University of Southern Queensland

Faculty of Health & Engineering and Sciences

AN ENERGY AND CARBON AUDIT OF MORNINGTON PENINSULA SHIRE COUNCIL

A Dissertation submitted by

Melissa Hope Baxter

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ABSTRACT

Climate change poses a serious threat not only at local council level but to the world. With a direct link to local communities local councils are considered to be well situated to provide leadership in the battle against climate change. In Australia, it is predicted that we will endure more heatwaves, droughts, bushfires, floods and more storms. Many of these impacts of climate change are thought to be caused by anthropogenic activities, namely the burning of fossil fuels for energy, Hence, they can be reduced, delayed or avoided by reducing greenhouse gas emissions. Therefore the first step in shaping a climate change response is to prepare a greenhouse gas emissions inventory.

With little guidance for councils for the reporting and accounting of greenhouse gas emissions a thorough review of literature was performed to provide an overview of international and national policy governing the area. Adopting relevant legislation a methodology was established for measuring annual council greenhouse gas emissions from raw data provided by the local council, based on the case study of the Mornington Peninsula Shire Council (MPSC) in Victoria, Australia. The inventory includes greenhouse gas emissions generated by electricity and gas consumption in council owned buildings, fleet vehicles, emissions from solid waste and emissions from landfills. The research has resulted in a carbon footprint of the MPSC greenhouse gas emissions for the calendar year 2013. Total emissions for MPSC operations in 2013 was 25418.6 tonnes of carbon dioxide equivalent. (tCO2-e).

The results of the carbon footprint have identified waste as the primary emissions source accounting for some 82% of MPSC's emissions. The outcomes of the carbon footprint have been used to outline recommendations for greenhouse gas emission reduction strategies for MPSC. The information relating to emissions by source; will assist in targeting programs to support these reductions and form the basis for the development of a MPSC Climate Action Plan. The recommendations for reduction are unique to MPSC but the underlying concepts behind the approach are applicable to other councils. It is therefore hoped that other councils will utilise this methodology to carry out carbon footprint assessments.

In conclusion, this study is an example for how to convert energy consumption based data into greenhouse gas emissions to produce a carbon footprint in a straightforward manner. Having completed a baseline inventory, the MPSC is well placed to update the greenhouse gas inventories on an annual basis to ensure long term commitment to action on climate change, whilst highlighting the effectiveness of their mitigation action to direct funding where necessary. It is recognised that through measuring their carbon emissions, councils can develop management strategies and reporting on progress towards reduction commitments they can set a good example for the community in the battle against the deleterious effects of climate change. Furthermore, future study should include measurement of MPSC community wide emissions with the added benefit of this commitment will be to further decrease emissions in the region.

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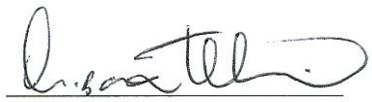 (Signature)

28. 10. 2014 (Date)

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ABBREVIATIONS

CCP…Cities for Climate Protection Program

CSIRO… Commonwealth Scientific and Industrial Research Organisation

GHG…Greenhouse Gas

GHG Protocol The Greenhouse Gas Protocol: a corporate accounting and reporting standard

GWP…Greenhouse warming potential

ICLEI… International Council for Local Environmental Initiatives

IPCC…Inter-governmental Panel of Climate Change

ISO… International Standards Organisation

LCA… Life Cycle Assessment

MPSC… Mornington Peninsula Shire Council

NGER…National Greenhouse and Energy Reporting

NCOS…National Carbon Offset Standard

OSCAR… Online System for Comprehensive Activity Reporting

REC… Renewable energy certificate

tCO2-e… tonnes of carbon dioxide equivalent

UNEP… United Nations Environment Program

WMO… World Meteorological Organisation

CHAPTER 1

1 INTRODUCTION

"The failure of our generation on climate change mitigation would lead to consequences that would haunt humanity until the end of time".

(Prof Ross Garnaut, 2008).

1.1 Introduction

Climate change poses a serious threat not only at local council level but to the world. The 2007 assessment of the Intergovernmental Panel on Climate Change (IPCC) concluded that it is now 'unequivocal' the world is warming (IPCC, 2007). This rise is most likely attributable to anthropogenic activities, predominately the emission of greenhouse gases through the burning of fossil fuels for energy. In addition to the increased global temperatures, there is evidence of more frequent extreme weather events, such as cyclones, bushfires, heatwaves, droughts, floods and storms (IPCC, 2007). In Australia, we are well aware of the deleterious effects of these extreme weather events with recent destruction from bushfires and floods in Victoria and Queensland respectively.

The IPCC report (2007) anticipates, in absence of new climate change policies, a projected increase in global average temperatures of between 1.4-5.8 degrees by 2100 (IPCC, 2007). Unaddressed such changes in global temperature and associated higher climate variability has the potential to have catastrophic consequences for humanity as we know it. Namely, increased hardship through loss of food security, water scarcity, and loss of biodiversity leading to possible loss of community health from worsening malnutrition and disease. The only way to reduce the potential impacts from climate change is to reduce the concentrations of greenhouse gases in the atmosphere. This will require a not only a global approach but also significant local effort.

Therefore, local councils in Australia face the challenge of reducing their greenhouse gas emissions, in order to mitigate climate change impacts on both its operations and

the local community. In addition, the local communities themselves are demanding greater accountability for organisations such as councils to reduce emissions. With a direct link to local communities and businesses local councils are well placed to provide leadership in the area of greenhouse gas emission reduction. Through measuring their energy consumption and associated greenhouse gas emissions, developing management strategies and reporting on progress towards reduction commitments they can set a good example for the community as a whole. Some local councils are thus adopting eco-efficiency measures in energy, water and waste management. Hence, by actively reducing their greenhouse gas emissions councils can reduce its impact on climate change.

With it clear that councils need to make themeselvs more resilient to the deleterious effects of climate change an important part in reducing greenhouse emissions is helping organisations understand how and what they do generates greenhouse gas emissions and how they should go about minimising them. Reh (2011) states 'You can't manage what you don't measure'. And on this basis that *what get measured gets managed* the first step to reducing your greenhouse gases is to measure them. Such an inventory will allow councils to identify major greenhouse gas emissions sources and identify potential areas for greenhouse emission reduction.

1.2 Motivation for this research

Despite the rigorous scientific evidence of the occurrence of climate change there is still a degree of uncertainty and scepticism surrounding climate change issues. As noted by Thomas et al, 2011 this is one of the battles inhibiting adoption of climate change action on local council level. It appears that greenhouse gas emission reporting and action of climate change is invariably occurring at local council level. As per recent study of 32 local councils in Queensland, whilst the majority of councils were implementing greenhouse gas emission reduction changes only 13 had a greenhouse gas inventory (Zeppel, 2012). Despite a slow uptake, climate change is however considered important at local council level because of the potential impacts on "council infrastructure, service delivery, community safety, biodiversity and economic development" (Zeppel, 2012). The uncertainty surrounding climate change and what form it will take should not discourage councils from reducing their

greenhouse gas emissions in the meantime. Investing in emission reduction, will future proof councils exposure to the deleterious effects of climate change on their operations.

In summary, the greenhouse gas emissions problem considered here is not whether mitigation is important, but rather how to measure in order to mitigate effectively at local council level. It is increasingly apparent that a consistent and recognised greenhouse gas emission managment and reporting approach should be adopted when managing council operational greenhouse gas emissions. Before we can control these emissions, we need to know how much we are emitting so can adopt changes to reduce these emissions. To date inventories have been undertaken voluntarily. However, they are needing to become part of standard practice for some councils as a legislative requirement.

Reporting greenhouse gas emissions for local councils can be a time complicated and time consuming task. There is no single standard for emissions reporting. There is little guidance for councils specifically on how to go about reporting and accounting of greenhouse gas emissions. With little guidance available, there lies the problem that will be addressed by this research. This research attempts to address this issue by exploring the methodologies for carbon footprint assessment available at local council level, based on the case study of Mornington Peninsula Shire Council.

1.3 Research Objectives

The aim of this research project is to establish a methodology for measuring annual council greenhouse gas emissions from raw data provided by the local council, based on the case study of Mornington Peninsula Shire council in Victoria, Australia.

Such regular reporting of this data would assist councils in measuring the success of their reduction initiatives in order to combat climate change. In addition, recommendations are made for how the council can reduce its emissions.

The research methodology is divided into the following parts,

1. Research the background information on carbon emissions and effect on climate change.

2. Research the relevant legislation governing carbon emissions.
3. Outline the importance of a carbon inventory for local councils.
4. Define Mornington Shire Council's sources of carbon emissions.
5. Define how Mornington Peninsula Shire Council's carbon emissions are to be measured.
6. Undertake a carbon inventory of Mornington Peninsula Shire Council's carbon emissions.
7. Outline the results of this carbon inventory and discuss any limitations of the inventory.
8. Outline recommendations for reducing carbon emissions and discussion of the feasibility of each of the recommendations.

1.4 Background – About the Mornington Peninsula

The Mornington Peninsula Shire is situated some 60km to the southeast of Melbourne and has approximately 40 townships spread over 720 square kilometres of land (Refer to Figure 1.2 below). It has over 190 kilometres of coastline where the majority of residential population live. The Mornington Peninsula is a diverse location highly valued by residents and visitors alike. The Mornington Peninsula Shire has an estimated permanent residential population of 152,260 (2014). As a popular holiday destination the population can swell by 30% during the summer holiday period. The Mornington Peninsula has a growing local economy that includes retail, manufacturing, construction, wine production and business services. Tourism is another significant contributor to the local economy with the Mornington Peninsula being a popular weekend, recreation and holiday destination (MPSC, 2014). The Mornington Peninsula Shire is dominated by micro businesses. Approximately, 90% of the 6500 local enterprises employ 10 or less employees (MPSC, 2014).

MPSC has an organisational structure that consists of five departments headed by General Managers, all reporting directly to the Chief Executive Officer. The five departments include;

Infrastructure Services; Water and Waste; Planning and Environment; Community, Sport and Cultural Services; and Corporate Services (MPSC, 2014). The MPSC

currently employs approximately 1,400 staff. The MPSC provides many services to the region and these are detailed in Figure 1.1 below.

Figure 1.1: The broad categories of services provided by MPSC

Figure 1.2:Map of Mornington Peninsula Shire Council

Source:ww:mornpen.vic.gov.au/Our_Shire/About_Us/Mapping_GIS/Peninsula_Maps

Table 1.1: Mornington Peninsula Shire Council at a glance

LOCALITY	
Area	72328 hectares (723km^2)
Distance from Melbourne CBD	60km
DEMOGRAPHIC	
Estimated residential population	152260 (www.profileid.com.au/Mornington-peninsula)
Population	2.11 persons per hectare
Projected population in 2031	185,702 (www.forcastid.com.au/Mornington-peninsula-home)
Proportion of families with children	15%
Persons born overseas	26271
Australian citizens	

1.5 Conclusions

This dissertation aims to establish a methodology for measuring annual council greenhouse gas emissions from raw data provided by the local council, based on the case study of the MPSC in Victoria, Australia. The research is expected to result in a carbon footprint of the MPSC greenhouse gas emissions. A review of literature for this research will summarise scientific evidence of climate change and provide an overview of international and national policy governing the area. This will provide the basis for greenhouse gas emission reduction planning for the future. The outcomes of this study will be used to outline recommendations for greenhouse gas emission reduction and discussion of the feasibility of each recommendation.

CHAPTER 2

2 LITERATURE REVIEW

2.1 Introduction

This chapter defines climate change, reviews literature to summarise scientific evidence of occurance of climate change and provides an overview of current international and national policy governing this area. After doing this this chapter will describe how climate change is affecting MPSC in particular and describes current climate change initiatives at local council level and associated barreirs to climate change action. Finally, his chapter will then discuss the literature for different approaches for undertaking carbon footprints.

2.2 What is climate change?

The worldwide consensus is that the world's climate is changing. In particular, there has been more droughts, storms, cyclones, rainfall patterns are changing as well as well as heatwaves and bushfires. These effects are all considered 'elements' of climate change. We now attempt to define climate change.

In a broad sense, 'climate' is the average of the weather conditions for a particular region over a longer period of time, and is described by the combination of measurements of temperature, sunshine, rainfall, wind, humidity, cloudiness, frost as these vary spatially (BOM, 2014). A change in average weather conditions over time can occur due to natural variability, e.g. volcanic eruptions. Recently, changes in climate have also been attributed to human activity, or anthropogenic causes (IPCC, 2007). Hence, most often when we say *climate change* it refers to climate change caused by humans. The terms global warming and climate change are often used interchangebly but there is a difference. "*Global warming* is a gradual increase in the earth's average temperature due to greenhouse gases in the atmosphere whereas *climate change* is a broader term long term changes in climate including average temperature and rainfall more extreme weather events" (LGA, 2010).

The IPCC defines *climate change* as "a change in the state of the climate that can be identified (using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer" (IPCC, 2007).

2.3 Understanding the greenhouse effect and the enhanced greenhouse effect

Greenhouse gas emissions have always been a inherent part of the atmosphere. They absorb and re-radiate the sun's heat and maintain the earth's temperature at a necessary level to sustain life. Without this effect temperatures would be much lower and life would not be possible. The presence of greenhouse gases in the atmosphere results in the maintenance of the earth's surface average global temperature at 14°C, 33°C warmer than if there were no greenhouse gases at all (IPCC, 2007). This process, which provides a moderate climate to which humans are presently adapted, is known as the greenhouse effect (see Figure 2.1 below).

The problem we now face is that human activity has caused a harmful increase in greenhouse gas emissions in the atmosphere (IPCC, 2007). This is called the enhanced greenhouse effect, which is contributing to a warming of the earth's surface. Thus, warming it beyond its normal temperature.

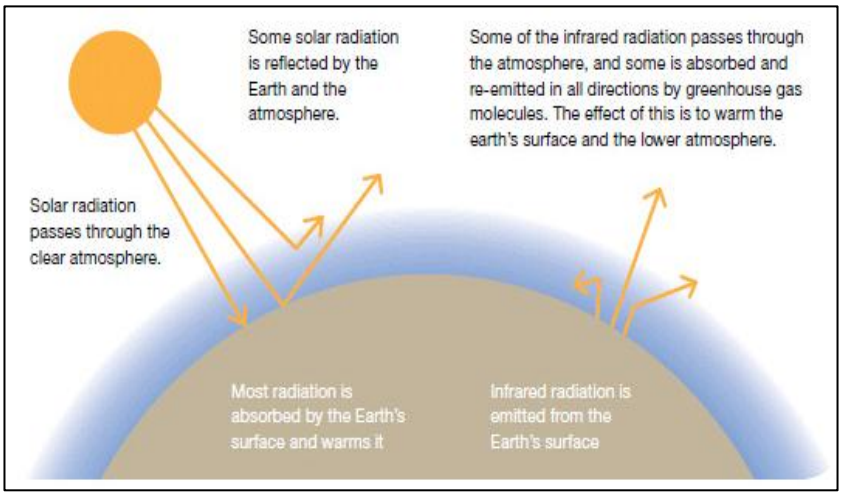

Figure 2.1: Schematic diagram of the greenhouse effect

Source: www.climatechange.vic.gov.au/what-is-climate-change/understanding-the-science

2.4 What is causing climate change?

There is strong evidence to suggest that human activity is a major contributor to a warming climate (Garnaut, 2008). The most likely cause is the greenhouse gases produced by the burning of fossil fuels for energy, intensive agriculture and land clearing. The main greenhouse gases generated by human activity are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2)). Since the beginning of the Industrial Revolution, atmospheric carbon dioxide, methane and nitrous oxide levels have risen substantially to now exceed the natural range of the last two million years by 35%, 148% and 18%, respectively (IPCC, 2007).

Anthropogenic causes of greenhouse gas emissions include the following

- Burning of fossil fuels such as coal, oil or gas
- Using energy generated by burning of these fossil fuels
- Some farming cattle and sheep, using fertilisers and growing some crops
- Land use changes Clearing land including logging
- Methane production from decomposition of solid waste and agriculture
- Some industrial processes such as making cement and aluminimum.

  (LGA, 2010)

In Australia, greenhouse gas emissions come primarily from electricity generation as we rely primarily on burning of coal for electricity.

2.5 The Scientific Evidence for Climate Change

The Intergovernmental Panel on Climate Change (IPCC) was established by the World Meteorological Organisation (WMO) and the United Nations Environment Program (UNEP) to assess scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts along with options for adaptation and mitigation (IPCC, 2007)

The IPCC Fourth Assessment Report provides the most current assessment of the scientific literature on the subject of climate change. The main results of the report can be summarised as follows:

(1) The warming of the climate is unequivocal

(2) There is strong evidence to suggest that human activity, namely, the production and release of greenhouse gases into the atmosphere, is the major cause of climate change

(3) Changes in climate and increased climate variability bring significant risks for human societies and for ecosystems; and

(4) Predict the impacts of climate change in the future include further warming, more drought, more extreme fire danger and increase in storm surges and extreme weather events anf that these changes will continue well into the future and that they will be larger than those seen in the past

(IPCC, 2007).

Major scientific evidence of climate change occurring includes

- Diminishing arctic sea ocean ice and sea level rises;
- Increased severe weather events;
- Increase in global average temperatures; and
- Reduction in rainfall run off.

Each of these are discussed in more detail below.

2.5.1 Diminishing arctic sea ocean ice caps and glaciers and sea level rises

One of the most concerning indicators of climate change is the significant rate that the arctic ice caps and glaciers are melting. The National Snow and Ice Data Centre (NSIDC) observed the lowest levels of Arctic sea ice at the end of the 2007 melt season since recording began in 1978, with levels at the end of the April 2014 only slightly higher, and the fifth lowest since recording began in 1979 despite cooler temperatures and ice favouring conditions (NSIDC, 2014). Furthermore, it is predicted that within a few decades there may be no ice in summer in the arctic sea for the first time in 1 million years. This would continue to have a devastating effect on "arctic wildlife, such as polar bears, which are unlikely to survive as a species if the sea ice disappears completely" (Stirling and De Rocher, 2012).

Due to glacier and ice sheet melting, global average sea levels have risen about 17cm during the 20th century (CSIRO and BOM, 2014). In Australia sea levels rose 10cm between 1920 – 2000 (CSIRO and BOM, 2014). Such changes to sea level are

projected to continue, and could cause an inundation of low lying coastal terrain, most notably when the sea level rise is combined with storm surges. Figure 2.2 illustrates how the sea level has increased around Australia since 1920.

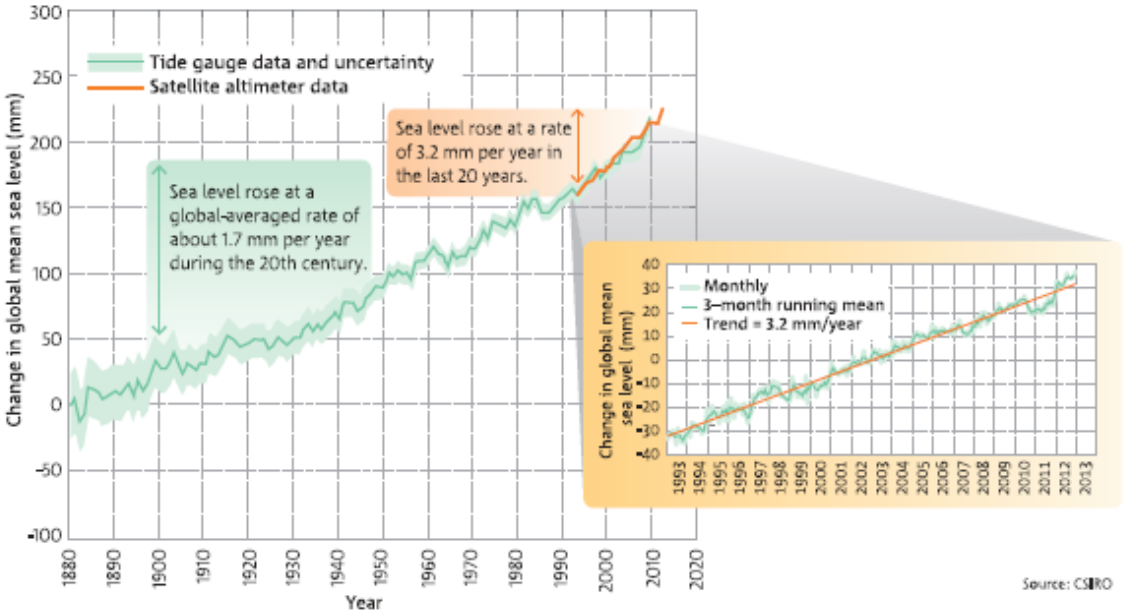

Figure 2.2: Sea level rise in Australia

Source: State of Climate 2014 (CSIRO and BOM, 2014)

2.5.2 Increased severe weather events

The number of weather related disasters reported, such as droughts, tsunamis, hurricanes, typhoons extreme rainfall and floods has risen and will continue to rise (Steffen, 2009). Climate models predict that droughts will become more frequent and severe in southern Australia (CSIRO and BOM, 2014). A reduction in rainfall contributing to the recent drought conditions in south eastern Australia have been thoroughly studied. "Although there is some evidence that these reductions are linked to climate change, the mechanisms driving the change are not fully understood, and consequently a definite link has not been reported" (Murphy and Timbal, 2008). Similarly, increases in extreme rainfall events and hence flooding are predicted for many regions (CSIRO and BOM, 2014). The CSIRO and BOM, 2014 reports that "rainfall patterns have also changed - the northwest has seen an increase in rainfall over the last 50 years while much of eastern Australia and the far southwest have experienced a decline" (Refer to Figure 2.3 and 2.4 below). In

Australia, while there is evidence of an increase in extreme rainfall in some regions there is as yet no conclusive evidence to link these events to increasing greenhouse gas concentrations (CSIRO and BOM, 2014)

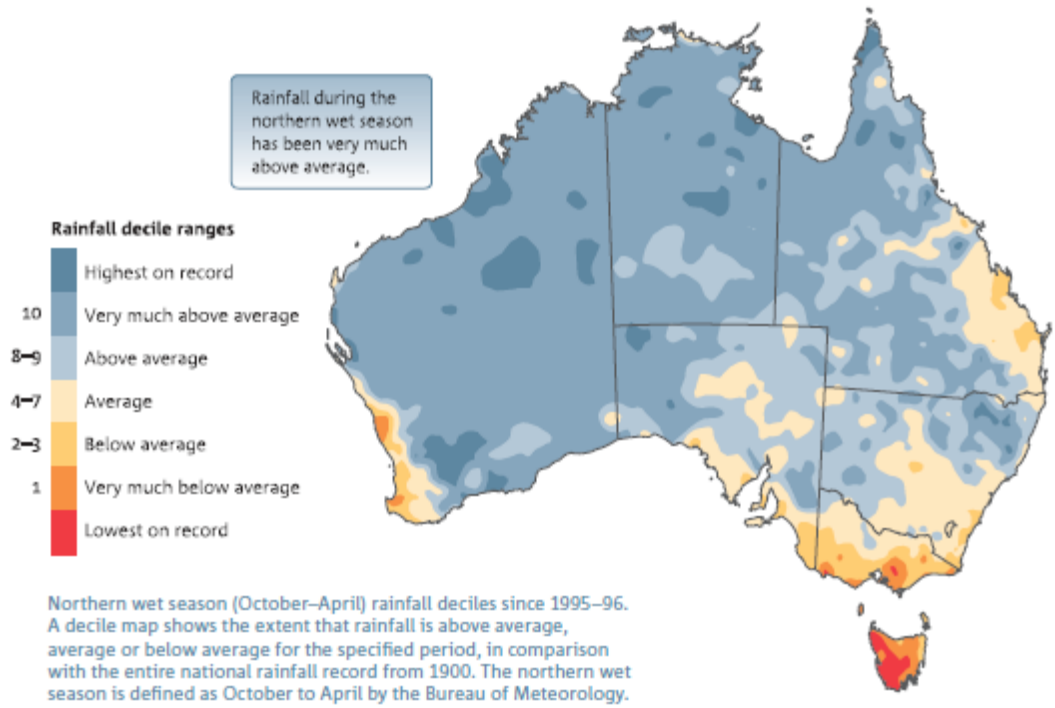

Figure 2.3: Rainfall patterns in Australia during northern wet season.

Source: State of Climate 2014 (CSIRO and BOM, 2014)

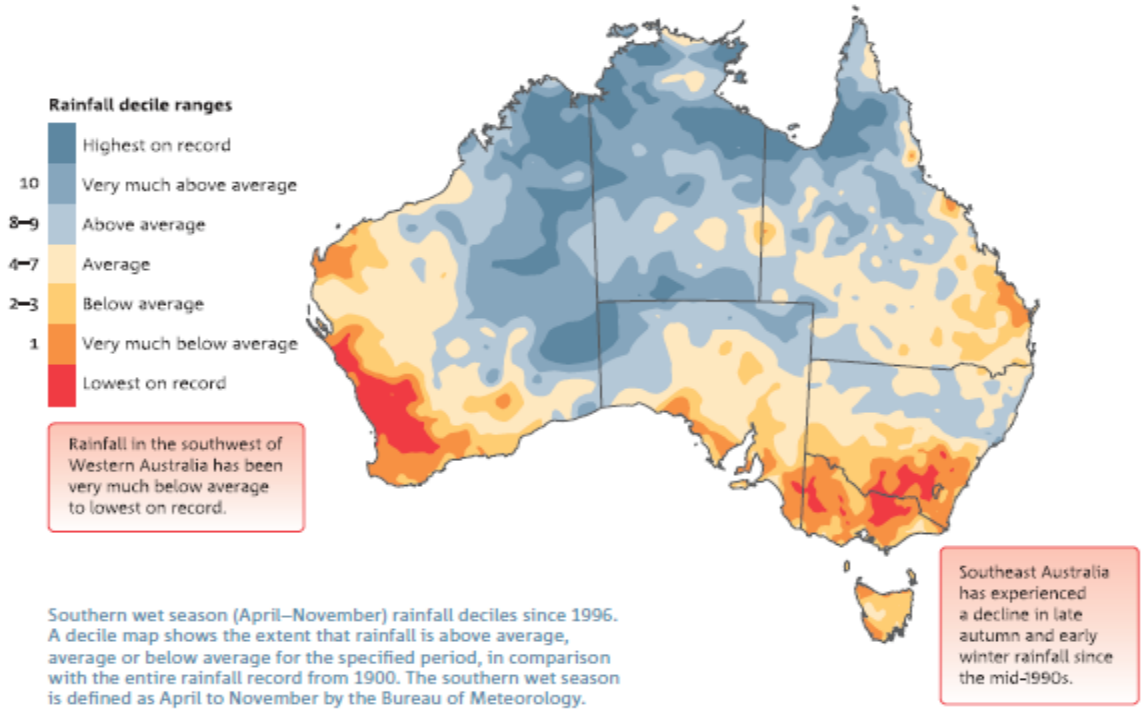

Figure 2.4: Rainfall patterns in Australia during southern wet season

Source: State of Climate 2014 (CSIRO and BOM, 2014)

2.5.3 Increase in average temperatures

Global annual average temperatures have risen by 0.74 degrees over the past 100 years (IPCC, 2007). Australia's annual average temperatures have also been increasing over recent years. Over the past 15 years, the frequency of warm months has increased five-fold (CSIRO and BOM, 2014). The BOM, 2014 reports that "Australia's annual mean temperature for 2013 was 1.2°C above the standard 1961-90 average, making it the nation's warmest year since comparable records began in 1910".

As shown in Figure 5 below, ince 1910 Australian temperatures have on average risen by about 0.9degrees with an increase in frequency of heatwaves, and a subsequent decrease in the number of frosts and cold days. (CSIRO and BOM, 2014).

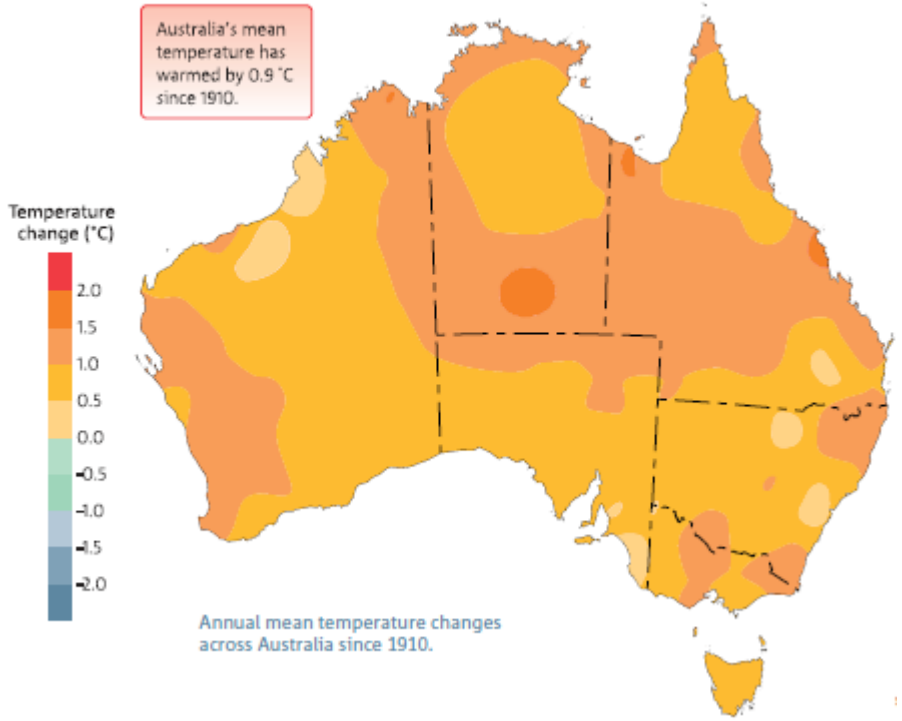

Figure 2.5: Trend in mean temperature since 1910

Source: State of Climate 2014 (CSIRO and BOM, 2014)

2.5.4 Reduced run off

Cai and Cowan, 2008 have reported that "reduced run off has been observed in many catchments in Australia due to changes in rainfall and increases in evaporation that has seen a magnified reduction in dam inflow by 30-60%".This has significantly affected the water inflows into dams which supply communities with water. Subsequently, many Australian regions are experiencing water restrictions due to the reduction in water storage.

2.6 What does this science mean for Australia?

In Australia, we are very vulnerable to the effects of climate change. Australia's location means it is already a hot and dry country and small variations in climate will be more damaging to us economically than many other countries (Garnaut, 2008). Australia is considered to be the driest inhabited continent, heavily exposed to he

dangers of extreme heat and drought, placing food production, agriculture and many vulnerable flora and fauna under threat. Australia has mostly coastal dwellers exposing them to sea level rise impacting on buildings and assests. Furthermore, the low rainfall run off into dams will impact on water availability for future human use. This is unsustainable. The longer we wait to act on climate change, the more it will cost and the worse its effects will be.

We cannot predict what the impacts of climate change will be looking into the future, as they vary with each region. However it is estimated that in the future Australia will face

- a further 1ºC of warming in temperatures by 2030
- increase in sea levels by approximately 0.4 metres
- up to 20 per cent more months of drought
- up to 25 per cent increase in days of very high or extreme fire danger
- increases in extreme rainfall events

(CSIRO and BOM, 2014)

Australia's greenhouse gas emissions make up a small percentage (approximately 1.5%) of worldwide emissions (Garnaut, 2008) (Refer to Figure 2.6 below). However, Australia has the highest greenhouse gas emissions per person in the developed world, excluding land-use change emissions (Garnaut, 2008) (refer to Figure 2.7 below).

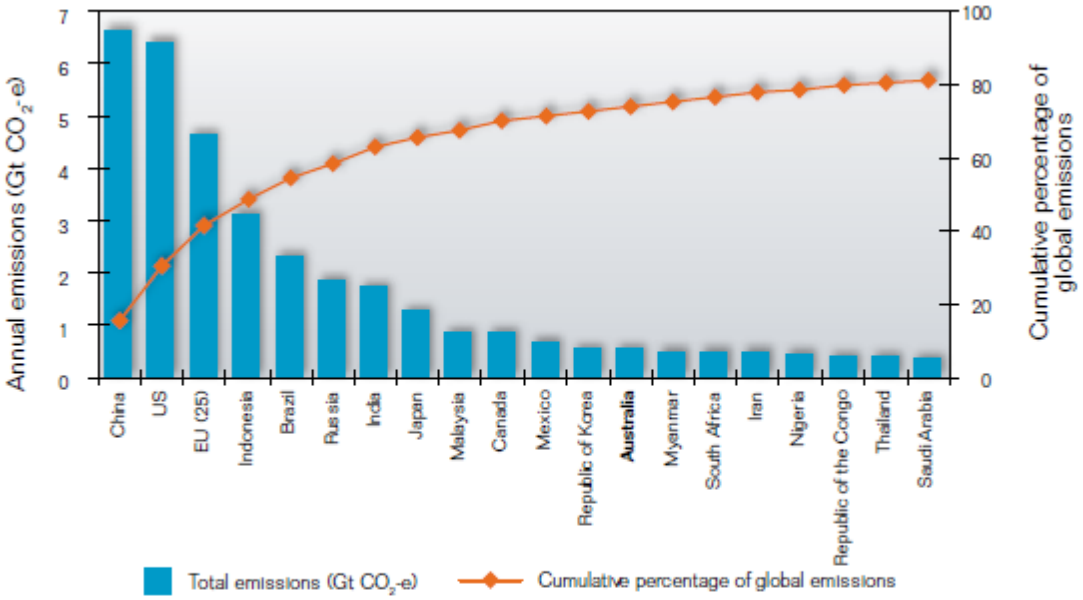

Figure 2.6: The 20 largest greenhouse gas emitters

Source: The Garnaut Climate Change Review, 2008

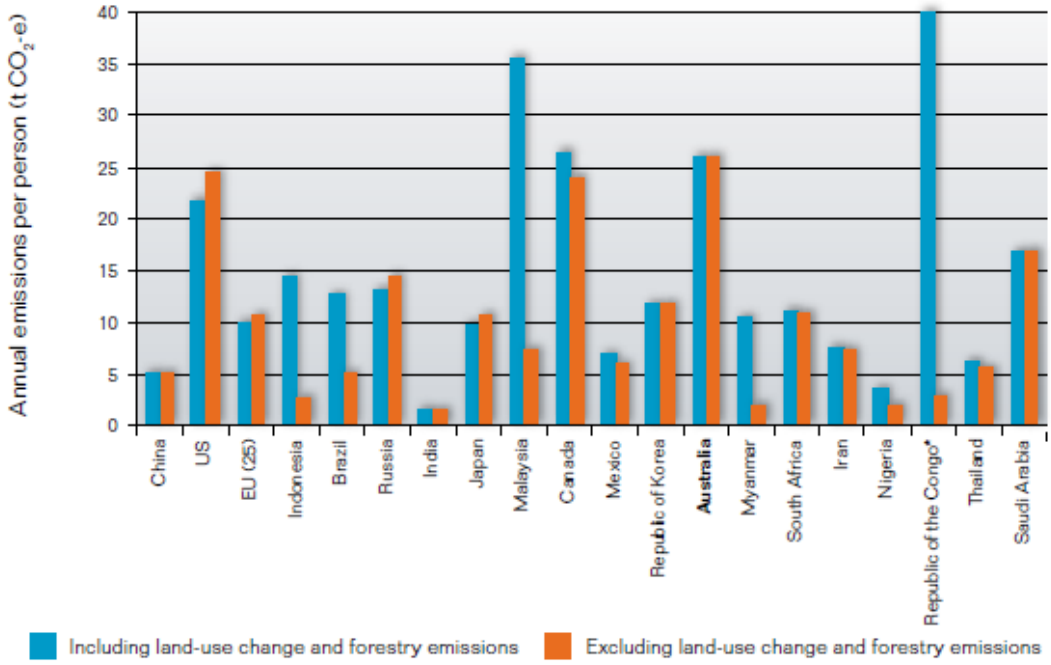

Figure 2.7: The 20 largest greenhouse gas emitters on a per capita basis

Source: The Garnaut Climate Change Review, 2008

As Australia produces such a small percentage of global emissions, reduction in Australia's emissions alone will not have a significant impact on climate change.

However, Australia needs set a good example by reducing their emissions to have a positive impact on global emissions overall.

2.7 Climate change scepticism

Despite rigorous scientific evidence, there are still many people who debate that climate change is occurring. While the evidence presented in this chapter is only a brief summary of current research into the area and is focused on Australian observations, international scientific consensus supports the claim that that "the average global temperature is increasing" (IPCC, 2007). However, it shall be noted that scientific research is ongoing in this area.

2.8 Climate Change-Related Policy, Standards and Guidelines

In response to the threat of climate change, policy responses have occurred at international, federal and state levels. As a result there are numerous tools, standards and guidelines available to organisations. There is a plethora of online calculators and tools. Description of each is beyond the scope of this report. The focus of this chapter is the main policy and guidelines governing climate change.

2.8.1 International level

The Kyoto Protocol

At the international level, the initial policy response to climate change was the signature of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. The ultimate goal of the Convention, as articulated in Article 2, is to

"achieve . . . stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." (United Nations, 2014).

The UNFCC committed developed countries to aim to stabilise their greenhouse gas emissions at 1990 levels by the year 2000. Such commitment, however, was

voluntary and was not followed up by adequate policies. Five years later at the United Nations meetings in Kyoto in 1997, developed countries, including Australia, agreed that they would take the first steps towards reducing emissions (Garnaut, 2008). The 1997 Kyoto Protocol established legally-binding emission reduction targets for developed countries. To enter into force, the Kyoto Protocol required ratification by 55 parties to the Convention, including 55% of developed countries. In 1997 Australia signed but did not ratify until 2007. Australia's refusal to ratify the Kyoto Protocol prior to 2007 is considered to have slowed progress on global emissions reduction planning. As a signatory to the Kyoto Protocol, Australia has committed to a national target of 5% emissions reduction on 2000 levels by 2020.
There are six greenhouse gases which are considered the key contributors to global warming. The greenhouse gases described by the Kyoto Protocol include

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous Oxide (N_2O)
- Hydroflurocarbons (HFCs)
- Perflurocarbons (PFCs) and
- Sulfur hexafluoride (SF_6)

The term 'carbon' is often used interchangeably with the phrase 'greenhouse gas emissions' and includes all six greenhouse gases, not just carbon dioxide. Hence, the quantities of greenhouse gas emissions are often expressed as carbon dioxide equivalent (CO_2e). In additon, carbon dioxide is considered the most significant greenhouse gas due to its signinicant amount within the atmosphere. Hereafter, we consier carbon emissions and greenhouse gas emissions to be the same.

The Greenhouse Gas Protocol

Developed by the World Business Council for Sustainable Development and published in 2004 the *Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard (GHG Protocol)* is a widely used accounting tool for organisations to understand, quantify, and manage greenhouse gas emissions. Key areas covered in the standard include:

- Greenhouse gas accounting and reporting principles
- Business goals and inventory design
- Setting organisational boundaries
- Tracking emissions over time
- Identifying and calculating greenhouse gas emissions
- Managing inventory quality
- Accounting for greenhouse gas reductions
- Reporting greenhouse gas emissions
- Verification of greenhouse gas emissions
- Setting greenhouse gas emissions reduction targets

(GHG Protocol, 2004)

ISO 14064-1:2006 Greenhouse gases – Part 1: Specification with guidance at the organisation level for quantification and reporting of greenhouse gas emissions and removals

The International Standards Organisation (ISO) built on the GHG Protocol method and formalised it with *ISO:14064-1: Greenhouse gases – Part 1: Specification with guidance at the organisation level*. ISO 14064-1specifies principles and requirements for quantification and reporting of greenhouse gas emissions. It includes requirements for the design, development, management, reporting and verification of an organisation's greenhouse gas inventory (LGA, 2010).

2.8.2 National level

The development of legislation, standards and guidelines in Australia has been based heavily on the GHG Protocol.

The National Greenhouse and Energy Reporting (NGER) Act 2007

The National Greenhouse and Energy Reporting (NGER) Act (2007) established a national framework for the collation and reporting of carbon emissions of corporations in order to provide a consistent approach and avoid the duplication of similar reporting requirements in the States and Territories.

Only corporations whose greenhouse gas emissions are large enough to meet certain thresholds are required to report under the Act. At present, most local councils are unlikely to have reporting obligations under the Act. This is because the Act applies only to constitutional corporations and local councils in most cases are not considered to be constitutional corporations (LGA, 2010). The first reporting period commenced on 1 July 2008 and applies to:

1. Corporate groups that emit more than 125kt CO2-e/year or consume more than 500TJ of energy; and
2. Single facilities that emit more than 25kt CO2-e/year or consume more than 100TJ of energy (NGER, 2007).

The obligations for reporting are detailed in the *National Greenhouse and Energy Reporting (Measurement) Determination 2008 Act*, and associated *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines 2013.* For each source of greenhouse gas emissions, the guidelines detail a number of methods that can be used to estimate the quantity of emissions to be reported.

OSCAR

For organisations that are required to report under the NGER, data will be reported to the Australian Government using the Online System for Comprehensive Activity Reporting (OSCAR). The tool includes all the current emission factors and calculate the greenhouse gas emissions from consumption data entered i.e electricity.

The National Carbon Offset Standard (NCOS)

The *National Carbon Offset Standard (NCOS)* and associated *NCOS Carbon Neutral Guidelines* provide guidance for organisations that wish to take voluntary action on climate change and measure their emissions. The Australian Government introduced the NCOS on 1 July 2010 and sets a voluntary minimum standard for calculating, auditing and offsetting the carbon footprint of an organisation or product to voluntarily achieve 'carbon neutrality'

The Clean Energy Act 2011 (and amendments)

The *Clean Energy Act 2011* established a carbon pricing framework with a price starting at $23 per tonne of carbon dioxide equivalent (tCO2-e) commencing 1 July 2012. The price will be payable by Australia's 500 most carbon-intensive entities for

each tonne of carbon dioxide equivalent they produce. Some local councils are liable entities required to pay a carbon price as their emissions exceed 25 kilo tonnes of carbon dioxide equivalent (ktCO2-e) a year from a single facility (i.e. landfill).

At the time of writing The Australian Government has abolished the carbon tax. The carbon tax repeal legislation was passed on Thursday 17 July 2014 effective from 1 July 2014. In its place is the Direct Action Plan the centrpiece of which is the Emissions Reduction Fund and supports a reduction of Australian emissions to 5 per cent below 2000 levels by 2020 (Clean Energy Regulator, 2014). The Emissions Reduction Fund is budgeted to cost 2.55 billion over four years starting from 1 July 2014 to pay businesses for emission reduction projects giving them and incentive to reduce emissions. The Australian Government argues this is the cheapest method to reduce emissions and is better for the economy than the carbon tax where the biggest polluters pay for the amount of pollution they produce. In addition will build an environemtal workforce made up of 15000 young people to undertake conservation projects. Including re vegetating sand dunes, cleaning up reiver bancks, weed control and regenrating local parks (Australian Government, 2014).

Victorian Climate Change Act

The Victorian Climate Change Act came into effect on the 1 July 2011. The Act creates a legal framework for key actions and inititatives in response to Climate Change in Victoria. The Act provides the basis for key actions to be implemented including:

- A carbon reduction target of 20 per cent by 2020
- A framework for measuring and reporting climate change actions

International Council for Local Environmental Initiatives (ICLEI)

For many years *ICLEI – Local governments for sustainability* have been working with local councils to support and guide them toward their carbon goals through the Cities for Climate Protection (CCP) program. Approximately 70 Victorian councils have been active participants in the program; collecting data, establishing policies and strategies, an taking steps towards their emission reduction targets. Though ICLEI ongoing support is on a fee for service basis.

2.9 How is climate change affecting MPSC

The MPSC is no exception to the deleterious effects of climate change. The MPSC participated in a study conducted by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) investigating the impacts of climate change on the Mornington Peninsula region. The study gave some serious predictions for changes from climate change in the next 60 years including

- Droughts will be longer and more severe.
- Average annual rainfall will decrease by 8 per cent by 2030 and decrease up to 23 per cent by 2070. When it does rain the rain will be more intense leading to flash flooding and worsening erosion.
- Temperature is predicted to rise by 3.5 degrees by 2070 and the number of days above 30 degrees will increase by 5 by 2030 and by 16 by 2070. A greater demand for air conditioning will also place stress on the power grid resulting in more frequent and longer blackouts and increasing greenhouse gas emissions
- Sea level is predicted to rise by up to 49 cm and storm surges could increase by 65 cm putting coastal communities and infrastructure at risk of erosion and flooding
- High fire risk weather will increase placing ecosystems, life and property at risk
- Storms will be more frequent and severe.

(Kinrade and Preston, 2008)

2.10 Is MPSC taking action on climate change?

MPSC is committed to assisting and leading its community to recognise and respond to their individual contribution to climate change. In light of these predicted risks from climate change MPSC is committed to reducing its carbon emissions and improving its sustainability through their Sustainable Peninsula Initiative which was developed in conjunction with the community in 2001. The initiative provides a framework that ensures incorporation of sustainable principles into all council operations (MPSC, 2013).

In 2008, in conjunction with the CSIRO and with funding from Federal (Department of Climate Change) and State (Department of Sustainability and Environment) produced the report 'Impacts of Climate Change on Human Settlements in the Western Port Region: People Property and Places' which identified the potential climate change impacts on the region over the next 60 years (Kinrade and Preston, 2008).

From this a risk management framework was applied to determine the risk associated with the impacts identified in the report. The MPSC has undertaken several projects to reduce their greenhouse gas emissions and overall contribution to climate change to address the issues identified in the CSIRO report. In addition they hope to undertake the following initiatives

- Plans for capturing methane gas from the landfill and converting this to electricity to power around 1400 homes
- Plans to purchase 100 per cent accredited Green power for all MPSC buildings and facilities. This Green Power is sourced from mini hydro, wind and biomass
- Downsizing the MPSC vehicle fleet
- Improving energy efficiency in MPSC buildings including insulation, improved heating and cooling controls and installation of energy efficient lights
- Building public cycle paths to encourage cycling as an alternative to car travel.
- Providing tours at our Eco Living Display Centre to show people how to save water and energy and reduce waste at home and in the garden to reduce potable water use
- using recycled water and storm water for irrigating major sports grounds and for road maintenance
- planting drought tolerant grasses on sporting fields
- incorporating water efficient design features such as rain water tanks and appliances into Shire buildings
- Coastal Management Plans are being developed for key coastal areas to help protect foreshore reserves, environmental, heritage and recreational values; these plans also identify and respond to sea level rise risk.
- The MPSC has doubled the bushfire prevention budget to $4 million each year.

- The MPSC is spending $30 million over 10 years to improve drainage through the Integrated Drainage Strategy. This Strategy will plan for upgrades to the Shire's drainage system so it can cope better with the intense rainfall and sea level rise associated with climate change.

(MPSC, 2014)

2.11 Barriers to effective action on climate change

Climate change creates many challenges and also some opportunities for local councils. Whilst some local councils are taking some form of action on climate change it is at an ad hoc manner (MAV, 2012). Where emission reduction actions are being undertaken in some instances they are not being monitored. Whilst key motives for adopting emission reduction actions are cost savings; legislative requirements, regulations; and to demonstrate climate leadership there are many barriers (Zeppel, 2012). In a climate change mitigation survey of Queensland councils by Zeppel, 2012 the "main barriers cited by council participants as impediments to carbon reduction actions were, costs and lack of funding; lack of council policies; indifference to climate change by some councillors and managers; lack of staff to implement climate action; and regulations". The main driver for carbon emission reductions was cost savings for the majority of surveyed Queensland councils (88%).

Similarly, in Victoria, in 2010, the Municipal Association of Victoria (MAV) surveyed local councils and their action on climate change. This study revealed that 28% of Victorian councils have not undertaken any form of planning for climate change. In 2011 the MAV undertook another project 'Supporting Victorian Local Government to Manage Climate Risks and Plan for change' in order to understand the barriers and constraints councils face in understanding, integrating and implementing actions on climate change. The report identified the following trends as main barriers

- Lack of information and guidance on climate change
- Lack of understanding and engagement amongst executive council staff and councillors

- Lack of resources to conduct initial assessments and planning and to facilitate and monitor implementation
- Lack of Policies and guidelines to facilitate implementation

(MAV, 2012)

Furthermore, combating climate change can be time-consuming, and as a result, very few local councils are fully committed. Also, skepticism surrounding climate change is one of the battles inhibiting adoption of adaptation strategies at local council level.

In addition, climate change initiatives must be thoroughly thought out. For example, MPSC residents who participated in the MPSC's buy back scheme for rainwater tanks noted the cost of the pump for the tank was more expensive than the savings achieved by reducing the amount of potable water they use. Hence, water restrictions would be a more effective option.

In conclusion, the flow in effects to local council from lack of direction from the State and Federal levels can result in lack of clarity around roles and responsibilities and resourcing for climate change actions at a local level thus creating a barrier to effective action. Often issues are left unresolved as there are no clear roles of who is responsible. The current political structure supports 4 year terms of Government and focus on shorter term but lack the ability to focus longer term. Action on climate change requires us to think 100 years ahead. Local councils are presently not appropriately resourced in terms of staff and finances equipped to respond to climate change. State and Federal government with their emerging policies are going to have to ensure that appropriate resourcing, training and support is provided and appropriate funding models developed to take effective action on climate change.

2.12 Why a carbon footprint assessment for MPSC

MPSC made a commitment to contribute to the global reduction of greenhouse gases when it became a signatory to the International Council for Local Environmental Initiatives (ICLEI) Cities for Climate Protection (CCP) program in 1997 (ICLEI, 2009).. Council finalised a Greenhouse Strategy in 1999 with specific targets for Corporate and Community emissions. Mornington Peninsula Shire Council's

community emissions target is 20% reduction from 1995/96 levels by 2010/11. In the past, council received community greenhouse gas emission data every five years from ICLEI which was based on analysis of Census data. However ICLEI, 2009 admit that "this data has a level of uncertainty when applied at the municipal level, as it is based on emissions averaged across the state". It would be difficult for MPSC to use this data to measure the success of any recent climate change programs and ICLEI no longer provides this data service to its members (ICLEI, 2009).

MPSC currently has no independent greenhouse gas emission reporting structure in place. It is therefore important for MPSC to undertake measurement of their greenhouse gas emissions to define their climate change contribution so they can accurately address their carbon emissions.

2.13 Background of a carbon footprint

A carbon footprint is a "measure of the carbon dioxide equivalent (CO2-e) emissions attributable to an organisation or product level" (NCOS, 2012). It is meant to help individuals and organisations to determine their contribution to climate change by understanding the various sources of emissions, their relative magnitude, and thus where to focus resources and actions to reduce them (Wiedmann and Minx, 2008).

While it is referred to as a 'carbon' footprint, all 6 greenhouse gases are incorporated into the reporting process (as described in Chapter 2.8.1 above. These gases are equalised in terms of their ratio to carbon dioxide (CO2) concentrations and reported as carbon dioxide equivalent (CO2-e). For example, methane has a greenhouse warming potential (GWP) of 21 and carbon has a GWP of 1. Therefore methane is 21 times more potent than carbon dioxide. Each greenhouse gas has a different GWP and emissions can be made up of a number of gases, so for ease of emissions calculations all gases are converted CO2-e.

There are two predominant methods used in quantifying greenhouse gas emissions to determine an organisations carbon footprint. The first methodology considers the direct and indirect emissions at an organisational or facility level. This is called the *GHG inventory* approach.

The other considers the emissions associated with a particular product or service. This is called the *Life Cycle assessment (LCA)* approach. The LCA method accounts for all of the greenhouse gas emissions involved in from the manufacture, distribution use, consumption and disposal of the product.

2.14 GHG inventory accounting and reporting standards

Reporting carbon emissions for local councils can be a complicated task. There is no single standard for carbon emissions reporting.

As discussed above there are two accepted approaches for calculating a carbon footprint:

1.) the greenhouse gas (GHG) inventory approach, and

2.) the life cycle assessment (LCA) approach.

The ISO 14064.1:2006, the NGER Act, 2007 and supporting documentation including the NGER (Measurement) Determination 2008, and associated NGER Technical Guidelines 2013 along with the GHG Protocol 2004 provide guidance for organisations on how to prepare a carbon footprint according to the GHG inventory approach (NCOS, 2012).

International standard ISO 14040:2006 and ISO 14044:2006 provide guidance on how to undertake an LCA to calculate the carbon footprint of a product (goods or service). Other international standards based on the ISO 14040 series may also be applied, such as the British Standard PAS 2050 and the GHG Protocol (NCOS, 2012).

Which method chosen depends upon the organisations carbon accounting requirements. If an organisation is required to report carbon emissions under national legislation, then following the GHG approach will be sufficient. If an organisation wants to market a product as having low carbon emissions, then it is necessary consider the entire supply chain of the product and will need, a LCA approach should be used to support the low carbon emission claims.

2.15 Summary

Australia generates only 1.5% (Garnaut, 2008) of total global greenhouse gas emissions so its actions to reduce emissions alone cannot avert the consequences of climate change. However Australia is one of the world's biggest polluters per capita basis. To help avoid the serious consequences of climate change it is imperitive for the global community to work together to collectively reduce carbon emissions. Local councils services residents, businesses, visitors alike and given this is well placed to make positive change to combat climate change.

CHAPTER 3

3 RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

Chapter 3 describes in detail the methodologies and any assumptions used to develop the carbon footprint based on a case study of MPSC. The methodology adopts and applies greenhouse gas accounting and reporting principles as outlined in relevant national legislation. A description of the methodologies, source of data and emissions factors for each source of emissions shall be described herein.

3.2 Establishment of a carbon footprint methodology

As described in Chapter 2 there are a number of national and international methodologies that exist for carbon footprint calculation. In addition, there are a number of calculators and tools available online to assist in the development of a carbon footprint, however many have not been validated and are therefore not recommended.

The *GHG Protocol (2004)*, *ISO 14064.1:2006*, the *NGER Act 2007* and supporting documentation including the *NGER (Measurement) Determination 2008* and the *The National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (2013)* all provide guidance on how to prepare a carbon footprint.

The *GHG Protocol* is an internationally recognised methodology for determining an organisations carbon footprint and as such it forms the basis for nearly all reporting frameworks. Drawing on the GHG protocol, Australia's NGER Act, 2007 introduced a national framework for the reporting and collation of information relating to carbon emissions. To effectively manage data and reporting obligations it is recommended that MPSC should align emission reduction approaches with this standard through application of NGER Act, 2007 and associated Technical Guidelines as this approach will equip council to understand direct and indirect exposure to potential mandatory reporting under the NGER Act in the future. However, MPSC is currently

not expected to report under NGER Act as its due to its size i.e. its emissions are not large enough to meet the thresholds that are required to report under the NGER Act.

Using the *NGER (Measurement) Determination 2008* and associated *Technical Guidelines(2013)* described above as a guide the following sections describe the steps/methodology that was taken to complete a carbon footprint for MPSC:

- Defining the boundary of an organisation;
- Defining the operational boundary;
- Defining emissions sources associated with the organisational boundary;
- Collection of activity and emissions data for emissions attributable to the organisation.
- Detail calculation methodology using recognised emission factors and identification of any assumptions used.

3.3 Setting Organisation boundary

The first step was to clearly define MPSC's organisational boundary. According to the NGER Act 2007 an entire organisation's boundary includes:

i. all corporate group members; and
ii. all facilities under the operational control of corporate group members including any subsidiaries, joint ventures and partnerships (NGER, 2007)

The organisational boundary therefore defines the entities/facilities that will be included in the carbon footprint. The NGER Act, 2007, requires reporting organisations to compile greenhouse gas emissions utilising the *Operational Control* approach. Hence the organisational boundary defines which operations and sections within an organisation which is the responsibility of that organisation for the purpose of calculating the carbon footprint. This generally includes owned and tenanted buildings, car fleet, other facilities (e.g. visitor centres) and owned land. For MPSC this constituted the majority of the organisation. MPSC owns some 115 facilities. The facilities operated by the council can be categorised as follows:

- Administration Buildings
- Health Care Centre

- Libraries
- Parks and Reserves
- Aquatic Leisure Centres
- Sporting Ovals
- Town Hall
- Note The MPSC does not own or operate any preschools/kindergartens or child care centres.

Some properties owned by the council are leased to third parties, these are mostly sporting clubs. These have been mostly excluded from the inventory, as they outside of the organisational activities of the Council except where council pays for electricity uses for water pumps for the irrigation of sporting ovals. MPSC subsidises sports clubs using council owned facilities under seasonal tenancy agreements, but the clubs themselves are responsible for providing financial contribution towards the operational costs. For these facilities whereby MPSC is not the sole tenant of a building, then the percentage of consumption data shall be taken into account. In addition, council operates a fleet of vehicles is owned and maintained by the Council. There are 32 vehicles in total and these are comprised of cars, vans and utilities. Council is also responsible for various types of street lighting (e.g. parks/reserves, major roads etc). However, MPSC does not have primary operational control over the asset. Therefore, under NGER Act (2007), council would not be obliged to incorporate streetlights into its emissions scope.

The majority of MPSC's operations have been accounted for in this inventory. The assessment has been based on the premise that all emissions are included which would not otherwise have occurred if the MPSC did not exist.

3.4 Setting Operational Boundary

The purpose of setting an operational boundary is to define the scope of emissions that will be included in the inventory. Such an operational boundary shall incorporate all of the emissions generating activities associated within the council.

A diagrammatical representation of the inventory boundaries is shown in Figure 3.1 below.

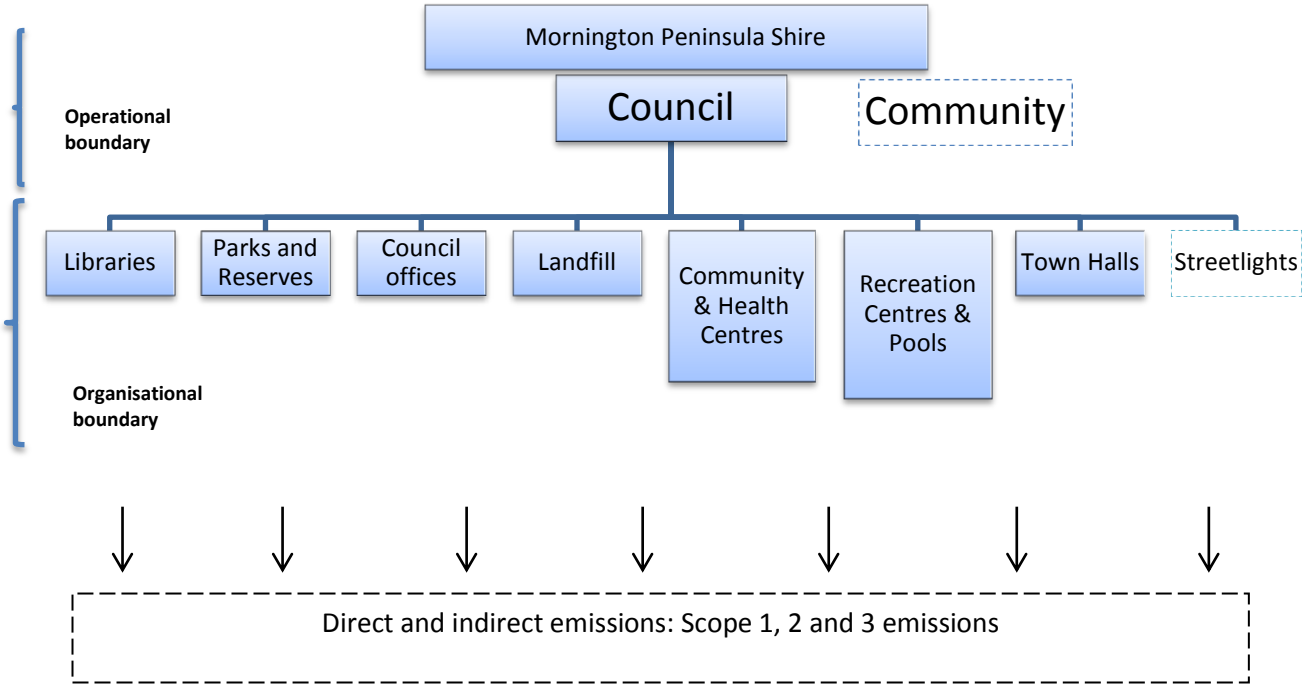

Figure 3.1: Organisational and operational boundaries for MPSC

3.5 Determination of what emission generating activities occur within council

Generally, under guidance from the GHG Protocol, 2004 and in line with the NGER Act 2007 and supporting guidelines the council emission sources can be divided into the following 3 categories for greenhouse gas accounting and reporting purposes. The GHG Protocol definitions for each scope are given below

Scope 1– Scope 1 emissions are direct emissions that occur from sources that are owned or controlled by council. This would include emissions arising from landfills and the combustion of fuels in equipment, buildings and employee commuting in vehicles that are owned by the council.

Scope 2–Scope 2 emissions account for emissions arising from the generation of purchased electricity and natural gas consumed by the council. Scope 2 emissions are considered indirect as they occur at the facility where electricity is generated.

Scope 3 –Scope 3 emissions are all other emissions not covered in scope 2 that occur as a result of activities within the operation of the local council that are a consequence of the activities of council, but occur from sources not owned or controlled by council. Examples of scope 3 emissions include business travel, employee commuting, leased assets and outsourced waste disposal.

The GHG Protocol and NGER Act, 2007, recommends that an organisation, at a minimum, reports scope 1 emissions and scope 2 emissions. In this case we included scope 3 emissions where possible.

(GHG Protocol, 2004).

The following sources of emissions are commonly included in council greenhouse gas inventories in Figure 3.2 below. These emissions sources have been included on the basis that they account for a comprehensive overview of all emissions related to Councils operations.

Figure 3.2: Common council sources of emissions

Sources of emissions specific to MPSC that shall be included in the inventory include the following:

- *Electricity* – emissions resulting from the energy use (electricity) of council owned and operated buildings for water pumping on council-owned and managed reserves, parks and gardens

- *Gas* – emissions resulting from the energy use (gas) for council owned and operated buildings

- *Vehicle Fleet* – emissions resulting from the energy use (unleaded petrol, gas and diesel) of Council-operated vehicles

- *Employee commute* – emissions resulting from the energy use from council employee commute

- *Waste* – emissions resulting from the breakdown of waste originating from corporate activities and emissions released from council owned landfill sites.

Information for each source of emissions is described in more detail below including where data was sourced.

3.6 Selection of Base year

Once the organisational and operational boundaries and emission sources had been established we could then calculate emissions for each source for a reporting period. The period that an organisation chooses to examine and whether the inventory is aligned with calendar or financial year reporting is dependent on the organisation's specific needs or goals. However, there are specified reporting periods (aligned with the financial year) under the NGER Act 2007. The 2013 calendar year was selected for the purposes of this dissertation.

3.7 Emission Factors

An emission factor is a factor which identifies the per kg carbon dioxide equivalent (kgCO2-e) arising from a particular activity. Published emissions factors for the reporting period (2013) were researched and collected from leading sources such as the National Greenhouse Accounts (NGA) Factors (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2013). At the time of writing, the latest version was published in June 2013 containing detailed emissions factors for energy consumption. Where needed emissions factors shall be converted so that they are based on the same units as the data collected by MPSC.

Emission factors vary by scope, activity and location to reflect differences in global warming potential of the particular source. As an example, for every kWh of electricity consumed in Victoria 1.17kg of CO2-e is emitted into the atmosphere. In South Australia 0.62kg of CO2-e is produced for the same amount of electricity consumed (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2013). The differences reflect the high carbon intensity of Victoria's energy source, with brown coal providing the majority of the State's electricity.

3.8 Data Collection

Collecting the information required to populate an inventory and calculate an organisation's footprint is often one of the most challenging parts of the carbon footprint methodology. Council has a number of data sources that independently record consumption data needed to calculate greenhouse gas emissions. These may include, vehicle fuel use data for fleet cars is collected via a fuel card system with monthly usage reports and electricity and gas consumed by council owned facilities is collected directly from the usage data on monthly bills. More details of sources of data are included in Chapter 3.10 below.

3.9 Software for developing a basic greenhouse gas inventory

Microsoft Excel shall be used to develop the inventory in the form of an excel spreadsheet.

The inventory was set out in a way which allows for easy interpretation of inputs and outputs. The inventory included a cell for entering data, a cell for the emissions factor and a cell for emissions (expressed in t/ CO2-e). Refer to Appendices for copies of the excel spreadsheets used in this research.

An Excel spreadsheet for the inventory was chosen for the ability to produce visual representations such as bar graphs and pie charts. Interpreting the carbon footprint in this way can assist council to identify its priority emission sources to target mitigation measures appropriately. In addition, council can analyse emissions data on a monthly or quarterly basis to highlight seasonal variations that may assist in developing appropriate emission reduction measures for council operations.

3.10 Calculation Methodology for MPSC emissions

This section defines how MPSC's greenhouse gas emissions were measured.
Greenhouse gas emissions can be quantified in two ways

- *Measurement-based methodologies* refer to the direct measurement of greenhouse gas emissions from a monitoring system e.g. emissions from a flue of a power station, wastewater treatment plant, landfill, or industrial facility.
- *Calculation-based methodologies* refer to equations for calculating emissions using activity data and emission factors.

Calculation based methodology is considered to be the most common approach used to calculate greenhouse gas emissions and is detailed in the following equation below.

$$Activity\ data\ \times\ Emission\ Factor\ =\ GHG\ emissions$$

Activity data may include fuel consumption by fuel type in kilolitres, electricity consumption in kilowatt hours. Emissions are usually expressed in terms of emissions per unit of activity data (e.g. kg CO_2/kWh of electricity). The *calculation based method* shall be used to generate this inventory.

If it is not possible to calculate emissions from known activity data then they shall be estimated or may be extrapolated on the basis of known activity data where reasonable. This is described below.

$$Estimated\ activity\ data\ \times\ emission\ factor\ =\ GHG\ emissions$$

Greenhouse gas emissions from scope 1 and scope 2 emissions sources were calculated in accordance with the methods and guidance provided in the NGER (Measurement) Determination, 2008. Options for calculating emissions include:
i. Method 1 – using default emissions factors derived from the latest version of the National Greenhouse Account Factors;

ii. Method 2 – a method using industry sampling and Australian or international standards listed in the NGER (Measurement) Determination or equivalent for analysis;

iii. Method 3 – a method using Australian or international standards listed in the Determination or equivalent standards for both sampling and analysis of fuels and raw materials. Method 3 is very similar to method 2, but it requires compliance with Australian or equivalent documentary standards for sampling; and

iv. Method 4 – direct measurement using continuous or periodic emissions monitoring.
(NGER Measurement (Determination), 2008)

Calculation of scope 3 emissions shall be in line with the National Greenhouse Account Factors, 2013 and GHG Protocol, 2004. Due to the nature of local council activities, the use of default factors derived from the National Greenhouse Account (NGA) Factors is sufficient. Hence Method 1, was used in this instance for calculation of MPSC's carbon footprint.

After gathering consumption information for each activity, and organising the data, the next step was to calculate the resulting council emissions.
A methodology for calculating emissions for each source is described below. The inventory shall therefore be divided into the following sections electricity, vehicle

fleet, local council generated solid waste and solid waste landfills along with employee commute.

3.10.1 Electricity

This section describes the method of determining greenhouse gas emissions from the consumption of purchased electricity.

To determine the greenhouse gas emissions in tonnes of carbon dioxide equivalent (CO2-e), the following formula and emission factors should be used.

$$Y = Q \times \frac{EF}{1000}$$

where:

Y is the scope 2 emissions measured in CO2-e tonnes.

Q is the quantity of electricity purchased (kilowatt hours).

For a company operating an electricity transmission network or distribution network, ***Q*** is the quantity of electricity losses for that transmission network or distribution network during the year.

For ***Q***, if the electricity purchased is measured in gigajoules, the quantity of kilowatt hours must be calculated by dividing the amount of gigajoules by 0.0036.

EF is the scope 2 emission factor, for the State, Territory or electricity grid in which the consumption occurs (kg CO2-e per kilowatt hour). If the electricity is not sourced from the main electricity grid the emission factor can be either provided by the supplier of the electricity or, if that factor is not available, the emission factor for the Northern Territory may be used

Source: National Greenhouse Accounts (NGA) Factors (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2013)

State, Territory or grid description	Emission factor kg CO_2-e/kWh
New South Wales and Australian Capital Territory	0.87
Victoria	1.17
Queensland	0.82
South Australia	0.62
South West Interconnected System in Western Australia	0.78
Tasmania	0.20
Northern Territory	0.69

Table 3.1: Indirect scope 2 emission factors for consumption of purchased electricity from the grid

Source: Table 5 from National Greenhouse and Energy Reporting (Measurement) Determination 2008

There are numerous buildings/facilities in the inventory which include parks, amenities, administration buildings and pools that consume electricity. A list of MPSC's facilities is included in Appendix B. Data on consumptions of council wide purchased electricity were calculated using data from electricity distributor customer billing data for the 2013 calendar year.

It should be noted that there is no specific reduction in emissions for companies that purchase Green Energy as the emissions factors already include the Green Energy electricity sources.

MPSC subsidises sports clubs using council owned facilities under seasonal tenancy agreements however clubs are responsible for providing financial contribution towards the operational costs. Electricity used by clubs for water pumps to maintain lawns and ovals is subsidised by council. The remaining electricity costs are considered the clubs responsibility. In this case the council reports on average they reimburse sporting clubs $800 Australian dollars per oval for watering lawns of ovals during the summer season. In this case the number of ovals were used to estimate the dollar amount for the 2013 calendar year. The emissions were then calculated using the following relationship

$$Electricity\ usage\ (kWh) = \frac{No.of\ ovals \times \$800}{0.2523}$$

Where $0.2523 is the $ per kWh of electricity consumption.

Refer to results section which shows amount of electricity consumed and emissions generated from council operations.

3.10.2 Natural gas

This section describes the method of determining greenhouse gas emissions from the consumption of purchased natural gas. MPSC uses natural gas for cooking, water and heating.

Data on consumption of council wide natural gas were calculated using data from gas distributor customer billing data for the 2013 calendar year.

The method uses the energy content of the fuel and emission factors for greenhouse gases produced during combustion using the following formula

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$$

where:

E_{ij} is the emissions of gas type (j), (carbon dioxide, methane or nitrous oxide), from gaseous fuel type (i) (CO2-e tonnes).

Q_i is the quantity of fuel type (i) (cubic metres)

EC_i is the energy content factor of fuel type (i) (gigajoules per cubic metre according to Table 2).

If Q_i is measured in gigajoules, then EC_i is 1.

EF_{ijoxec} is the emission factor for each gas type (j) (which includes the effect of an oxidation factor) for fuel type (i) (kilograms CO2-e per gigajoule of fuel type (i) according to Table 3).

Source: National Greenhouse Accounts (NGA) Factors (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2013)

Table 3.2: Emission factors for the consumption of natural gas

Source: Table 2 from National Greenhouse and Energy Reporting (Measurement) Determination 2008

Fuel combusted	Energy content factor (GJ/m^3 unless otherwise indicated)	Emission factor kg CO_2-e/GJ (relevant oxidation factors incorporated)		
		CO_2	CH_4	N_2O
Natural gas distributed in a pipeline	39.3×10^{-3}	51.2	0.1	0.03
Coal seam methane that is captured for combustion	37.7×10^{-3}	51.1	0.2	0.03
Coal mine waste gas that is captured for combustion	37.7×10^{-3}	51.6	5.0	0.03
Compressed natural gas (reverting to standard conditions)	39.3×10^{-3}	51.2	0.1	0.03
Unprocessed natural gas	39.3×10^{-3}	51.2	0.1	0.03
Ethane	62.9×10^{-3}	56.2	0.02	0.03
Coke oven gas	18.1×10^{-3}	36.8	0.03	0.06
Blast furnace gas	4.0×10^{-3}	232.8	0.02	0.03
Town gas	39.0×10^{-3}	59.9	0.03	0.03
Liquefied natural gas	25.3 GJ/kL	51.2	0.1	0.03
Gaseous fossil fuels other than those mentioned in the items above	39.3×10^{-3}	51.2	0.1	0.03
Landfill biogas that is captured for combustion (methane only)	37.7×10^{-3}	0.0	4.8	0.03
Sludge biogas that is captured for combustion (methane only)	37.7×10^{-3}	0.0	4.8	0.03
A biogas that is captured for combustion, other than those mentioned in the items above	37.7×10^{-3}	0.0	4.8	0.03

In Victoria, 51.2 kg CO2 equivalent is produced for every gigajoule of natural gas used.

Refer to the results section which shows amount of natural consumed and emissions generated from council operations.

3.10.3 Transport

Vehicle Fleet

MPSC currently operates a vehicle fleet with 30 vehicles consisting of cars, utilities and vans. The operation of such vehicles contributes to greenhouse gas emissions in two ways. Vehicles burn gas, petrol and diesel fuels with result in carbon emissions and secondly vehicles with air conditioning emit hydroflurocarbons and other greenhouse gases when these systems leak. Analysis of such hydroflurocarbons is

beyond the scope of this report and will only focus on greenhouse gas emissions from the burning of fuel.

The total for each vehicle fuel use in Litres was provided by fuel card summaries.

The following formula can be used to estimate greenhouse gas emissions from the combustion of each type of fuel listed in Table 4 used for transport energy purposes.

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$$

where:

Eij is the emissions of gas type (j), carbon dioxide, methane or nitrous oxide, from fuel type (i) (CO2-e tonnes).

Qi is the quantity of fuel type (i) (kilolitres or gigajoules) combusted for transport energy purposes

ECi is the energy content factor of fuel type (i) (gigajoules per kilolitre or per cubic metre) used for transport energy purposes — see Table 4.

If ***Qi*** is measured in gigajoules, then ***ECi*** is 1.

EFijoxec is the emission factor for each gas type (j) (which includes the effect of an oxidation factor) for fuel type (i) (kilograms CO2-e per gigajoule) used for transport energy purposes — see Table 4.

Source: National Greenhouse Accounts (NGA) Factors (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2013)

Table 3.3: Fuel combustion emission factors – fuels used for transport energy purposes

Source: Table 4 from National Greenhouse and Energy Reporting (Measurement) Determination 2008

Transport equipment type	Fuel combusted	Energy content factor (GJ/kL unless otherwise indicated)	Emission factor kg CO_2-e/GJ (relevant oxidation factors incorporated)		
			CO_2	CH_4	N_2O
General transport					
	Gasoline (other than for use as fuel in an aircraft)	34.2	66.7	0.6	2.3
	Diesel oil	38.6	69.2	0.2	0.5
	Gasoline for use as fuel in an aircraft	33.1	66.3	0.04	0.7
	Kerosene for use as fuel in an aircraft	36.8	68.9	0.01	0.7
	Fuel oil	39.7	72.9	0.06	0.6
	Liquefied petroleum gas	26.2	59.6	0.6	0.6
	Biodiesel	34.6	0.0	1.2	2.2
	Ethanol for use as fuel in an internal combustion engine	23.4	0.0	1.2	2.2
	Biofuels other than those mentioned in items above	23.4	0.0	1.2	2.2
	Natural gas (light duty vehicles)	39.3×10^{-3} GJ/m^3	51.2	5.5	0.3
	Natural gas (heavy duty vehicles)	39.3×10^{-3} GJ/m^3	51.2	2.1	0.3
	Liquefied natural gas (light duty vehicles)	25.3	51.2	5.5	0.3
	Liquefied natural gas (heavy duty vehicles)	25.3	51.2	2.1	0.3
Post-2004 vehicles					
	Gasoline (other than for use as fuel in an aircraft)	34.2	66.7	0.02	0.2
	Diesel oil	38.6	69.2	0.01	0.6
	Liquefied petroleum gas	26.2	59.6	0.3	0.3
	Ethanol for use as fuel in an internal combustion engine	23.4	0	0.2	0.2
Heavy vehicles conforming to Euro design standards					
Euro iv or higher	Diesel oil	38.6	69.2	0.05	0.5
Euro iii	Diesel oil	38.6	69.2	0.1	0.5
Euro i	Diesel oil	38.6	69.2	0.2	0.5

Refer to results section which shows amount of fuel consumed and emissions generated from council owned vehicle fleet.

Employee commute

In order to establish these emissions, a short and simple online survey using Survey Monkey – a free web based questionnaire tool (http://www.surveymonkey.com) was developed. First the questionnaire asked staff how many weeks they had worked in the previous year. Following this, employees were asked the number of days per week they travelled to work and by which transport mode. They were then asked the distance of the return journey in kilometres. A copy of the questions in located in Appendix G. Where staff had not answered the survey their staff commuting kilometres travelled and transport mode was extrapolated based on the average of all respondents. This helped to quantify 100% of the 1400 staff commuting travel data. Data for vehicle model, manufacturer, fuel type, body type (e.g. sedan, wagon, van, 4 wheel drive etc.) and year of manufacture was also obtained from the survey. This data was then entered into an excel spreadsheet. Total emissions from vehicles was determined by the total number of vehicles and their fuel efficiency per 100km, total distance travelled and fuel type using the fuel efficiency from the Federal Government's Green Vehicle Guide and Fairfax's Drive website (fuel efficiency factors depend on the type and age of each vehicle).

The distance travelled data was then converted into fuel use values based on fuel efficiency factors for each vehicle using the following equation

$$i.e.\, fuel\ use\ =\ distance\ travelled\ \times\ fuel\ efficiency\ factor$$

Now having the total kL of fuel the following formula can be used to estimate greenhouse gas emissions from the combustion of each type of fuel listed in Table 4 used for transport energy purposes using the following equation

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$$

where:

Eij is the emissions of gas type (j), carbon dioxide, methane or nitrous oxide, from fuel type (i) (CO2-e tonnes).

Qi is the quantity of fuel type (i) (kilolitres or gigajoules) combusted for transport energy purposes

ECi is the energy content factor of fuel type (i) (gigajoules per kilolitre or per cubic metre) used for transport energy purposes — see Table 4.
If ***Qi*** is measured in gigajoules, then ***ECi*** is 1.
EFijoxec is the emission factor for each gas type (j) (which includes the effect of an oxidation factor) for fuel type (i) (kilograms CO2-e per gigajoule) used for transport energy purposes — see Table 4. (Refer to Table 3.3 above).

Source: National Greenhouse Accounts (NGA) Factors (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2013)

Refer to results section which shows amount of fuel consumed and emissions generated from council employee commute.

3.10.4 Waste

Corporate Solid Waste

Corporate waste emissions result from the disposal of waste to landfill. Corporate waste emissions are considered to be from all council owned facilities and exclude waste collected in the community e.g. residential kerbside waste collection. It shall be noted that some facilities are responsible for their own waste disposal hence shall not be included in this inventory.

The source of data was MPSC's Waste Department using reports from waste collection per week. To determine the emissions from council waste the total weekly litres of waste will be converted to annual litres then annual cubic metres of waste then into tonnes of waste. The conversion of volume to weight will be based on a conversion factor for different waste types, from National Greenhouse Account Factors (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2013).

The component types of the waste to landfill (paper products, food waste, plant debris, nappies, recyclable and general) was obtained from a Waste Audit conducted by Council in 2009 (MPSC, 2009).

The analysis of how many emissions are generated from waste was determined through assumptions about the percentage of active carbon converted to gas (carbon dioxide and carbon monoxide) and how much methane is oxidised before it reaches the atmosphere and how much methane escapes from the landfill. The National Greenhouse Account Factors (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2013) provided all the variables to calculate emissions per tonne of putrescible waste.

Therefore estimates of greenhouse gas emissions associated with the disposal of waste can be calculated according to the general equation:

$$GHG\ emissions\ (t\ CO2-e)\ =\ Q_j\ \times\ EF_j$$

where:

Q_j is the quantity of waste by type j

EF_j is the emission factor of waste type j (see Table 42, column B) taken from the National Greenhouse Account Factors (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2013)

Table 3.4: Putrescible Waste Streams

Putrescible waste stream	% audit from 2008	Tonnes of waste (t) Q	DOC	Conversion factor CO2-e ($t = tonnes$) Table 42 Column 3	GHG [tCO2/tWaste]
Paper	12		0.4	$t\ \times\ 2.5$	
Food waste	31		0.15	$t\ \times\ 1.6$	
Plant debris	6		0.2	$t\ \times\ 1.2$	
Nappies	7		0.24	$t\ \times\ 1.5$	
Recyclable	9		0	$t\ \times\ 0$	
General	25		0	$t\ \times\ 0$	
	$= 100\%$				

Where Q = quantity of waste in tonnes/annum $\times$ %

Note: DOC Degradable Organic Carbon [tCarbon/tWaste] is from Table 42 National Greenhouse Account Factors July 2013 (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2013).

Table 3.5: Waste mix conversion factors

Source: Table 42 in National Greenhouse Account Factors (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2013).

Waste types	Default DOC proportion	Conversion factor CO_2-e (t=tonnes)
	A	B
Food	0.15	t x 1.6
Paper and cardboard	0.4	t x 2.5
Garden and green	0.2	t x 1.2
Wood	0.43	t x 1.2
Textiles	0.24	t x 1.5
Sludge	0.05	t x 0.3
Nappies	0.24	t x 1.5
Rubber and leather	0.39	t x 2.5
Inert waste (including concrete/metal/plastics/glass)	0	t x 0
Alternative waste treatment residues	0.08	t x 0.5

Note: The conversion factors have been calculated according to the default variables detailed in Table 43 of National Greenhouse Account Factors (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2013) and the following formula

$$GHG\ Emissions\ (t\ CO2-e) = [((Q \times DOC \times DOCF \times F1 \times 1.336) - R) \times (1 - OX)] \times 21$$

Where each variable is outlined in Table 3.6 below.

Table 3.6: Waste Variables and Default values

Source: Table 43 from National Greenhouse Account Factors July 2013

Variable	Default values
Q (Activity)	Quantity of municipal solid waste expressed in tonnes and sourced from waste records or contractor invoices
DOC	Degradable Organic Carbon expressed as a proportion of the particular waste type and contained in Table 42.
DOC_F	Fraction of degradable organic carbon dissimilated for the waste type produced with default values as follows: Food – 0.84 Paper and cardboard – 0.49 Garden and green – 0.47 Wood – 0.23 Textiles – 0.5 Sludge – 0.5 Nappies – 0.5 Rubber and leather – 0.5 Inert waste, i.e. concrete, metal, plastic and glass – 0.0 Alternative waste treatment residues – 0.5
F_I	Methane fraction of landfill gas which has a default value of 0.50
1.336	Conversion rate of carbon to methane
R	Recovered methane during the year, measured/expressed in tonnes
OX	Oxidation factor which has a default value of 0.1 for covered, well-managed landfills (and a value of 0 for uncovered landfills)
21	CH_4 global warming potential used to convert the quantity of methane emitted to CO_2-e from the quantity of waste produced

Refer to results section which shows emissions generated from council waste operations.

Landfill sites

Emissions from landfill consist mainly of the uncontrolled release of methane from decomposing organic material. Typical sources of waste in local council operations include paper and food waste from offices and facilities along with plant debris. After being placed in a landfill, organic waste (such as paper, food scraps, and plant debris) is initially decomposed by aerobic bacteria. However, when other wastes are placed on top and compacted, there is little air left. After the oxygen has been depleted, the remaining waste is available for consumption by anaerobic bacteria, which break down organic matter into substances such as cellulose, amino acids, and sugars. These substances are further broken down through fermentation into gases and organic compounds that form the substrates for the growth of methanogenic

bacteria. These bacteria convert the fermentation products into stabilised organic materials and biogas consisting of carbon dioxide and methane (MPSC, 2009).

The MPSC operates three Resource Recovery Centres (tips) that accept a variety of wastes. There are also 3 landfill sites owned by MPSC.

Landfills continue to emit methane long after they have been closed, although emissions do drop over time. There are a number of closed landfills in MPSC, and the greenhouse gas inventory includes estimates of their methane emissions. The MPSC conducted a Municipal Waste Management Strategy in 2009 and engaged Hyder Consulting Pty Ltd (Private Consultants) to carry out an assessment of greenhouse gas emissions from active and closed landfills owned by MPSC. This report provides estimates of emissions from the landfill in accordance with this assessment.

Refer to results section which summarises these results for landfills within MPSC.

CHAPTER 4

4 RESULTS: MPSC GREENHOUSE GAS EMISSIONS

4.1 Introduction

The summary of findings will describe total council greenhouse gas emissions and then analyse it by source (electricity, natural gas, transport and waste).

4.2 Total council greenhouse gas emissions

MPSC activities produced 25,418.6 equivalent tonnes of carbon dioxide (tCO2-e) in the calendar year 2013. MPSC's emissions profile is shown in Figure 4.1 and detailed in Table 4.1 below. As a comparison, Victoria's total net greenhouse gas emissions in 2012 were 124,500 million equivalent tonnes (Department of Environment, 2014).

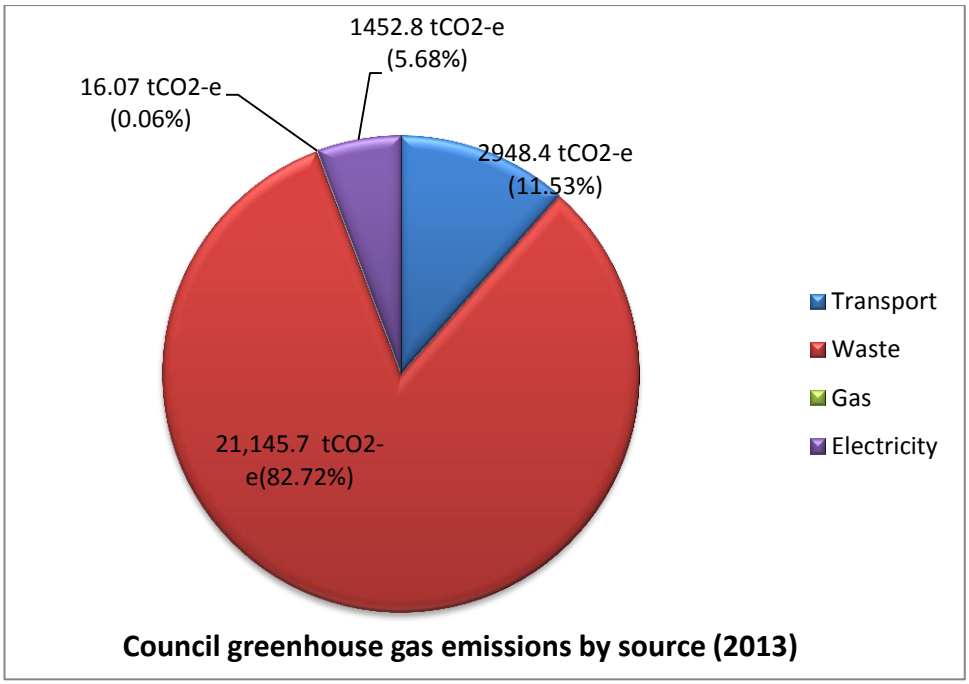

Figure 4.1: Council greenhouse gas emissions proportions by source

Table 4.1: Council greenhouse gas emissions by source

Source	tonnes CO2-e	%
Transport	= 2948.370	11.53
Waste	= 21, 145.697	87.72
Gas	= 16.072	0.06
Electricity	= 1452.787	5.68
Total	= 25562.9	100

The breakdown of emissions by source (as shown in Table 4.1) shows that the largest proportion of council emissions in 2013 was waste (82.72%) followed by electricity (5.68%), transport (11.53%) and gas (0.06%). The high proportion of emissions from waste reflects the high emissions from closed landfill sites in the region.

The breakdown of emissions by scope is detailed in Table 4.2 below. Landfill, a scope 1 emission was the greatest contributor with 82.62% of total emissions.

Table 4.2: Breakdown of emissions by scope.

SCOPE	GHG emission (tCO2-e)	Proportion of total inventory (%)
Scope 1		
Landfill	21000	82.62
Vehicle fleet	393.222	1.54
Natural Gas	16.072	0.063
Scope 2		
Electricity	1452.787	5.71
Scope 3		
Corporate waste	0.973	0.0038
Employee commute	2555.51	10.05

Next the results from each source of emission will be described in detail.

4.3 Transport

Results

The results show that transport contributes a total of 11.53% to the total council greenhouse gas emissions.

4.3.1 Vehicle Fleet

The results from transport for MPSC shows the vehicle fleet contributes 1.54% of total council greenhouse gas emissions. The total emissions per year from the vehicle fleet are 393.22 tCO2-e, which makes the average emissions per car 13.11 tCO2-e. This is significantly higher than the Victorian state average of 4 tCO2-e per car per year (RACV, 2014). The average fuel efficiency for vehicles in MPSC is 10.2 litres per 100km. This is lower than the national average of 13.7 litres per 100km (ABS, 2012)

Fuel types for vehicles in MPSC is largely diesel (63.0%) followed by petrol (20.0%), gas (17%) and hybrid (0.0%). Greenhouse gas emissions for fuel types are tabulated in Table 4.3 below. Greenhouse gas emissions from vehicle types are tabulated in Table 4.4 below.

Table 4.3: Vehicle emissions by fuel type

Fuel type	GHG emissions t CO2 -e
Diesel	282.041
Petrol	64.086
Gas	47.095
Total	393.222

Table 4.4: Vehicle emissions by vehicle type

Vehicle type	GHG emissions
Car	100.500
Van	89.066
Utility	203.656
Total	393.222

Greenhouse gas missions from MPSC's vehicle fleet are illustrated in Figure 4.2 below. Utility vehicles have the highest emissions, followed by cars then vans. Note there were no hybrid vehicles in the council fleet.

Greenhouse gas emissions from diesel vehicles are highest followed by petrol then gas and this may reflect high number of utility vehicles in council fleet that consume diesel.

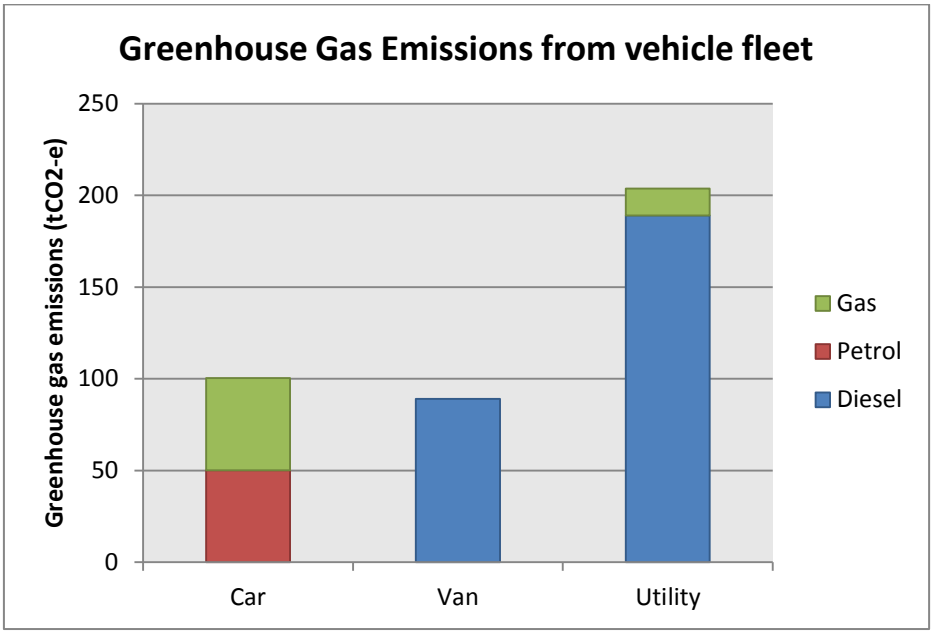

Figure 4.2: Greenhouse gas emissions from council vehicle fleet

Assumptions

There are several assumptions that were made and these are outlined below:

- That data form fuel cards is complete and correct.
- Vehicles with air conditioning emit hydroflurocarbons and other greenhouse gases when these systems leak. Although leaked refrigerants from air conditioning is a likely source of emissions from council vehicles, council will not be able to directly reduce those emissions. Therefore analysis of such hydroflurocarbons is beyond the scope of this research and were not considered. Therefore the results may have underestimated the carbon emissions from council vehicles.

Limitations of the data

There are several limitations to the data that are outlined below:

- The accuracy of the emissions estimates is dependent on the accuracy of the input data.
- Human errors in the data collection and unit conversion process may also have occurred.
- Use of hire cars by council has not been accounted for.
- Fuels purchased by the employee and then reimbursed by council are not included.
- The data only includes emissions from cars small vans and utes without including heavy transport/buses owned by council as council could not provide this data accurately.

4.3.2 Employee commute

The results from transport in MPSC show the employee commute contributes 10.05% of total council greenhouse gas emissions.

The total emissions from the employee commute for the 121 employee respondents were 203.274 tCO2-e. Multiplying this by 12.57 to extrapolate for the 1400 MPSC total employees equals 2555.15 tCO2-e total emissions. This which makes the average emissions per car 1.89 tCO2-e. This is less than the Victorian state average of 4 tCO2-e per car per year (RACV, 2014). In Victoria, the average car emits about 4 tonnes of carbon dioxide equivalent per year (RACV, 2014). The average fuel efficiency for vehicles in MPSC is 10.2 litres per 100km. This is lower than the national average of 13.7 litres per 100km (ABS, 2012).

Using the data the average distance travelled per car was 7350 km per year. This is lower than the national average of 14,000 km per vehicle in 2012 (ABS, 2012). This may reflect the short distance travelled by most vehicles. This is likely due to employees residing close to council offices/facilities.

Fuel types for vehicles in MPSC is largely diesel (63.0%) followed by petrol (20.0%), gas (17%) and hybrid (0.0%). Emissions for fuel types are tabulated in Table 4.5 below.

Table 4.5: Vehicle emissions by fuel type

Fuel type	GHG emissions t CO2 -e
Diesel	20.528 (258.04)
Petrol	175.039 (2200.24)
Gas	7.707 (88.87)
Total	203.274 (2555.51)

MPSC employees use cars 100% of the time to commute to work. The emissions for vehicle types are tabulated in Table 4.6 below. Again, there were no hybrid vehicles.

Table 4.6: Vehicle emissions by vehicle type

Vehicle type	GHG emissions
Car (61.2%)	125.521 (1577.80)
4WD (32.3%)	67.395 (847.155)
Utility (6.5%)	10.298 (129.45)
Total	203.274 (2555.51)

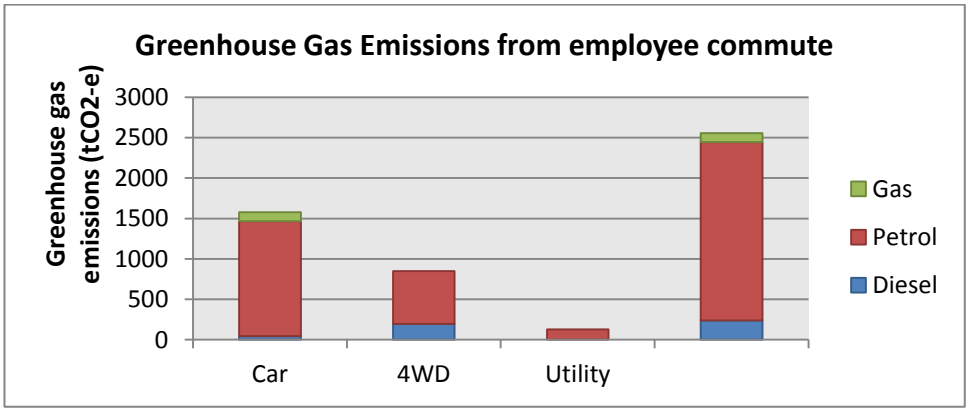

Figure 4.3: Greenhouse gas emissions from employee commute

Assumptions

There are several assumptions that were made and these are outlined below:

- Vehicles with air conditioning emit hydroflurocarbons and other greenhouse gases when these systems leak. Although leaked refrigerants from air conditioning is a likely source of emissions from council vehicles, council will not be able to directly reduce those emissions. Therefore analysis of such hydroflurocarbons is beyond the scope of this research and were not considered. Therefore the results may have underestimated the carbon emissions from council vehicles.
- As the survey attracted an average response the results we assumed an extrapolation for the 1400 council employees.

Limitations

- Limited to estimating emissions due to consumption only within council itself therefore, emissions produced due to transport of material outside the council are not accounted for in this inventory.

- The accuracy of the emissions estimates is dependent on the accuracy of the input data.
- Human errors in the data collection and unit conversion process.
- Limitation due to error in the extrapolation of employee commute data due to the survey attracting a poor response.

4.4 Waste

Results

The results show that waste contributes a significant amount (82.72%) to the total council greenhouse gas emissions. The total emissions per year from landfill waste were 21145.7 tCO2-e. The high proportion of emissions from waste reflects the high emissions from closed landfill sites as corporate waste was negligible at 0.973tCO2-e.

4.4.1 Corporate Solid Waste

It is assumed a constant pattern of waste in council offices and other facilities for the MPSC. It has been summarised below.

Waste – 81 × 120 L bins emptied weekend assumed 100% full each week.

=9720 L per week

Convert L to m^3 then to tonnage –

= 505,440 L annually × 0.001

= 505.44 m^3

=149.74 tonnes

Next the conversion of weight was based on an average factor of 0.296 t/m^3 which is an average of different waste types (refer Table 4.7 below).

Table 4.7: Municipal solid waste volume to weight conversion factors

Source: Table 30 from National Greenhouse Factors, 2013

Material type	Volume to weight (t/m^3)
Paper	0.09
Textiles	0.14
Wood	0.15
Garden	0.24
Food	0.50
Sludge (wet)	0.72
Nappies	0.39
Rubber and leather	0.14

MPSC is estimated to have produced a solid waste stream of 149.74 tonnes which was deposited into local landfill.

Using the % waste stream from 2008 Waste Audit (MPSC, 2009) this waste comprised

- 17.9698 tonnes of paper
- 46.4194 tonnes of food waste
- 8.9849 tonnes of plant debris
- 10.4818 tonnes of nappies
- 13.4766 tonnes of recyclable
- 13.4350 tonnes of general waste

Table 4.8: Calculate emissions per tonne of putrescible waste

Putrescible waste stream	% audit from 2008	Tonnes of waste (t)	DOC	Conversion factor CO2-e ($t = tonnes$) Table 42 Column 3	GHG [tCO2/tWaste]
Paper	12	17.9698	0.4	$t \times 2.5$	0.3
Food waste	31	46.4194	0.15	$t \times 1.6$	0.496

Plant debris	6	8.9849	0.2	$t \times 1.2$	0.072
Nappies	7	10.4818	0.24	$t \times 1.5$	0.105
Recyclable	9	13.4766	0	$t \times 0$	0
General	25	37.4350	0	$t \times 0$	0
	$= 100\%$	=149.74			0.973

Putrescible Waste Totals	2013	Units
Number of employees	1400	
Tonnes Putrescible waste	149.74	Tonnes/annum
GHG tCO2-e	145.697	tCO2-e per annum
Total per employee	0.104	tCO2-e per annum per employee

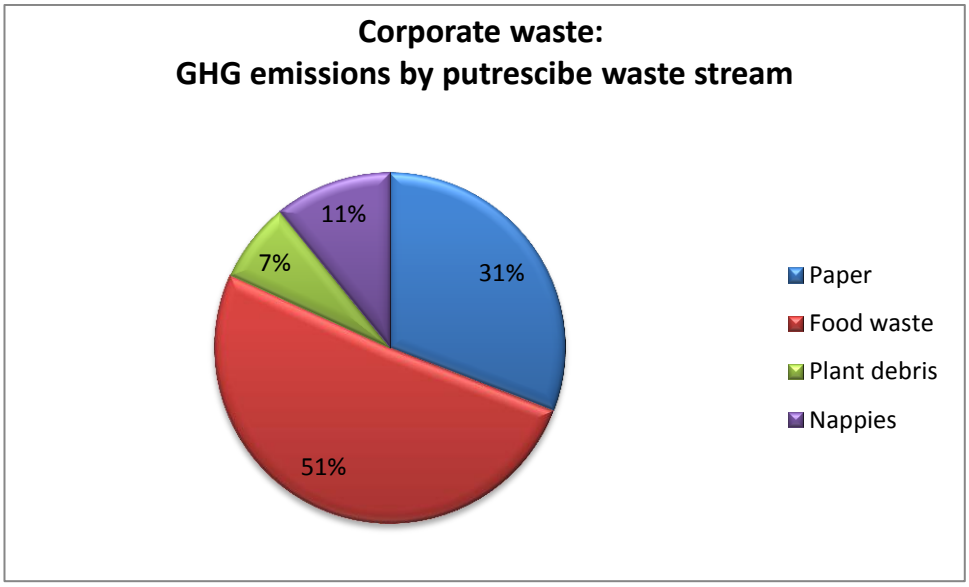

Figure 4.4: Corporate Waste- Greenhouse gas emissions by putrescible waste stream (2013)

Assumptions

There are several assumptions that were made and these are outlined below:

- Assumed council bins were 100% full each week and this may have overestimated the results.
- Assumed a constant pattern of waste in council offices and other facilities for the MPSC
- It should be noted that when council owned buildings/facilities are hired for private functions, they are responsible for their own recycling and waste

disposal. Hence we have assumed that this waste has been disposed of outside of council operations and is therefore not included in the results.

- Green waste was excluded because it is from a biogenic source which means any released carbon dioxide has been absorbed from the atmosphere, hence contributing zero greenhouse gas emissions.
- Estimates of emissions associated with other aspects of solid waste management, including the collection and processing, transportation of waste and recyclable materials is beyond the scope of this research

Limitations of the data

There are several limitations to the data that are outlined below:

- Data from putrescible waste stream was from several years ago (2008) so results described for waste streams may differ but this will generally not effect the waste totals
- Estimates of emissions associated with other aspects of solid waste management, including the collection and processing of waste and recyclable materials is beyond the scope of this report and therefore results may have been underestimated.
- The accuracy of the emissions estimates is dependent on the accuracy of the input data.
- Human errors in the data collection and unit conversion process may have occurred.

4.4.2 Closed Landfill Sites

The MPSC conducted a Municipal Waste Management Strategy in 2009 and engaged Hyder Consulting Pty Ltd (Private Consultants) to carry out an assessment of greenhouse gas emissions from landfills owned by MPSC. The table below summarises these results for operating landfills within MPSC.

Table 4.9: Emissions estimates from MPSC Landfill sites

Source: MPSC 'Municipal Waste Management Strategy (2009)

Landfill	Description	Emission Estimate (kt CO_2-e/yr)
Rye Landfill	Closed – cell 1	18
Tyabb landfill	Closed	3

The most significant greenhouse gas emissions from 2009 report are from the Rye landfill site.

The estimated 21,000 tonnes CO_2-e equates to 82.72% of MPSC's total emissions.

Assumptions

There are several assumptions that were made and these are outlined below:

- As council employs no ongoing definitive method for measuring fugitive emissions from landfill sites assumptions based on information provided by the MPSC Waste Management Department were used for the calculation.
- Green waste was excluded because it is from a biogenic source which means any released carbon dioxide has been absorbed from the atmosphere, hence contributing zero greenhouse gas emissions if treated aerobically.

Limitations of the data

There are several limitations to the data that are outlined below:

- Data from landfill emissions was from several years ago so actual emissions so results are likely underestimated.
- Estimates of emissions associated with other aspects of solid waste management, including the collection and processing of waste and recyclable materials is beyond the scope of this report.
- The accuracy of the emissions estimates is dependent on the accuracy of the input data.
- Human errors in the data collection and unit conversion process may have occurred.

4.5 Electricity

Results

MPSC consumes a total of 1241698 kWh of purchased electricity from the grid.

Total GHG emissions are therefore 1452.787 tCO2-e for the 2013 calendar year. This is 5.68% of total council emissions.

There are 115 entries of buildings/facilities in the inventory which include halls, libraries, council offices, administration buildings, healthcare centres reserves, and pools. Of the 115 facilities, 10 emit 40% of the total greenhouse gas emissions for this sector.

The buildings/facilities are listed in Figure 4.5 below with their associated emissions. The Pelican Park Recreation Centre has the highest emissions of any facility and is close to 25% that of the next highest facility which is the Mornington Council offices.

The energy consumptions, energy costs and greenhouse gas emissions from electricity for the top 40% of buildings/facilities are presented in Table 4.10.

Table 4.10: Electricity usage, GHG emissions and costs for the top 40% of buildings

Building/Facility	Electricity kWh	GHG (t CO2-e)	Energy cost ($ exc GST)
Pelican Park Recreation Centre	81872	95.79024	20656
Mornington Council Offices	60671	70.98507	15307
Visitor Information Centre	51789	60.59313	13066
Mornington Library	51156	59.85252	12907
Somerville Recreation & Community Centre/Health Centre	48204	56.39868	12162
David Collings Leisure Centre	41050	48.0285	10357
Hastings Library	38837	45.43929	9799
Rosebud Council Offices	38745	45.33165	9775
Mornington Resource Recovery Centre	31020	36.2934	7826
MP Regional Gallery	30641	35.84997	7731
		Total	119586

*Based on electricity cost of $0.2523 per kWh.

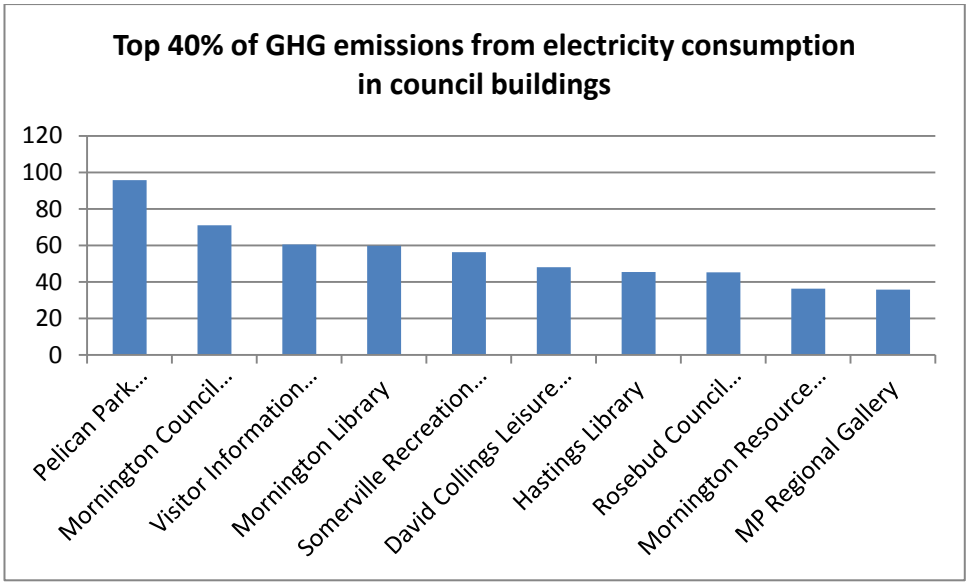

Figure 4.5: Top 40% of GHG emissions from electricity consumption in council buildings

The top 10 buildings/facilities listed here which represent the top 40% of GHG emissions for MPSC. These represent the greatest opportunity for energy efficiency upgrades.

Electricity use from pumps for watering grounds at sporting clubs contributes 15% of carbon emissions. These represent another area for carbon emissions reduction possibly with solar powered pumps.

Assumptions

There are several assumptions that were made and these are outlined below:

- To calculate electricity, consumption data was used. We assume this data is accurate.
- Council reports on average they reimburse sporting clubs $800 Australian dollars per oval for watering lawns of sporting grounds during the summer season. This was assumed to estimate the electricity usage.

Limitations of the data

There are several limitations to the data that are outlined below:

- Has not accounted for supply losses as these are problematic to calculate.

- In addition readings are regularly estimated, electricity retailers are legally able to estimate three out of four readings therefore may lead to data errors
- Council does not have primary operational control over the public lighting asset. Therefore, under NGER Act (2007), council would not be obliged to incorporate streetlights into its emissions scope and we have therefore not included street lighting in the inventory hence emissions from electricity reported here will be less than actual emissions.
- MPSC subsidises sports clubs using council owned facilities under seasonal tenancy agreements however clubs are responsible for providing financial contribution towards the operational costs. Hence occupancy of the pavillions by sporting clubs will affect the outcome. Electricity used by clubs for water pumps to maintain lawns and ovals is subsidised by council. The remaining electricity costs are considered the clubs responsibility. We assumed $800 per oval and this may have under or overestimated the actual results
- The accuracy of the emissions estimates is dependent on the accuracy of the input data.
- Human errors in the data collection and unit conversion process.

4.6 Natural Gas

Results

MPSC consumes a total of 313.904 GJ of purchased natural gas.

Total greenhouse gas emissions are therefore 16.072 tCO2-e

Greenhouse gas emissions from natural gas constituted overall a negligible amount (0.063%) of total council greenhouse gas emissions. This is likely due to the fact that MPSC leases council owned facilities to sporting clubs under seasonal tenancy agreements however clubs are responsible for providing financial contribution towards the operational costs. Gas used by sporting clubs is not subsidised by council and the club is responsible for 100% of natural gas costs.

Assumptions

There are several assumptions that were made and these are outlined below:

- To calculate natural gas usage, consumption data was used. We assume this data is accurate.

Limitations of the data

There are several limitations to the data that are outlined below:

- The accuracy of the emissions estimates is dependent on the accuracy of the input data.
- Has not accounted for supply losses as these are problematic to calculate.
- In addition readings are regularly estimated, electricity retailers are legally able to estimate three out of four readings therefore may lead to data errors
- Human errors in the data collection and unit conversion process.

4.7 Results summary

Table 4.11 outline the results of MPSC greenhouse gas inventory with a total carbon footprint of 25418.6 tCO_2-e.

Table 4.11: MPSC Greenhouse Gas Inventory 2013

SCOPE	GHG emission (tCO2-e)	Proportion of total inventory (%)
SCOPE 1 EMISSIONS		
Landfill	21000	
Vehicle fleet	393.222	
Natural Gas	16.072	
Total Scope 1	21409.3	84.23
SCOPE 2 EMISSIONS		
Electricity	1452.787	
Total Scope 2	1452.787	5.72
SCOPE 3 EMISSIONS		
Corporate waste	0.973	
Employee commute	2555.51	
Total Scope 3	2556.48	10.06

TOTAL	25418.6	100

4.8 Verification

When developing the greenhouse gas inventory and carbon footprint we included where possible all assumptions used in the calculations and references for emissions factors to maintain transparency at all times.

Now the inventory has been developed, it is recommended that it be reviewed and verified by a third party for accuracy and creditability. Unfortunately due to time constraints and costs this was unable to be completed during the research period.

Such verification and assessment of any uncertainties is important where the results of measurement and management activities will be communicated outside of the organisation and particularly important to be completed if reporting emissions in line with the NGER Determination (2008) legislation. However MPSC is currently not expected to report under the Act as its emissions are below the threshold for mandatory reporting.

CHAPTER 5

5 RECOMMENDATIONS

5.1 Overview

The next step is for MPSC to identify strategies to reduce their greenhouse gas emissions. To achieve this we recommend the following 5 strategic milestones in line with the ICLEI Cities for Climate Protection Program (CCP):

1. Establishment an inventory to determine key sources of greenhouse gas emissions for council operations (Completed)
2. Set an emissions reduction goal
3. Develop and adopt a local greenhouse action plan to achieve these reductions
4. Implement the action plan
5. Monitor and report on greenhouse gas emissions and the implementation of actions and measures

   (ICLEI Cities for Climate Protection Program, 2008)

These strategies were chosen to be in line with this ICLEI Cities for Climate Protection Australia local government action on climate change initiative, as MPSC council is familiar with this initiative and it has proven emission reduction potential. 184 councils that are participating in this program have shown proven ability for significant reduction in greenhouse gas emissions under this program. There has been a 18 million tonnes CO2-e abatement since start of reporting in 1998 as reported by CCP Australia councils (ICLEI, 2008).

5.2 Greenhouse emissions reduction goal

The first step we recommend is to set a greenhouse gas emissions reduction goal.

'Mornington Peninsula Shire Council will strive to be carbon neutral by 2050 and will actively reduce its greenhouse gas emissions by 20% on 2013 levels by 2020.'

The reduction goal is a quantitative objective for greenhouse gas emission reduction in line with the Victorian Climate Change Act (2011) and MPSC current commitment under ICLEI Cities for Climate Protection Program.

Figure 5.1 illustrates that a 20% reduction goal based on the 2013 emissions would result in a decline of CO2-e emissions by 5112.6 tonnes over the period until 2020. Ongoing monitoring of emissions will be particularly important to determine whether actions are having an impact on the emissions reduction target that has been set.

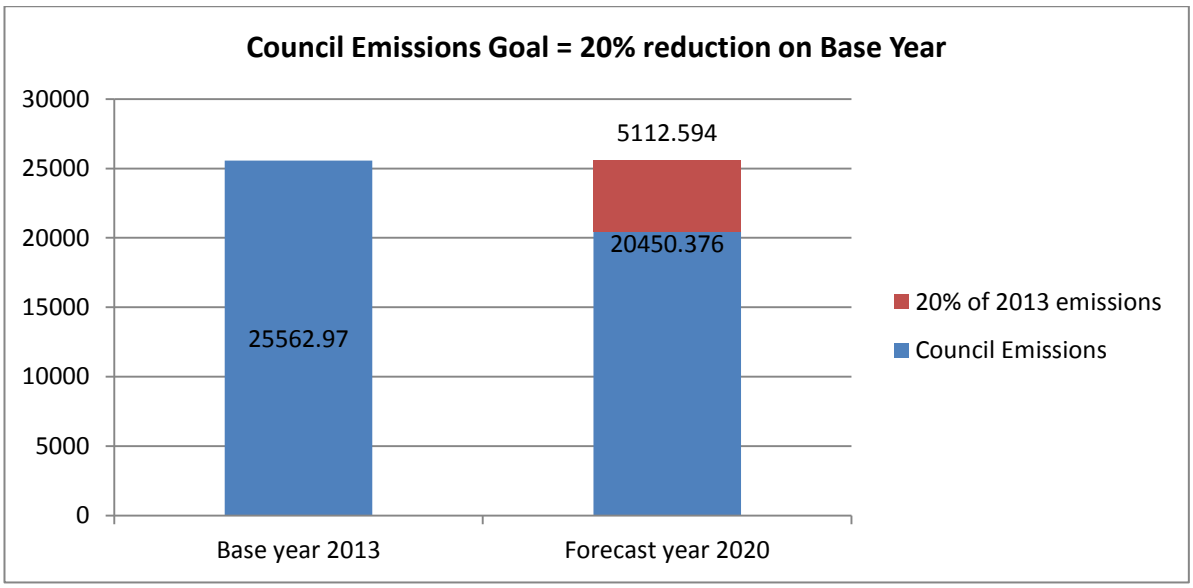

Figure 5.1: Council emissions reduction goal – 20% reduction of 2013 emissions

5.3 Development of a Climate Action Plan

It is recommended that council develop a Climate Action Plan that will help MPSC to strategically pursue greenhouse gas reduction measures to achieve this 20% emissions reduction goal by 2020. It is recommended that the plan be updated regularly to allow for continuous improvement and to ensure the plan remains consistent with relevant legislation and standards.

5.4 Reducing climatic impact of the MPSC

After developing a basic greenhouse gas inventory and identify council's major emission sources we set out to recommend ways to reduce emissions. Mitigating an organisations impact on climate change can be achieved through a variety of actions which aim to either reduce emissions or offset them in some way.

When making recommendations for MPSC the following hierarchical approach towards emissions reduction was used:

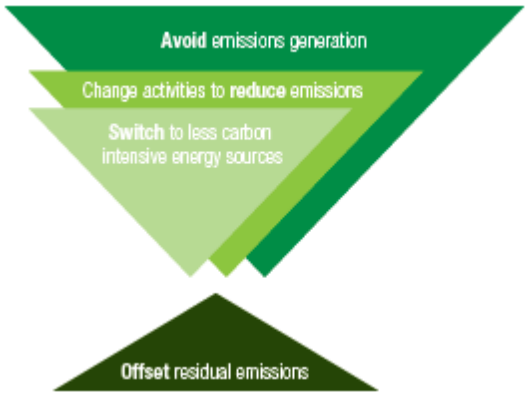

Figure 5.2: Greenhouse Gas Emissions Reduction Hierarchy

It is considered best practice to prioritise emissions reduction actions according to this carbon management hierarchy. Figure 5.2 steps out the different categories within the hierarchy and these are described further below:

Priority 1. Avoid energy consumption

Avoid energy consumption and generating greenhouse gases in the first place through such things as turning off lights and appliances or using public transport to travel between council sites.

Priority 2. Improve energy efficiency

These initiatives involve replacing less efficient products with energy efficient ones to reduce energy demand, for example by upgrading to energy efficient lighting

Priority 3. Renewable energy

These initiatives involve reducing emissions using renewable energy sources, either through directly producing energy (solar power) or purchasing renewable energy (GreenPower).

Priority 4. Carbon offsets and off-site renewable energy

Buying carbon offsets e.g. GreenPower to further reduce emissions after avoidance, energy efficiency and renewable energy resources have been fully exploited.

5.5 Analysis of GHG Emissions and opportunities for emission reduction

A review of the emissions contributions from all of MPSC operations to develop a targeted analysis of opportunities for emissions reductions was undertaken.

The recommendations outlined below are focused on three primary emission sources: transport, electricity and waste. With reference to the carbon footprint, the options were discussed for each of these emission sources, the objective being to discuss the associated source and identify opportunity for MPSC, without compromising MPSC's ability to perform its function in anyway.

Research into each opportunity for emission reduction would be beyond the scope of this research. Therefore the main research into opportunities for emissions reduction for councils was the consideration into what other councils have recently adopted successfully. It is intended that MPSC would do their own feasibility study prior to implementation of the recommended actions. This analysis has neglected technologies that are not sufficiently discussed in the literature or implemented successfully at local council level as this is considered beyond the scope of this research and it is assumed that their practical application would be less technically feasible and more costly since more research and development work would be required for their application.

5.5.1 Waste emission reduction

Operating landfill sites is one of the challenging problems local council faces. Emissions from MPSC landfill sites comparatively significantly higher than the other emission sources for all council operations. It is therefore the most critical than the other emission sources in terms of emissions reduction. Without intervention these emissions are expected to continue rising into the future.

As described in detail in Chapter 3 above the primary source of greenhouse gas resulting from conventional landfill practices is due to the anaerobic break down of organic materials contained within the waste stream. The strategy for reducing landfill associated emissions should therefore either be to lessen the amount of organic waste that is deposited in landfill or alternatively to capture the landfill gas, preventing it from entering the atmosphere.

Landfill gas capture is a maturing technology that provides significant revenue and emission reductions for landfill sites throughout Australia. Methane is the principal component of landfill gas and is 21 times more harmful than carbon dioxide in terms of its global warming potential (Department of Climate Change, 2014). One of the most effective mechanisms to abate greenhouse gas emissions from landfills is destruction of methane by flaring of the captured landfill gas, or combusting it in a generator to produce power through a methane gas extraction and flaring system.

Gladstone Council in Queensland commissioned a landfill gas extraction and flaring system at the site in offering the ability for council to halve its greenhouse gas emissions. In addition, the system producing electricity and will also generate Renewable Energy Certificates (RECs) to further help offset Council's carbon emissions and carbon tax liability (Gladstone Council, 2014). While this approach would have a comparably good environmental outcome, it will however depend on the efficiency of the capturing system and the initial financial outlay. Furthermore capture methane and electricity generation can generate income. For example Hume City Council generated 19,223,882 kWh of electricity and $75,000 of income from its capped landfills in the past year (Hume City Council, 2009). Electricity generated from methane capture can only reduce council’s emissions if the RECs created are kept and not sold to the market as electricity.

It is recommended that MPSC expand their methane capture system from which electricity is generated and sell onto distributors which in turn is sold as GreenPower for revenue or used as RECs to offset emissions.

From an emissions reductions perspective, the most preferred and cheapest option is that organic material is removed from the waste stream in the first place. Approaches to reducing organic material in landfill include a range of recycling options such as mulching; composting. MPSC already does this and sells the compost to community for revenue.

5.5.2 Transport emission reduction

The results show that emissions associated with the employee commute constitute 10.05% of the total emissions with a further 1.54% attributed to council fleet.

There are many well established alternatives to the conventional fuels that council can consider for use in its vehicle fleet. Such technologies include biofuels such as biodiesel, biogas or bioalcohols or electric vehicles that are run on clean electricity. Many of these options however would require significant capital investment for the conversion of current fleet vehicles or the purchase of new electric or hybrid vehicles. From the cost benefit point of view, such an investment would be very difficult to justify for such a small percentage of emissions. Further to this, council's high turnover in fleet vehicles would impede the uptake of such technologies. This has been demonstrated at Lismore City Council where they have trialled an electric car powered by solar electricity. The car costs $12,000 more than a petrol equivalent (Northern Star, 2014). There is little opportunity for a return on investment and it is likely that this option would only be investment from the point of view of reducing emissions.

The alternative approach is therefore to consider technologies that do not require alteration to the existing vehicle fleet by exploring more sustainable alternative fuels for these compatible vehicles. Mackay Regional Council is using a bioalcohol by making it compulsory for all unleaded council vehicles that are compatible to use an ethanol blend when refueling with the benefit of reducing greenhouse gas emissions and supporting cane farmers (Mackay Regional Council, 2014).

Some councils have reported that biodiesel offered opportunity to reduce council’s vehicle fleet emission profile without significant cost. While other trials have also

demonstrated successful application of the technology, drivers of the vehicles reported significant power loss which impeded on their capacity to perform their duties. Other councils such as Newcastle Council initially trialled a 20% Biodiesel and 80% diesel (B20) in one of its waste collection vehicles as part of 'Biodiesel Truck Trial: Biodiesel as an Alternative Fuel to Improve Local Air Quality' Project in 2003. The results were compared to that of a vehicle operating exclusively on standard diesel with reported approximately 30% reduction in emissions (Brisbane Biodiesel, 2014).

From MPSC's point of view, the uptake of an alternative fuel would need to demonstrate minimal financial impact and therefore minimal alteration to vehicles, as well as minimal reduction in vehicle function. The potential for emission savings in this area is only as great as the emissions that are generated by council's vehicle fleet which is little at 1.54%. Council should therefore only explore the alternative fuel options that provide minimal impact on council's vehicle fleet budget.

Given the significant share of emissions that are attributed to employee commute this should be a priority area for transport associated emission reduction at MPSC. For the employee commute (and a community as a whole) to enjoy significant reductions in transport associated emissions, an improved public transport system is required though this comes with significant cost. This could be considered the responsibility of the State government but should be and encouraged supported through council advocacy. The strategy for reducing emissions associated emissions should therefore either be to lessen the amount of usage or use alternative technology. As council cannot impose alternative technology on council employee private vehicles they can encourage other strategies such as car pooling/walking programs and these are considered a more cost effective alternative.

Finally, by adopting changes to current practices council can protect itself from future fuel scarcity and fuel price rises. As an example, if MPSC was to convert its fleet to an alternative fuel it would in effect be hedging against future increases in petroleum based fuel costs with the added effect of reducing emissions. It could however potentially become reliant on that fuel source and thus dependant on the

production of the fuel. These issues are beyond the scope of this research and are simply mentioned here for completeness.

5.5.3 Electricity emission reduction

While electricity usage contributes only 5.68% of MPSC's total emissions there are still a range of options that MPSC should consider for reducing emissions associated with electricity. Broadly speaking, these options include reductions in electricity consumption by improved efficiency, generation of renewable energy and the purchase of green energy and other offset strategies.

Council is however dependant on energy for a number of its functions and it is therefore limited in its capacity to reduce emissions by simply improving efficiency. The strategy for reducing emissions associated with electricity should therefore either be to lessen the amount of usage that is used through energy conservation practices. MPSC should explore options to improve their usage of electricity as a first step to reducing electricity associated greenhouse gas emissions with implementation of software to turn computers off at night, occupancy sensors for lighting, installation of energy efficient lighting and time control of heating and air conditioning units. It is identified that energy conservation actions along with improved efficiency is likely to be the most cost effective option for reducing emissions since this approach is directly reducing energy costs at the same time. Furthermore, by generating renewable energy, council has the opportunity to not only offset usage, but to sell excess electricity to the grid for greater economic and environmental returns. In a renewable energy report by Blue Mountains City Council a range of renewable energy technologies have been compared (Alison Winn, 2011).

A summary of the various technologies studied in terms of their paybacks and capital outlay costs over annual emissions abatement is shown in the following table

Table 5.1: Comparison of common renewable energy devices for councils

Renewable Energy Device	Average payback	Average $ capital outlay/tonne of greenhouse emission reductions
(1.5kW to 3kW) photovoltaics	6 to 8 yrs	1455
(4.9 kW to 30 kW) photovoltaics	10 to 11 yrs	2459
Stand alone 400L solar h/w	5 to 6 yrs	1697

systems		
Wind turbines (5kW to 50kW)	10 to 13 yrs	2848
Wind turbine (4MW) exporting all electricity	13 yrs	889
Bioenergy(1MW) utilising all electricity	9 yrs	942

Source: Renewable Energy Investigation Report www.bmcc.nsw.gov.au viewed September 28th 2014 Alison Winn, 2011

In terms of small scale energy systems, solar hot water systems offer the most cost effective option with the lowest paybacks and the lowest capital outlay per tonne of greenhouse emission abated. Photovoltaics offer the next best return on capital invested with wind turbines up to 50kW capacity being the least cost effective option for council.

In terms of medium scale sustainable energy systems, the 1MW bioenergy methane capture has the lowest payback, however the 4MW wind turbine is comparable in costs to reduce greenhouse emissions.

It is identified that for organisations with substantial emissions from waste such as MPSC the waste to energy technologies provide the greatest potential for achieving greenhouse gas emission reductions.

Waste to energy technologies demonstrate good economics when compared to small scale wind and solar, particularly when considering capacity.

For areas not close to waste, it is suggested that the capacity for solar be assessed at the location of their largest energy usage point, in order to maximise the return on investment by offsetting their electricity tariff costs.

At Byron Shire Council in New South Wales they undertook analysis including detailed wind mapping of the Shire. The study provided valuable information about the viability of local wind and solar resources that may facilitate investment in renewable energy across the Shire. The study indicated that Byron Shire's wind resource is highly variable and constrained for reasons such as tree cover and scenic protection (Byron City Council, 2014). This suggests that the wide-scale deployment of wind turbines is unlikely to be viable option. However, the study identified solar power as having a strong financial basis compared with wind technology (Byron Shire Council, 2014).

In purchasing electricity from the electricity retailers, organisations have the option of paying a higher tariff for electricity that has an emission factor of zero. This option is commonly known as the purchase of `Green Energy' or GreenPower and has the capacity to offset all electricity associated emissions. At the time of writing an additional 5 cents per kWhr would be added to the current tariff for the MPSC locality for 100% accredited green power (Green Power, 2014). This option provides a very simple way for MPSC to reduce its corporate emissions however it comes at a significant cost with no return on investment.

In a similar way to the purchase of green energy, council could opt to purchase renewable energy certificates (REC). Renewable energy certificates used to encourage the uptake of renewable energy in Australia. Each REC has an associated amount of CO2-e and by voluntarily purchasing them, that amount is directly prevented from entering the atmosphere. It can therefore be accredited to an organisation for the purpose of reducing their carbon footprint. Again this option provides a very simple economic mechanism for council to reduce its corporate emissions. Purchase of renewable energy certificates is a more cost effective way for reducing emissions.it also provides opportunity to negate all of councils emissions and not just emissions associated with electricity. However, since it will still create a significant economic burden to council with no return on investment it is not considered here to be a feasible option.

In terms of renewable energy there are a number of technologies available to council, that would enable the production of electricity in a sustainable manner.

Renewable energy generation by council itself is an attractive option for investment into emission reductions since in many cases it offers the opportunity to offset not only emissions associated with electricity, but the entire emission profile. By producing a greater amount than is required and then on selling the excess to the grid, council for example could offset some of its emission profile. In this capacity it is a better option than investment into alternative fuels which is limited by its proportion within the organisation's emission profile. Moreover, if a renewable energy facility was to fail, council could revert back to grid power without disruption. A further consideration in the assessment of renewable energy generation is the capacity to hedge against increasing energy costs and grid outages. This could be of considerable benefit to council in the future.

5.6 Costs of reducing greenhouse gas emissions

Cost-benefit analysis is one of the main ways to assess various emission reduction initiatives. It works by identifying all the costs and benefits that would result from a particular action. These include non-monetry costs and benefits (Rolfe, 2007). Costs include capital costs and operation and maintenance costs of the emission reduction option. Benefits may include the reduction in expenditure on fuels due to a more efficient technology and the benefits related to a reduction in greenhouse gas emissions to limit the harmful effects of climate change. Because the latter type of benefits cannot be monetised, cost benefit analysis for assessment of greenhouse gad emission reduction initiatives is reduced to cost-effectiveness analysis i.e. the analysis of achieving the stated objective in the least costly manner. Therefore the cost effectiveness is an important criterion in a comparison of the options for MPSC. It is recommended MPSC structure future policies to get the maximal reduction in harmful greenhouse gases for a given level of expenditure.

The potential emissions reduction actions the Council can undertake to achieve its target have been outlined in Table 5.2b below. The proposed costs are indicative only and are based on information provided in the following Marginal Abatement Cost Curve shown in Figure 5.3. The curve describes actions and their relative cost of emissions abatement, as well as the total estimated emissions reduced in a year. The most cost effective actions are those below the horizontal axis of the graph with the greatest width. These actions indicate the greatest financial benefit, and have the largest potential reduction in emissions. Marginal abatement curves are therefore a convenient way to give potential costs and benefits of options considered herein.

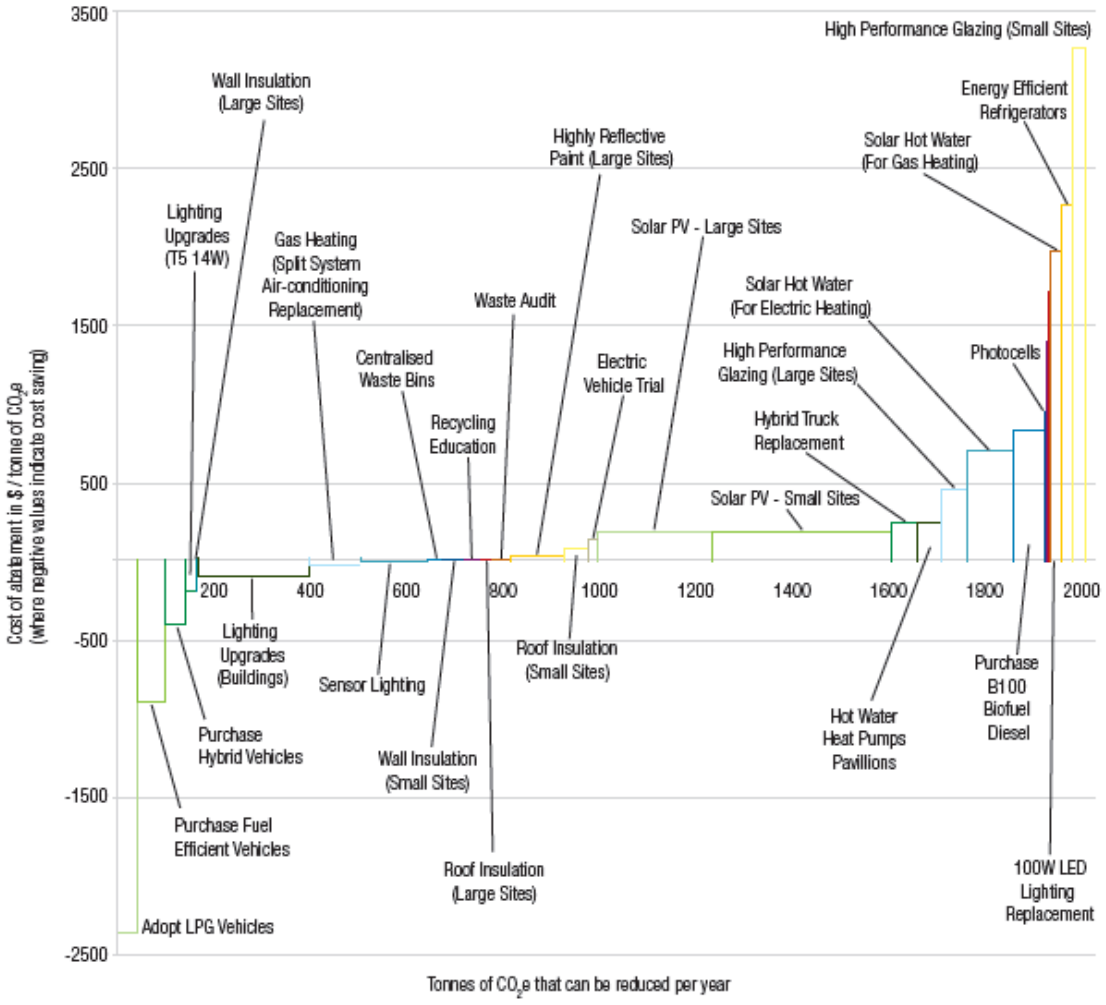

Figure 5.3: Marginal Abatement Cost Curve: Cost effectiveness of greenhouse gas emissions abatement actions.

Source: McKinsey et al 2008

Note: The vertical axis represents the cost of reducing emissions. If the cost is negative, this indicates financial loss reductions associated with reducing emissions (for example, reducing electricity reduces energy costs, as well as emissions). The horizontal axis represents the amount of emissions that can be reduced by implementing an action across one year, in tonnes of CO_2e.

5.7 Summary of recommendations for emission reduction

The following is a table of recommended actions that MPSC to reduce its greenhouse gas emissions.

Table 5.2a:.Summary of carbon emission mitigation actions recommendations legend

COST ESTIMATE	
No cost	Nil
Minor cost	$
Considerable cost	$$
Substantial cost	$$$
CARBON REDUCTION POTENTIAL	
Low	L
Medium	M
High	H
TIMEFRAME	
Short term	ST
Medium term	MT
Long term	LT

Timeframe ST =short term LT = Long term MT = medium term

Table 5.3b:.Summary of carbon emission mitigation actions recommendations

	RECOMMENDATION/ACTION	CARBON REDUCTION POTENTIAL	TIME-FRAME	COST
	GAS/ELECTRICTY			
Policy	• Policy to ensure that energy efficiency is maintained for all Council owned and operated buildings and compulsory for all new buildings (specify that all new buildings meet a minimum Five Star Green Star standard)	H	ST	$
Facility improvements	• Replace existing sub-standard lighting with installation of energy efficient lighting upgrades to buildings/facilities with highest emissions first	M	ST	$$
	• Skylights installed at Pools/Leisure Centre - natural light not artificial	M	ST	$$
	• Install heating and air conditioning and hot water, refrigeration energy efficient retrofit options to buildings/facilities with highest emissions first	L	MT	$$$
	• improvement to building thermal shell by blocking draughts, window treatments, double glazing, insulation and external shading, etc.to reduce energy losses	M	MT	$$$
	• Installation of energy efficiency retrofit options for pools including: heat pump control, installation and use of pool blankets, solar water heating	M	MT	$$
	• Install time control of heating and air-conditioning units	M	ST	$
	• Install occupancy sensors for lighting	M	ST	$
	• implementation of software to automatically turn off computers overnight	M	ST	$
Behaviour	• Consider operational changes to reduce emissions	L	ST	$
Fuel switch	• Consider installation of on-site renewable energy generation such as solar electricity and hot water	M	MT	$$$
Offset	• Consider purchase of 100% green power and green gas for energy requirements	M	ST	$$$
	VEHICLE FLEET AND EMPLOYEE COMMUTE			
Policy	• Reassess the current vehicle fleet purchase policy with vision to specify high fuel efficiency standards for each	M	MT	$$

	class of vehicle e.g efficient diesel or hybrid vehicles			
Fleet improvements	• Switch fleet to LPG vehicles	M	ST	$
	• Upgrade current aging vehicle fleet to more efficient vehicles	M	MT	$$
	• Upgrade fleet to hybrid vehicles	H	LT	$$$
	• Upgrade entire fleet to electric vehicles	H	LT	$$$$
Fuel Switch	• Use of low emission or alternative fuels	M	ST	$$
Behaviour	• Encourage and provide incentives for staff to use alternative transport methods e.g. car-pooling	L	ST	$
	• Investigate use of shuttle bus for employee commute between council offices	L	ST	$$
	• Improved end of trip facilities, such as showers and change facilities, to increase walking and cycling.	L	MT	$$
	• Create designated local area traffic zones to improve safety and pedestrian and cycling use.	L	LT	$$
	• Establish a bonus/ incentive scheme for staff who walk or cycle or catch public transport to work	L	MT	$$
	• Examine ways of allowing travel passes to be offered as an option instead of a car when recruiting new staff.	L	MT	$$
Facility improvements	• Improve the quality and frequency of public transport in the region	M	LT	$$$
	• Maintain and improve the condition of footpaths, ramps and intersections to encourage walking for short trips.	L	MT	$$
Education	• Provide public transport access guides for council employees	L	ST	$
	• Education and promotion programs to encourage use of active travel	L	ST	$
	• Encourage use of bicycles and increase the availability of safe and secure bike parking facilities	L	ST	$
Offset	• Offset remaining emissions	H	ST	$$$
	CORPORATE WASTE AND LANDFILL			
Policy	• Make a landfill gas capture of methane emissions for electricity generation policy	M	ST	$
Facilities improvements	• Install a methane monitoring options for landfill sites to provide more accurate emissions data	L	ST	$$
	• Installing a landfill gas extraction system and collecting the landfill gas	H	ST	$$$
	• The gas captured can be burned/flared to destroy the methane and reduce its global warming contribution.	H	ST	$$$
	• Capture of methane emissions for electricity generation	H	ST	$$$
	• Include provision for recyclables storage at existing and new facilities	L	ST	$
	• Investigate local collection options for the responsible disposal or recycling of non-putrescible wastes e.g.			

Behaviour	batteries, paints etc. • Install permanent water coolers in council facilities to reduce plastic bottle waste • Promote composting of organic waste • Continue to educate the council employees on correct recycling practices in addition to avoiding food and packaging waste where possible	L L L L	ST ST ST ST	$ $ $ $

5.8 Funding for emissions reduction strategies

Budget allocation and access to funding sources is critical to delivering MPSC's greenhouse gas emission reduction actions. Numerous recommendations for potential mitigation have been described herein and it will take time and resources to implement these actions. This is likely to pose significant resourcing and budgeting challenges for MPSC. Any actions should have minimal financial implication to council. It will be important for council to prioritise and allocate funding for the implementation of mitigation actions. Furthermore by annual measurement of the reduction of emissions and associated cost savings will highlight the effectiveness of the mitigation action to direct funding where necessary. In addition it will help support State and Federal government funding applications for budget requirements. By using the carbon footprint to develop a business case for particular initiatives which require resources and investment.

5.9 Summary

Avoiding and reducing emissions, prior to switching to an alternative source and offsetting, are likely to be longer lasting. This is because to avoid and reduce often involves changing infrastructure or a behaviour, resulting in a more permanent reduction. Avoiding and reducing emissions are also generally more cost effective actions as uch actions have an immediate financial return because they involve little to no financial capital outlay. Improving efficiency is also a cost effective method of reducing emissions, even at current energy prices but does have a financial outlay.

However, renewable energy initiatives have an initial financial outlay but will become less expensive as they can be scaled down to match a reduced energy demand. Finally, council may seek to reduce impact of their emissions by purchasing carbon offsets to compensate for emissions. Buying carbon offsets is a practical solution to further reduce emissions after avoidance, energy efficiency and renewable resources have been fully explored. However council must realise that purchasing offsets does not lead to actual reduction in corporate emissions and it therefore does not provide any financial savings benefits but requires an ongoing

financial commitment. Therefore this approach is considered only appropriate after other emissions reduction alternatives have been explored and exhausted.

Overall, the process of measuring councils carbon footprint then setting targets, and actions to mitigate the impact on climate change is an ongoing process. Ongoing monitoring should be undertaken on a yearly basis to monitor effect of emission reduction actions. This facilitates accurate and transparent reporting whilst enabling the council to demonstrate improvement to the community. Currently a number of efforts to reduce greenhouse gas emissions are already underway at MPSC. These are detailed in Chapter 2.10 above. However without a suitable greenhouse gas emission accounting and reporting approach there is no baseline to assess the effectiveness of these programs.

Finally, it must be noted that although council should try to reduce its emissions, it still needs to purchase goods and services to ensure that all council functions are being performed to a satisfactory standard. MPSC cannot simply cut certain services because produce high emissions – but it can search for less carbon intense alternatives or purchase carbon offsets to reduce environmental impacts within their council operations.

CHAPTER 6

6 DISCUSSION

6.1 Overview

This study is an example for how to convert consumption based data into greenhouse gas emissions and has resulted in a relatively robust picture of MPSC's carbon footprint that is discussed in more detail below. Based on this footprint we developed recommendations for the MPSC strategy to reduce emissions. We conclude by explaining the limitations of the study, opportunities for future research, and broader implications of the study beyond the MPSC.

6.2 Magnitude and composition of MPSC's carbon footprint

Total emissions for MPSC operations in 2013 were 25,418.6 tonnes of carbon dioxide equivalent. (tCO2-e). This is an average of 18.16 tonnes carbon dioxide equivalent (tCO2-e) per employee. Comparatively the Victorian average is 21 t CO2-e per capita (Department of Sustainability and Environment, 2012) making this much higher than Victorian average as the MPSC is only considering a working day. We suggest benchmarking of similar sized councils to determine if these results are common or not. However, it is difficult to 'benchmark' as each council is a different size and may include different emissions sources within their footprint. For example City of Melbourne 49,030 tCO2 equivalent (City of Melbourne, 2013) however this is community wide emissions and they do not operate a landfill site so contributions from waste is minimal.

Certain sources produced a large quantity of emissions. The results of this study show a high level from waste due to contributions from closed landfill sites owned by MPSC. In addition, there is high contribution from electricity perhaps because these goods are associated with a more carbon intensive emission factor. The next highest offender was transport, particularly the employee commute, likely due to poor public transport in the area and employees primarily use cars to commute to

work. However, average emissions per car were 1.89 tCO2-e making it less than the Victorian state average of 4 tCO2-e per car per year so is considered acceptable.

6.3 Evaluation of study methodology

Council had in the past collated some consumption data into a software package prepared for the Cities for Climate Protection Program (CCP) however the program was not designed to enable strategic analysis of data or to generate a broad range of data outputs. At the time of writing, federal funding for the CCP program has been withdrawn. There was therefore a need for a new approach. A simplified way of conducting greenhouse gas accounting for MPSC is developed in this research in line with methodology from relevant national legislation (NGER Determination 2008 and associated NGER Technical Guidelines, 2013). We have been realistic when choosing an organisational and operational boundary and made sure we considered the practicalities of collecting complete and accurate data within that boundary, whilst encompasses all council operations. A Microsoft excel spreadsheet was developed consisting of consumption data, emission factors, and associated emissions which aided in ease of calculations. The proposed excel spreadsheet is also particularly advantageous as it is simple and easy to use. The excel spreadsheet has been configured to use minimal input data whilst employing appropriate estimations and assumptions in calculating emissions in line with relevant standards. In addition, the excel spreadsheet will also facilitate replication in subsequent years to produce a comparable emissions inventory.

Given, the importance of climate change due to the damaging effects on the environment we know we must consider all contributions if we plan to slow future effects from climate change. Both direct and indirect emissions were considered when determining total emissions and this methodology enables us to assess a variety of emission sources in a simple, cost effective way without the need for outsourcing to private companies for similar computer accounting packages.

Validity of the spreadsheet outputs will always be dependent on the quality of data that is inputted and thus the quality and source of data that is used. Hence, the methodology in which data is sourced is critical to the success of an inventory. The method of data collection was however quite time consuming as it involved

manually gathering data from multiple council departments and conversion of different units. It is recommended that smart meters and Ausfleet (2014) data in the future to reduce errors. However it is anticipated that this will be easier in subsequent inventories when council streamline data collection processes to efficiently record activity data and improve ease of data collection for inventories in the future. MPSC should implement Utility Tracker (Sustainability Victoria, 2012) as it provides an excellent management tool for stationary energy and is used by many councils. Such a program will also enable billing anomalies to be resolved and identify opportunities to reduce usage costs.

Finally the methodology for calculating the greenhouse gas emissions for this research must be prepared in accordance with the following principles in line with the GHG Protocol, 2004.

(a) transparency — we have maintained transparency by ensuring all equations and assumptions for emission estimates are documented and verifiable;

(b) comparability — the excel spreadsheet created for calculation of emissions has been designed to be comparable using the same method in subsequent years;

(c) accuracy — we have endeavoured to be mostly accurate although have needed to extrapolate data in certain circumstances.

(d) completeness—we have maintained all identifiable emission sources and have even included scope 3 emissions even though they are not required under NGER Act.

6.4 Costs of action on climate change

A common misconception about mitigation strategies is that it is costlier than the "business-as-usual" scenarios. When considering the rising costs of energy, the payback on energy efficiency projects is becoming shorter thus making energy efficiency projects more economically viable

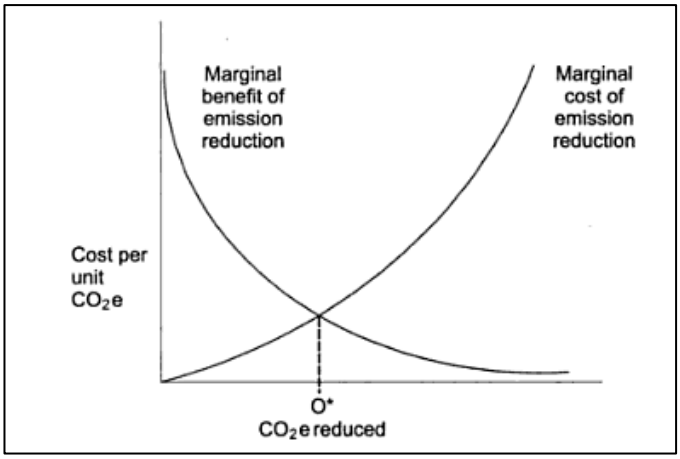

Figure 6.1: Benefits vs costs of emission reduction

Source: Jaccard, M Nyboer, J Sadownik,B (2002) The Cost of Climate Policy UBC Press: Canada

Note: the estimates of the cost of reduction are relative to a trajectory in which there is business as usual scenario.

Figure 6.1 demonstrates the relationship between the benefits and costs of emission reduction. Figure 6.1 shows that the cost of reducing greenhouse gas emissions is low for small reductions then increases exponentially. This is because there are little low cost substitutes that currently exist for many uses of fossil fuels. For example, a major reduction in greenhouse gas emissions from transport would require either that people travel less or that fewer goods are transported, use renewable energy both of which would be quite costly. Therefore there is a need to ensure a balance between emission reduction at relatively low cost.

In summary, the anticipated future cost rises in electricity, gas and fuel mean that inaction is not an option for MPSC. Reducing emissions makes economic sense. By reducing council's consumption this also translates to reduced costs. .Taking effective action will require balancing the costs and benefits of carbon emissions reduction so that significant and permanent emission reductions will be achieved.

6.5 Limitations and Future study

As with most inventories the study was constrained by time, availability of data and lack of external validation. To verify the inventory it is recommended to estimate the data uncertainty be undertaken in accordance with the NGER Determination, 2008. Due to time limitations I did not complete all of the planned components of my

research so these parts are opportunities for further study. Namely I wanted to identify how the recommendations will individually and collectively achieve the emission reductions including feasibility of each through a thorough cost benefit analysis. Incorporating energy costs into the inventory would facilitate identification of cost savings opportunities within emissions reduction planning. Furthermore, the recommendations provided herein are only at a very basic level and require more research into their effectiveness prior to being considered for implementation by MPSC and this is also an opportunity for future study.

There are also limitations of the study due to restricted data availability. The latest data available at council level in the area of emissions from closed landfill sites are for 2008, which implies that this may have significantly underestimated the results and emissions are likely to exceed those stated. The quality of data across all sources is considered to be high, given that the majority of raw data has been obtained from records kept by council and only some data was required to be extrapolated.

Data was not considered for consumption that occurs outside of the MPSC as this was considered beyond the scope of this research. Hence the methodology focuses only on emission sources within the organisational boundaries and may result in underestimation of council emissions, and bring about the risk of missing important areas for emission reduction. As reporting standards become more rigorous and transparent, these supply chain emissions may need to be addressed. Thus, if council starts addressing this now, they will be better prepared when new requirements are established. In particular, future studies could sort develop a straightforward method for incorporating supply chain emissions into the annual emissions inventory.

While the data used has limitations, data comparable between years can help to improve the understanding of how much is used and what emissions were created. Such measurement can help to understand if MPSC is efficient compared to others councils. Furthermore it would be beneficial to develop inventory process education package according to the instructions presented in the research for other councils to use.

As noted the importance of the present research is evident through the identification of an initiative for MPSC that not only demonstrates good potential to reduce

emissions, but also reasonable economic returns through methane capture. It is recommended that the business case for methane captures be further developed

Further to the above recommendations, it is recognised that climate change is a developing issue and therefore research of this type should be considered dynamic. Inventory accounting and technology comparisons should be updated as new information becomes available in order to ensure that the limited councilfunding and resources are utilised effectively and that economic opportunities in climate change are not over looked.

6.6 Broader implications

Future study should also include measurement of MPSC community wide emissions as the carbon footprint from council operations likely represents only a tiny amount of anticipated total community greenhouse gas emissions for MPSC region. Accessing data and measuring greenhouse gas emissions on a local level can help residents connect their local contribution to the global issue. With the added benefit of this commitment will be to further decrease emissions in the region.

My recommendations are unique to MPSC but the underlying concepts behind my approach are applicable to other councils. Hopefully other councils will utilise this methodology to carry out carbon footprint assessments. The excel spreadsheet can also be used for other councils in Victoria of similar size with minor adjustment to local situation.

CHAPTER 7

7 CONCLUSION

The main contribution of this research has been establishing a methodology for measuring annual council greenhouse gas emissions from raw data provided by MPSC to determine their carbon footprint that will form the basis for their carbon emission reducing planning for council to address their own contribution and take action against climate change.

Climate change as a result of greenhouse gas emissions from anthropogenic activities is considered the overarching environmental issue of our time. While there is still a degree of uncertainty about the exact nature of predicted impacts, the general trends are well understood. Many of the impacts of climate change can be reduced, delayed or avoided by reducing carbon emissions. Given this knowledge, we cannot wait for greater certainty before acting, but have a responsibility to act now to avoid the worst of the future negative economic, environmental and social impacts of climate change. In a literature review in Chapter 2 this research has explored the impacts of climate change on Australia. With the impacts being wide and serious and include increased global temperatures and increased climate variability such as droughts, floods, storms and bushfires. International efforts to address climate change include the United Nations Framework Convention (UNFC) Kyoto Protocol which established legally-binding emission reduction targets for developed countries. As worldwide support for emissions reduction continues to grow, an increasing number of policies and regulations have been developed in Australia to encourage all organisations to reduce their carbon footprint. A consistent and recognised carbon emission reporting approach should be adopted when managing emissions. The various legislation and standards governing climate change have also been discussed in Chapter 2.

With a direct link to local communities local councils are well placed to provide leadership in the area of greenhouse gas emission reduction and set a good example to the community as a a whole. MPSC was already committed to reduce greenhouse gas emissions at the local level to show leadership to the community and to take

responsibility for its own organisational carbon emissions through joining the Cities for Climate Protection (CCP) program. However, MPSC like many local councils did not have a greenhouse gas inventory. The first step in crafting a climate change response for is to prepare a greenhouse gas emissions inventory – as 'you can't manage what you can measure.'

By acknowledging the need for a more rigorous data driven response to safeguard our environmental future against the deleterious effects of climate change a carbon footprint is considered an essential first step. Finding out quantities and sources of these greenhouse gas emissions is essential in order to reduce the carbon emissions and take action on climate change. Chapter 3 describes in detail the methodologies and any assumptions used to develop the carbon footprint based on a case study of MPSC. The methodology adopted greenhouse gas accounting and reporting principles to be in line with relevant national legislation (NGER Act and associated Technical Guidelines). The proposed method outlined herein is considered a simple method that council can adopt without little financial outlay.

Chapter 4 discussed the results of the carbon footprint including the relative contributions of council operations by source. The data provided in the footprint serves as a baseline against which future emissions can be compared to determine the success of emission reduction efforts. The information gathered relating to emissions by source can be used in targeting programs and initiatives to focus carbon emission reduction efforts on as well as set emission reduction targets. Of the emissions generated from MPSC operations, waste was the most significant. At some 82%, generate a substantial share of the MPSC emissions.

Identification of a number of opportunities that are available to local council for the purpose of reducing emissions was outlined in Chapter 5. It provided recommendations for emission reduction for the key areas such as gas/electricity consumption, transport and waste. Namely, actions related to energy efficiency initiatives in council buildings, waste reduction recycling, fuel efficient vehicles, solar power and behaviour changes along with landfill emission avoidance through methane gas capture and flaring for electricity generation. Opportunity for future

work will include full feasibility analysis undertaken to reduce emissions without affecting council's ability to perform its function in anyway.

The research however only discussed the role of local council as focuses on reduction of corporate emissions rather than emissions from community as a whole. As discussed in Chapter 6 further study in the area will include measuring community wide emissions and engaging the full community in greenhouse gas reduction efforts as illustrated by the fact that the footprint from council operations likely represents only a tiny amount of anticipated total community greenhouse gas emissions.

The outcomes described in this research demonstrate successful achievement of the research objectives there are still some limitations, mainly owing to the unavailability of data. These limitations are described in Chapter 6. Future research should try to overcome the limitations.

It is anticipated that adopting the recommendations of the present research will not only lead to savings in emissions for the MPSC it is hoped that through strategic consideration of the options with feasibility analysis, real economic opportunity can be found in climate change mitigation in the longer term. It is recommended that council investigate opportunities for methane capture and gasification for production of electricity, as waste is the primary emitter for MPSC.

In conclusion, it is not only an organisation that affect the climate; the climate change also has an effect on the organisation. Continued investment in measurement, along with energy efficiency and offsetting of residual emissions will direct actions where they are most needed will allow council to measure their emissions so they can manage them effectively whilst future proofing council’s exposure to the deleterious effects of climate change on their operations. Finally, my recommendations for reduction are unique to MPSC but the underlying concepts behind my approach are applicable to other councils. Hopefully other councils will utilise this methodology to carry out carbon footprint assessments.

8 APPENDICES

APPENDIX A: PROJECT SPECIFICATION

University of Southern Queensland

FACULTY OF HEALTH, ENGINEERING AND SCIENCES

ENG4111/4112 Research Project
PROJECT SPECIFICATION

FOR:	MELISSA HOPE BAXTER
TOPIC:	AN ENERGY AND CAROB AUDIT OF MORNINGTON PENINSULA SHIRE COUNCIL
SUPERVISOR:	Guangnan Chen
ENROLMENT:	ENG4111 – S1, 2014 ENG4112 – S2, 2014
SPONSORSHIP:	N/A
PROJECT AIM:	This project seeks to investigate the energy use and carbon emissions of a local council and provide recommendations of how the said council can reduce their emissions
PROGRAMME:	**Issue A, 12 March 2014**

1.) Research the background information on carbon emissions and effect on climate change.
2.) Research the relevant legislation governing carbon emissions.
3.) Outline the importance of a carbon inventory for local councils.
4.) Define Mornington Shire Council's sources of carbon emissions.
5.) Define how Mornington Peninsula Shire Council's carbon emissions are to be measured.
6.) Undertake a carbon inventory of Mornington Peninsula Shire Council's carbon emissions.
7.) Outline the results of this carbon inventory and discuss any limitations of the inventory.
8.) Outline recommendations for reducing carbon emissions and discussion of the feasibility of each recommendation.

AGREED: _____ (Student) _____ (Supervisor)

Date: 12/3/14 12/3/14

APPENDIX B:

List of MPSC facilities included in carbon footprint

SITE	NAME
1	Mornington Council Offices
2	Somerville Council Offices
3	Hastings Council Offices
4	Rosebud Council Offices
5	Dromana Old Shire Offices
6	Visitor Information Centre
7	Mornington Resource Recovery Centre
8	Rye Resource Recovery Centre
9	Tyabb Resource Recovery Centre
10	Somerville Library
11	Rosebud Library
12	Mornington Library
13	Hastings Library
14	Community Information & Support Centre Southern Peninsula
15	Community Information & Support Centre Mornington
16	Currawong Stables Meeting Rooms
17	Mornington Peninsula Regional Gallery
18	Mornington Toy Library
19	Bittern Memorial Centre
20	Eco Living Display Centre
21	Crib Point Pool
22	Peninsula Community Theatre (PCT)
23	The Briars
24	Shoreham Community Hall
25	Rosebud West Community Hall
26	Boneo Community Hall
27	Dromana Community Hall
28	Baxter Community Hall
29	Balnarring Community Hall
30	Bittern Community Hall
31	Blairgowrie Community Hall
32	Crib Point Community Hall
33	Currawong Community Hall
34	Fenton Community Hall
35	Flinders Civic Hall
36	Hastings Community Hall
37	Main Ridge Community Hall
38	Mornington Park Pavilion
39	Mount Eliza Community Hall
40	Red Hill Community Hall
41	Red Hill Community Pavilion
42	Rosebud Memorial Hall
43	Rosebud Youth and Band Hall
44	RW Stone Pavilion
45	Rye Civic Hall
46	Somerville Mechanics Institute Hall
47	St Andrews Beach Recreation Hall
48	The Studio @ PCT

49	Tootgarook Community Hall
50	Tyabb Community Hall
51	Tootgarook Health Centre
52	Mount Eliza Health Centre
53	Balnarring Health Centre
54	Hastings Health Centre
55	West Park Health Centre
56	Mornington Health Centre
57	Tanti Park Health Centre
58	Mt Martha Health Centre
59	Dromana Health Centre
60	Red Hill Health Centre
61	Waterfall Gully Health Centre
62	Rye Health Centre
63	Shed 11 Youth Centre
64	YLounge Youth Centre
65	Bentons Square Community Centre/Health Centre
66	Mount Martha House Community & Learning Centre
67	Dromana Community House
68	Crib Point Community House/Health centre
69	Good Shepherd Community House
70	Sorrento Community Centre/Health Centre
71	Somerville Recreation & Community Centre/Health Centre
72	Pelican Park Recreation Centre
73	David Collings Leisure Centre
74	Hastings Community House
75	Rye Beach Community Centre
76	Beleura Hill Sports Pavilion*
77	AR & F Ditterich Reserve*
78	Alexandra Park*
79	BA Cairns Reserve*
80	Barber Reserve*
81	CB Wilson Reserve*
82	Citation Reserve*
83	Cyril Fox Reserve*
84	Dallas Brooks Park*
85	David MacFarlan Reserve*
86	Dromana Recreation Reserve*
87	Ferrero Reserve*
88	Fruit Growers Reserve*
89	Graham Myers Recreation Reserve*
90	Hastings Park*
91	Long Point Reserve*
92	Mace Oval*
93	Main Ridge Equestrian Ground*
94	Merricks Red Hill Station Equestrian Ground*
95	Moorooduc Recreation Reserve*
96	Narambi Reserve*
97	Olympic Park Reserve*
98	Portsea Recreation Reserve*
99	RJ Rowley Recreation Reserve*
100	RW Stone Reserve*

101	Red Hill Recreation Reserve*
102	Somerville Recreation Reserve*
103	Stringer Road Reserve*
104	Truemans Road Reserve*
105	Tyabb Central Reserve*
106	Vern Wright Reserve*
107	Woolleys Road Reserve*
108	Balnarring Recreation Reserve*
109	Boneo Recreation Reserve*
110	Bunguyan Reserve*
111	Elsie Dorrington Reserve*
112	Emil Madsen Reserve*
113	RM Hooper Reserve*
114	Howard Parker Reserve*
115	Civic Reserve*

*Sporting reserves

APPENDIX C

Excel sheet for greenhouse gas emissions from Electricity

Site	Name	Consumption (kWh)	Emissions (tCO2-e)
1	Mornington Council Offices	60671	70.98507
2	Somerville Council Offices	29959.1	35.05215
3	Hastings Council Offices	29435	34.43895
4	Rosebud Council Offices	38745	45.33165
5	Dromana Old Shire Offices	14030	16.4151
6	Visitor Information Centre	51789	60.59313
7	Mornington Resource Recovery Centre	31020	36.2934
8	Rye Resource Recovery Centre	24429	28.58193
9	Tyabb Resource Recovery Centre	26489	30.99213
10	Somerville Library	20579	24.07743
11	Rosebud Library	20280	23.7276
12	Mornington Library	51156	59.85252
13	Hastings Library	38837	45.43929
14	Community Information & Support Centre Southern Peninsula	11580	13.5486
15	Community Information & Support Centre Mornington	10771	12.60207
16	Currawong Stables Meeting Rooms	2481	2.90277
17	Mornington Peninsula Regional Gallery	30641	35.84997
18	Mornington Toy Library	1599	1.87083
19	Bittern Memorial Centre	19439	22.74363
20	Eco Living Display Centre	5442	6.36714
21	Crib Point Pool	13339	15.60663
22	Peninsula Community Theatre (PCT)	20823	24.36291
23	The Briars	19733	23.08761
24	Shoreham Community Hall	7268	8.50356
25	Rosebud West Community Hall	4619	5.40423
26	Boneo Community Hall	3212	3.75804

27	Dromana Community Hall	2389	2.79513
28	Baxter Community Hall	2861	3.34737
29	Balnarring Community Hall	2404	2.81268
30	Bittern Community Hall	2460	2.8782
31	Blairgowrie Community Hall	1945	2.27565
32	Crib Point Community Hall	2487	2.90979
33	Currawong Community Hall	2109	2.46753
34	Fenton Community Hall	2609	3.05253
35	Flinders Civic Hall	2215	2.59155
36	Hastings Community Hall	2506	2.93202
37	Main Ridge Community Hall	3143	3.67731
38	Mornington Park Pavilion	2503	2.92851
39	Mount Eliza Community Hall	1866	2.18322
40	Red Hill Community Hall	2103	2.46051
41	Red Hill Community Pavilion	2230	2.6091
42	Rosebud Memorial Hall	2036	2.38212
43	Rosebud Youth and Band Hall	1977	2.31309
44	RW Stone Pavilion	2033	2.37861
45	Rye Civic Hall	1988	2.32596
46	Somerville Mechanics Institute Hall	2506	2.93202
47	St Andrews Beach Recreation Hall	3028	3.54276
48	The Studio @ PCT	1915	2.24055
49	Tootgarook Community Hall	1975	2.31075
50	Tyabb Community Hall	2530	2.9601
51	Tootgarook Health Centre	7823	9.15291
52	Mount Eliza Health Centre	8425	9.85725
53	Balnarring Health Centre	9004	10.53468
54	Hastings Health Centre	12018	14.06106
55	West Park Health Centre	19084	22.32828
56	Mornington Health Centre	21386	25.02162

57	Tanti Park Health Centre	19853	23.22801
58	Mt Martha Health Centre	17312	20.25504
59	Dromana Health Centre	13382	15.65694
60	Red Hill Health Centre	16101	18.83817
61	Waterfall Gully Health Centre	17740	20.7558
62	Rye Health Centre	9578	11.20626
63	Shed 11 Youth Centre	3730	4.3641
64	YLounge Youth Centre	1711	2.00187
65	Bentons Square Community Centre/Health Centre	18115	21.19455
66	Mount Martha House Community & Learning Centre	17933	20.98161
67	Dromana Community House	9404	11.00268
68	Crib Point Community House/Health centre	10039	11.74563
69	Good Shepherd Community House	3591	4.20147
70	Sorrento Community Centre/Health Centre	6248	7.31016
71	Somerville Recreation & Community Centre/Health Centre	48204	56.39868
72	Pelican Park Recreation Centre	81872	95.79024
73	David Collings Leisure Centre	41050	48.0285
74	Hastings Community House	5602	6.55434
75	Rye Beach Community Centre	2530	2.9601
76	Beleura Hill Sports Pavilion*	3155.82	3.692308
77	AR & F Ditterich Reserve*	6311.64	7.384615
78	Alexandra Park*	3155.82	3.692308
79	BA Cairns Reserve*	3155.82	3.692308
80	Barber Reserve*	3155.82	3.692308
81	CB Wilson Reserve*	3155.82	3.692308
82	Citation Reserve*	6311.64	7.384615
83	Cyril Fox Reserve*	6311.64	7.384615
84	Dallas Brooks Park*	9467.46	11.07692
85	David MacFarlan Reserve*	3155.82	3.692308
86	Dromana Recreation Reserve*	6311.64	7.384615

87	Ferrero Reserve*	6311.64	7.384615
88	Fruit Growers Reserve*	3155.82	3.692308
89	Graham Myers Recreation Reserve*	6311.64	7.384615
90	Hastings Park*	6311.64	7.384615
91	Long Point Reserve*	3155.82	3.692308
92	Mace Oval*	3155.82	3.692308
93	Main Ridge Equestrian Ground*	3155.82	3.692308
94	Merricks Red Hill Station Equestrian Ground*	3155.82	3.692308
95	Moorooduc Recreation Reserve*	3155.82	3.692308
96	Narambi Reserve*	3155.82	3.692308
97	Olympic Park Reserve*	9467.46	11.07692
98	Portsea Recreation Reserve*	3155.82	3.692308
99	RJ Rowley Recreation Reserve*	3155.82	3.692308
100	RW Stone Reserve*	3155.82	3.692308
101	Red Hill Recreation Reserve*	6311.64	7.384615
102	Somerville Recreation Reserve*	3155.82	3.692308
103	Stringer Road Reserve*	3155.82	3.692308
104	Truemans Road Reserve*	6311.64	7.384615
105	Tyabb Central Reserve*	3155.82	3.692308
106	Vern Wright Reserve*	3155.82	3.692308
107	Woolleys Road Reserve*	3155.82	3.692308
108	Balnarring Recreation Reserve*	3155.82	3.692308
109	Boneo Recreation Reserve*	3155.82	3.692308
110	Bunguyan Reserve*	6311.64	7.384615
111	Elsie Dorrington Reserve*	631.16	0.738462
112	Emil Madsen Reserve*	9467.46	11.07692
113	RM Hooper Reserve*	1577.91	1.846154
114	Howard Parker Reserve*	3155.82	3.692308
115	Civic Reserve*	6311.64	7.384615
TOTAL		1241698.193 (kWh)	1452.787(tCO2-e)

Emission Factor	1.17	kg CO2-e/kWh

RESULTS

Electricity	Activity data	Units		Emissions Factor	Units		Emissions	Units
	1241698.2	kWh	X	1.17	kg CO2-e/kWh	=	1452.787	t CO_2-e

APPENDIX D

Excel sheet for greenhouse gas emissions from Gas

Site	Name	Consumption (MJ)
1	Mornington Council Offices	1704.45
2	Somerville Council Offices	1013.79
3	Hastings Council Offices	3980.08
4	Rosebud Council Offices	3922.83
5	Dromana Old Shire Offices	811.46
6	Visitor Information Centre	2675.72
7	Mornington Resource Recovery Centre	296.48
8	Rye Resource Recovery Centre	301.37
9	Tyabb Resource Recovery Centre	383.63
10	Somerville Library	1089.63
11	Rosebud Library	713.52
12	Mornington Library	1231.12
13	Hastings Library	1085.44
14	Community Information & Support Centre Southern Peninsula	1278.96
15	Community Information & Support Centre Mornington	1385.86
16	Currawong Stables Meeting Rooms	59.03
17	Mornington Peninsula Regional Gallery	3408.02
18	Mornington Toy Library	39.94
19	Bittern Memorial Centre	89.07
20	Eco Living Display Centre	0.00
21	Crib Point Pool	126643.15
22	Peninsula Community Theatre (PCT)	2846.10
23	The Briars	876.20
24	Shoreham Community Hall	1128.41
25	Rosebud West Community Hall	1242.14
26	Boneo Community Hall	989.08

27	Dromana Community Hall	1055.18
28	Baxter Community Hall	1151.72
29	Balnarring Community Hall	1086.04
30	Bittern Community Hall	849.49
31	Blairgowrie Community Hall	840.59
32	Crib Point Community Hall	1145.10
33	Currawong Community Hall	1030.83
34	Fenton Community Hall	943.91
35	Flinders Civic Hall	949.16
36	Hastings Community Hall	991.92
37	Main Ridge Community Hall	1098.48
38	Mornington Park Pavilion	845.33
39	Mount Eliza Community Hall	952.66
40	Red Hill Community Hall	1021.84
41	Red Hill Community Pavilion	1136.37
42	Rosebud Memorial Hall	1029.64
43	Rosebud Youth and Band Hall	1041.41
44	RW Stone Pavilion	1055.97
45	Rye Civic Hall	722.49
46	Somerville Mechanics Institute Hall	915.06
47	St Andrews Beach Recreation Hall	754.94
48	The Studio @ PCT	921.76
49	Tootgarook Community Hall	902.11
50	Tyabb Community Hall	738.02
51	Tootgarook Health Centre	763.68
52	Mount Eliza Health Centre	802.91
53	Balnarring Health Centre	673.51
54	Hastings Health Centre	661.54
55	West Park Health Centre	691.99
56	Mornington Health Centre	642.78

57	Tanti Park Health Centre	683.03
58	Mt Martha Health Centre	721.20
59	Dromana Health Centre	658.27
60	Red Hill Health Centre	671.14
61	Waterfall Gully Health Centre	576.94
62	Rye Health Centre	608.90
63	Shed 11 Youth Centre	268.50
64	YLounge Youth Centre	251.51
65	Bentons Square Community Centre/Health Centre	976.92
66	Mount Martha House Community & Learning Centre	1111.38
67	Dromana Community House	732.17
68	Crib Point Community House/Health centre	378.45
69	Good Shepherd Community House	336.89
70	Sorrento Community Centre/Health Centre	634.98
71	Somerville Recreation & Community Centre/Health Centre	1280.62
72	Pelican Park Recreation Centre	109937.38
73	David Collings Leisure Centre	6492.72
74	Hastings Community House	464.02
75	Rye Beach Community Centre	506.74
TOTAL		313903.66 (MJ)

Emission	Factor	0.0512 kg CO2-e/MJ

16071.86764

RESULTS

Gas	Activity data	Units	Emissions Factor	Units	Emissions	Units

	313903.66	MJ	X	0.0512	kg CO2-e/MJ	=	16.071868	t CO2-e

APPPENDIX E

Excel sheet for greenhouse gas emissions from Council Fleet

Total (kL)	RESULTS: COUNCIL FLEET VEHICLES													
	Fuel	**Activity data**	**Units**		**Energy content factor**	**Units**		**Emissions Factor**	**Units**		**Emissions**	**Units**
105589	**Diesel**	105.589	kL	X	38.6	GJ/kL	X	69.2	kg CO2-e/GJ	=	282.041	t CO_2-e
	Fuel	**Activity data**	**Units**		**Energy content factor**	**Units**		**Emissions Factor**	**Units**		**Emissions**	**Units**
28094	**Petrol**	28.094	kL	X	34.2	GJ/kL	X	66.7	kg CO2-e/GJ	=	64.086	t CO_2-e
	Fuel	**Activity data**	**Units**		**Energy content factor**	**Units**		**Emissions Factor**	**Units**		**Emissions**	**Units**
30160	**Gas**	30.16	kL	X	26.2	GJ/kL	X	59.6	kg CO2-e/GJ	=	47.095	t CO_2-e
										TOTAL	393.22268	

APPENDIX F

Excel sheet for greenhouse gas emissions from Employee commute

Total kL fuel	RESULTS: EMPLOYEE COMMUTE												
	Fuel	**Activity data**	**Units**		**Energy content factor**	**Units**		**Emissions Factor**	**Units**		**Emissions**	**Units**
76.73288	Diesel	76.73288	X		38.6	GJ/kL	X	69.2	kg CO2-e/GJ	=	204.963	t CO_2-e
	Fuel	**Activity data**	**Units**		**Energy content factor**	**Units**		**Emissions Factor**	**Units**		**Emissions**	**Units**
7.68446	Petrol	7.68446	X		34.2	GJ/kL	X	66.7	kg CO2-e/GJ	=	17.529	t CO_2-e
	Fuel	**Activity data**	**Units**		**Energy content factor**	**Units**		**Emissions Factor**	**Units**		**Emissions**	**Units**
7.70688	Gas	7.70688	X		26.2	GJ/kL	X	59.6	kg CO2-e/GJ	=	12.034	t CO_2-e
										TOTAL	234.5265	

APPENDIX G

Copy of Survey monkey survey used for employee commute data.

MPSC Employee Commute Survey

1. Do you drive to work?

Yes

No

2. What is the year, make and model of the vehicle that you most often drive to work?

3. What fuel type does your vehicle use?

Gas

Petrol

Diesel

Hybrid

4. How far is your commute to/from work (in kilometres)?

5. Approximately how many days per week do you travel to work?

1

2

3

4

5

6. Approximately how many weeks per year do you travel to work?

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