

Reducing carbon emissions at the City of Darwin: an evaluation of battery electric vehicles

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Statement of authorship

I declare this thesis is my own work and has not been submitted in any form for any other degree or diploma at any university or other institute of tertiary education. Information derived from the published and unpublished work of others has been acknowledged in the text and list of references. Information received from the City of Darwin has been used with permission and approval.

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Abbreviations

BEV – battery electric vehicle

CBSM – community-based social marketing

CEO – Chief Executive Officer

CO₂-e – carbon dioxide equivalent

CoD – City of Darwin

COG – Chief Officer's Group

CPRS – carbon pollution reduction scheme

EV – electric vehicle

Gg – gigagram

HEV – hybrid electric vehicle

km – kilometre

Mt – mega tonne

t – tonne

Abstract

The introduction of the Australian Government's *Clean Energy Future Legislation 2011* coupled with community expectation is placing pressure on councils liable under the carbon pricing mechanism (such as the City of Darwin) to reduce its carbon footprint. One carbon mitigation option is to replace fossil-fuel powered passenger fleet vehicles with battery electric vehicles. This thesis makes a contribution to understanding the challenges associated with implementing this activity in the City of Darwin's fleet, and does so from a triple bottom line (financial, environmental and social) perspective. A possible implementation scenario is outlined which includes a three phase program, where the initial phase includes the purchase of a Mitsubishi i-MiEV as an additional fleet vehicle. The second phase suggests procuring three electric vehicles (Nissan Leaf x two and Renault Fluence Z.E.) as a trial. The third phase is a gradual battery electric vehicle roll-out across the passenger fleet. The research reported in this thesis applies three complementary program planning tools (program logic models, the Cynefin Framework and community-based social marketing theory) to the implementation scenario. It is shown that they are methodologically complementary and in combination, could be used to increase the likelihood of success of the implementation scenario. This thesis shows replacing existing fleet passenger vehicles with battery electric vehicles will reduce City of Darwin's carbon footprint while using program planning tools will increase the likelihood of success of vehicle replacement, both from a planning, management and staff behaviour change perspective.

Chapter 1 – Introduction

A key component of the Australian Government's *Clean Energy Future Legislation 2011* was the introduction of a carbon pricing mechanism which placed a price on airborne carbon emissions from July 2012 (Australian Government 2011b; McKenzie-Mohr 2012). This, and community expectation is placing pressure on organisations to take responsibility for their carbon emissions. City of Darwin (CoD) who is liable under the carbon pricing mechanism, is working towards being a leader in climate change policies amongst local government, by exploring different ways of reducing its carbon footprint.

CoD, situated in the Northern Territory, faces potential climate change impacts including storm surge, rising sea levels and increased water temperatures, coupled with greater intensity of weather events such as cyclones (Preston & Jones 2006). CoD recently released its *Climate Change Action Plan 2011-2020* (Darwin City Council 2011)¹ which provides a series of corporate and community actions which it will undertake in order to mitigate and adapt to the potential impacts. The actions are grouped under climate change, water, biodiversity, land, air quality, energy, and waste and recycling topics. The plan identifies performance indicators and aspirational outcomes for each action. The key goals of CoD's plan are:

Action C1 – Develop strategies for Council to reduce its carbon footprint.

Action C2 – Develop best appropriate practice planting strategy to address erosion and habitat conservation and restoration

Action C3 – Advocate for the provision of coastal sea surge buffer zones

Action C4 – Provide input into development proposals in relation to energy efficiency and climate change impacts.

Action C5 – Develop strategic partnerships for climate change initiatives.

Changing motor vehicle fleet composition which results in neutral or low carbon emissions is considered a key mitigation option. Battery electric vehicles offer such an opportunity. This type of mitigation activity has been implemented at other organisations in Darwin, Australia and abroad.

¹ The name change from Darwin City Council to City of Darwin was officially gazetted on 9 August 2012. Therefore, reports prepared prior to this date are referenced as Darwin City Council.

This thesis makes a contribution to understanding the challenges associated with substituting conventional fleet vehicles in the CoD's fleet with battery electric vehicles.

Program planning tools can be used to increase the likelihood of success of a project. The thesis demonstrates how three complementary program tools could be used to support the process of replacing existing passenger fleet vehicles with battery electric vehicles in order to reduce CoD's transport-related carbon emissions. The tools are program logic models, the Cynefin Framework and community-based social marketing theory. The three tools were chosen because of the complementarity of their strengths. Program logic models are used in the initial stage of a project where inputs, activities, outputs and results are mapped with feedback from stakeholders (Cooksy, Gill & Kelly 2001). Once this is clear and agreed to, the Cynefin Framework helps to identify appropriate management techniques for project implementation. The Cynefin Framework is a sense-making framework which aids in exploring and dissecting complex concepts (Snowden 2005). Community-based social marketing theory on the other hand, is centred on identification of barriers to programs and removing them in order to foster environmentally sustainable behaviours (McKenzie-Mohr 2000b).

The thesis first provides relevant context by analysing the current political landscape in regards to climate change action on an international, national and local level. Chapter 3 explores battery electric vehicles and relevant considerations, as an option for reducing CoD's carbon emissions. This option has been selected as it is specified as a feasible action in CoD's *Climate Change Action Plan 2011-2020* but to date no action has been taken. Chapter 4 begins by outlining a possible implementation scenario for introducing battery electric vehicles into the CoD fleet. It then explores the three tools for program implementation. The tools are applied to the possible implementation scenario illustrating how each one can increase the likelihood of success. Chapter 5 offers conclusions and recommendations for the City of Darwin around this strategy.

This thesis makes a contribution to understanding the challenges associated with substituting conventional fleet vehicles in the City of Darwin's fleet with battery electric vehicles, doing so from a triple bottom line (social, environmental and financial) perspective.

Chapter 2 – The need for reducing carbon emissions

2.1 National setting

One of the key barriers to climate change action is the uncertainty of climate change impacts (Heal & Kriström 2002; McMichael, Woodruff & Hales 2006; Millar, Stephenson & Stephens 2007). Some scientists believe the uncertainty will result in greater risk averse policies and may be of future benefit if climate change predictions underestimate future impacts (Quiggin 2008). Conversely, the uncertainty will make it difficult to develop policies and programs in the first place as they must cater for a number of possible scenarios (Jorgenson & Pizer 1997).

Climate scientists generally agree the earth is warming; however there is debate on the scale of predicted impact. The uncertainty relates to parameters, models, emissions, feedbacks, sinks and lags used to estimate warming impacts (Quiggin 2008). For example, the Australian Bureau of Meteorology is confident in the data and models used to calculate increased temperatures (Bureau of Meteorology, Department of Climate Change and Energy Efficiency & CSIRO 2012c). Figure 2.1 shows small variability, and increased confidence for temperature increase in the Northern Territory in comparison to future predictions of rainfall for the same period (Figure 2.2) (Bureau of Meteorology, Department of Climate Change and Energy Efficiency & CSIRO 2012b). Figure 2.1 illustrates temperature range predictions for low, medium and high emissions scenarios. It shows expected temperature variation from 0.6 to 2 degrees centigrade between the 10th and 90th percentile. Figure 2.2 illustrates predicted rainfall for the same three emissions scenarios. There is much less confidence between the 10th and 90th percentile with variation ranging from -20 to 20 percent change in rainfall. This variation makes it difficult for policy makers to make long term decisions regarding future adaptation activities, across all levels of government (Jorgenson & Pizer 1997).

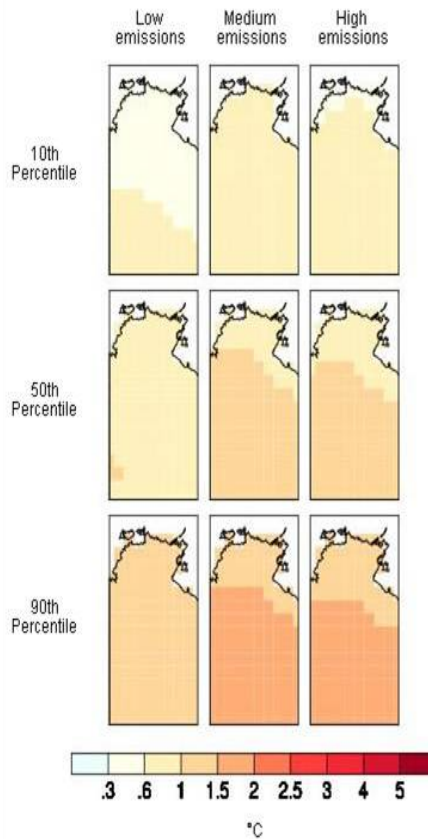


Figure 2.1: Temperature Prediction for 2030 for the Northern Territory

Source: Bureau of Meteorology, Department of Climate Change and Energy Efficiency & CSIRO 2012c.

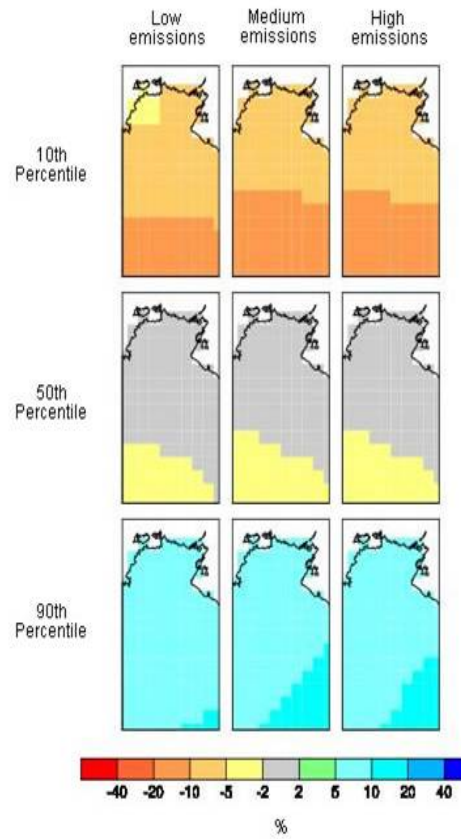


Figure 2.2: Rainfall Climate prediction for 2030 for the Northern Territory

Source: Bureau of Meteorology, Department of Climate Change and Energy Efficiency & CSIRO 2012b.

Although developing climate change policy can be difficult, the Australian Government has recognised its responsibility to develop strong policy (Australian Government 2011b). Australia is one of four countries who feature in both the top 20 total emitting and per capita emitting countries (see Figure 2.3). Australia produced approximately 549 million tonnes of greenhouse gas emissions in 2009 equating to approximately 25 tonnes per capita annually (Department of Climate Change and Energy Efficiency 2011b). This is approximately two percent of total global emissions, or six times the global average per capita (Department of Climate Change and Energy Efficiency 2011b). Meanwhile, the Northern Territory produces approximately 64 tonnes per capita annually (highlighted in green in Figure 2.3) (Department of Climate Change and Energy Efficiency 2011b).

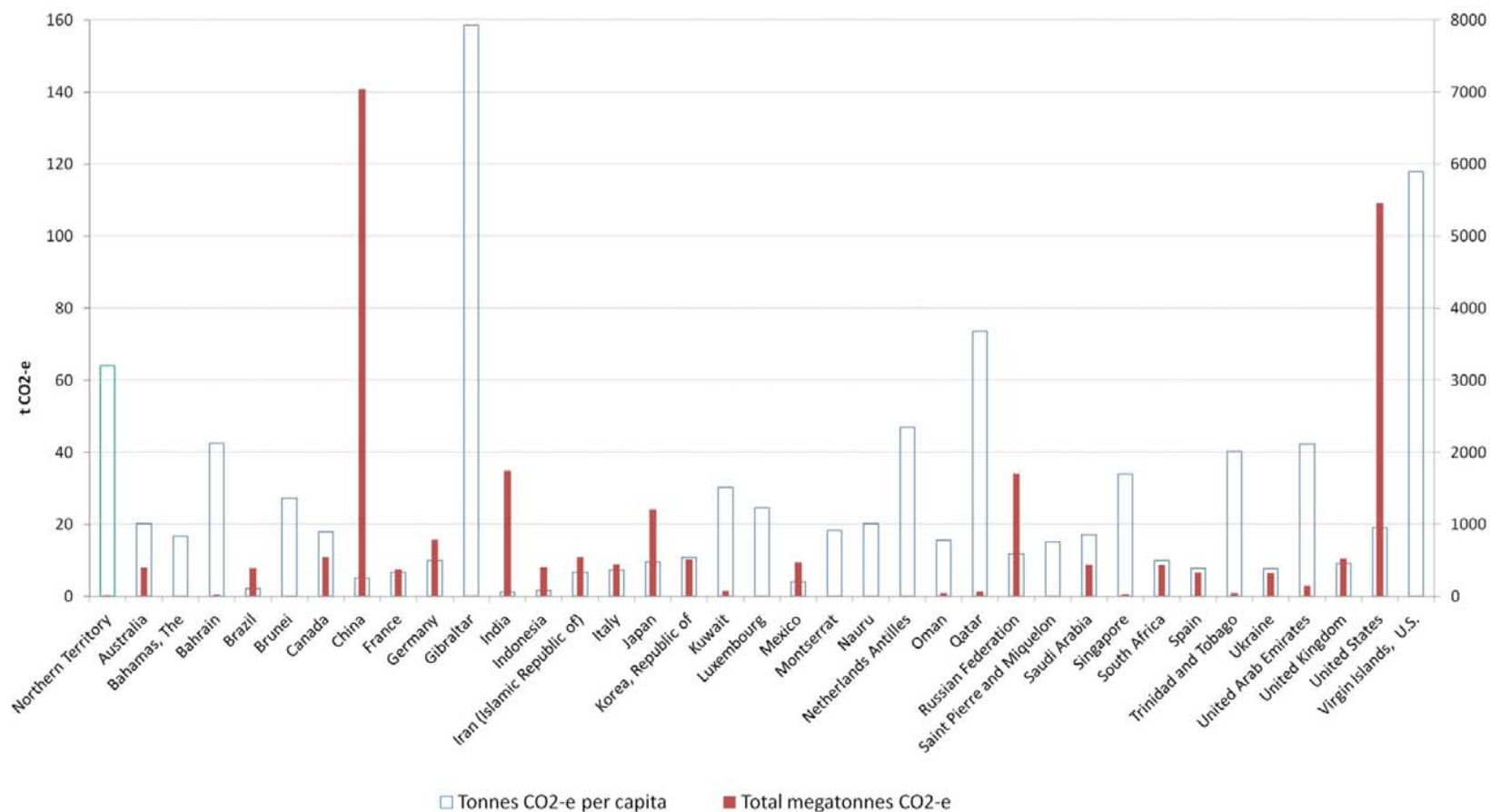


Figure 2.3: Population of top carbon producing countries total and per capita for 2009, including the Northern Territory

Northern Territory is highlighted in green, data based on 2010 data.

Source: adapted from Australian Government 2012c; United Nations Statistics Division 2009; United States of America Energy Information Administration 2010.

The Australian Government ratified the Kyoto Protocol at the Council of Parties 13 meeting in 2007, and began working on a carbon pollution reduction scheme (Department of Climate Change and Energy Efficiency 2010a). Due to political pressure in 2010, the carbon pollution reduction scheme was postponed until after the Protocol expired (Department of Climate Change and Energy Efficiency 2010a). The Australian Government continues to reiterate its intention to meeting its Kyoto Protocol targets by 2020 by releasing its greenhouse gas projections annually (Department of Climate Change and Energy Efficiency 2010b, 2011a).

The Federal Government commissioned *The Garnaut Climate Change Review* in 2008 and subsequent update in 2011. The review investigated climate change impacts on the Australian economy and provided recommendations which included placing a price on carbon pollution (Garnaut 2011). As a result, the *Clean Energy Future Legislation 2011* passed the Australian Senate in November 2011, outlining actions focussed on renewable and energy efficient industries and technologies. It also introduced a price on airborne carbon emissions in effect July 2012 (Department of Climate Change and Energy Efficiency 2011b).

Although the Northern Territory only contributes 2.4 percent to the country's total annual emissions, this equates to three times the Australian per capita average and nineteen times the global average (see Figure 2.3) (Australian Government 2012c). The Northern Territory produces the highest per capita emissions by any state or territory in Australia (see Figure 2.4) (Australian Government 2012c). This equates to a total of 14.7 mega tonnes of CO₂-e produced annually in the Northern Territory (Australian Government 2012c).

The Northern Territory deals with unique issues due to its location and climatic zone in comparison to other states (Garnaut 2010). These issues impact mitigation and adaptation activities and include savanna burning, future residential and commercial development, low population densities over large geographical areas and the presence of emission intensive mining (Garnaut 2010; Northern Territory Government 2009a). Figure 2.5 shows the breakdown of the Northern Territory's emissions profile where the top three emission producing sectors are agriculture, stationary energy and transport.

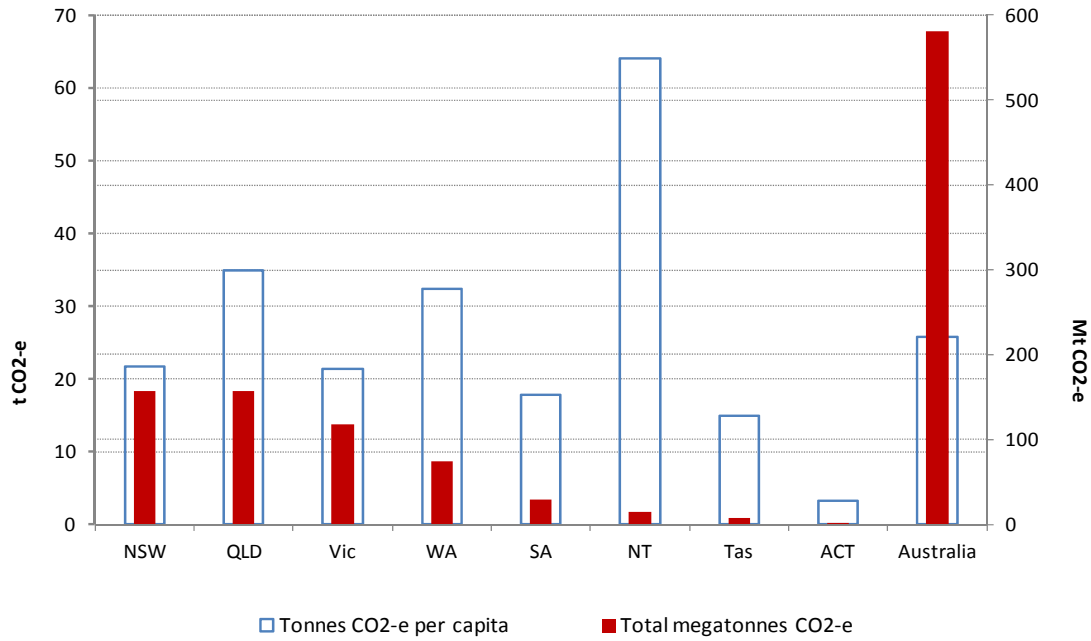


Figure 2.4: Tonnes of CO₂-e per capita by State and Territory (2010) compared to the national average

Source: adapted from Australian Bureau of Statistics 2011a, 2011b; Australian Government 2012b, 2012c.

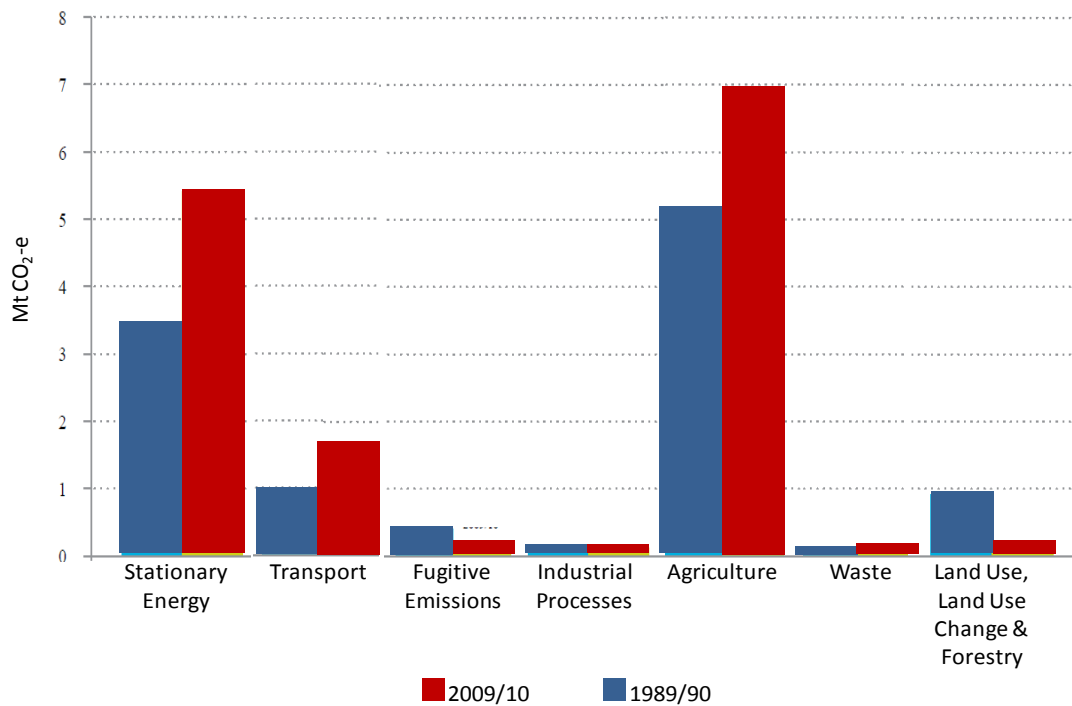


Figure 2.5: Northern Territory emissions by sector (mega tonnes CO₂-e)

Source: adapted from Australian Government 2012c.

In 2009 the Northern Territory Government launched its *Greening the Territory* program including the *Climate Change Policy* (Northern Territory Government 2009b). The policy highlights the challenges and opportunities for the Northern Territory and stresses the need for integrated management between all levels of government, business and the community to achieve common goals (Northern Territory Government 2009b). The policy highlights the Northern Territory Government's major goal of reaching carbon neutrality for its operations by 2018. Other major policy statements include:

1. By 2020, at least four million tonnes of carbon per year will be removed from the atmosphere through better land management. Working with business, landholders and the community the Territory can become a major player in the emerging carbon economy, assisted by the establishment of new Carbon Fund arrangements.
2. The Territory will be a low land-clearing jurisdiction, protecting the 'carbon bank' in our landscape. The rate of clearing will be contained. The government will introduce native vegetation legislation to protect Territory vegetation.
3. By 2020, the Territory will be a world leading generator of renewable and low emissions power in remote communities.
4. The Territory will be at the forefront of efforts to save the best of our priceless coastal wetlands, at risk from rising sea levels – through specific interventions aimed to reduce salt water intrusion, protect fishing and save biodiversity (Northern Territory Government 2009b).

The *Climate Change Policy* sets the direction for the Northern Territory Government as well as providing future strategic direction for local government within the Territory. Considering the City of Darwin municipality contains 34 percent of the Northern Territory's population (Australian Bureau of Statistics 2011a), City of Darwin sees implementing proactive steps to reduce carbon emissions as a priority (Darwin City Council 2011).

2.2 City of Darwin

According to its strategic document *Evolving Darwin – Strategic Directions: Towards 2020 and Beyond*, City of Darwin (CoD) recognises it must play an active role in contributing to the reduction of carbon emissions in the Northern Territory. The strategic document states the aspiration to 'Be a leader with climate change policies'

amongst other local councils (Darwin City Council 2008). Steps taken to reach this goal include the development of a *Climate Change Policy* committing CoD to ‘finding practical and effective ways to address climate change risks within the municipality’, and the *Climate Change Action Plan 2011-2020* which informs CoD’s actions to 2020 (Darwin City Council 2010). The plan consists of actions CoD will implement both internally and in the community.

In comparison to other capital city councils, however, the plan lacks targets. Fellow capital city councils have set ambitious targets which are specific, measurable, attainable, realistic and timely. The majority of these councils are working towards carbon neutrality. As Table 2.1 demonstrates, apart from CoD, City of Perth is the other remaining council who has not committed to a carbon neutrality target. This provides CoD an opportunity to learn from its more progressive counterparts, and take steps towards becoming a local government leader in climate change issues. In order to help reach their carbon neutral targets, Melbourne, Sydney and Adelaide councils have commenced purchasing electric vehicles for their fleet with the intention to increase the proportion in the future. If charged on 100 percent green power, electric vehicles offer organisations a way to mitigate a proportion of their transport-related emissions (Brown et al. 1998; Thomas 2012).

Table 2.1: Australian capital city council carbon reduction targets

Council	Carbon target
City of Melbourne	carbon neutrality by 2020
City of Sydney	carbon neutrality by 2011
Adelaide City Council	carbon neutrality by 2020
City of Perth	reduction of emissions by 20% by 2020 based on 2005 levels
Brisbane City Council	carbon neutrality by 2026
Hobart City Council	carbon neutrality by 2020

Source: Adelaide City Council 2009; Brisbane City Council 2012; City of Melbourne 2012; City of Perth 2012; City of Sydney 2012; Hobart City Council 2009; Scott 2012.

Chapter 3 – Exploration of battery electric vehicles as a tool for reducing carbon emissions

3.1 Transport-related emissions

Transport-related emissions play a growing part in the global emissions profile (Holdway et al. 2010). Jarvinen, Orton et al. (2011) suggest up to half of the global emissions are caused by transport. In 2010, Australia's transport emissions accounted for 15 percent of total emissions (Australian Government 2012c). Globally transport and fleet sectors accounted for 29 percent of total emissions produced in the United States (Samaras & Meisterling 2008; value for year 2004) while in Germany and the United Kingdom in 2005, 16 percent and 21 percent of total emissions respectively resulted from the transport sectors (European Environment Agency 2010).

Since 1990, Australia has experienced an increase of 40 percent in road transportation energy consumption (Samaras & Meisterling 2008). This translates to a 34 percent increase in transport-related emissions (Australian Government 2012a). The Northern Territory's transport-related emissions have grown from 1.5 percent to two percent of Australia's total emissions (Australian Government 2012c) resulting in an 89 percent increase of carbon dioxide produced by the transport sector as demonstrated in Figure 3.1 (Australian Government 2012c). Not only in Australia, but globally, the increase in transportation is causing a major obstacle in reducing carbon emissions at all levels of government (Australian Government 2012c). However, it also offers governments a tangible opportunity to reduce their carbon footprint.

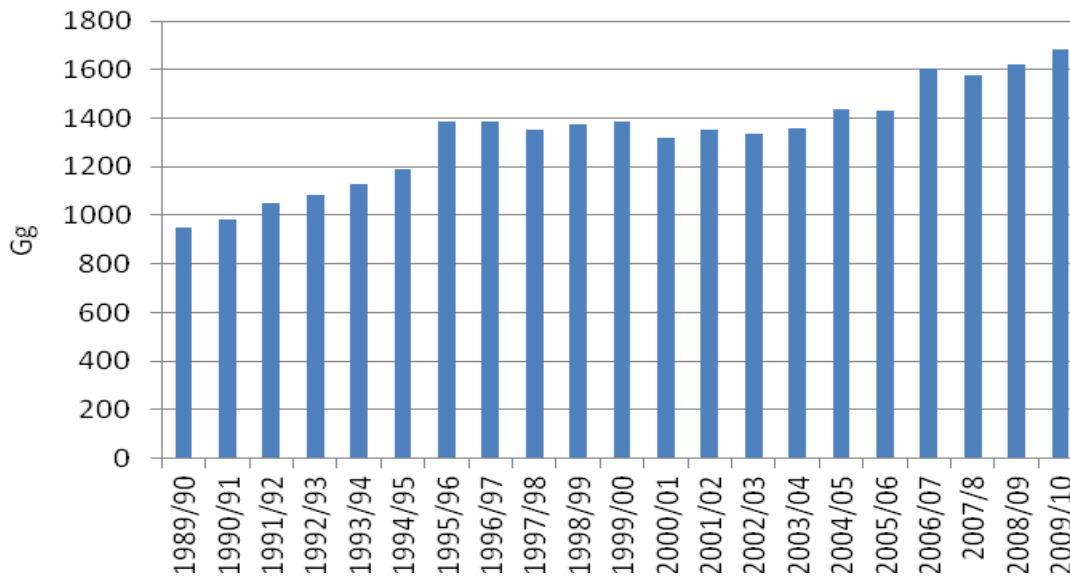


Figure 3.1: Northern Territory trend consumption of CO₂-e transportation sector emissions from 1989/90 – 2009/10 (gigagrams)

Source: adapted from Australian Government 2012c.

At CoD, community expectations and the introduction by the Australian Government of the carbon price are placing pressure on the organisation to investigate new ways of reducing carbon generated from transport-related activities (Darwin City Council 2011). In 2009, CoD consumed 306,407 litres of diesel and 113,233 litres of petrol, accounting for 10 percent (1085 tonnes of CO₂- e) of CoD’s corporate carbon emissions (see Figure 3.2) (RG Consulting 2011).

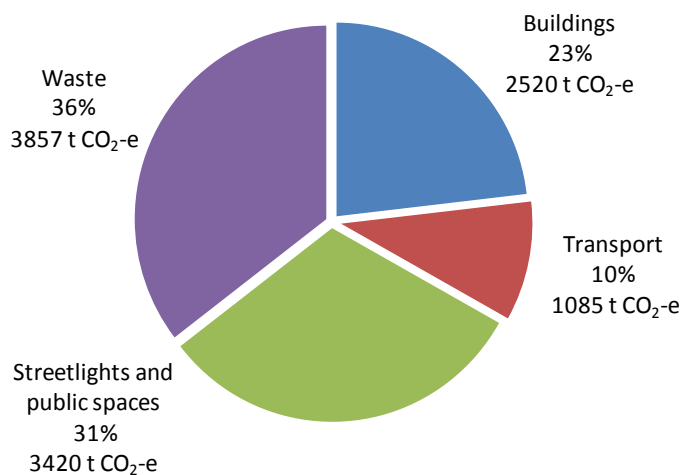


Figure 3.2: City of Darwin’s corporate emissions profile 2009

Source: RG Consulting 2011.

The *Climate Change Action Plan 2011-2020* includes a number of transport-related actions which guide CoD in its activities (outlined in Table 3.1). Action C1 requires CoD to investigate strategies to reduce its carbon footprint while Action E8 requires CoD to investigate the feasibility of electric vehicles for internal council usage.

Table 3.1: City of Darwin’s Climate Change Action Plan 2011-2020 – actions relevant to electric vehicles

Action	Performance Indicator	Time Frame	Responsibility	Outcome
C1 Develop strategies for Council to reduce its carbon footprint.	C1.1 Number of strategies adopted and targets met.	Ongoing	Office of the Chief Executive	Council adopted strategies and targets for carbon emission reductions.
E8 Develop a Green Fleet policy to minimise GHG emissions including investigating the use of electric vehicles/ scooters for Darwin central business district usage.	E8.1 Development of a Green Fleet Policy E8.2 Investigation into electric vehicles/ scooters undertaken	2013/14	Corporate Services	Council’s travel related greenhouse gas emissions are reduced. Electric vehicles or scooters are considered for city usage. Percentage of lower emissions vehicles in Council’s fleet increased.

Source: Darwin City Council 2011.

CoD has made efforts to reduce its fleet related emissions by replacing conventional passenger vehicles and trucks with hybrid models (Newcombe, P. 2012c).

Replacement hybrid passenger vehicles alone have reduced CoD’s fleet related emissions by nine tonnes of CO₂-e since 2004 (see Table 3.2). CoD’s current fleet policy is to continuously improve the efficiency and reduce fleet emissions as long as the vehicles are fit for purpose due to specific job requirements (Newcombe 2012b).

Table 3.2: City of Darwin CO₂-e savings from replacing fleet vehicles with hybrid vehicles

Year	Number purchased per year	Number of hybrids fleet	Savings in tonnes of CO ₂ -e
2004	1*	1	0.36
2008	1**	1	0.36

Year	Number purchased per year	Number of hybrids fleet	Savings in tonnes of CO ₂ -e
2010	4	5	1.8
2011	4	8	2.88
2012	2	10	3.6
Total savings (cumulative over seven years)			9 tonnes of CO₂-e

*Vehicle replaced in 2008 **Vehicle replaced in 2010

Calculations based on the emissions produced by a standard fleet option (Sedan 5 Seat, Toyota Aurion) in comparison to the selected hybrids (Sedan Family, Hybrid Camry) for the CoD's fleet. Australasian Fleet Management Association emissions calculator used to calculate emissions.

3.2 Battery electric vehicles as a mitigation option

An effective way to reduce the impact of transport-related emissions is to alter the makeup of the fleet and move from conventional petroleum engine vehicles to electric vehicles (Ng 2011; Zackrisson, Avellán & Orlenius 2010). Replacing a conventional vehicle with an electric vehicle which uses 100 percent green power creates zero operational greenhouse gas emissions (Libo-on 2011; Victorian State Government 2012). Added benefits of electric vehicles include reduced dependence on fossil fuels and decoupling from oil prices (Feeney et al. 2012; Ng 2011).

Electric vehicles can be hybrids (referred to as battery hybrid electric vehicles) where batteries and fuel are used together to propel the car (Samaras & Meisterling 2008). Other electric vehicles are 'pure' electric vehicles which use only a battery for propulsion (Samaras & Meisterling 2008). These are referred to as 'plug-ins' or battery electric vehicles (BEV) (Chan 2004; Høyer 2008). All electric (hybrid and battery) vehicles must meet specified International Standards Organisation 43.120: *Electric road vehicles for safety, operating characteristics, speed measurement, battery packs, torque, compactness and robustness* providing the driver with a degree of security and assurance (International Standards Organisation 2012; Profumo & Teconi 1997). Electric vehicles alert the driver to low power, just as conventional vehicles alert the driver to low fuel reserves (Loeser & La Vorgna 2011).

The size and the cost of the battery, the associated costs of electricity consumption required to charge the battery as well as related infrastructure costs are major inhibiting factors for take-up of electric vehicles (Becker, Sidhu & Tenderich 2009;

Waldron & Kobylarek 2011). However novel schemes of separate battery ownership or battery leasing are increasing the viability of ownership allowing for a significant reduction in initial outlay and battery replacement (where current battery replacement is approximately \$12,000 - \$15,000) (Seetharamam 2012).

Jarvinen, Orton et al. (2011) describe the electric vehicle market as 'poised to proliferate' while overseas electric car sales are predicted to increase by 64 percent in the United States of America by 2030 as a result of the government's investment of \$2.4 billion into the industry (Becker, Sidhu & Tenderich 2009; New York City 2012; United States of American Government 2011). New York City in particular, has 70 mixed electric vehicles including ten trucks and is looking to replace the existing taxi fleet with battery electric vehicles (New York City 2012). Across the European Union, electric vehicle registration has increased tenfold since 2010 and is forecast to continually increase (European Environment Agency 2012). The United Kingdom's Committee on Climate Change is predicting 1.7 million electric vehicles on the road by 2020 (Nichols 2012). There is also growing interest in electric vehicles among the Australian community according to Better Place, an installation and maintenance provider for electric vehicle infrastructure, who surveyed 8,000 people across five countries including 1,500 Australians, and found 39 percent were interested in purchasing an electric vehicle in the future (Better Place 2009).

3.3 Considerations affecting the uptake of battery electric vehicles

Although BEVs offer organisations a way to reduce their carbon emissions, there are a number of considerations which must be addressed prior to inclusion within the fleet. These considerations are discussed from a Triple Bottom Line perspective. Triple Bottom Line reporting looks not only into financial but also broader social and environmental dimensions of an innovation. By doing so, it extends the traditional group of stakeholders – those with financial interests – to a wider group of people who are impacted (negatively or positively) by social or environmental decisions the organisation makes (Norman & MacDonald 2004). Triple Bottom Line reporting reflects the organisations values and awareness of associated issues (Savitz & Weber 2006; Willard 2002).

3.3.1 Financial considerations

Purchase and operating costs

The cost of purchasing a BEV is an important consideration for fleet managers. There are currently three BEV models available for purchase in Australia. Table 3.3 describes the specifications of the three available (or soon to be available) BEV models including estimated cost. It also provides a comparison purchase price to that of similar vehicles in CoD's existing fleet. BEVs clearly have a greater purchase cost due to the battery cost and low production of BEVs. Battery cost makes up 21 to 47 percent of a BEV purchase price (Cuenca, Gaines & Vyas 1999). As production of BEV vehicles increases, cost per unit is expected to fall below that of conventional vehicle (once production reaches 100,000 vehicles). However it is unlikely the combined purchase price of vehicle and battery will be less than the price of a conventional vehicle (Cuenca, Gaines & Vyas 1999).

Table 3.3: Battery electric vehicle models available on the Australian market as of October 2012

Manufacturer and model	Description	Max speed (km/hr)	Distance on full battery (km)	Estimated cost	Comparable vehicle in terms of size in CoD's fleet	Estimated cost of CoD's vehicle	Comparable conventional vehicle in terms of size on the market	Estimated cost of conventional vehicle
Nissan Leaf	Hatchback	160	160	\$59,000 incl battery	Honda Insight	\$18,000 excl on road costs	Ford Focus	\$19,880 excl on road costs
Mitsubishi i-MiEV	Small car	130	150	\$48,000 incl battery	*	*	Nissan Micra	\$14,900 excl on road costs
Renault Fluence Z.E.	Sedan Automatic battery switch at stations	135	185	\$40,000 excl battery	Toyota Camry H	\$34,990 excl on road costs	Toyota Corolla Ascent	\$24,500 excl on road costs

*CoD does not have a comparable vehicle in its fleet

Source: adapted from Better Place 2012b, 2012c; Cars Guide 2012; Colquhoun 2012; Fallah 2011; Honda 2012; Mathioudakis 2011; Nissan 2012b; Origin Energy 2012; Stevens 2012.

BEVs offer large operational (including maintenance) savings of up to 70 to 80 percent compared to traditional vehicles (Australian Institute of Traffic Planning and Management 2012) because they have fewer moving parts, and therefore reduced servicing needs (Cuenca, Gaines & Vyas 1999). Ford compared their conventional Ford Focus to their Ford Focus Electric and found a saving of approximately \$1,171 on maintenance costs over the vehicle life (240,000 kilometres) (Beissmann 2011). BEVs on average, have 2.6 times greater well-to-wheel efficiency in comparison to conventional vehicles and a much lower oil consumption as the engine does not require lubrication (Telsa 2012; Werber, Fischer & Schwartz 2009). Well-to-wheel relates to the efficiency of the fuel cycle conversion, and the amount of energy lost through heat and friction in the process of reaching the wheel (Telsa 2012; Unnasch & Browning 2000). Energy costs are also lower for BEVs instead as the power used to idle in a conventional vehicle is used to recharge the battery (Cikanek & Bailey 2002; Cuenca, Gaines & Vyas 1999).

Cost variance of fuel versus electricity

Using electricity to power vehicles in comparison to fuel can be financially beneficial (Cuenca, Gaines & Vyas 1999). It has been estimated BEVs can ‘save’ users in excess of \$1,600 annually (see Figure 3.3) (Cars Guide 2012). Anair and Mahmassan (2012) estimate savings up to \$750-\$1,200 annually however multiple factors influence absolute and relative costs (Beissmann 2011).

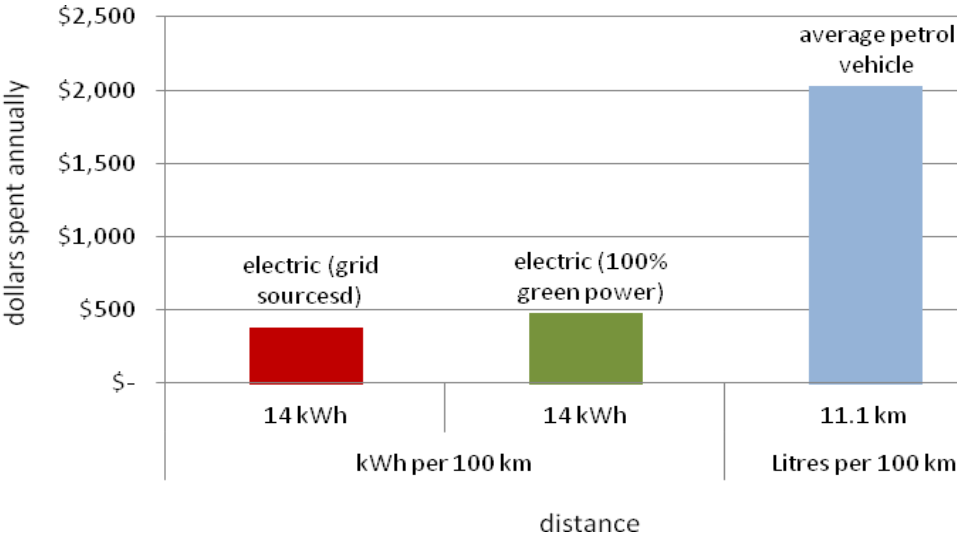


Figure 3.3: Dollar comparison of fuel and electricity consumption

Source: adapted from My Electric Car 2012.

Resale value

Resale value of vehicles is a consideration for fleet managers (Alberini, Harrington & McConnell 1995; Birch 2010). Brisbane City Council recently sold a two year old electric vehicle for less than a third of its original price (4000 kilometres on the odometer), while a second BEV failed to sell (Hinchliffe 2012). It is thought the current lack of infrastructure available in the community for BEV owners to recharge vehicles and the associated price of infrastructure is inhibiting resale price (Birch 2010). The secondary market for hybrid electric vehicles is better. The Kelley Blue Book (which provides new and used car pricing indexes in the USA) places a 42 percent resale value after the length of a typical lease of 36 months for the 2011 Chevrolet Volt (electric hybrid vehicle) (Sawyers 2011). With the added federal tax credit for purchasing an electric vehicle in the United States of America, this increases the resale to 51 percent and is considered a better resale than the Nissan Leaf at 39 percent, or Toyota Prius at 46 percent (Kelley Blue Book 2012; Sawyers 2011).

Infrastructure installation costs

BEVs require infrastructure to recharge their batteries (AV Environment 2012). Figure 3.4 illustrates a standard multi-station and a commercial AC charging station. There are a number of businesses in the market today who offer different tiers of service for electric vehicle infrastructure. The first level of service offers annual kilometre-based subscription packages which include implementation and maintenance of the infrastructure, associated electricity fees, battery cost (the company owns the battery) and the setting up of a separate electricity account (Better Place 2012a). Although membership prices were unavailable at the time of writing, it is understood that this level of service comes at a premium cost.



Figure 3.4: A multi-station charging station and a commercial charging station

Source: AV Environment 2012.

The second tier and more autonomous level of service includes infrastructure installation with a one year maintenance warranty (Touling 2012). A real time portal is also included which provides the user with live consumption feeds. This type of service uses existing electricity accounts; has one off installation fees and ongoing annual portal management fees (Touling 2012).

In choosing which service is suitable, organisations need to consider the following factors:

- Level of involvement – does the organisation want a hands-on or hands-off approach?
- Costs associated with holistic memberships – can the organisation justify the price of membership to its rate payers?
- Technical capability within the organisation – are there opportunities for staff to attend training and workshops on BEV maintenance?
- Ability to easily integrate into existing financial systems – do the organisation's existing financial systems have the capacity to add extra billing functions to allow for BEV electricity consumption allocation?
- Local back up support – is there local support from the dealers in regards to maintenance?

3.3.2 Environmental considerations

Production and operating phase greenhouse gas emissions

Greenhouse gas emissions released as a result of the production phase of electric vehicles are higher than that of conventional vehicles (Ma et al. 2012). After undertaking a life-cycle analysis, Ma et al (2012) concluded the BEV produced more life-cycle carbon emissions than a comparable conventional vehicle due to the emission intensive lithium battery manufacture process. While improvements to battery technology have reduced production related emissions, production phase emissions remain significantly higher than conventional vehicles (Zackrisson, Avellán & Orlenius 2010).

BEVs however, produce lower greenhouse gas emission than conventional vehicles during operation if powered by a low or zero emission-intensive fuel source such as gas or green power (Hawkins, Gausen & Strømman 2012; Ma et al. 2012; Victorian State Government 2012). Thomas (2012) estimates consumption of oil could be reduced by 48.74 million litres per year if small cars and wagons within the United States were replaced with BEVs. This results in net greenhouse gas savings of

38,300 tonnes of CO₂-e and assumes a mixed electricity source of coal, gas and other (Thomas 2012). The electricity source greatly impacts the carbon emissions produced which is reflected in the Scope 2 emission factors used to determine electricity generation impact (see Table 3.4) (Australian Government 2012a; Department of Transport 2012). Higher carbon intensive energies are allocated a higher emissions factor in order to compare energy consumption across states and territories. Scope 2 emissions are those produced in the process of generating electricity, steam, cooling or heating consumed by an organisation (Department of Climate Change and Energy Efficiency 2012a). The Northern Territory is at the lower end of the scale as the main source of electricity is generated from gas, and as a result, BEVs would provide much lower operational emissions in comparison to BEVs powered by electricity sourced from a brown coal or other emission-intensive source.

Table 3.4: Scope 2 emission factors for grid purchased electricity

Region	kg CO ₂ -e/kWh
Tasmania	0.26
South Australia	0.65
Northern Territory	0.71
Queensland	0.86
NSW & ACT	0.88
Western Australia	0.94
Victoria	1.19

Source: Australian Government 2012a.

In an ideal situation, green power is used to recharge the BEV battery, emitting zero greenhouse gas emissions (Libo-on 2011; Samaras & Meisterling 2008). However, if green power is not an available option, then BEV owners must either purchase conventional electricity provided by the local utility, or generate its own power. Infrastructure service organisations who provide membership packages guarantee the purchase of 100 percent green power by purchasing Large-scale Generation Certificates (previously called Renewable Energy Certificates) from the Federal Government’s Clean Energy Regulator on behalf of the client (Better Place 2012a). In doing so they guarantee the owner an emission free vehicle (Australian Government 2011a; Better Place 2012a). Better Place, who will soon offer memberships with the Nissan Leaf, Renault Fluence Z.E., Mitsubishi i-MiEV, and the Holden Volt (electric hybrid vehicle), signed a green power supply deal with

ActewAGL in 2011 worth \$60 million over ten years (EcoGeneration 2011). As a result, Better Place can guarantee its members 100 percent green power (Better Place 2012a). In this case, membership cost must also be added to the running cost of the BEV.

Alternatively, purchasing accredited GreenPower is a viable option. Northern Territory utility Power and Water Corporation sells accredited GreenPower at an additional 8 cents per kilowatt² hour on top of the general retail price (Power and Water Corporation 2012a). Based on the average number of kilometres driven by CoD’s passenger fleet, purchasing GreenPower could cost CoD up to \$3.60-\$5.07 per vehicle per month (see Table 3.5). The additional cost is considered insignificant if CoD chose to purchase GreenPower for an entire BEV passenger fleet.

Table 3.5: Approximate additional cost of purchasing accredited GreenPower to City of Darwin

Vehicle	Battery capacity (kWh)	Full battery distance (km)	Charging frequency (days)	Green-Power premium per charge	Charging events per month* (no.)	Green-Power premium per charge per month
Nissan Leaf	24	160	11.5	\$1.92	2.6	\$5.07
Mitsubishi i-MiEV	16	150	10.8	\$1.28	2.8	\$3.60
Renault Fluence Z.E.	22	185	13.3	\$1.76	2.3	\$4.02

Calculations based on average Class 1-3 vehicle daily distance travelled of 13.9 km, and extra 8 cents per kWh of Power and Water Corporation’s GreenPower.

Table 3.6 outlines the Class in the CoD fleet.

**Assuming 30.4 days per month*

Source: adapted from Mitsubishi Motors 2012; Nissan 2012b; Power and Water Corporation 2012a; Renault 2012.

An alternative option is own power generation through installation of solar panels. This reduces reliance on conventionally generated electricity while reducing

² GreenPower has not been impacted by the 30 percent rise in retail electricity prices scheduled for January 1 2013 (Power and Water Corporation 2012b).

emissions. As the Nissan Leaf requires 3.2 x 200 W solar panels to charge, it is assumed the i-MiEV would use either the same or less while the Fluence Z.E. the same or more considering the size difference (One Block Off the Grid 2010).

Battery life

An average lithium-ion battery can last for up to 4000 cycles or five to six years, however a number of factors influence the battery life. Factors which reduce the life of a battery include environmental temperature variations, depth of discharge and discharge rates (Price, Dietz & Richardson 2012; Väyrynen & Salminen 2012). For example, excessive charge rates reduce the electric vehicle battery by half for every increase in cell temperature, whereas inadequate charge rates can result in sulphate formation which also impacts battery life (Dhameja 2002). Once a battery reaches 80 percent capacity, it is not longer fit for use within an electric vehicle and is considered at the end of its life (Price, Dietz & Richardson 2012). Disposal of electric vehicle batteries provides another environmental impact dimension (Terada et al. 2001).

The literature identifies three methods for disposal of batteries including re-use, recycling and disposal (Hawkins, Gausen & Strømman 2012; Price, Dietz & Richardson 2012).

In regards to re-use, Price, Dietz et al (2012) suggest decommissioned battery packs can be used as energy storage packs for the grid while Waldron and Kobylarek (2011) suggest batteries could be used to provide backup power to residential and commercial buildings. Major car manufactures such as Nissan Motor and General Motors are working with power companies to investigate opportunities using decommissioned batteries to store wind or solar energy (Kanter 2011). If these secondary use markets can be developed, it may contribute to reducing the original cost of the battery however it is assumed that eventually the battery will reach its second end of life and will need to be disposed of (ABB 2012; Waldron & Kobylarek 2011).

There is scope for recycling of electric vehicle batteries. Price, Dietz et al (2012) discuss the opportunity of precious metal and electrolyte recovery. Precious and speciality metal recyclers are beginning to build infrastructure to deal with the expected influx of BEV and hybrid electric vehicle batteries (Kanter 2011). However considering the cost of recycling lithium is five times greater than mining the metal, and the limited market for BEVs given Darwin's population, it is unlikely a lithium

recycler would set up in the Northern Territory and offer this service (Hawkins, Gausen & Strømman 2012; Kanter 2011).

3.3.3 Social considerations

Availability of comparable vehicles

As the three available BEVs in Australia are passenger vehicles, this limits the opportunity for replacement of the entire CoD fleet, as many are specific work purpose vehicles including buses, trucks, backhoes, utilities and scooters. Table 3.6 lists CoD's fleet make-up as of October 2012. There is scope to replace Classes 1-3 (passenger vehicles) with BEVs, totalling in 19 vehicles.

Table 3.6: City of Darwin's fleet make-up as of October 2012

Vehicle Class	Vehicle Class Description	Number of vehicles	Fuel type	Total average cost to own and operate per unit per annum	Rate per kilometre*
1	Sedan, luxury	4	Diesel	\$29,959.09	\$1.14
2	Sedan, wagon medium	7	Unleaded **	\$14,463.34	\$0.90
3	Sedan, hatchback small (hybrid)	8	Unleaded	\$11,514.10	\$0.78
4	Utilities, 4 x 2	58	Diesel	\$12,749.48	\$0.81
5	Vans	6	Diesel + 1 x unleaded	\$15,095.48	\$1.47
6	Utilities, wagon 4x4	6	Diesel	\$48,501.62	\$1.25
7	Motor Scooter	6	Unleaded	\$3,403.83	\$1.97
8	Truck, single cab 2x4	11	Diesel	\$19,951.91	\$1.50
9	Truck, single cab, tipper 2x4	16	Diesel	\$26,616.12	\$1.61
10	Truck, dual cab, tipper 2x4	6	Diesel	\$25,842.15	\$1.19
11-24	Other trucks and specialised vehicles including backhoes, graders, loaders and tractors	38	Mixed	Information not available	

*Calculation takes into account of depreciation, maintenance, distance travelled, fuel costs, etc. ** One vehicle in this category is a hybrid.

Source: adapted Newcombe 2012d.

Vehicle size comparison

Size will play a major role in determining the suitability of the vehicle. CoD's Classes 1-3 consist of a mixture of Toyota Prado (x3), Toyota Aurion (x3), Ford Territory (x1), Holden Sportswagon (x1), Camry Hybrids (x8), Holden Calis (x1) and Honda Insight (x1), and as Figure 3.5 demonstrates, there is a size difference between the BEVs and conventional vehicles. The Renault Fluence Z.E. or RAV4 EV would be a comparable vehicle to the current passenger fleet size and capability. The RAV4 EV, although planned for release in the United States of America in late 2012, is not planned for roll out across Australia (Monaghan 2012). The Renault Fluence Z.E. is expected to be on sale in Australia in early 2013, however the nominated Australian dealers have not been announced (Newcombe 2012a). The Fluence Z.E. will not be available in the Northern Territory for some time due to the low market demand (Newcombe 2012a). Passenger vehicle purchase and market in the Northern Territory contributed only 0.7 percent of Australia's total passenger vehicles for 2011 making it not economically feasible for Renault at this stage (Feeney et al. 2012).

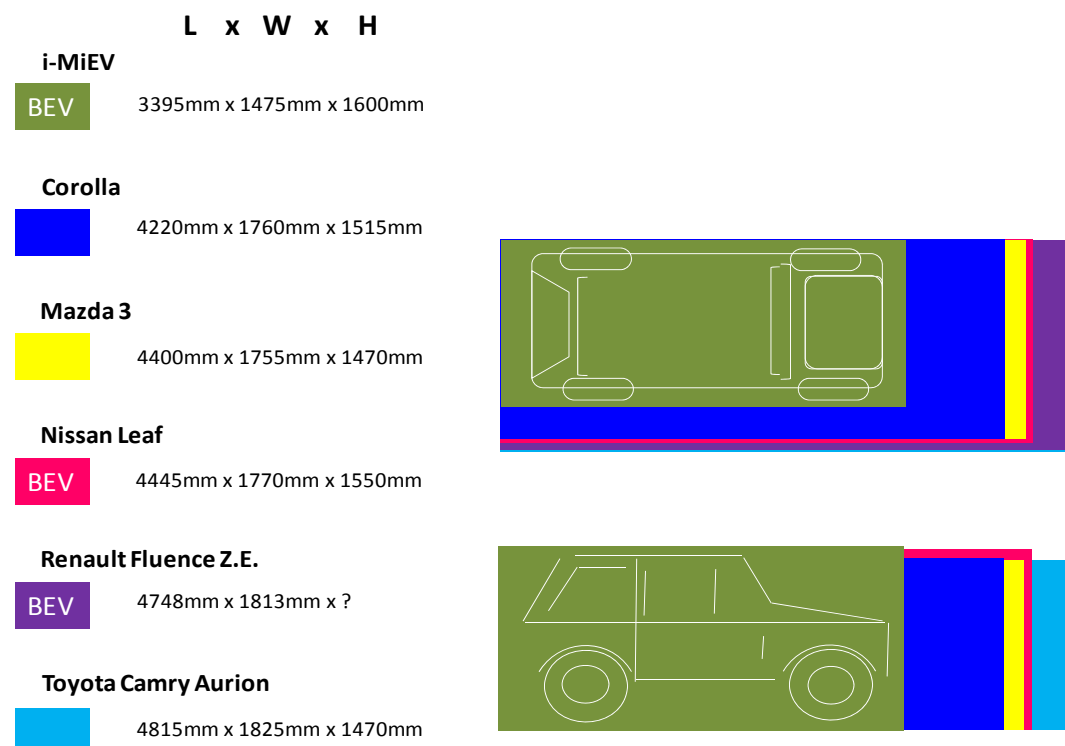


Figure 3.5: Size comparisons of available battery electric vehicles against existing City of Darwin passenger fleet vehicles

Source: adapted from Newcombe 2012c.

Range anxiety

Another consideration is 'range anxiety'. Range anxiety is the concern a BEV will not complete the scheduled journey, and may leave the driver stranded (Waldron & Kobylarek 2011). At this stage of early uptake of BEVs, range anxiety is a legitimate concern for long range trips as public charging stations do not exist in the Northern Territory. However at CoD, Class 1-3 vehicles average car driver trips is 35 kilometres per day (Figure 3.6). This is not unusual. Almost 90 percent of car driver trips in the municipality of Sydney drive less than 100 kilometres per day (Lamb 2011) while in America, 60 percent of car driver trips are 50 kilometres or less per day (Loeser & La Vorgna 2011).

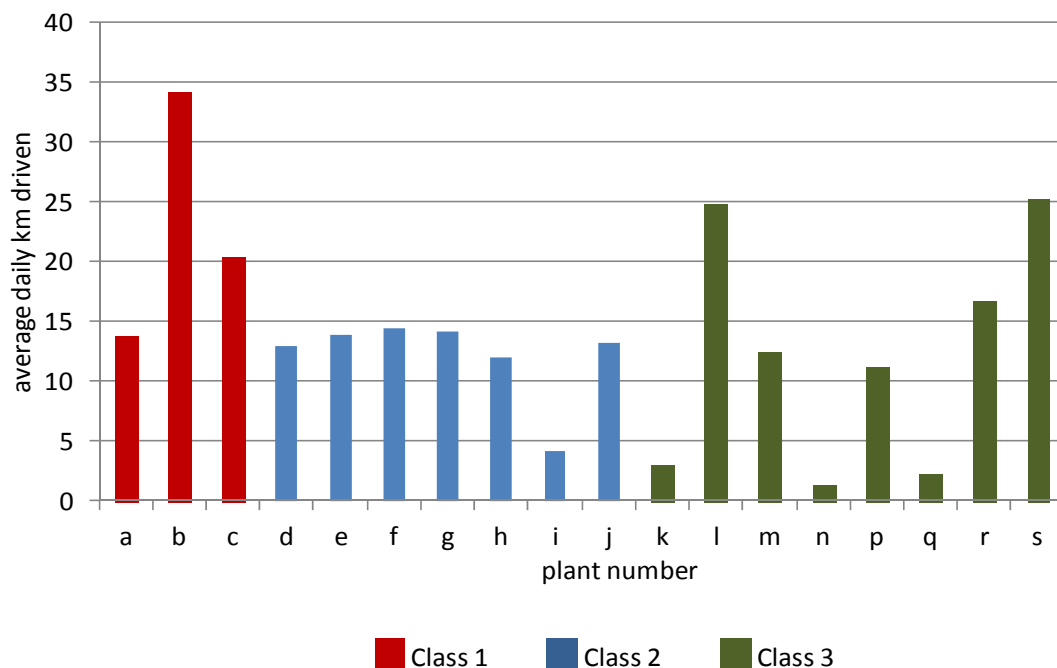


Figure 3.6: Average daily kilometres driven by City of Darwin's Class 1-3 vehicles (2013 forecast)

Plant number has been substituted with lettering to ensure privacy.

Source: adapted from Newcombe 2012d.

Table 3.7 identifies the maximum distance the Leaf, i-MiEV and Fluence Z.E. can travel on one full battery. Based on these distances, any of the three BEVs would easily cover the 35 kilometre daily distance of the CoD Class 1-3 vehicles. It should be noted, the distances in Table 3.9 assume the vehicle is driven in the most efficient manner, as driving modes and driver behaviours can reduce battery mileage (Fellner & Newman 2000; Lee, Lee & Lim 2010)

Table 3.7: Maximum travel distance on a full battery electric vehicle battery

EV	Distance (km)
Mitsubishi i-MiEV	150
Nissan Leaf	160
Renault Fluence Z.E.	185

Source: Mitsubishi Motors 2012; Nissan 2012a; Renault 2012.

Although there is little concern on average travel, Figure 3.5 does not highlight the number of long range trips vehicle owners may take. Many of the Class 1-3 vehicles have an unrestricted 300 kilometre driving allowance from Darwin (or 600 kilometre return trip). This is the distance along the Stuart Highway to Katherine (see Figure 3.7) and as Figures 3.8 demonstrates, none of the three BEVs would make the return trip on a full battery. Therefore, BEVs may be limited to the Darwin residential and rural areas. As 15 of the 19 vehicles in Classes 1 – 3 have this allowance, convincing managers to forego this part of its entitlement may prove difficult.³

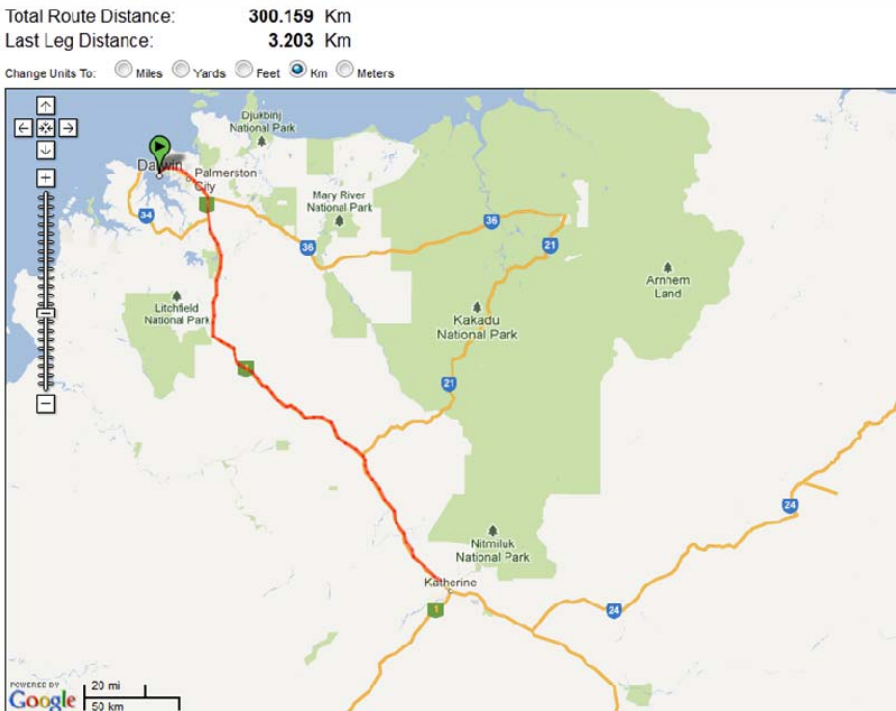


Figure 3.7: 300 kilometre driving allowance

Source: <http://www.geodistance.com/>.

³ Although there is the opportunity to replace Classes 1-3 with BEVs, choice of vehicle is a major drawcard for attracting quality senior management (including the Chief Executive Officer) to the City of Darwin, and as such, this consideration will need to be taken into account when implementing BEV policies in the future.

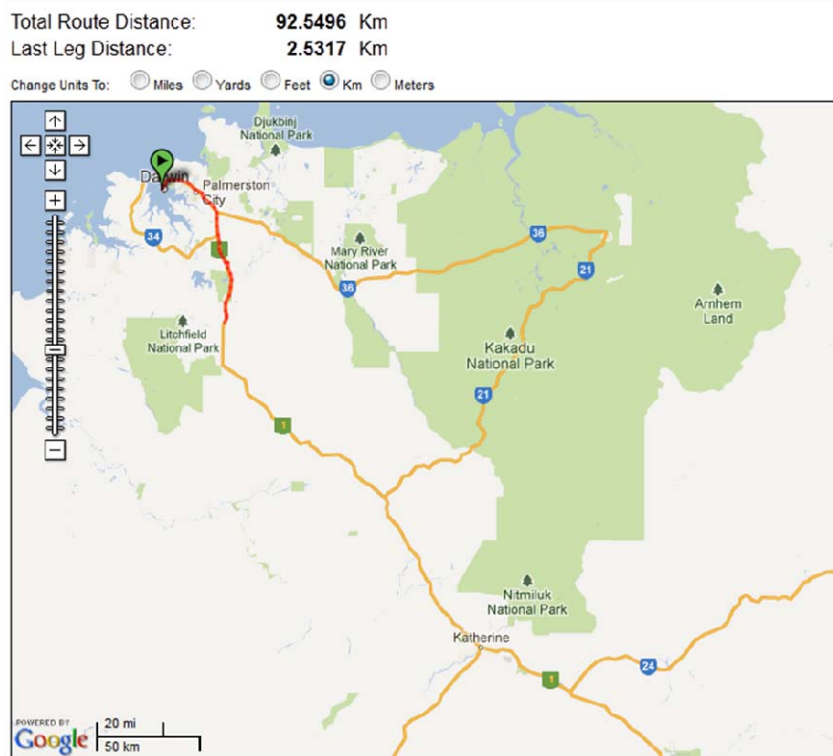


Figure 3.8: Maximum return trip in a battery electric vehicle departing from Darwin (based a fully charged Renault Fluence Z.E. battery) (kilometres)

Source: <http://www.geodistance.com/>.

Leading by example

As CoD aspires to ‘Be a leader with climate change policies’ it must demonstrate commitment to reducing its carbon footprint (Darwin City Council 2008). Table 3.8 lists organisations within Darwin and other capital city councils that currently have BEVs in their fleet. Some of these organisations have, or are investigating installing public charge points across their cities for community use.

Table 3.8: Battery electric vehicle models used in selected Darwin organisations and Australian capital city councils

Organisation	BEV
Darwin	
Power and Water Corporation	1 x Mitsubishi i-MiEV
Charles Darwin University	1 x Mitsubishi i-MiEV
Capital city councils	
City of Melbourne	2 x Nissan Leaf

Organisation	BEV
City of Sydney	Plug in hybrids, Mitsubishi i-MiEV 4 with the intention to increase to 10 vehicles in 2012/13
Adelaide City Council	1 x Nissan Leaf (replacing 1 x Mitsubishi i-MiEV) Solar electricity community bus
City of Perth	1 x converted Ford Focus
Brisbane City Council	In process of replacing 2 x Mitsubishi i-MiEV with Nissan Leaf
Hobart City Council	3 week trial of Nissan Leaf and Mitsubishi i-MiEV with intention to purchase a Leaf in 2013

Source: adapted from City of Melbourne 2012; City of San Francisco 2012; Farley 2012; Havas 2012; Hinchliffe 2012; Hope 2012; Lamb 2011; Loeser & La Vorgna 2011; Morgan 2012; Samaras & Meisterling 2008.

Impact on the grid

From a power utility's perspective, a major concern about BEVs is the potential impact that recharging the batteries of a large fleet of BEVs could have on the grid. Simultaneous recharge can place considerable load on electricity sources and infrastructure (Kassakian & Schmalensee 2011; Rouselle 2009). For example, studies undertaken by the New York City Government identified if 70 percent of its 430 electric vehicle fleet were recharging at the same time, it would increase electricity peak demand by 'less than two percent' (New York City 2012). The small proposed BEV fleet of CoD is unlikely to have a major impact on the peak load of the grid.

Chapter 4 – Review of battery electric vehicle adoption and implementation strategies by City of Darwin using three program planning tools

4.1 Possible implementation scenario

A possible implementation scenario for replacement of existing passenger fleet vehicles with BEVs is illustrated and reviewed taking into account the considerations discussed in Chapter 3. The scenario includes a three phase approach. Phase 1 consists of purchasing a Mitsubishi i-MiEV; Phase 2 is a trial of two different BEV models, constrained by market availability; and Phase 3 completes the roll out, pending successful undertaking of Phases 1 and 2.

Phase 1 – Purchase of a Mitsubishi i-MiEV

The initial phase involves the purchase of a Mitsubishi i-MiEV as an additional pool vehicle. Having a BEV amongst the fleet provides CoD staff with the opportunity to familiarise themselves with electric vehicle technology, ultimately reducing resistance which may occur prior to implementation of Phase 2 and 3. Research shows engaging staff during a change of process through communication, participation and support can reduce resistance come time for implementation (Byvelds & Newman 1997; Smollan 2011).

Constraints

CoD's Fleet division is located at the Operations Centre, approximately five kilometres away from the Civic Centre where the vehicle would be housed overnight. This may cause slight issues if the i-MiEV is located at the Civic Centre, so discussions about who is responsible for the vehicle at the Civic Centre will need to occur.

Benefits

Benefits include:

- Increase exposure and awareness of BEVs across the organisation including addressing misconceptions about battery life and power.
- Training opportunities for workshop staff.
- Identifying managers who may be interested in trialling BEVs for Phase 2.
- Reduced greenhouse gas emissions.
- Good external public relations.

If Phase 1 is considered successful and Phase 2 not ready to be implemented (due to unavailability of BEVs or other reason), CoD could take the opportunity to purchase a second i-MiEV which could be housed at the Operations Centre in Winnellie. Not only does it also have the benefits as listed above, it demonstrates good will from senior management (based at the Civic Centre) to the Operations Centre staff.

Phase 2 – One year trial of Nissan Leaf and Renault Fluence Z.E.

The second phase includes a one year trial of the Renault Fluence Z.E. and Nissan Leaf. As Figure 2.5 ‘Size comparisons of available battery electric vehicles against existing City of Darwin fleet vehicles’ demonstrates, these vehicles are the preferred sized vehicle and comparable to existing fleet vehicles (each of similar size to current the fleet vehicles Honda Insight and Camry Hybrid). It is recommended CoD purchase one Fluence Z.E. and two Nissan Leaf, in addition to the existing i-MiEV. This provides CoD with the opportunity to test out a small hatchback as well as a sedan. The Lord Mayor has expressed interest in driving a Nissan Leaf (Newcombe 2012b). Having a second Leaf and a Fluence Z.E. allows managers to trial and provide feedback on the issues identified in Section 3.3 ‘Considerations affecting the uptake of battery electric vehicles’. It is recommended a one year trial be undertaken where four managers are invited to trial the BEVs for a six month period each. The first manager drives the Leaf while the second drives the Fluence Z.E. during the first six months, the third and fourth managers then drive the two vehicles over the second six month period.

Constraints

If the barriers outlined in Section 3.3 ‘Considerations affecting the uptake of battery electric vehicles’ in particular range anxiety, are not appropriately addressed, this may impact on finding four managers who are willing to participate in the trial.

If the funding to purchase the vehicles is unavailable, then purchasing one Leaf and one Fluence Z.E. may be an alternative option. As this Phase is dependent on availability of vehicles, by the time there is availability in the Northern Territory vehicle prices may reduce as efficiencies across the BEV industry improve.

Although CoD currently purchases vehicles, there may be the opportunity to lease the vehicles for the trial period. If the trial was unsuccessful, this would provide CoD with an option to end the lease as opposed to holding onto the vehicles for at least two more years prior to selling (as per current practice to ensure maximum resale

value). To lease fleet vehicles CoD requires approval from the Northern Territory Government Minister for Local Government (Blackburn 2012b).

Benefits

Benefits include:

- Increase exposure and awareness of BEVs across the organisation including addressing misconceptions about battery life and power.
- Training opportunities for workshop staff.
- Reduced greenhouse gas emissions.
- Places CoD as a leader amongst councils.
- Good external public relations.

Phase 3 – Roll out of BEVs

Phase 3 is dependent on the successful implementation and evaluation of Phases 1 and 2, and consists of a progressive roll-out of electric vehicle replacement for Classes 1-3 as contracts are renewed and vehicles are due for replacement.

Benefits

Coupled with the benefits listed in Phase 1 and 2, the other major benefit to CoD will be the impact on its carbon footprint which will be dramatically reduced. This assumes green power of some description is used to power the vehicles whether CoD generates it themselves, purchases membership package or accredited GreenPower from Power and Water Corporation.

Constraints

In part, some of the constraints expected in Phase 3 will reflect those outlined in Phase 1 and Phase 2. However due to the larger scale of Phase 3 and its viability being contingent on the first two phases, there is considerable uncertainty surrounding the potential constraints and as such they are not outlined in this thesis.

4.2 Application of program planning tools

To increase the likelihood of success of projects or programs, managers have at their disposal a range of tools which aid in program development and decision making. Proper project planning includes stakeholder input, shared understanding, direction and purpose, and many programs fail because the planning process was inadequate (Gugiu & Rodriguez-Campis 2007). Using multiple, systematic

frameworks of complementary nature can result in higher success rates. Program logic models, the Cynefin Framework and community-based social marketing theory are accessible complementary tools commonly used in Australia, and when used in tandem, can increase the likelihood of success. Program logic models map out the inputs, activities, outputs and desired results, while the Cynefin Framework helps to identify the appropriate management techniques during program implementation. Community-based social marketing theory can be used once the project mapping has been completed, and provides tools for fostering sustainable behaviours by identifying barriers to behaviours. These three tools, described in detail below, can help to achieve program success for implementation and uptake of BEVs in the CoD fleet, and have been applied to the implementation scenario described previously.

4.3 Program logic models

If CoD chose to undertake the implementation scenario of introducing BEVs and eventually replacing existing passenger fleet vehicles, a project plan would be developed where CoD stakeholders and resources are identified and outcomes agreed to. To ensure the planning phase is undertaken to maximise efficiency and understanding among stakeholders, it is suggested a program mapping tool such as a program logic model be used.

Program logic models provide a visual schematic of a program, demonstrating the linkages between program components and the rationale behind these linkages (Cooksy, Gill & Kelly 2001; Framst 1995; Gugiu & Rodríguez-Campos 2007; Renger & Titcomb 2002). Program logic models inform the project plan where individual tasks and deadlines are captured (Sweeney & Pritchard 2012).

Program logic models were first developed in the early 1960s and have been increasingly used since (Framst 1995). The increased use is spurred by governments passing legislation requiring program evaluation such as the United States of America's *Government Performance and Results Act 1993* which requires organisation to report annually against program goals (Gugiu & Rodríguez-Campos 2007).

Developing a program logic model provides stakeholders with a 'narrative description' where the inputs, activities, outputs, outcomes and often contextual factors including resources are described and relationships highlighted in a logical sequence (Dwyer & Makin 1997; Renger & Titcomb 2002; Yampolskaya et al. 2004). The model also offers the ability to explore factor sensitivities and plan for

corrective action if components alter during project implementation (Sweeney & Pritchard 2012). Although program logic models are used across a range of sectors, the underlying principles are the same (illustrated by Figure 4.1) (Gugiu & Rodríguez-Campos 2007; United Way of America 1996).

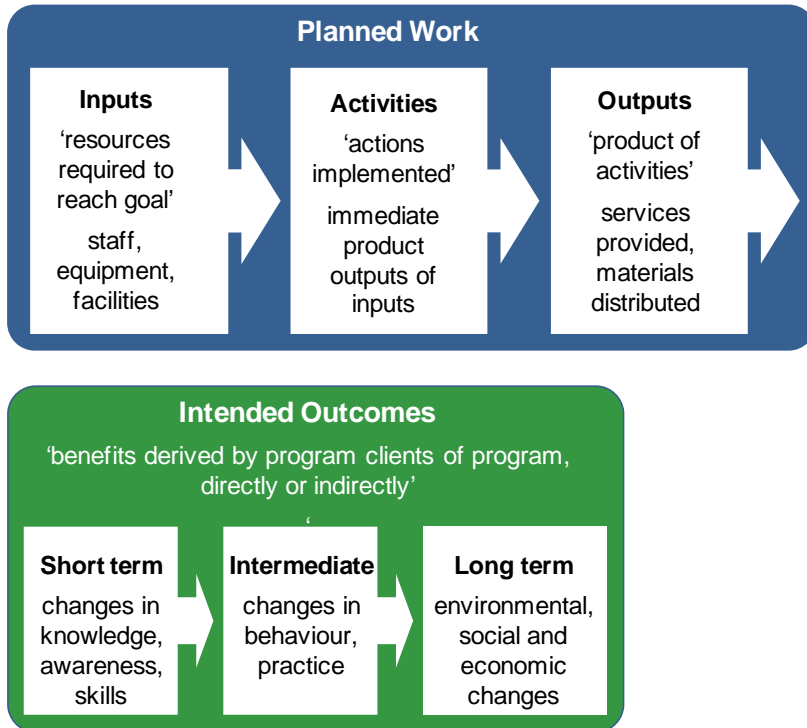


Figure 4.1: Underlying principles of logic models

Source: adapted from Gugiu & Rodríguez-Campos 2007; Sweeney & Pritchard 2012; United Way of America 1996.

Program logic models provide a participatory approach where stakeholder expectations are made explicit from the outset (Cooksy, Gill & Kelly 2001). As a result, common understanding of program goals are identified and agreed upon (Sweeney & Pritchard 2012). The downside however is that the model lacks an explicit list of questions which should be asked during the planning process, making it challenging for inexperienced managers to use (Gugiu & Rodríguez-Campos 2007). Table 4.1 outlines the advantages and disadvantages of using project logic models.

Table 4.1: Advantages and disadvantages for using program logic models

Advantages	Disadvantages
<ul style="list-style-type: none"> • provides a clear summary of the project • expectations of inputs and outcomes are clearly established • creates a common understanding of the program objectives and expected benefits among stakeholders • instills in stakeholders a structured framework for thinking through a project • greater stakeholder involvement resulting in greater commitment to the final project concept • opportunity for open negotiation of project objectives. 	<ul style="list-style-type: none"> • often takes more time than anticipated to construct and verify a model • distinguishing between program <i>impacts</i> and <i>effects</i> can be a challenge for project managers • short and long term impact concepts can easily be confused • a linear model may not be appropriate for complex programs.

Source: adapted from Dwyer & Makin 1997; Framst 1995; Gugiu & Rodríguez-Campos 2007; Sweeney & Pritchard 2012.

4.3.1 Example application of project logic modelling

An example of the use of a logic model in developing a program is discussed in Dwyer and Makin (1997). A local hospital wanted to introduce a bike safety program with the goal:

‘To reduce incidence and severity of bicycle-related head injuries in North York’.

A logic model was developed which outlined the planned work and intended outcomes (see Figure 4.2).

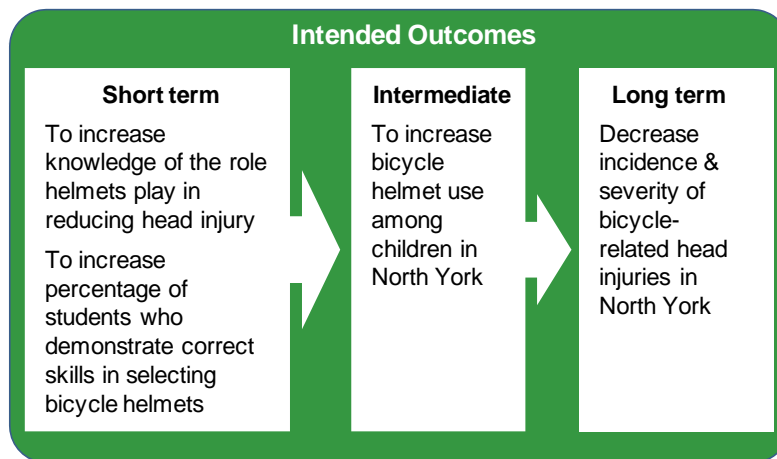
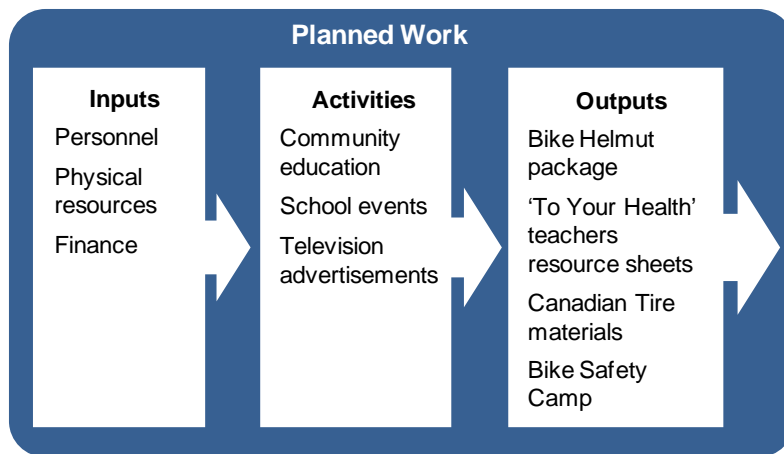


Figure 4.2: Bicycle safety program logic model

Source: adapted from Dwyer & Makin 1997.

The project control team referred to questions sourced from Rutman (1980) and Smith (1989) to ensure all aspects of the program had been accounted for including:

- Are the objectives clearly stated and measurable?
- Are the components/activities well defined?
- Are the type and amount of activities sufficient to achieve the desired outcomes?
- Are the causal linkages in the logic model plausible?
- Are the type and amount of resources sufficient?

The program was successfully implemented in 1995, and is continually evaluated to ensure the target audience and messages are reached (Dwyer & Makin 1997).

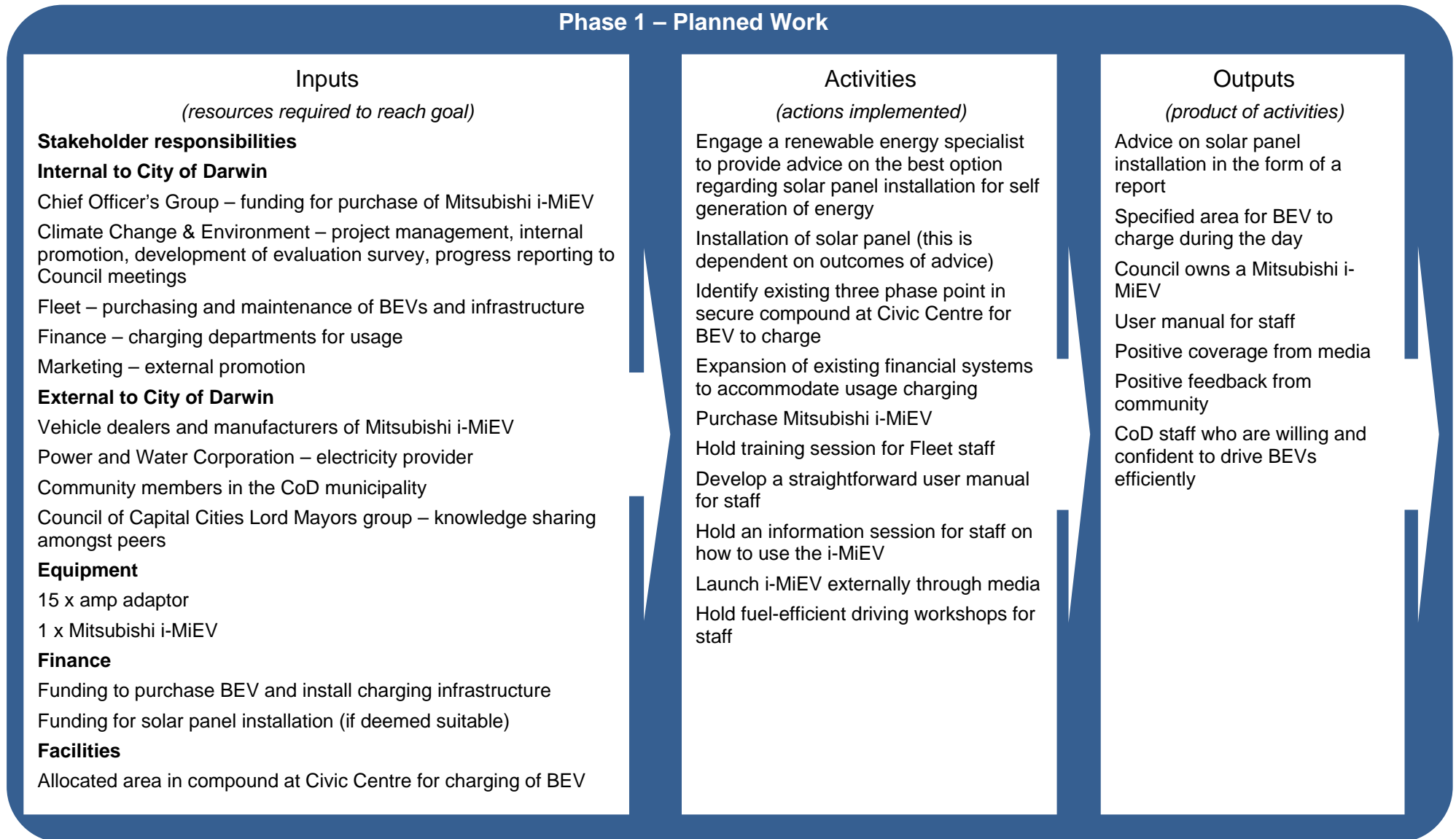
4.3.2 Application of project logic modelling to the battery electric vehicle implementation scenario

A program logic model maps the project from the start to end highlighting outcomes at different project stages. In the case of CoD, its objective is:

‘To decrease City of Darwin’s fleet-related greenhouse gas emissions.’

Three project logic models have been developed to represent each of the three phases in the implementation scenario.

Figure 4.3: Project logic model – Phase 1 purchase of a Mitsubishi i-MiEV



Phase 1 – Intended Outcomes

Short Term

(changes in knowledge, awareness, skills)

- Increased exposure of BEVs for CoD managers and staff
- Positive public response as CoD is demonstrating commitment to reducing its carbon footprint
- Fleet staff trained in BEV maintenance

Intermediate

(changes in behaviour, practice)

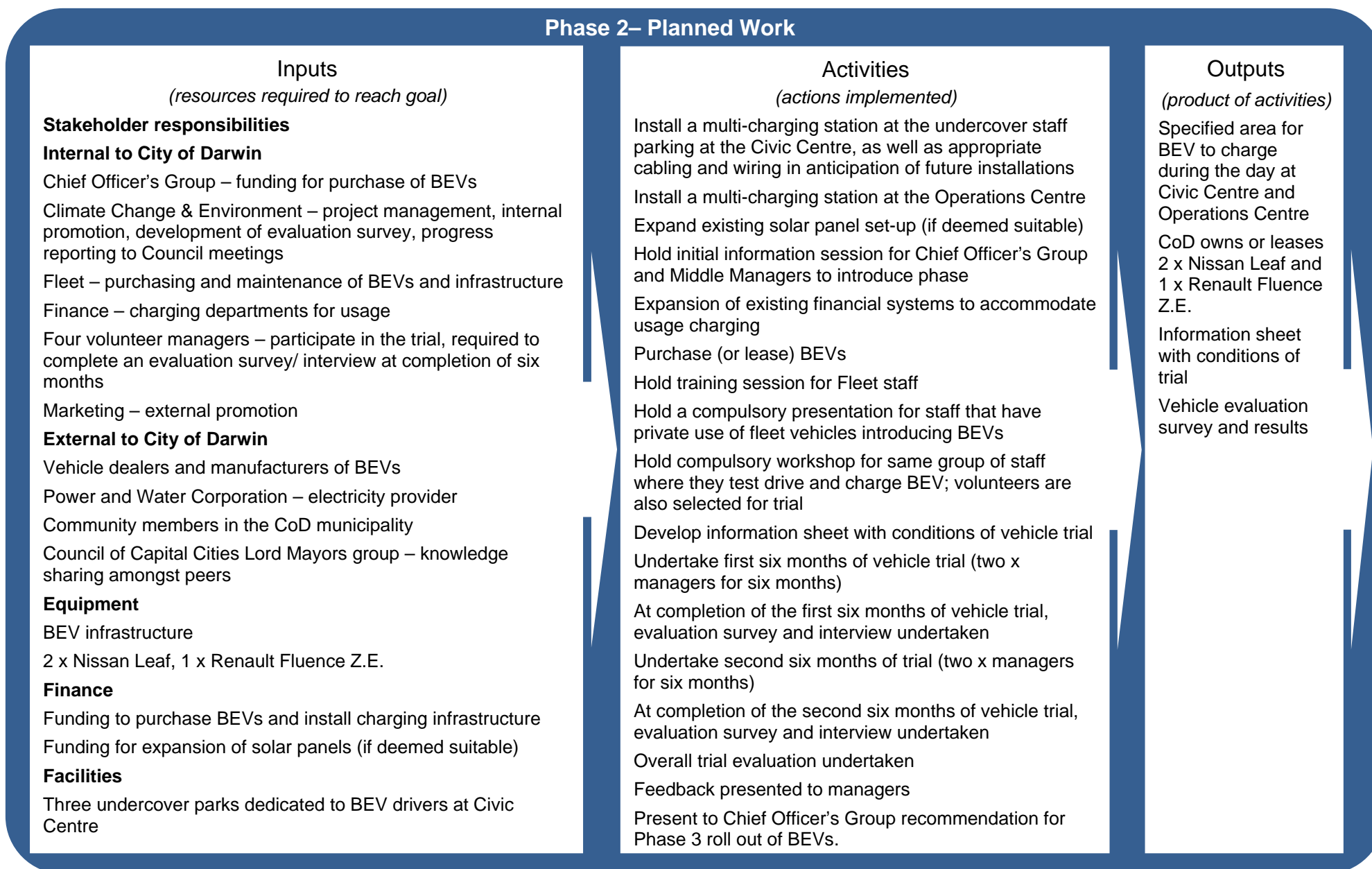
- Increased exposure of BEV to peers and community
- Reduction in fuel costs
- Reduction in CoD corporate fleet related greenhouse gas emissions

Long Term

(environmental, social and economic changes)

- CoD increasingly seen as a leader in climate change and environment issues
- Gradual roll out of BEVs across the fleet (Phase 2 and 3)
- CoD has a carbon neutral passenger fleet
- BEV industry in the Northern Territory matures

Figure 4.4: Project logic model – Phase 2 one year trial of Nissan Leaf and Renault Fluence Z.E.



Phase 2 – Intended Outcomes

Short Term

(changes in knowledge, awareness, skills)

- Increased exposure of BEVs to CoD managers and staff
- Community confidence in BEV technology increased
- Demonstrated leadership by Lord Mayor driving a BEV
- Positive public response as CoD demonstrates commitment to reducing its carbon footprint
- Fleet staff trained in BEV maintenance

Intermediate

(changes in behaviour, practice)

- Increased exposure of BEV to peers and community
- Reduction in fuel costs
- Reduction in CoD corporate fleet related greenhouse gas emissions
- Installation of charging infrastructure

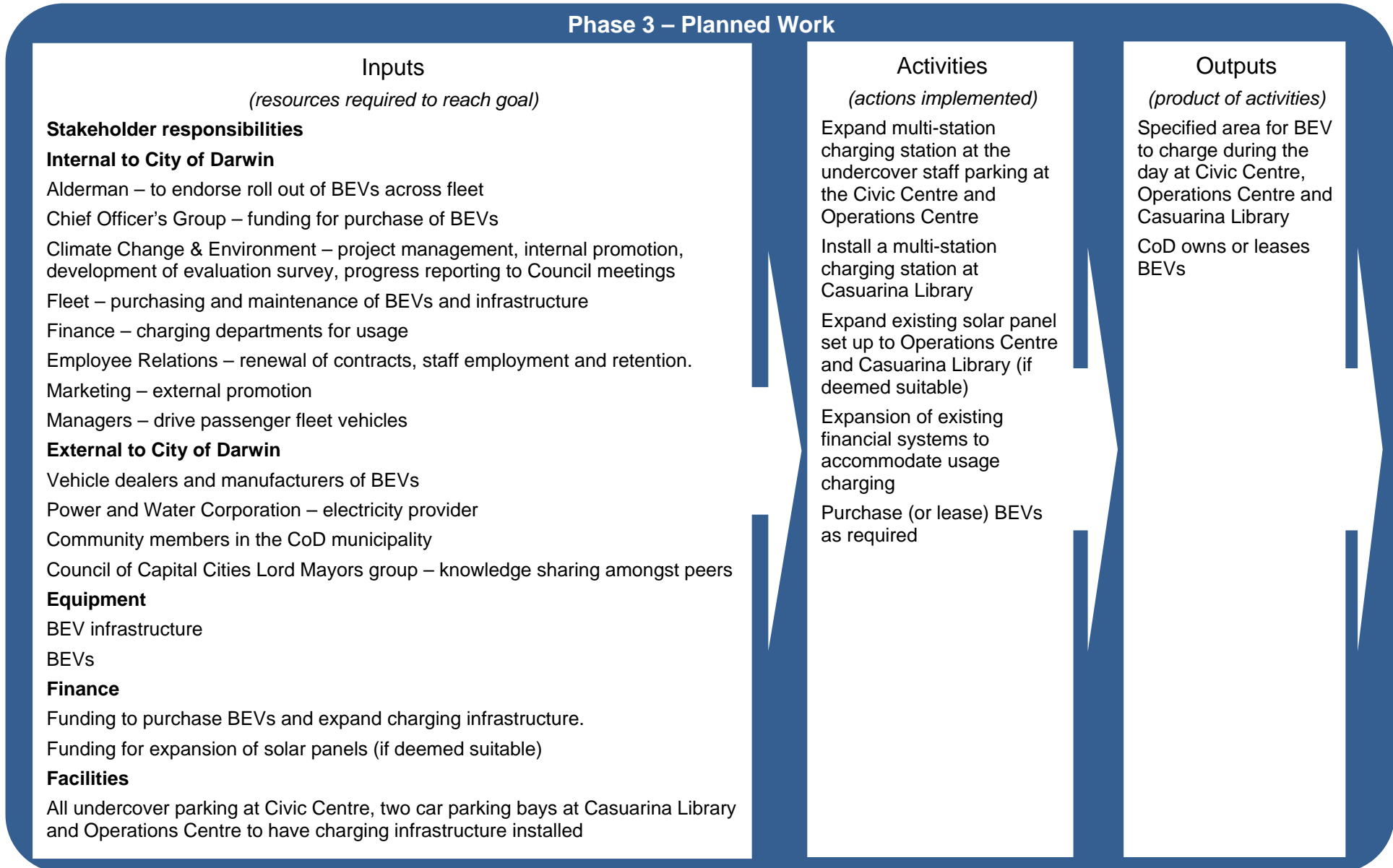
Long Term

(environmental, social and economic changes)

- CoD seen as a leader in climate change and environment issues
- Gradual roll out of BEVs occurs (Phase 3)
- CoD has a carbon neutral passenger fleet
- BEV industry in the Northern Territory matures

Figure 4.5: Project logic model – Phase 3 roll out of battery electric vehicles

Phase 3 assumes Phase 1 and 2 have been successful, and that there is funding for future replacement of existing vehicles with BEVs.



Phase 3 – Intended Outcomes

Short Term

(changes in knowledge, awareness, skills)

Increased exposure of BEVs to CoD managers and staff

Community confidence in BEV technology increased

Demonstrated leadership as CoD managers drive BEVs

Positive public response as CoD is demonstrating commitment to reducing its carbon footprint

Intermediate

(changes in behaviour, practice)

Increased exposure of BEVs to peers and community

Reduction in fuel costs

Reduction in CoD corporate fleet related greenhouse gas emissions

Long Term

(environmental, social and economic changes)

CoD increasingly seen as a leader in climate change and environment issues

CoD has a carbon neutral passenger fleet

BEV industry in the Northern Territory matures

CoD looks to work with other organisations such as Charles Darwin University and Power and Water Corporation to provide a network of community charging stations

By mapping out the project plan, stakeholders are engaged and understand their responsibilities as well as the agreed, shared outcomes.

4.4 Cynefin Framework

Climate change issues are difficult to deal with as they are multi-disciplinary and involve a range of stakeholders (Curran 2009). To increase the likelihood of success, sense-making frameworks can be applied to ensure the appropriate project management techniques are employed (Sturmborg & Martin 2008). Sense-making is the process of giving meaning to an experience (Klein, Moon & Hoffman 2006). An example of such a framework is the Cynefin Framework.

The Cynefin Framework is a flexible tool which allows complex systems to be explored, analysed and structured (Hasan 2012; Snowden 2005). The framework, developed by David Snowden in the late 1990s, uses ontologies to explore causal relationships within a system and explore the way in which a project can be approached (Elford 2012). An ontology is a set of concepts grouped in a certain way (Corazzon 2012; Obitko 2007). The ontologies within the Cynefin Framework include 'ordered', 'unordered' and 'disorder' domains where the characteristics of each domain determines the management and action paths (Callahan 2004). The ontologies highlight specific management techniques used to reach an effective outcome and avoid costly mistakes (Callahan 2004; Elford 2012).

The ordered ontology includes the simple and complicated domains (see Figure 4.6). These are considered relatively straightforward where cause equals effect (although in complicated systems there may be a lag). Ordered domains are considered best practice and use fact-based management (Kurtz & Snowden 2003). Management techniques for dealing with the ordered ontology include standard operating procedures, systems thinking, and expert opinions (Kurtz & Snowden 2003).

The unordered ontology includes complex and chaotic domains where there is no obvious link between cause and effect (see Figure 4.6). There are generally no clear patterns in the unordered ontology, so new and emerging patterns must be identified which can be difficult (Snowden & Boone 2007). Sustainability and climate change issues generally fit into the unordered ontology as they require 'more challenging long-term perspectives' (Curran 2009; Hasan 2012). Management practices for this ontology include pattern, adaptive and crisis management techniques (Snowden & Boone 2007).

The third ontology includes the disorder domain. Problems, programs and projects which fall into this category are often referred to as 'wicked' problems (Kazlauskas &

Hasan 2009). Wicked problems are those which cannot be solved easily and are considered 'destructive' (Kazlauskas & Hasan 2009). Snowden and Boone (2007) describe this ontology as 'multiple perspectives jostle for prominence, factional leaders argue with one another, and cacophony rules'. The best management approach for a project in the disorder ontology is to isolate parts of the bigger project and guide them individually to one of the other four domains (Kazlauskas & Hasan 2009; Snowden & Boone 2007).

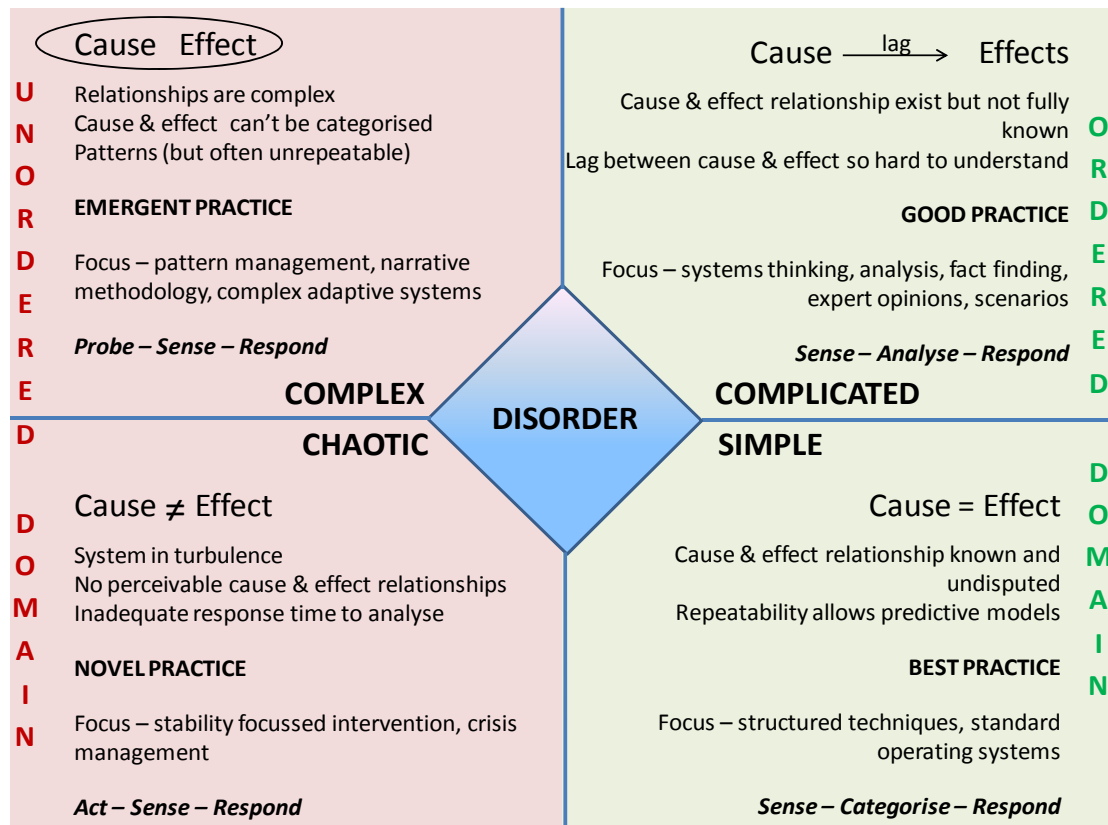


Figure 4.6: The Cynefin Framework demonstrating the three ontologies and domain principles

Source: adapted from Kurtz & Snowden 2003; Snowden 2005; Snowden & Boone 2007; Sturmborg & Martin 2008.

The Simple Domain

The simple domain requires managers to sense, categorise and then respond (Snowden & Boone 2007). Snowden and Boone (2007) illustrate the simple domain using an example of a borrower falling behind with his loan payments and the employee of the lending company analysing the situation. The reason why the borrower has fallen behind is categorised by the employee according to an existing procedure. The procedure outlines steps which must occur and how the employee

must respond to the situation. The example demonstrates a 'command and control' management technique where directives are straightforward, tried and tested procedures are in place, and outcomes are known (Hasan 2012; Snowden & Boone 2007).

The simple domain is considered the most straightforward domain as the outcome is known, and cause equals effect (Hasan 2012). There are downfalls to a simple domain however. Snowden and Boone (2007) highlight three potential areas. The first is referred to as 'entrained thinking' which prevents managers from seeking new innovative ways to complete tasks. Although 'best practice' is generally considered leading the way, Snowden and Boone (2007) point out that best practice is past practice and not innovative. The second downfall relates to over simplifying projects which can result in incorrectly assigning projects into the wrong domains. However it should be noted that this is a downfall of any domain, not only the simple domain. The third downfall relates to managers finding a balance between complacency (which can propel a project into the chaos domain) and micro-managing project staff (Snowden & Boone 2007).

The Complicated Domain

The complicated domain differs from the simple due to the time lag before the cause and effect relationship becomes evident. This domain is often referred to as the 'domain of the expert' (Hasan 2012; Snowden & Boone 2007). It requires managers to assess the situation, but instead of categorising it straight away, analyse it with the aid of expert advice before responding (Snowden & Boone 2007). Once the lag has ended, the interacting elements are able to be identified and defined (Hasan 2012). Snowden and Boone (2007) provide the example of a motorist who is aware of something wrong with his vehicle but unsure of the issue. The motorist takes it to the mechanic (the expert) who investigates and identifies the issue.

The Complex Domain

The first of the unordered ontology is the complex domain. In comparison to the complicated 'unknown knowns', the complex is considered the 'unknown unknowns', requiring managers to probe, sense and then respond (Snowden & Boone 2007). Managers must first probe the situation and then wait for the next steps to reveal themselves as imposing a 'course of action' is likely to be unsuccessful due to numerous interacting elements (Kazlauskas & Hasan 2009; Snowden & Boone 2007). Managers will only be able to understand a situation once it has run its course (Hasan 2012). Millar, Stephenson and Stephen (2007) highlight a rainforest

as a complex domain as it has dynamic conditions including changing weather patterns, the introduction of pests, the extinction of animals, external water pressures, etc. In comparison to the vehicle example in the complicated domain, where the vehicle is the sum of its parts, in a complex situation ‘the whole is far more than the sum of its parts’ (Snowden & Boone 2007).

The Chaos Domain

The chaos domain is the second in the unordered ontology and Snowden and Boone (2007) describe it by saying ‘searching for right answers would be pointless: the relationships between cause and effect are impossible to determine because they shift constantly and no manageable patterns exist—only turbulence.’ In a chaos situation, the manager must act, sense and then respond. In the first instance order must be restored. The next step is to respond in a manner which changes the domain of the situation, moving it to a complex domain (Snowden & Boone 2007). Once the situation is downgraded the manager can start to look for patterns or future opportunities, but before that the chaos domain requires emergency management. Snowden and Boone (2007) highlight the terrorist attacks of 11 September 2001 as a chaos situation and commend the mayor of the time on his ability to act and restore order. The literature does reiterate however, that once order is restored, managers must alter their management style to match the ‘context shift’ (Snowden & Boone 2007).

In order to identify which domain a problem sits in, seven aspects should be considered, and then applied to the project (Rogers 2011). Answers then identify which domain the project sits in and how it should be managed using the techniques outlined above. The aspects are outlined in Table 4.2. Note these aspects cannot be used for the chaos domain as it is difficult to define an answer as the cause and effect relationships are in constant turbulence (Rogers 2011; Snowden & Boone 2007).

Table 4.2: Seven aspects to consider when applying the Cynefin Framework

Aspect		Domain Type		
		Simple	Complicated	Complex
1	Governance – who's involved?	Single organisation	Multiple organisations	Multiple organisations where roles are not defined
2	Focus – what is to be achieved?	Single set of outcomes	Different stakeholders expect different outcomes on different levels	Different intended outcomes emerge overtime
3	Consistency – what does intervention look like?	Best practice standards	What works for whom	Ongoing adaptation to emerging issues Engaging with each individual group
4	Necessariness – are there other ways to derive the same results?	Only way to achieve intended outcomes	One of several ways Can be identified in advance	One of several ways Overtime results emerge
5	Sufficiency – is there enough information to produce intended results?	Produce results by itself	Only works in conjunction with other programs	As with complicated, only works in conjunction with other programs
6	Change trajectory – what is the close response relationship overtime?	Constant, known relationship	Non-linear but knowable with expertise	Emergent as tipping points are unpredictable
7	Unintended impacts – how are unintended impacts accounted for and managed, both positive and negative impacts?	Easily anticipated and monitored	Arise in particular situations Knowable with expert opinion Risk management Early warnings	Emergent behaviours or outcomes

Source: adapted from Rogers 2011.

4.4.1 Example application of the Cynefin Framework

Van Beurden et al. (2011) describes health promotion issues using the Cynefin Framework. As health promotion issues vary greatly, so do the domains in which they belong too, and consequently the management methods required to deal with them. For example, reducing hot water scalds in children has a relatively obvious cause and effect relationship as the issues causing the effect can be identified and prevented (Van Beurden et al. 2011). This example sits in the simple domain as there are existing evidence-based procedures which can be used such as the ‘Hot Water Burns Like Fire’ prevention campaign program (Smith & Price 2002).

Other health promotion issues are far more intricate and require multifaceted approaches. For example, addressing the issue of increasing physical activity among children in child care is more difficult as there are multiple factors which may influence the result (Van Beurden et al. 2011). Are the carers trained to undertake physical activity? Is there the space to undertake physical activity? Are the children able to participate? Are the carers adequately trained in first aid practices? Are the children dressed appropriately? Do any of the children have a health issue that prevents them from undertaking physical activity? There is no evident direct link between cause and effect, so issues such as physical activity sit in the complex domain. By addressing individual aspects of the issue, it can be moved to the complicated domain (Hasan & Kazlauskas 2009).

4.4.2 Application of Cynefin Framework to the battery electric vehicle implementation scenario

Applying the Cynefin Framework to a project provides guidance on which project management techniques should be employed. The Framework has been applied to the possible implementation scenario for the replacement of existing vehicles with BEVs in CoD’s fleet by considering the seven aspects (see Table 4.3).

Table 4.3: Benefits to replacing existing passenger vehicles with battery electric vehicles using the Cynefin framework

Aspect	Domain	Reasoning
1. Governance – who’s involved?	Simple	Although there are external stakeholders, the governance is within a single organisation – City of Darwin.
2. Focus – what is to be achieved?	Complicated	The different internal stakeholders expect different outcomes on different levels. For example:

Aspect	Domain	Reasoning
		<ul style="list-style-type: none"> • Elected members (Alderman and Lord Mayor) expect positive feedback outcomes from the community • Chief Officer's Group expects reduced whole-of-life costs • Fleet division expects reduced frequency of maintenance • Climate Change & Environment division expects reduced carbon emissions and behaviour change outcomes • Marketing division expects promotional opportunities with positive feedback • Employee Relations division expects smooth transition of renewal of contracts as staff are well informed • Managers driving the BEVs expect to be properly informed prior to and during implementation, and for smooth transition from existing vehicles to BEVs.
3. Consistency – what does intervention look like?	Complicated	<p>Although Figure 3.6 Average daily kilometres driven City of Darwin Class 1-3 vehicles (2013 forecast) demonstrates suitable battery life for the BEV, this assumes that no longer trips are regularly taken. For example, a manager may live in the rural town of Acacia. Although Acacia is approximately 120 kilometres round trip to CoD, this would only allow them an extra 180 kilometres (in a Nissan Leaf and Renault Fluence Z.E. respectively) on the weekend. This may be seen as penalising staff who live in the rural area as managers who live closer to town have more 'kilometres' to drive on one charged battery. To counter this, different approaches may be required for individual cases.</p>
4. Necessariness – are there other ways to derive the same results?	Complicated	<p>There are several ways to reduce CoD's carbon footprint, and the introduction of BEVs into the fleet is one of them.</p>
5. Sufficiency – is there enough information to produce intended results?	Complicated	<p>Replacing BEVs in the fleet without consultation and engagement of the proposed users could result in an unsuccessful program. As a result, other information and programs such as a behaviour change and maintenance training programs will need to be developed to increase likelihood of success.</p>
6. Change trajectory – what is the response relationship over time?	Complicated	<p>Although it can be difficult to predict, the literature suggests replacement and uptake of BEVs can occur smoothly, as long as the issues outlined in Section 3.3 'Considerations affecting the uptake of battery electric vehicles are taken into account'.</p>

Aspect	Domain	Reasoning
7. Unintended impacts – how are unintended impacts accounted for and managed, both positive and negative impacts?	Complicated	The unintended impacts can be easily anticipated as this is not a new project and has been previously undertaken by other organisations. Therefore being familiar with the literature can identify unintended impacts and experienced methods of how to deal with it.

As the majority of considerations sit in the complicated domain, then management techniques will largely be around systems thinking, scenario planning and acquiring expert opinions. However, as illustrated, there are some elements of the approach which are in the simple domain, and can be dealt with existing structures including standard operating procedures.

4.5 Community-based social marketing theory

Ensuring that any replaced vehicle has the same capability as current vehicles will play an important role in convincing CoD managers of the benefits of electric vehicles and in effect, increasing uptake. As previously discussed, there is only opportunity to replace current Class 1-3 vehicles with BEVs at this stage (see Table 3.6). The vehicles in Classes 1-3 are allocated to managers who have a 300 kilometre driving allowance to unrestricted use in the Northern Territory and Australia. The literature demonstrates that by engaging staff through communication, participation and support can reduce resistance to change (Byvelds & Newman 1997; Smollan 2011). Taking this into account, CoD should develop a behaviour change campaign in order to increase uptake. Community-based social marketing theory provides tools and principles to do this.

Community-based social marketing (CBSM) theory offers a way in which to successfully implement programs and ensure uptake (Flocks et al. 2011). CBSM is a combination of social psychology research and marketing strategies (Flocks et al. 2011). If undertaken at a community level, it is an effective methodology for fostering behaviour changes (McKenzie-Mohr 2000b). It can also increase the effectiveness of environmental regulatory frameworks (Kennedy 2010). CBSM was first coined by Doug McKenzie-Mohr in the mid 1990s as an alternative to traditional means of information promotion which were not resulting in the desired behaviour changes (McKenzie-Mohr 2000a).

The major difference between traditional marketing processes and CBSM is the time spent on identifying barriers and benefits with the intention of preventing the

undesired behaviour while promoting the desired behaviour (Thompson 2008). CBSM has five major steps in program development outlined below.

Step 1. Selecting behaviours

The desired behaviour change must be an end-state behaviour and not a divisible behaviour. An end-state behaviour refers to a specific behaviour which actually causes the desired effect. For example, if the desired outcome is to reduce energy efficiency through change of lighting, then buying compact fluorescent light bulbs is not an end-state behaviour. The desired behaviour is the installation of the bulbs which will impact on energy consumption. The purchase of the bulbs is a step towards reaching the desired behaviour.

A divisible behaviour is where more than one behaviour contributes to an outcome. McKenzie-Mohr (2012) provides the example of a desired behaviour as increasing home electricity efficiency by installing insulation. Installing insulation in an attic is an inexpensive and relatively easy process, whereas installing insulation to the walls is time consuming and expensive. In order to reach the desired behaviour, CBSM states that separate programs would need to be developed for the attic and the walls, as each process has different barriers to success. McKenzie-Mohr (2012) warns 'failure to create a list of non-divisible behaviours will jeopardize the development of effective strategies as there will be insufficient information regarding the barriers to specific behaviours'.

Step 2. Identifying the barriers and benefits to an activity

Identifying barriers to a behaviour change is crucial for a program to be successful. Understanding why someone will not do something provides the program planner with an insight as to how to develop a program. The following steps and questions should be undertaken in identifying key barriers and benefits:

- What 'class' of behaviour is to be promoted? A one-time or repetitive action?
- What is the potential of an action to bring about the desired change?
- Review relevant literature to identify recorded trends or results.
- Observe people undertaking the desired behaviour to identify recorded trends or results.
- Undertake focus groups to understand attitudes and behaviours towards the desired behaviour.
- Undertake a survey of a sub section of the focus group to further dissect the barriers (McKenzie-Mohr 2000c; Thompson 2008).

Step 3. Developing a strategy that utilises effective tools in changing behaviour

CBSM focuses on two behaviours. The first is encouraged and has associated benefits, and the second is discouraged and is associated with barriers (McKenzie-Mohr 2012). By increasing the likelihood of the undesired behaviour, the desired behaviour appears attractive and has a higher chance of take up (Figure 4.7).

Behavior	Barriers	Benefits
Encourage	↓	↑
Discourage	↑	↓

Figure 4.7: Increasing benefits and barriers by encouraging or discouraging certain behaviours using community-based social marketing theory

Source: McKenzie-Mohr 2012.

There are a range of tools which can be incorporated into a strategy. Each tool has different effects, and managers must pick the most appropriate tools for their identified benefits and barriers. Larger programs may require many tools, where smaller programs may only require one or two. Tools include:

- Commitment – asking a small request initially which can lead the way for a subsequent larger request.
- Social norms – doing what others do.
- Social diffusion – the way new ideas spread through society.
- Trusted other – people are more likely to uptake if someone they trust is doing it.
- Prompts – visual aids that remind.
- Communication – understand the audience, use credible sources, frame messages, provide feedback.
- Incentives – work better in some situations than others.
- Convenience – vital in the successful implementation of a desired behaviour (Kennedy 2010; McKenzie-Mohr 2012).

Once the strategy is developed using the above tools, focus groups should be used to provide comment and feedback.

Step 4. Piloting the strategy

A minimum of two groups should be used to pilot the strategy and should not be the group who provided input into the barriers and benefits. In order to assess the strategy and the desired behaviour change, it is recommended not to rely solely on individuals reporting on their own behaviour, but to visit organisations and review records as well (McKenzie-Mohr 2012).

Step 5. Broad-scale Implementation

If the pilot is successful, the strategy is ready to be implemented. If the pilot is not successful, the first four steps are repeated to identify why, and the program redesigned to reflect the learnings from the four steps.

4.5.1 Example application of community-based social marketing theory

Newman (2000) and McKenzie-Mohr (2012) report on an example where Boulder City Council, United States of America, wanted to promote sustainable methods of transportation. The Council held a series of public forums where the barriers and benefits were highlighted and discussed. The project team identified and discussed each barrier, how it could be overcome, and articulated the benefits of the desired behaviour. A major barrier was the inconvenience of catching public transport. In order to reduce the impact of this barrier, the Council altered the bus fleet make up to include smaller sized busses which ran at a greater frequency than the previous larger vehicles. This reduced the barrier, while increasing the benefit at the same time. Other tools such as incentives, social norms and communication were used to promote the desired behaviour changes. Results demonstrated increases in transit, bicycle and pedestrian trips across the community (desired behaviour) and a shift away from single-occupant vehicles (undesired behaviour) (Newman 2000).

4.5.2 Application of community-based social marketing theory to the battery electric vehicle implementation scenario

The five broad steps of CBSM theory have been applied to the BEV implementation scenario as a whole to ensure an all encompassing approach.

Step 1 – Selected behaviour / activity

The selected behaviour is:

‘For managers to replace their existing vehicles with a BEV.’

Step 2 – Identifying barriers and benefits

A review of the literature and discussions with CoD staff identified the benefits and barriers to replacing existing fleet vehicles with BEVs. The benefits are listed in Table 4.4, while the barriers are dissected further to understand the root causes. The barriers are essentially the social considerations outlined in Section 3.3 ‘Considerations affecting the uptake of battery electric vehicles’.

Table 4.4: Benefits to replacing existing passenger vehicles with battery electric vehicles

Benefit to the driver	Benefit to CoD
<ul style="list-style-type: none">• time not spent filling vehicle with petrol• priority parking• manager seen as cooperative/ good leader• demonstrates early adopter behaviour• reduces individual and Council footprint.	<ul style="list-style-type: none">• increases awareness and exposure across organisation• CoD seen as a leader in climate change policies amongst other local governments• reduced fuel consumption and costs.

Source: adapted from Adelaide City Council 2009; Blackburn 2012a; Feeney et al. 2012; Fellner & Newman 2000; Lamb 2011; Lee, Lee & Lim 2010; Loeser & La Vorgna 2011; Morgan 2012; Newcombe 2012b; Scott 2012; Waldron & Kobylarek 2011.

Understanding the root causes of the barriers increases the likelihood of success of a program (Seyfang & Haxeltine 2010). As Figure 4.8 demonstrates, when the barriers are dissected further to reveal their root cause, lack of awareness of BEV capability is the major root cause, highlighting the need for a behaviour change program.

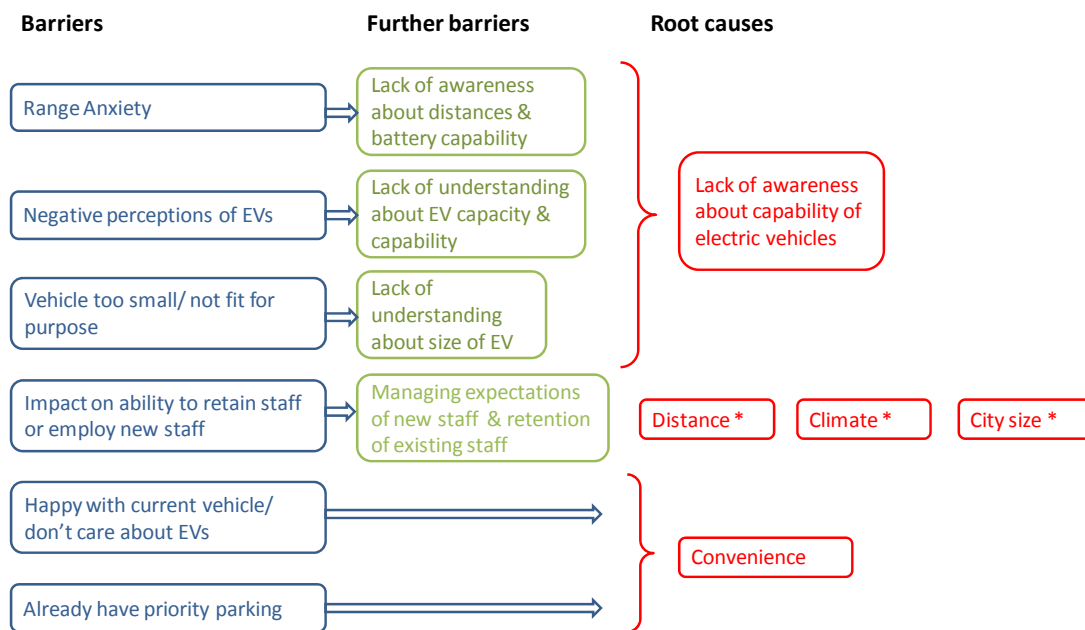


Figure 4.8: Root causes to replacing existing passenger vehicles with battery electric vehicles

**These root causes are not addressed in this thesis as they are broader issues for the Northern Territory.*

Step 3 – Developing a strategy that utilises ‘tools’ that have been shown to be effective in changing behaviour

Table 4.5 outlines the suggested CBSM strategy and the tools which could be used. It assumes senior management (Chief Officer’s Group) has endorsed the implementation scenario in Section 4.1 ‘Possible implementation scenario’.

Table 4.5: Behaviour change tools for community-based social marketing used to increase uptake of battery electric vehicle

Project stages	Behaviour change tools	Impact on benefit, barrier
Three meetings are held: Meeting 1 Initial information is provided at a combined Chief Officers Group/ Middle Managers meeting including: <ul style="list-style-type: none"> intention to green the fleet and reduce CoD’s carbon footprint introduction to BEVs how it links to CoD’s strategic document and the <i>Climate Change Action Plan</i> 	Communication	Reduces the barrier of ‘lack of awareness and capability of BEVs’ by setting the scene in regards to CoD’s commitment to reducing its carbon footprint and acting as a leader in the community. This meeting also introduces the BEV.

Project stages	Behaviour change tools	Impact on benefit, barrier
<p>2011-2020</p> <ul style="list-style-type: none"> expectation of CoD as a leader in the community and needs to 'walk the talk' <p>After the meeting, Chief Executive Officer forwards brochure on Nissan Leaf and Renault Fluence Z.E. to managers for information.</p>		
<p>Meeting 2</p> <p>A special, compulsory presentation for managers who drive a fleet passenger vehicle. This session covers:</p> <ul style="list-style-type: none"> background on BEVs how they work information on battery range, size of vehicles and general capability comparison against current fleet vehicles environmental and financial benefits explanation of the one year trial (Phase 2) provided guest speaker from an external organisation who owns a BEV to answer questions. 	<p>Communication</p> <p>Social norm</p> <p>Trusted other</p>	<p>Reduces the barrier of 'lack of awareness and capability of BEVs' by providing information on how the BEV works and the impact it may have on BEV drivers (i.e. the managers).</p> <p>Highlights benefits including priority parking, time not spent filling vehicles, and managers seen as a good leader.</p>
<p>Meeting 3</p> <p>A second compulsory meeting takes a 'hands-on approach' where the Leaf and Fluence Z.E. are on view. Staff are provided with the opportunity to recharge and test drive the vehicles.</p> <p>At the end of the session, four volunteers are requested to participate in the trial. If more than four volunteers, then their names are randomly selected.</p>	<p>Commitment</p>	<p>Reduces the barrier of 'lack of awareness and capability of BEVs' by providing a 'touch and feel' opportunity so managers can experience firsthand.</p>
<p>Remove three undercover staff car parks, install charging infrastructure, and designate the car parks to BEVs (although ideally the i-MiEV would charge at this location, as it is not secure, it will continue to be charged overnight in the secure compound at CoD).</p> <p>Eventually replace all undercover parking with charging stations so BEVs have priority parking.</p>	<p>Incentive</p>	<p>Increases the barrier by removing the convenience of parking undercover for those who currently have an allocated car park.</p> <p>Increases the incentive to drive a BEV as guaranteed access to undercover parking.</p>
<p>Lord Mayor replaces existing vehicle with BEV and undertakes the following activities to promote and provide updates:</p> <ul style="list-style-type: none"> regular weekly radio segment social media such as Twitter and 	<p>Social norm</p> <p>Trusted other</p>	<p>Reduces the barrier of 'lack of awareness and capability of BEVs' by demonstrating someone else respected has trust in the activity.</p>

Project stages	Behaviour change tools	Impact on benefit, barrier
Facebook <ul style="list-style-type: none"> • local newspaper interview • CoD website. 		

Step 4 –Piloting the strategy

The second phase is the pilot or trial phase. It is recommended a one year trial of the Renault Fluence Z.E. and Nissan Leaf is undertaken. As McKenzie-Mohr (2012) suggests, a minimum of two groups should be used to pilot the strategy.

As part of the trial, four managers should trial a vehicle for a six month block each. The first manager drives the Leaf while the second drives the Fluence Z.E. during the first six months, the third and fourth managers then drive the two vehicles over the second six month period, culminating in a one year trial. Using a six month trial block has dual benefits. Firstly, the greater number of managers who have firsthand experience with the vehicle may reduce resistance when change occurs at a later date. In conjunction, if the manager has a good experience and is considered a 'trusted other' then this has a flow on effect on their peers. Secondly, if the vehicle does not meet the managers needs (in terms of range or other issues), then they have the opportunity to return to their original vehicle after a six month period.

To evaluate the success of the trial, managers will be asked to attend an interview to discuss the following topics:

- issues they had with charging the BEV, or with the vehicle in general
- suggested improvements
- would they recommend BEVs to others
- would they consider replacing their existing fleet vehicle with a BEV either
- immediately
- at the time of vehicle replacement
- when renewing their employment contract
- other feedback.

This information would then be used to strengthen Phase 3 roll out of battery electric vehicles.

Step 5 –Broad scale implementation

Phase 3 (roll out of battery electric vehicles), although dependent on the success of Phases 1 (purchase of a Mitsubishi i-MiEV) and 2 (one year trial of Nissan Leaf and Renault Fluence Z.E.), recommends when existing fleet vehicles are due for replacement (for passenger fleet this is every three years or 60,000 kilometres) (Darwin City Council 1997), the manager is provided with the option to upgrade to a BEV. As managers contracts are renewed (every five years), it is recommended then the current vehicle is replaced with a BEV. Similarly, if the position is vacated, then the existing vehicle is replaced with a BEV for the new incumbent. This will provide a fair and equitable process, as well as a financially responsible one.⁴

⁴ As previously mentioned, although there is the opportunity to replace Classes 1-3 with BEVs, choice of vehicle is a major drawcard for attracting quality senior management (including the Chief Executive Officer) to the City of Darwin. Implementation of the suggested scenario or otherwise must address this in order to gain the support of the Chief Officer's Group.

Chapter 5 – Conclusion and recommendations for including battery electric vehicles into City of Darwin’s fleet

Although CoD’s contribution to global carbon emissions is small, it has an ethical responsibility to reduce its carbon footprint. CoD has recognised this by releasing its *Climate Change Policy* and *Climate Change Action Plan 2012-2020*.

CoD has the opportunity to learn from its peers who are moving towards carbon neutrality by investigating different carbon reducing options. Fleet make-up offers CoD an opportunity to do this. Although CoD has made major adjustments to its fleet by replacing conventional passenger vehicles and trucks with hybrids, leading councils are beginning to replace their existing passenger fleet with BEVs. BEVs are a small but important mitigation option for organisations. However, as demonstrated in this thesis, financial, environmental and social considerations must be addressed and overcome before BEVs could be considered as a viable option for CoD’s passenger fleet. Financial considerations include the purchase and operating costs of the vehicle as well as resale value; cost variance of fuel versus electricity and the related infrastructure costs. Environmental considerations relate to whole of life greenhouse gas emissions and end-of-life battery disposal. Social considerations range from availability of comparable vehicles and the actual size of the vehicle to considerations around range anxiety, CoD’s responsibility to lead by example and the possible impact on the electricity grid. Application of multiple, systematic frameworks such as program logic, the Cynefin Framework and community-based social marketing theory, offer a comprehensive analysis and can maximise the success of the programs such as the implementation scenario outlined in Chapter 4. To maximise successful implementation and take-up of electric vehicles, it is recommended CoD should:

- Endorse the implementation scenario outlined in Chapter 4.
- Undertake the first phase of the implementation scenario immediately, which involves the purchase of a Mitsubishi i-MiEV as an additional pool vehicle. This demonstrates leadership and provides CoD staff the opportunity to become familiar with a BEV.
- Prior to implementing Phase 2 (one year trial of the Renault Fluence Z.E. and Nissan Leaf, or an alternative BEV on the market), undertake a cost-benefit analysis on electricity and green power premiums. Also work with

universities to determine viability of solar panel installation at CoD facilities for own power generation to charge BEVs. This analysis will help inform CoD's decision as to whether it purchases GreenPower from the utility or generates own power.

- Prior to implementing Phase 3 (undertaking a progressive roll-out of BEV replacement for Classes 1-3) review other suitable BEVs on the market. It is recommended the roll-out occurs as staff contracts are renewed and vehicles are due for replacement.
- Use program logic models to highlight expectations around inputs, activities, outputs and intended outcomes prior to the beginning of each phase. Stakeholders including Alderman, Chief Officer's Group, Climate Change & Environment, Fleet, Finance, Employee Relations and Marketing divisions should be involved in this process.
- Use the Cynefin Framework to ensure management techniques are appropriately identified prior to the undertaking the implementation scenario. At this stage, the implementation scenario sits in the complicated domain, requiring expert advice and scenario building to provide the best way forward.
- Develop a behaviour change campaign based on community-based social marketing theory using tools such as incentives, communication, social norms, and trusted other to change the perceptions and behaviours of council staff regarding BEVs prior to undertaking the implementation scenario.
- Continue replacing Class 4 – 11 fleet vehicles with hybrid vehicles wherever possible until suitable BEVs are available.

If CoD chose to implement the three phase scenario of introducing and ultimately replacing existing vehicles with BEVs, not only will this reduce CoD's carbon footprint, but demonstrates its commitment to climate change issues.

References

ABB 2012, *ABB and partners to evaluate the reuse of the Nissan Leaf battery for commercial purposes*, ABB, viewed 09/12/12, <<http://www.abbaustralia.com.au/cawp/seitp202/a2b2d2aff96520bec1257989004e62ae.aspx>>.

Adelaide City Council 2009, *Go Green With Energy - Adelaide City Council Neutral Council Action Plan 2008-2012*, Adelaide.

Alberini, A, Harrington, W & McConnell, V 1995, 'Determinants of participation in accelerated vehicle-retirement programs', *Journal of Economics*, vol. 26, no. 1, p. 19.

Australian Bureau of Statistics 2011a, *3218.0 - Regional Population Growth, Australia, 2009-10*, Australian Government, viewed 09/09/12, <<http://www.abs.gov.au/ausstats/abs@.nsf/Products/3218.0~2011~Main+Features~Northern+Territory?OpenDocument#PARALINK0>>.

Australian Bureau of Statistics 2011b, *3101.0 - Australian Demographic Statistics, Dec 2010*, Australian Government, viewed 10/09/12, <<http://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/85774508661E6720CA2579190013CB5C?opendocument>>.

Australian Government 2011a, *What is GreenPower?*, viewed 24/09/12, <<http://www.greenpower.gov.au/About-Us/What-Is-GreenPower/>>.

Australian Government 2011b, *An overview of the Clean Energy Legislative Package*, viewed 01/09/12, <http://www.cleanenergyfuture.gov.au/wp-content/uploads/2012/05/CEF-overview_Apr2012.pdf>.

Australian Institute of Traffic Planning and Management 2012, 'Electric Vehicles - The Car of the Future?', in *Growing traffic skills and knowledge to deliver sustainable traffic - AITPM Technical Forum*, Melbourne.

AV Environment 2012, *EV Solutions - Electric Vehicle Charging Products & Services*, viewed 03/09/12, <http://evsolutions.avinc.com/products/retail_commercial/>.

Becker, TA, Sidhu, I & Tenderich, B 2009, *Electric Vehicles in the United States - A New Model with Forecasts to 2030*, 2009.1.v.2.0, University of California, Berkley, viewed 27/07/12,

<http://cet.berkeley.edu/dl/CET_Technical%20Brief_EconomicModel2030_f.pdf>.

Beissmann, T 2011, *2012 Ford Focus Electric saves thousands in running costs*, Car Advice, viewed 06/11/12, <<http://www.caradvice.com.au/103841/2012-ford-focus-electric-saves-thousands-in-running-costs/>>.

Better Place 2009, *Better Place research reveals Australian interest in Electric Vehicles in response to climate change concerns*, Sydney, viewed 06/11/12 <<http://www.betterplace.com.au/media/media-releases/better-place-research-reveals-australian-interest-in-electric-vehicles-in-response-to-climate-change-concerns.html>>.

Better Place 2012a, *We make electric cars make sense*, viewed 03/09/12, <<http://www.betterplace.com.au/>>.

Better Place 2012b, *The Renault Fluence Z.E.*, viewed 27/07/12, <<http://www.betterplace.com.au/electric-cars/renault-fluence-ze.html>>.

Birch, R 2010, 'Lower Resale Values an Issue for 'Green' Cars', *Credit Union Journal*, News, p. 1, <http://tn3tv8rl4l.search.serialssolutions.com/?ctx_ver=Z39.88-2004&ctx_enc=info%3Aofi%2Fenc%3AUTF-8&rft_id=info:sid/summon.serialssolutions.com&rft_val_fmt=info:ofi/fmt:kev:mtx:journal&rft.genre=article&rft.atitle=Lower+Resale+Values+An+Issue+For+%27Green%27+Cars&rft.jtitle=Credit+Union+Journal&rft.date=2010-10-11&rft.pub=SourceMedia%2C+Inc&rft.issn=1521-5105&rft.volume=14&rft.issue=41&rft.spage=23&rft.externalDBID=n%2Fa&rft.externalDocID=238985881>.

Blackburn, M 2012a, *Staff retention and car choice*, City of Darwin, Darwin, 26/09/12, face to face discussion.

Blackburn, M 2012b, *Leasing vehicles and ministerial approval*, City of Darwin, Darwin, 27/11/12, face to face discussion.

Brisbane City Council 2012, *Council's Green Commitment*, viewed 13/09/12, <<http://www.brisbane.qld.gov.au/environment-waste/green-living/councils-green-commitment/index.htm>>.

Brown, MA, Levine, MD, Romm, JP, Rosenfeld, AH & Koomey, JG 1998, 'Engineering - Economics studies of energy technologies to reduce greenhouse gas emissions: Opportunities and Challenges', *Annual Review of Energy and the Environment*, vol. 23, no. 1, pp. 287-385, viewed 13/09/12, <<http://www.annualreviews.org/doi/abs/10.1146/annurev.energy.23.1.287>>.

Bureau of Meteorology, Department of Climate Change and Energy Efficiency & CSIRO 2012a, *Australian Climate Change Science Program - Climate Change in Australia – Northern Territory Rainfall Change* viewed 21/03/12, <<http://www.climatechangeinaustralia.gov.au/ntrain1.php>>.

Bureau of Meteorology, Department of Climate Change and Energy Efficiency & CSIRO 2012b, *Australian Climate Change Science Program - Climate Change in Australia – Northern Territory Temperature Change Summer* viewed 21/03/12, <<http://www.climatechangeinaustralia.gov.au/nttemp1.php>>.

Byvelds, R & Newman, J, 1997, *Understanding Change*, Ministry of Agriculture, Food and Rural Affairs, viewed 02/06/12, <<http://www.omafra.gov.on.ca/english/rural/facts/91-014.htm#Strategies%20for%20Successful%20Change>>.

Callahan, S 2004, *Cultivating a Public Sector Knowledge Management*, Idea Group Publishing, Hershey, 1-59140-201, viewed 06/11/12, <http://books.google.com.au/books?hl=en&lr=&id=4ANH1c6b6YC&oi=fnd&pg=PP1&dq=Cultivating+a+Public+Sector+Knowledge+Management&ots=8YbJNhejQ2&sig=gXCi8e_mqzM1WFVTs0upL24b_jg#v=onepage&q=Cultivating%20a%20Public%20Sector%20Knowledge%20Management&f=false>.

Cars Guide 2012, *Buy a car*, News Limited, viewed 06/11/12, <<http://www.carsguide.com.au/buy-a-car#expanded=no&s=true&searchLimit=12&searchOffset=0>>.

Chan, CC 2004, 'Electric vehicles charge forward', *Power and Energy Magazine*, vol. 2, no. 6, Nov - Dec 2004, p. 10, viewed 28/7/12, <http://ieeexplore.ieee.org.ezproxy.cdu.edu.au/xpls/abs_all.jsp?arnumber=1359010&tag=1>

Cikanek, SR & Bailey, KE 2002, 'Regenerative braking system for a hybrid electric vehicle', in *American Control Conference, 2002. Proceedings of the 2002*, vol. 4, pp. 3129-34 vol.4.

City of Melbourne 2012, *Sustainability - Key Programs*, viewed 03/03/12, <<http://www.melbourne.vic.gov.au/Sustainability/KeyPrograms/Pages/KeyPrograms.aspx>>.

City of Perth 2012, *Environment*, viewed 13/09/12, <<http://www.cityofperth.wa.gov.au/web/Council/Environment/>>.

City of San Francisco 2012, *City Fleet Activity - SF Environment*, viewed 24/07/12, <<http://sfenvironment.org/article/fleet-activity/city-fleet-activity>>.

City of Sydney 2012, *Environment* viewed 03/07/12, <<http://www.cityofsydney.nsw.gov.au/Environment/Default.asp>>.

Colquhoun, S 2012, 'Toyota slashes entry price for Hybrid Camry', *Brisbane Times*, 13/03/12, Drive, viewed 05/07/12 <<http://news.drive.com.au/drive/motor-news/toyota-slashes-entry-price-for-hybrid-camry-20120313-1uxq8.html>>.

Cooksy, LJ, Gill, P & Kelly, PA 2001, 'The program logic model as an integrative framework for a multimethod evaluation', *Evaluation and Program Planning*, vol. 24, no. 2, pp. 119-28, <<http://www.sciencedirect.com/science/article/pii/S0149718901000039>>.

Corazzon, R 2012, *The Place of Ontology in Modern Philosophy*, viewed 21/10/12, <<http://www.ontology.co/>>.

Cuenca, RM, Gaines, LL & Vyas, AD 1999, *Evaluation of Electric Vehicle Production and Operating Costs*, ANL/ESD-41, Centre for Transportation Research, Energy Systems Division, Argonne National Laboratory, Illinois, <<http://www.transportation.anl.gov/pdfs/HV/14.pdf>>.

Curran, D 2009, 'Wicked: if you feel like community sustainability is a moving target, that's because it is', *Alternatives Journal*, vol. 35, no. 5, p. 8, viewed 16/11/12, via Academic OneFile (Gale), <<http://go.galegroup.com/ps/i.do?id=GALE%7CA208681722&v=2.1&u=ntu&it=r&p=AONE&sw=w>>.

Darwin City Council 1997, *Plant Reserve Replacement Policy*, Darwin.

Darwin City Council 2008, *Evolving Darwin - A dynamic, different and diverse city. Strategic Directions: Towards 2020 and Beyond*, viewed 03/03/12,
<<http://www.darwin.nt.gov.au/sites/default/files/Evolving%20Darwin%20Towards%202020%20%26%20Beyond%20Strategic%20Plan%20%28June%202011%29.pdf>>.

Darwin City Council 2010, *Climate Change Policy*, viewed 03/03/12,
<<http://www.darwin.nt.gov.au/sites/default/files/documents/Policy%20No%20059%20-%20Climate%20Change%20Policy.pdf>>.

Darwin City Council 2011, *Climate Change Action Plan 2011-2020*, viewed 03/03/12,
<http://www.darwin.nt.gov.au/sites/default/files/images/DCC_ClimateChangeActionPlan_web.pdf>.

Department of Climate Change and Energy Efficiency 2010a, *Carbon Pollution Reduction Scheme - Media Release*, viewed 06/03/12,
<http://www.climatechange.gov.au/minister/previous/wong/2009/media-releases/November/mr20091124.aspx>

Department of Climate Change and Energy Efficiency 2010b, *National Greenhouse Accounts (NGA) Factors*, Canberra.

Department of Climate Change and Energy Efficiency 2011a, *Australia's National Greenhouse Gas Accounts - State and Territory Greenhouse Gas Inventories*, Australian Government, Canberra.

Department of Climate Change and Energy Efficiency 2011b, *Clean Energy Future legislation is passed - Media Release*, Australian Government.

Department of Climate Change and Energy Efficiency 2012a, *Australian National Greenhouse Accounts - National Greenhouse Accounts Factors*, Australian Government, viewed 18/05/12,
<<http://www.climatechange.gov.au/~media/publications/nga/NGA-Factors-20120829-PDF.pdf>>.

Department of Climate Change and Energy Efficiency 2012b, *Australian National Greenhouse Accounts - National Inventory Report 2010*, vol. 1, Australian Government.

Department of Energy 2011, *One Million Electric Vehicles by 2015 - Status Report*, United States of American Government, viewed 11/07/12
<<http://cleanenergysolutions.org/content/one-million-electric-vehicles-2015-february-2011-status-report>>.

Department of Transport 2012, *The Victorian Electric Vehicle Trial - Environmental Impacts of Electric Vehicles in Victoria*, Victorian State Government, viewed 15/07/12, <http://www.transport.vic.gov.au/__data/assets/pdf_file/0010/83665/EV-Environmental-Impacts-of-Electric-Vehicles-in-Victoria.pdf>.

Dhameja, S 2002, *Electric Vehicle Battery Systems*, Butterworth-Heinemann, Massachusetts.

Dwyer, JJ & Makin, S 1997, 'Using a program logic model that focuses on performance measurement to develop a program', *Canadian Journal of Public Health*, vol. 88, no. 6, pp. 421-5, viewed 17/04/12,
<<http://journal.cpha.ca/index.php/cjph/article/view/955/955>>.

EcoGeneration 2011, *ActewAGL and Better Place sign deal on renewable energy*, Great Southern Press, viewed 24/09/12,
<http://ecogeneration.com.au/news/actewagl_and_better_place_sign_deal_on_renewable_energy/061238/>.

Elford, W 2012, 'A multi-ontology view of ergonomics: Applying the Cynefin Framework to improve theory and practice', *Work*, vol. 41, no 1, pp. 812-7.

European Environment Agency 2010, *Greenhouse gas emission trends and projections in Europe 2007 - Tracking progress towards Kyoto targets*, Luxembourg, DOI 10.2800/14432, viewed 18/08/12,
<http://www.eea.europa.eu/publications/eea_report_2007_5>.

European Environment Agency 2012, *New cars sold in 2011 were 3.3% more fuel efficient than those sold in 2010*, viewed 18/09/12,
<<http://www.eea.europa.eu/highlights/new-cars-sold-in-2011/key-facts/electric-cars>>.

Fallah, A 2011, *Nissan LEAF Australian pricing announced*, viewed 18/09/12,
<<http://www.caradvice.com.au/152116/nissan-leaf-australian-pricing-announced/>>.

Farley, R 2012, *Re: Electric Vehicles in your fleet*, Response from City of Perth re: EVs in their fleet edn, Perth, 20/09/12, email.

Feeney, K, Brass, D, Kua, D, Yamamoto, A & Tourneboeuf, E 2012, *Impact of Electric Vehicles and Natural Gas Vehicles on the Energy Markets - Final Advice*, viewed 18/05/12, <<http://www.aemc.gov.au/Media/docs/Impact-of-EVs-and-NGVs-2012-06-22-Final-4fa9e9f6-49e9-40cc-a271-59af3459b2f2-1.PDF>>.

Fellner, C & Newman, J 2000, 'High-power batteries for use in hybrid vehicles', *Journal of Power Sources*, vol. 85, no. 2, pp. 229-36, viewed 22/06/12, <<http://www.sciencedirect.com/science/article/pii/S0378775399003444>>.

Flocks, J, Clarke, L, Albrecht, S, Bryant, C, Monaghan, P & Baker, H 2011, 'Implementing a Community-Based Social Marketing Project to Improve Agricultural Worker Health', *Environmental Health Perspective*, vol. 109, no. 3, pp. 461-8.

Framst, G 1995, 'Application of Program Logic Model to Agricultural Technology Transfer Programs', *The Canadian Journal of Program Evaluation*, vol. 10, no. 2, pp. 123-32, viewed 22/06/12, <<http://cjpe.ca/secure/10-2-123.pdf>>.

Garnaut, R 2010, *Abating greenhouse gas emissions through strategic management of savanna fires: opportunities and challenges - Northern Territory*, Canberra, viewed 02/07/12, <[http://www.garnautreview.org.au/ca25734e0016a131/WebObj/Casestudy-strategicmanagementofsavannafires-NorthernTerritory/\\$File/Casestudy-strategicmanagementofsavannafires-NorthernTerritory.pdf](http://www.garnautreview.org.au/ca25734e0016a131/WebObj/Casestudy-strategicmanagementofsavannafires-NorthernTerritory/$File/Casestudy-strategicmanagementofsavannafires-NorthernTerritory.pdf)>.

Garnaut, R 2011, *The Garnaut Review 2011 – Australia in the Global Response to Climate Change*, Canberra.

Gugiu, PC & Rodríguez-Campos, L 2007, 'Semi-structured interview protocol for constructing logic models', *Evaluation and Program Planning*, vol. 30, no. 4, pp. 339-50, viewed 02/09/12, <<http://www.sciencedirect.com/science/article/pii/S0149718907000717>>.

Hasan, H 2012, 'Unordered Business Processes, Sustainability and Green', in J vom Brocke, S Seidel & J Recker (eds), *Green Business Process Management* Springer Berlin Heidelberg, pp. 39-58, viewed 03/07/12, <http://dx.doi.org/10.1007/978-3-642-27488-6_3>.

Hasan, HM & Kazlauskas, A 2009, 'Making sense of IS with the Cynefin framework', *Proceedings of the Pacific Asia Conference on Information Systems (PACIS)*, pp. 1-13, viewed 03/09/12,

<<http://ro.uow.edu.au/cgi/viewcontent.cgi?article=2008&context=commpapers>>.

Havas, L 2012, *Electric Vehicles*, Charles Darwin University, Casuarina, 11/09/12, phone conversation.

Hawkins, T, Gausen, O & Strømman, A 2012, 'Environmental impacts of hybrid and electric vehicles—a review', *The International Journal of Life Cycle Assessment*, vol. 17, no. 8, pp. 997-1014.

Heal, G & Kriström, B 2002, 'Uncertainty and Climate Change', *Environmental and Resource Economics*, vol. 22, no. 1-2, pp. 3-39, viewed 2002/06/01, viewed 03/07/12, <<http://dx.doi.org/10.1023/A%3A1015556632097>>.

Hinchliffe, M 2012, 'Electric car resale values low', *The Courier-Mail*, 03/05/12, viewed 15/08/12 <http://www.carsguide.com.au/news-and-reviews/car-news/electric_car_resale_values_low>.

Hobart City Council 2009, *Hobart's Climate Change Strategies x 5 (HCC S5) - Climate Change an Issue for Everybody 2008-2013*, Hobart, viewed 19/08/12 <http://www.hobartcity.com.au/Environment/Climate_Change>.

Holdway, AR, Williams, AR, Inderwildi, OR & King, DA 2010, 'Indirect emissions from electric vehicles: emissions from electricity generation', *Energy & Environmental Science*, vol. 3, no. 12, pp. 1825-32, viewed 15/08/12 <<http://dx.doi.org/10.1039/C0EE00031K>>.

Honda 2012, *The INSiGHT - a hybrid for everyone*, Honda, viewed 06/11/12, <<http://automobiles.honda.com/insight-hybrid/>>.

Hope, M 2012, *Electric Vehicles in your fleet*, Adelaide City Council, Adelaide, 19/09/12, email.

Høyer, KG 2008, 'The history of alternative fuels in transportation: The case of electric and hybrid cars', *Utilities Policy*, vol. 16, no. 2, pp. 63-71,

International Standards Organisation 2012, *Standards Catalogue - 43.12: Electric road vehicles*, viewed 15/10/12,

<http://www.iso.org/iso/home/store/catalogue_ics/catalogue_ics_browse.htm?ICS1=43&ICS2=120>.

Jarvinen, J, Orton, F & Nelson, T 2011, 'Electric Vehicles in the NEM: energy market and policy implications', *Applied Economic and Policy Research*, p. 28, viewed 10/10/12 <<http://www.aemc.gov.au/Media/docs/AGL%20Energy%20-%20111101%20-%20Attachment-c406f80c-8eb8-464f-aece-3cb9c3f680c1-0.PDF>>.

Jorgenson, DW & Pizer, WA 1997, 'Uncertainty and Climate Change Policy', *Economic Analysis & Policy*, vol. 38, no. 2, pp. 203-10.

Kanter, J 2011, 'No Consensus on Reuse of Electric Car Batteries', *The New York Times*, 2011/09/06/, p. B1(L), viewed 26/09/12 via Academic OneFile (Gale), <<http://go.galegroup.com/ps/i.do?id=GALE%7CA266194809&v=2.1&u=ntu&it=r&p=AONE&sw=w>>.

Kassakian, JG & Schmalensee, R 2011, 'Chapter 5 – The Impact of Distributed Generation and Electric Vehicles' *The Future of the Electric Grid – an interdisciplinary MIT study Massachusetts Institute of Technology*, Massachusetts.

Kazlauskas, A & Hasan, H 2009, 'Web 2.0 Solutions to Wicked Climate Change Problems ', *Australasian Journal of Information Systems*, vol. 16, no. 2, pp. 23-36.

Kelley Blue Book 2012, *2012 Best Resale Value Awards: Electric Car*, viewed 23/09/12, <<http://www.kbb.com/new-cars/best-resale-value-awards/best-resale-electric-car/>>.

Kennedy, AL 2010, 'Using Community-Based Social Marketing Techniques to Enhance Environmental Regulation', *Sustainability*, vol. 2010, no. 2, pp. 1138-60.

Klein, G, Moon, B & Hoffman, RF 2006, 'Making sense of sensemaking 1: alternative perspectives', *IEEE Intelligent Systems*, vol. 21, no. 4, pp. 70-3.

Kurtz, CF & Snowden, DJ 2003, 'The new dynamic of strategy: Sense-making in a complex and complicated world', *IBM Systems Journal*, vol. 42, no. 3, pp. 462-83.

Lamb, G 2011, 'The Reality of Running a Low Emission Fleet', paper presented to *2011 National Fleet Conference*, March 22-23, Australasian Fleet Managers Association, Melbourne.

Lee, H, Lee, W & Lim, YK 2010, 'The effect of eco-driving system towards sustainable driving behaviour', paper presented to *CHI 2010 - Proceedings of the 28th of the international conference extended abstracts on Human factors in computing systems*, April 10-15, Computer Human Interaction (CHI) New York.

Libo-on, LB 2011, 'Expert suggests electric vehicles to cut emissions', *Khaleej Times*, 20/04/11, viewed 06/09/12, <http://www.khaleejtimes.com/darticlen.asp?xfile=data/theuae/2011/April/theuae_April571.xml§ion=theuae>.

Loeser, S & La Vorgna, M 2011, 'Mayor Bloomberg announces additions of 70 new electric vehicles to city's fleet and launches new city efforts to inform the public about electric vehicles ', *News from the Blue Room*, viewed 23/05/12, <http://www.nyc.gov/portal/site/nycgov/menuitem.c0935b9a57bb4ef3daf2f1c701c789a0/index.jsp?pageID=mayor_press_release&catID=1194&doc_name=http%3A%2F%2Fwww.nyc.gov%2Fhtml%2Fom%2Fhtml%2F2011b%2Fpr248-11.html&cc=unused1978&rc=1194&ndi=1>.

Ma, H, Balthasar, F, Tait, N, Riera-Palou, X & Harrison, A 2012, 'A new comparison between the life cycle greenhouse gas emissions of battery electric vehicles and internal combustion vehicles', *Energy Policy*, vol. 44, no. 0, pp. 160-73.

Mathioudakis, B 2011, *First drive: Electric Fluence closes on \$40K*, viewed 18/09/12, <<http://www.goauto.com.au/mellor/mellor.nsf/story2/69D619DF1B518491CA257932008290B0>>.

McKenzie-Mohr, D 2000a, 'Promoting Sustainable Behaviour: An introduction to Community-Based Social Marketing', *Journal of Social Issues*, vol. 56, no. 3, pp. 543-54.

McKenzie-Mohr, D 2000b, 'Fostering sustainable behavior through community-based social marketing', *American Psychologist*, vol. 55, no. 5, pp. 531-7.

McKenzie-Mohr, D 2000c, 'New Ways to Promote Proenvironmental Behavior: Promoting Sustainable Behavior: An Introduction to Community-Based Social Marketing', *Journal of Social Issues*, vol. 56, no. 3, pp. 543-54.

McKenzie-Mohr, D 2012, *Fostering Sustainable Behaviour*, viewed 29/06/12, <<http://www.cbsm.com/public/world.lasso>>.

McMichael, AJ, Woodruff, RE & Hales, S 2006, 'Climate change and human health: present and future risks', *The Lancet*, vol. 367, no. 9513, pp. 859-69.

Millar, CI, Stephenson, NL & Stephens, SL 2007, 'Climate Change and Forests of the future: managing in the face of uncertainty', *Ecological Applications*, vol. 17, no. 8, pp. 2145-51, viewed 01/07/12, <<http://dx.doi.org/10.1890/06-1715.1>>.

Mitsubishi Motors 2012, *Plug into the Future today with i-MiEV*, viewed 22/08/12, <<http://www.mitsubishi-motors.com.au/vehicles/cars/i-miev>>.

Monaghan, M 2012, 'RAV4 EV races to market', *SAE Vehicle Engineering Online*, viewed 27/09/12, <<http://www.sae.org/mags/SVE/11317>>.

Morgan, S 2012, *Electric Vehicles in your fleet*, Hobart City Council, Hobart, 19/09/12, Email.

My Electric Car 2012, *Running Costs Comparison - Electric v Petrol*, Electric Future, viewed 10/10/12, <<http://www.myelectriccar.com.au/cheaper-to-run/>>.

New York City 2012, *City Initiatives - Drive Electric NYC*, viewed 23/03/12, <<http://www.nyc.gov/html/ev/html/city/city-initiatives.shtml>>.

Newcombe, P 2012a, *Holden Volt not selling in Northern Australia*, Darwin, 3/09/12, face to face discussion.

Newcombe, P 2012b, *Electric Vehicles and City of Darwin brainstorm*, Darwin, 13 August 2012, phone discussion.

Newcombe, P 2012c, *Car size comparison - Comparison of EVs to conventional vehicles*, Darwin, 03/09/12, email.

Newcombe, P 2012d, *Current Holdings as at 14 Aug 12*, Darwin, 14/08/12, Email.

Newman, P 2000, *Case Studies – Model Cities: USA - Institute for Social Sustainability* viewed 30/07/12, <http://www.istp.murdoch.edu.au/ISTP/casestudies/Case_Studies_Asia/us/us.html>.

Ng, M 2011, 'Short and Long-Term Cost Efficiency Analysis of Fossil Fuel versus Alternative Energy Vehicles', *Journal of business studies quarterly*, vol. 3, no. 2, p. 45.

Nichols, W 2012, 'Electric cars step up a gear for 2012', *Business Green*, viewed 18/09/12, <<http://www.guardian.co.uk/environment/2012/jan/09/electric-cars-2012>>.

Nissan 2012a, *Nissan Electric Vehicle Reviews*, viewed 22/09/12, <<http://www.nissan.com.au/webpages/categories/Electric-Vehicle-reviews.html>>.

Nissan 2012b, *Nissan Leaf Specifications*, viewed 27/07/12, <http://www.nissan.com.au/webpages/models/LEAF_model.html#/specifications>.

Norman, W & MacDonald, C 2004, 'Getting to the Bottom of 'Triple Bottom Line'', *Business Ethics Quarterly*, vol. 14, no. 2, pp. 243-62.

Obitko, M 2007, *What is Ontology*, Czech Technical University, viewed 21/10/12, <<http://www.obitko.com/tutorials/ontologies-semantic-web/what-is-ontology.html>>.

One Block Off the Grid 2010, *Charging an Electric Car at Home: How many more Solar Panels do I need?*, viewed 30/09/12, <<http://1bog.org/blog/charging-an-electric-car-at-home-how-many-more-solar-panels-do-i-need/>>.

Origin Energy 2012, *Holden Charging Towards Volt Launch*, Origin Energy, viewed 15/10/12, <<http://www.originenergy.com.au/3960/Holden-charging-towards-Volt-launch>>.

Power and Water Corporation 2012a, *Territory GreenPower*, viewed 25/09/12, <http://www.powerwater.com.au/newsroom/front_page_stories?a=8237>.

Power and Water Corporation 2012b, *Pricing and tariffs*, viewed 27/11/12, <http://www.powerwater.com.au/news_and_publications/tariffs_and_prices/pricing>.

Preston, BL & Jones, RN 2006, *Climate Change Impacts on Australia and the Benefits of Early Action to reduce Global Greenhouse Gas Emissions - A consultancy report for the Australian Business Roundtable on Climate Change*, CSIRO, Canberra, viewed 1/12/12, <<http://www.csiro.au/files/files/p6fy.pdf>>.

Price, B, Dietz, E & Richardson, J 2012, 'Life cycle costs of electric and hybrid electric vehicle batteries and End-of-Life uses', in *Electro/Information Technology (EIT), 2012 IEEE International Conference on*, pp. 1-7.

Profumo, F, Z., Z & Teconi, A 1997, 'Axial flux machines drives: a new viable solution for electric cars', *IEEE Transactions on Industrial Electronics*, vol. 44, no. 1, pp. 39-45, viewed 12/06/12,

<http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=557497&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxppls%2Fabs_all.jsp%3Farnumber%3D557497>.

Quiggin, J 2008, 'Uncertainty and climate change policy', *Economic Analysis & Policy*, vol. 38, no. 2, pp. 203-10.

Renault 2012, *Fluence Z.E.*, viewed 22/08/12, <<http://www.renault-ze.com/au-au/-80376.html>>.

Renger, R & Titcomb, A 2002, 'A Three-Step Approach to Teaching Logic Models', *American Journal of Evaluation*, vol. 23, no. 4, pp. 493-503, viewed 1/12/12.

RG Consulting 2011, *Greenhouse Gas Emission Inventory 2010*, prepared for Darwin City Council, Darwin.

Rogers, P 2011, 'Seven aspects to consider when applying the Cynefin Framework', *2011 National Behaviour Change Congress*, November 10-11, 3 Pillars Network, Melbourne.

Rouselle, M 2009, *Impact of the Electric Vehicle on the Electric System* KTH Electrical Engineering, France, Unpublished master's thesis.

Samaras, C & Meisterling, K 2008, 'Life Cycle Assessment of Greenhouse Gas Emissions from Plug-in Hybrid Vehicles: Implications for Policy', *Environmental Science & Technology*, vol. 42, no. 9, pp. 3170-6.

Savitz, AW & Weber, K 2006, *The Triple Bottom Line: How Today's Best-Run Companies Are Achieving Economic, Social and Environmental Success - And How You Can Too*, John Wiley & Sons, San Fransisco.

Sawyers, A 2011, 'Volt's 36-month resale value set at \$17,000', *Automotive News*, vol. 85, no. 6464, 2011/05/16/, p. 0006, viewed 22/09/12, via Academic OneFile (Gale),
<<http://go.galegroup.com/ps/i.do?id=GALE%7CA256867887&v=2.1&u=ntu&it=r&p=AONE&sw=w>>.

Scott, A 2012, *EcoHub Perth Enquiry*, City of Perth, Perth, 14/09/12, Email.

Seetharamam, D 2012, '*Electri-vehicle batteries cost may drop 70 pct by 2020 - study*', no. 27/07/12, viewed 23/09/12,

<<http://www.reuters.com/article/2012/07/11/autos-batteries-idUSL2E8IB5UT20120711>>.

Seyfang, G & Haxeltine, A 2010, *Growing grassroots innovations: Exploring the role of community-based social movements for sustainable energy transitions*, University of East Anglia, East Anglia, viewed 05/07/12 <<http://hdl.handle.net/10419/48802>>.

Smith, K & Price, S 2002, *Hot water burns like fire*, Queensland Government, visited 06/07/12, <<http://www.health.qld.gov.au/chipp/documents/28207.pdf>>.

Smollan, R 2011, 'Engaging with Resistance to Change', *University of Auckland Business Review*, vol. 13, no. 1, pp. 12-5, viewed 06/10/12, via bth (EBSCOhost), <<http://ezproxy.cdu.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,url,cookie,uid&db=bth&AN=69621051&site=ehost-live>>.

Snowden, D 2005, 'Strategy in the context of uncertainty', *Handbook of Business Strategy*, pp. 47-54, viewed 03/08/12, <http://networkingaction.net/wp-content/uploads/Snowden-Change-Strategy_in.pdf>.

Snowden, DJ & Boone, ME 2007, 'A Leader's Framework for Decision Making - Wise executives tailor their approach to fit the complexity of the circumstances they face', *Harvard Business Review*, vol. November.

Stevens, M 2012, *Holden Volt Pricing and Specifications announced for Australia*, viewed 18/09/12, <<http://www.themotorreport.com.au/54487/holden-volt-on-sale-in-australia-later-2012-pricing-and-specifications-announced>>.

Sturmberg, JP & Martin, CM 2008, 'Knowing – in Medicine', *Journal of Evaluation in Clinical Practice*, vol. 14, no. 5, pp. 767-70, viewed 18/09/12, <<http://dx.doi.org/10.1111/j.1365-2753.2008.01011.x>>.

Sweeney, D & Pritchard, M 2012, *Community Sustainability Engagement Evaluation Toolbox*, National Centre of Sustainability, Whitehorse City Council, Knox City Council, Bayside City Council, Shire of Gannawarra, viewed 18/03/12,, <<http://www.evaluationtoolbox.net.au/>>.

Telsa 2012, *Go Electric - Efficiency - Using Energy Efficiently*, viewed 20/10/12, <<http://www.teslamotors.com/goelectric/efficiency>>.

Terada, N, Yanagi, T, Arai, S, Yoshikawa, M, Ohta, K, Nakajima, N, Yanai, A & Arai, N 2001, 'Development of lithium batteries for energy storage and EV applications', *Journal of Power Sources*, vol. 100, no. 1–2, pp. 80-92.

Thomas, SCE 2012, 'How green are electric vehicles?', *International Journal of Hydrogen Energy*, vol. 37, no. 7, pp. 6053-62.

Thompson, MH 2008, 'Fostering sustainable behaviours in community-based co-managed fisheries', *Marine Policy*, vol. 32, no. 3, pp. 413-20.

Touling, S 2012, *Charge Point discussion*, Charge Point, Sydney, 21/08/12, Phone call.

United Nations Statistics Division 2009, *7.2 Carbon dioxide emissions, total, per capita and per \$1 GDP (PPP)* viewed 16/07/12, <<http://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=788>>.

United States of America Energy Information Administration 2010, *Per Capita Carbon Dioxide Emissions from the Consumption of Energy (Metric Tons of Carbon Dioxide per Person)*, International Energy Statistics, viewed 13/04/12, <<http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=90&pid=45&aid=8&cid=regions&syid=2000&eyid=2009&unit=MTCDPP>>.

United Way of America 1996, *Measuring Outcomes - A Practical Approach*.

Unnasch, S & Browning, L 2000, *Fuel Cycle Energy Conversion Efficiency Analysis*, California Energy Commission and Air Resources Board, California, viewed 11/07/12, <<http://evworld.com/library/efficiency.pdf>>.

Van Beurden, EK, Kia, AM, Zask, A, Dietrich, U & Rose, L 2011, 'Making sense in a complex landscape: how the Cynefin Framework from Complex Adaptive Systems Theory can inform health promotion practice', *Health Promotion International*, vol.27, no.4, pp.1-11, viewed 28/08/12, <<http://heapro.oxfordjournals.org/content/early/2011/11/29/heapro.dar089.full.pdf+html>>.

Väyrynen, A & Salminen, J 2012, 'Lithium ion battery production', *The Journal of Chemical Thermodynamics*, vol. 46, no. 0, pp. 80-5, viewed 15/07/12 <<http://www.sciencedirect.com/science/article/pii/S0021961411003090>>.

Waldron, CD & Kobylarek, P 2011, 'The Reality of Electric Vehicles and the Grid', *Electric Light & Power*, vol. 89, no. 1, pp. 54-6.

Werber, M, Fischer, M & Schwartz, PV 2009, 'Batteries: Lower cost than gasoline?', *Energy Policy*, vol. 37, no. 7, pp. 2465-8.

Willard, B 2002, *The Sustainability Advantage: Seven Business Case Benefits of a Triple Bottom Line*, New Society Publishers, Gabriola Island, viewed 25/04/12, <http://books.google.com.au/books?id=SQ6BhCQh728C&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false>.

Yampolskaya, S, Nesman, TM, Hernandez, M & Koch, D 2004, 'Using Concept Mapping to Develop a Logic Model and Articulate a Program Theory: A Case Example', *American Journal of Evaluation*, vol. 25, no. 2, pp. 191-207, viewed 25/04/12, <http://www.stes-apes.med.ulg.ac.be/Documents_electroniques/EVA/EVA-PROG/ELE%20EVA-PROG%207389.pdf>.

Zackrisson, M, Avellán, L & Orlenius, J 2010, 'Life cycle assessment of lithium-ion batteries for plug-in hybrid electric vehicles – Critical issues', *Journal of Cleaner Production*, vol. 18, no. 15, pp. 1519-29.