

Strategic Options for Reducing Emissions in 2030, 2040 and 2050

Final Report

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Client: ACT Environment and Planning Directorate

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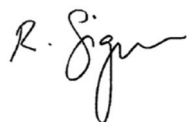
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Executive Summary

In demonstrating its leadership in relation to addressing climate change, the ACT Government passed the *Climate Change and Greenhouse Gas Reduction Act 2010* which established greenhouse gas reduction targets for the Territory which included a near term target of peaking per capita emissions in 2013, a mid-term (2020) target of a 40% reduction compared to 1990 levels and the long term target of carbon neutrality by mid-2050. Transport is a major contributor to emissions (26%) and is expected to account for more than 60% as the ACT moves to 100% renewable electricity.

In support of efforts to reduce carbon emissions, the ACT Government has commenced operation of a number of policies and strategies, including Action Plan 2 (AP2, the second action plan as part of the *Climate Change Strategy: Weathering the Change*), Transport for Canberra and has commenced supplementary actions such as the development of a Low Emission Vehicle Strategy.

To assist with identifying strategic options for the ACT Government to consider as part of future emissions reduction strategies, the Environment and Planning Directorate (EPD) commissioned AECOM to undertake a feasibility study of options to reduce transport sector emissions in the ACT to assist with gaining a deeper understanding of the issues and options to support the emission reduction commitments set by the ACT Government.

This report summarises the outcomes from the study and includes:

- An overview of the transport emissions sector in the ACT
- Outcomes from the modelling of the spatial distribution of emissions across Canberra associated with journey to work trips.
- Quantification of the potential for reducing transportation emissions based on adoption of a range of avoid, switch and reduce approaches for 2030, 2040 and 2050
- Identification of practical options for new policies and programs to achieve the reduction scenario aligned to the avoid, switch and reduce approaches across 2030, 2040 and 2050
- Case studies of national and international programs and policies aligned to the practical options identified

In developing the scenarios for achieving the emission targets for 2030, 2040 and 2050, the emission reduction potential associated with increases in public and active transport participation rates and penetration of electric powered vehicles (as the potential form of low emissions vehicles in 2030 and beyond) for a range of potential stretch targets has been calculated and are presented. Five scenarios, inspired by mode share and Electric Vehicle purchase (passenger vehicles) levels from global analogues, have been modelled in detail, these scenarios are referred to as:

- Transport for Canberra
- Wellington
- Small City (best in class)
- Carbon Neutral
- Leading Edge

The *Leading Edge* Scenario is the most aggressive where public transport mode share is lifted to above global best in class levels, there is significant numbers of avoided trips and full penetration of electric vehicles, whereby all new vehicles from 2030 are fully electric or plugin hybrids (representing vehicle technologies which use electricity rather than liquid hydrocarbons. This could include fuel cell / hydrogen vehicles). Should the *Leading Edge* Scenario be realised, the emission reductions for 2030 are 668,823 t CO_{2-e}; 1,024,875 t CO_{2-e} in 2040 and 1,498,669 t CO_{2-e} in 2050, exceeding the quantities required for carbon neutrality with the target being achieved approximately 2 years ahead of schedule.

The report also identifies a range of strategic options and policy responses which could be implemented by the ACT to achieve the outcomes identified under the *Leading Edge* scenario, including those which focus on ACT Government activities and through using the role the Government has to influence the community and stakeholders.

1.0 Introduction

In demonstrating its leadership in relation to addressing climate change, the ACT Government passed the *Climate Change and Greenhouse Gas Reduction Act 2010* which established greenhouse gas reduction targets for the Territory which includes a near term target of peaking per capita emissions in 2013, a mid-term (2020) target of a 40% reduction compared to 1990 levels and the long term target of carbon neutral by mid-2050.

The ACT Environment and Planning Directorate (EPD) engaged AECOM to:

- Review the transport emissions of the ACT;
- Identify potential policies and options which can assist the ACT in meeting its policy commitments; and
- Quantify emission reductions from existing and potential future options and policies.

1.1 ACT's Greenhouse Gas Emissions

The transportation sector is a major contributor to Australia's greenhouse gas emissions, and is the second largest emitter of greenhouse gases in the ACT, accounting for more than 26% of emissions in the 2014-15 Inventory (excluding land use, land use change and forestry) as shown in Figure 1. As with Australia's national emissions, transport emissions in the ACT are increasing, with a 7.4% increase between the 2013-14 and 2014-15 inventories (Figure 2), in part due to significant increases in the reported consumption of diesel (Pitt and Sherry, 2014; Pitt and Sherry, 2015).

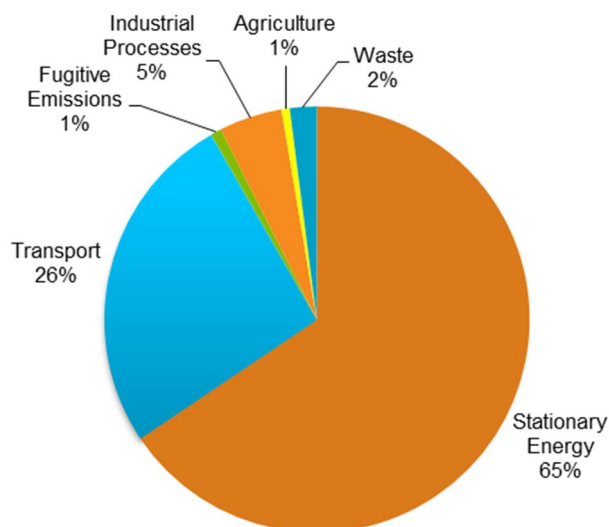


Figure 1 2014-15 ACT Greenhouse Gas Emissions (Pitt and Sherry, 2015)

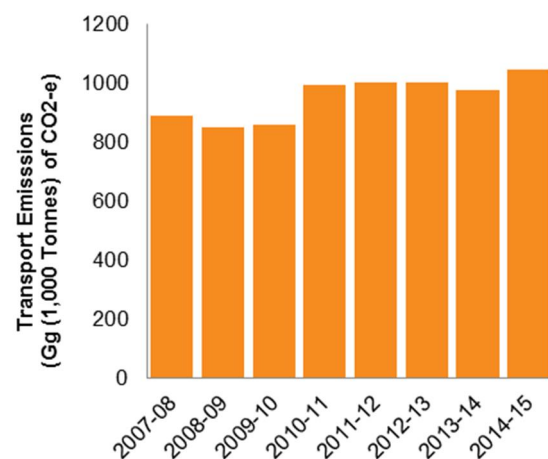


Figure 2 ACT Transport Emissions 2007-8 to 2014-15

Petrol is the dominant source of emissions, accounting for more than half of the total emissions, followed by diesel as shown in Figure 3 and Figure 4.

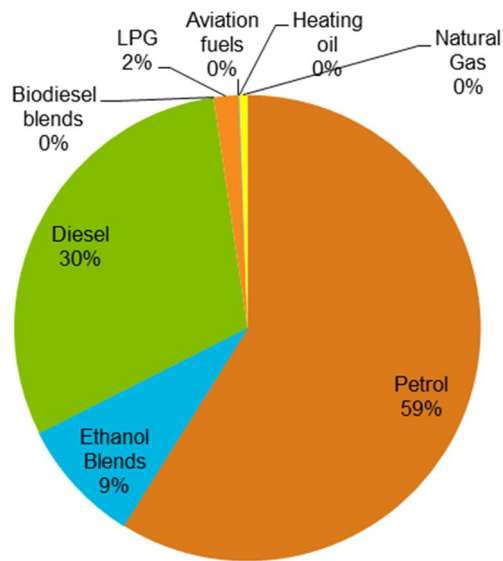
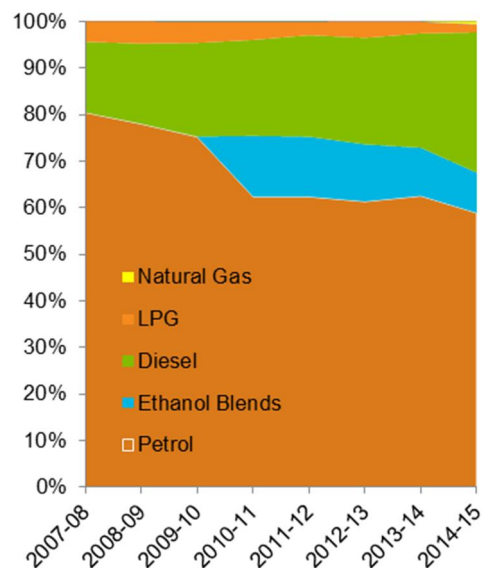


Figure 3 Transport emissions by fuel type (2014-15)

Figure 4 Percentage contribution to ACT emissions by fuel type 2007-8 to 2014-15¹

Whilst Ethanol blends (E10) are widely available and have developed a measurable market share, biodiesel blends have not achieved the same penetration and in the ACT, like many other parts of Australia, have low availability. In recent years, diesel consumption has increased and a corresponding decline in ethanol blends has been observed.

It is possible that this is a result of consumers swapping E10 compatible vehicles for diesel vehicles which had been promoted widely as having better fuel efficiency and lower carbon emissions prior to the Volkswagen scandal. The introduction of compressed natural gas (CNG) into the ACT bus fleet has also seen natural gas enter the transport emissions mix.

1.2 Emissions Reduction Targets

The ACT set progressive greenhouse gas emissions reduction targets as part of the *Climate Change and Greenhouse Gas Reduction Act 2010*, which is aligned with more recent targets, set by countries who have been early adopters of actions to combat climate change.

The key commitments of the *Climate Change and Greenhouse Gas Reduction Act 2010* are:

- 100% renewable energy by 2020;
- 40% reduction in greenhouse gas emissions on 1990 levels by 2020; and
- zero net emissions by 2050.

The ACT Government has also committed to being carbon neutral in its operations by 2020, which included the establishment of carbon budgets for agencies.

These targets will require substantial reductions in emissions, particularly by 2020 as shown in Figure 5.

¹ Small (<0.001%) contributions from aviation fuels, heating oil and biodiesel blends have been omitted from the legend.
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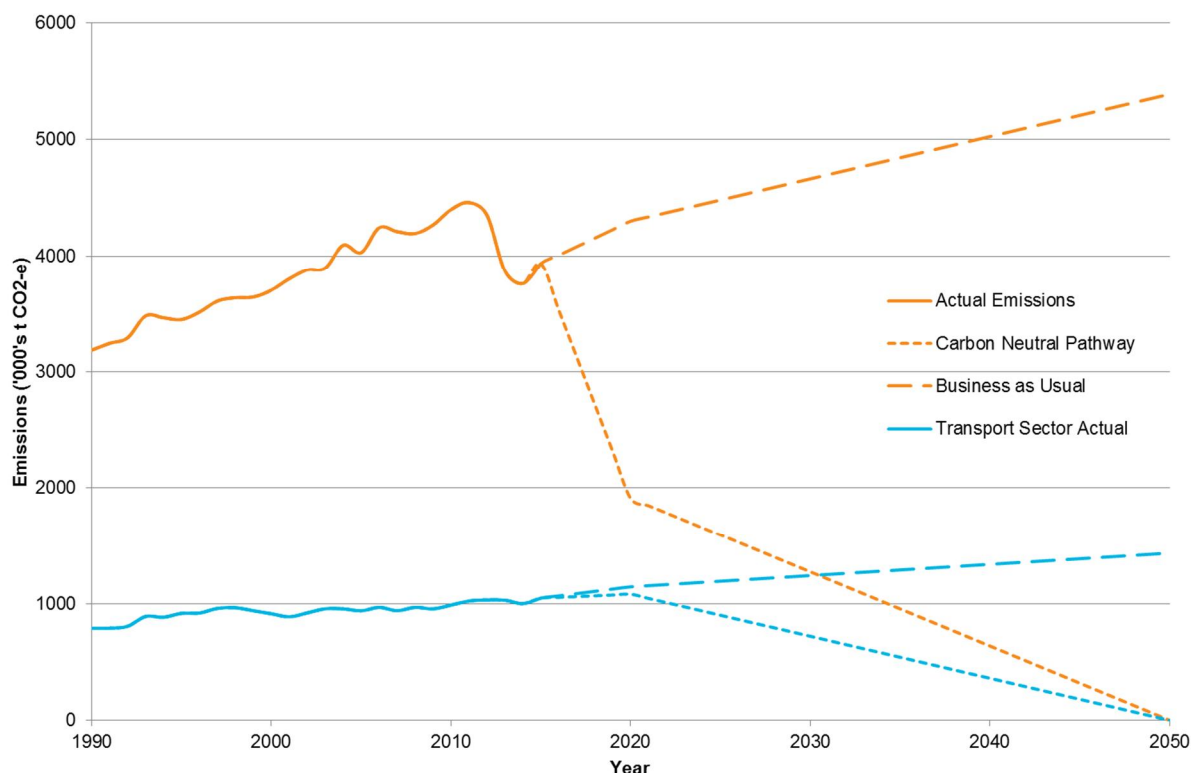


Figure 5 ACT (including Land Use, Land Use Change and Forestry, LULUCF) and Transport Emissions 1990 through to 2050

A significant portion of these reductions by 2020 will be achieved through the 100% renewable energy commitment. Upon achieving this milestone, ACT's transport emissions are projected to increase to 62% (EPD, nd) with natural gas (21%), synthetic gas (9%) and waste (6%) the next largest contributors (Figure 6).

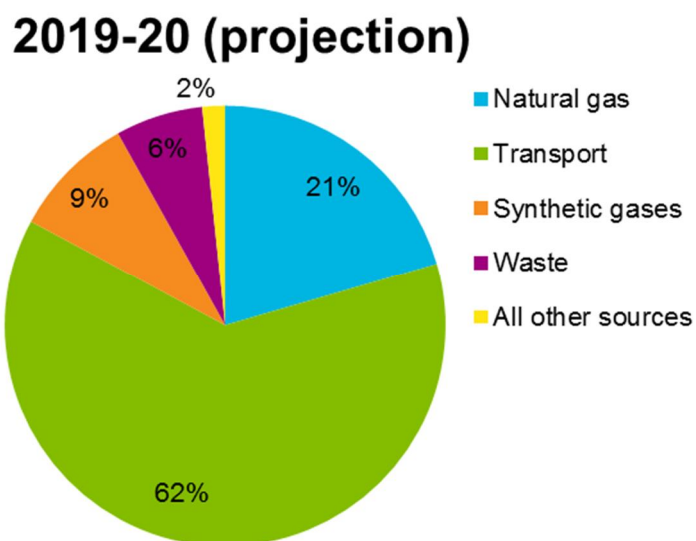


Figure 6 2019-20 (referred to as 2020) emissions profile of the ACT.

If it is assumed that all sectors contribute equally to the reduction targets following the move to 100% renewable energy derived electricity, then the anticipated emission reductions for the transport sector from the business as usual (BAU) scenario are presented in Table 1.

Table 1 Transport emissions and reduction targets through to 2050 (Tonnes of CO_{2-e})

Forecast Year	BAU Trajectory	BAU Transport Emissions	Carbon Neutral Trajectory	Carbon Neutral Transport Emissions	Transport sectoral reduction (BAU – Carbon Neutral)
2020	4,300,000	1,219,000	1,911,000	1,081,000	138,000
2030	4,662,500	1,241,564	1,274,000	720,667	520,897
2040	5,025,000	1,338,093	637,000	360,333	977,759
2050	3,000,000	1,434,622	0	0	1,434,622

1.3 Existing ACT Government's Policy Responses

The ACT Government has already undertaken considerable work to address its greenhouse emissions, including commitments to meaningfully reduce emissions in the near and long term as well as from investment in light rail and the development of a Low Emissions Vehicle Strategy. As such, we are excited to have the opportunity to utilise our knowledge of the ACT transport sector into emissions reductions and assist the Territory with meeting its targets. Summaries of the key policy responses provided here are not intended to be exhaustive, but are used to illustrate the significant progress the ACT has already made in addressing transport emissions.

1.3.1 Carbon Neutral Government Framework

The Carbon Neutral Government (CNG) Framework was released in 2014 to provide direction for the Territory government and its stakeholders to assist with meeting the ambitious greenhouse gas reduction targets set in 2010. In laying out the steps to become carbon neutral the Framework identifies the need to develop and use sustainable transport solutions (Strategy 8, Actions 29-34) as well as the promotion and encouragement of sustainable work practices (Strategy 2, Action 6) in the suite of initiatives.

1.3.2 AP2

AP2 was released in 2012 and was aimed at providing a roadmap to support the emissions reductions targets set for the ACT. AP2 identifies emission reductions by 2020 of 138,000 tonnes of carbon dioxide equivalent (t CO_{2-e}) (about 11% of current) through the implementation of Transport for Canberra and the development of a Low Emission Vehicle Strategy.

1.3.3 Transport for Canberra

Transport for Canberra (TfC) sets out principles and actions to guide integrated transport and land-use planning in order to achieve an efficient and cost effective, socially inclusive, accessible and safe ACT transport system. It focuses on:

- Integrated urban and transport planning;
- Increased accessibility;
- Active travel (walking and cycling);
- Network management;
- Demand management;
- Mode share targets for active and public transport; and
- Performance monitoring and evaluation to ensure the TfC actions are on track to achieve the policy objectives.

As part of TfC, there are two key actions:

- Capital Metro, new light rail transit system, the preparation for construction of the first stage between the City and Gungahlin is currently underway;
- Low Emissions Vehicle Strategy; the draft strategy has resulted in some implementation occurring, with a final strategy still under development.

1.3.4 Low Emission Vehicle Strategy

The LEVS Discussion Paper (EPD, 2014) was released in June 2014 and identified a range of options for encouraging the uptake of low emission vehicles. The actions established to implement the strategy are presented on two- five- and ten year time horizons and are thematically grouped into:

- Financial incentives
- Fleet purchasing and procurement
- Demand Management
- Education and awareness
- Electric Vehicle Opportunities
- Emerging Technologies

As the Strategy is in its early stages of development, primary data to assess the impact of the LEVS actions is not currently available. It is noted that explicit review and evaluation of initiatives are identified in the LEVS actions. The following sub-sections provide a summary of key LEVS actions and early indicators of performance where available.

Financial incentives

The key financial incentive of the LEVS actions is the implementation of the Vehicle Emission Reduction Scheme. This introduced a differential duty for new vehicles whereby low emissions vehicles including motorcycles pay a lower registration fee than other vehicles. As noted in the LEVS Discussion Paper, it is likely that the replacement of aging, emission intensive cars with lower emission vehicles will take time and the efficiency trend for new vehicles will continue to improve.

New vehicle purchases represent approximately 7% of the total number of vehicles registered in ACT (ABS, June 2016) and the average retirement age is 16 years (LEVS Discussion Paper). In 2015, low emission vehicles of all variants made up 4.7% of total sales, whilst in 2014 and 2013 low emissions vehicles accounted for 2.8 % and 2.2% respectively (NTC, 2016, 2015). This is higher than the global average for 2016 of approximately 3% (Vorrath, 2016).

Whilst the current uptake of electric and natural gas vehicles in the ACT is relatively low (~2%) of the total vehicle population, it is likely that the uptake of low emission vehicles, including petrol/diesel variants with low emissions intensity (below the LEVS intensity of 130 g per km) will continue to increase.

Fleet purchasing and procurement

Recognising the role that the ACT Government has in providing leadership in the adoption of low emissions vehicles, the LEVS includes the development of guidelines to encourage the procurement of low emissions vehicles. The ACT Government has the lowest average emissions intensity of its fleet purchases of all local, State/Territory and Commonwealth Government buyers. It also achieved an 8.9% reduction in the average intensity of the fleet between 2014 and 2015, from 198 g/km to 181 g/km, which is below the national average intensity for vehicles sold in 2015.

The LEVS options also include a continuation of the modernisation and replacement of the ACTION bus fleet, to meet enhanced environmentally friendly vehicle (known as an EEV) and/or Euro Standards (i.e. Euro VI).

Demand Management

More efficient demand management is a focus for LEVS and has the potential for co-benefits, including addressing congestion issues. LEVS includes

- Car sharing
- Car pooling
- Freight network efficiency
- Bus network efficiency

Car sharing services have recently commenced in the ACT, with 22 car share bays available across the CBD, Dickson and within the parliamentary triangle, and it is likely that providers would be aiming for utilisation rates of 60-70% based on international benchmarks (Choice, 2015).

Choice's (2015) review also noted that car-sharing is a cost effective alternative to ownership for low mileage drivers (on average less than 100 km per week) and is typically more beneficial for inner city locations, where there is more likely to be vehicles.

The ACT government has also implemented a 'three for free' car parking scheme, which is designed to encourage car pooling and a review of this is proposed as part of LEVS.

Participation and support for inter-governmental freight network efficiency programs and progressing bus network improvements were also included as demand management actions.

Education and Awareness

As acknowledged in the LEVS, the ACT Government has an opportunity to provide leadership not only to the ACT community, but also in the role it can play in influencing national policy and regulatory settings. This includes aspects such as the Intelligent Access Program for heavy vehicles and through establishing, hosting and supporting community awareness raising and education programs.

Emerging Technologies

The LEVS also outlines several key areas for 'keeping a watching brief' on emerging technologies, and where lessons from overseas and interstate can inform future developments in the ACT. These include developments in:

- Priority and transit lanes
- Autonomous vehicles
- Electric vehicles
- Intelligent transport systems and traffic signals
- Alternate fuels
- Rise of online retail

2.0 Decarbonising the Journey to Work

A key focus of the existing ACT Government response is the promotion of shift to public and active (cycling/walking) transport modes for trips to and from work. A focus on to and from work journeys has several advantages; for many people it would form the bulk of the kilometres travelled each week, typically strongly correlated spatially (in the same direction of travel, e.g. to the City, from the City) and temporally (occurring in defined 'peak periods' in the morning and in the evenings).

For these reasons, mode shift from single occupant vehicles to multi-occupant public transport services significantly reduces the volume of traffic and hence congestion as well as having considerably lower carbon emissions per passenger per kilometre travelled (approximately half of single occupant vehicles). In addition, there is usually good sets of data available to support journeys associated with trips to work aligned to traditional 'business hours'. BITRE (2015) identified that the average distance to work for Canberra residents was 11.5 km, whilst non journey to work bus passengers have a typical distance of 9.4 km (MRCagney, 2015).

Journey to Work (JTW) data collected as part of the Australian census every five years is one of the main ways in which travel data is collected. Although JTW data is not time coded, which means it is unable to distinguish a journey which occurs during peak time from one which occurs off peak, it is frequently used during the transport and urban planning as an approximation for travel demand from locations. JTW mode share data is also a key indicator used to measure progress towards meeting the TfC objectives (Environment and Sustainable Development Directorate (ESD), 2011).

As part of a review of the ACT Parking and Vehicular Access General Code (PVAGC), AECOM (2016) analysed vehicle movements between the town centres within the ACT based on the 2011 Census data. The analysis is summarised graphically in Figure 7.

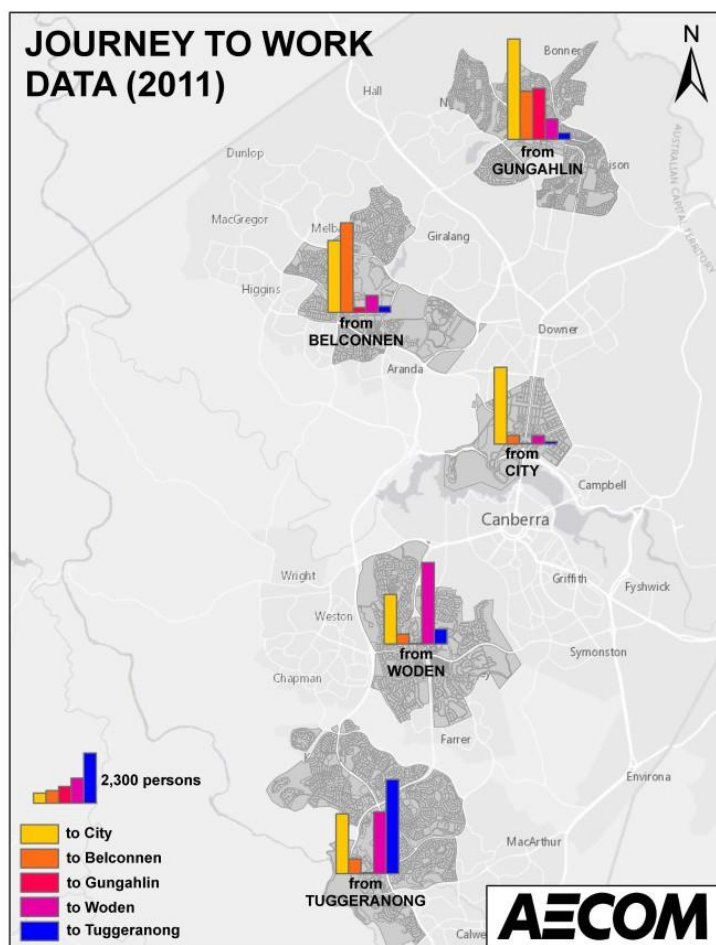


Figure 7 ACT Journey to Work destination origin pairs (source ABS 2011 JTW data)

The key findings of the analysis were:

- Approximately 44% of the workforce analysed live and work in the same area and drive by car.
- Approximately 40% of the workforce analysed travelled to work in the city, whilst approximately 23% of the workforce travelled between the two other town centres (excluding city).
- The greatest proportion of the workforce moving between town centres for their JTW was from Gungahlin to the city (although it should be noted that in 2011 Gungahlin did not have any significant commercial development).

Integrated urban planning and public transport accessibility were also key policy aspects of TfC and are discussed in Sections 2.1 and 0.

2.1 Urban planning and Changes to Journey to Work Distances

As the ACT population grows, there will be increasing pressure on existing dwellings, infrastructure and services which is likely to result in the need for urban infill and the establishment of new suburbs in the peri-urban areas particularly those between existing suburbs and the Territory border to the north. These challenges have been recognised in the ACT Planning Strategy: Planning for a Sustainable City (ACT Environment and Sustainable Development, 2012) which identifies areas of urban intensification around major transportation routes, including those well serviced by public transport.

Areas of future urban development have been identified around Belconnen, Molonglo and Gungahlin as shown in Figure 8. Although previous analysis (AECOM 2015) has identified significant portions of people work within their local areas, as these new urban areas are developed, the level of service provision and employment zones is lower than for established suburbs. As a result trip distances for both work and non-work journeys should be expected to increase, based on changes to population distributions across the suburbs projected for the ACT (ACT Treasury, 2013). To avoid these impacts, early consideration and implementation of walkability, public transport and economic activities zones will be needed to avoid these new developments becoming dormitory suburbs, where people live but must travel away from in order to work or study.

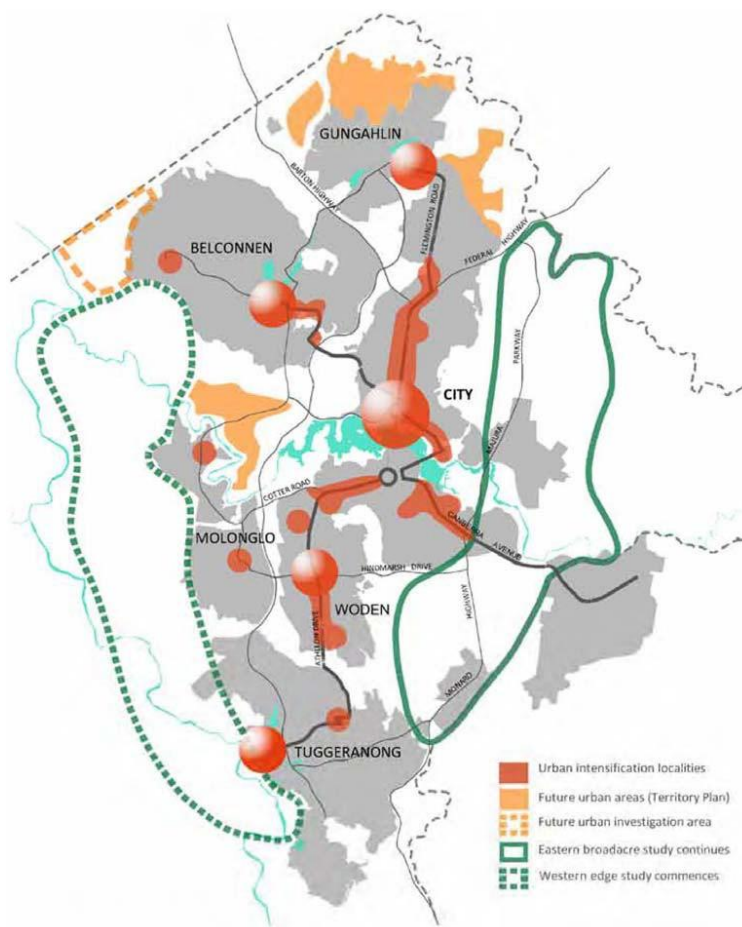


Figure 8 ACT future growth zones (ESDD, 2012)

Using population projections for the ACT at the town centre level (ACT Treasury, 2013) as the basis, forecasts for 2030, 2040 and 2050 population distributions have been developed². These forecasts do not predict densification of the city (north and south Canberra) but show population growth in the outer suburbs.

The impact on these population changes on the projected carbon emissions for work journeys is shown in Figure 9. Of particular note is the increase in emissions arising from the development of the places such as Molonglo; where residents will travel to other locations, including Queanbeyan which has not been modelled, for employment. The densification of inner parts of Canberra (within ~5 km of the Parliamentary triangle), establishment of high levels of public transport services for commuters and improving infrastructure to enable decentralised or teleworking opportunities will be essential to mitigate against this potential impact.

² The approach for this is discussed in Section 3.2

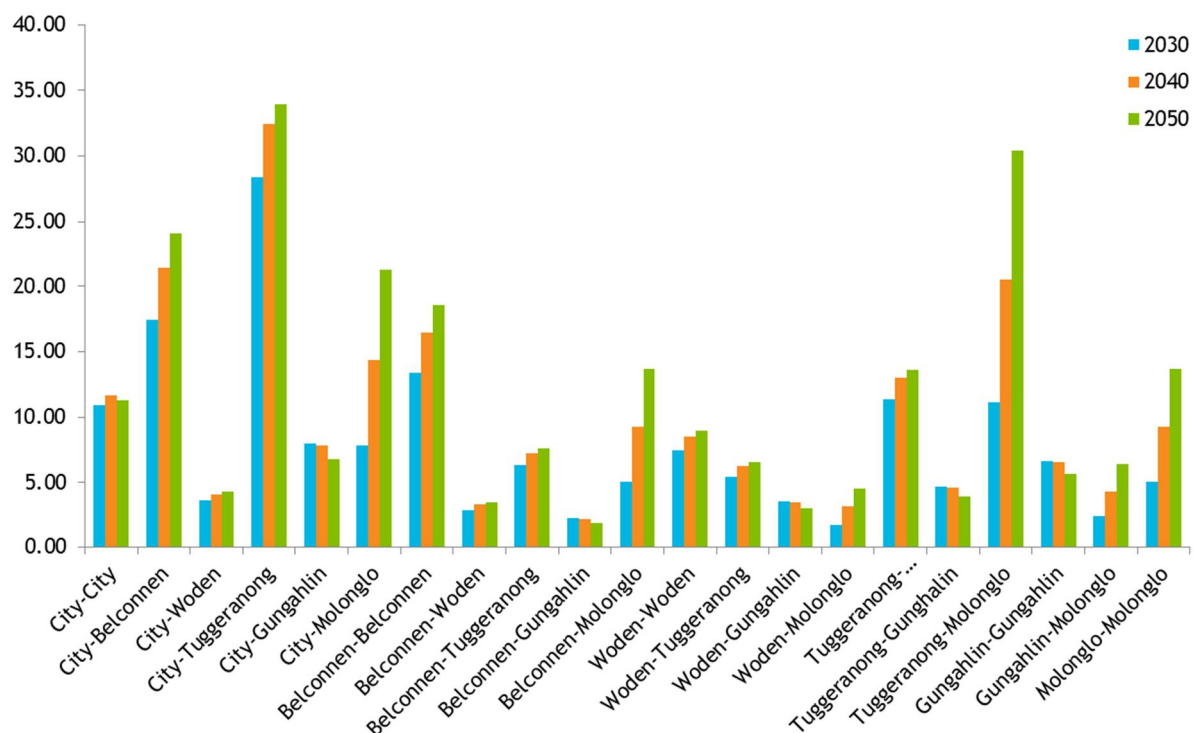


Figure 9 Carbon footprint for work related journeys for origin –destination pairs across the ACT for 2030, 2040 and 2050.

3.0 Quantifying Reduction Potential

A key aspect of this project has been to quantify the emissions reduction potential of a range of existing strategy and policy responses aligned with the key themes of TfC (e.g. public and active transport, low emission vehicles) as well as potential future strategic options (such as improved telework/avoided trips). Potential additional actions to meet the emissions reductions calculated for the scenarios presented in this Chapter are noted in Section 4.0.

3.1 Scenario Development

To develop scenarios presented in this report, four future stretch-target pathways were based on:

- Existing commitments outlined in Transport for Canberra and ACT government policies;
- Targets for public and active transport based on the highest percentages across Australian and New Zealand cities;
- Targets for public and active transport based on the highest percentages for cities of similar population Canberra;
- Targets for public and active transport based on the highest percentages for cities irrespective of size.

These scenarios were developed to assist with representing potential futures for the ACT with particular consideration how scenarios may serve as stepping stones to achieving the next scenario as part of a broader roadmap to achieving the ACT's carbon neutral commitments.

3.2 Modelling emissions

An Excel based spreadsheet was developed to calculate the emissions reduction potential for a range of emission reduction activities for the transport sector. The model consists of a set of pre-defined input values described in Section 3.2.1 and inputs which could be varied depending on the scenario being analysed. This combination of pre-defined inputs with the variation of the six activity areas were used to calculate the potential emission reductions for each of the near term (2030), the mid term (2040) and the target year (2050). There are four scenarios presented in this report:

- Transport for Canberra;
- Wellington;
- Small City (best in class); and
- Leading edge.

For the last two scenarios, the Microsoft Excel's inbuilt Goal Seek function was used to determine the input value required to produce the emissions reduction target.

3.2.1 Non-variable inputs

In developing the model, a variety of data sources were used to develop baseline and forecast future inputs which influenced the outcome of the modelling. Where different factors have been used in Scenarios as part of this assessment, they are denoted by "value for future time horizons determined by Scenario". Fixed, or defined are also provided for baseline and future time horizons as appropriate. These data sets which were used to produce included:

- Population;
- Journey to work data;
- Public and active transport patronage;
- Motor vehicles;
- Electric vehicle penetration; and
- Emissions intensity factors.

References for the data sources cited are provided in Section 8.0.

Table 2 Data sources, approach and input values for the emissions reduction estimation model

Factor	Data Sources	Approach Addressing Data Gaps	Values And Notes
Population			
Total Population	ACT Treasury Population Projections (2015)	Interpolation methods were used based on data for years · 2012 · 2017 · 2032 · 2052	2015: 393,233 2030: 453,300 2040: 550,844 2050: 615,069
Working Population	ABS catalogue 3225.0 for 2011 data CMD (2010) for future workforce participation rates	Population based factors used	2012: 71% of total population 2030: 69.5% of total population 2040: 68.7% of total population 2050: 67.8% of total population Microsoft Excel FORECAST function used to estimate 2040
Journey to Work			
Average One Way Distance (walk)	-	Estimated based on distance for 15 minute walk	All time horizons (2030, 2040 and 2050): 1.5 km
Average One Way Distance (all modes other than walk)	BITRE (2015b)	-	2015: 11.5km 2030: 11.5km 2040: 11.5km 2050: 11.5km
Number of Work Days in a Year	-	Estimated	All time horizons: 241 days
Telework / Avoided Journey to Work Trips	ABS (2012b)	Calculated using ACT Method of Travel to Work data. ("Worked at home" divided by the population of people who reported going to work on census day)	Value for future time horizons determined by Scenario. Where default factor is used this is the same as the 2015 baseline 2015: 3%
Public and Active Transport			
Annual Public Transport Patronage	ACTION (2016)	Mode Share based factors used	Assumed that all boarding's are based on Working Population times, two boardings are assumed, one for the inbound and one for the outbound journey. Weekday / Weekend patronage percentages were calculated based on 2016 actuals

Factor	Data Sources	Approach Addressing Data Gaps	Values And Notes
Public Transport Mode Share	Environment and Planning Directorate. (2014)	-	Value for future time horizons determined by Scenario. Where default factor is used this is the Transport for Canberra mode share 2014: 7.8% Transport for Canberra (2026 used for 2030): 16%
Walk to Work Mode Share	Environment and Planning Directorate. (2014)	-	Value for future time horizons determined by Scenario. Where default factor is used this is the Transport for Canberra mode share 2014: 4.9% Transport for Canberra (2026 used for 2030): 7%
Cycle to Work Mode Share	Environment and Planning Directorate. (2014)	-	Value for future time horizons determined by Scenario. Where default factor is used this is the Transport for Canberra mode share 2014: 2.8% Transport for Canberra (2026 used for 2030): 7%
Average Distance per Boarding	MRCagney (2015)	-	Baseline: 9.4 km 2030: 11.5 km 2040: 12 km 2050: 13 km
Impact of Capital Metro	-	-	The impact of Capital Metro has not been factored into the modelling as the alignment is likely to replace an existing public transport route. All PT journeys are assumed to be carbon neutral (i.e. emissions intensity of 0 g/km)
Additional Journey to Work Patronage	Environment and Planning Directorate. (2014)	-	Additional patronage is based on target mode share minus baseline mode share
Carbon Neutrality of Public Transport	AP2	Calculated	Reduction equivalent to the entire mode share based patronage times the bus emission intensity factor
Motor Vehicles			
Total number of vehicles by make and fuel type	EPD provided 2015 vehicle registration data	Population based factor used	Factor: 0.72 vehicles per capita; which was calculated from 2015 population and registration data
Number of Passenger Vehicles		Market share based factor use	Factor: 83% of all vehicles are passenger vehicles
Number of Motorcycles (including scooters)			Factor: 3.8% of all vehicles are motorcycles

Factor	Data Sources	Approach Addressing Data Gaps	Values And Notes
Number of Commercial vehicles			Factor: 12.9% of all vehicles are commercial vehicles (balance of registrations)
Annual Kilometres Travelled by vehicle class	ABS Catalogue 9208.0 (2004, 2005, 2006, 2007, 2010, 2014).	Microsoft Excel FORECAST function used for 2030, 2040 and 2050 based on data from 2004-2007, 2010 and 2014	-
Age of Vehicles by class	ABS Catalogue 9309.0 (2016)	-	-
Electric Vehicles			
Community (passenger) EV ownership	AECOM (2011)	Microsoft Excel FORECAST function used for 2040 and 2050. Interpolation used for annuals EV sales data for 2015-2020 and 2020-2030. Total number of vehicles calculated as a summation of the current and previous 9 year's estimated the annual BEV/PHEV sales using interpolated and or FORECAST data divided by number of registered vehicles.	Value for future time horizons determined by Scenario. Where default penetration values are used they are as follows: <i>BEV</i> 2015: 0% (too small to register) 2030: 9% of all vehicles 2040: 10% of all vehicles 2050: 11% of all vehicles <i>PHEV</i> 2015: 0% (too small to register) 2030: 20% of all vehicles 2040: 26% of all vehicles 2050: 32% of all vehicles
Commercial Vehicles		No widespread Commercial EV available for sale in Australia. First production sales expected in for manufacture year 2017/18	2030: 1% of all commercial vehicles 2040: 1.5% 2050: 2.5% See also footnote 3: Section 3.6
ACT Government operations	-		ACT government fleet assumed to be 1,000 (all electric) vehicles Percentage of ACT Fleet (excluding buses) which is electric vehicle is added to the community EV ownership
Emissions Intensity Factors			
PHEV / Hybrid	-	Calculated, assumed 80% electric drivetrain use and 20% from petrol/diesel	Baseline: 140.3 g/km travelled
Electric Vehicle (based on electricity emissions factors for NSW / ACT Grid)	Green Vehicle Guide Website National Greenhouse Accounts (2015)	Calculated from Nissan Leaf 2015 model	Baseline: 145.3 g/km travelled
Low Emission Vehicle	Road Transport Authority (2016)	Low Emission Vehicle Strategy Definition	Baseline: 130 g/km travelled

Factor	Data Sources	Approach Addressing Data Gaps	Values And Notes
Passenger Vehicle	National Transport Commission (2015)	Calculated as a summation of the current and previous 9 year's emissions intensity of new car data	Baseline: 189.0 g/km travelled for MY2014 vehicles; weighted average for all passenger vehicles is 200.4 g/km travelled
Commercial	National Transport Commission (2015)		Baseline: 228.8 g/km travelled
Motorcycle	UK Government (2016)	Calculated based on ratio of average motorbike / average car multiplied by Passenger Vehicle intensity	Baseline: 131.1 g/km travelled for 2015; 65% of future passenger emission intensity
Bus	GBCA Sustainable Transport Calculator (GBCA STC)	-	Baseline: 131.1 g/km travelled per passenger
Light Rail	GBCA STC	-	Baseline: 152.4 g/km travelled
Heavy Rail	GBCA STC	-	Baseline: 141.0 g/km travelled
Bicycle	-	-	No emissions
Walk / Cycle	-	-	No emissions
ACT Government Policy Commitments			
Percentage of ACT electricity emissions which are carbon neutral	EPD (2016c)	-	Baseline: 100% of emissions offset
Percentage of ACT Government Operations which are carbon neutral	EPD (2016b)	-	Baseline: 100% of emissions offset
Percentage of ACT Government Fleet (excluding buses/LRT) which are Electric Vehicles (or carbon neutral)	EPD (2016b)	-	Based on Carbon Neutrality in operations commitment.

3.2.2 Variable scenario inputs

In addition to default values for variables, the model allowed for manual input of seven variables representing key policy areas which could be influenced by the ACT Government:

- Public transport mode share
- Walking mode share
- Cycling mode share
- Avoided trips
- Uptake of electric passenger vehicles (as a model of a low carbon option), representing low emission passenger vehicles
- Carbon neutral percentage of electricity supply
- Carbon neutral fraction of ACT Government operations (including public transport)

Vehicle efficiency improvements, considered as emissions intensity reductions have been included in the model. However, these were set at the same level across all scenarios as noted in Table 2, based on the forecast future emissions intensity results, as responsibility for these sits outside the direct control of the ACT Government. The Ministerial Forum on Vehicle Emissions is working towards identifying opportunities to reduce impacts from motor vehicle emissions, and released a discussion paper in February 2016 (Department of Infrastructure and Regional Development, 2016). This paper included discussion of changes to fuel quality and vehicle efficiency standards which is likely to reduce the emissions intensity of all plant, equipment and vehicles in the future. The outcomes from the Forum, and international commitments to reduce emissions intensity in new vehicles will directly influence the emissions trajectory for the ACT.

Analysis

For each activity area, formulae are used to calculate emissions reductions from the pre-defined and scenario inputs and determine where there is an unidentified emissions reduction requirement where the Scenario is unable to achieve the emissions reductions.

The Model analyses the three time horizons concurrently, where future year inputs are provided so that a single Excel Workbook is used for each Scenario. Concurrently, the model also produces a Wedge Analysis graph which represents the emissions reductions by activity graphically.

3.3 Transport for Canberra Scenario

The *Transport for Canberra* Scenario focuses on policy responses aligned with Transport for Canberra and existing strategy announcements made by the ACT Government:

- increasing Public Transport mode share as proposed for 2026 in Transport for Canberra
- increasing Active Transport mode share as proposed for 2026 in Transport for Canberra
- small growth in mode share for Active and Public Transport post 2030;
- increasing penetration of Electric Vehicles at levels based on 'no carbon price' scenarios; and
- no change to current levels of telework/ avoided trips.

Scenario inputs

A summary of the model inputs for the Transport for Canberra Scenario are provided in Table 3.

Table 3 *Transport for Canberra Scenario input values*

Parameter	2030	2040	2050
Public Transport mode share	16%	17%	18%
Cycling mode share	7%	7.5%	8%
Walking mode share	7%	7.5%	8%
Electric Vehicle purchases (passenger vehicles)	26%	30%	39%
Telework / avoided trips	3%	3%	3%
Carbon neutral percentage of electricity supply	100%	100%	100%
Carbon neutral fraction of ACT Government operations (including public transport)	100%	100%	100%

Results and Discussion

The results from the model are presented in Table 4 and contribution by activity is presented graphically in Figure 10.

Table 4 *Transport for Canberra emission reductions for 2030, 2040, 2050*

Activity	Emission Reduction (t CO ₂ -e)		
	2030	2040	2050
Additional Public Transport Mode Share	72,273	85,215	95,593
Carbon Neutral Public Transport	39,802	51,390	60,757
Additional Active Transport Mode Share	55,527	67,616	77,786
Avoided Single Driver Trips	-	-	-
Vehicle Efficiency Improvements	95,590	212,014	259,672
Uptake of Electric Passenger Vehicles	149,742	193,959	277,151

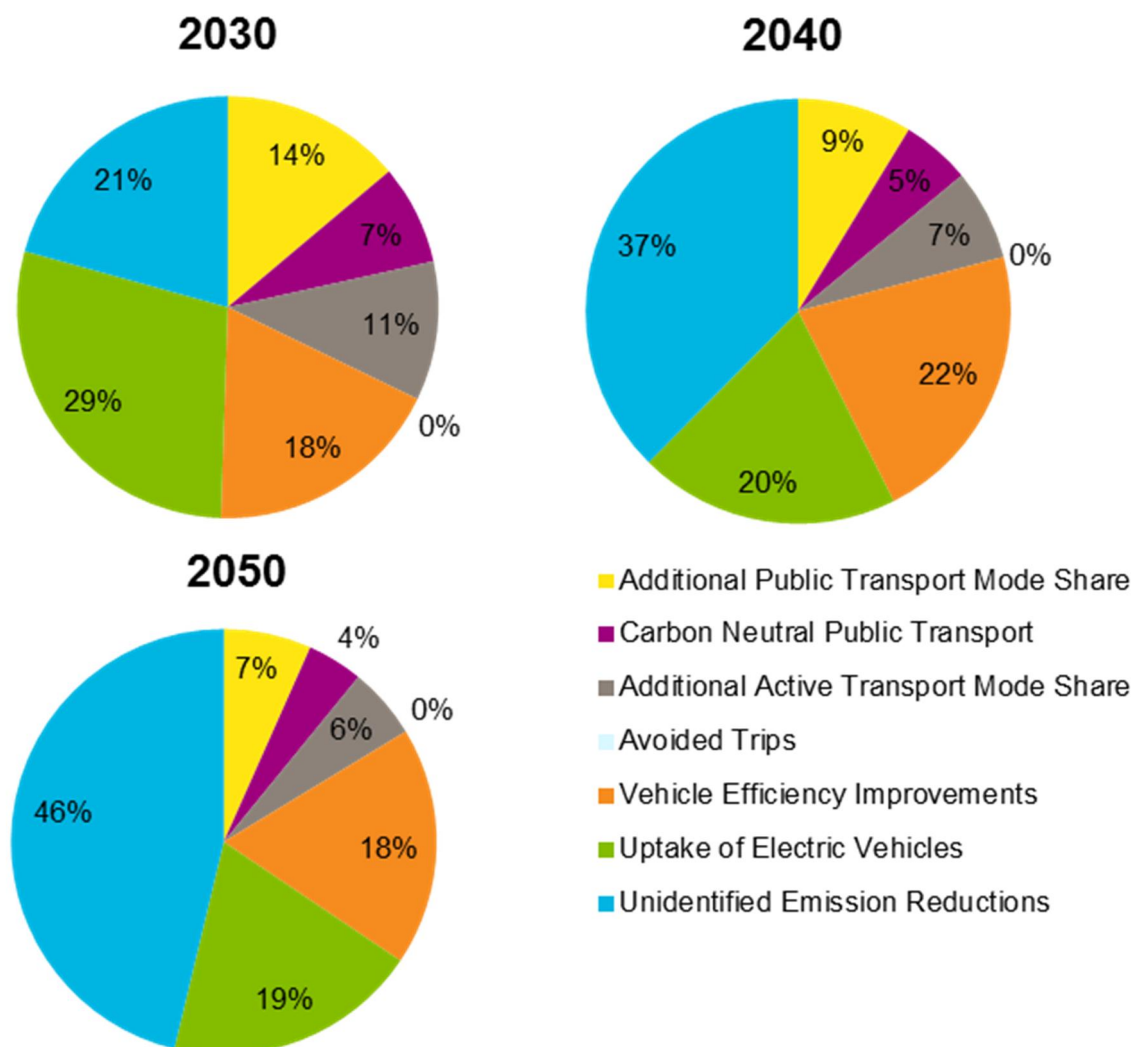


Figure 10 Transport for Canberra emission reductions for 2030, 2040, 2050

Whilst public and active transport account for reductions of between 55,527 t CO_{2-e} in 2030 and 77,786 t CO_{2-e} by 2050, there remains a significant gap between the emission reductions achievable and the reductions required to achieve the policy goals as noted in Table 5 and illustrated in the wedge analysis graph (Figure 11). In all cases, the identified emission reduction approaches achieves slightly more than 50% of the total reduction required.

Table 5 Unidentified (-Surplus) Emission Reductions for the future time horizons (2030, 2040, 2050)

Forecast Year	Transport Sectoral Reduction Required	Total Emission Reductions	Unidentified (-Surplus) Emission Reductions
2030	520,897	412,933	107,964
2040	977,759	610,195	367,564
2050	1,434,622	770,959	663,662

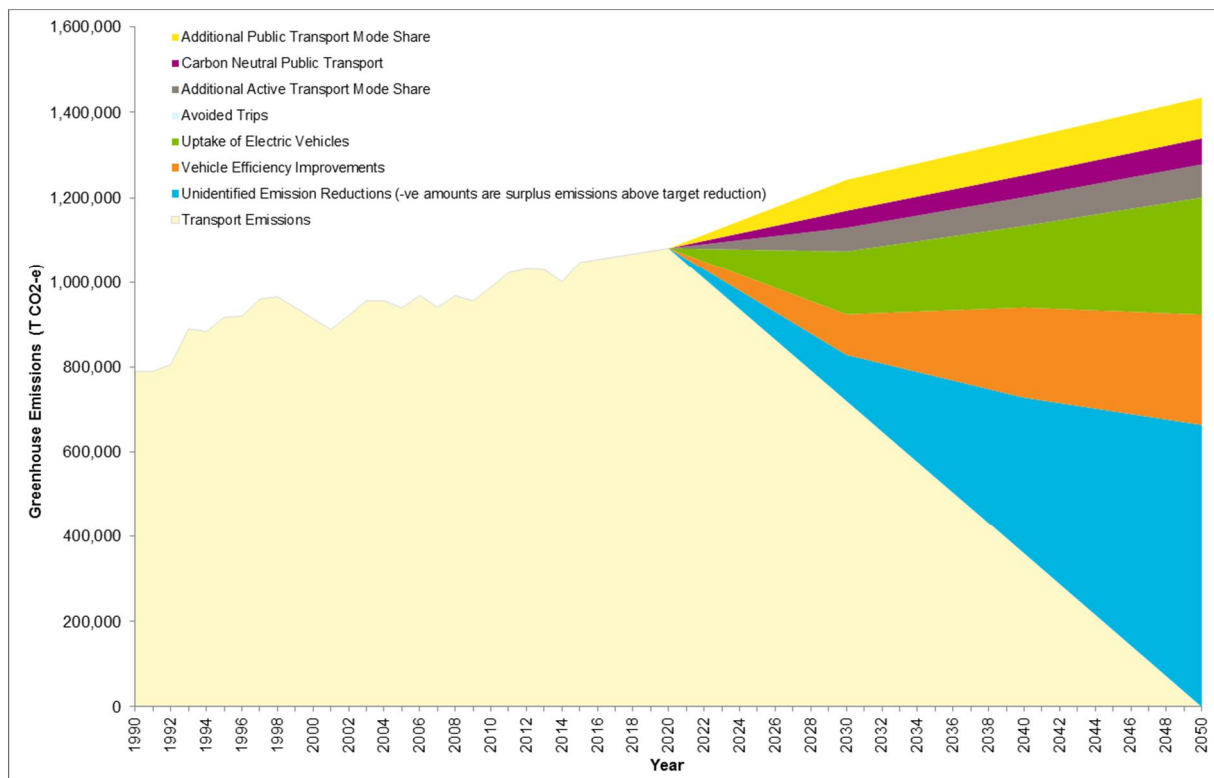


Figure 11 Transport for Canberra wedge analysis graph

On the basis of this assessment, the existing actions which form part of the Transport for Canberra strategy, no improvement to the level of avoided trips / teleworking and conservative predictions for Electric Vehicle purchases (passenger vehicles) will mean that the ACT is unable to achieve its 2030, 2040 or 2050 commitments. As a result, more aggressive mode share, Electric Vehicle purchases (passenger vehicles) and/or teleworking is required.

3.4 Wellington Scenario

The *Wellington* Scenario aligns Canberra's public transport targets with the current performance to Wellington, NZ, which is similarly sized:

- increasing public transport mode share to Australian and New Zealand best in class levels;
- increasing active transport mode share to Australian and New Zealand best in class levels;
- growth in mode share for active and public transport of 20% relative to 2030 for 2040 and further 20% by 2050;
- no change to the current level of avoided trips from current levels and
- no change to the penetration of electric vehicles from the Transport for Canberra Scenario.

Scenario inputs

A summary of the model inputs for the *Wellington* Scenario are provided in Table 6.

Table 6 *Wellington scenario input values*

Parameter	2030	2040	2050
Public Transport mode share	19%	22.8%	27.4%
Cycling mode share	11%	13.2%	15.8%
Walking mode share	7%	8.4%	10.1%
Electric Vehicle purchases (passenger vehicles)	26%	30%	39%
Telework / avoided trips	3%	3%	3%
Carbon neutral percentage of electricity supply	100%	100%	100%
Carbon neutral fraction of ACT Government operations (including public transport)	100%	100%	100%

Results and Discussion

The results from the model are presented in Table 7 and contribution by activity is presented graphically in Figure 12.

Table 7 *Wellington scenario emission reductions for 2030, 2040, 2050*

Activity	Emission Reduction (t CO ₂ -e)		
	2030	2040	2050
Additional Public Transport Mode Share	98,714	138,938	183,688
Carbon Neutral Public Transport	47,265	68,923	92,486
Additional Active Transport Mode Share	55,527	84,289	117,148
Avoided Trips	-	-	-
Vehicle Efficiency Improvements	91,710	191,778	207,447
Uptake of Electric Passenger Vehicles	143,246	172,278	220,909

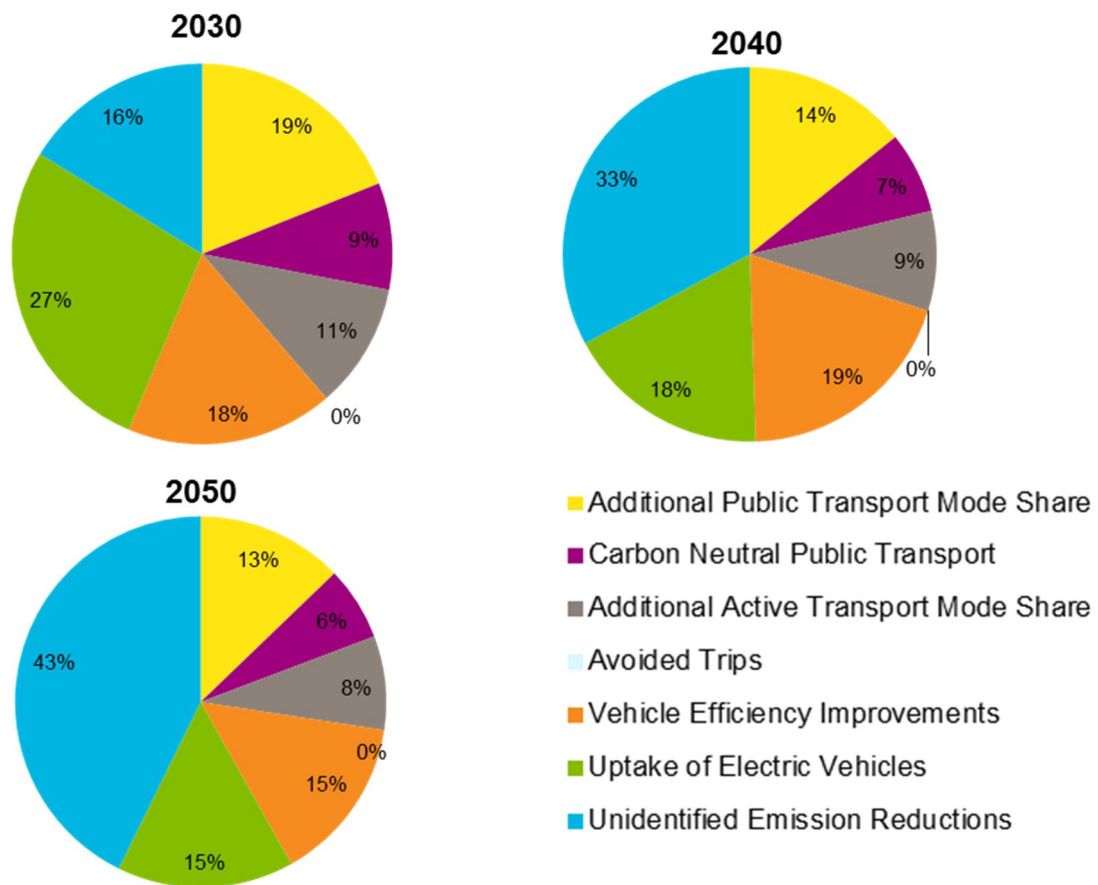


Figure 12 Share of *Wellington Scenario* emission reductions by activity for 2030, 2040, 2050

Public and active transport reductions are between 13% and 19% of all emission reductions. However, as with the *Transport for Canberra* scenario, there is a significant gap between the emission reductions achievable and the reductions required to achieve the policy goals as noted in Table 8 and illustrated in the wedge analysis graph (Figure 13). In all cases, the identified emission reduction approaches account for between 58 and 73% of the total reduction required.

Table 8 Unidentified (-Surplus) Emission Reductions for the future time horizons (2030, 2040, 2050)

Forecast Year	Transport Sectoral Reduction Required	Total Emission Reductions	Unidentified (-Surplus) Emission Reductions
2030	520,897	436,462	84,435
2040	977,759	656,207	321,553
2050	1,434,622	821,679	612,943

Whilst the gap between the Wellington Scenario and the emissions reduction targets is smaller, there are still shortfalls between the emission reductions for the proposed suite of options and the commitments, which would need additional actions and/or offsetting.

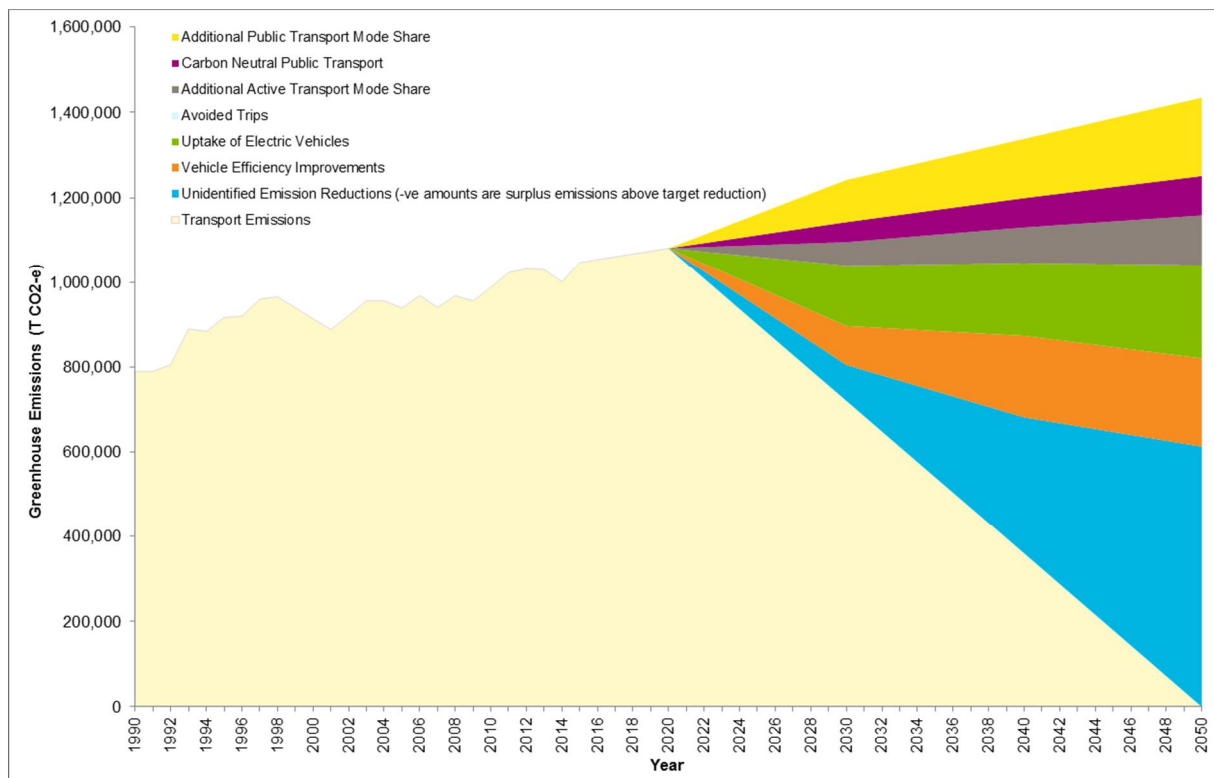


Figure 13 Wellington wedge analysis graph

3.5 Small City (best in class) Scenario

The *Small City (best in class)* Scenario, lifts public and active transport levels to those of similar sized best in class levels and doubles the uptake of electric vehicles. Inspired by Zurich, this scenario features:

- increasing Public Transport mode share to global best in class levels for cities of similar size;
- increasing Active Transport mode share to global best in class levels for cities of similar size;
- no change in mode share for public and active transport due to saturation rates being achieved;
- higher levels of avoided trips; and
- increasing penetration of Electric Vehicles through more aggressive percentages of new electric vehicles purchased annually in the near and mid terms.

Scenario inputs

A summary of the model inputs for the Small City (best in class) Scenario are provided in Table 9.

Table 9 *Small City (best in class)* Scenario input values

Parameter	2030	2040	2050
Public Transport mode share	34%		
Cycling mode share	15%		
Walking mode share	7%		
Electric Vehicle purchases (passenger vehicles)	33%	34%	41%
Telework / avoided trips	12%		
Carbon neutral percentage of electricity supply	100%		
Carbon neutral fraction of ACT Government operations (including public transport)	100%		

Results and Discussion

The results from the model are presented in Table 10 and contribution by activity is presented graphically in Figure 14.

Table 10 *Small City (best in class)* emission reductions for 2030, 2040, 2050

Activity	Emission Reduction (t CO ₂ -e)		
	2030	2040	2050
Additional Public Transport Mode Share	230,921	242,678	245,542
Carbon Neutral Public Transport	84,580	102,780	114,764
Additional Active Transport Mode Share	126,037	132,454	134,017
Avoided Trips	79,324	83,363	84,347
Vehicle Efficiency Improvements	50,325	124,147	140,630
Uptake of Electric Passenger Vehicles	92,614	111,991	155,740

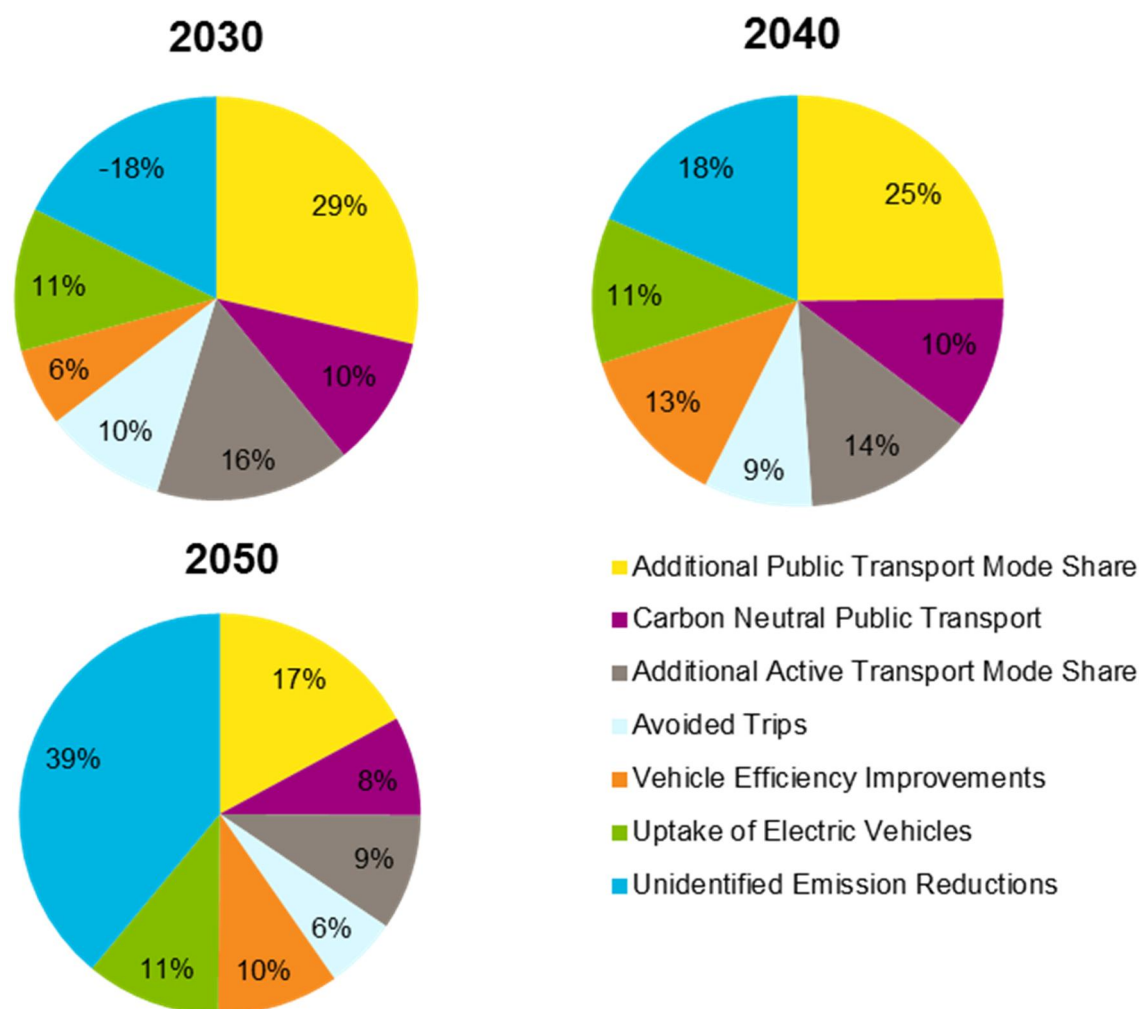


Figure 14 Share of *Small City (best in class)* emission reductions by activity for 2030, 2040, 2050

Summary of the results are provided in Table 11 and illustrated in the wedge analysis graph (Figure 15).

Table 11 Unidentified (-Surplus) Emission Reductions for the future time horizons (2030, 2040, 2050)

Forecast Year	Transport Sectoral Reduction Required	Total Emission Reductions	Unidentified (-Surplus) Emission Reductions
2030	520,897	663,800	-142,903
2040	977,759	797,414	180,346
2050	1,434,622	875,039	559,582

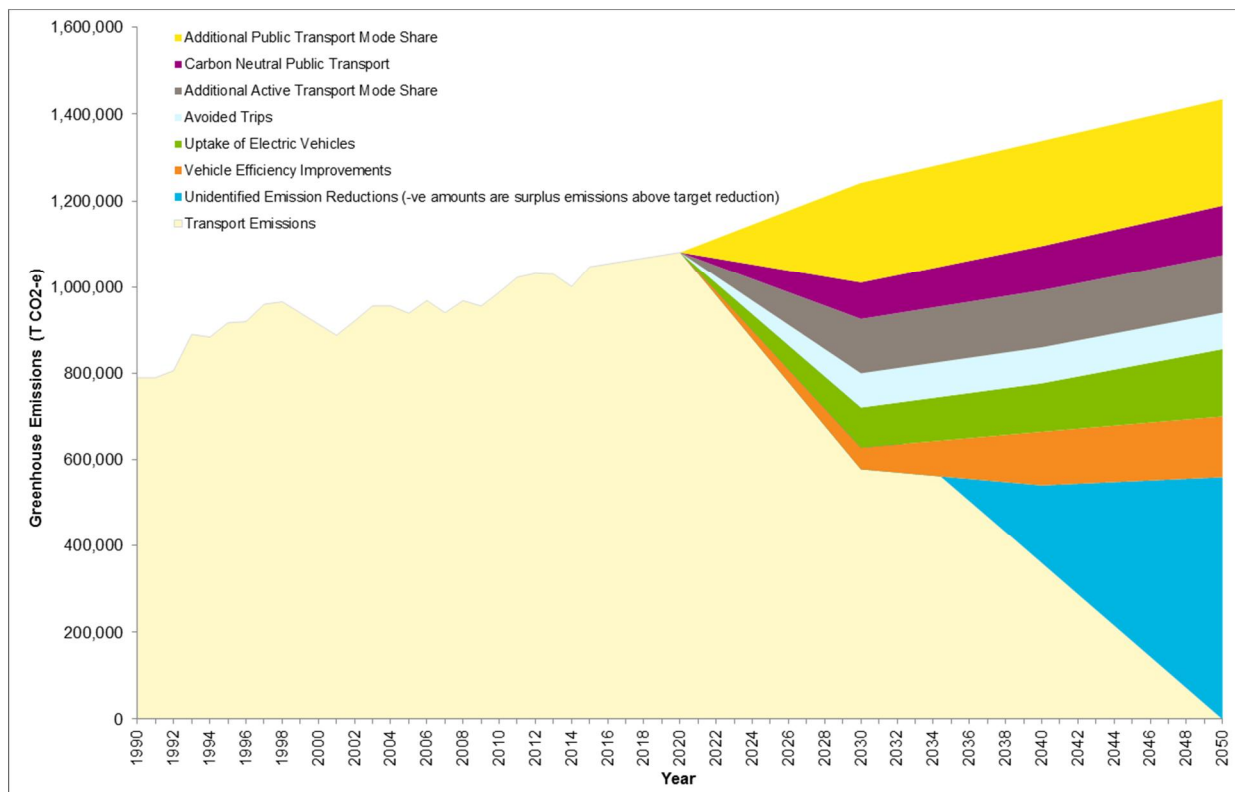


Figure 15 Small City (best in class) wedge analysis graph

The Small City (best in class) scenario is the first scenario in which policy commitments are met across most time horizons, largely as a result of the significant increase in electric vehicle uptake. To achieve a market penetration of 34% of all passenger vehicles to be electric vehicles by 2030, it would require more than half of all new vehicle sales (cars etc.) to be electric vehicles. Given the relatively short time to the near term target year, the cost premium and supply issues impacting availability of electric vehicles, and an average vehicle age in the ACT of 9.4 years, this may require additional intervention to address these barriers if this is to be achieved. In the case for the 2040 and 2050 time horizons, 70% and 90% of all vehicles will need to be powered by electric motors.

Achievement of the ACT's emissions reduction targets would also require offsetting of non-passenger movement emissions, or significant improvements in either the fuel efficiency of these vehicles or rapid Uptake of Electric Passenger Vehicles in the freight and logistics sector, with fully electric and plug in hybrid commercial and heavy truck fleets not yet available in Australia.

3.6 Carbon Neutral Scenario³

The *Carbon Neutral* Scenario identifies a set of mode share targets and market share percentage for electric vehicles which would be required to meet the ACT's commitment of carbon neutrality by 2050. Whilst the previous scenarios include conservative uptake of electric powered commercial vehicles, the Carbon Neutral Scenario uses aggressive uptake from 2030; in particular in the 2040-2050 period as these are expected to become more widely available.

Scenario inputs

A summary of the model inputs for the Transport for Canberra Scenario are provided in Table 9.

³ Modelling for the Carbon Neutral and Leading Scenarios was undertaken using a modified version of the Sustainable Transport Emissions Explorer which included a separate variable for commercial electric vehicle purchases and used Goal Seek functionality to determine percentage.

Table 12 Carbon Neutral Scenario input values

Parameter	2030	2040	2050
Public Transport mode share	34%		
Cycling mode share	15%		
Walking mode share	7%		
Electric Vehicle purchases (passenger vehicles)	37%	55%	61%
Electric Vehicle purchases (commercial vehicles)	1%	20%	81%
Telework / avoided trips	24%		
Carbon neutral percentage of electricity supply	100%		
Carbon neutral fraction of ACT Government operations (including public transport)	100%		

Results and Discussion

The results from the model are presented in Table 4 and contribution by activity is presented graphically in Figure 10.

Table 13 Carbon Neutral emission reductions for 2030, 2040, 2050

Activity	Emission Reduction (t CO ₂ -e)		
	2030	2040	2050
Additional Public Transport Mode Share	230,921	242,678	245,542
Carbon Neutral Public Transport	84,580	102,780	114,764
Additional Active Transport Mode Share	126,037	132,454	134,017
Avoided Trips	185,089	194,513	196,809
Vehicle Efficiency Improvements	34,806	92,196	94,549
Uptake of Electric Passenger Vehicles	66,298	113,132	145,985

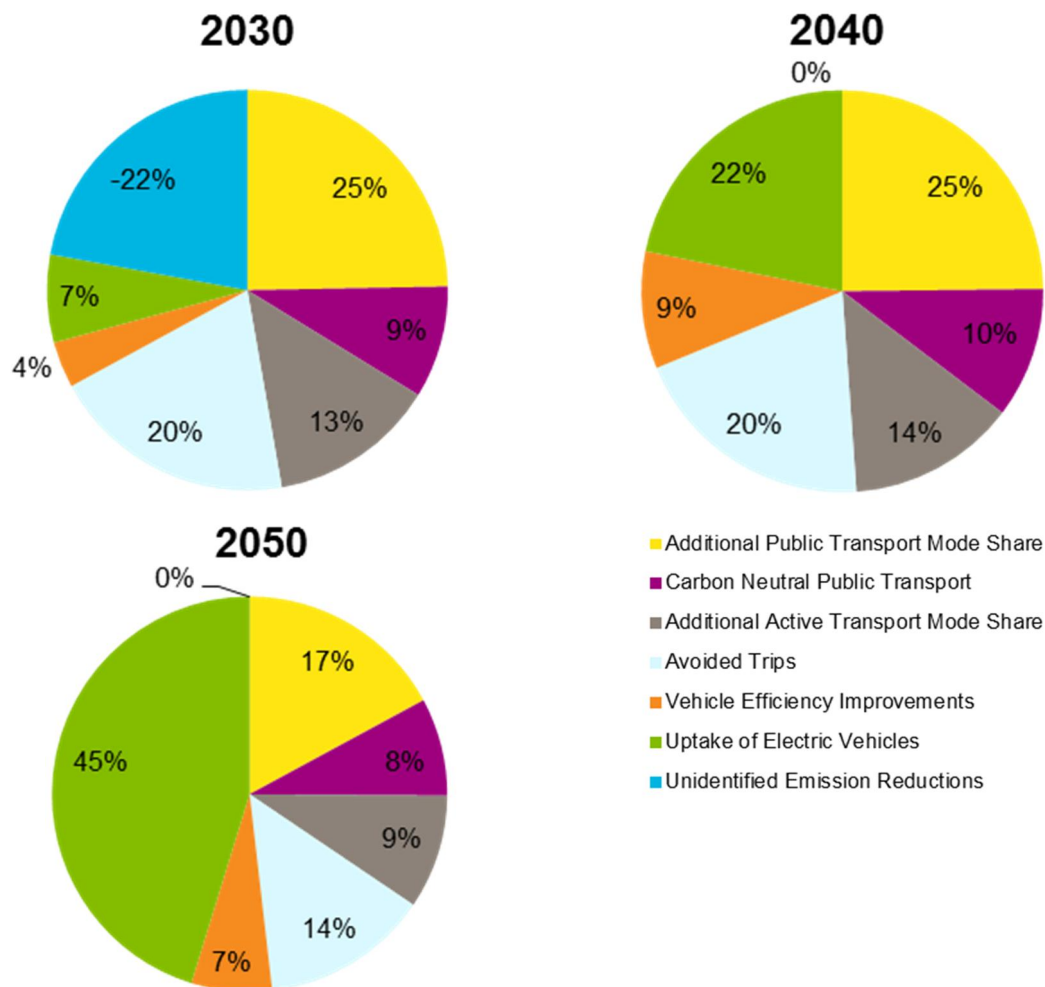


Figure 16 Share of Carbon Neutral emission reductions by activity for 2030, 2040, 2050

Given the Carbon Neutral Scenario is more aggressive in terms of increases to telework and the uptake of both electric passenger and commercial vehicles than the Small City (best in class) scenario, it is unsurprising that it also results in the carbon neutral target being achieved as demonstrated in Table 14.

Table 14 Unidentified (-Surplus) Emission Reductions for the future time horizons (2030, 2040, 2050)

Forecast Year	Transport Sectoral Reduction Required	Total Emission Reductions	Unidentified (-Surplus) Emission Reductions
2030	520,897	727,730	-206,833
2040	977,759	977,759	0
2050	1,434,622	1,434,622	0

Based on the wedge analysis (Figure 17) carbon neutrality is achieved by the target year, with a significant surplus in 2030, allowing room for passenger movements to not achieve targets as the ACT moves from current levels of non-motorised and public transport, whilst still meeting 2040 and beyond targets.

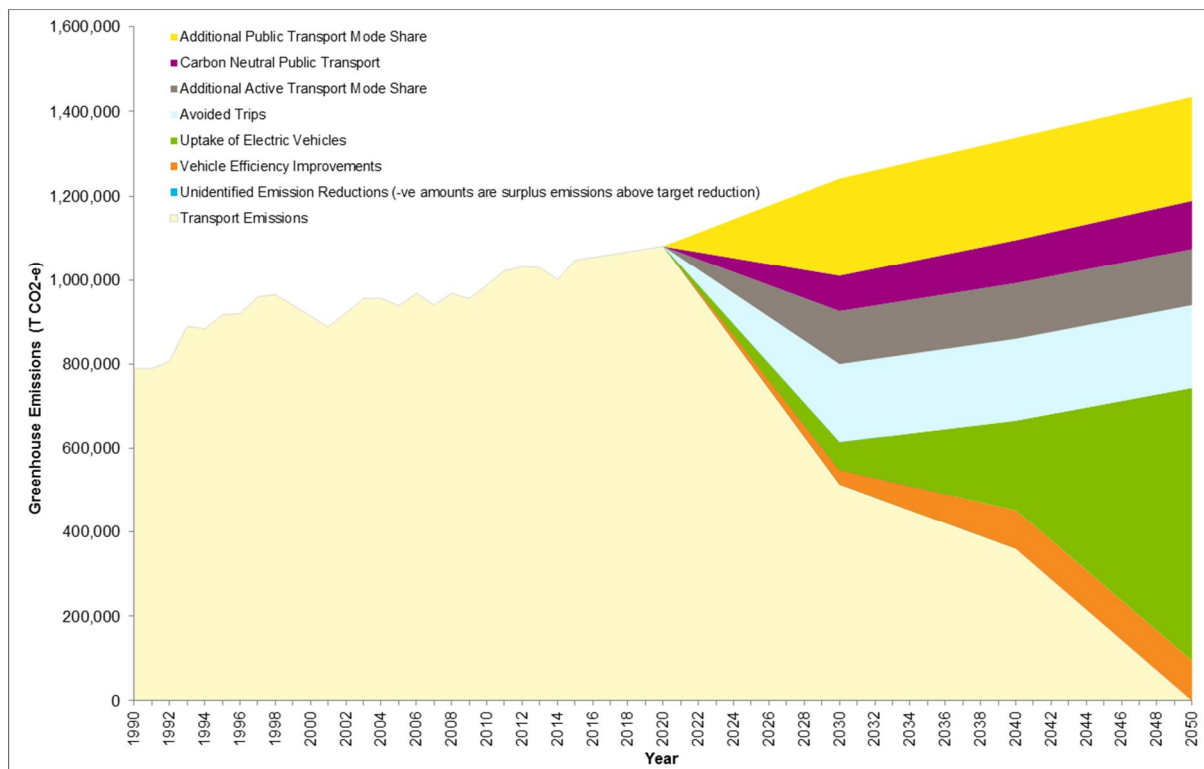


Figure 17 Carbon Neutral wedge analysis graph

3.7 Leading Edge Scenario⁴

The *Leading Edge* Scenario is where public transport mode share is lifted to global best in class levels and progressive market share percentages for electric vehicles.

- increasing Public Transport mode share to global best in class levels;
- increasing Active Transport mode share to global best in class levels; and
- continual aggressive growth in mode share for Active and Public Transport;
- double the amount of avoided trips through telework; and
- all new vehicles from 2030 are fully electric or plugin hybrids (representing vehicle technologies which use electricity rather than liquid hydrocarbons. This could include fuel cell / hydrogen vehicles).

Scenario inputs

A summary of the model inputs for the Transport for Canberra Scenario are provided in Table 15.

⁴ Modelling for the Carbon Neutral and Leading Scenarios was undertaken using a modified version of the Sustainable Transport Emissions Explorer which included a separate variable for commercial electric vehicle purchases and used Goal Seek functionality to determine percentage.

Table 15 Carbon Neutral Scenario input values

Parameter	2030	2040	2050
Public Transport mode share	34%	40%	45%
Cycling mode share	7%	10%	15%
Walking mode share	7%	10%	15%
Electric Vehicle purchases (passenger vehicles)	50%	70%	100%
<i>Electric Vehicle purchases (commercial vehicles)</i>	1%	20%	81%
Telework / avoided trips	8%	12%	16%
Carbon neutral percentage of electricity supply	100%		
Carbon neutral fraction of ACT Government operations (including public transport)	100%		

Results and Discussion

The results from the model are presented in Table 16 and contribution by activity is presented graphically in Figure 18.

Table 16 Carbon Neutral emission reductions for 2030, 2040, 2050

Activity	Emission Reduction (t CO ₂ -e)		
	2030	2040	2050
Additional Public Transport Mode Share	230,921	298,253	348,632
Carbon Neutral Public Transport	84,580	120,918	151,893
Additional Active Transport Mode Share	55,527	113,929	208,992
Avoided Trips	44,069	83,363	121,834
Vehicle Efficiency Improvements	65,844	113,497	52,308
Uptake of Electric Passenger Vehicles	187,883	294,916	615,010

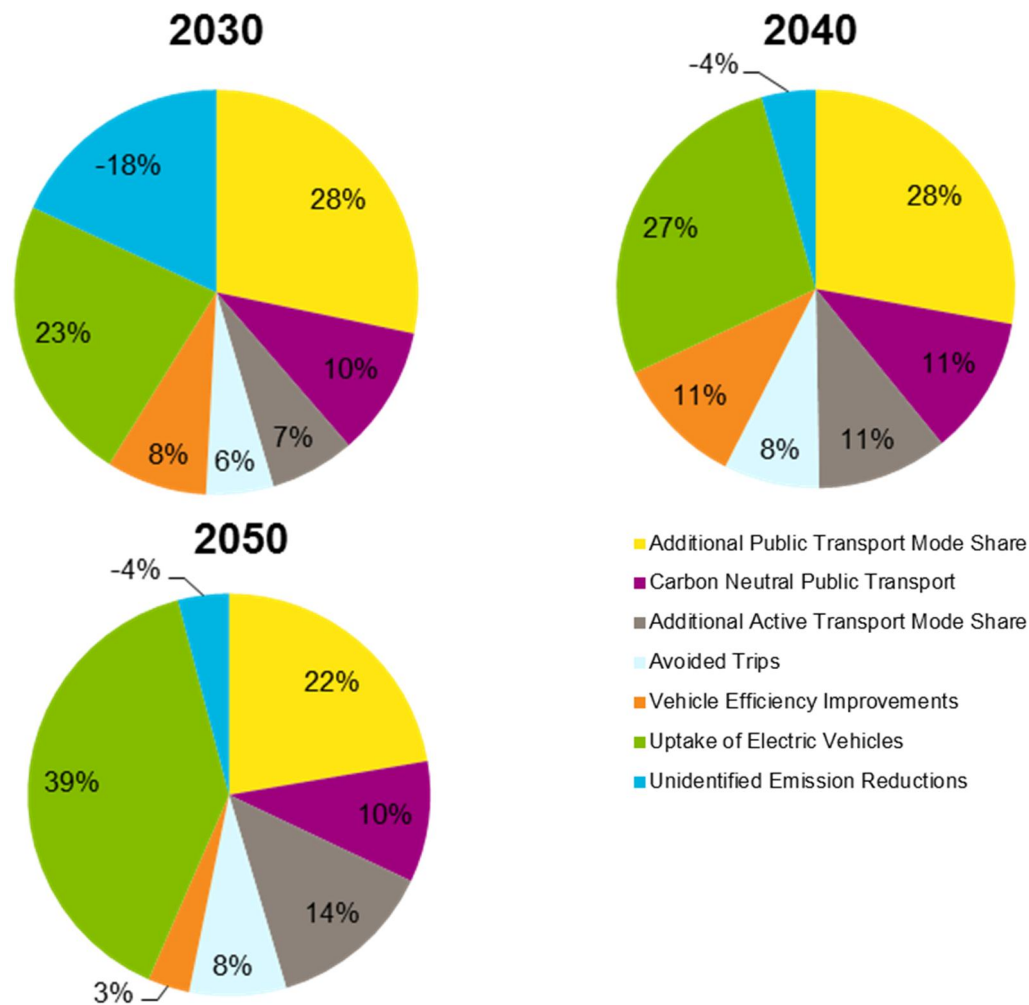


Figure 18 Share of Carbon Neutral emission reductions by activity for 2030, 2040, 2050

Should these percentages be achieved, emission reductions for 2030 are 668,823 t CO_{2-e}; 1,024,875 t CO_{2-e} in 2040 and 1,498,669 t CO_{2-e} in 2050, exceeding the quantities required for carbon neutrality

The *Leading Edge* Scenario is the most aggressive scenario, with mode share and Electric Vehicle purchases (passenger vehicles) greater than the *Carbon Neutral Scenario*, so it is unsurprising that it also results in the carbon neutral target being exceeded. Based on the wedge analysis (Figure 17) carbon neutrality is achieved approximately two years ahead of schedule.

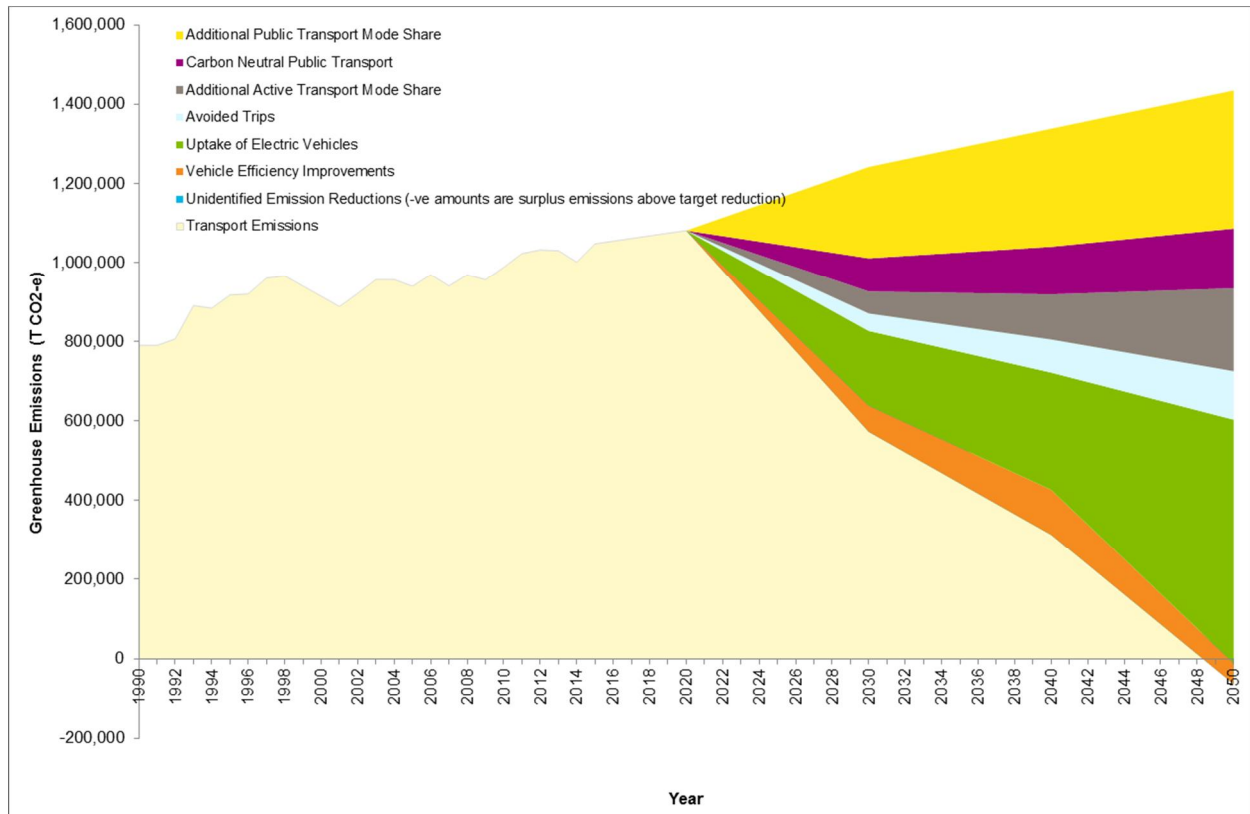


Figure 19 *Leading Edge wedge analysis graph*

4.0 Strategic Actions to Achieve Reductions

It is unrealistic to assume that in the next 35 years that the need for motorised travel will be alleviated. Globalisation and the fossil fuel age have capitalised on the mobility of people and goods in such a way that the need (and desire) for travel to distant locations is unlikely to abate. Decentralisation of services and employment centres, increased provision of cycle and ride facilities at public transport nodes, increased access to work from home through greater accessibility, speed and reliability of broadband services as well as the densification of urban centres, particularly around transit nodes are all potential approaches for avoiding the emissions through displacing the need for vehicle trips and/or reducing the length of journeys.

The ACT Government, like governments around the country, is responsible for a significant portion of the ACT's emissions. These emissions arise as a natural function of provision of services for government and the community. Some of the emissions are direct emissions from the ACT Government – emissions associated with fuel consumption of ACT government vehicles and the operation of public facilities. However, a considerable portion of the emissions are indirect emissions - the result of the activities of the government, but not emitted by equipment and vehicles owned by the Government. In both of these cases, the ACT Government can strongly influence the nature and scale of the emissions; through leveraging off its position through regulation, incentivisation and purchasing. The ACT Government can also leverage its position to influence the community through demonstrating leadership, influencing economic and recreational activities and through education and awareness raising.

This Chapter identifies a range of strategic options which may be considered as part of a suite of actions focused on reducing the carbon intensity of the transport sector in the ACT. A number of the potential initiatives presented below are being pursued by the ACT Government as part of existing initiatives to various degrees, and as a result, the focus is on expanding and improving service levels for these areas.

In keeping with the mitigation measures and offsets hierarchy of the CNG Framework, a range of strategic options which align with the emission reduction hierarchy are presented in this report for consideration.



Figure 10 Mitigation and offsets hierarchy (ACT Government, 2014)

Iconography is used in this chapter to demonstrate the alignment of the initiatives presented with those of the CNG Framework:

 Avoid

 Reduce

 Switch

4.1 Strategic Options Development

In identifying approaches in the following sections of this report, leading and emerging practices from around the world, such as those identified in the Fifth Assessment Report (5AR) of the Intergovernmental Panel on Climate Change, have been identified. In developing options the following broad approaches were considered as ways to achieve the emission reductions required:

- Technical approaches which focus on investment in new transport infrastructure and technologies
- Regulatory approaches which focus on the introduction of policies, laws and regulation
- Planning approaches which influence planning and development approaches to assist other approaches
- Economic approaches which use financial approaches including penalties and incentives to send price or cost signals to encourage the transition; and
- Education approaches are also a fundamental mechanism by which change, including technological and behavioural change can be stimulated.

A number of options were presented as thought starters in an Issues Paper which was prepared for the Options Workshop which was held on 29 July 2016.

In addition to the thought starting options presented, participants were asked to consider four questions:

- What additional actions, beyond LEVS and Transport for Canberra can help the ACT achieve the medium term targets by 2040?
- How low can the ACT go?
- Where should the ACT focus its efforts?
- What cross agency support is needed to progress the options identified?

The Outcomes from this workshop are presented in Appendix A.

Case Studies are presented in Section 6.0 and are used to illustrate examples of where strategies have been implemented.

4.2 Option Hierarchy

This Chapter is structured around a potential roadmap for achieving the commitment by 2050, whereby the focus is on the additional actions (beyond the existing policy commitments) to be implemented to achieve the Wellington Scenario by 2023 as a mid-way and the Small City (best in class) by 2030 as well as opportunities to continue reducing emissions out to 2050. Beyond 2030, it is likely that there will be few, if any No Regrets options; the nature of these options means that they suitable for early implementation. Conversely, if monitoring of progress towards meeting the commitments identifies that emissions reductions are not on track, investment actions are likely to be needed to achieve the targets.

The options are grouped thematically against one of thirteen areas:

- Leadership
- Data Capture, Monitoring and Evaluation
- Regulations, Standards and Specifications
- Procurement and Purchasing
- Education and Awareness
- Urban Planning
- Avoided Journeys
- Active Transport
- Public Transport
- Low Emissions Vehicles
- Canberra plus one hour and cross border movement (C+1)
- Vehicle Fuel Efficiency
- Innovation and Emerging Technologies

4.3 Getting to Wellington by 2023

4.3.1 No Regrets

Leadership

- ✗ Engage with, and support, peak bodies (AustRoads, Australian Bicycle Council, etc.) to develop and update national strategies aimed at encouraging sustainable transport, such as the National Cycling Strategy

Data Capture, Monitoring and Evaluation

- Use Transport for Canberra Snapshot approach to monitor and report on progress towards meeting targets for public and active transport
- ✗ Collect emissions data and standards information for heavy vehicles, plant and equipment used in major projects to identify opportunities for influencing private investment in lower emissions plant and heavy vehicles
- ✗ Continue to monitor and report on progress towards meeting emission reduction targets for the transportation sector

Procurement and Purchasing

- ✗ Specify requirement for low emissions and/or higher environmental performance standards for buses, plant, equipment and vehicles used by ACT Government for major ACT Government funded construction projects.
- Develop a framework for Forward Commitment Procurement⁵ style approaches as part of ACT Procurement refer to Birmingham City Council - low carbon mini bus services case study in Section 6.2.4 for community and flexible bus services.

⁵ Forward Commitment Procurement is a strategy designed to encourage innovation where the Specifications for the good/service are not currently available in the market, and suppliers are encouraged to innovate to meet the requirements set at a defined time in the future. Where this differs from market sounding activities is that a contract to purchase the innovative good/service is entered into.

Education and Awareness

- Adopt community based social marketing approaches during development of education and awareness raising programs to support behaviour change; including identification of barriers to increased uptake; selecting strategies and approaches to address the actual and perceived barriers and regular monitoring and evaluation.
- Continue to use traditional and social media to increase the awareness of programs with the community.
- ✗ Develop education programs which identify bicycle highways which are designed for commuter cyclists who travel at speed, from casual users who might be intimidated by the speed of seasoned commuters.
- ✗ Continue to promote behaviour change programs with the community and schools, which encourage and support the use of public transport services
- ✗ Support eco driver training programs for staff, especially those who drive commercial vehicles and plant operators.
- ✗ Look for opportunities to grow the service offered by the ACT Government Active Transport Office, including through
 - § Supporting car free days
 - § TravelSmart (travel planning programs)
 - § Bicycle education programs in schools

Avoided Journeys

- Promote flexible work arrangement for ACT Public Servants including opportunities for :
 - ✗ Teleworking (working from home) for Government employees [refer to the IP Australia case study in Section 6.2]
 - ✗ Condensed work weeks, where staff work 4 day weeks and/or 9 day fortnights by working longer hours on their days in the 'office'; or
 - ✗ Staggered start and finish times and or off peak work hours, avoiding peak periods for road and cycleway users.

Active Transport

- ✗ Provide end of trip facilities for staff that cycle and or walk to work at all State Government Offices in line with best practice guidelines, such as the Sustainable Transport credits of the GreenStar rating scheme.

4.3.2 Easy Wins

Leadership

- ✗ Work with fleet provider(s) to progressively increase the offering electric vehicles available for government fleet leasing within the options available.
- ✗ Advocate faster roll out of the high speed broadband services and continued improvements in speed and reliability.

Regulations, Standards and Specifications

- X Develop infrastructure to support the continued uptake of more efficient modes of passenger transport such as electric vehicles, motorbikes and scooters, including adoption of priority lanes and parking areas
- X Embed fuel efficiency considerations as part of the design, alignment and speed limiting of new road infrastructure
- X Manage congestion through the use of operational improvements including:
 - § Geometric and design changes
 - § Access management
 - § ITS (Intelligent Transport Systems)
 - § Traffic signalisation
- Review and update ACT Design Standards and Planning Guidelines to promote further uptake of, and accessibility to, public and active transport for infrastructure projects and urban development (for example consider alignment with Cycling Aspects of AustRoads Guides)

Procurement and Purchasing

- Adopt IT solutions which displace the need for travel (Skype for Business, video conferencing etc.)
- X Continue to consider alternate fuel options as part of procurement decisions for bus fleet replacement following evaluation of the alternative fuel trail
- X Use fuel consumption data for buses to identify vehicles in need of maintenance and/or replacement (use as a prioritisation approach and an opportunity to learn from better practices used) [refer to LinFox case study in Section 6.2.2].
- X Work with the supply chain to address perceived barriers relating to voiding of warranties for vehicles, plant and equipment that use biofuels
- X Conduct market sounding with the retail fuels sector to understand barriers preventing the availability of alternate fuels
- X Facilitate market sounding to identify opportunities to expand bicycle courier/ home delivery services into new markets and new areas

Urban Planning

- Continue to pursue integrated transport planning as part of updates to Planning Strategies
- X Encourage densification and urban infill development and regeneration activities within a 2 km radius of major employment centres and transport nodes to enhance the walkability, access to public transport and or cycling
- X Set maximum car parking service ratios, minimum bicycle parking service ratios and end of trip facilities for new developments and major refurbishments for commercial and industrial buildings
- Future proof transport infrastructure by selecting and designing infrastructure (including road corridors) which can adapt or respond to the changes in the use (roads which become light rail or bus rapid transit routes)

Active Transport

- ✗ Conduct a crime prevention through environmental design (CPTED) Audit of main pedestrian and cyclist paths and implement corrective action where required.
- ✗ Engage with cyclist groups such as Peddle Power to identify gaps and areas for improvement in the continuity and connectedness of the shared path network.

Public Transport

- ✗ Provide carbon neutral and public transport options for staff to use for work related travel (bike fleet, cars, MyWay).

Innovation and Emerging Technologies

- ✗ Develop relationships with the autonomous vehicle industry to enhance understanding of how infrastructure will need to respond to the requirements of these vehicles, including new communication infrastructure requirements.

4.3.3 Investment**Leadership**

- ✗ Support research, development and demonstration of urban planning and non-motorised transport approaches to avoiding emissions

Data Capture, Monitoring and Evaluation

- Develop comprehensive monitoring and evaluation program to review the effectiveness of strategic options implemented and actively manage strategies which are underperforming and need sun setting or revising.




Regulations, Standards and Specifications

- ✗ Mandate natural gas, biodiesel and/or ethanol sales targets
- ✗ Incentivise existing fuel retailers to install natural gas, B20 / B100 biodiesel and ethanol (E10 / E85) pumps for retail sale
- ✗ Mandate the establishment of dedicated car pool lanes and parking as part of changes to infrastructure and urban development guidelines


Public Transport

- ✗ Enhance public transport infrastructure (shelters, buses) and level of service (frequency and accessibility, including for passengers who need assistance), particularly to areas with low public transport accessibility through a fully integrated transport network.
- ✗ Work towards equitable access to public transport solutions for all residents of the ACT
- ✗ Commence program to procure a range of vehicles which are sized based on demand refer to Birmingham City Council - low carbon mini bus services case study in Section 6.2.4 for community and flexible bus services.
- ✗ Trial 'mobility on demand' bus services which are responsive to passenger demand rather than based on set routes, particularly to areas where dead running (service with no passengers) is high.
- ✗ Explore opportunities to provide additional incentives to promote public transport uptake.

Low Emissions Vehicles

-  Incentivise flexi fuel and alternate fuel conversions for existing vehicles
-  Incentivise early adoption of sustainability sourced renewable fuelled and electric vehicles.
-  Trial fast charging stations for electric and plug in hybrid vehicles (including bikes, which have recently been introduced) at government facilities, including dedicated EV car parking bays.

C+1 (Canberra plus one hour; cross border movement)

-  Continue to engage with State and Commonwealth governments and passenger rail developers, including potential High Speed Rail proponents to capitalise opportunities for cross border and commuter movement between Sydney and Melbourne.

Vehicle Fuel Efficiency

- Continue participation in the Ministerial Forum on Vehicle Efficiency and, Council of Australian Governments and other inter-jurisdictional activities which are focused on regulating vehicle emission standards.

Innovation and Emerging Technologies


- Track the Legislative, Regulatory and Design Standard changes that would be required to respond to emerging autonomous vehicle technologies and levels of autonomy

4.4 Getting to Small City (Best in Class) by 2030

As the ACT heads from 2023 to 2030, it is unlikely that the programs and actions committed and implemented as part of the 2023 milestone will stop, but it is likely that these will need to be refined, updated or replaced with additional actions to maintain the momentum towards the carbon neutral target for 2050.

4.4.1 No Regrets



Leadership

-  Work with Commonwealth government agencies to displace hydrocarbon fuelled Government Vehicles with electric vehicles.


Data Capture, Monitoring and Evaluation

- Use outcomes of previous monitoring and evaluation to update Strategies and Plans to respond to changes in technology, planning and the transportation requirements of the ACT Community.

Regulations, Standards and Specifications

-  Update definition for low emissions vehicles based on improvements in vehicle efficiency and introduce regular review of the definition of low emission vehicle
-  Introduce congestion pricing and/or distance based road pricing mechanisms to promote mode shift

C+1 (Canberra plus one hour; cross border)

-  In conjunction with engagement associated with High Speed Rail, commence planning for interconnection between potential High Speed Rail Station at Canberra Airport with light rail services and potential for servicing the broader Airport precinct, including Pialligo.

4.4.2 Easy Wins

Leadership

- ✗ Embed in decision making processes a requirement to consider non-asset and/or non-car/truck solutions when evaluating transport planning options for the movement of people and goods

Urban Planning

- ✗ Set maximum car parking service ratios, minimum bicycle parking service ratios and end of trip facilities for new developments and major refurbishments for commercial and industrial buildings

C+1

- ✗ Partner with key stakeholders to develop an 'electric highway' with fast electric vehicle charging stations available for travellers (refer to the Electric Highway case study in Section 6.2.5)
- ✗ Maintain and enhance freight rail infrastructure and services, including pursuing opportunities for private investment in new and upgraded services

4.4.3 Investment

Leadership

- ✗ Work with ICT providers to identify and address gaps in broad band availability, quality and reliability, particularly in areas with poor public transport access level as an enabler of teleworking

Urban Planning

- ✗ Adopt Planning Requirements which support transit orientated and '20 minute neighbourhood' urban planning opportunities for new developments, building on the Garden City movement philosophy which influenced Burley-Griffin's idea for Canberra
- ✗ Discourage urban sprawl through the use of development controls for example mandating car limits or car free developments, public transport provisions etc.

Public Transport

- ✗ Pursue future stages of Capital Metro as outlined in the Light Rail Master Plan, where the demand and business case are suitable.

Low Emissions Vehicles

- ✗ Develop a network of fast charging stations for electric and plug in hybrid vehicles, including dedicated EV car parking bays.
- ✗ Transition public transport fleet to lower emission alternatives

C+1

- ✗ Collaborate with NSW and regional councils in the C+1 to establish low emission options for regional connectivity and urban planning to avoid emissions leakage (into or out of the ACT)

4.5 Towards 2050

As the ACT moves beyond 2030, there is significant opportunity to achieve beyond the bare minimum required to achieve the Carbon Neutral Scenario by 2050. Whilst early adoption and achievement of mode share and market penetration targets are the key to achieving the potential reductions identified in the *Leading Edge* scenario. To achieve this, development and implementation of progressive policies and programs, as well as regular monitoring, evaluation and updating of tactical plans at relatively short intervals, for example every third year, would be required.. This section provides some additional examples of strategic options which could be implemented following achievement of near and or mid-term targets.

4.5.1 Easy Wins

Regulations, Standards and Specifications

- X Develop sun setting clauses in regulations and/or incentive approaches for the replacement of 'old world' vehicle and transportation technologies, including financial incentives for low income households such as 'Cash for internal combustion engine car' schemes

Innovation and Emerging Technologies

- Continue to consider implications and actions to future proof transport infrastructure including the potential needs associated with increasing levels of autonomy in vehicles, such as:
 - § Dedicated autonomous vehicle lanes and/or routes
 - § IT / communications and power requirements for autonomous and vehicle to grid technologies;
 - § Emergency response training, approaches and tools
 - § Distributed 'refuelling' infrastructure, including home and workplace electric network upgrades for electric vehicles

4.5.2 Investment

Public Transport

- Commence permanent 'mobility on demand' bus services, based on autonomous vehicles

Low Emissions Vehicles

- X Transition public transport fleet to non-emission / carbon neutral alternatives
- X Mandate phasing out of non-electric powered and poorer efficiency commercial and industrial vehicles
- X Consider implications of how emerging technologies may inadvertently promote increased travel and conflict with efforts to displace personal motorised transport with active and public transport
- X As technology advances, adopt public infrastructure which results in the application of efficient methods of transmitting, storing, powering and refuelling low emissions vehicles of all types:
 - § High efficiency conductors
 - § Superconductors
 - § Maglev technologies

4.6 Emerging Technologies and Developments

Whilst disruptive technologies and developments frequently appear unexpectedly and have dramatic consequence on the normal conditions, they can usually be addressed through adaptive management practices and from 'keeping a watching brief' as it noted in the LEVS. Whilst it is unlikely that the strategy will be able to develop detailed actions around these areas, it is suggested that the strategy is agile; with 'keep a watching brief' actions for disruptive technologies and events assigned. It is also recommended that consideration of regular monitoring, review and update is embedded into the process.

During the workshop, participants were asked to identify what potential emerging technologies could fundamentally impact on the low carbon future proposed for the Territory. These included:

- Autonomous vehicles
- Vehicle to grid technologies
- Fuel cell vehicles
- Changes in the availability of alternate fuels, including fuel cell vehicles, synthesized diesel and waste to fuel
- Sustained low oil prices
- Digital disruption, revolution and/or infrastructure roll out stagnation.
- Enhanced teleworking services, including virtual reality 'meetings'

For a full listing of the potentially disruptive innovations identified during the workshop, see Appendix A.

4.7 Summary of Options

The following table summarises the options presented in this Chapter.

Options	Technical	Regulatory	Education	Planning	Economic
Leadership					
✗ Engage with, and support, peak bodies (AustRoads, Australian Bicycle Council, etc.) to develop and update national strategies aimed at encouraging sustainable transport, such as the National Cycling Strategy	ü			ü	
✗ Work with fleet provider(s) to progressively increase the offering electric vehicles available for government fleet leasing within the options available.	ü				
✗ Advocate faster roll out of the high speed broadband services and continued improvements in speed and reliability.	ü				
✗ Support research, development and demonstration of urban planning and non-motorised transport approaches to avoiding emissions	ü			ü	
✗ Work with Commonwealth government agencies to displace hydrocarbon fuelled Government Vehicles with electric vehicles.	ü				
✗ Embed in decision making processes a requirement to consider non-asset and/or non-car/truck solutions when evaluating transport planning options for the movement of people and goods				ü	
✗ Work with ICT providers to identify and address gaps in broad band availability, quality and reliability, particularly in areas with poor public transport access level as an enabler of teleworking	ü				
Regulations, Standards and Specifications					
✗ Develop infrastructure to support the continued uptake of more efficient modes of passenger transport such as electric vehicles, motorbikes and scooters, including adoption of priority lanes and parking areas				ü	
✗ Embed fuel efficiency considerations as part of the design, alignment and speed limiting of new road infrastructure				ü	

Options	Technical	Regulatory	Education	Planning	Economic
<p>X Manage congestion through the use of operational improvements including:</p> <ul style="list-style-type: none"> • Geometric and design changes • Access management • ITS (Intelligent Transport Systems) • Traffic signalisation 	ü				
<p>Review and update ACT Design Standards and Planning Guidelines to promote further uptake of, and accessibility to, public and active transport for infrastructure projects and urban development (for example consider alignment with Cycling Aspects of AustRoads Guides)</p>		ü		ü	
<p>X Incentivise existing fuel retailers to install natural gas, B20 / B100 biodiesel and ethanol (E10 / E85) pumps for retail sale</p>	ü	ü			ü
<p>X Mandate natural gas, biodiesel and/or ethanol sales targets</p>	ü	ü			ü
<p>X Update definition for low emissions vehicles based on improvements in vehicle efficiency and introduce regular review of the definition of low emission vehicle</p>	ü	ü			
<p>Introduce congestion pricing and/or distance based road pricing mechanisms to promote mode shift</p>					ü
<p>X Develop sun setting clauses in regulations and/or incentive approaches for the replacement of 'old world' vehicle and transportation technologies, including financial incentives for low income households such as 'Cash for internal combustion engine car' schemes</p>	ü	ü			
Data Capture, Monitoring and Evaluation					
<p>Use Transport for Canberra Snapshot approach to monitor and report on progress towards meeting targets for public and active transport</p>			ü		
<p>X Collect emissions data and standards information for heavy vehicles, plant and equipment used in major projects to identify opportunities for influencing private investment in lower emissions plant and heavy vehicles</p>	ü			ü	ü
<p>X Continue to monitor and report on progress towards meeting emission reduction targets for the transportation sector</p>			ü		

Options	Technical	Regulatory	Education	Planning	Economic
Develop comprehensive monitoring and evaluation program to review the effectiveness of strategic options implemented and actively manage strategies which are underperforming and need sunseting or revising.		ü	ü	ü	ü
Use outcomes of previous monitoring and evaluation to update Strategies and Plans to respond to changes in technology, planning and the transportation requirements of the ACT Community.	ü	ü	ü	ü	ü
Procurement and Purchasing					
X Specify requirement for low emissions and/or higher environmental performance standards for buses, plant, equipment and vehicles used by ACT Government for major ACT Government funded construction projects.	ü				
- Develop a framework for Forward Commitment Procurement				ü	
Adopt IT solutions which displace the need for travel (Skype for Business, video conferencing etc.)	ü				
X Continue to consider alternate fuel options as part of procurement decisions and trial/implement for bus fleet replacement	ü				ü
X Use fuel consumption data for buses to identify vehicles in need of maintenance and/or replacement	ü				
X Work with the supply chain to address perceived barriers relating to voiding of warranties for vehicles, plant and equipment that use biofuels	ü		ü		
X Conduct market sounding with the retail fuels sector to understand barriers preventing the availability of alternate fuels	ü		ü		
X Facilitate market sounding to identify opportunities to expand bicycle courier/ home delivery services into new markets and new areas			ü	ü	

Options	Technical	Regulatory	Education	Planning	Economic
Education and Awareness					
- Adopt community based social marketing approaches during development of education and awareness raising programs to support behaviour change; including identification of barriers to increased uptake; selecting strategies and approaches to address the actual and perceived barriers and regular monitoring and evaluation.			ü		
- Continue to use traditional and social media to increase the awareness of programs with the community.			ü		
✗ Develop education programs which identify bicycle highways which are designed for commuter cyclists who travel at speed, from casual users who might be intimidated by the speed of seasoned commuters.			ü		
✗ Continue to promote behaviour change programs with the community and schools, which encourage and support the use of public transport services	ü		ü		
✗ Support eco driver training programs for staff, especially those who drive commercial vehicles and plant operators.			ü		
✗ Look for opportunities to grow the service offered by the ACT Government Active Transport Office, including through	ü		ü	ü	
· Supporting car free days					
· TravelSmart (travel planning programs)					
· Bicycle education programs in schools					
Urban Planning					
- Continue to pursue integrated transport planning as part of updates to Planning Strategies				ü	
✗ Encourage densification and urban infill development and regeneration activities within a 2 km radius of major employment centres and transport nodes to enhance the walkability, access to public transport and or cycling				ü	
✗ Set maximum car parking service ratios, minimum bicycle parking service ratios and end of trip facilities for new developments and major refurbishments for commercial and industrial buildings	ü	ü		ü	

Options	Technical	Regulatory	Education	Planning	Economic
Future proof transport infrastructure by selecting and designing infrastructure (including road corridors) which can adapt or respond to the changes in the use (roads which become light rail or bus rapid transit routes)	ü			ü	
✗ Adopt Planning Requirements which support transit orientated and '20 minute neighbourhood' urban planning opportunities for new developments, building on the Garden City movement philosophy which influenced Burley-Griffin's idea for Canberra				ü	
✗ Discourage urban sprawl through the use of development controls for example mandating car limits or car free developments, public transport provisions etc.		ü		ü	
✗ Set maximum car parking service ratios, minimum bicycle parking service ratios and end of trip facilities for new developments and major refurbishments for commercial and industrial buildings		ü	ü	ü	
Avoided Journeys					
- Promote flexible work arrangement for ACT Public Servants including opportunities for :					
✗ Teleworking (working from home) for Government employees [refer to the IP Australia case study in Section 6.1]	ü				
✗ Condensed work weeks, where staff work 4 day weeks and/or 9 day fortnights by working longer hours on their days in the 'office'; or				ü	
✗ Staggered start and finish times and or off peak work hours, avoiding peak periods for road and cycleway users.				ü	
Active Transport					
✗ Provide end of trip facilities for staff that cycle and or walk to work at all State Government Offices in line with best practice guidelines, such as the Sustainable Transport credits of the GreenStar rating scheme.	ü				
✗ Conduct a CPTED Audit of main pedestrian and cyclist paths and implement corrective action where required.	ü			ü	
✗ Engage with cyclist groups such as Bicycle Users Groups to identify gaps and areas for improvement in the continuity and connectedness of the shared path network.	ü		ü		

Options	Technical	Regulatory	Education	Planning	Economic
Public Transport					
X Provide carbon neutral and public transport options for staff to use for work related travel (bike fleet, cars, MyWay).	ü		ü		
Enhance public transport infrastructure (shelters, buses) and level of service (frequency and accessibility, including for passengers who need assistance), particularly to areas with low public transport accessibility through a fully integrated transport network.	ü				ü
Work towards equitable access to public transport solutions for all residents of the ACT	ü			ü	ü
X Commence program to increase the capacity diversity of bus fleet including community and flexible bus services	ü				ü
X Trial 'mobility on demand' bus services which are responsive to passenger demand rather than based on set routes, particularly to areas where dead running (service with no passengers) is high.	ü			ü	ü
X Provide free public transport for all ACT Government permanent employees.			ü		ü
Commence permanent 'mobility on demand' bus services, based on autonomous vehicles	ü			ü	
X Pursue future stages of Capital Metro as outlined in the Light Rail Master Plan, where the demand and business case are suitable.	ü		ü	ü	ü
Low Emissions Vehicles					
X Incentivise flexi fuel and alternate fuel conversions for existing vehicles	ü				ü
X Incentivise early adoption of sustainability sourced renewable fuelled and electric vehicles.	ü				ü
X Trial fast charging stations for electric and plug in hybrid vehicles (including bikes, which have recently been introduced) at government facilities, including dedicated EV car parking bays.	ü				ü

Options	Technical	Regulatory	Education	Planning	Economic
X Develop a network of fast charging stations for electric and plug in hybrid vehicles, including dedicated EV car parking bays.	ü				
X Transition public transport fleet to lower emission alternatives	ü		ü		ü
X Transition public transport fleet to non-emission / carbon neutral alternatives	ü		ü		
X Consider implications of how emerging technologies may inadvertently promote increased travel and conflict with efforts to displace personal motorised transport with active and public transport	ü	ü	ü	ü	ü
X As technology advances, adopt public infrastructure which results in the application of efficient methods of transmitting, storing, powering and refuelling low emissions vehicles of all types: <ul style="list-style-type: none"> · High efficiency conductors · Superconductors · Maglev technologies 	ü	ü	ü	ü	ü
C+1 (Canberra plus one hour; cross border)					
Continue to engage with State and Commonwealth governments and passenger rail developers, including potential High Speed Rail proponents to capitalise opportunities for cross border and commuter movement between Sydney and Melbourne.	ü	ü		ü	ü
X In conjunction with engagement associated with High Speed Rail, commence planning for interconnection between potential High Speed Rail Station at Canberra Airport with light rail services and potential for servicing the broader Airport precinct, including Pialligo.	ü	ü		ü	ü
X Partner with key stakeholders to develop an 'electric highway' with fast electric vehicle charging stations available for travellers (refer to the Electric Highway case study in Section 6.5	ü		ü	ü	
Maintain and enhance freight rail infrastructure and services, including pursuing opportunities for private investment in new and upgraded services	ü		ü	ü	

Options	Technical	Regulatory	Education	Planning	Economic
X Collaborate with NSW and regional councils in the C+1 to establish low emission options for regional connectivity and urban planning to avoid emissions leakage (into or out of the ACT)	ü		ü	ü	
Vehicle Fuel Efficiency					
- Continue participation in the Ministerial Forum on Vehicle Efficiency and, Council of Australian Governments and other inter-jurisdictional activities which are focused on regulating vehicle emission standards.		ü	ü		
Innovation and Emerging Technologies					
- Track the Legislative, Regulatory and Design Standard changes that would be required to respond to emerging autonomous vehicle technologies and levels of autonomy	ü	ü	ü		
X Develop relationships with the autonomous vehicle industry to enhance understanding of how infrastructure will need to respond to the requirements of these vehicles, including new communication infrastructure requirements.	ü				
<p>- Continue to consider implications and actions to future proof transport infrastructure including the potential needs associated with increasing levels of autonomy in vehicles, such as:</p> <ul style="list-style-type: none"> · Dedicated autonomous vehicle lanes and/or routes · IT / communications and power requirements for autonomous and vehicle to grid technologies; · Emergency response training, approaches and tools · Distributed 'refuelling' infrastructure, including home and workplace electric network upgrades for electric vehicles 	ü	ü	ü	ü	ü

5.0 Abatement Cost

Little marginal abatement cost data is publically available for the range of options presented in this report. Much of the Marginal Abatement Cost Curve (MACC) work undertaken has focused on engine and fuel efficiency improvements which have the greatest potential for emission reductions.

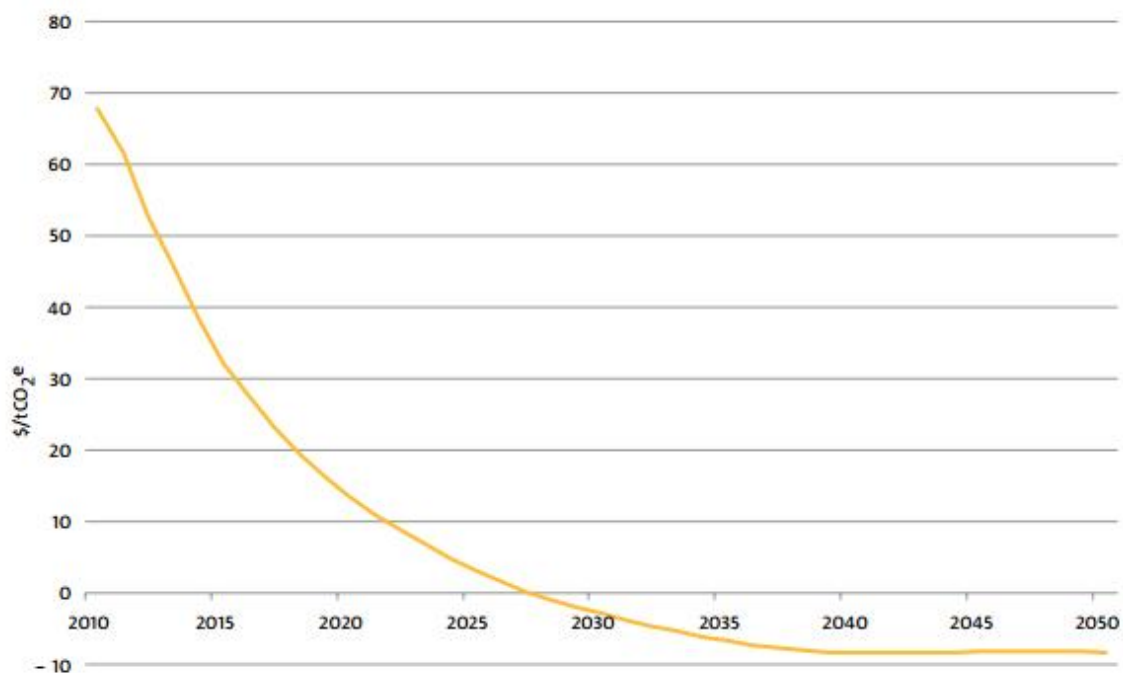
Using MACC methodology, marginal abatement costs for a number of the options proposed in Section 4.0 are presented in Table 17 based on publically available capital and operational cost data for ACTION buses, Capital Metro, CBD and SE Light Rail and manufacturer data).

Table 17 Marginal abatement cost for selected options

Option	Marginal abatement cost (\$/T CO ₂ -e)
mode shift to walk	-\$3,837
mode shift to public transport	-\$2,992
Bus services	\$53
LRT not replacing rapid route service	\$101
LRT replacing rapid route service	\$132
Private EV	\$1,256

It is unsurprising that mode shift from private vehicle trips to active and public transport have positive marginal abatement costs. Whilst electric vehicles currently have a high marginal abatement cost, significant cost reductions are expected with cost neutrality occurring around 2027. It is likely that factors which influence the trend for EVs will also influence other electric based modes, including LRT.

Figure 20 Abatement cost trend of electric vehicles (ARRB, BITRE and CSIRO, 2012)



6.0 International Policy Approaches and Case Studies

In this section, the report explores a range of international policy approaches and actions which align with the strategic options identified.

6.1 Policy Approaches

Across the globe, numerous jurisdictions are considering the policy responses required to decarbonise their transport sectors. This section highlights a number of key examples which are used to illustrate four priority areas

- Public transport
- Displacement of single occupant journeys
- Net zero emission vehicle technologies
- Infrastructure and urban planning

Jurisdiction	Policy Area	Here and now	Future Considerations
Norway	Electric vehicle penetration	<ul style="list-style-type: none"> • Financial incentives at point of purchase, and throughout the life of the vehicle including exemptions from road user (toll) and parking charges. • Access to bus lanes to avoid congestion. • Electric vehicle car sharing schemes 	<ul style="list-style-type: none"> • Ban on sale of fossil fuel vehicles by 2025
Selected UK Localities participating in Ultra Low City Scheme	Electric vehicle penetration	<ul style="list-style-type: none"> • Access to bus lanes • Public recharging locations (dual purpose street lights and electric highways) • Renewable powered park and ride facilities • Dedicated and free parking • Support for businesses to 'road test' vehicles for suitability 	
Paris	Sustainable Transport	<ul style="list-style-type: none"> • Annual car free day • Enhancements to active and public transport services and infrastructure • Electric vehicle and bike sharing schemes • Electric vehicle fleet • Financial incentives for replacing taxi fleet with low emission alternatives, purchase of bicycles and electric scooters and for giving up vehicles in favour of car share and public transport • Pedestrian only zones • Promotion of non-motorised transport for delivery of goods • Changes to speed limits to create walk friendly zones 	<ul style="list-style-type: none"> • Monthly car free days • Ban on diesel vehicles • Significant increase in investment in new cycleways. • Creation of new pedestrian only zones

Jurisdiction	Policy Area	Here and now	Future Considerations
Brazil	Wheelchair Bus Services	<ul style="list-style-type: none"> Dedicated low emission minibus fleet and services designed to enable mobility impaired passengers to access bus services Bus rapid transit services to meet commuter demand as well as servicing international airport New cycle ways and community bike racks Pedestrian only streets Elimination of minimum parking requirements and establishment of maximum parking levels 	<ul style="list-style-type: none"> Extension to cycle network Public transport accessibility target (60% of residents to have access) Integrated urban planning
India (Chennai)	Adoption of non-motorised transport	<ul style="list-style-type: none"> Dominant share of transport funding allocated to non-motorised transport projects 	

6.2 Case Studies

6.2.1 Teleworking Case Study – IP Australia

In response to rising staff turnover rates amongst Patent Examiners, particularly those with between three and five years' experience, IP Australia evaluated the causes of high turnover and identified that many of the Patent Examiners had relocated to commence working with IP Australia and subsequently left to return to home (or the location where they were educated).

In response, IP Australia introduced teleworking options and as a result approximately 12% of the Patent and Trade Mark Examiner workforce moved to one of the outposted or home based options. As a result of the move, turnover rates reduced, productivity increased and there were significant cost reductions for the agency (APSC, 2015).

Relevance to the ACT: Both the outpost model, whereby satellite offices are established in town centres outside of the city, and the home based work options offer the potential for reducing the number of trips to work required by staff.

6.2.2 Fleet Monitoring Case Study -Efficiency improvements fleet operations

Linfox is one of Australia's largest logistics and trucking providers and an early adopter of energy efficient practices in its operations. Since 2007, they have measured the energy intensity of their service delivery and have cut greenhouse emissions by 46.5% on 2006/7 levels by 2015. Their strategy has focused on:

- Considering and selecting low emission standard vehicles and tyre technologies during procurement
- Improvements in vehicle aerodynamics
- Driver education, resulting in 14% fuel efficiency improvements
- Data collection and analysis

In 2016, LinFox used simulation and analytics to scenarios to simulate trucking operations and assess the robustness of schedules against a range of performance indicators such as on-time delivery. Running on a personal desktop computer without special hardware, the system features a simulation engine, a results analytics platform and a scenario visualizer. The visualizer produces 3D animations of loading operations at distribution centres, and of trucks traveling across the network and unloading at customer delivery locations (LinFox, 2014; AECOM, 2016b)

Relevance to the ACT: The ACT manages a diverse fleet of passenger and commercial vehicles, including buses. Through implementing a range of data collection, analysis and improvement initiatives there is the potential for reductions in direct emissions.

6.2.3 Workplace bike fleets case study – City of Sydney

The City of Sydney established a fleet of 27 bikes, including bikes suitable for use for carrying cargo at a number of its facilities. Fitted with odometers, the City has been able to track the use of the fleet bikes, with almost 10,000 km being recorded in the first two years.

To support the program, potential fleet bike users completed an induction/training prior to being able to use fleet bikes. Monthly lunchtime rides are also held, to assist inexperienced city riders gain confidence and identify preferred routes within 30 minutes cycle distance, which are also promoted to all staff via a staff travel guide.

In addition to the bike fleet, 150 bike parking spaces at a dedicated end of trip facility known as PitStop, which is used by ~100 staff each day. PitStop is also used widely by non-riding council staff, who use it after exercise or walking to work.

Relevance to the ACT: The ACT has well established cycleways and good participation rates. However, the need for more and better end of trip facilities for cyclists, including government employees should be an area of priority.

6.2.4 Forward Commitment Procurement and Fleet Sizing Case Study - Low carbon mini bus services

In 2015, the Birmingham (UK) City Council conducted a market sounding process to support its plan to provide a low carbon mini-bus service to provide greater accessibility for clients of their Adult and Communities Services. During the planning phase of the procurement, it was identified by Council that there were no low or zero carbon options available on the market which would meet their needs.

A Nissan Leaf EV was trialled for a six month project and enabled the Council to collect data to support future procurement decisions. From the trial, the council reports at 70% reduction in cost compared to comparable diesel vehicles.

Building on their experience of the Leaf, and concurrent small electric van trial, the Council developed a clear service specification which was used as part of the discussions for the market sounding and the Prospectus was sent to potential mini-bus suppliers.

At the time (2015), the Council was able to gain a greater understanding of the proposed future development of low emission mini-buses, but was unable to find a suitable vehicle on the market but was intending to use the outcome of the study to stimulate market transformation.

Relevance to the ACT: Constraints around EV availability through the Government's fleet vehicle provider (SG Fleet) and more broadly through vehicle dealerships is likely to impact the short term penetration of EV in the ACT vehicle base. The Government is a significant fleet purchaser; based on a three year lease life approximately 500 vehicles per year are procured and could be used to stimulate the market to make EVs more widely available by demonstrating a committed demand.

6.2.5 Electric Highway case study – Royal Automobile Club of WA

The Royal Automobile Club of WA (RACWA) and local governments partnered to establish a network of rapid charging stations for electric vehicles providing the sites.

One of the key aims for the Electric Highway was to increase the Uptake of Electric Passenger Vehicles– approximate 125 are known to be registered in WA as of 2015.

The initial infrastructure was funded by the RACWA, with the charging stations being owned and maintained by the local government.

Driver management, including payment for the charging service is managed using cloud based software which is provided by the infrastructure manufacturer. Free charging throughout the network was provided by the RACWA during the first six months (to 31 March 2016).

To support the project, the RACWA have also established a website with educational information about EVs, the technology behind EVs, links to EV driver forums and tips on eco driving.



Figure 21 Electric Highway (source: electrichighway.rac.com.au)

Relevance to the ACT: The ACT has a number of desirable characteristics which would make it suitable for higher penetration of electric vehicles. An electric highway could be established with charging stations located along major roads (for example Federal, Barton and Monaro Highways or Canberra Avenue) providing connectivity throughout the Territory.

6.2.6 Mandating biofuel targets case study – NSW *Biofuels Act*

Several jurisdictions have introduced mandates which require set percentages of all fuel sold by wholesalers and major retailers to be biofuels. Biodiesel can be used as blended or unblended fuel in diesel engines, whereas ethanol can be used as a blended fuel in petrol engines and up to 85% ethanol in flex-fuel vehicles.

In New South Wales, biofuel mandates are established under the *Biofuels Act 2007*.

The effectiveness of this legislation in relation to ethanol was reviewed in 2015 (IPART, 2015). On the consumer side, the review noted that there was resistance by consumers to purchasing ethanol blended fuel, with a significant proportion of consumers paying the premium to purchase ethanol free premium unleaded. The review also identified that it did not deliver value for consumers, given that the pricing of E10 was such that the cost saving did not offset the increased fuel consumption associated with the lower energy density.

The review found that the Act as drafted was ineffective at achieving the objective, and the exemption rules made it possible for non-compliance with the Act to be acceptable. Detailed cost benefit analysis for a range of options to address the barriers to achieving the target by 2024-25, found that few actions were likely to deliver a positive net cost benefit. The review recommended:

- Consumer education and converting government vehicles to flex-fuels
- Broaden the scope to either capture all retail and wholesale providers, require ethanol in all petrol
- Regulate price to ensure competitiveness, including diversifying the producer base (currently dominated by a single ethanol producer)
- Amend the definition of E10 to increase the minimum ethanol content from 9% to 9.5%

The application of biofuels for heavy vehicles has also been reviewed in the context of both NSW and Victorian situations and is available at

<http://www.rms.nsw.gov.au/documents/about/environment/air/case-study-biodiesel.pdf>

Relevance to the ACT: Whilst ethanol is available in the ACT, retail supply of biodiesel has significantly contracted. Consumers who purchased diesel vehicles in preference to petrol models with the intention of using biodiesel would have reverted to mineral diesel as a result of lack of supply. Plugin hybrids which typically rely on hydrocarbon based fuels for approximately 20% of their drivetime, are likely to form a considerable share of the passenger vehicle market and the mandating of biofuels can assist in reducing the emissions from these fuels.

7.0 Conclusions

For the ACT to achieve its emission reduction targets, a significant program of policies, programs and actions would be needed to facilitate the transition to a decarbonised Transport sector. This study has investigated a range of potential pathways to identify how the ACT might achieve carbon neutrality by 2050. The study has identified that to achieve the commitment, a considerable number of vehicle trips would need to be made using low emission vehicle technologies, on carbon neutral public transport and/or avoided.

One potential pathway is to consider the adoption of increasingly aggressive targets for mode share, avoided journeys and electric vehicles, for example through adopting the *Leading Edge* scenario as the chosen pathway which influences the nature and timing of the new policies, programs and actions.

To achieve the outcomes identified under the *Leading Edge* scenario, policy responses should focus on four key areas in the near to mid-term:

- Increasing public transport mode share through addressing inequity in levels of service and accessibility through:
 - Developing tactical plans to improve public transport accessibility and service levels.
 - Progress public transport solutions which cater for both high capacity commuter services such as Capital Metro and lower capacity movements, such as on-demand services, between strategic centres.
 - Provide for all weather (dry and shade) stops and termini for interchanges and on rapid and frequent service routes.
 - Continue to promote behaviour change programs with the community and schools, which encourage and support the use of public transport services.
 - Consider community based social marketing approaches during development of new and upgraded education and awareness raising programs to support behaviour change; including identification of barriers to increased uptake; selecting strategies and approaches to address the actual and perceived barriers and regular monitoring and evaluation.
- Encouraging the displacement of single occupant journeys including working from home and car pooling by:
 - Promote flexible work arrangement for ACT Public Servants.
 - Adopt IT solutions which displace the need for travel (Skype for Business, video conferencing etc.) for ACT Government agencies.
 - Work with ICT providers to identify and address gaps in broad band availability, quality and reliability, particularly in areas with poor public transport access level as an enabler of teleworking.
 - Advocate faster roll out of the high speed broadband services and continued improvements in speed and reliability.
 - Mandate the establishment of dedicated car pool lanes and parking as part of changes to infrastructure and urban development guidelines.
- Encouraging the early adoption of net zero emission vehicles by;
 - Develop and adopt Forward Commitment Procurement approaches to promote market transformation by mandating low emission and ultimately net zero emission plant and equipment for major ACT Government funded construction projects.
 - Transition public transport fleet to lower emission alternatives and ACT heavy duty fleet (plant, equipment) and vehicles used by ACT Government to net zero emissions technologies, noting this may require an upgrade to electrical grid and other infrastructure.

- Develop sunset clauses in regulations and/or incentive approaches for the replacement of 'old world' vehicle and transportation technologies for both commercial and passenger vehicles, including financial incentives for low income households such as 'Cash for internal combustion engine car' schemes.
- Identify industry support mechanisms to assist hydrocarbon fuel sector transition in response to the adoption of net zero emission vehicles.
- Develop relationships with the autonomous vehicle industry to enhance understanding of how infrastructure will need to respond to the requirements of these vehicles, including new communication infrastructure requirements.
- Incentivise flexi fuel and alternate fuel conversions for existing vehicles.
- Incentivise early adoption of sustainability sourced renewable fuelled and electric vehicles.
- Develop a network of fast charging stations for electric and plug in hybrid vehicles, including dedicated EV car parking bays.
- Influencing capital works programs and urban planning to facilitate active transport and avoided journeys for both new and existing communities.
 - Continue to pursue integrated transport planning as part of updates to Planning Strategies
 - Encourage densification and urban infill development and regeneration activities within a 2 km radius of major employment centres and transport nodes to enhance the walkability, access to public transport and or cycling
 - Set maximum car parking service ratios, minimum bicycle parking service ratios and end of trip facilities for new developments and major refurbishments for commercial and industrial buildings
 - Future proof transport infrastructure by selecting and designing infrastructure (including road corridors) which can adapt or respond to the changes in the use (roads which become light rail or bus rapid transit routes)
 - Adopt Planning Requirements which support transit orientated and '20 minute neighbourhood' urban planning opportunities for new developments, building on the Garden City movement philosophy which influenced Burley-Griffin's idea for Canberra
 - Discourage urban sprawl through the use of development controls for example mandating car limits or car free developments, public transport provisions etc.
 - Review and update ACT Design Standards and Planning Guidelines to promote further uptake of, and accessibility to, public and active transport for infrastructure projects and urban development (for example consider alignment with Cycling Aspects of AustRoads Guides)

Whilst the scenarios are based on defined mode share targets for public and active transport, in reality, any combination of these which result in cumulative percentage of previously vehicle based journeys being replaced by a new zero emissions mode would achieve the desired targets.

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Appendix A

Workshop Output

Identification and Prioritisation of Options Workshop

A 3 hour workshop was held on 29 July to evaluate the options presented as part of an Issues Paper (which follows this summary of options) with the goal of ground truthing the potential for the options to be additional and complementary to ACT and Commonwealth government reduction strategies and to identify the priority initiatives to progress through to the portfolio development phase.

Participants were asked as groups to respond to the following key questions:

- What additional actions can be started by to help ACT achieve the medium term targets by 2040?
- Getting to the End Game 2050: How low can the ACT go?

Each table / group was assigned a theme and asked to review and discuss what options presented have the greatest potential to help the ACT achieve the mid-term target of 40% reduction. The themes are

- Avoid
- Reduce
- Switch

As a third question, the groups were also asked to identify what existing programs could be used to achieve the targets.

This report summarises the options identified in the workshop, which informed the Scenarios and Options presented in the Final Report.

Invited Participants

Peta Olesen	Kerry Bell
Tim Wyatt	Satinder Sahota
Ben Essery	Antonio Mozqueira
Vanessa Morris	Heather Cook
Alison Moore	Ian McGlenn
Melanie Pill	Richard Horton
Anna Gurnhill	Nicola Plunkett-Cole
Jenny Dibley	Marcus Sainsbury
Petra Oswald	Tom Percival
James Lachlan	Glenn Dougall
Sean Das	Katrina O'Mara
Alexander Konovalov	Brendan Hogan
Trish Campbell	

The following sections capture the outcomes of the workshop and the prioritisations identified by participants.

What can be done to avoid generating emissions in the transport sector?

Pursuing opportunities to avoid emissions typically provides the greatest potential for reducing carbon emissions. Whilst there will always be a need for people and goods to be transported, there are opportunities for some of this movement to be facilitated using non-motorised methods. Many of the potential initiatives presented below are being pursued by the ACT Government, and as a result, the focus is on expanding and improving service levels

Priority Actions
Public service milestones / KPI's for active travel r switch
Planning for flexible work start finished (avoid 9-5 requirement)
Work hubs which support working from home / out of office
Invest in behaviour change
Ongoing education needs To be one of the first considerations in any new program – driving test
Better end of trip facilities – promotes active travel
Other potential actions
Target particular demographics
24/7 shifts approach in hot desking
Education and promotion in schools
Use novated leases better for sustainable outcomes
Concessions for household providing charging stations
Telecommute
Possible government incentives
Localised hot desking in town centres
Land release initiatives
Better facilitates about VC
Activity base workers
Continued improvements on active travel and public transport policy incentives and disincentives
Do more bike access Canberra Cosmopolitan building Hot desking and Woden

What can be done to reduce the emissions where motorised travel is required?

It is unrealistic to assume that in the next 35 years that the need for motorised travel will be alleviated. Globalisation and the fossil fuel age have capitalised on the mobility of people and goods in such a way that the need (and desire) for travel to distant locations is unlikely to abate. With this in mind, consideration should be given to ways in which the emissions intensity (typically grams of carbon dioxide equivalent per kilometre) can be reduced.

Priority Actions
Improve public transport experience <ul style="list-style-type: none"> Shelters Buses Timing (schedule)
More flexible bus fleet Smaller busses for non-peak periods
Network enhancements ITS efficiency <ul style="list-style-type: none"> Smart parking Demand management / response Buses review how drivers drive Learner driver education
Street design to accommodate more efficient buses Coordination across planning and procurement
Driver behaviour / education to promote energy efficient driving
EVs as an option for Salary packaging (preferred option)
Higher taxes for fuel inefficient vehicles
Incubator for transport ideas <ul style="list-style-type: none"> Regulation Technology Knowledge economy
Continue to expand public transport to major events
Environment stickers (traffic light coloured) certain colours not allowed in certain areas
Others potential actions
How can tenancy arrangement support
Operational ability / support <ul style="list-style-type: none"> Work from home Car share Laptop availability
Use lever we have to influence Commonwealth <ul style="list-style-type: none"> National road map EVs Look at luxury car tax Use rego incentives
New transport investments <ul style="list-style-type: none"> Integrating across travel smart / other policy Learn from iron ore / coal sector
Economic Opportunities <ul style="list-style-type: none"> Cycle culture End of trip facilities
Autonomous vehicles and buses

Priority Actions
Logical placement of transport infrastructure <ul style="list-style-type: none">· Dual purpose facilities (i.e. car park at Stadium to double as park and ride)
<ul style="list-style-type: none">· Issues of internal re-assessment of public transport sources / plan for up to 3 years, forward looking plan updated annually
Toll for City Centre
Reduced speed limits for buses
Traffic optimisation data (ITS into practice)
Promote grade separation better efficiency for both modes
Park and ride
Incentives for service fleets to improve sustainability (preventative maintenance)

What can be done to use alternate modes and fuels which produce fewer emissions?

The aim of these 'switch' strategies is to promote the uptake of lower emission modes of travel and vehicles. Public transport and alternate fuels are the cornerstone of these strategies, although opportunities for the movement of goods is also required in order to achieve emissions reduction targets.

Priority Actions
Move away from designing city for cars as first consideration
Use govt workforce (>40% of ACT employment) <ul style="list-style-type: none"> · Incentives for mode shift
Internal communications – no one knows that Uber can be used for work; get involved with car share trial
Understand the barrier as to why people don't avoid, reduce shift now ? will these reasons change?
How do we need to fitout a building for mode shift? <ul style="list-style-type: none"> · Desk · Storage · End of trip facilities · Incentives
End of trip facilities need to improve
EVs (buses and cars – battery storage)
Consider non commuter peaks(retail school)
Electric bus <ul style="list-style-type: none"> · infrastructure · Free city loop, introduce an alternative · Buses; small percentage overall large to ACT
EVs for ACT government vehicles <ul style="list-style-type: none"> · EV car spots – better connection to policy
Other potential actions
Star ratings for cars, especially the used car market
Identify barriers (physical and behavioural)
Explore 'on demand' bus or vehicle services
Provide for feedback on experience of active travel (e.g. Bunda St)
Make parking super expensive; make public transport cheap for public service (my way card), but also a requirement like Police in SA
Identify who is leading the way (Norway and California) and model
Awareness raising (health benefits)
Mid trip facilities
Good interchanges (park and ride and bike or ride)
Thinking on demand responsive transport
Multimode / sector connection friendly timetables – linked trips
Fuel cell etc. buses with diverse fleet passenger size
Incentives – pricing of transport; car registration etc. what works?
Bike sharing

Priority Actions
Perverse outcomes; i.e. financial incentives may lead to increased car ownership
Analyse and target park and risk (e.g. Canberra Stadium complex)
Tax free bikes (bikes, lights, rain gear)
Ticket scheme
Tax incentives <ul style="list-style-type: none"> · Green vehicle rego scheme · work in retailers stickers / into education · - 3 phase power to houses
How do travel needs differ between weekday and weekends and seasons?
It all starts from here <ul style="list-style-type: none"> · How do we ensure home life supports influence behaviour · Design, planning

What are the disruptive and emerging ideas that could assist getting to carbon neutrality in 2050

Priority Actions
De-centralised multi-directorate work hubs in each T.C.
Telepathy / virtual meeting rooms
Solar powered EVs (straight from a solar panel)
Sense of community, landscaping thoroughfare - trees / water
New State – no one at work (all computer / robots), everyone has free time, singularity + 30 printing
Hydrogen fuel cell
Build on knowledge economy
Satellite offices (decentralise)
Algae fuel / hydrogen fuel for aviation
Change of vehicles – e-bike (plexi-glass cover)
Virtual reality
Change of vehicles
Plexiglass bubble on electric bike
Fully autonomous car-share EV light passenger fleet
Use organic waste to power vehicles
Hover vehicle – road / root other surfaces are innovative (metal filings)
No private vehicles / mass transit
Other Potential Options
Parcel efficiency ad optimal delivery to ascending company ownership
High atmosphere transport for international
Functionality of building and change infrastructure
Health benefits (active travel and ride or walk)

What is the ACT already doing?

Priority Actions
End of Trip facilities
Adjusting parking controls prices town centres
Health, amenity & sustainability
Masterplans for town centres / group centre
Flexible working arrangements – flextime, working from home, hot desk
Some flexible working arrangements
Building comfort / thermal properties
Parking / duty incentives for motorcycles & scooters
Built environment standards / smart

Priority Actions
Sustainable September
Smart parking sensors and licence plate recognition using parking efficiently
Design for accessibility (infrastructure, fleet, operation) has effect of active travel. RTI for buses
Transport – efficiency in operation to reduce running cost and maintenance
Rent a bike – reduce congestion
Other Potential Options
Emails / fax / phones, printing and paper usage and black & white printing
‘Change your mode’ for March Challenge
Locked printing – “follow-me”
Bike fleet EPD
Improved efficiency and resource use of vehicles
Working from home / work life balance. Note benefits and disadvantages
Promote business roll out of smart meters
Healthy you program
JACS ‘Share the road’ campaign
Parking code reviews
Electric bus trial (pending)
More efficient lighting (bus depots)
Centralised office buildings
Next generation solar battery storage roll out