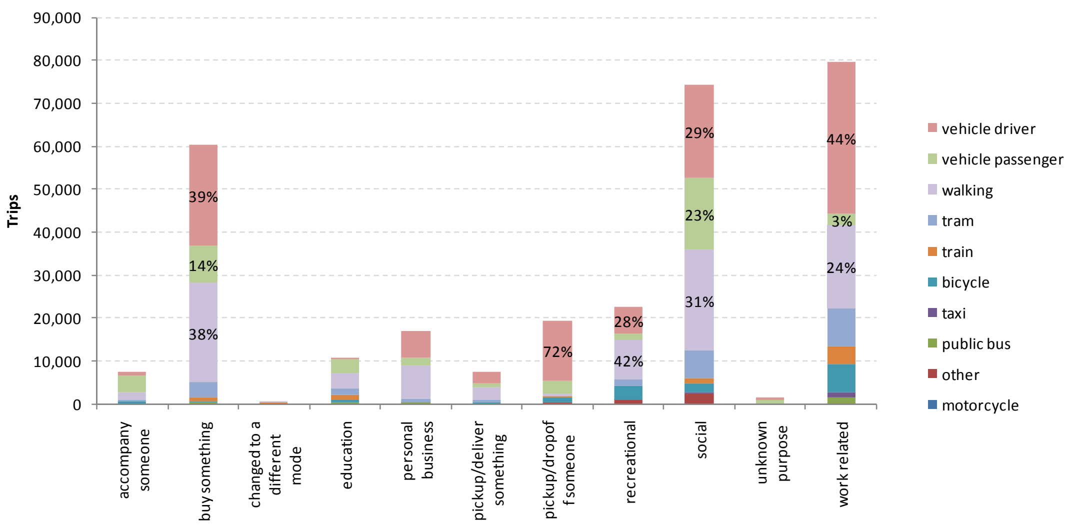


■ Figure 2.5: Trip kilometres by mode of transport (per day)

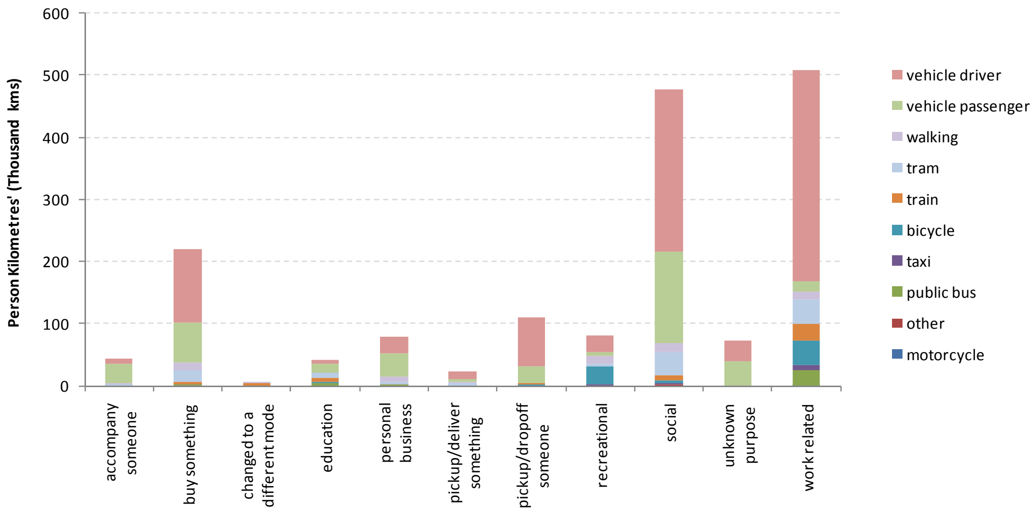


Further analysis of trip purposes has been conducted in Figure 2.6: Trips by purpose and mode (per day) Figure 2.6 and Figure 2.7. These graphs show the trips and trip kilometres travelled by purpose and mode. Again this analysis highlights the high proportion of trips undertaken by private vehicles and also highlights that private vehicles are used to undertake all purposes of travel. It also shows that the majority of private vehicle trips and trip kilometres travelled are for work related, social and shopping trips. This analysis also shows the high proportion of walking trips undertaken for all trip purposes.

■ Figure 2.6: Trips by purpose and mode (per day)

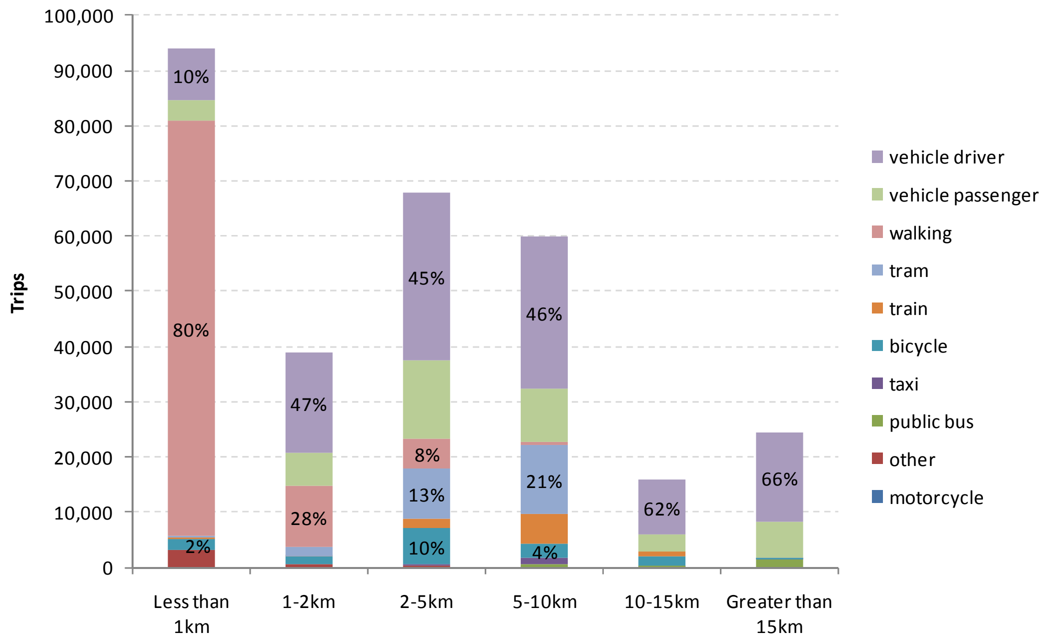


■ Figure 2.7: Trip kilometres by purpose and mode (per day)



Analysis of trips by mode choice and distance travelled is shown in Figure 2.8. The majority of trips made in the municipality are walking trips less than one kilometre in distance (80% of trip stages less than 1 km in length, corresponding to 25% of all trip stages). Private vehicle trips make up a considerable proportion of trips across all trip lengths greater than 1 km. The majority of trips made by cycling are between 2 and 5 kilometres in distance while tram trips are mostly trips between 5 and 10 kilometres.

■ Figure 2.8: Trips by distance and mode (per day)



The average trip distances travelled by each mode (Figure 2.9) gives some insight into the likely mode shifts that could be achievable by cycling and walking, both of which are likely to be most attractive only for shorter trips. From the analysis it can be seen that the average trip distance for all modes expect buses and taxis is less than 10 kilometres. Average bicycle and walking distances are 5.8 and 0.8 kilometres respectively.

■ Figure 2.9: Average distance travelled by mode

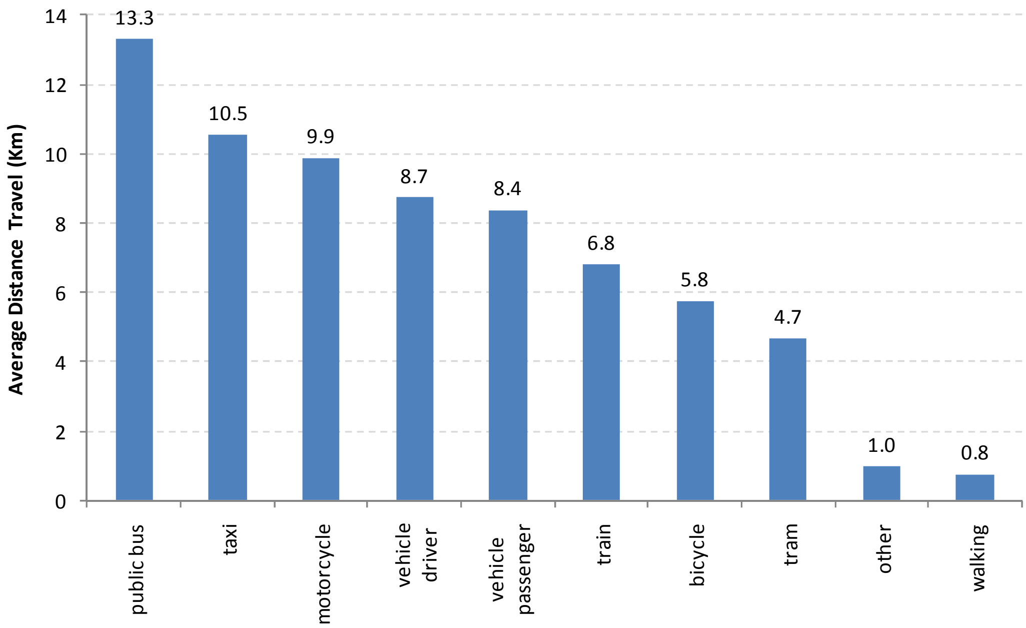
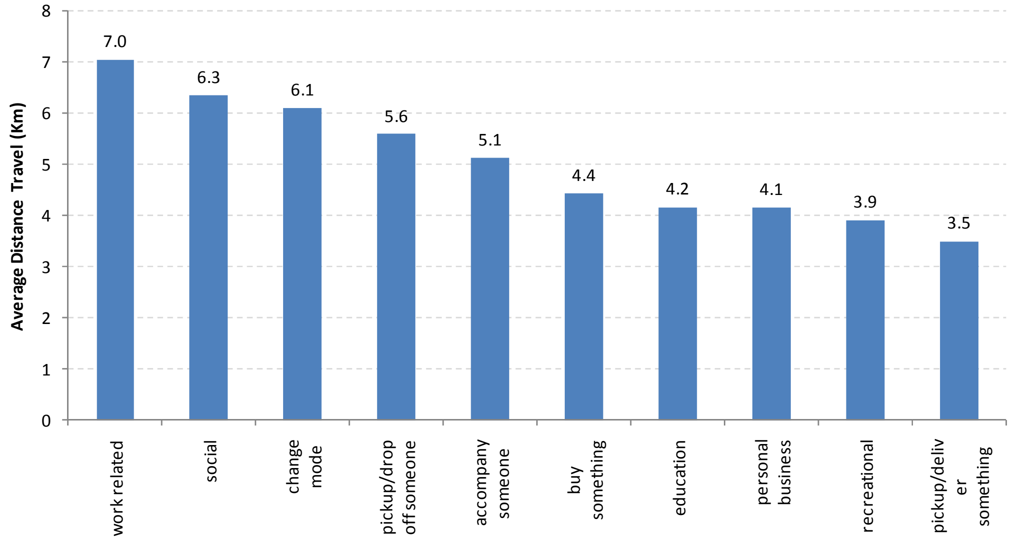


Figure 2.10 shows the average trip length for trips made for each purpose. Work related travel and social trips have the longest average trip distance.

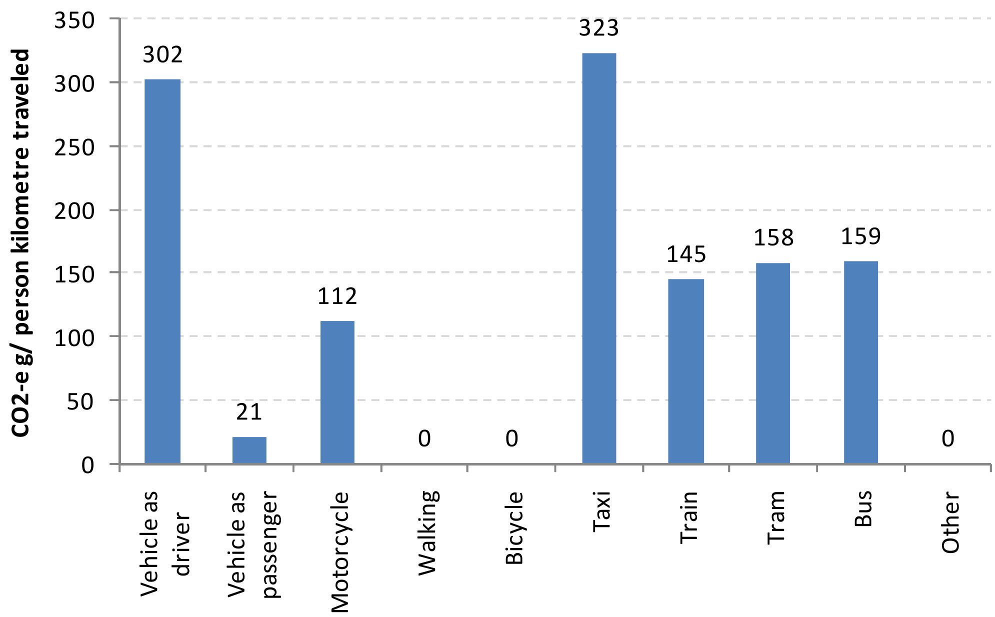
■ Figure 2.10: Average trip distance travelled by purpose



2.4 Emissions intensity factors

The Department of Transport in 2007[7] developed a set of emissions intensity factors for private and public transport in Melbourne (Figure 2.11). These factors take into account not only the average emissions intensity of private vehicles but also the emissions from the electricity grid in Victoria (for trains and trams) and average vehicle occupancy. All values have been expressed in terms of grams of CO_2e[8] per person kilometre travelled[9]. Using these values and the trips kilometres shown in Figure 2.5, the GHG emissions by mode are presented in Figure 2.12. In the case of a vehicle passenger, the additional GHG intensity is the marginal contribution due to the weight of the extra individual. The public transport emission intensities are based on the marginal contribution incorporating the additional weight and assumptions about whether additional services would be required

■ Figure 2.11: Average greenhouse intensity of transport modes



Combining the emission intensity factors in Figure 2.11 with the passenger kilometres by mode in Figure 2.5 gives an estimate of the average daily emissions by transport mode (Figure 2.12).

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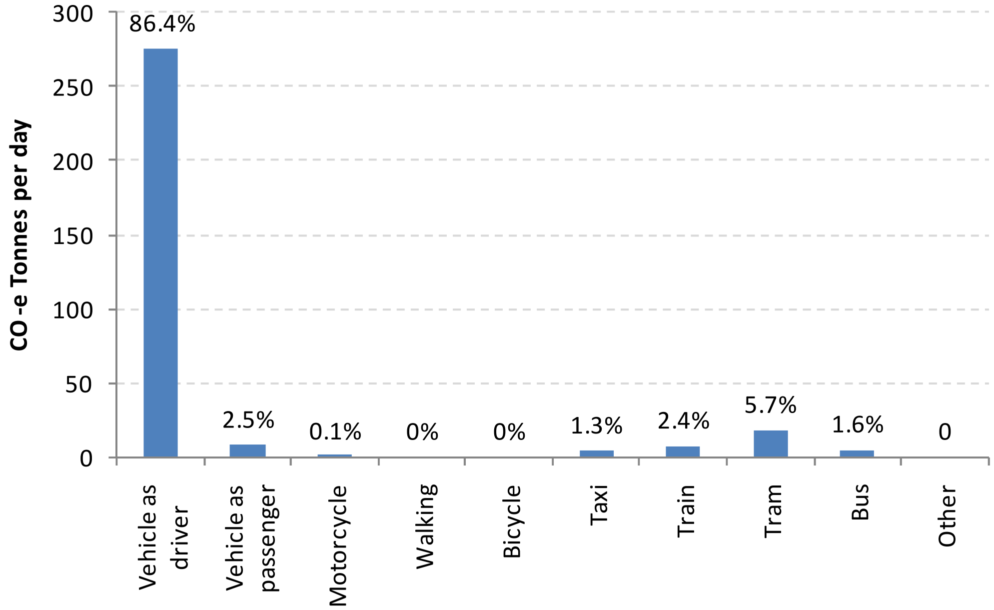
[7] Commissioner for Environmental Sustainability Victoria (2008), *Public transport's role in reducing greenhouse emissions*.

[8] Greenhouse gas emissions in this report have been measured in Carbon Dioxide equivalent grams (or CO_2e). This measure takes into account all of the gases that contribute to the greenhouse effect. While carbon dioxide is the most prevalent of these gases, other gases such as nitrous oxide, methane and perflurocarbons have a greater greenhouse effect per unit of mass than CO_2. CO_2e takes into account the different warming effects of all the gases and rationalises their unique warming effects to give an equivalent volume of CO_2.

[9] The *"other"* mode has been given a CO_2eq/pkt value of zero as it represents other active forms of transport such as roller skating and skate boarding

■ Figure 2.12: City of Port Phillip total daily greenhouse gas emissions by personal transport mode



From the analysis performed the average daily greenhouse gas emissions for residents of the City of Port Phillip in 2007 is approximately 318 tonnes of CO_2e per day. 86.4% of these emissions are from private vehicle travel. All other modes have relatively minor contributions because they (a) tend to be shorter trips, and (b) have a lower emissions intensity.

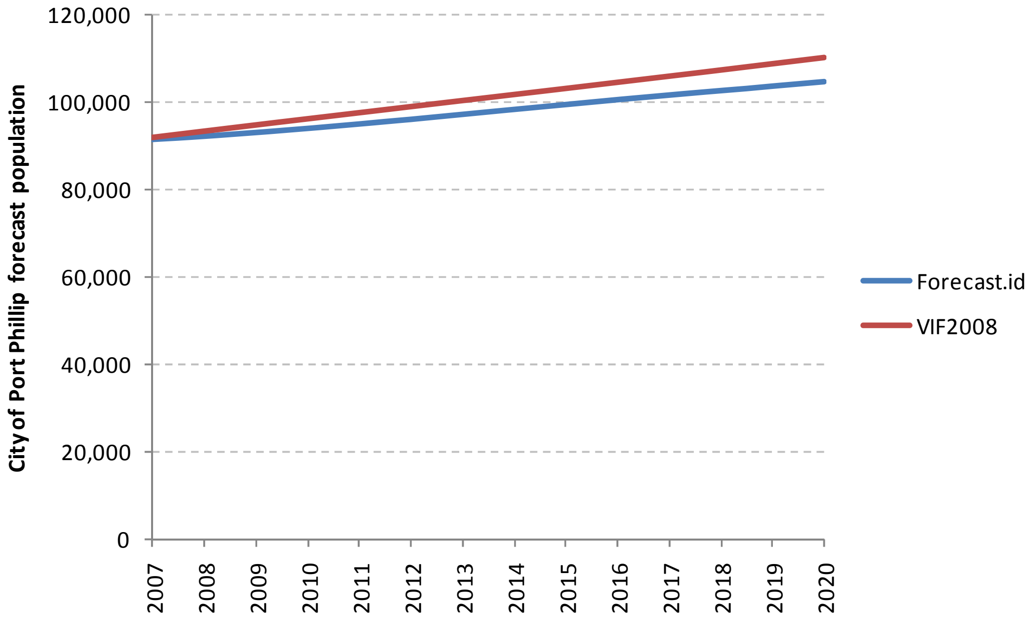
3 Baseline forecasts

In this section we project transport emissions by residents to 2020, based on forecasts of population and demographic changes in the municipality as well as forecast changes in transport emission intensities. The forecasts presented in this chapter represent the baseline situation against which the scenarios in the subsequent chapter will be considered.

3.1 Population forecasts

Population forecasts for the City of Port Phillip has been provided by forecast.id[10] (Figure 3.1). Forecast id uses census information for their base data and then supplements this information with modelling based on information on demographic changes, policy, environment and urban development within the municipality. Over the study period the population of the City of Port Phillip is expected to increase from 91,172 in 2007 to 104,462 by 2020. This equates to a per annum increase of about 0.97% or a 12.9% increase over the study period. For reference, Victoria in Future (VIF[11]) forecasts for the municipality are also shown in this figure, and suggest a marginally higher baseline population and stronger growth to 2020 than the forecast.id estimates.

■ Figure 3.1: Population forecasts for City of Port Phillip (2007-2020)



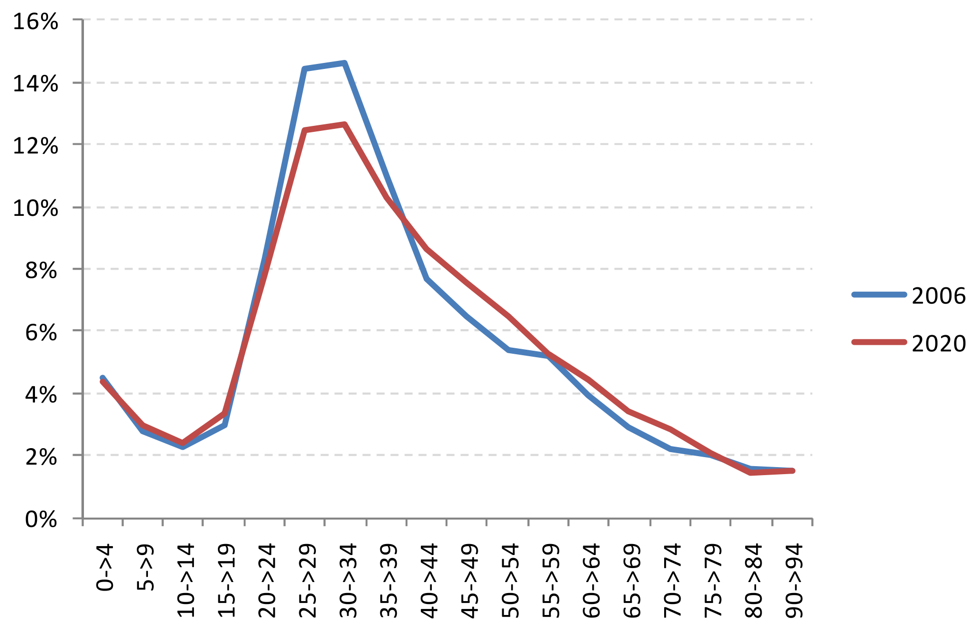
[10] .Id, viewed 15/11/10 <http://www.id.com.au/portphillip/forecastid/default.asp?id=221&gid=10&pg=0&svg=0&bhcp=1>

[11] Victoria in Future (2008) Department of Planning & Community Development

3.1.1 Age profiles

Forecast changes in the age profile of residents have also been obtained from forecast id (Figure 3.2). The age profile is forecast to shift slightly towards older age groups over the period. There will be a slight decline in the proportion of the population in the 20-35 age group and a slight increase in the overall average age.

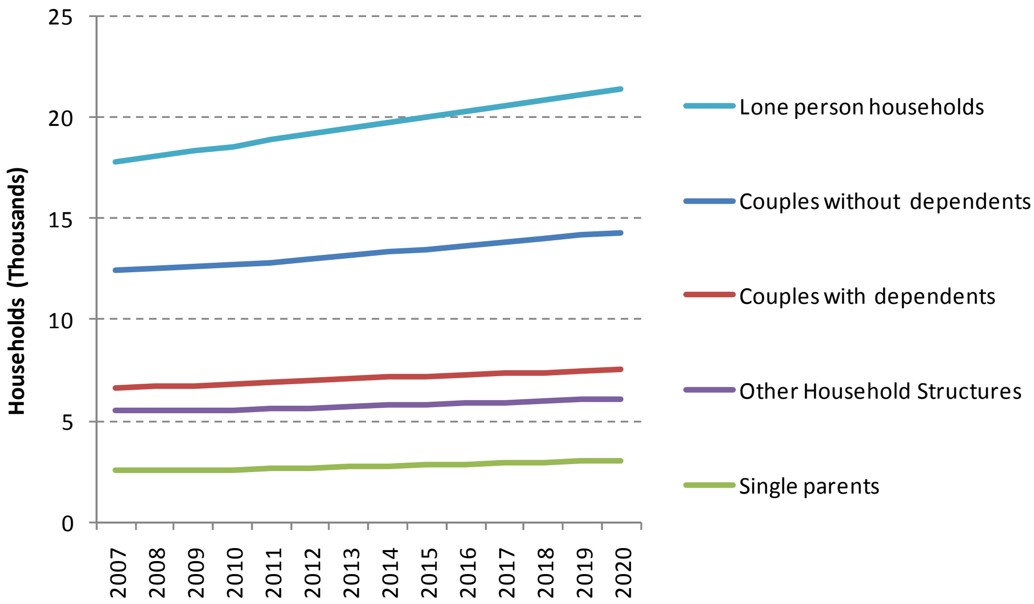
- Figure 3.2: Age profile forecasts for City of Port Phillip (2006-2020)



3.1.2 Household structure

Household structure changes have also been obtained from forecast id (Figure 3.3). Consistent with the forecast population growth, there will be an increase in the number of households over the period. All types of household structures will experience between 14-19% increases over the study period. The most significant increases will be the additional 3,500 single person households and 1,850 couples without dependant households.

■ Figure 3.3: Household structure forecasts for City of Port Phillip (2007-2020)



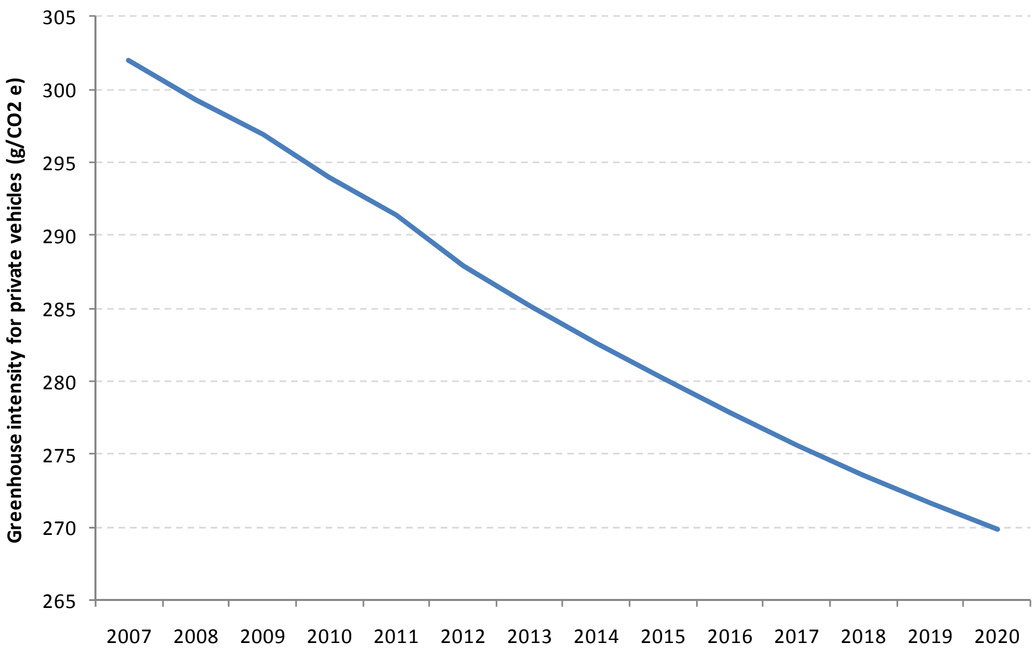
3.2 Fuel efficiency

Motor vehicle fuel efficiency gains, either through the introduction of alternative technologies, incremental improvements to existing technologies, or consumer vehicle type choice, will result in improvements in per kilometre vehicle emissions over the forecast period. Modelling by the Federal Bureau of Infrastructure, Transport and Regional Economics (BITRE)[12] has been used as the basis for forecasts in the present study. This modelling suggests that across Australia from 2006 to 2020 there will be a CO_2e/km improvement for cars of 12% to 2020. While representing a national forecast, it is possible these forecasts may be conservative for residents in the City of Port Phillip due to the greater affluence and likelihood of owning a more recent vehicle compared to the national average[13].

[12] BITRE (2009), *Greenhouse gas emissions from Australian transport: projections to 2020*, Working Paper 73, Bureau of Infrastructure, Transport and Regional Economics.

[13] Conversely, if this relative affluence were to influence vehicle type choices towards larger, more powerful vehicles the average per kilometre emissions may be greater than the Australian average.

■ Figure 3.4: BITRE predicted private vehicle emissions (2007-2020)



The City of Port Phillip has the third highest average per capita income of all Victorian municipalities[14]. The greater income of residents is reflected in the average vehicle age in the municipality. Analysis of the ABS motor vehicle census indicates that the average registration year for vehicles in Port Phillip in 2009 was 2003[15], compared to the average registration year of all Australian vehicles which is 2001.

Based on BITRE data (Figure 3.4) a vehicle that is two years newer also produces approximately 2% lower emissions. This additional assumption has been included in the baseline data from the DOT estimates, which apply across Melbourne..

3.3 Electricity generation emissions intensity

Much of Victoria's public transport network (trains and trams) is reliant on electricity. Furthermore, if all-electric and plug-in hybrid-electric cars become more prevalent in the future there would be an increasing link between electricity generation and car emissions.

The Federal Department of Energy and Climate Change have estimated the emissions factors for the Victorian power grid (Figure 3.5)[16] . By extrapolating this data out to 2020 the

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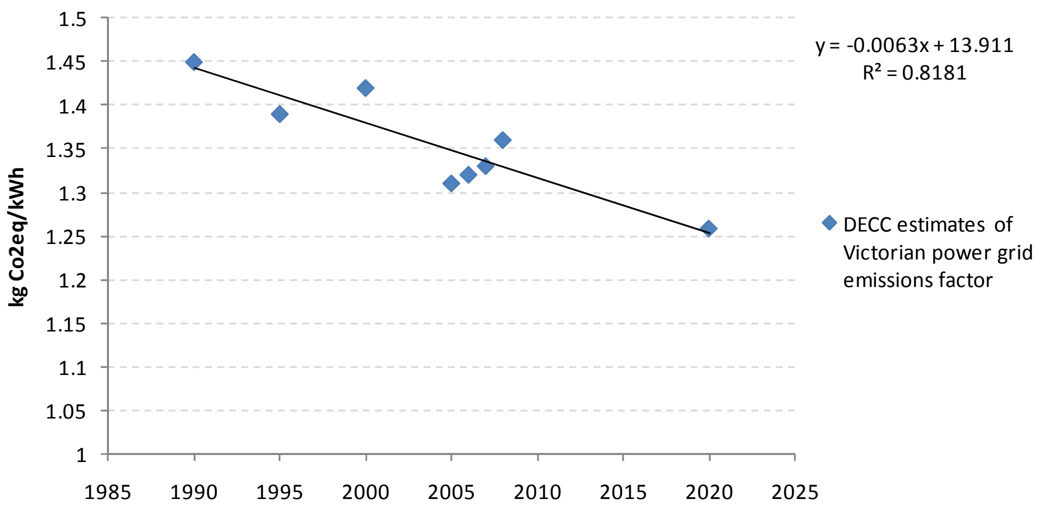
[14] ABS (2009) *Estimates of Personal Income for Small areas, Time Series.* Australian Bureau of Statistics Cat No. 6524.0.55.002.

[15] ABS (2009) *Estimates of Personal Income for Small areas, Time Series.* Australian Bureau of Statistics Cat No. 6524.0.55.002.

[16]DECC (2010), National Greenhouse Accounts Factors, Department of Climate Change.

emissions intensity is predicted to drop to 1.177 kg CO_2e/kWh. This represents a 19% improvement over 1990 levels, or an 11% improvement between 2007 and 2020.

- Figure 3.5: Department of Climate Change estimates of Victoria power grid Emissions factors

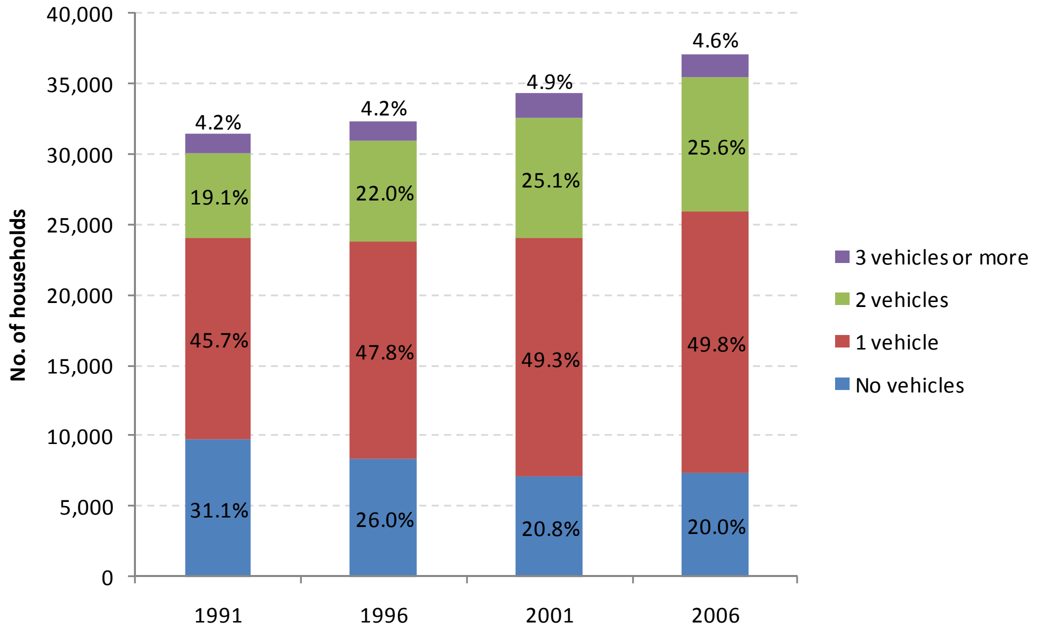


3.4 Car ownership

The proportion of households that do not own a car has dropped from 31% to 20% between 1991 and 2006 (Figure 3.6). Over the same period the proportion of households owning two or more vehicles has increased from 19% to almost 26%. There is much less change between 2001 and 2006, suggesting some stabilisation in car ownership levels in the municipality[17], although the total number of cars owned by residents has increased in a manner consistent with overall population growth.

[17] In other words, existing households did not substantially increase their average car ownership between 2001 and 2006. Instead, the growth in car ownership in the municipality may be explained by the increasing number of households.

■ Figure 3.6: Household car ownership



The forecasting approach used in this study assumes that household vehicle ownership remains steady from 2007 to 2020. This does not imply that the total number of vehicles resident in the municipality will remain constant – rather, they will grow in line with the forecast growth in population (and, by implication, households) over the period.

There is a strong link that has been established empirically between car ownership and travel behaviour. Households who own cars, and particularly those with multiple cars, tend to travel further and more often by motorised modes than non-car owning households. However, the link between car ownership and active transport usage is less clear and has not been well researched (at least, not in Australia). There are significant methodological issues understanding such links, not least the correlations between urban form, household characteristics (particularly income), car ownership and transport choices. Encouraging lower levels of car ownership would be likely to reduce car travel (and hence car mode share). As there is not strong empirical evidence on the extent of such an effect, it is assumed in the present study that the likelihood of owning one or more car at the household level will remain at 2007 levels. This assumption is consistent with the observed car ownership data, which suggests saturation in car ownership.

3.5 Future energy prices

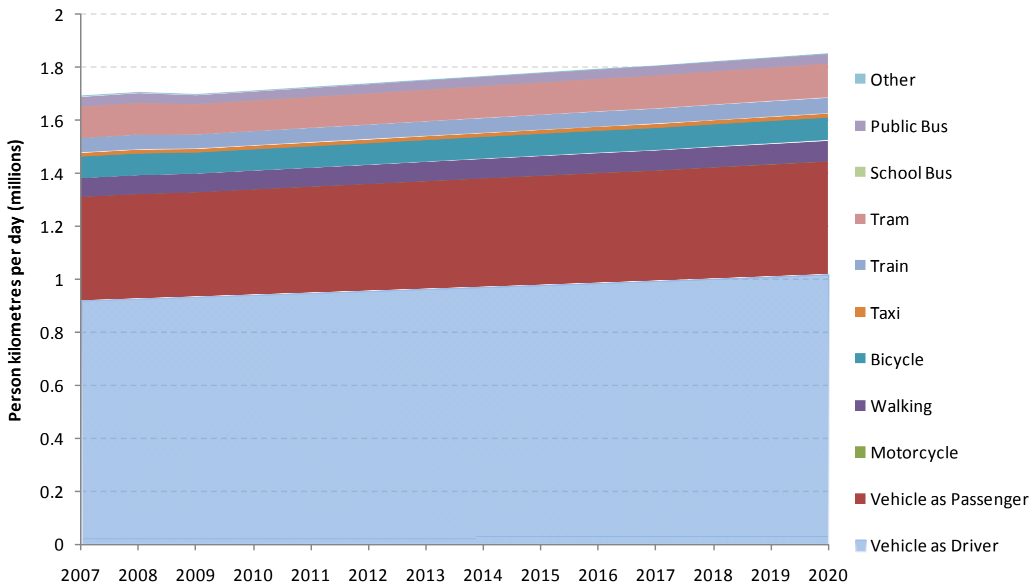
Energy prices, and particularly the cost of oil, has a significant impact on car travel. This is particularly true in areas where there exist good quality alternative travel options, such as Port Phillip. The evidence on fuel price elasticities varies between the region, time period (long term elasticities are greater than short term) and the scale of price changes (oil shocks tend to result in greater changes in behaviour, at least over the short term, than more gradual changes in price).

Forecasts for future oil prices vary widely, due to differences in assumptions with regard to remaining economically viable supply and demand. A CSIRO study[18] estimated the retail price of petrol in 2018 (in 2008 prices) could be anywhere from $2/L to $8/L should supply not continue to grow steadily (the 'peak oil' theory). In such a situation, there would be a strong economic incentive for car owners to use their vehicle less (in part by substituting travel for other modes) and to consider buying a more fuel efficient vehicle. How these responses pan out in practice will depend on numerous factors, many of which are very hard to predict or subject to significant speculation. In this study we have constrained our scenario testing to making plausible assumptions with regard to vehicle fuel economy improvements and mode shifts. Whether these shifts are achieved through policy or external economic factors such as energy prices is not speculated upon.

3.6 Forecast kilometres travelled

Using the information presented in the previous chapter, forecasts for the total vehicle kilometres travelled by residents of Port Phillip have been estimated based on changes in the population and demographics (Figure 3.7). These calculations have taken into account the changes in population, age and household structure and using these changes the 2007 baseline data has been factored to predict kilometres travelled by Port Phillip residents up to 2020. Based on the analysis we predict that total kilometres travelled by residents of Port Phillip will increase by about 11.8% by 2020 (compared with 2007), or almost 700,000 additional daily kilometres travelled per day. This is somewhat lower than the forecast population growth of 12.9%, and is attributable to the change in demographics and household structure towards groups which travel less. As for the 2007 baseline year private vehicle kilometres are the most significant contributor to total kilometres travelled.

■ Figure 3.7: Forecast person kilometres travelled by mode (2006-2020)

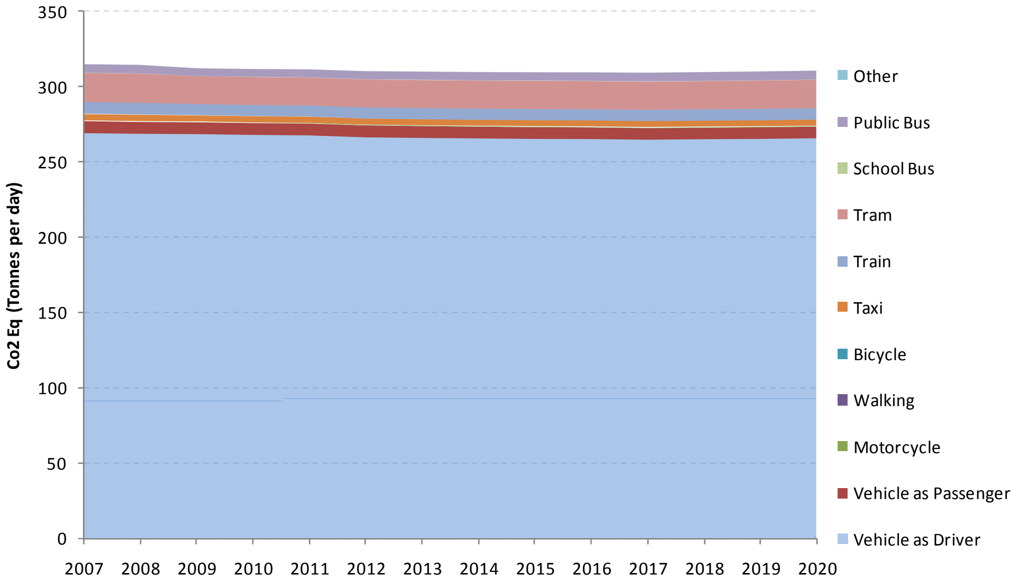


[18] CSIRO (2008), *Fuel for thought: the future of transport fuels*.

3.7 Greenhouse gas forecasts

Using the forecast kilometres travelled and the BITRE fuel efficiency forecasts the forecast annual CO_2e emissions are shown in Figure 3.8. The estimates suggest that total emissions should stay reasonably constant over the study period. This is largely due to the growth in kilometres travelled being cancelled out by improvements in vehicle efficiency (mainly private car fuel economy, but also improved emissions intensity of the electricity grid[19] for public transport). Figure 3.8 shows that around 90% of greenhouse gas emissions are attributable to private vehicle travel, significantly higher than the 60% of person kilometres attributable to private vehicle travel.

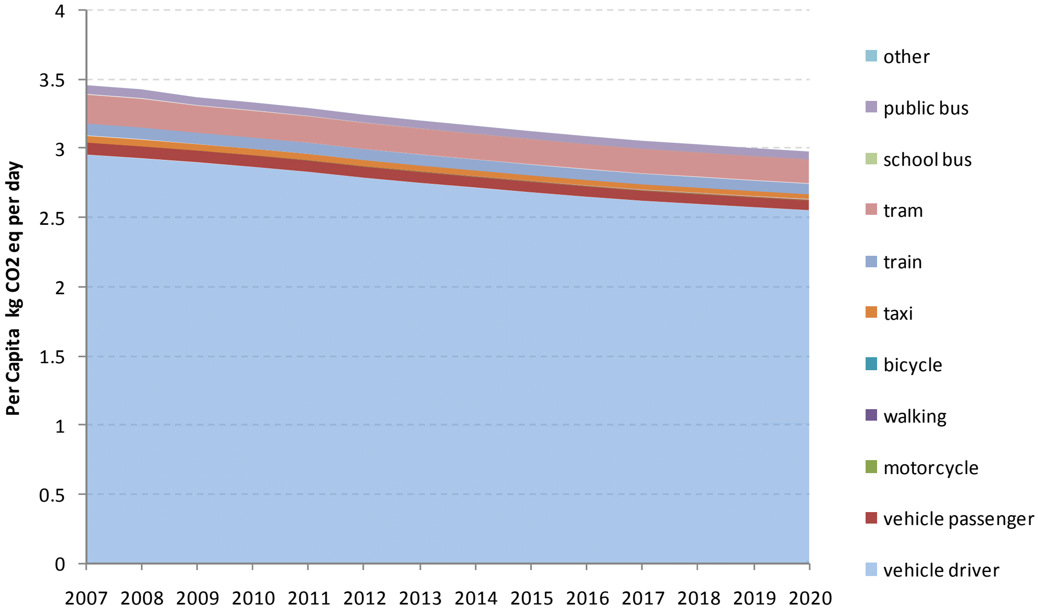
■ Figure 3.8: Forecast CO_2e tonnes by mode (2006-2020)



Turning now to consider emissions **per capita**, Figure 3.9 shows that per capita greenhouse gas emissions from private transport will reduce by 13.9% over this time period. This reduction in GHG emissions is largely attributed to forecast fuel efficiency improvements for private vehicles and the improvements in the electrical grid which in turn reduces emissions from public transport (all of which, as shown above, tend to result in stable overall emissions), combined with a growth of around 12% in the population. The baseline GHG emissions are 3.5 kg CO_2eq per person per day. This will form the baseline value which all scenario testing will be measured.

[19] Assumptions as per Section 3.3, which are the result of forecasts for increased use of renewable energy and reduced greenhouse intensity of existing fossil fuel electricity generation.

■ Figure 3.9: Per capita forecast CO_2eq by mode (2006-2020)



4 Scenario testing: individual measures

Baseline per capita transport greenhouse gas emissions have been established in the previous section at approximately 3.5 kg CO_2eq per capita in 2007. It has also been established that between 2007 and 2020 per capita emissions will decrease by 13.9%, attributable to increases in vehicle efficiencies and emissions intensity improvements in the Victorian electricity grid.

In this section we consider a number of indicative scenarios which could contribute to the achievement of the *Towards Zero* target of a 50% reduction in greenhouse gas emissions associated with private transport. It should be noted that no individual measure will be capable of achieving the required reduction in GHG emissions alone and rather a package of policies will be required to achieve the target. These packages of measures are discussed in the following chapter.

4.1 Mode shifts

As identified in Section 3, private vehicle travel contributes the majority of greenhouse gas emissions by residents. For the *Toward Zero* target to be achieved a significant mode shift away from emissions intensive modes towards low emission modes will be required. In order to investigate how these changes in mode share could occur a set of scenarios have been developed across three different trip lengths. Included in this analysis are explanations of each scenario, the forecast reductions in per capita emissions associated with implementing each of these changes and brief commentary on measures by which council may be able to influence these changes.

4.1.1 Local trips (<5km)

Trips fewer than five kilometres in distance make up around one third of all trip stages made by residents of the City of Port Phillip. The short distance of these trips make cycling and walking suitable alternatives for at least some of these trips. As 80% of trips under one kilometre are already made by walking, the majority of trips which could be shifted to cycling and walking would be those trips between one and 5 km, where motorised travel rapidly becomes the dominant mode.

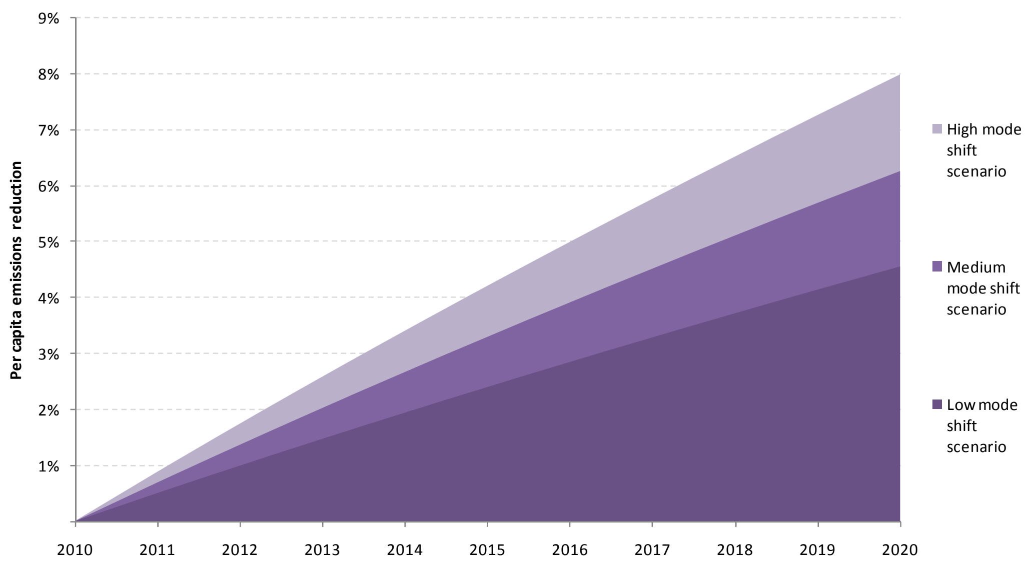
Three scenarios have been investigated looking at what the impacts different mode shift scenarios may have on reducing per capita greenhouse gas emissions. The scenarios investigated are shown in Table 4.1.

■ Table 4.1: Local trip scenarios mode shares

Scenario	Active Transport	Public Transport	Private Transport
Baseline	29.2%	12.0%	58.8%
High (+50% active transport,+20% public transport)	43.8%	14.4%	41.8%
Medium (+40% active transport,+15% public transport)	40.8%	13.8%	45.4%
Low (+30% active transport,+10% public transport)	37.9%	13.2%	48.9%

These scenarios have been investigated assuming public transport is operating using 50% renewable energy by 2020. Figure 4.1 shows the potential percentage emissions reduction per capita based on the three different scenarios. From this analysis it can be seen that a 7% per capita reduction in greenhouse gases could be achieved with the most ambitious local mode shift targets.

■ Figure 4.1: Local trip emission reduction scenarios



We do not consider explicitly in this study what policies could achieve these emission reductions. However, the types of policies which may contribute include:

- Upgrading walking facilities, including greater pedestrian priority at crossings, particularly to encourage walking trips greater than one kilometre.
- Upgrading on road bicycle facilities including signal priority to cyclists, enhanced lane markings, lane segregation and installing head start boxes.
- Upgrades to off-road path facilities such as improved lighting, increased pavement widths and pavement markings
- Reducing on-street parking and free parking
- Replacing private vehicle parking spaces outside key attractors with bicycle parking facilities
- Reducing the connectivity of the road network to create longer journeys for vehicles and shorter journeys for walking and cycling trips (that is, create a more permeable walking and cycling network while reducing the permeability for vehicles).
- Encouraging the use of car share schemes to encourage more careful consideration of when a car is really necessary for a trip.

4.1.2 Medium distance trips (5-15km)

Medium distance trips between five and fifteen kilometres make up 25% of all trips made by residents of the municipality. These trips include journeys that are typically still located within inner Melbourne municipalities where there are good public transport and, in some cases, as well connected bicycle network.

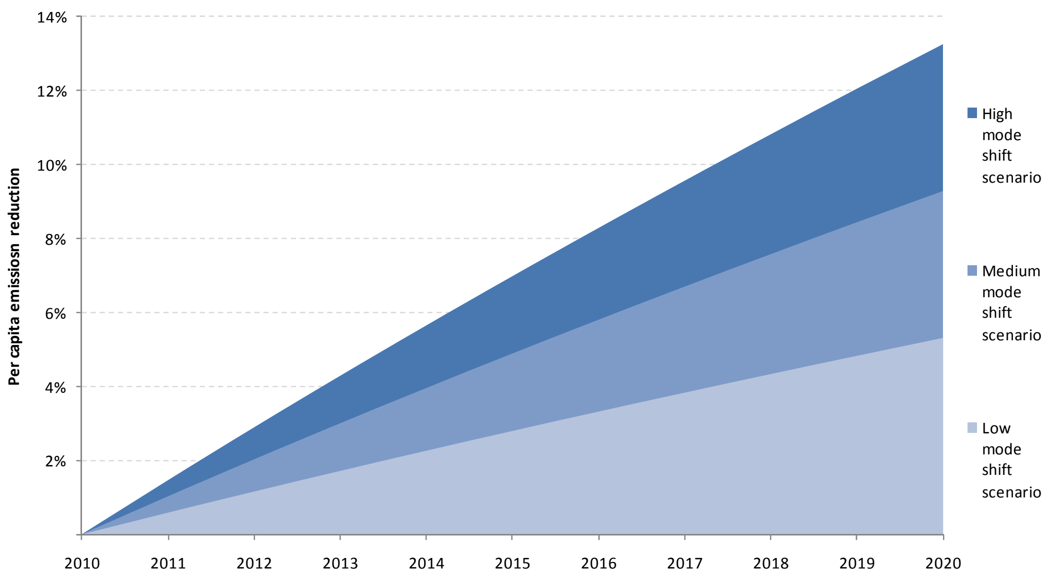
Again, three scenarios have been analysed looking at high, low and medium mode shifts towards public and active transport for medium distance trips (Table 4.2).

- Table 4.2: Medium distance trip scenarios mode shares

Scenario	Active Transport	Public Transport	Private Transport
Baseline	7.1%	21.7%	71.2%
High (+10% active transport,+25% public transport)	7.8%	27.1%	65.1%
Medium (+5% active transport,+20% public transport)	7.5%	26.0%	66.5%
Low (+3% active transport,+15% public transport)	7.3%	25.0%	67.8%

In Figure 4.2 the mode shift scenarios for medium distance trips have been shown. The most ambitious scenario results in almost a 13% reduction in per capita greenhouse gas emissions. This analysis highlights that reasonably low levels of modal change for longer trips can contribute to a considerable reduction in greenhouse gas emissions.

■ Figure 4.2: Medium distance trip emission reduction scenarios



To achieve these mode shifts for medium distance trips council could consider a combination of the following strategies:

- Bicycle parking at public transport terminals
- Increasing council residential parking charges
- Upgrading on road bicycle facilities including signal priority, lane markings, lane segregation and installing head start boxes.
- Upgrades to shared path facilities such as improved lighting, increased pavement widths.
- Reducing on-street parking and free parking
- Replacing private vehicle parking spaces outside key attractors with bicycle parking facilities
- Advocating to State Government to improve the availability and extent of the public transport network serving the City of Port Phillip and neighbouring municipalities.
- Encouraging the use of car share schemes to encourage more careful consideration of when a car is really necessary for a trip.

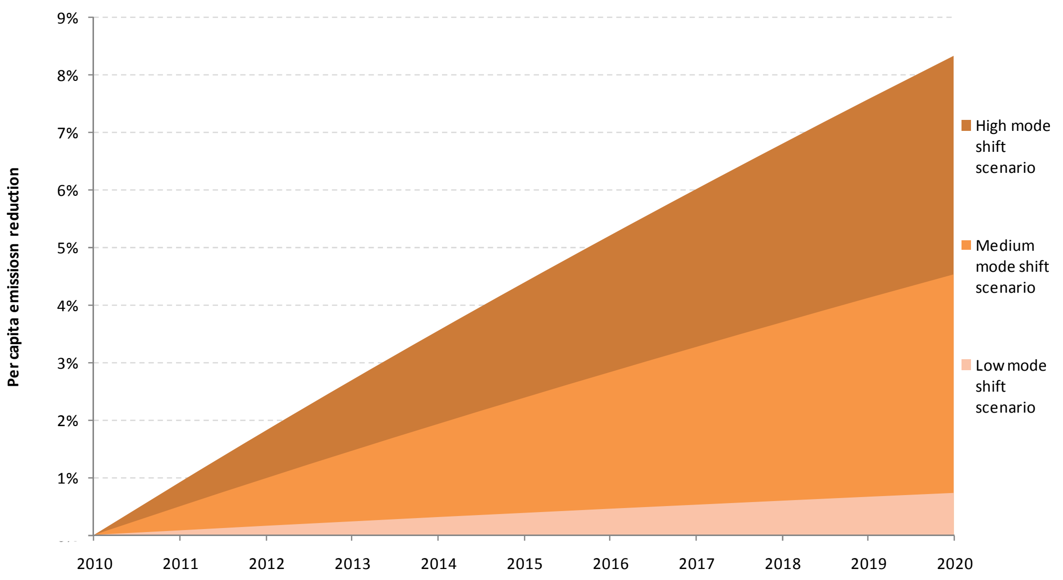
4.1.3 Longer distance trips (>15km)

Trips greater than 15 kilometres represent only 8.1% of total trips made by residents of Port Phillip but contribute to 43.1% of the total kilometres travelled. Trips greater than 15 kilometres are not typically suitable to active transport modes. Depending on the destination, trips of this length can also have limited public transport options and those that do exist may be indirect and uncompetitive with private car use. In order to reasonably address these issues only trips to specific municipalities with strong public transport links to Port Phillip have been considered in this mode shift analysis. Table 4.3 expresses the municipalities where we believe a reasonable mode shift would be possible and the percentage mode shift assumed for each municipality under three different scenarios. Based on these three scenarios Figure 4.3 illustrates the possible emissions reductions if these targets were met.

■ Table 4.3: Long distance trip scenarios (mode shift from private vehicles travel to public transport)

Municipality	High mode shift	Medium mode shift	Low mode shift
Melbourne , Yarra, Stonnington, Glen Eira, Bayside	25%	15%	5%
Banyule, Boroondara, Darebin, Kingston, Monash, Moonee Valley, Moreland, Hobsons Bay	10%	5%	0%

■ Figure 4.3:Long distance trip emission reduction scenarios



From this analysis it can be seen that up to an 8% reduction in per capita emissions could be achieved by 2020 under the high mode shift scenario, the medium mode shift scenario would also be able to achieve over a 4% reduction in emissions compared to 2007 levels.

In order to achieve these scenarios considerable enhancements of the public transport network would be required, while many of these improvements fall outside of council's jurisdiction some potential options that council could investigate include:

- Increase parking prices to disincentivise car ownership and use
- Bicycle parking at major train and bus interchanges
- Prioritise movement of public transport and active transport modes at the expense of private vehicle transport.
- Encouraging the use of car share schemes to encourage more careful consideration of when a car is really necessary for a trip.

4.2 Vehicle fuel economy improvements

As discussed in Section 3.2, BITRE forecast around a 12% improvement in vehicle fuel efficiency between 2007 and 2020. These forecasts assume a continuation of the incremental improvements that have occurred over the recent past. It is possible that significant technological change due to alternative fuel sources, combined with higher than anticipated oil prices, may drive consumer demand towards increasingly efficient vehicles. To what extent this may occur is difficult to forecast. Furthermore, the average vehicle age in Australia is just under 10 years[20] and so even in the highly unlikely event that **all** new vehicles sold were of some future technology it would take to well beyond 2020 for a the majority of the vehicle fleet to be of this new technology.

However, as a means of testing what the plausible impact of an acceleration towards more fuel efficient vehicles would be we consider in this section that a proportion of vehicles by 2020 will be all-electric. Electric vehicles typically consume between 0.2-0.3 kWh/km[21].

Using the emissions factors for the Victorian power grid discussed in section 3.3. the CO_2e emissions per kilometre travelled for a 'typical' electric vehicle charged using Victoria's electricity grid are shown in Figure 4.4. From these estimates an electric vehicle would have an emissions intensity around 45% less than an average car[22]. These values are largely dependent on the efficiency the power grid. Any improvements to reduce emissions from stationary power sector would have cumulative effects on the efficiency of electric vehicles.

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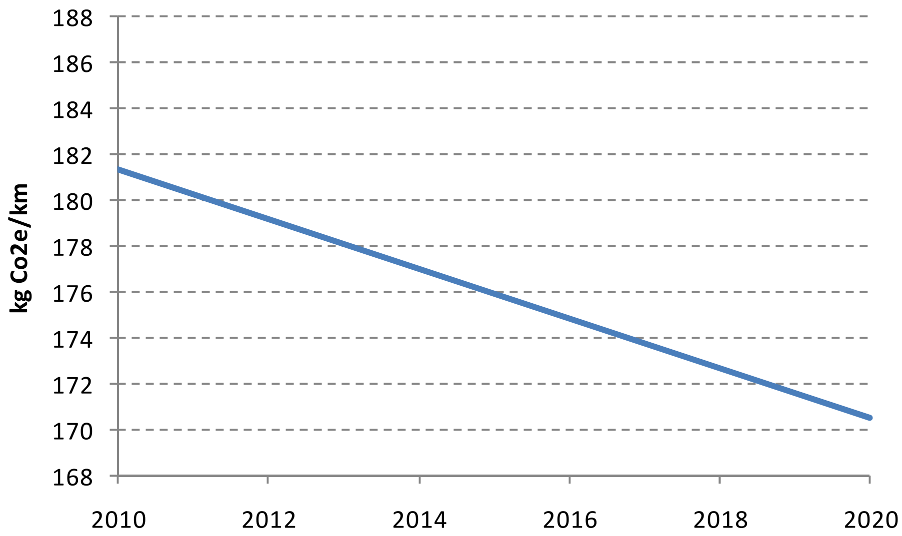
[20] ABS (2009), *Motor Vehicle Census*. Australian Bureau of Statistics, Cat No. 9309.0.

[21] Based on published performance data for currently available and proposed electric vehicles (e.g. Nissan Leaf, Mitsubishi MiEV).

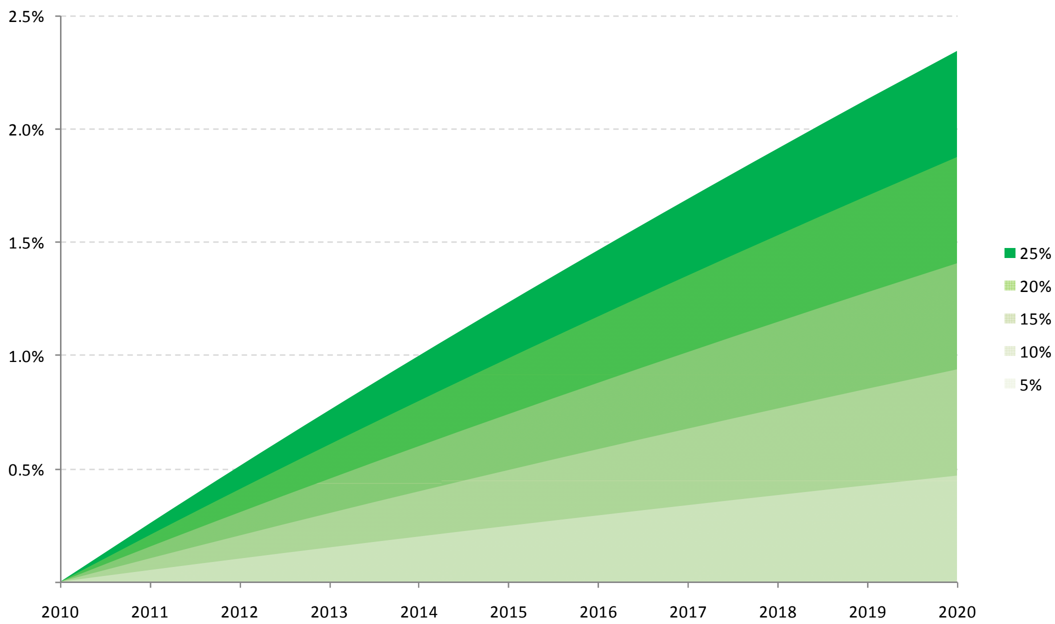
[22] Note however that the emissions intensity of a efficient conventionally powered car would be lower again – a Toyota Prius emits around 105 g/km and small cars such as the Toyota Yaris, Honda Jazz and Ford Fiesta generally emit less than 150 g/km.

■ Figure 4.4: Electric vehicle kg CO_2e per kilometre



Using these assumptions on the potential emissions savings associated with converting a percentage of the vehicle fleet to electric vehicles, Figure 4.5 illustrates the percentage emissions savings that would occur if a proportion of vehicles owned by residents were electric powered in 2020.

■ Figure 4.5: Emissions reductions for electric vehicles

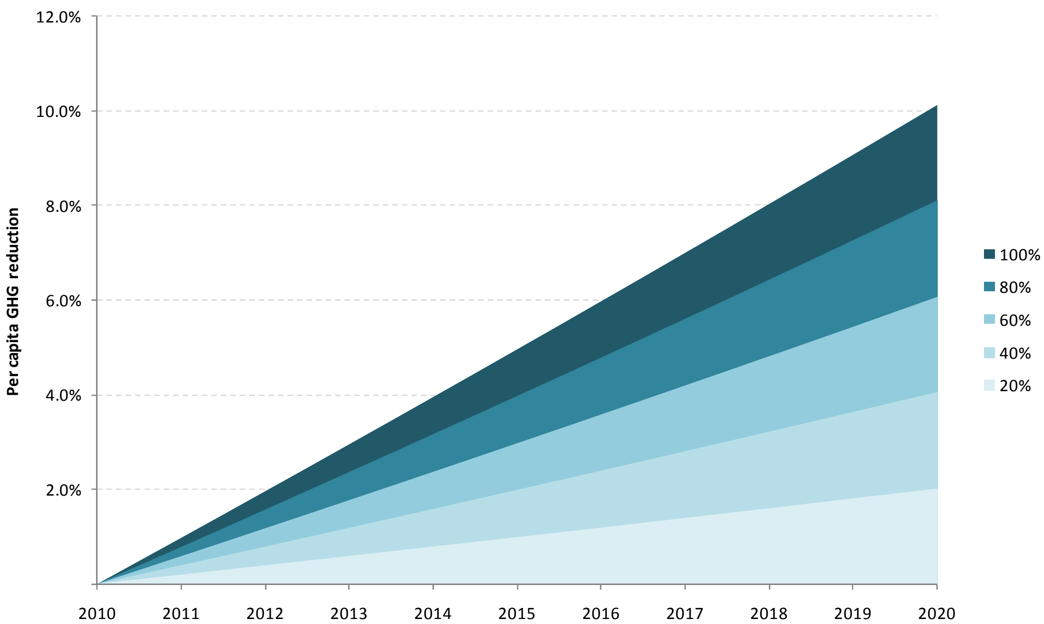


As these green technologies become more cost effective and readily available it is assumed that more vehicles would be fitted with these or similar technologies. The City of Port Phillip could further encourage residents to make a shift towards greener vehicles by introducing variable parking permit costs that were priced proportionally to the greenhouse emissions produced by the vehicle per kilometre travelled (as has been done in a number of London Boroughs).

4.3 Green public transport

The emissions intensity of electrified public transport (train, tram) in Melbourne is significant given that the stationary power sector has a relatively high greenhouse footprint. By converting some, or all, of the power used for public transport to renewable energy the emissions profile could be significantly reduced (if not eliminated altogether). This would result in a considerable reduction in GHG transport emissions by residents, particularly if combined with other efforts to shift private vehicle trips onto public transport. Figure 4.6 shows the potential reductions in per capita emissions associated with varying percentages of renewable energy use for public transport.

■ Figure 4.6: Emissions reductions for using renewable energy for public transport



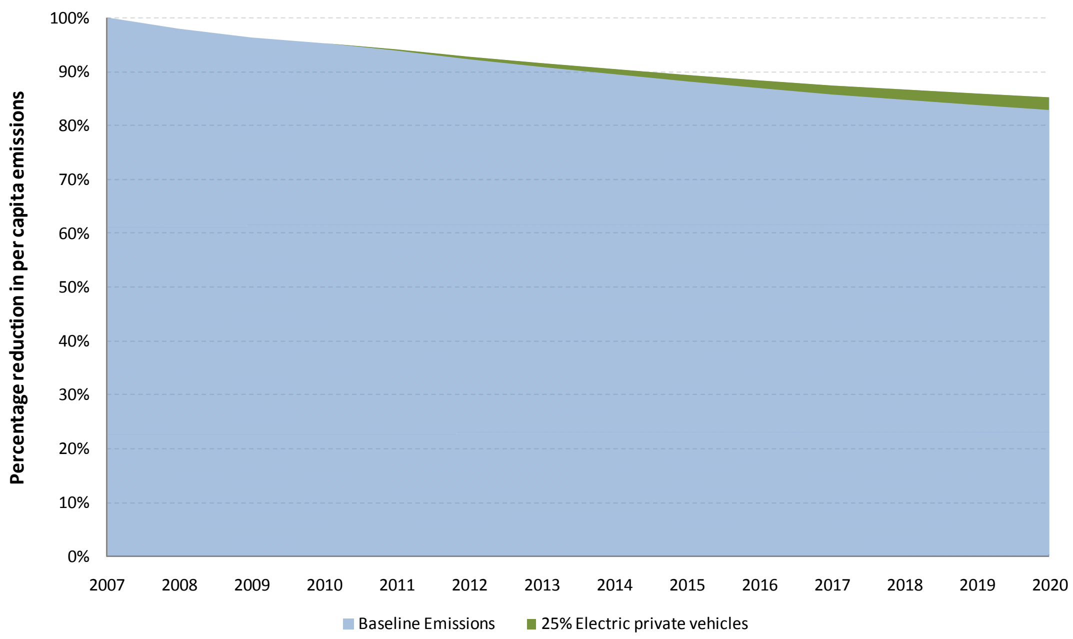
5 Scenario testing: packages of measures

Having established what emissions reductions are capable from single interventions in the previous section, three scenarios have been developed which focus on alternative ways in which the 50% per capita reduction could be met. These scenarios rely on different combinations of all the previously mentioned emissions reductions methods. The approach taken is to build up sequentially towards the target – from improving private vehicle emissions intensity, to mode shifts to reducing the emissions intensity of public transport.

5.1 Scenario 1 – Green Cars

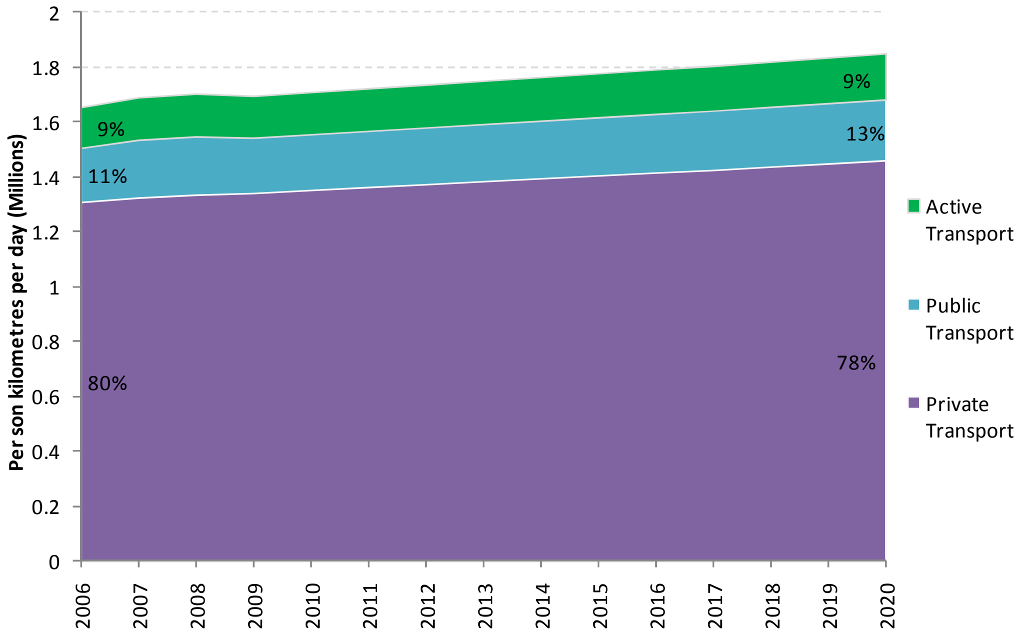
In this first scenario we consider what impact focusing on improving private transport emissions intensity would achieve in the absence of any mode shift. We have assumed that 25% of the vehicles within the municipality will be electric (or have equivalent emissions intensity) by 2020. This rapid take-up would be unprecedented. It may be anticipated that for such radical changes to occur so rapidly significant technical and financial improvements would need to be made to electric vehicles, fuel prices would need to increase rapidly as well as Council introducing measures to facilitate the uptake of low emissions vehicles.

■ Figure 5.1: Scenario 1 per capita greenhouse gas reductions



Under this scenario the projected reduction in per capita emissions is 17% below baseline levels. This scenario highlights that Council will need to focus on mode shift as a significant component of achieving the required reductions and that significant improvements in vehicle efficiency will not meet the 50% reduction target of themselves. The mode share splits under this scenario are shown in Figure 5.2; these reflect purely the forecast changes in population demography over the period.

■ Figure 5.2: Scenario 1 mode share of person kilometres



The average kilometres travelled by mode and emissions forecast targets are shown in Table 5.1 for this scenario.

■ Table 5.1: Scenario 1 forecast targets

	2007	2012	2014	2016	2018	2020
Private Transport forecast pkt (thousand pkt/day)	1,327 (78.3%)	1,375 (79.0%)	1,397 (79.0%)	1,418 (78.9%)	1,439 (78.9%)	1,463 (78.9%)
Public Transport forecast pkt (thousand pkt/day)	212 (12.5%)	207 (11.9%)	211 (12.0%)	215 (12.0%)	219 (12.0%)	223 (12.0%)
Active Transport forecast pkt ((thousand pkt/day)	155 (9.1%)	157 (9.0%)	160 (9.0%)	162 (9.1%)	165 (9.1%)	168 (9.1%)
Per capita emissions ($kgCO_2$-e / day)	3.45	3.22	3.13	3.04	2.96	2.89

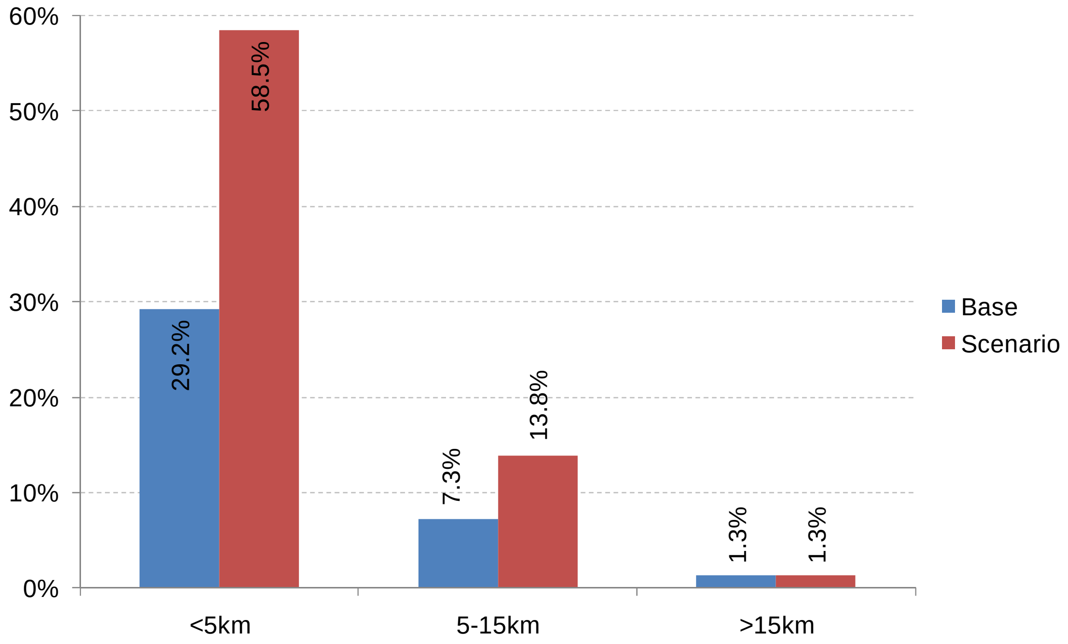
5.2 Scenario 2 – Active Transport Mode Shift

This scenario assumes that very significant shifts towards cycling and walking will occur, due to a combination of 'pull' policy actions by Council (such as infrastructure, education and marketing) and, possibly, external factors such as fuel price increases. The shifts assumed are as follows:

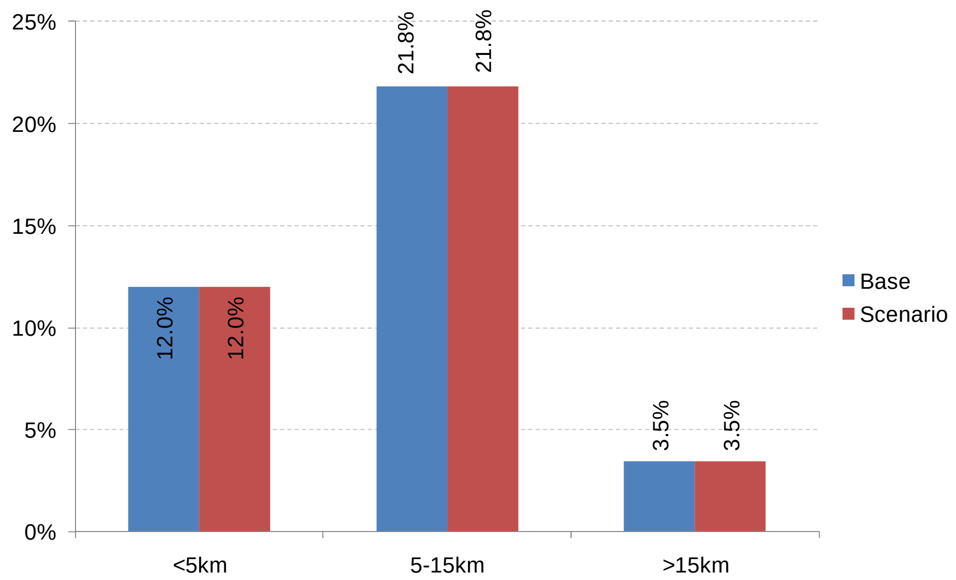
- For short trips under 5 km there will be a 100% increase (i.e. a doubling) in active transport person kilometres.
- For trips between 5 km and 15 km there will a 90% increase in active transport person kilometres.
- For long trips over 15 km there will be no mode shifts.

The increase in absolute person kilometres each of these changes represent over the baseline are given in Figure 5.3 for active transport and Figure 5.4 for public transport.

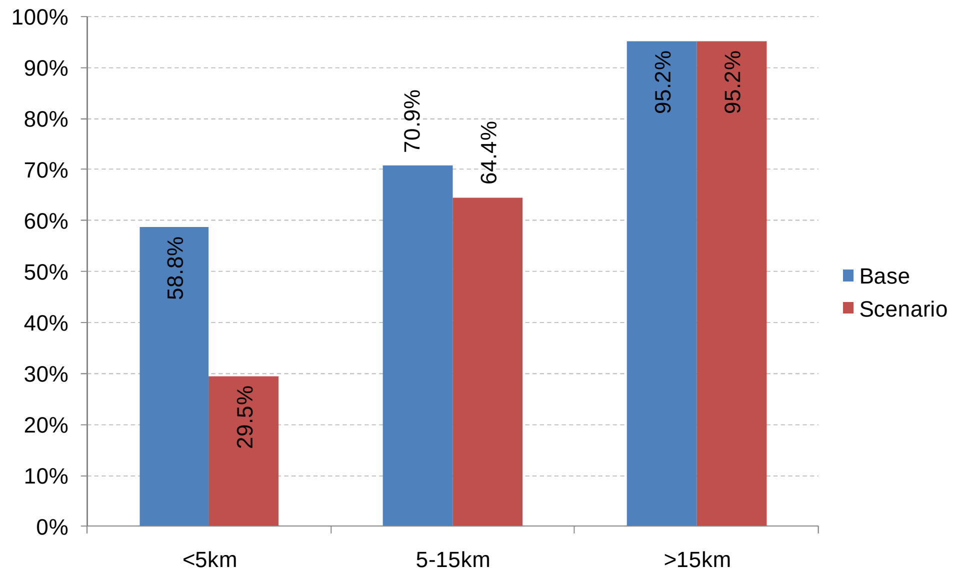
■ Figure 5.3: Share of person kilometres by active transport



■ Figure 5.4: Share of person kilometres by public transport

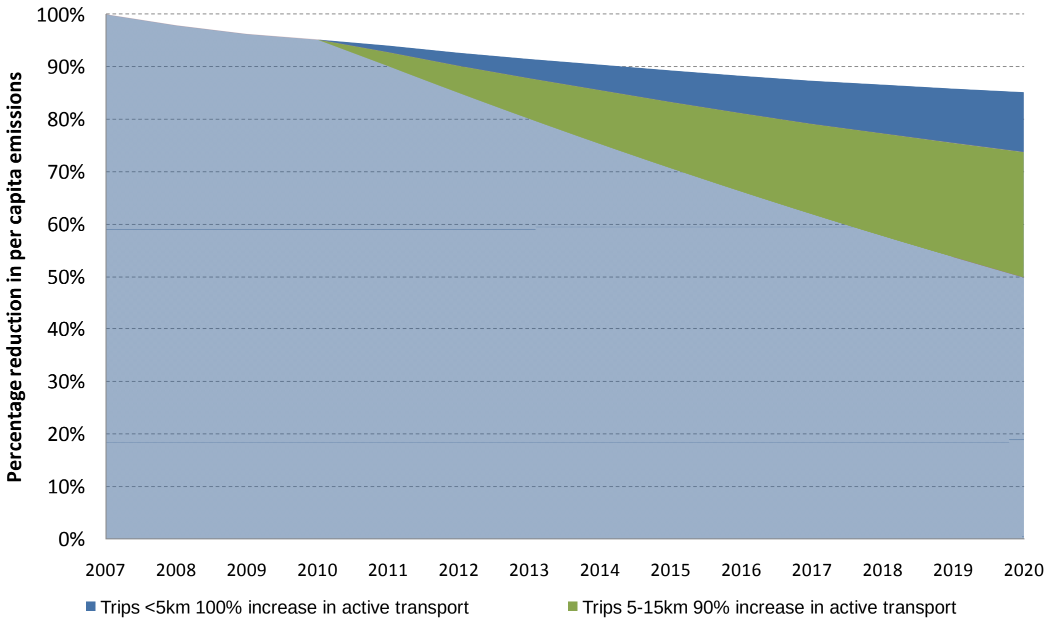


■ Figure 5.5: Share of person kilometres by private vehicle



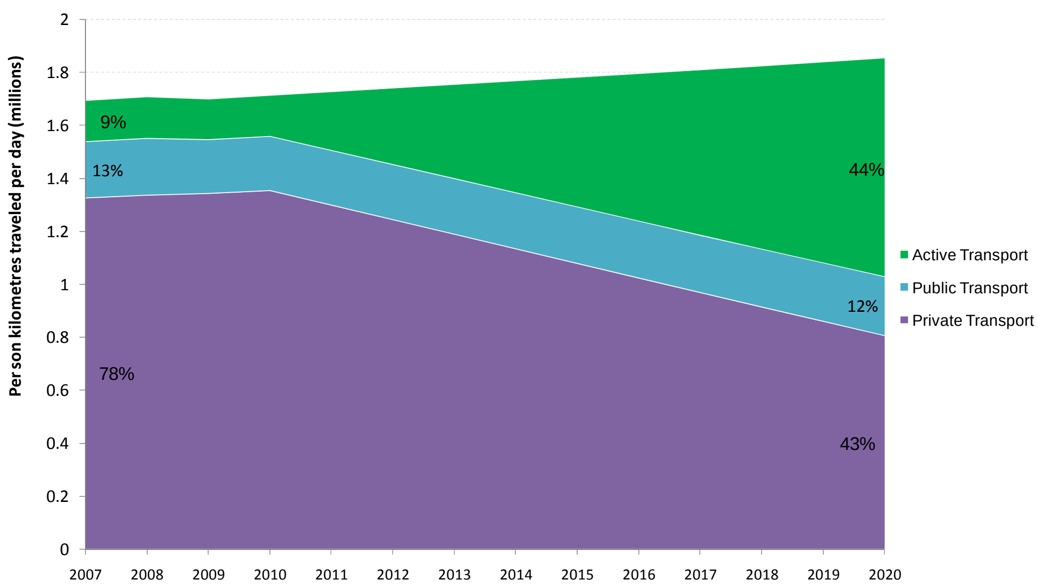
Around two thirds of the greenhouse gas reduction under this scenario would come from shifting medium length trips to active transport (Figure 5.6). Given the length of these trips are between 5 and 15 km, it may be expected that the majority of the mode shift would be towards cycling as opposed to walking.

■ Figure 5.6: Scenario 2 'mode shift' per capita greenhouse gas reductions



The change in person kilometre shares associated with this forecast is shown in Figure 5.7. Under this scenario private vehicle kilometres would decrease from 78% to 53% of all kilometres travelled in 2020. Public transport kilometres would increase from 13% to 28% and active transport kilometres would increase from 9% to 19% of all person kilometres. Even with these dramatic changes in mode shift the target of a 50% reduction would still not be met by 2020; per capita emissions would decrease by just over 30% in comparison with 2007 levels.

■ Figure 5.7: Scenario 2 share of person kilometres



Kilometres by mode and per capita greenhouse gas emissions for this scenario are given in Table 5.2.

- Table 5.2: Scenario 2 forecast targets

	2007	2012	2014	2016	2018	2020
Private Transport forecast pkt (thousand pkt)	1,327 (78.3%)	1,244 (71.5%)	1,135 (64.2%)	1,024 (57.0%)	915 (50.1%)	806 (43.5%)
Public Transport forecast pkt (thousand pkt)	212 (12.5%)	208 (11.9%)	212 (12.0%)	215 (12.0%)	219 (12.0%)	223 (12.0%)
Active Transport forecast pkt (thousand pkt)	155 (9.1%)	288 (16.6%)	422 (23.9%)	556 (31.0%)	690 (37.8%)	825 (44.5%)
Per Capita emissions (kgCO_2-e)	3.45	2.93	2.60	2.29	2.00	1.72

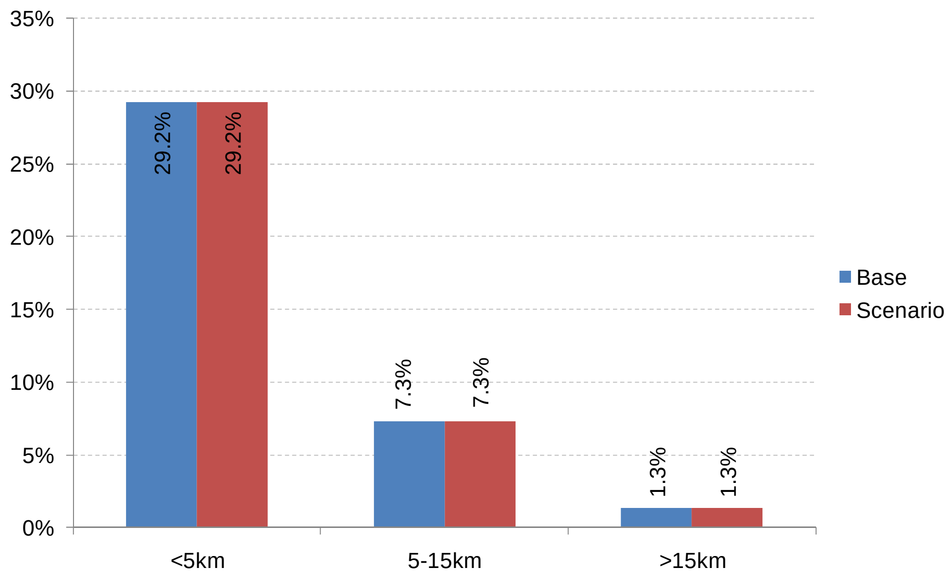
5.3 Scenario 3 – Public transport mode shift

Scenario three assumes significant shifts towards public transport:

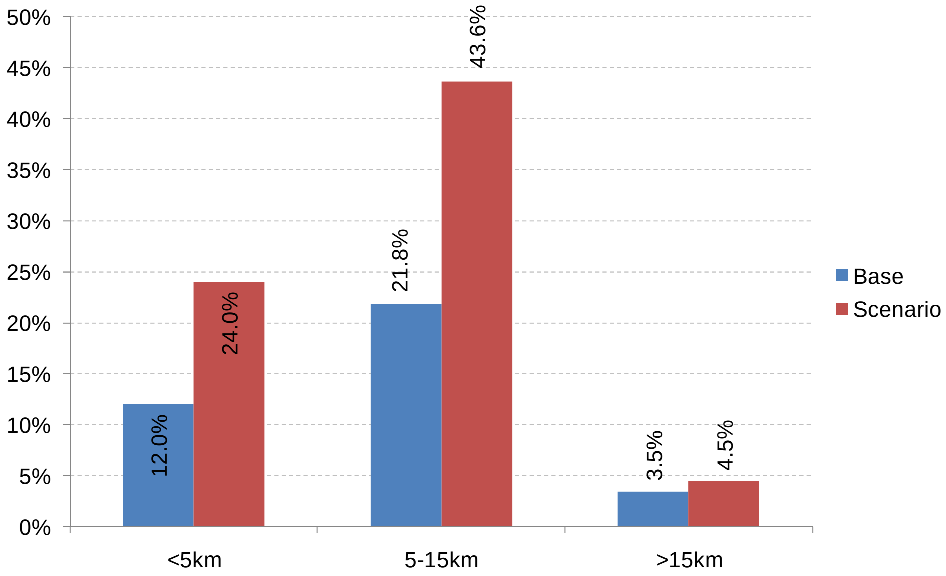
- For short trips under 5 km there will be a 100% increase (i.e. a doubling) in public transport person kilometres.
- For trips between 5 km and 15 km there will a 100% increase (i.e. a doubling) in public transport person kilometres.
- For long trips over 15 km there will be a 75% increase in public transport person kilometres to neighbouring municipalities, and a 45% increase to municipalities farther afield with good public transport accessibility.

There is no shift to or from active transport under this scenario (Figure 5.8). The proportion of short trips by public transport increase from 12 to 24%, and for medium trips from 22 to 44% (Figure 5.9).

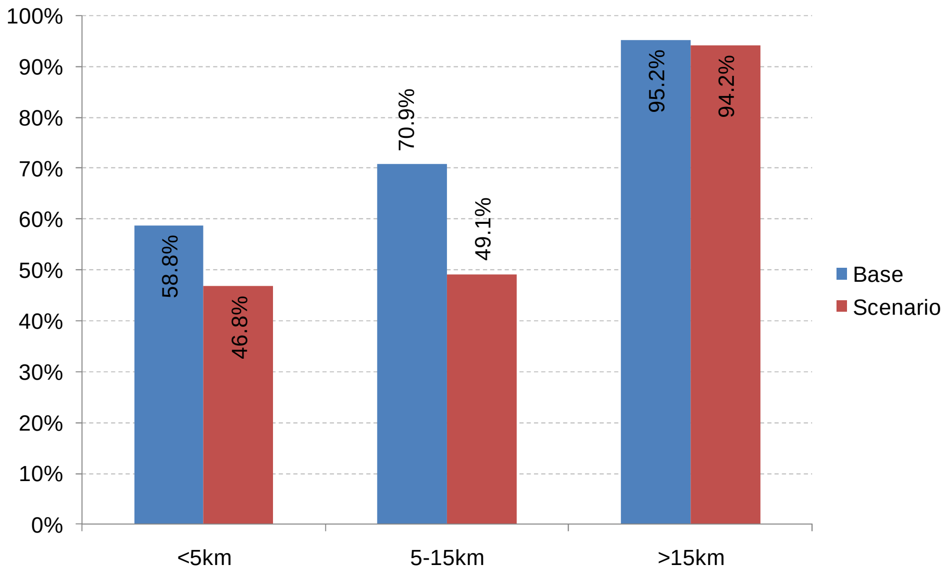
■ Figure 5.8: Share of person kilometres by active transport (Scenario 3)



■ Figure 5.9: Share of person kilometres by public transport (Scenario 3)

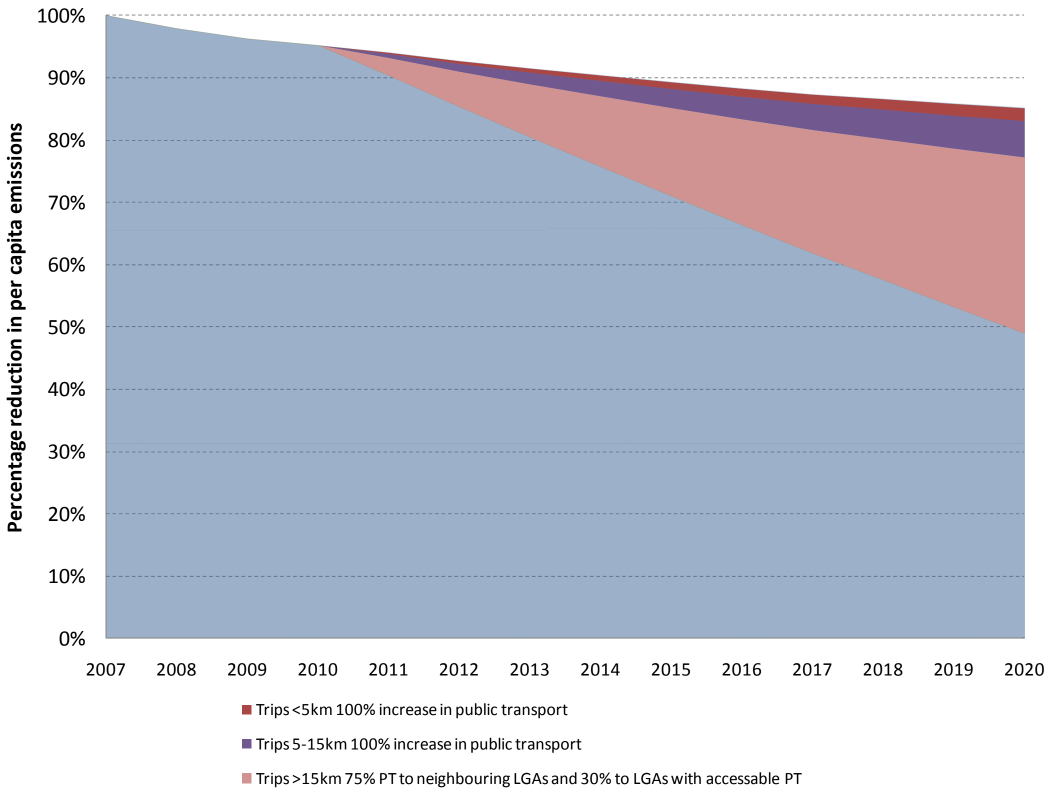


■ Figure 5.10: Share of person kilometres by private vehicle (Scenario 3)



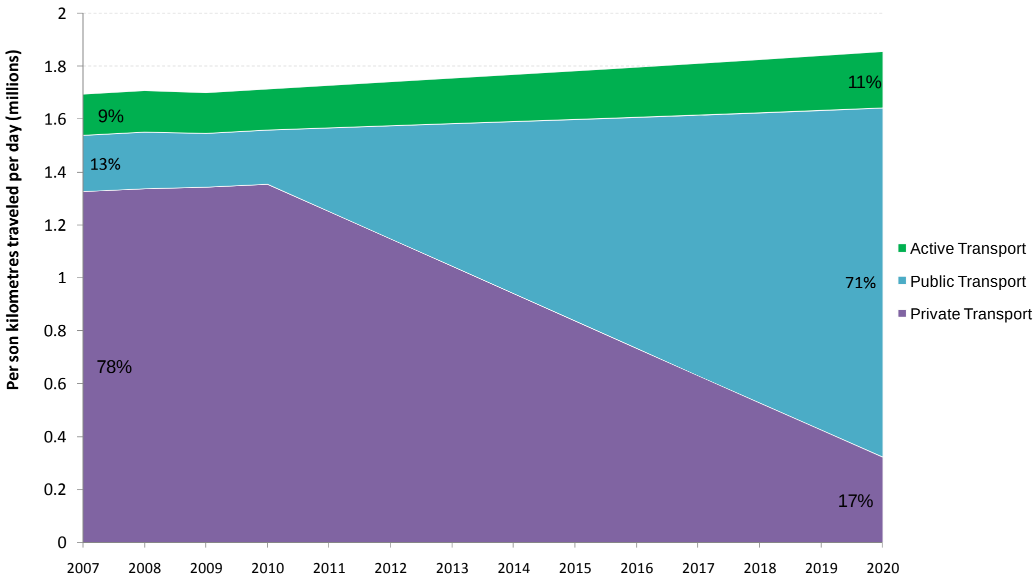
The majority of the greenhouse gas savings in this scenario come from shifting the longer trips (currently made almost exclusively by private car) to public transport (Figure 5.11).

■ Figure 5.11: Scenario 3 per capita greenhouse gas reductions



Under this scenario public transport would increase its share of person kilometres travelled from 13% in 2007 to 71% in 2020 (Figure 5.12).

■ Figure 5.12: Scenario 3 share of person kilometres



A summary of annual targets for this scenario are shown in Table 5.3.

■ Table 5.3: Scenario 3 forecast targets

	2007	2012	2014	2016	2018	2020
Private Transport forecast pkt (thousand pkt)	1,327 (78.3%)	1,148 (65.9%)	941 (53.2%)	734 (40.9%)	527 (28.9%)	322 (17.4%)
Public Transport forecast pkt (thousand pkt)	212 (12.5%)	427 (24.6%)	650 (36.8%)	874 (48.6%)	1,097 (60.1%)	1,320 (71.2%)
Active Transport forecast pkt (thousand pkt)	155 (9.1%)	165 (9.5%)	177 (10.0%)	188 (10.5%)	200 (11.0%)	212 (11.4%)
Per capita emissions (kgCO_2-e)	3.45	2.95	2.61	2.29	1.99	1.69

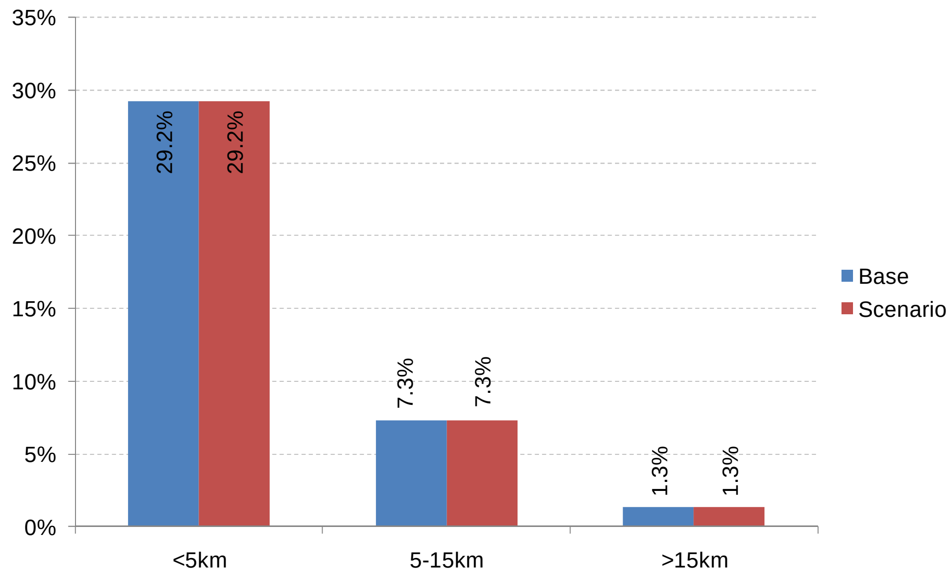
5.4 Scenario 4 – Green public transport

In this scenario it is assumed that the electrified public transport network (tram, train) would move to source their electricity from 100% renewable sources. Under this scenario the mode shifts to public transport required to meet the target are significantly less than those in Scenario 3:

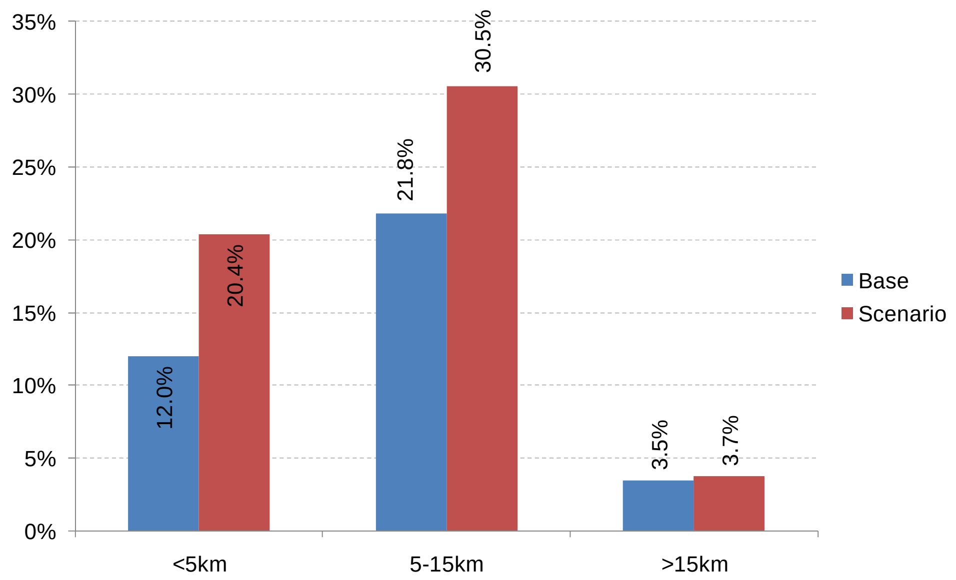
- For short trips under 5 km there will be a 70% increase in public transport person kilometres.
- For trips between 5 km and 15 km there will a 40% increase in public transport person kilometres.
- For long trips over 15 km there will be a 20% increase in public transport person kilometres to neighbouring municipalities, and a 10% increase to municipalities farther afield with good public transport accessibility.

There is no shift to or from active transport under this scenario (Figure 5.13), while public transport share increases (Figure 5.14) and short and medium private vehicle trip share decreases (Figure 5.15).

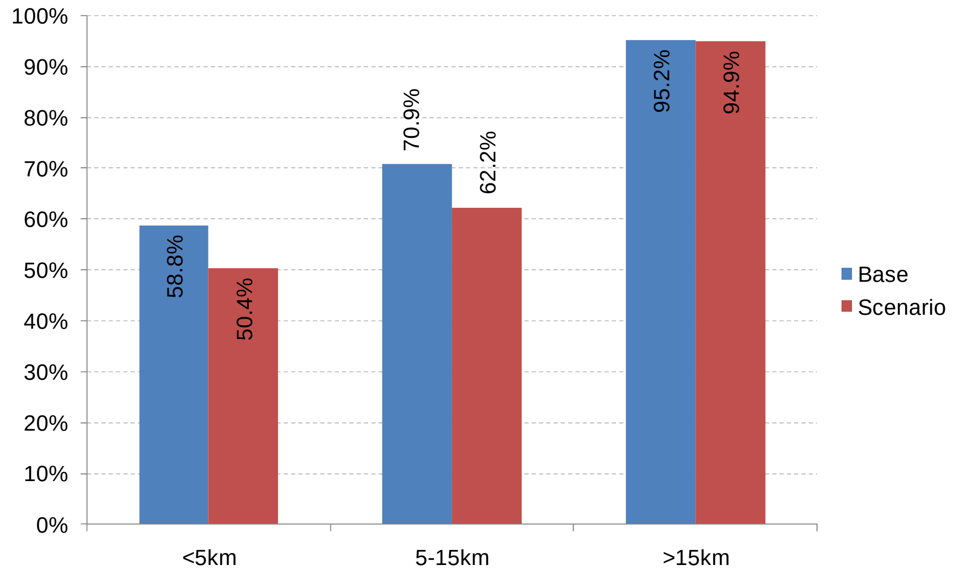
■ Figure 5.13: Share of person kilometres by active transport (Scenario 4)



■ Figure 5.14: Share of person kilometres by public transport (Scenario 4)

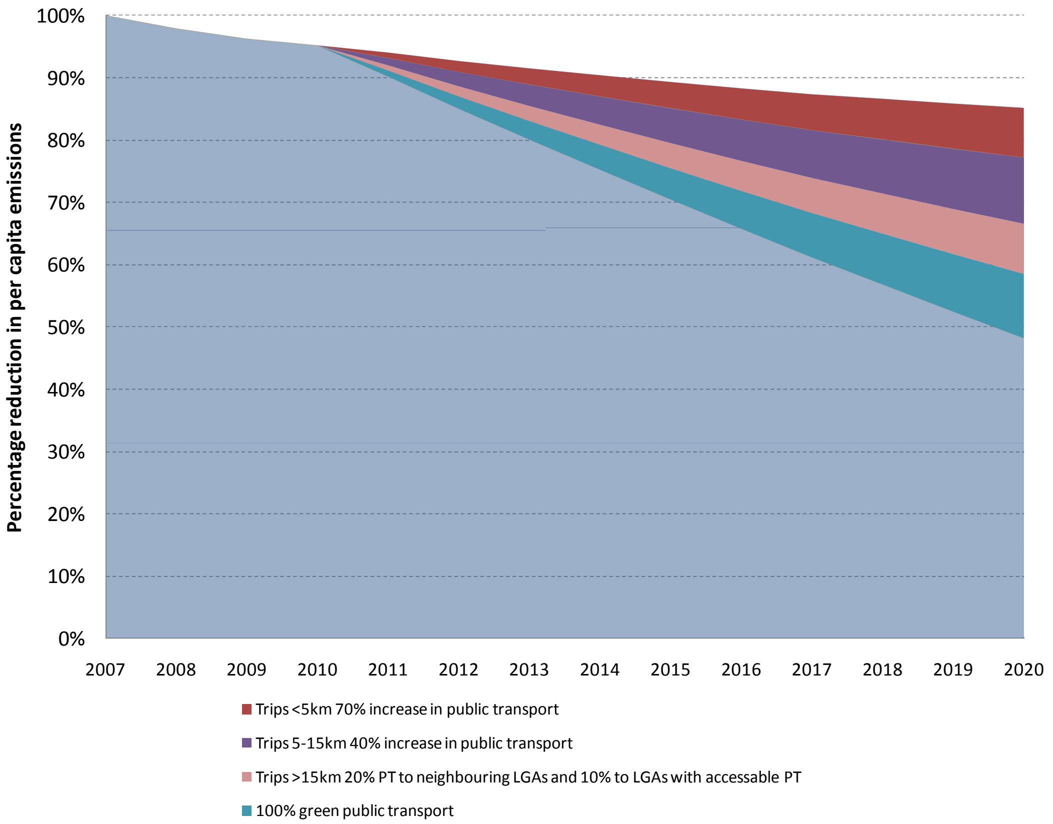


■ Figure 5.15: Share of person kilometres by private vehicle (Scenario 4)



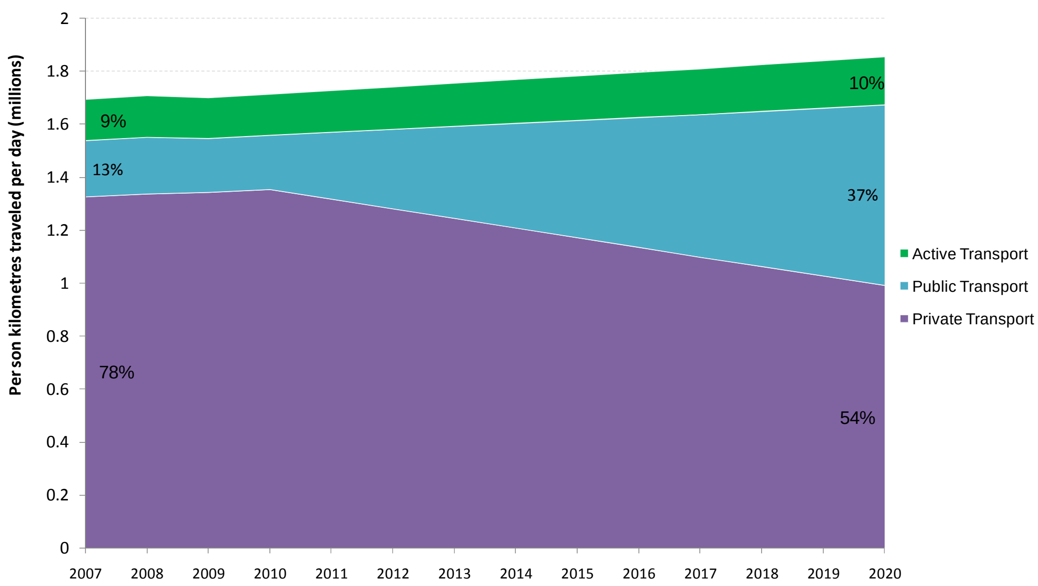
The majority of the greenhouse gas savings in this scenario come from shifting the longer trips (currently made almost exclusively by private car) to public transport (Figure 5.16).

- Figure 5.16: Scenario 4 per capita greenhouse gas reductions



Under this scenario public transport would increase its share of person kilometres travelled from 13% in 2007 to 37% in 2020 (Figure 5.17).

- Figure 5.17: Scenario 4 share of person kilometres



A summary of annual targets for this scenario are shown in Table 5.3.

■ Table 5.4: Scenario 4 forecast targets

	2007	2012	2014	2016	2018	2020
Private Transport forecast pkt (thousand pkt)	1,327 (78.3%)	1,282 (73.6%)	1,209 (68.4%)	1,136 (63.3%)	1,064 (58.3%)	992 (53.5%)
Public Transport forecast pkt (thousand pkt)	212 (12.5%)	300 (17.2%)	395 (22.3%)	490 (27.3%)	586 (32.1%)	681 (36.7%)
Active Transport forecast pkt (thousand pkt)	155 (9.1%)	159 (9.2%)	164 (9.3%)	170 (9.5%)	175 (9.6%)	181 (9.7%)
Per capita emissions (kgCO_2-e)	3.45	3.11	2.60	2.27	1.96	1.67

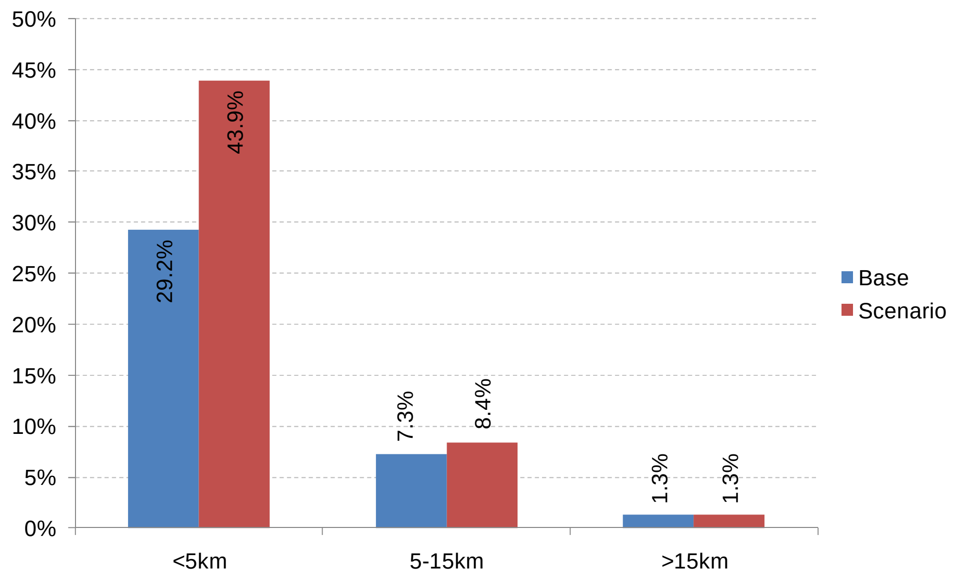
5.5 Scenario 5 – Green public transport and active transport mode shift

In this scenario we assume a combination of strategies:

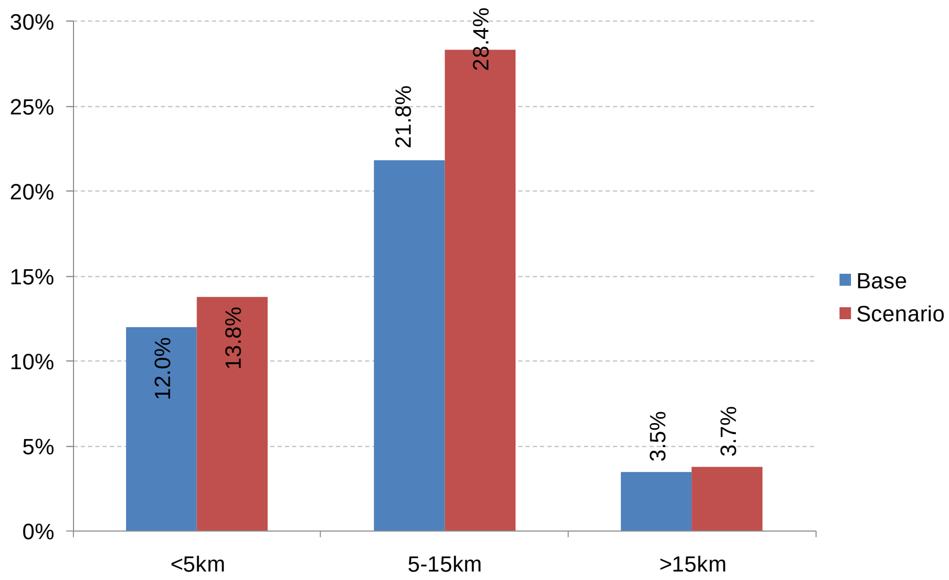
- 100% renewable electricity for the electrified public transport network
- For short trips under 5 km there will be a 15% increase in public transport person kilometres and a 50% increase in active transport person kilometres.
- For trips between 5 km and 15 km there will a 30% increase in public transport person kilometres and a 15% increase in active transport kilometres.
- For long trips over 15 km there will be a 20% increase in public transport person kilometres to neighbouring municipalities, and a 10% increase to municipalities farther afield with good public transport accessibility (there will be no shift to active transport for these longer trips).

The changes in mode shares in each distance segment, by mode are shown in the following graphs.

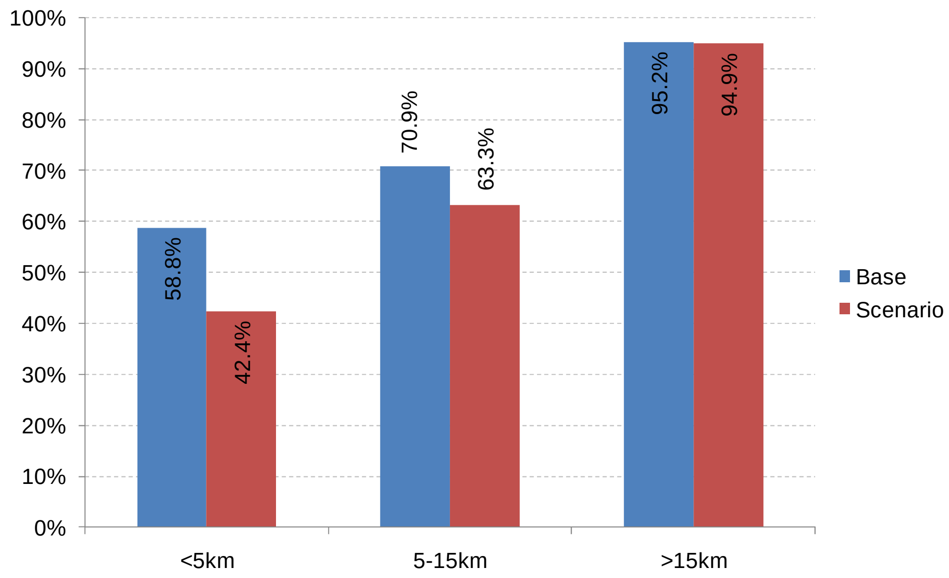
■ Figure 5.18: Share of person kilometres by active transport (Scenario 5)



■ Figure 5.19: Share of person kilometres by public transport (Scenario 5)

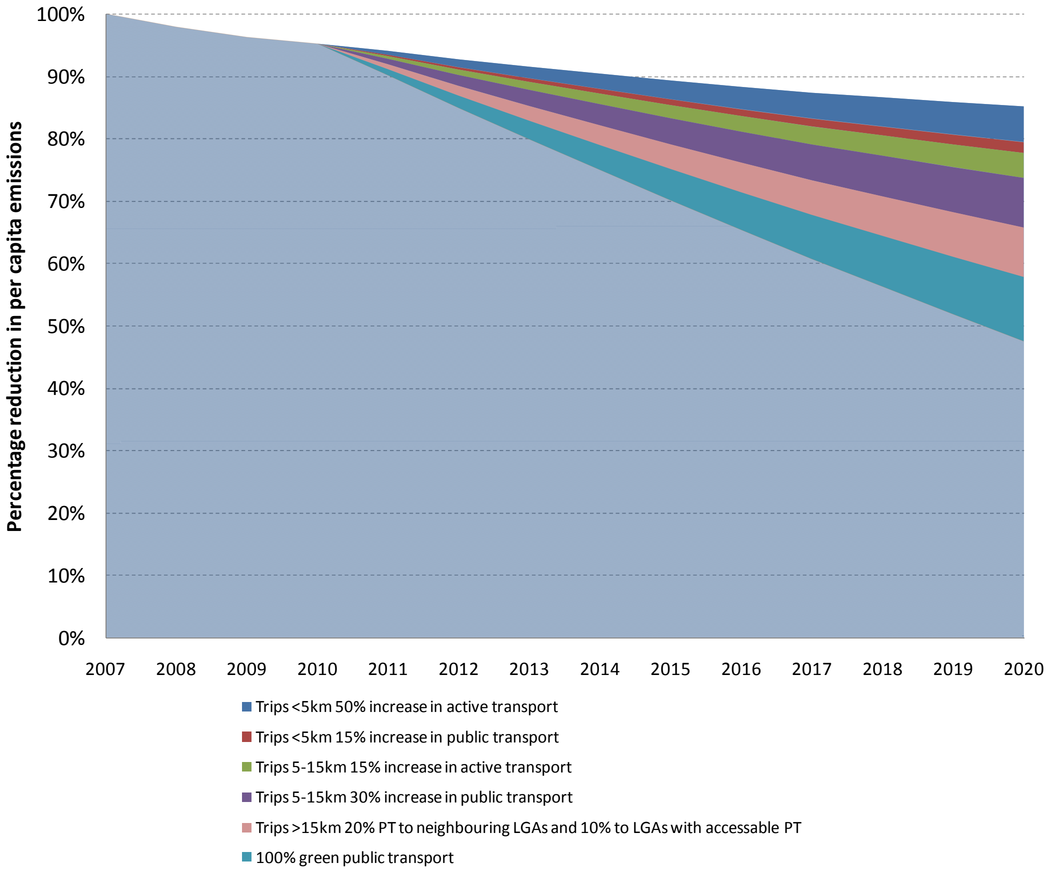


■ Figure 5.20: Share of person kilometres by private vehicle (Scenario 5)



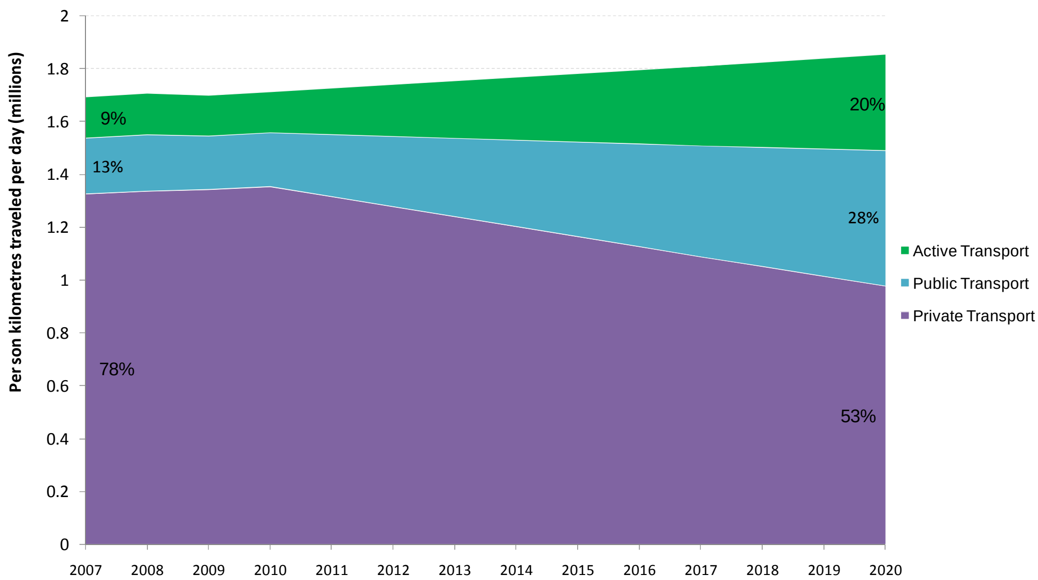
The contribution of each strategy on achieving the emissions target are shown in Figure 5.21.

- Figure 5.21: Scenario 5 per capita greenhouse gas reductions



Under this scenario public transport would increase its share of person kilometres travelled from 13% in 2007 to 28% in 2020 and active transport share of travel would double (Figure 5.22).

■ Figure 5.22: Scenario 5 share of person kilometres



A summary of annual targets for this scenario are shown in Table 5.5.

■ Table 5.5: Scenario 5 forecast targets

	2007	2012	2014	2016	2018	2020
Private Transport forecast pkt (thousand pkt)	1,327 (78.3%)	1,279 (73.5%)	1,209 (68.1%)	1,128 (62.8%)	1,053 (57.7%)	979 (52.8%)
Public Transport forecast pkt (thousand pkt)	212 (12.5%)	266 (15.3%)	328 (18.5%)	390 (21.7%)	452 (24.8%)	514 (27.7%)
Active Transport forecast pkt (thousand pkt)	155 (9.1%)	196 (11.2%)	237 (13.4%)	279 (15.5%)	320 (17.6%)	362 (19.5%)
Per capita emissions (kgCO_2-e)	3.45	2.93	2.59	2.26	1.94	1.64

5.6 Discussion

Shifts to public transport, while offering significant emissions benefits and ancillary benefits such as congestion relief, will of itself not meet the *Toward* Zero target. In part this is because of the emissions intensity of the Victorian electricity grid, which makes electrified public transport far from an emissions neutral mode. Moving public transport to emissions neutrality would significantly contribute to the achievement of the target – particularly in conjunction with measures which increase public transport mode share for medium and long distance trips. The benefits of a carbon neutral public transport network are significant, as they will neutralise emissions from the longer trips by Port Phillip residents, which while fewer in number than short trips, disproportionately contribute to emissions.

For trips under one kilometre walking is already the dominant mode. Walking, and particularly cycling, can compete with motorised travel over distances of 1 to 5 km where motorised travel currently dominates. These distances contribute a significant proportion of all travel by Port Phillip residents, and so mode shifts within this band can significantly reduce greenhouse gas emissions by residents. However, above 1 km the time competitiveness of walking quickly deteriorates in comparison to motorised travel and cycling. As such, the greatest benefits will likely come from encouraging cycling for those trips which are too far to walk, but not so far that an average person could not readily make such a trip by bicycle.

Achieving very significant shifts in a relatively short period of nine years will require a combination of 'carrots' and 'sticks'. We summarise what we consider to be the primary policy levers in Table 5.6. It is very difficult to quantify the impact of each of the policies in isolation; indeed, it is more than likely a combination of measures would be more effective than measures introduced in isolation. In this table the likely financial implications for the council, community and businesses are also discussed. Not identified explicitly here, but significant nonetheless, are the costs to the community and across all levels of government are the health costs avoided by encouraging active transport and health benefits to residents of reduced exposure to transport-related pollutants such as NO_x and particulates. Furthermore, there are likely to be very significant avoided costs by reducing reliance on private car travel should carbon pricing or external impacts such as peak oil significantly and rapidly change the cost of driving. Even in a situation where there were a viable technical solution, such as electric vehicles, those who would be most sensitive to energy costs would also be those least able to afford to buy new, more efficient vehicles. The provision of attractive, cost effective alternatives such as public transport and walking and cycling is therefore desirable to minimise any impact on the community generally, and the most vulnerable most significantly.

■ Table 5.6: Summary of recommended actions

Measure	Comment	Financial implications		
Carrots		**Council**	**Community**	**Business**
Car sharing	Reduces parking demand, encourages less car travel and increased PT/active travel. Will have only a limited impact if not implemented on a large scale – and has a large take-up rate (which may require significant deterrents to private car ownership).	Subsidy may be required, at least initially. Will require dedicated parking (which will impact on parking revenues where paid parking is used).	Beneficial for those who take advantage of the scheme and save money compared to self ownership.	Beneficial where car sharing may replace leased or owned fleet vehicles.
Public transport service improvement	Increased service frequency and decreased fares will improve competitiveness with private car travel. The existing network in Port Phillip is already extensive, apart from limited service offerings to distant middle and outer suburbs.	Possible subsidy contribution. Reduced revenues from residential parking permits if car ownership decreases.	Beneficial for existing and potential public transport users.	Beneficial by improving accessibility for customers and staff.
Public transport emissions	Victoria's electricity grid is very emissions intensive, which means that public transport, while more efficient than private car travel, is far from emissions neutral. Initiatives to purchase some or all electricity for electrified PT from renewable	None – assume financial cost would be borne by State Government and/or franchisees.	Potential increase in PT fares if introduced on a cost recovery basis.	Potential increase in PT fares if introduced on a cost recovery basis.

	sources would significantly reduce greenhouse emissions, even in the absence of mode shift (because of the relatively high PT share).			
Connectivity for cycling and walking	Providing direct connections between trip origins and destinations will increase the competitiveness of cycling and walking	May require land resumption and loss of paid parking.	Beneficial for those who increase their cycling and walking by reducing out-of-pocket transport costs and reduced health costs.	Potential indirect benefits through reduced absenteeism if staff increase their walking and cycling. May improve accessibility to local businesses.
Segregated cycling provision	High quality, segregated cycleways will improve the perceived safety of cycling and so encourage more cycling for short distance trips.	High capital cost, loss of parking revenue.	Beneficial for those who increase their cycling and walking by reducing out-of-pocket transport costs and reduced health costs. Disbenefit for those who lose on-street car parking but continue to own a car.	Potential indirect benefits through reduced absenteeism if staff increase their walking and cycling. May improve accessibility to local businesses.
End-of-trip facilities for cycling	High quality bicycle parking, located close to trip attractors, will encourage cycling.	Relatively low capital cost, loss of parking revenue where parking is provided in reallocated paid parking.	Beneficial for those who increase their cycling and walking by reducing out-of-pocket transport costs and reduced health costs.	Potential indirect benefits through reduced absenteeism if staff increase their walking and cycling. May improve

				accessibility to local businesses.
Residential speed limits to 30 km/h	Lower residential speed limits would improve safety for cyclists and pedestrians and encourage more cycling and walking (it would have little to no negative impact on car travel times).	Relatively low capital cost.	Amenity benefits (e.g. noise) as well as improved objective and subjective safety.	No impact.
Signal prioritisation for public transport, cycling and walking	Signal plans such as scramble crossings, dwell-on-red, cyclist early starts and improved pedestrian signal responsiveness will encourage cycling and walking. Vehicle-actuated signal prioritisation would improve tram travel times and reliability.	Requires VicRoads approval, significant capital cost for new signals.	Accessibility benefits through reduced travel time for cycling and walking. Potential travel time disbenefits for car travel.	Accessibility benefits through reduced travel time for cycling and walking. Potential travel time disbenefits for car travel.
At-grade tram boarding	Tram platform stops reduce dwell times, improving travel times and reliability as well as providing more accessible PT.	High cost, although DDA will require DOT to fund by 2032. Loss of parking revenues in vicinity of stop.	Loss of on-street parking, but improved accessibility to trams.	Loss of on-street parking, but improved accessibility to trams.
Sticks				
Residential parking levies	Increased overall residential parking permit charges would decrease vehicle ownership, but may raise social equity issues. Levies linked to	Depends on design of scheme. Could be revenue neutral, but to influence overall vehicle ownership	Would increase costs for those who chose to retain a car, particularly of high emission vehicles.	No impact.

	vehicle CO_2 emissions may be more equitable, and could have a significant impact in the medium term – even within a particular vehicle class emissions can vary up to 50% between vehicles.	would need be revenue positive.		
Parking charges and availability	Increased parking charges, including as levies on businesses with private parking, combined with reduced parking availability will serve to encourage alternative modes. Where parking is provided, it should be located distant from attractors (except for delivery/disabled parking) to discourage use.	Reduced parking revenues.	Indirect impacts on accessibility for those who continue to own a car.	Increased business costs, unless passed onto customers/staff. May impact on accessibility for customers if improvements to alternative modes are insufficient.
Restricted vehicle network	A ‘cellular’ road network, where vehicles must travel longer distances than by active transport. Examples may include selected road closures to force vehicles onto peripheral arterial roads rather than to ‘rat run’ within and between suburbs.	Moderate capital costs.	Moderate increased fuel costs resulting from longer travel distances for those who use a car.	Moderate increased fuel costs resulting from longer travel distances for those who use a car.

6 Resident case studies

In order to give some insight into what the required changes may look like for ‘typical’ residents of Port Phillip we have considered the possible impacts on three typical households. These households are representative of some of the common household structures found in Port Phillip and give an insight into what these people’s daily travel may need to look like in 2020 in order to meet the 50% GHG emissions reduction target. The travel patterns of these individuals are extracted from the VISTA dataset.

6.1 Case Study 1: Shared household

The first household is a share house with three residents who are all between 25 and 35 years of age. All members of the household are in full time employment, they each own their own vehicle and within the household they also have 2 bicycles. Each member of the household is also single and they have no dependants. Each person’s trip profile is described briefly in Table 6.1.

▪ Table 6.1: Trips profiles for Case Study 1

Person	Trip profile
Person 1 (Single, Female, 30-34)	Person 1 works in Boorondara and drives 10 kilometres there and back daily. She also walk the dog around 4km on a typical day.
Person 2 (Single, Female, 30-34)	Person 2 drives 700m to the train station to catch a train to work and home totalling 17km. On the interview day she also drove 28km to the shops in the City of Kingston and walked the dog (with Person 1) for 4km.
Person 3 (Single, Male, 25-29)	Person 3 drives 6.2 km to Glen Eira for work and also went as a passenger to the shops in Kingston.

The daily GHG emissions for the household have been calculated in Table 6.2. The travel on this sample day would have resulted in 22 kilograms of CO_2e being emitted.

In order to reduce their greenhouse gas emissions, the following changes could be made to their trip choices:

- The trip to the shop could be made by public transport or alternatively could be made locally using active transport.

- Instead of driving to work in Glen Eira person 3 could either catch public transport or ride a bicycle, which are both very suitable modes of transport for the 6.2km journey to work.
- Person 1's car trip to Boroondara could be made using a more fuel efficient vehicle (for the purposes of this discussion, we consider an average vehicle in 2020). Public transport alternatives to Boroondara could also be considered such as the 109 Tram from Port Phillip to Balwyn, however this would be dependent on travel time and walking distance.
- Finally, person 2 could walk or cycle to the train station instead of driving 700 metres each way.

Applying these changes the reduction in GHG emissions in shown in Table 6.2. A total of 16.6 kilograms CO_2e could be saved from the households' daily transport emissions. This equates to a 75.6% reduction, well beyond the required 50% target set by council.

■ Table 6.2: Change in personal GHG emissions for Case Study 1

Mode	2007 – Baseline Conditions		2020 – GHG reducing measures	
	Kilometres	CO_2e (kg)	Kilometres	CO_2e (kg)
Public Transport	17.2	2.49	74.4	0
Active Transport	11.0	0	24.9	0
Private Transport	91.1	19.49	20.1	5.37
Total	119.4	21.98	119.4	5.37

6.2 Case Study 2: Retired Couple

The second household is an elderly retired couple in the 60 to 69 year age group. They have no dependents and the majority of their trips are recreational or social trips. They own two cars and no bicycles. A summary of each person's trip profile is shown in Table 6.3.

■ Table 6.3: Trips profiles for Case Study 2

Person	Trip profile
Person 1 (Married, Male, 65-69)	Person 1 walks 4.3km to the shops during the day, they also go for a walk and drive to the swimming pool to go for a swim. At night they drive 15km to the cinema.
Person 2 (Married, Female, 60-64)	Person 2 makes 6.5km worth of errands during the day, they also go for a 4.3km walk to the shops and travel as a passenger to the cinemas.

This travel would have resulted in the emission of approximately 7.5 kg of CO_2e during the day. Using the GHG reduction assumptions outlined previously the couple could reduce their transport emissions by:

- Walking the 1km trip to the swimming pool rather than driving
- Catching public transport to the cinema to further reduce their private vehicle kilometres travelled.
- Selling one or possibly both of their cars and upgrading to a new more fuel efficient or electric car. This could potentially have a significant reduction on their total emissions depending on the age and efficiency of their current cars.

Based on these minor changes the couple could reduce their transport based GHG emissions by 76.6% or 5.7 kilograms of CO_2e (Table 6.4).

■ Table 6.4: Change in personal GHG emissions for Case Study 2 (retired couple)

Mode	2007		2020	
	Kilometres	**CO_2e (kg)**	**Kilometres**	**CO_2e (kg)**
Public Transport	0	0	30.6	0
Active Transport	9.4	0	10.5	0
Private Transport	39.2	7.54	6.6	1.76
Total	48.6	7.54	48.6	1.76

6.3 Case Study 3: Young family

The third case study household is a young family with two parents in their 40s and three children aged between 5 and 14 years. Only one of the two parents works full-time, while the other looks after the kids and runs errands throughout the day. A summary of their trips is shown in Table 6.5.

■ Table 6.5: Trips profiles for Case Study 3

Person	Trip profile
Person 1 (Married, Male, 45-49)	Person 1 drives 48.5km to work and back in the City of Hume. They also make a number of car trips to shops and dropping and picking up kids from after school activities
Person 2 (Married, Female, 45-49)	Person 2 drives a SUV. They take the two youngest children to school and pick up all three children after school, totalling around 50km of travel. They also drive kids to after school commitments.
Person 3 (Child, Male, 10-14)	Person 3 catches walks and catches the tram to school in the morning which totals about 4km of travel. They are picked up by a parent after school and participate in after school activities.
Person 4 (Child, Female, 5-9)	Person 4 is picked up and dropped at school by car daily and also has after school activities.
Person 5 (Child, Male, 5-9)	Person 5 has similar trips to Person 4

According to their trip profile, this household produce approximately 32.5 kg of CO_2e daily from their transport activities. The vast majority of these emissions come from private vehicle travel, with family members travelling a total of 159km daily by car. The choice of schools, being distant from Port Phillip, have a significant impact on the amount of travel and mode choices for this family. Alternatives that could reduce their GHG emissions would probably involve switching to smaller, less emissions intensive vehicles should a local school not be a viable alternative. No suitable mode change options are really available for travel to the City of Hume, the only real measure to reduce reductions from this trip would also be to use a smaller more efficient vehicle for the journey.

■ Table 6.6: Change in personal GHG emissions for Case Study 3

Mode	2007		2020	
	Kilometres	CO_2e (kg)	Kilometres	CO_2e (kg)
Public Transport	3.1	0.49	3.1	0
Active Transport	0.2	0	0.2	0
Private Transport	159.2	32.0	159.2	16.2
Total	162.5	32.5	162.5	16.2

6.4 Case Study 4: Single person household

The final case study is a single person household with one male resident aged between 40 and 44. Single person households represent the greatest proportion of households in the municipality (27%). In this particular household the resident is a rostered worker who did not work on the day of the VISTA survey, they drive a ute and also own a bicycle. The trip profile for this resident on the survey day is described in Table 6.7

■ Table 6.7: Trips profiles for Case Study 4

Person	Trip profile
Person 1 (Single, Male 40-44)	Person 1 drives his ute to run personal errands in both Port Phillip and Bayside in the morning totalling 6.6km. He is then picked up by a friend and driven to Bayside for a meal, a distance of 9.6km. Later that day he walks just under 1 kilometre to the gym and back and then walks 400 metres to have dinner locally. Later that night he drives his ute to the CBD for social reasons (a distance of 12km).

The daily greenhouse gas emissions for the household are calculated in Table 6.2. The travel on this sample day would have resulted in 5.7 kg of CO_2e being emitted, which is well above the average 3.5kg CO_2e per capita determined earlier in this report.

In order to reduce the greenhouse gas emissions, the following changes could be made to his trip choices on this particular day:

- The errands run in Port Phillip could be made by active transport and the errands in Bayside could be made using public transport.
- He could use public transport for his social trip into the CBD, where public transport connections are particularly good.

Applying these changes the reduction in GHG emissions in shown inTable 6.2. A total of 4.5 kg CO_2e could be saved from the households' daily transport emissions. This equates to a 79% reduction.

- Table 6.8: Change in personal GHG emissions for Case Study 4

Mode	2007 – Baseline Conditions		2020 – GHG reducing measures	
	Kilometres	**CO_2e (kg)**	**Kilometres**	**CO_2e (kg)**
Public Transport	0	0	11.9	0
Active Transport	2.3	0	5.6	0
Private Transport	28.1	5.7	12.9	1.2
Total	30.4	5.7	30.4	1.2

7 Monitoring

This section outlines a possible monitoring strategy that the City of Port Phillip could implement in order to monitor performance towards the target. The principle adopted here is to develop a strategy that leverages off existing datasets as much as possible, and presents minimal recurring costs to Council. Recall that emissions are directly related to distance travelled, not just to mode share (measured by trips). As such, monitoring would ideally be undertaken on a kilometres travelled basis.

Travel diaries such as VISTA are the only method of directly measuring distances of travel. VISTA has been performed biennially since 2007/08 and may continue to do so. This data could provide the best baseline for monitoring; data is usually available within six months of completing fieldwork (e.g. VISTA 09/10 is due for public release around Christmas 2010). This data can readily be interrogated to determine person kilometres travelled and mode shares across the municipality.

Should data be required in intervening years, or should VISTA be discontinued, it is recommended that automatic counts data be used to proxy for changes in travel. These counts would not provide a comprehensive network across the municipality, would double count some trips while missing others altogether and would not directly measured distances travelled. Nonetheless, counts are readily available for motor vehicle travel, public transport usage and cycling. The **trends** provided from permanent count sites, or from regular manual counts, could be used to adjust a base year of travel diary (as provided by VISTA) in order to estimate changes in travel.

SCATS (Sydney Coordinated Adaptive Traffic System) inductive loop counts be used to monitor the change in motor vehicle travel. Further, permanent bicycle counters on St Kilda Road and the Sandridge Trail in combination with additional counters on sites such as Fitzroy Street and Cecil Street could provide trend data on cycling growth. Ticket validation data for public transport services would be obtainable from the Department of Transport for services through the municipality for monitoring changes in public transport usage (and, by implication, in kilometres travelled by public transport).

Measuring walking is much more challenging, as no automatic technology for counting walking has yet demonstrated very high accuracy, and the length of many walking trips would mean any counting cordon would invariably only detect a small minority of walking trips. Ad hoc manual pedestrian counts at key locations may be the only cost effective means for Council to monitor walking travel over the period of the strategy.

Another approach worthy of consideration is the City of Darebin's 'Going Places' program, which encourages residents to sign up and commit to reducing their car-based travel. However, a self selected sample of this type is likely to be biased – particularly given their behaviour is self reported. It is not clear that such commitments would be maintained over time, and so other means of *observed* behaviour such as counts would also be required.