UNIVERSITY OF SOUTHERN QUEENSLAND

FACULTY OF HEALTH, ENGINEERING AND SCIENCES

ENERGY & CARBON AUDIT OF THE SCENIC RIM REGIONAL COUNCIL

A dissertation submitted by

Mr Jason Andrew Gauld

In fulfilment of requirements of

ENG4111 and ENG4112 Research Project

Towards the degree of

Bachelor of Engineering (Honours) (Environmental)

Submitted: October 2016

ABSTRACT

In recent years, climate change has become widely accepted as a reality by the scientific community. Generally speaking, climate change is a long-term shift in weather conditions such as average rainfall, temperatures and winds. Climate change in a modern context refers to anthropogenic climate change, being that created by excessive human generated Carbon Dioxide equivalent (CO_2-e) emissions entering the atmosphere exacerbating the greenhouse effect. Australia has recently re-committed its efforts to reduce its greenhouse gas (GHG) emissions by 26-28% on 2005 levels by 2030. Local Government has a growing role to play in the commitment to reduce GHG emissions in an effort to mitigate the impacts of global warming.

The key objective of this dissertation is to assist the Scenic Rim Regional Council (SRRC) to identify their carbon footprint and provide recommendations and strategies to assist in the reduction of their GHG emissions. The SRRC is located approximately 60 km south of Brisbane and 40 km west of the Gold Coast in Queensland. The region is predominately zoned as Rural Use and encumbers an area of 4248 sq km and is home to over 37,780 people.

In 2011, the Australian Government introduced The Clean Energy Act (2011) which would see organisations and businesses whose Scope 1 emissions exceeded 25,000 tonnes of CO_2-e in a financial year liable for a carbon emissions tax. Based upon this energy and carbon audit, the SRRC would have been liable to a carbon tax should they have not been able to reduce their GHG emissions. In 2015, the carbon tax was successfully repealed in parliament and replaced by a Direct Action Plan. While the SRRC is no longer liable for any such carbon tax, an underlying commitment to the community to reduce their GHG emissions remains.

Various guidelines currently exist for the assessment of GHG emissions however the National Greenhouse Emissions Reporting (NGER) Act (2007) which incorporates the NGER Determination 2008 and the NGER Technical Guidelines 2014 is the most widely accepted methodology as it complies with The Corporate Standard ISO

14064-1: *Specification with Guidance at the Organisation Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals*.

By researching and complying with the NGER process, a GHG emissions assessment of the SRRC was successfully completed. Specifically, this was achieved by defining the organisation and operational boundary of the SRRC, breaking down the operational boundary into three scopes to capture all direct and indirect emissions and identify the respective emissions sources within each of these scopes. Data was then subsequently collected from each source such as fuel (petrol and diesel) and energy (electricity) consumption as well as landfill waste received. This data was then calculated and converted into tonnes of CO_2-e per year.

This investigation found the SRRC overall GHG emission footprint equated to 29,197 tonnes of CO_2-e in the year 2014. Scope 1 emissions (fuel consumption and waste) accounted for 95.5% (27881 tonnes CO_2-e) of all GHG emissions, however, fugitive emissions from the landfill facility accounted for 89.0% (24813 tonnes CO_2-e) of all Scope 1 emissions or 85.0% of all SRRC emissions. Scope 2 emissions (electricity consumption) accounted for 3.2% (933 tonnes CO_2-e) of all GHG emission while Scope 3 emissions (full fuel cycle) only accounted for 1.3% (368 tonnes CO_2-e) of all emissions. Compared to other Councils in Queensland, the SRRC has a relatively high percentage of fugitive emissions and high emissions per capita. With the SRRC expecting population growth from 29,463 (2014) to 81,985 by 2036, it is important Council acts now to reduce their carbon emissions and set a reduction target.

An emissions target of a 20% reduction of 2014 levels by 2031 has been proposed. In order to achieve this, mitigation strategies were researched, assessed and proposed. An emission abatement strategy matrix was also developed to clearly identify the various ways to reduce GHG emissions and their respective cost, implementation time frame and abatement type (i.e. direct, improve, alternative or offset) and abatement potential. The cost and benefit associated with GHG emission reduction was also discussed including the importance of developing a marginal abatement cost curve specifically for the SRRC.

This dissertation successfully set out and undertook a comprehensive energy and carbon audit of the SRRC. By doing so, total GHG emissions were identified allowing an emission reduction target to be set and appropriate strategies identified in order to meet the reduction goal.

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Jason Andrew Gauld

Student Number: 0050101624

Signature: .... Date: 13-10-2016......

ACKNOWLEDGEMENTS

This dissertation acknowledges Dr Guangnan Chen from the University of Southern Queensland, Toowoomba campus for his support, assistance and guidance throughout the completion of this document.

I would also like to acknowledge the assistance from the Scenic Rim Regional Council who allowed me to gather the necessary information in order to assess their carbon footprint.

Acknowledgement is also due to my partner, family, friends and work colleagues for their support over the past eight years making my study towards a Bachelor of Engineering possible.

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GLOSSARY OF TERMS & ABBREVIATIONS

ABS	Australia Bureau of Statistics
AFOLU	Agriculture, Forestry and Other Land Uses
Anthropogenic emissions	GHG emissions resulting from human activity
BOM	Bureau of Meteorology
Carbon Footprint	The amount of carbon dioxide released into the atmosphere as a result of a particular activity/organisation
CCP	Cities for Climate Protection
CFI	Carbon Farming Initiative
CH_4	Methane
CO_2	Carbon Dioxide
CO_2-e	Carbon Dioxide equivalent: a measure to compare various GHG emissions based on their global warming potential
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEE	Department of Climate Change and Energy Efficiency
EPA	Environment Protection Authority
GHG	Greenhouse Gas
GHG Protocol	The Greenhouse Gas Protocol: Global standard for measuring, managing and reporting GHG emissions.
GRC	Gladstone Regional Council
GWP	Global Warming Potential: a relative measure of how much heat a GHG traps in the atmosphere
H_2O	Water
ICLEI	International Council for Local Environmental Initiatives
IPCC	Intergovernmental Panel on Climate Change

ISO	International Organisation for Standardisation
LCA	Life Cycle Assessment
LGC	Large-scale Generation Certificates: Emission savings generated from LRET
LRET	Large-scale Renewable Energy Target
MACC	Marginal Abatement Cost Curve
MPSC	Mornington Peninsular Shire Council
N_2O	Nitrous Oxide
NGA	National Greenhouse Accounts
NGER	National Greenhouse Energy Reporting Act (2007): widely accepted methodology for calculating and reporting GHG emissions
OECD	The Organisation for Economic Co-operation and Development
SRRC	Scenic Rim Regional Council
STC	Small-scale Technology Certificate
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	The United Nations Framework Convention on Climate Change
WMO	World Meteorological Organisation

CHAPTER 1 INTRODUCTION

1.1. Introduction

Unequivocally, the Earth's climate system is warming, and since the 1950's, many observed changes in recent decades of the millennia are unprecedented (IPCC, 2014). It is also clear human activity is influencing the climate system, with anthropogenic greenhouse gas emissions at the highest levels in history (IPCC, 2014). The side effects of climate change include ocean warming, diminishing snow and ice and rising sea levels (IPCC, 2014). Climate change also impacts public health via poor air quality and increased water and food scarcity, more so adversely impacting those who are vulnerable, in particular, developing countries (USGCRP, 2016) .

Countries around the world are recognising the need to minimise the impact of climate change and are reducing their greenhouse gas emissions. Following on from the success of the Kyoto Protocol, Australia has moved the "goal posts" and re-committed to reducing greenhouse gas emissions further with a revised emission target to a 26-28% reduction on 2005 levels by 2030. In order to achieve this target, Local Government has a growing role to play in the commitment to reduce GHG emissions in an effort to limit the impacts of global warming.

The first step to reducing GHG emissions is establishing a baseline. This research project will provide an Energy and Carbon Audit of the Scenic Rim Regional Council (SRRC) operational boundary, providing their own specific baseline for future use. The undertaking of the energy and carbon audit will be researched and carried out in accordance with best practice utilising the National Greenhouse and Energy Reporting (NGER) Act (2007) and complying with ISO 14064-1 (2006) and amendments.

Furthermore, this research project will also provide GHG emission reduction strategies and recommendation following research and review. The overall intent of this work is to develop and provide the SRRC with the tools to undertake their own energy and carbon footprint audits into the future and ultimately, reduce their GHG emissions.

1.2. Research Objectives

The goal of this research project is to understand and develop a method for measuring and assessing local government (Council) greenhouse gas emissions. This assessment will utilize raw data obtained from the Scenic Rim Regional Council to construct the case study.

The development of this report will assist Council to understand their current greenhouse gas emission position, develop policies to reduce emissions, and provide a tool to then measure and monitor the effectiveness of the policies.

The research methodology is divided into the following subsections:

1. Research anthropogenic climate change and greenhouse gas emissions.
2. Research the effect of climate change.
3. Research current and relevant legislation surrounding carbon emissions on an international and national level.
4. Define extents of carbon emission inventory for Scenic Rim Regional Council analysis.
5. Define carbon emission sources of Scenic Rim Regional Council.
6. Define methodology for measuring carbon emissions of Scenic Rim Regional Council.
7. Conduct inventory of Scenic Rim Regional Council carbon emissions based upon the scope detailed within this report.
8. Establish results and findings of carbon inventory analysis and discuss limitations of the assessment.

9. Provide recommendations to be implemented into the Scenic Rim Regional Councils policies to reduce carbon emissions and provide feasibility of each recommendation.

1.3. About the Scenic Rim Regional Council

The Scenic Rim Regional Council is located approximately 60 km south of Brisbane and 40 km west of the Gold Coast in Queensland, Australia. The region is predominantly zoned as Rural Use and encumbers an area of 4248 sq km with 300 sq km being parkland. The main towns are Beaudesert, Boonah, Rathdowney, Kooralbyn, Kalbar, Aratula, Canungra, Tamborine Mountain, Harrisville and Peak Crossing (Figure 1 below). The Scenic Rim is home to over 37,780 residents with an average population growth of 1.6%, slightly below the Queensland average of 1.8%.

Figure 1: Map of the Scenic Rim Regional Council area

Source: http://www.scenicrim.qld.gov.au/about-the-scenic-rim

The most recent Australian Business Register indicated approximately 4,165 local businesses, with the predominant sector being Agriculture, Forestry and Fishing (27.3%), followed by Construction (16.2%) and Retail, Hiring and Real Estate Services (7.4%) (Reuben, 2015).

At an executive level, SRRC is governed by a Chief Finance Officer, Director Infrastructure Services and Director Regional Services overseen by the CEO, which manage information services, property and operations, works, community and culture, health, building and environment, and planning (Figure 2) (SRRC, 2015).

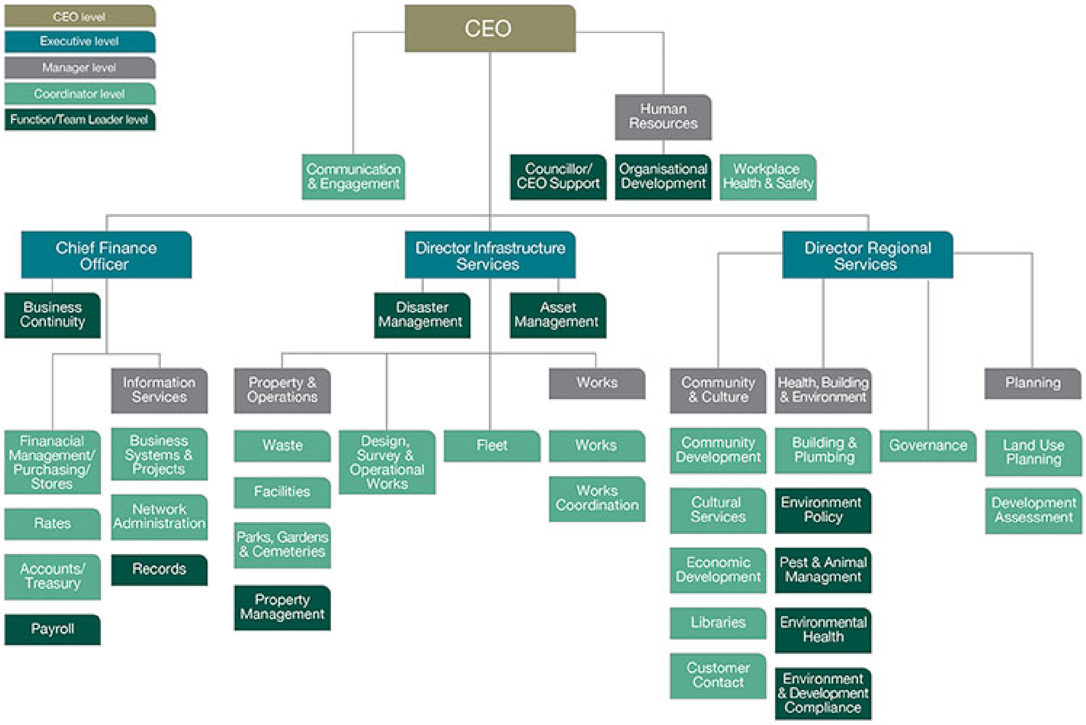

Figure 2: SRRC Organisational Structure

Source: http://www.scenicrim.qld.gov.au/council-administration

Table 1 below provides a summary of the SRRC statistics.

Table 1: Summary of SRRC statistics

Local Government Authority	Scenic Rim Regional Council
Distance from State Capital	60 km south
Area	4,248 km^2
Estimated Residential Population (2014)	39,463
Population Density	9.31 personal per km^2
Projected Population (2036)	81,985

Source: (SRRC, 2015)

1.4. Conclusion

With the SRRC having committed to reducing its environmental impacts, this research project aims to establish a baseline energy and carbon footprint audit of the SRRC for the 2014 year. Extensive research will be undertaken to understand global warming, its implications and the current best practice methodology to assess the carbon footprint of an organisation. This research will also collect SRRC energy consumption data in order to calculate their baseline carbon footprint. These findings will allow the establishment of a GHG emission reduction target and further research and development of emission abatement strategies to be recommended for implementation by the SRRC. This project also aims to develop a simple yet useful carbon footprint determination tool for future use by the SRRC or other Councils.

CHAPTER 2 LITERATURE REVIEW

2.1. Introduction

This chapter will undertake a critical analysis of published sources and literature relating the climate change, impacts, policies and standards. Specifically, this chapter will cover anthropogenic climate change and the impacts of climate change to Australia and the SRRC. Current policies, standards and guidelines in place to combat climate change on both an international and national level will also be covered as well as challenges facing the SRRC, benefits of a carbon footprint assessment and reduction plan and carbon footprint assessment standards. This research will provide the information necessary to identify the correct methodology in order to undertake a carbon footprint assessment of the SRRC.

2.2. What is climate change?

The Oxford dictionary 2015 defines climate change as *"a change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels."*

In recent years, climate change has become a widely accepted reality by the scientific community, with the consensus being over 97% (Cook J, et al, 2013).

Generally speaking, climate change is a long-term shift in weather conditions such as rainfall, temperatures and winds. These changes may affect average conditions, variability and severity; generating extreme weather events (Government of Canada, 2013). Naturally, the Earth's climate is variable throughout time, however increased human activity and CO_2 emissions has lead to a sharp rise in measurable climate shifts (IPCC, 2014).

The term climate change is commonly associated with global warming. With reference to anthropogenic climate change, this refers to the clear and sustained change to the climate over several decades such as temperature and precipitation whereas global warming refers to an increase in the average temperature of the earth's surface due to a change in the atmospheres composition, also known as the greenhouse effect (Aust. Parliament, 2008).

2.3. The Greenhouse Effect

The greenhouse effect describes the natural physical process whereby trace gases (or greenhouse gases) within the Earth's atmosphere, warm the earth. The key naturally occurring trace greenhouse gases account for just 1% of the atmosphere by volume, include carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), ozone (O_3) and water vapour (H_2O) (IPCC, 2001).

The greenhouse effect is an essential process to sustain life, as it warms and regulates Earth's temperature. Without the presence of greenhouse gases and the greenhouse effect, the average global surface temperature would be approximately -19ºC, and would not be supportive of life as we know it. Naturally, the Earth's average surface temperature is 30ºC warmer, being 14ºC due to the greenhouse effect (Garnaut, 2008).

Generally, the greenhouse effect describes the following activity within the Earth's atmosphere:

1. Incoming solar radiation from the Earth's sun hits the atmosphere;
2. Some solar radiation is reflected by the atmosphere;
3. Some incoming solar radiation is absorbed by the Earth's surface while the remaining portion is reflected back out of atmosphere;
4. Absorbed solar radiation is converted into heat resulting in emissions in infrared radiation back to the atmosphere;
5. Some infrared radiation passes through the atmosphere and into space;

6. While the remaining infrared radiation is absorbed and re-emitted by the greenhouse gasses further warming the Earth's surface and troposphere.

Details of the greenhouse effect are depicted in Figure 3 below.

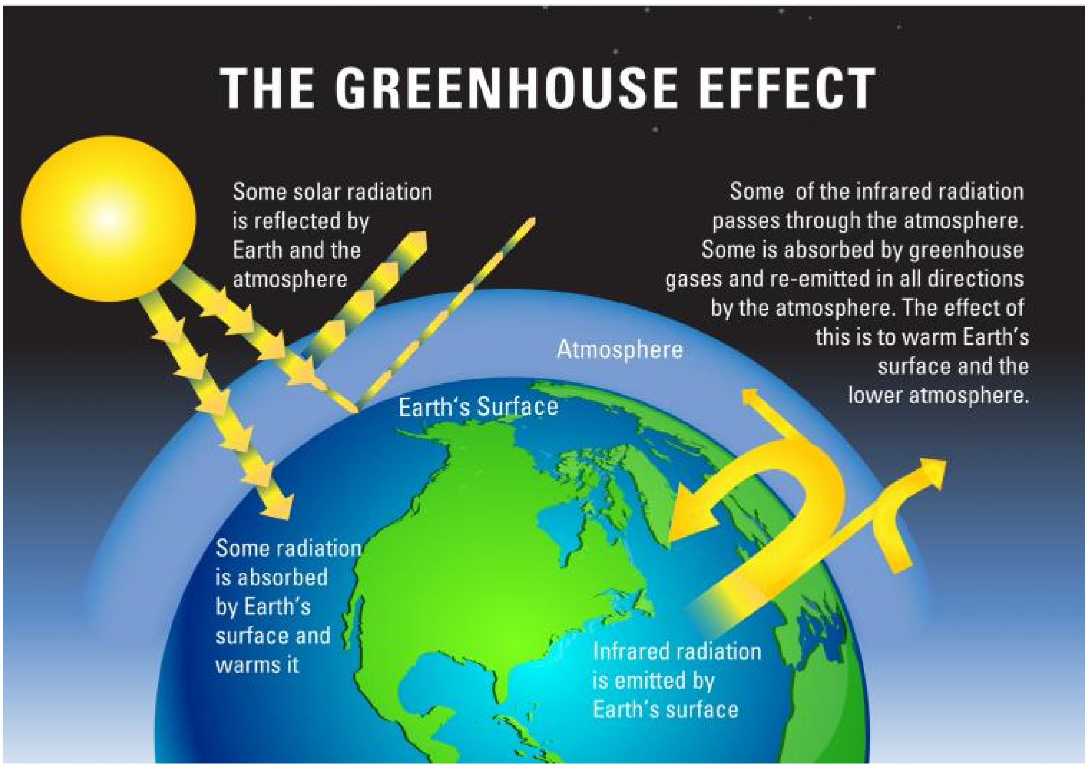

Figure 3: The Greenhouse Effect (US EPA, 2012)

2.4. The Greenhouse Effect & Anthropogenic Climate Change

When the term "climate change" is used in modern text, this is referring to anthropogenic climate change, the consequential result of the enhanced greenhouse effect. Both anthropogenic climate change and the enhanced greenhouse effect references are interchangeable. For the purpose of this report, the term anthropogenic climate change will be used for consistence with the scientific community.

The meaning of anthropogenic climate change is twofold and distinguished by the following definitions.

1. "Emissions of greenhouse gases will lead global warming". That is, in the absence of effective climate policies, increases in average temperatures of 1.4ºC to 5.8 ºC can be expected between now and 2100 (IPCC, 2014).

2. "Existing human activity has already had an adverse impact on global climate change". That is, scientists are now detecting and identifying climate change due to greenhouse emissions from the past several decades. In the 2001 IPCC Synthesis Report, it was stated "There is a new and stronger evidence that most of the warming observed over the last fifty years is attributable to human activities" (IPCC, 2001)

Anthropogenic greenhouse gas emissions are primarily influenced by population size, energy consumption, economic activity, land use, technology and the policies in place to mitigate climate change and emissions. Direct greenhouse gas emissions are those generated from sources that are owned or controlled by the reporting entity, while indirect emissions are those generated as a consequence of the activities of the reporting entity but occur at sources owned or controlled by another entity (India GHG Program, 2013).

In 2014, the key economic activities that lead to direct CO_2 greenhouse gas emissions were:

- Energy Supply (25%) - burning of fossil fuels such as coal, oil and natural gas.
- Agriculture, Forestry and Other Land Uses (AFOLU) (24%) - forest fires, peat decay and peat fire (excludes methane CH_4 from animal sources).
- Industry (21%) - energy consumption to produce goods and materials.
- Transport (14%) - movement of people and goods by trucks, trains, cars, ships, airplanes, and all other vehicle types.
- Buildings (6.4%) - commercial and residential sectors including homes and commercial businesses and their operational energy requirements.
- Other Energy (9.6%) - all other sources not mentioned above.

(IPCC, 2014; US EPA, 2015)

In 2014, the key economic activities that led to indirect CO_2 greenhouse gas emissions were buildings (12%), industry (11%), energy (1.4%), AFOLU (0.87%) and transport (0.3%) (IPCC, 2014).

Figure 4 details the breakdown of each key greenhouse gas emission source.

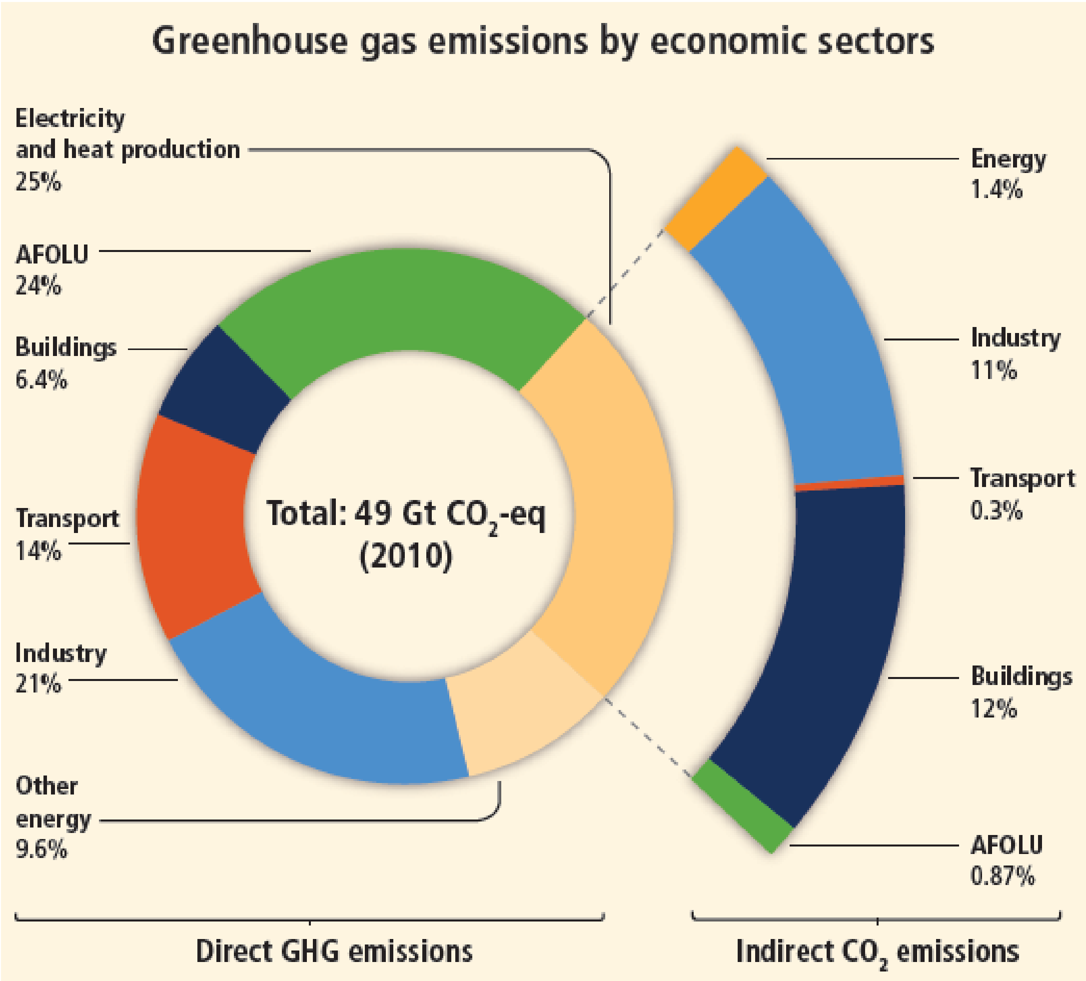

Figure 4: CO_2 greenhouse gas emissions by economic sector (IPCC, 2014)

Since 1750, marking the beginning of the industrial revolution, the level of greenhouse gases have sharply risen above the natural range of the past two million years. Levels of carbon dioxide, methane and nitrous oxide have increased 35%, 148% and 18% respectively, above pre 1750 levels (IPCC, 2007).

2.5. Greenhouse Gas Emissions in Australia

Greenhouse gas emissions vary from country to country based on demographic, economics, energy sources and climate policy. While Australia is responsible for approximately 1.3% of global emissions (Aust. Gov Dept Enviro, 2016), Australia's greenhouse gas emissions per capita is 28.1 tonnes of CO_2 equivalent per person, and is the highest of all the countries of The Organisation for Economic Co-operation and Development (OECD) and one of the highest in the world (DCC, 2008). Figure 5 details Australia's emissions per capita against the OECD and world average.

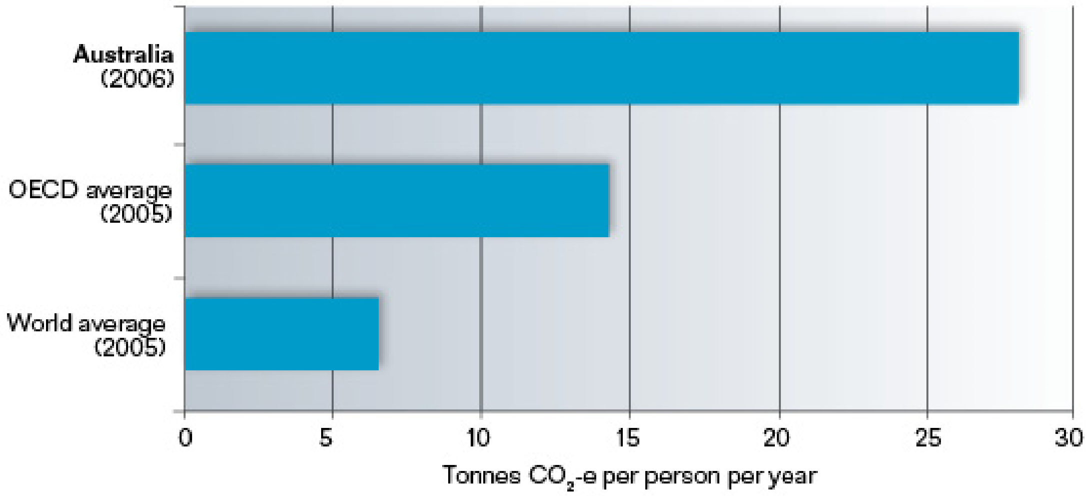

Figure 5: Australia's average CO_2 emissions per capita per year source (R. Garnaut, 2008)

The Australian Bureau of Statistics (ABS) carried out an analysis of Australia's greenhouse gas emissions according to a consumption approach. This approach identified what emissions were produced within Australia for use by Australians, and what emissions were produced within Australia for exported goods. Of the 759 M tonnes of greenhouse emissions, 70% were produced while satisfying the needs of the domestic market, while 30% of emissions were induced through exported goods. Nineteen percent of all mining and 41% of manufacturing emissions were generated through the production and delivery of goods for export (ABS, 2013). Figure 6 details the estimated cumulative direct and indirect greenhouse gas emissions by categories of final demand as a proportion of the 759 M tonnes of emission from 2008 to 2009.

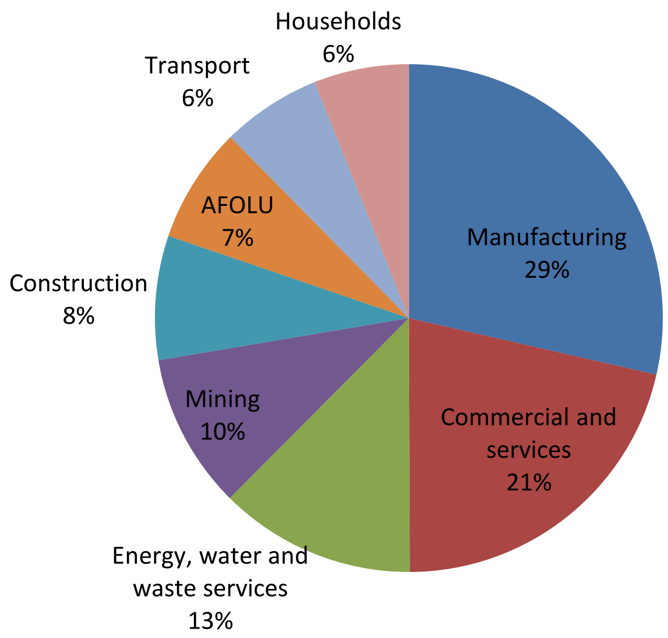

Figure 6: Direct and indirect emissions by categories. Data (ABS, 2013)

2.6. Evidence for Climate Change

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 through both the United Nations Environment Program (UNEP) and the World Meteorological Organisation (WMO). The purpose of the IPCC was to utilise available information within the scientific community, and assess all aspects of climate change including its impacts, and to prepare realistic strategies to address the issues at hand (IPCC, 2007).

The most recent assessment report released by the IPCC was the 5th Assessment in 2014 (AR5). The key findings in this scientific literature assessment and results were:

1. Warming of the climate system is unequivocal. The atmosphere and ocean have warmed, the amount of snow and ice have diminished, sea level has risen, and the concentration of greenhouse gasses have increased.

2. CO_2 emissions provide the largest impact to positive radiative forcing.

3. It is clear human activity has adversely impacted the climate system through increased greenhouse gas concentrations in the atmosphere.

4. Significant and sustained reduction to greenhouse gas emissions is required to limit climate change. Without intervention:

   - atmosphere temperatures will rise;
   - the contrast in precipitation rates between wet and dry regions will grow;
   - air quality will be reduced;
   - oceans will continue to warm, impacting on the circulation effect;
   - Arctic sea ice cover will shrink;
   - average sea levels will rise, and
   - carbon cycle process will change exacerbating the increase of CO_2 and increasing acidification in the ocean.
     (IPCC, 2014)

Key aspects of scientific evidence are discussed in detail below.

2.7. Impacts to Australia from Climate Change

The continual increase in greenhouse gas emissions will have an unequivocal adverse affect to the climate and subsequent negative impact to the Australian region. Four key aspects of climate change that will be most noticeable are increasing average temperatures, rising sea levels, increases to weather severity and reduced runoff. These four aspects and examined further below.

2.7.1. Increasing Average Temperatures

Global average temperatures have risen by 0.85ºC over the past 132 years (1880 to 2012) (IPCC, 2014). Australia has certainly felt the impact of these increases in average temperatures. Since recording of temperature data by the Bureau of Meteorology in 1910, the mean surface air temperature has increased 0.9ºC. Furthermore, daytime maximum temperatures have increased 0.8ºC while night time minimum temperatures have risen 1.1ºC. Seven of the ten warmest days on record have occurred since 1998 with 2013 being the warmest year on record; 1.2ºC above the 1961 to 1990 average (CSIRO & BOM, 2014).

Figure 7 below details mean temperature increases across different regions of Australia since 1910. It is evident that all of Australia has been impacted by climate change with an average increase of 0.9ºC, with some areas increasing more than 1.5ºC.

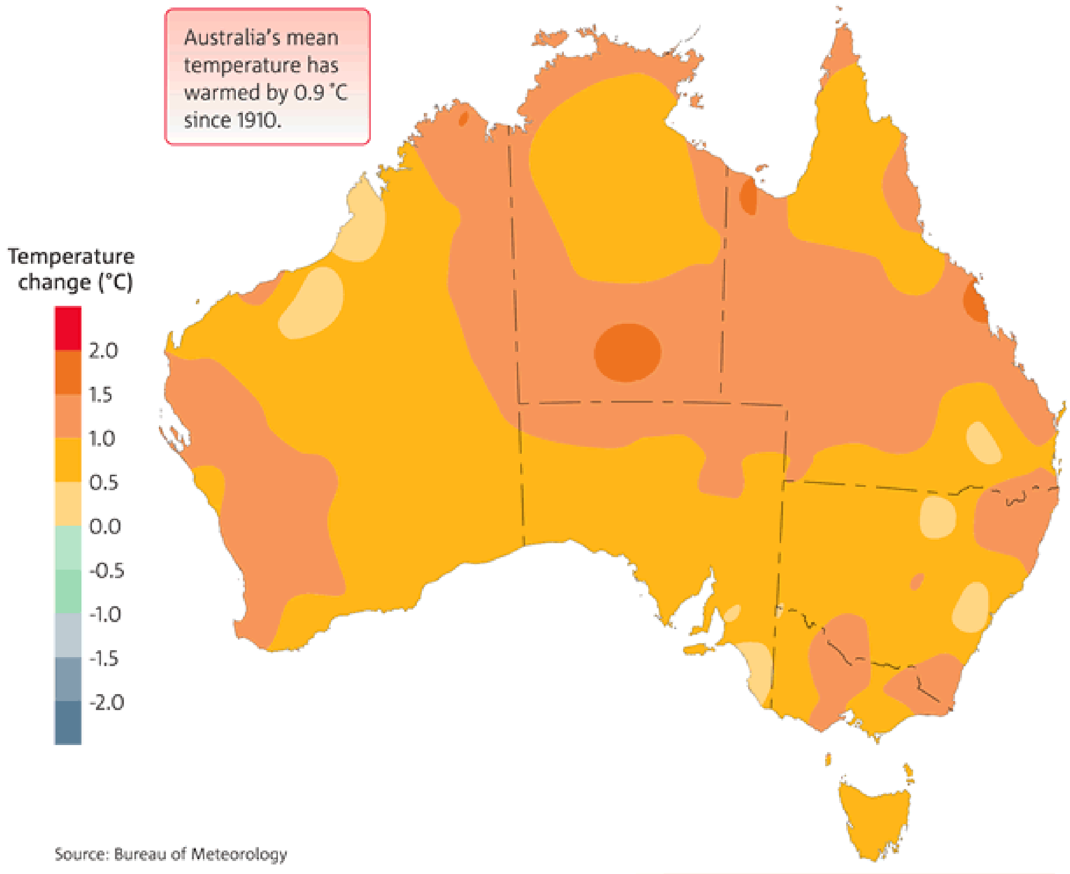

Figure 7: Annual mean temperature changes across Australia since 1910 (CSIRO & BOM, 2014)

2.7.2. Rising Sea Levels and Ocean Acidification

The ocean absorbs approximately 93% of additional energy generated from the greenhouse effect, therefore making it one of the most critical measuring points to monitor and understand climate change.

Due to increases in temperatures, the global mean sea level has increased 225 mm (± 30 mm) since 1880 to 2012. Since 1993, a 3.2 mm per year linear increase in mean ocean levels has been observed (CSIRO & BOM, 2014).

Ocean acidification is a direct result from the absorption of anthropogenic CO_2 emissions. Since 1750, the oceans pH level has decreased 0.1 (increase in acidity), and is projected to decrease a further 0.4 by 2100 (GBRMPA, 2015).

As CO_2 is absorbed by the ocean, it bonds with H_2O forming carbonic acid, releasing bicarbonate and hydrogen ions. The hydrogen ions bond with free carbonate ions to form more bicarbonate ions, resulting in a net loss of carbonate ions. These carbonate ions are essential to marine animals for the creation of carbonate shells and skeletons (GBRMPA, 2015).

Figure 8 below details the change in global mean sea levels since 1880.

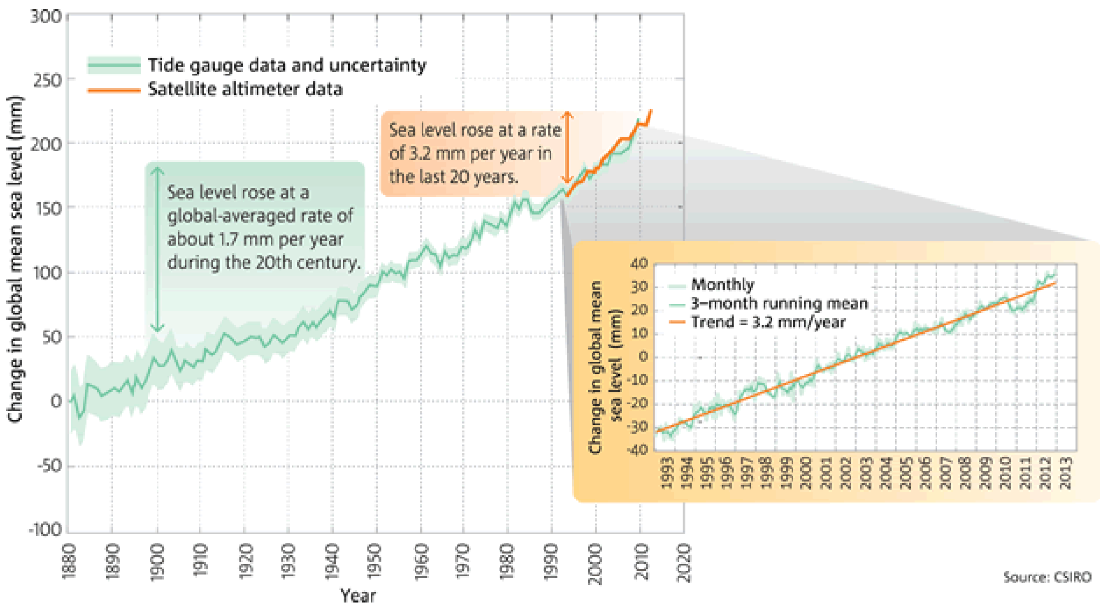

Figure 8: Change in global mean sea level since 1880 (CSIRO & BOM, 2014)

2.7.3. Increases in Severe Weather

The three key areas of severe weather experienced in Australia are heatwaves (fire weather), heavy rainfall and tropical cyclones. Increases in the severity and/or frequency have been seen over the past decades across all three areas (Steffen et al, 2014).

Across Australia, heatwaves have increased in duration, frequency and intensity since 1950. With an increase in heatwaves, comes an increased risk of bushfires. The potential for bushfires is determinant upon various meteorological factors such as humidity, wind speeds, periods of drought and temperature. Since 1973, the number of "extreme" fire-weather days has increased at 24 of the 38 monitoring sites. Figure 9 details the number of days in which the temperature was in the warmest 1% of records since 1910 (CSIRO & BOM, 2014).

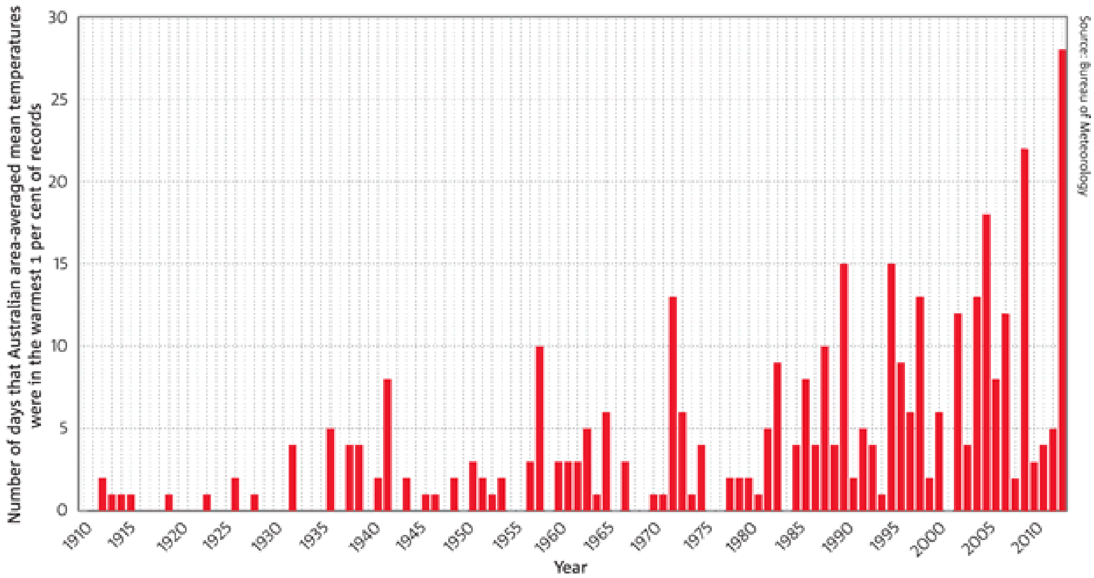

Figure 9: Number of days Australia's area-averaged mean temperatures were in the warmers 1% of records (CSIRO & BOM, 2014)

Analysis of heavy rainfall event frequency is an emerging study within the climate change scope. Observational data has found areas of Australia have been experiencing rainfall events above the 90th percentile more frequently; however, it is not conclusive if this is a result of climate change, and commonly explained by natural variability (CSIRO & BOM, 2014).

Similar to heavy rainfall events, tropical cyclone frequency cannot be pin pointed to climate change. Changes in analysis methods, relatively short satellite records and limited tropical cyclone numbers to study potential influences of climate change, provide equivocal results (CSIRO & BOM, 2014).

2.7.4. Changes in Rainfall and Reduced Runoff

Throughout Australia rainfall averages have slightly increased since 1910, however this is not consistent across the entire country. Northwest Australia has seen a large increase in average rainfall since 1970, while southwest Australia has experienced lower than average winter rainfall and the southeast experiencing below average rainfall in autumn and early winter since 1990.

Stream flows in river systems are adversely impacted in the areas experiencing reduced rainfall. Stream flows in southwest Australia have reduced by 50% since the 1970's. Similarly, southeast Australia saw half of the long-term average during the 1997 to 2009 millennium drought.

Figure 10 details changes in rainfall during the northern wet season of October to April.

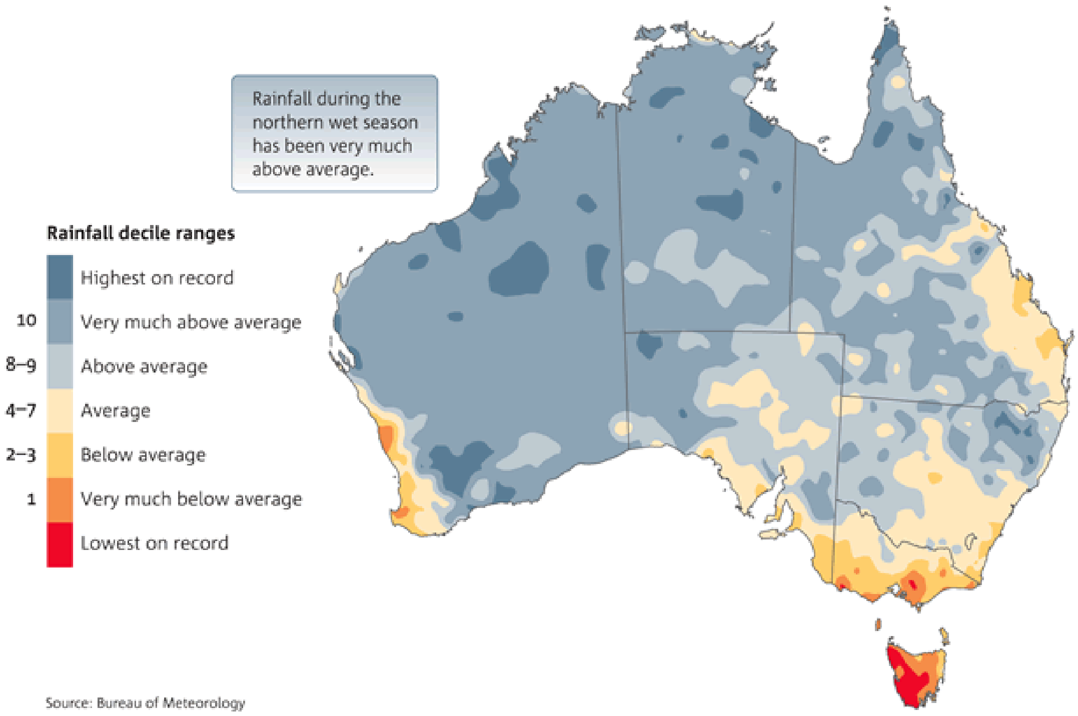

Figure 10: Changes in rainfall during October to April since 1995 compared to historical averages (CSIRO & BOM, 2014)

2.7.5. Summary of Impacts to Australia

Australia's level of exposure and sensitivity to the impacts of climate change is high (R. Garnaut, 2008). The agriculture industry will be affected by water scarcity in irrigated areas, and dry land cropping by changes in rainfall averages; increased temperatures will also have an impact on crops and livestock. Water supply to major cities will also become an issue with water scarcity; long term raises in sea levels will also adversely impact costal settlements. Human health will be impacted by extreme weather events including heat waves and increased air pollution. Ecosystems and biodiversity will also be affected by changes to average water temperatures, ocean acidification, and migration of habitats due to changes in temporal patterns (R. Garnaut, 2008).

2.8. Climate Change Scepticism

Anthropogenic climate change is met with resistances and is still a debated topic. This report provides a brief window into the large scope of climate change and the wide range of aspects associated with the topic. Multiple peer-reviewed scientific journals have found 97% of actively publishing climate scientists agree "climate-warming trends over the past century are very likely due to human activity" (NASA, 2013).

The challenge of consensus remains with policy makers and the general public. A recent study conducted by Yale found that 44% of Americans responded 'Yes' to the question "Assuming global warming is happening, do you think it is caused mostly by human activities?" (sample size 1,013) (Yale, 2014). Continuously, research is being undertaken in the field of anthropogenic climate change, to further develop the understanding within the scientific community and that of the broader community.

2.9. Combating Climate Change: Policies, Standards and Guidelines

Over recent decades, media, governmental figures and parties, and the broader community have opened up the discussion of climate change in many public forums. Continual research and review of scientific data has lead to the development of a deeper and broader understanding of anthropogenic climate change. Through this research, numerous tools have been developed to assess emission outputs and their impacts, standards and policy guidelines. The focus of this report is to investigate key policies at both international and national levels addressing climate change.

2.9.1. International Level

The United Nations Framework Convention on Climate Change (UNFCCC) provides the main global forum for climate change negotiations. The objective of the UNFCCC is to "stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UNFCCC, 2014). Negotiations at the UNFCCC cover themes including mitigation, adaptation and climate finance. As a result, the Kyoto Protocol was formed and the new Durban Platform for Enhanced Action (ADP) which will replace the Kyoto Protocol in 2020.

2.9.1.1. Kyoto Protocol

The Kyoto Protocol is an agreement with developed and transition economies to reduce their greenhouse gas emissions to specified levels, with the overall goal of achieving at least a 5% reduction in emissions from 1990 levels by 2020 (R. Garnaut, 2008).

The protocol was adopted in Kyoto, Japan in 1997. In order for the protocol to enter into force, 55 parties of the convention must make the protocol officially valid, this was achieved in 2005. To date, 192 Parties (191 States, 1 regional economy integration organisation) have ratified the Kyoto Protocol (UNFCCC, 2014).

It was not until 2007 that Australia ratified the Kyoto Protocol with a commitment to reduce emissions to 108% of 1990 levels. In 2014, the Australian Government had announced it had met its targets. This achievement should be taken with a "grain of salt". During negotiations, a clause was created to allow carbon emissions from land clearing to be included. Up until 1990, there had been a surge in land clearing across Australia which sharply fell between 1990 and 1997 (C. Hamilton, 2015), this greatly assisted Australia in meeting its obligations under the Kyoto Protocol. Figure 11 details the changes in emissions by sectors between 1990 and 2012.

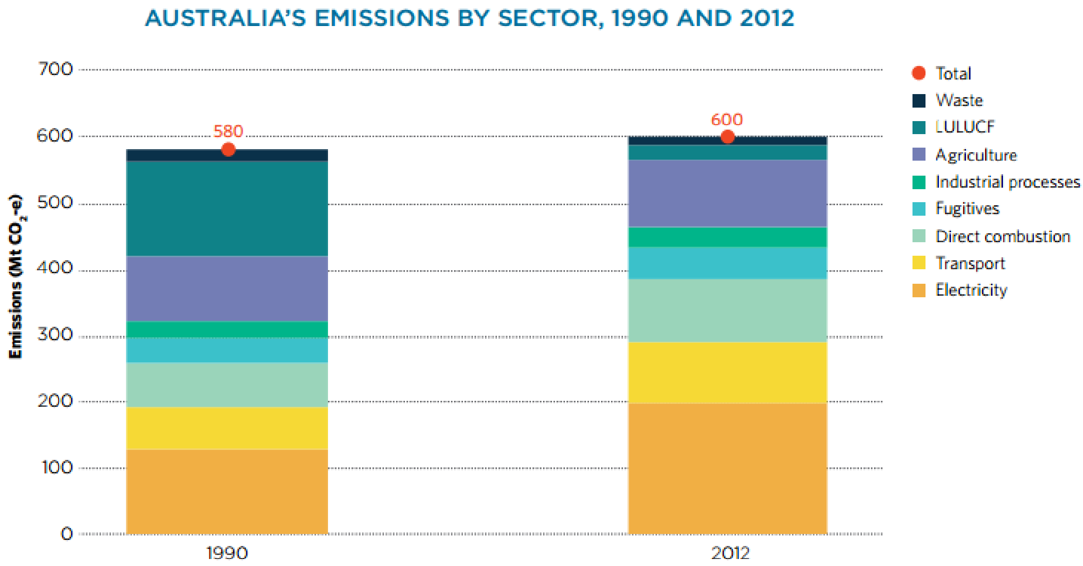

Figure 11: Changes in emissions by sectors between 1990 and 2012 (Climate Change Authority, 2014)

Knowing Australia could meet its targets, the protocol was amended with a second commitment for the period of 2013 to 2020 to reduce emissions 5% below 2000 levels by 2020 (DFAT, 2013).

2.9.1.1. Durban Platform for Enhanced Action

The Durban Platform for Enhanced Action (ADP) was born from the 2011 Durban UNFCCC Conference of the Parties. The ADP is designed to replace the Kyoto Protocol in 2020. The directive of the ADP is to provide "a protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties" (UNFCCC, 2011). The most recent achievements at the time of writing was the outcome of the historic climate change agreement reached at the Paris COP21. Parties adopting the Paris Agreement continue with emission reduction targets beyond 2020 with 5 yearly reviews, a target to hold global average temperature increase to below 2ºC and pursue efforts to keep warming below 1.5 ºC (UN, 2015).

2.9.1.2. The Greenhouse Gas Protocol

The Greenhouse Gas Protocol (GHG Protocol) was developed by both the World Resources Institute (WRI) and World Business Council on Sustainable Development (WBCSD). The goal is to develop and provide a "set of global standard for how to measure, manage and report greenhouse gas emissions" (GHG Protocol, 2012).

The GHG Protocol is the most widely used international accounting tool to understand, quantify and manage greenhouse gas emissions; and is adopted by both governments and businesses around the world.

GHG Protocol standards include:

- Corporate Accounting and Reporting
- Corporate Value Chain
- Product Life Cycle
- Project Protocol
- Greenhouse Gas Protocol for Cities
- Mitigation Goal Standard
- Policy and Action
- ISO 14064-1 (2006)

(GHG Protocol, 2012).

The Corporate Standard was adopted by the International Organisation for Standardisation (ISO) as the basis of ISO 14064-1: *Specification with Guidance at the Organisation Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals*. The standard consists of 3 parts:

Part 1: Conducting greenhouse gas emission inventories
Part 2: Quantification and reporting of emission reductions
Part 3: Verification of greenhouse gas emission statements
(J Wintergreen & T Delaney, 2006)

2.9.2. National Level

In order for Australia to meet its Kyoto Protocol requirements, and to provide a positive contribution to global climate change mitigation, a number of policies, acts, guidelines and standards have been developed. Much of this has been developed off the back of the GHG Protocol.

2.9.2.1. Australia's Climate Change Policy

There are several policies and initiatives being undertaken by the Australian Government providing various options to reduce the greenhouse gas footprint.

2.9.2.1.1. The Clean Energy Act (2011) (and amendments)

The Clean Energy Act (2011) established framework for carbon pricing, payable by Australia's 500 most carbon-intensive entities, at a rate of $23 per tonne of carbon dioxide equivalent. In July 2015, the Clean Energy Legislation (Carbon Tax Repeal) Bill 2014 entered into parliament and passed, receiving the Royal Assent. "Abolishing the carbon tax will lower costs for Australian businesses and ease cost of living pressures for households (Dept Env, 2015). The Government intends to replace the Act with the Direct Action Plan which is further discussed in section 2.9.2.1.5.

2.9.2.1.2. Renewable Energy Target

Australia's Renewable Energy Target (RET) was reformed on the 23rd June 2015 in parliament. The RET is broken down into two parts; Large-scale Renewable Energy Target and the Small-scale Renewable Energy Scheme.

The Large-scale Renewable Energy Target (LRET) provides funding and/or financial incentives for the establishment or expansion of renewable energy sources such as large scale solar, wind and hydroelectricity. The emission savings generated from these investments create Large-scale Generation Certificates (LGCs) (1 MWh = 1 LGC). Under the LRET, certain large entities are required to meet emission targets. If these targets cannot be achieved through investment into renewable energy, they may buy carbon credits in the form of LGCs or from the Clean Energy Regulator. The LRET 2020 target is for the generation of 33,000 GWh of renewable energy (Dept Env, 2015).

The Small-scale Renewable Energy Scheme (SRES) provides incentives for households, community groups and small businesses to install small scale renewable energy systems. The installation of these systems generates Small-scale Technology Certificate (STCs), which are in essences a credit for the emissions saving. RET-liable entities with an obligation to under the LRET, buy back the STCs and give these to the Clean Energy Regulator (Dept Env, 2015).

2.9.2.1.3. Carbon Farming Initiative

The Carbon Farming Initiative (CFI) commenced in 2011 and allowed approved projects to generate Australian Carbon Credit Units. The CFI is targeted towards the agriculture and forestry industry, allowing the generation of Carbon Credit Units through schemes such as tree plantations, management of burning and capture of methane for power generation. The generated Carbon Credit Units can be sold to individuals or organisations who wish to voluntarily offset their emissions (Dept Env, 2015).

2.9.2.1.4. Building Energy Efficiency Disclosure Act (2010)

The Building Energy Efficiency Disclosure Act (2010) created a legal requirement for Council to obtain energy efficiency information for any office space over 2,000 square metres. A Building Energy Efficiency Certificate provides data such as energy efficiency rating for the building, assessment of energy efficiency of lighting that is expected to remain with the building if sold, and to provide guidance as to how to improve the energy efficiency of the building. The assessment will allow

Council to fully assess both economic cost and environmental impacts of the buildings (S. Barrett, 2012).

2.9.2.1.5. Direct Action Plan

Since the repeal of the Clean Energy Act (2011), the Australian Government has committed to introducing a Direct Action Plan. The centrepiece of the Direct Action Plan is the Emissions Reduction Fund. Under the Fund, the following commitments have been made/indicated by the government.

- Target of 5% below 2000 levels by 2020 as required under the existing Kyoto Protocol amendment. Recent reduction target reviews through the Durban Platform has resulted in an improved target of 26-28% below 2005 levels by 2030 (Dept Env, 2016);
- $2.55 billion over 4 years (A. St John & K. Swoboda, 2015);
- Establishment of an Emissions Reduction Fund;
- Purchase least-cost emissions reductions in Australia through reverse auctions;
- Expand the Carbon Farming Initiative;
- Rebates of small-scale renewable energy systems;
- Grants for renewable energy in schools and towns;
- Planting 20 million trees

(Dept Env, 2015).

2.9.2.2. National Carbon Offset Standard

The National Carbon Offset Standard (NCOS) was introduced on 1 July 2010, and provides guidance for the voluntary carbon market. The standard sets out to provide consistency and consumer confidence by providing guidance on genuine voluntary carbon emission offsets and sets minimum requirements for calculating, carbon offsetting, carbon neutrality and auditing.

2.9.2.3. National Greenhouse Energy Reporting Act (2007)

In accordance with the National Greenhouse Energy Reporting (NGER) Act (2007), the key objective is to "introduce a single national reporting framework for the reporting and dissemination of information related to greenhouse gas emissions, greenhouse gas projects, energy consumption and energy production of corporations" (NGER Act (2007), Sect 3). Essentially the Act provides a single emissions reporting framework, allows Australia to meet its international reporting obligations under the Kyoto Protocol, facilitates informed policy making and informs the Australian public (Dept Env, 2015).

While the NGER Act provided the reporting mechanism under the Clean Energy Act (2011), the repeal does not affect the reporting obligations for controlling corporations, reporting transfer certificate holders and other responsible members (Dept Env, 2015).

2.9.2.4. Online System for Comprehensive Activity Reporting

The Online System for Comprehensive Activity Reporting (OSCAR) is an Australian Government system for the reporting of data under the requirements of the NGER. The online tool provides up-to-date emission factors and the ability to calculate greenhouse gas emissions from energy consumption data collected by organisations.

2.9.2.5. International Council for Local Environmental Initiatives

The International Council for Local Environmental Initiatives (ICLEI) - Local Governments for Sustainability provides local government with technical consulting, training and information services to support the implementing of sustainable development. The organisation consists of over 1,000 towns, cities and metropolises throughout the world (ICLEI, 2015).

In October 2003, the SRRC committed to reducing greenhouse gases and joined Cities for Climate Protection Program (CCP), an initiative of ICLEI. SRRC believe the CCP will assist in "demonstrating to residents, local businesses and stakeholders that effective greenhouse management makes good environmental and economic sense" (SRRC).

2.9.2.6. Queensland Climate Change Response

In addition to the Commonwealth level legislation and national reporting schemes and tools available, the Queensland Government has also developed several policy responses to climate change. Many of these policies and initiatives work in conjunction with similar policies at the Commonwealth level. The following responses have been provided by the State:

- EPA - Climate change in Queensland
    - Administer renewable energy certificates
- Queensland Climate Change Strategy
- Climate smart living program
- Caring for our air program
- Queensland Transport - transport and the environment
- ClimateSmart Adaptation 2007-12 and ClimateSmart 2050
- Queensland Climate Change Centre of Excellence
- Green initiatives for QFleet
- Department of Mines and Energy
    - Sustainable energy program, Solar Bonus Scheme, Smart Energy Policy, Queensland Renewable Energy Fund and Queensland Gas Scheme

Details of each of the aforementioned are outside the scope of this report.

2.10. Impact to the Scenic Rim Regional Council as a result of Climate Change

The SRRC is in no way immune to the detrimental impacts associated with climate change. While being inland, impacts such as rising sea levels will not be felt directly, there are a number of other climatic impacts to the region as identified in a study undertaken by Griffith University in conjunction with the CSIRO, State

Government, Federal Government, University of Sunshine Coast and the University of Queensland. The study investigated climate change vulnerability in the South East Queensland region. The following affects were identified:

- Decrease in total annual rainfall of 55mm per decade over the past 50 years has been observed with droughts becoming longer and more severe into the future
- Storms are likely to be more severe
- Increase in bushfire risk
- Increase in temperature

Due to the topography and both built and natural environment of the area, the SRRC did however rate overall lower than surrounding councils such as the Gold Coast City Council, Brisbane City Council and Ipswich City Council (Choy et al, 2010).

One of the most susceptible industries to climate change is Agriculture which is the largest industry and top three employment industries within the SRRC LGA. Therefore while the vulnerability to climate change may be low, the effects to the community will likely be high.

2.11. Scenic Rim Regional Council's Commitment to Climate Change

In 2003, SRRC made a commitment to reduce GHG emissions through joining the Cities for Climate Protection (CCP) program. SRRC hopes the commitment to the CCP will demonstrate to the community and stakeholders that "effective greenhouse management makes good environmental and economic sense" (SRRC, 2016).

The CCP initiative consists of five milestones which are designed to assist a council in reducing its contribution to global warming. The five milestones are:

Milestone 1: Conduct a Greenhouse Gas Emissions Analysis: Baseline Inventory and Forecast
Milestone 2: Establish a Reduction Target
Milestone 3: Develop a Climate Action Plan
Milestone 4: Implement the Climate Action Plan

Milestone 5: Monitor Progress and Report Results

SRRC have committed to participating under the CCP and are in the process of achieving Milestone 1, being the undertaking of a *Greenhouse Gas Emissions Analysis: Baseline Inventory and Forecast*. Pre-emptively, the SRRC has developed the frame work of an action plan which can be broken down into 2 areas; community and corporate as well as commence GHG reduction initiatives. The following actions have been outlined by SRRC to reduce greenhouse gas emissions:

<u>Community</u>

- Through energy giveaway projects, providing water efficient shower heads and light globes to residents
- Where possible, green waste is being used to mulch Council gardens
- Giving away 5,000 trees per year for residents use
- Providing support to community projects which aim to make residents energy aware and to reduce their consumption

<u>Corporate</u>

- Progressively phasing out 6 cylinder vehicles with more economical 4 cylinder vehicles
- Installation of timers on administration building air conditioning and lighting system so that it turns off outside of business hours
- Accredited *GreenPower* for administration building being purchased
- Waterless urinals being installed throughout Council buildings
- Waste paper being recycled throughout Council buildings
  (Aust. Dept. Environment, 2009)

Furthermore, SRRC detail the appointment of an Environmental Strategy Officer whose role will be dedicated to implementing and monitoring the CCP, providing solutions to advance the program and to educate the wider community regarding the environment and sustainability.

While some of the above strategies that are being implemented do not directly reduce GHG emissions, they do provide secondary or flow on effects to the reduction of GHG. It can also be argued that much more can be done to reduce emissions. The likes of Brisbane City Council has an extensive list of initiatives with benefits far exceeding that of SRRC, it must also be noted the funding budget to implement strategies is much greater; $2.6 billion compared to $79.4 million (SRRC, 2015). However, when compared to the similar sized Council with the likes of Hervey Bay City Council, Rockhampton City Council, Redland City Council and Douglas Shire Council, the initiatives being undertaken by SRRC are comparable.

The effectiveness of the current initiatives will be reviewed and discussed throughout Chapter 5.

2.12. Challenges facing Scenic Rim Regional Council in the Reduction of GHG

While local government identifies climate change impacts and the need for carbon mitigation is of high importance (Zeppel, 2011), there are certainly challenges facing policy makers when attempting to reduce GHG emissions.

Generally speaking, local governments have identified a lack of council policy, uncertainty surrounding Carbon Farming Initiatives, offset rules, limited offset options, and limited land and fiscal availability as some of the major challenges (Zeppel, 2013). These challenges adversely impact Councils enthusiasm to reduce GHG as reflected in a study undertaken by H. Zeppel (2013), which found that carbon offsetting was not necessary or not a priority in 18 of the 29 councils surveys (see Figure 12). Furthermore, with limited financial support, providing the needed department support to drive emission reduction initiatives to facilitate change is difficult.

Carbon offsetting	Ab. Shire Council	Shire Council	Regional Council	City Council	Total
No – not necessary	1	6	4	0	11
No – not a priority	0	1	6	0	7
Yes – partially offset	0	0	2	5	7
No – next 12 months	0	1	3	0	4

Figure 12: Carbon offsetting by Queensland Councils (H. Zeppel, 2013)

Policy changes are also driven from bodies of power typically elected to their position for a four year term. Making sustainable long term changes to emission policy is needed however having results to back up a governing bodies decision can be difficult to present within a four year time frame. Should government change at election time, not only can Governmental departments undergo serious re-structure, but also government policies are typically amended. As identified in a report commissioned by UNESCO, the best results are achieved when policy initiative is carried out systematically; that is policy design, planning, implementation, impact assessment and re-design as it should idyllic be, however, this long-term policy analysis and planning is unfortunately not often carried out in such a way (Haddad & Demsky, 1995). A recent paper prepared by the Australian Institute of Company Directors called for fixed, four-year terms for federal government in a hope to provide some policy certainty following the past 15 federal governments having served only two and a half years on average (EICD, 2016).

The recent 2016 SRRC local election found Michael Enright taking out the top position of mayor after beating long term councillor and mayor since 1994, John Brent who was in power during the commitment to the CCP. Michael Enright is yet to provide comment on his vision for the SRRC stance of emissions reduction.

2.13. Benefits of Carbon Footprint Assessment and Reduction Plan

While there may be several challenges facing local government when implementing a carbon reduction plan, there are certainly great benefits for not only Council but also the wider community through effective action. There are many motives for Council to implement carbon offsetting. As identified in a study undertaken by

Zeppel (2013), the following list of motives was identified by local government (ranked from high to low):

- Concern about environmental impacts of climate change
- The 'right thing to do' for the environment (i.e. conservation)
- Promote Council as a climate friendly business enterprise
- Financially support tree planting or renewable energy projects
- Generate income or earn carbon credits from carbon farming initiatives
- Other: 'meet emissions reduction targets' and 'reach carbon neutrality'
- (Zeppel, 2013)

It is foreseeable that action will be required by local government in order to meet greater federal government reduction targets into the future. Early action limits the future cost of climate change and can also limit the expenditure on mitigation efforts. Over time, innovation is anticipated to reduce the cost of low-emissions technology and open new opportunities. Both technology advancement and employment with studies of the cost vs. benefit of mitigation measures should not be delayed (Climate Change Authority, 2014).

For SRRC, carbon footprint reduction is ultimately driven by policy at the local government level. An effective and efficient policy should:

- Reduce emissions cost-effectively
- Be applied consistently and predictably over the long term
- Take into account conflicts between emission reduction policies and other Council objectives to avoid perverse outcomes or duplications
- Assign responsibility to the right department and personnel
- Identify each policy's distribution effects and where appropriate, ensure transition or assistance measures are in place.
  (Climate Change Authority, 2014)

In recent history, there was great financial benefit to Councils if they could reduce their carbon footprint. The Australian Labour Government introduced the Clean Energy Act (2011) which would see Council paying a carbon tax liability associated with emissions from landfill. Under the current Liberal National coalition, the Act was repealed in 2014 and is no longer in affect. Notwithstanding, preparing a carbon footprint reduction plan still provides benefits to achieve local government goals.

2.14. Carbon Footprint Assessment Standards

A carbon footprint assessment determines the total amount of Carbon Dioxide (CO_2) and other GHG emitted over the full life cycle of a product, or in this case, a service i.e. SRRC (CRI, 2015). The amount of Carbon Dioxide is a cumulative measure of Carbon Dioxide Equivalence (CO2-e), a standard common unit of measurement that accounts for the global warming potential (GWP) by various GHG (DCCEF, 2012). The IPCC Fourth Assessment Report outlined the GWP of various gases. With Carbon Dioxide as a base point of 1 GWP, Methane has a GWP of 25 while Nitros Oxide has a GWP of 298 (IPCC, 2007).

There are two main approaches to assessment of a carbon footprint; Life Cycle Assessment (LCA) and the GHG Inventory as discussed further in the below section.

2.14.1. Life Cycle Assessment (LCA)

The LCA is a carbon footprint calculation of a product. A LCA is to be undertaken in accordance with ISO14040:2006 (Environmental management- Life Cycle Assessment - Principles and framework) and ISO 14044:2006 (Environmental management- Life cycle assessment - Requirements and guidelines). Other international standards based on the ISO 14040 series may also be used e.g. PAS2050:2011 (Specification for the assessment of the life cycle greenhouse gas emissions of goods and services) and the GHG Product Life Cycle Accounting and Reporting Standard (DCCEF, 2015).

2.14.2. GHG Inventory

The GHG Inventory is focused towards organisations allowing them to calculate their GHG footprint. GHG reports must rigorously comply with ISO 14064-1:2006 (Specifications with guidance at the organisation level for quantification and reporting of greenhouse gas emissions and removals), ISO14064-3:2012

(Specification with guidance for the validation and verification of greenhouse gas assertions), Australian Government Department of Climate Change and Energy Efficiency: National Carbon Offset Standard - Version 3 (2015), and the National Greenhouse Energy Reporting (NGER) Act (2007) (Pangolin Assoc., 2016)

In essence, the LCA is important when assessing the GHG footprint of a product while the GHG Inventories objective is to assess an organisations GHG footprint. Therefore as the SRRC is considered and organisation and the GHG Inventory approach will be adopted when assessing SRRC carbon footprint.

2.15. Summary

It is evident there are concerns relating to global warming and its impact to the environment and public health. While Australia is responsible for approximately 1.3% of all global GHG emissions (Dept Env, 2016), the country's population also produces 28.1 tonnes CO_2-e per capita per year of GHG emissions being the highest of all OECD counties (DCC, 2008). Australia recognises its role in reducing GHG gas emissions and has committed to a target of GHG emission levels being 26-28% below 2005 levels by 2030 (Dept Env, 2016). The SRRC also has a role to play in the reduction of GHG emissions and have made some steps to reduce levels however more can be done. Following review of various carbon footprint assessment methods, the GHG inventory approach will be adopted in accordance with the NGER and ISO 14064 in order to assess the SRRC carbon footprint.

CHAPTER 3 METHODOLOGY

3.1. Introduction

Chapter 3 details the methodology used to develop the carbon footprint analysis for SRRC. The methodology employed adopts current and relevant legislation requirements and utilises greenhouse emissions inventory covering the organisation and its operations. This Chapter also aims to clearly identify all assumptions and omissions made within the development of the analysis process. Details of methodology, data sources and emission factors for each category is described herein.

3.2. Determination of Carbon Footprint Assessment Methodology

As detailed in *CHAPTER 2: LITERATURE REVIEW*, there is various legislation and guidelines in place at both an international and national level which define GHG emission reduction schemes, emission targets, assessment guidelines and reporting requirements.

Within Australia there are two key carbon footprint assessment standards, being the Life Cycle Assessment (LCA) and the GHG Inventory. For the purpose of the SRRC Energy and Carbon Audit, the GHG Inventory assessment method will be employed.

The GHG Inventory method is tailored for organisations such as the SRRC to calculate their GHG footprint; the purpose of this investigation, whereas the LCA is designed for a product life cycle. The inventory method is intended to provide organisations with a means to identify and report the sources of GHG emissions attributed to their various operations (M. Hall, 2002).

There are several benefits for an organisation undertaking a GHG Inventory assessment. First and foremost, the inventory provides a way to systematically identify and log both known and unknown sources of GHG emissions. Secondly, the assessment provides a benchmark that improvements can be tested and quantified against to justify the commitment or provide indication that alternative solutions and or approach is required. Thirdly, the inventory provides a means to communicate an organisations emissions and success of reduction methods to key stake-holders and the wider community.

There are four key standards associated with the GHG Inventory method defining the quantification, validation, verification and reporting procedures of GHG emissions.

3.2.1. National Greenhouse and Energy Reporting (Measurement) Determination 2008 (as amended)

The National Greenhouse and Energy Reporting Determination 2008 commenced on 1 July 2008 and supports the *National Greenhouse and Energy Reporting Act (2007)*. Subsection 10(3) of NGER provides for the measurement of the following arising from the operation of facilities:

- Greenhouse gas emissions
- The production of energy
- The consumption of energy
- The determination deals with Scope 1 and Scope 2 emissions.
- Fuel combustion
- Fugitive emissions from fuels, which deals with emissions released from the extraction, production, flaring of fuel, processing and distribution of fossil fuels.
- Industrial processes emissions
- Waste emissions

(National Greenhouse and Energy Reporting (Measurement) Determination 2008, Australian Government)

3.2.2. National Carbon Offset Standard - Version 3

The National Carbon Offset Standard was introduced by the Australian Government and provides a standard benchmark for businesses and organisations looking to offset their carbon emissions and/or become carbon neutral by:

- defining minimum requirements for calculating, auditing and offsetting carbon for an organisation; and
- provides guidance on what is a genuine offset unit

The standard therefore provided confidence and environmental integrity for carbon offsetting and carbon neutral claims to consumers and the community. The Carbon Neutral program is administered by the Department of the Environment (Aust. Gov. Dept. Enviro., 2015)

3.2.3. Australian Standards

The above two standards are further supported by a further two International Organisation for Standardisation (ISO) documents, namely ISO 14064-1:2006 (Specifications with guidance at the organisation level for quantification and reporting of greenhouse gas emissions and removals) and ISO14064-3:2012 (Specification with guidance for the validation and verification of greenhouse gas assertions).

3.2.4. Accepted Assessment Methodology

This report has employed the methodologies consistent with those described in the NGER Determination which covers Scope 1 and Scope 2 emissions. Offsets resulting from any existing Council initiatives will not be assessed as part of this report.

3.3. Defining the Boundaries of the Assessment

As specified within the NGER, there are two sets of boundaries being the organisational boundary and operational boundary. The first step in developing a GHG Inventory is to determine the organisational boundary.

3.3.1. Organisational

The organisational boundary includes:

- All corporate groups and members of a group; and
- All facilities being an activity or series of activities that involve the production of greenhouse gas emissions and the production or consumption of energy (NGER, 2007).

In essence, the organisational boundary defines all facilities and entities operated or controlled by the SRRC.

Examples of exclusions include SRRC owned assets that are leased to a third party, i.e. sporting facilities such as show grounds and swimming pools - unless otherwise specified within this report.

3.3.2. Operational Boundary

The operational boundary defines the scope of direct and indirect emissions for operations that fall within a company's established organisational boundary (WBCSD, 2004).

The operational boundary is broken down further into scope 1, scope 2 and scope 3, being the way in which GHG emissions are associated to the operation being either a direct or indirect emission. The GHG inventory consists of 3 scopes.

Scope 1: Direct GHG Emissions

Direct GHG emissions are defined as those emissions that occur from sources that are owned or controlled by the entity. Direct GHG emissions are those emissions that are principally the result of the following types of activities undertaken by SRRC:

- Transportation of materials, products, waste and employees. These emissions result from the combustion of fuels in entity owned/controlled mobile combustion sources, e.g. trucks, trains, ships, aeroplanes, buses and cars.
- Fugitive emissions. These emissions result from intentional or unintentional releases, e.g. equipment leaks from joints, seals, packing, and gaskets;

methane emissions from coal mines and venting; HFC emissions during the use of refrigeration and air conditioning equipment; and methane leakages from gas transport.

Scope 2: Energy Product Use Indirect GHG Emissions

Scope 2 emissions are a category of indirect emissions that accounts for GHG emissions from the generation of purchased energy products (principally, electricity and steam/heat) by the entity.

Scope 2, in relation to SRRC, covers purchased electricity defined as electricity that is purchased or otherwise brought into the organisational boundary of the entity. Scope 2 emissions physically occur at the facility where electricity is generated. Entities report the emissions from the generation of purchased electricity that is consumed in its owned or controlled equipment or operations as scope 2.

Scope 3: Other Indirect GHG Emissions

Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but which arise from sources not owned or controlled by that entity. Some examples of scope 3 activities include extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services.

The reporting of scope 3 emissions is optional. If an organisation believes that scope 3 emissions are a significant component of the total emissions inventory, these can be reported along with scope 1 and scope 2. However, reporting scope 3 emissions can result in double counting of emissions. Where scope 3 emissions can be determined with a level of accuracy, these have been included (WBCSD, 2004).

Figure 13 depicts emission sources common to each of the three scopes.

Figure 13: Typical sources of emissions for each scope (MAV, 2010)

In summary, the structure of the organisational and operational boundaries for the SRRC is as per the following Figure 14:

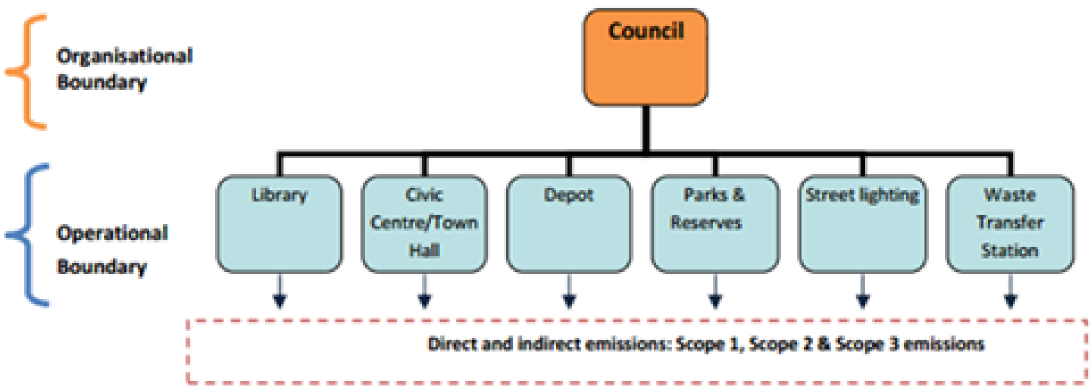

Figure 14: SRRC organisational and operational boundary.

The operational boundary for the GHG emission inventory is confined to the buildings, facilities, assets and activities outlined in Table 2.

Table 2: Organisational boundary and emissions scopes

Building or Activity	Emission Source	Emission Scope
Central landfill	Solid waste disposal (methane emissions)	Scope 1
Council buildings including administration and operations, community and recreation facilities	Electricity consumption	Scope 2
Street lighting	Electricity consumption	Scope 2
Council motor vehicles	Fuel combustion (petrol and diesel)	Scope 1
	Production, extraction and transport emissions associated with fuel production	Scope 3
Plant and equipment such as tractors, mowers, generators etc	Fuel combustion (petrol and diesel)	Scope 1
	Production, extraction and transport emissions associated with fuel production	Scope 3

3.4. Identification of GHG Emitters for Inclusion in Assessment

The sources of GHG emissions included in the inventory are detailed in Table 3.

Table 3: SRRC emission sources and respective scope

Emission Source	Description of Emission Source	Emission Scope
Solid waste disposal (methane emissions)	The degradable organic fraction of organic wastes deposited in landfills generates methane emissions under anaerobic conditions.	Scope 1
Electricity Consumption	Electricity is used for street lighting and in the nominated buildings and assets for lights, office, workshop and other equipment, air conditioning, aeration, pumping, heating and cooling, which	Scope 2

Emission Source	Description of Emission Source	Emission Scope
	generates emissions from combustion of fossil fuel (coal/gas) at power generation facilities.	
Fuel Consumption (petrol and diesel)	Emissions from the combustion of petrol or diesel from council owned vehicles. This includes all Council fleet including off-road engines (e.g. mowers, skit steer loads, bobcats etc).	Scope 1
	Emissions from extraction of crude oil, production of petrol and diesel and transport to Council plant and equipment.	Scope 3

3.5. Determination of Assessment Period

With the boundaries defined, the second step in line with the NGER is to define the assessment period. The reporting period can be any period to meet the organisations specific goals however, usually financial or calendar year; typically financial year in line with the NGER recommendations. To ensure a full set of data was available at the time of writing this report, the 2014 calendar year was selected for the Assessment period.

3.6. Data Collection

The process of data collection in order to calculate GHG emissions is one of the most critical steps and will significantly impact the accuracy of the assessment. The collection of data also proved to be one of the more challenging processes as data is collected by various departments within Council. By defining the organisational boundary the various pieces of data required were identified, being electricity consumption, fuel consumption (transport and stationary) and waste generation.

Electricity consumption from assets within SRRC organisational boundary was obtained via energy retailer bills which provided quarterly kWh usage per facility. Fuel consumption for transport purposes were obtained via the fuel card register which already tracks cost, date/time and volume. Fuel consumption for stationary purposes were obtained via delivery dockets which recorded costs, volume and area in which it was delivered to. The mass of waste received at the Bromelton Waste Transfer Facility was obtained from weigh bridge records however, composition of the waste entering the facility was not available.

Key data required for the assessment was tabulated into an excel spreadsheet in a format ready for computation.

3.7. Global Warming Potential and Emission Factors of GHG

In line with the National Greenhouse and Energy Reporting (Measurement) Determination 2008, the National Greenhouse Accounts (NGA) Factors have been prepared by the Department of the Environment for the estimation in greenhouse gas emissions (NGA, 2015). The NGA is calculated based upon "Method 1" of the NGER (Measurement) determination being a national average of estimates as is the default method used in emission assessment. The latest version of the NGA being August 2015 has been adopted for the assessment. The NGA provides waste composition ratios and state by state emission factors for industrial processes including the consumption of electricity and burning of fuel.

All factors within the NGA are standardised providing ease of impact assessment calculations; the standardised unit is referred to as carbon dioxide equivalent (CO_2-e). For example, indirect emissions from electricity consumption for the Queensland grid is 0.79 kg/CO_2-e/kWh where as Victoria is 1.13 kg/CO_2-e/kWh. The lower emission factor in QLD is a result from the burning of clean coal vs. VIC heavy reliance on brown coal (NGA, 2015).

It is these global warming potentials and emission factors contained within the NGA that will be adopted in the SRRC carbon footprint assessment.

3.8. Development of GHG Inventory

GHG emissions can be determined by either direct measurement or calculated using emission factors. Direct measurement involves determining the amount of GHG emissions by either using volumetric, flow or gas chromatographs. This is an intensive and time consuming method of determining GHG emissions and is rarely used in the determination of an organisation such as SRRC GHG footprint assessment. The commonly adopted approach is the calculation based method where by consumption of energy is determined via generic and readily available data such as electricity consumption and then converted to an equivalent amount of CO_2 emissions using standard emission factors. As no direct measurement devices are in place within the SRRC and due to the readily available consumption data, the calculation based approach is adopted for the SRRC Energy and Carbon Audit.

In accordance with the NGER (Measurement) Determination 2008, there are four methods to determine GHG emissions.

Method 1:
Method 1 also known as the default method, utilises methods outlined in the National Greenhouse Accounts and is based upon a national average estimates which are regularly updated.

Method 2:
Method 2 is a calculation process utilising standards specific to the industry e.g. emissions from the extraction of coal or crude oil production.

Method 3:
Is a similar approach to Method 2 however a sample of gas bearing strata is collected and assessed in accordance with AS2617 (1996) *Sampling from coal seams* and AS2519 (1993) *Guide to the technical evaluation of higher rank coal deposits* respectively or equivalent standard.

Method 4:
Utilises a direct measurement approach to determine emissions emitted from a particular source during the assessment period.

(NGER Measurement Determination, 2008)

Due to the data available, sources of emissions generated by the SRRC and user friendly nature of Method 1, Method 1 will be adopted for the calculation of emissions across all Scope 1, 2 and 3 emission sources as defined in Section 3.2.2. As discussed is in Section 3.7, GHG factors from the latest version of NGA will be used in the calculation process also.

Data was gathered as described by the processes detailed within Section 3.6 and sorted into their corresponding scope. This data was then entered into the GHG Inventory spreadsheet as detailed in the following Section 3.9.

3.9. Process and Formula to Determine GHG Emissions

The GHG Inventory utilised Microsoft Excel to tabulate, formulate and calculate the GHG data and emissions. The following section details the way in which emissions under each of the three scopes were calculated.

3.9.1. Scope 1 Emissions

3.9.1.1. Landfill Emissions

Methane is generated from the decomposition of organic material from solid waste disposal at the Central Landfill (Bromelton) and is currently released to the atmosphere.

Emissions of CH_4 were estimated using the NGER Solid Waste Emissions Calculator Tool (Waste Tool) in accordance with Method 1 (Division 5.2.2, Method 1 - emissions of methane released from landfills, of the Technical Guidelines (DCCEE, 2014)). Method 1 uses the IPCC first-order decay model and allows state or territory specific default waste composition data (waste streams and waste mix types) to be used.

Site specific waste composition data were limited and therefore the default composition of waste streams and waste mix types for Queensland was adopted. These compositions were sourced from Sections 5.10 and 5.11 of the Technical

Guidelines (DCCEE, 2014) and are listed in Figure 15 and Figure 16 below. SRRC currently keep an internal record of tonnes of waste received and is detailed in Table 4. This data was input into the NGER Solid Waste Emissions Calculator Tool (2014-2015).

	Col.1	Col.2	Col.3	Col.4	Col.5	Col.6	Col.7	Col.8	Col.9
Item	Waste stream	NSW %	VIC %	QLD %	WA %	SA %	TAS %	ACT %	NT %
1	Municipal solid waste	31	36	43	26	36	57	43	43
2	Commercial and industrial	42	24	14	17	19	33	42	14
3	Construction and demolition	27	40	43	57	45	10	15	43

Figure 15: Estimated of tonnage for various waste streams (DCCE, 2014, Sec 5.10)

Item	Waste mix type	Municipal solid waste default %	Commercial and industrial waste default %	Construction and demolition waste default %
1	Food	35	21.5	0
2	Paper and cardboard	13	15.5	3
3	Garden and park	16.5	4	2
4	Wood and wood waste	1	12.5	6
5	Textiles	1.5	4	0
6	Sludge	0	1.5	0
7	Nappies	4	0	0
8	Rubber and Leather	1	3.5	0
9	Inert waste	28	37.5	89

Figure 16: Default composition of waste mix types for landfills (DCCE, 2014, Sec 5.11)

Table 4: Annual waste received at Bromelton

Reporting Year	Waste Received at Landfill (tonnes)
2002	25,365
2003	43,483
2004	43,483
2005	43,483
2006	40,166

Reporting Year	Waste Received at Landfill (tonnes)
2007	40,196
2008	38,952
2009	38,622
2010	42,624
2011	44,090
2012	44,870
2013	44,735
2014	46,557

The NGER Waste Tool estimates the total emissions for the landfill during the reporting period and into the future. No emissions for the waste facility are capped, flared or captured. A copy of the Waste Tool is provided in Appendix B.

3.9.1.2. Fuel Combustion - Stationary Energy

3.9.1.2.1. Diesel

Diesel is used in engines and industrial vehicles under the SRRC's operational control (owned or leased by SRRC) for stationary energy purposes.

Emissions of CO_2, CH_4 and N_2O were estimated using Method 1 (Division 2.4.2, Method 1 - emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum based oils or greases, of the Technical Guidelines (DCCEE, 2014)):

$$E_j = \frac{Q \times EC \times EF_{joxec}}{1000}$$

where:

E_j	=	Estimated emissions of gas type (j) from diesel combustion	(t CO_2-e/year)
Q	=	Estimated quantity of diesel combusted for stationary energy purposes in a year.	(kL/year)
EC	=	Energy content factor of diesel	(GJ/kL)
EF_{joxec}	=	Emissions factor for each gas type (j)	(kg CO_2-e/GJ)

The default energy content factor for diesel and the default emission factor for each gas (i.e. CO_2, CH_4 and N_2O) were sourced from Table 2.4.2A *Emissions and energy content factors - liquid fuels and certain petroleum-based products for stationary energy purposes* of the Technical Guide (DCCEE, 2014) and are listed in Table 5. The activity data is presented in Table 6. All estimates are presented to the nearest kilolitre, in accordance with Australian greenhouse reporting convention, but should only be considered reliable to two significant figures.

Table 5: Emission and energy content factors for Diesel (DCCEE, 2014, Table 2.4.2A)

Method	Constant	Value	Units
Method 1	Default energy content factor	38.6	GJ/kL
Method 1	Scope 1 default CO_2 emissions factor	69.2	kg CO_2-e/GJ
Method 1	Scope 1 default CH_4 emissions factor	0.1	kg CO_2-e/GJ
Method 1	Scope 1 default N_2O emissions factor	0.2	kg CO_2-e/GJ

Diesel consumed for stationary energy purposes was sourced via records of delivery dockets for diesel fuel supply to stationary energy users.

Table 6: Stationary diesel consumption

Reporting Period	Data Required	Value	Units
2014	Estimated quantity of diesel combusted for stationary energy purposes in a year.	293	kL/year

3.9.1.2.2. Petrol

Petrol is used in engines and industrial vehicles under SRRC's operational control (owned or leased by SRRC) for stationary energy purposes.

Emissions of CO_2, CH_4 and N_2O were estimated using Method 1 (Division 2.4.2, Method 1 - *Emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum based oils or greases,* of the Technical Guidelines (DCCEE, 2014)):

$$E_j = \frac{Q \times EC \times EF_{joxec}}{1000}$$

where:

E_j	=	Estimated emissions of gas type (j) from petrol combustion	($t\ CO_2$-e/year)
Q	=	Estimated quantity of petrol combusted for stationary energy purposes in a year	(kL/year)
EC	=	Energy content factor of petrol	(GJ/kL)
EF_{joxec}	=	Emissions factor for each gas type (j)	(kg CO_2-e/GJ)

The default energy content factor for petrol and the default emission factor for each gas (i.e. CO_2, CH_4 and N_2O) were sourced from Table 2.4.2A *Emission and energy content factors- liquid fuels and certain petroleum-based products for stationary energy purposes (Gasoline (other than for use as fuel in an aircraft)* of the Technical Guide (DCCEE, 2014) and are listed in Table 7. The activity data is presented in Table 8. All estimates are presented to the nearest kilolitre, in accordance with Australian greenhouse reporting convention, but should only be considered reliable to two significant figures.

Table 7: Emission and energy content factors for Petrol (DCCEE, 2014, Table 2.4.2A)

Method	Constant	Value	Units
-	Default energy content factor	34.2	GJ/kL
Method 1	Scope 1 default CO_2 emissions factor	66.7	kg CO_2-e/GJ
Method 1	Scope 1 default CH_4 emissions factor	0.2	kg CO_2-e/GJ
Method 1	Scope 1 default N_2O emissions factor	0.2	kg CO_2-e/GJ

Petrol consumed for stationary energy purposes was sourced via records of delivery dockets for petrol fuel supply to stationary energy users.

Table 8: Stationary petrol consumption

Reporting Period	Data Required	Value	Units
2014	Estimated quantity of petrol combusted for stationary energy purposes in a year.	16	kL/year

3.9.1.3. Fuel Combustion - Transport Energy

3.9.1.3.1. Diesel

Diesel is used in light vehicles under the SRRC's operation control (owned or leased by SRRC) for transport energy purposes (i.e. transport by vehicles registered for road use).

Emissions of CO_2, CH_4 and N_2O were estimated using Method 1 (*Division 2.4.2, Method 1 - emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum based oils or greases,* of the Technical Guidelines (DCCEE, 2014)):

$$E_j = \frac{Q \times EC \times EF_{joxec}}{1000}$$

where:

E_j	=	Estimated emissions of gas type (j) from diesel combustion	(t CO_2-e/year)
Q	=	Estimated quantity of diesel combusted in vehicles per year	(kL/year)
EC	=	Energy content factor of diesel	(GJ/kL)
EF_{joxec}	=	Emissions factor for each gas type (j)	(kg CO_2-e/GJ)

The default energy content factor for diesel and the default emission factor for each gas (i.e. CO_2, CH_4 and N_2O) were sourced from Table 2.4.2B *Emission and energy content factors- fuels for transport energy purposes (Diesel oil)* of the Technical Guide (DCCEE, 2014) and are listed in Table 9. The activity data is presented in Table 10. All estimates are presented to the nearest kilolitre, in accordance with Australian greenhouse reporting convention, but should only be considered reliable to two significant figures.

Table 9: Emission & energy content factors for Diesel - transport (DCCEE, 2014, Table 2.4.2B)

Method	Constant	Value	Units
-	Default energy content factor	38.6	GJ/kL
Method 1	Scope 1 default CO_2 emissions factor	69.2	kg CO_2-e/GJ
Method 1	Scope 1 default CH_4 emissions factor	0.2	kg CO_2-e/GJ
Method 1	Scope 1 default N_2O emissions factor	0.5	kg CO_2-e/GJ

Diesel consumed for transport energy purposes was sourced via records of vehicle fuel cards and delivery dockets for diesel fuel supply related to transport purposes.

Table 10: Transport diesel consumption

Reporting Period	Data Required	Value	Units
2014	Estimated quantity of diesel combusted for transport purposes in a year.	528	kL/year

3.9.1.3.2. Petrol

Petrol is used in light vehicles under the SRRC's operation control (owned or leased by SRRC) for transport energy purposes (i.e. transport by vehicles registered for road use).

Emissions of CO_2, CH_4 and N_2O were estimated using Method 1 (*Division 2.4.2, Method 1 - emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum based oils or greases,* of the Technical Guidelines (DCCEE, 2014)):

$$E_j = \frac{Q \times EC \times EF_{joxec}}{1000}$$

where:

E_j	=	Estimated emissions of gas type (j) from petrol combustion	(t CO_2-e/year)
Q	=	Estimated quantity of petrol combusted in vehicles per year	(kL/year)
EC	=	Energy content factor of petrol	(GJ/kL)
EF_{joxec}	=	Emissions factor for each gas type (j)	(kg CO_2-e/GJ)

The default energy content factor for petrol and the default emission factor for each gas (i.e. CO_2, CH_4 and N_2O) were sourced from Table 2.4.2B *Emission and energy content factors- fuels for transport energy purposes (Gasoline (other than for use as fuel in an aircraft))* of the Technical Guide (DCCEE, 2014) and are listed in Table 11. The activity data is presented in Table 12. All estimates are presented to the nearest kilolitre, in accordance with Australian greenhouse reporting convention, but should only be considered reliable to two significant figures.

Table 11: Emission and energy content factors for petrol - transport (DCCEE, 2014, Table 2.4.2B)

Method	Constant	Value	Units
-	Default energy content factor	34.2	GJ/kL
Method 1	Scope 1 default CO_2 emissions factor	66.7	kg CO_2-e/GJ
Method 1	Scope 1 default CH_4 emissions factor	0.6	kg CO_2-e/GJ
Method 1	Scope 1 default N_2O emissions factor	2.3	kg CO_2-e/GJ

Petrol consumed for transport energy purposes was sourced via records of vehicle fuel cards and delivery dockets for petrol fuel supply related to transport purposes.

Table 12: Transport petrol consumption

Reporting Period	Data Required	Value	Units
2014	Estimated quantity of petrol combusted for transport purposes in a year.	345	kL/year

3.9.2. Scope 2 Emissions - Electricity Usage

Electricity (purchased from the grid) is used at a number of facilities under SRRC's operational control such as offices, libraries and information centres.

Scope 2 emissions associated with purchased electricity were estimated using Method 1 (*Division 7.2, Method 1 - purchase of electricity from main electricity grid in a State or Territory* (DCCEE, 2014)):

$$Y = Q \times \frac{EF_{S2}}{1000}$$

Where:

Y	=	Scope 2 GHG emissions	(t CO_2-e/year)
Q	=	Quantity of electricity purchased from the grid	(kWh/year)
EF_{S2}	=	Default Scope 2 emissions factor for specific State or Territory in which consumption occurs.	(kg CO_2-e/kWh)

Note that only one method is currently available for the estimation of emissions from electricity purchased from the grid. This method uses indirect emission factors based on the state, territory or electricity grid corresponding to the facility of interest. It should be noted that these indirect emission factors are updated each year.

The default energy content factor for electricity and the overall default emissions factor was sourced from Part 7.3.3 and Table 7.2 *Indirect (scope 2) emission factors from consumption of purchased electricity from a grid* (DCCEE, 2014) and is detailed in Table 13 below.

Table 13: Parameters for electricity purchased from the grid

Variable	Value	Units
Energy content factor	0.0036	GJ/kWh
CO_2 emission factor for Queensland	0.81	kg CO_2-e/kWh

Electricity consumption data was sourced via electricity usage tax invoices for the various facilities under SRRC's operation control. Table 14 details the electricity purchased during 2014. Note, due to billing cycles, most data was not discretely during 2014. Therefore data from the four quarterly billing cycles that fell mostly within the period were used.

Table 14: Summary of Facilities within SRRC and their respective kWh/year usage

Facilities Under SRRC's Operational Control	Electricity Purchased from the Grid (kWh/year) 2014
Beaudesert depot	197768
Beaudesert library	39872
Bicentennial park/Boonah information centre	5183
Boonah admin building	79823

Facilities Under SRRC's Operational Control	Electricity Purchased from the Grid (kWh/year) 2014
Boonah district cultural centre/Boonah library	193332
Canungra depot	2642
Canungra information centre/Canungra library	14836
Canungra pool	58749
Central place	7082
Council chambers/offices	114582
Council depot Lot 234	60032
Gallery walk toilets	12843
Central landfill	11853
Moogerah caravan park	179734
Mt Tamborine library	35492
Nursery	4532
Rathdowney depot	1801
State emergency service	10199
Tamborine Mountain information centre	7495
Tamborine Mountain swimming pool	22038
Street lighting	114371

3.9.3. Scope 3 Emissions - Full Fuel Cycles

Fuel used by SRRC, such as diesel and petrol, have associated indirect emissions resulting from exploration, processing and transport of these fuels. The consumption of purchased grid electricity also have associated Scope 3 emissions from the extraction, production and transport of fuel combusted at generation and the indirect emissions attribute to the electricity lost in delivery in the transmission and distribution network.

In order to estimate the greenhouse gas emissions from full fuel cycles, the total amount of fuel combustion and electricity consumption by SRRC are as follows:

$$E_{CO_{2-e}} = \frac{Q \times EC_i EF_{S3}}{1000}$$

Where:

$E_{CO_{2-e}}$	=	Scope 3 GHG emissions from fuel combustion	(t CO_2-e/year)
Q	=	Quantity of fuel combusted	(kL/year)
EC_i	=	Energy content of fuel type i	(GJ/kL)
EF_{S3}	=	Scope 3 emission factor	(kg CO_2-e/GJ)

and

$$E_{CO_{2-e}} = \frac{Q \times EF_{S3}}{1000}$$

Where:

$E_{CO_{2-e}}$	=	Scope 3 GHG emissions from electricity combustion	(t CO_2-e/year)
Q	=	Quantity of electricity purchased from the grid	(kWh/year)
EF_{S3}	=	Default Scope 3 emission factor specific to State (QLD) or Territory in which the consumption occurs	(kg CO_2-e/GJ)

The default energy content factors of diesel and petrol were sourced from Table 2.4.2B *Emissions and energy content factors - fuels for transport energy purposes* (DCCEE, 2014) and are listed in Table 15 below. The default Scope 3 emission factors of diesel/petrol and electricity were sourced from Table 40 *Scope 3 emission factors - liquid fuels and certain petroleum based products* and Table 41 *Scope 3 and 3 emissions factors - consumption of purchased electricity by end users* respectively of the National Greenhouse Accounts Factors (2014) are also recorded in Table 13 below.

Table 15: Emission factors associated with full fuel cycles

Variable	Value	Units
Energy content factor of diesel	38.6	GJ/kL
Energy content factor of gasoline (other than for use as fuel in an aircraft)	34.2	GJ/kL
Scope 3 emission factor of diesel oil	5.3	kg CO_2-e/GJ
Scope 3 emission factor of fuel oil	5.3	kg CO_2-e/GJ
Scope 3 emission factor of electricity (QLD)	0.13	kg CO_2-e/kWh

3.10. GHG Inventory Software

Microsoft Excel 2010 was used to develop a spreadsheet to tabulate and calculate/convert the collected data into kg CO_2-e by utilising the data and formula detailed in Section 3.9 to create the GHG Inventory. Refer to Appendix C for the GHG Inventory.

CHAPTER 4: RESULTS

4.1. Introduction

Chapter 4: Results will summarise the calculated results utilising the data and formula set out in Chapter 3. These results will be broken down into the three emission scopes followed by identification of data suitability by verification and validation.

4.2. SRRC Total Greenhouse Gas Emissions (Equivalent)

The SRRC's emissions are defined within the following subsets:

Scope 1 Emissions

- Landfill emissions
- Fuel combustion - stationary energy
    - Diesel
    - Petrol
- Fuel Combustion - transport energy
    - Diesel
    - Petrol

Scope 2 Emissions

- Electricity usage

Scope 3 Emissions

- Full fuel cycles

Calculations of the above emission sources can be found in Appendix C.

4.2.1. Scope 1 Emissions

4.2.1.1. Landfill Emissions

In 2014, a total of 46,557 tonnes of waste was recorded to be disposed at the Bromelton Central Landfill facility. As data on waste composition was not available or feasibly measurable, the waste mix ratio detailed within the DCCEE 2014 was adopted. Figure 17 details the breakdown of the various waste types, tonnage and percentage respectively.

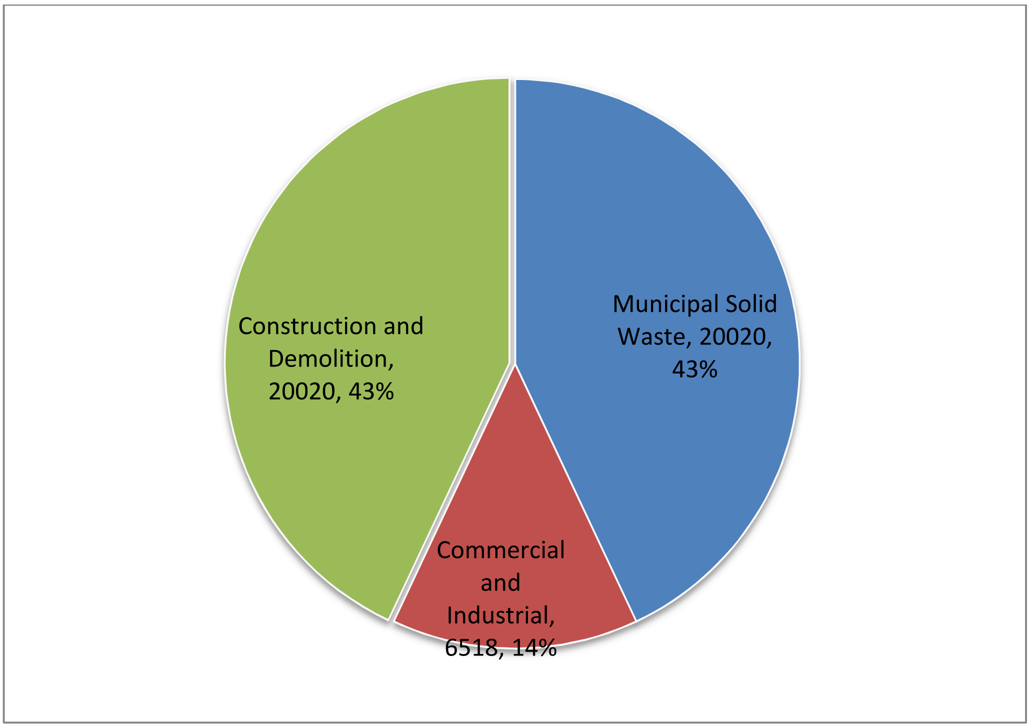

Figure 17: Proportional Tonnes of Waste (2014) at Bromelton Waste Transfer Facility

The above listed waste streams were broken down further into the various waste mix types typically expected as detailed in Table 16 and Figure 18.

Table 16: Tonnage of waste mix types from various waste streams

Waste Mix Type	Municipal Solid	Commercial and Industrial	Construction and Demolition
Food	7007	4304	0
Paper and Cardboard	2603	3103	601
Garden and park	3303	801	400
Wood and wood waste	200	2510	1201
Textiles	300	801	0
Sludge	0	300	0

Waste Mix Type	Municipal Solid	Commercial and Industrial	Construction and Demolition
Nappies	801	0	0
Rubber and leather	200	701	0
Inert waste	5605	7507	17817

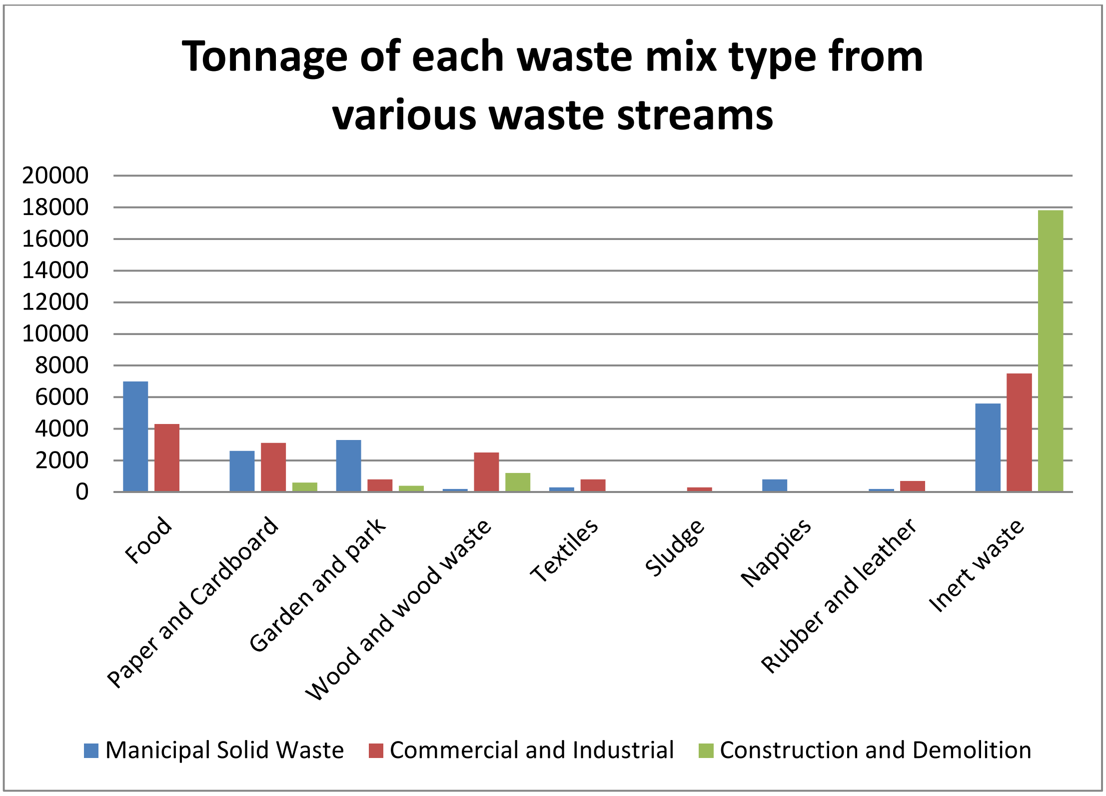

Figure 18: Tonnage of Landfill waste mix from various waste streams

Annual total waste delivered to the facility since recording took place providing data from 2002 through to 2014. This data was input into the Australian Government Clean Energy Regulator: The Solid Waste Emissions Calculator; see Appendix B. Note, at the Bromelton Waste Transfer Facility, no emissions are captured or are flared. The waste calculator derived a total of 24,813 tonnes of $CO_{2\text{-}e}$ emissions in 2014 were released from the waste facility.

Assumptions and limitations of the data included:

- It is assumed the weighbridge data collected at the waste facility are true and accurate.
- While it is unlikely waste generation in the SRRC is representative of Queensland due to its predominantly rural nature, DCCEE waste mix ratios

were assumed to be accurate and representative of the Bromelton waste facility.

- It is assumed recyclable material which may have been extracted from waste was considered to be included as part of the decomposing waste.
- It was assumed the solid waste emissions calculator operated as intended.
- The potential for human errors through the data collection and computation process.

4.2.1.2. Fuel Combustion - Stationary Energy

Fuel combustion utilised for stationary energy is broken down further into two subcategories being Diesel and Petrol.

4.2.1.2.1. Diesel

In 2014 a total of 293 kL of Diesel was consumed for stationary energy purposes. As a result of this consumption, the following GHG emissions from diesel combustion for stationary purposes were calculated and are detailed in Table 17 below.

Table 17: GHG emissions from diesel combustion for stationary energy purposes

Tonnes of CO_2-e per year			
CO_2	**CH_4**	**N_2O**	**Total CO_2-e**
783	1	2	786

4.2.1.2.2. Petrol

In 2014 a total of 16 kL of Petrol was consumed for stationary energy purposes. As a result of this consumption, the following GHG emissions from petrol combustion for stationary purposes were calculated and are detailed in Table 18 below.

Table 18: GHG emissions from petrol combustion for stationary energy purposes

Tonnes of CO_2-e per year			
CO_2	**CH_4**	**N_2O**	**Total CO_2-e**
36.5	0.1	0.1	37

Assumptions and limitations of the data for both diesel and petrol consumption included:

- Accuracy of fuel delivery dockets and book keeping. Errors in this data such as missing data records will result in an underestimate of total consumption.
- DCCEE 2014 energy and emission content factors were used and therefore assumed to be accurate.
- Human error in the formulation, calculation and presentation of results.

4.2.1.3. Fuel Combustion - Transport Energy

Fuel combustion utilised for transport energy is broken down further into two subcategories being Diesel and Petrol.

4.2.1.3.1. Diesel

In 2014 a total of 528 kL of Diesel was consumed for transport energy purposes. As a result of this consumption, the following GHG emissions from diesel combustion for transport purposes were calculated and are detailed in Table 19 below.

Table 19: GHG emissions from diesel combustion for transport energy purposes

Tonnes of CO_2-e per year			
CO_2	**CH_4**	**N_2O**	**Total CO_2-e**
1410	4	10	1424

4.2.1.3.2. Petrol

In 2014 a total of 345 kL of Petrol was consumed for transport energy purposes. As a result of this consumption, the following GHG emissions from petrol combustion for transport purposes were calculated and are detailed in Table 20 below.

Table 20: GHG emissions from petrol combustion for transport energy purposes

Tonnes of CO_2-e per year			
CO_2	**CH_4**	**N_2O**	**Total CO_2-e**
787	7	27	821

Assumptions and limitations of the data for both diesel and petrol consumption included:

- Accuracy of fuel delivery dockets and bookkeeping. Errors in this data such as missing data will result in an underestimate of total consumption.
- Accuracy of employee vehicle and fuel use e.g. vehicle for private use.
- If fuel was purchased by a SRRC employee and reimbursed through the employees' payroll, this data was not captured.
- DCCEE 2014 energy and emission content factors were used and therefore assumed to be accurate.
- Human error in the formulation, calculation and presentation of results.

4.2.2. Scope 2 Emissions - Electricity Usage

Scope 2 emissions from electricity usage is electricity purchased from the grid to provide power to of facilities under SRRC's operational control such as offices, libraries and information centres. Nineteen facilities within the SRRC are under Councils operational control which consumed a combined total of 1,152,221 kWh in 2014 resulting in 841 tonnes of CO_2-e. Table 21 below provides a breakdown of the total energy (GJ/year) and total emissions generated.

Table 21: Scope 2 emissions and energy consumed from electricity purchased from the grid

Facilities Under SRRC's Operational Control	Electricity Purchased from the Grid (kWh/year) 2014	Energy (GJ/year)	Emissions (t CO_2-e/year)
Beaudesert depot	197,768	712	160
Beaudesert library	39,872	144	32
Bicentennial park/Boonah information centre	5,183	19	4
Boonah admin building	79,823	287	65
Boonah district cultural centre/Boonah library	193,332	696	157
Canungra depot	2,642	10	2
Canungra information centre/Canungra library	14,836	53	12
Canungra pool	58,749	211	48
Central place	7,082	25	6
Council chambers/offices	114,582	412	93
Council depot Lot 234	60,032	216	49

Facilities Under SRRC's Operational Control	Electricity Purchased from the Grid (kWh/year) 2014	Energy (GJ/year)	Emissions (t CO_2-e/year)
Gallery walk toilets	12,843	46	10
Central landfill	11,853	43	10
Moogerah caravan park	179,734	647	146
Mt Tamborine library	35,492	128	29
Nursery	4,532	16	4
Rathdowney depot	1,801	6	1
State emergency service	10,199	37	8
Tamborine Mountain information centre	7,495	27	6
Street lighting	114371	412	93
Total kWh	**1,152,221**	**4,148**	**933**

Assumptions and limitations of the data for electricity consumption included:

- Assumed accuracy of meter readings carried out by energy retailer.
- Electricity usage was not available discretely within the 2014 calendar year therefore the four billing quarters that fell within the 2014 year the most were used.
- DCCEE 2014 energy and emission content factors were used and therefore assumed to be accurate.
- The SRRC purchases "Green Energy" for the main Council Chambers an offices located in Beaudesert however as CO_2 emissions factor from the specific energy retailer was unavailable, the standard CO_2 emissions factor detailed in the DCCEE 2014 was adopted.
- Human error in the formulation, calculation and presentation of results.

4.2.3. Scope 3 Emissions - Full Fuel Cycles

Energy sources such as diesel, petrol and electricity used by the SRRC have associated indirect emissions which result from the exploration, processing and transport of these fuels to their end use.

A total of 821 kL of diesel, 361 kL of petrol and 1,152,221 kWh of electricity were consumed by the SRRC in 2014 resulting in a total of 383 t CO2-e. Table 22 and

Figure 19 details the individually calculated t CO_2-e/year as a result of this consumption.

Table 22: Scope 3 emissions associated with the full fuel cycles of diesel, petrol and electricity

Fuel Type	t CO2-e in 2014
Diesel	168
Petrol	65
Electricity	150
Total t CO2-e	**368**

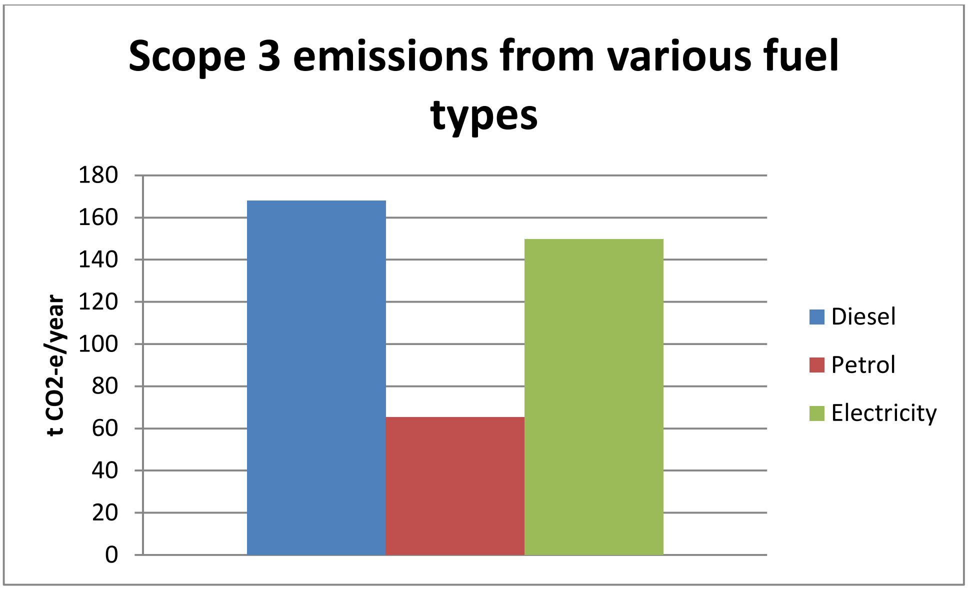

Figure 19: Scope 3 emissions associated with the full fuel cycles of diesel, petrol and electricity

Assumptions and limitations of the data for electricity consumption included:

- These calculations utilise the quantity of fuel consumption determined in Scope 2 emissions and therefore the assumptions and limitations with respects to data collection apply equally in these calculations.
- DCCEE 2014 energy and emission content factors were used and therefore assumed to be accurate.
- Human error in the formulation, calculation and presentation of results.

4.3. Summary of Results

A summary of emissions and energy consumption for the period of 01 January 2014 to 31 December 2014 for all sources associated with SRRC is provided in Table 23. A breakdown of Scope 1 and 2 emission sources is provided in Figure 20.

Total Scope 1 and 2 GHG emissions were 28,814 tonnes of CO_2-e. Scope 1 methane emissions from the Bromelton Waste Transfer Facility were the largest contributor comprising 86% of total Scope 1 and 2 emissions. Scope 1 emissions from fuel usage for stationary energy and transport purposes totalled 3,068 t CO_2-e and comprised 11% of total Scope 1 and 2 emissions. Scope 2 electricity emissions were 933 t CO_2-e equating to 4% of total Scope 1 and 2 emissions.

Scope 3 emissions included in the inventory to account for the full fuel cycle of petrol, diesel and electricity production were determined to be 383 t CO_2-e.

Table 23: GHG emissions inventory summary of results 01 January 2014 to 31 December 2014

Category	Activity	CO_2 Emissions	CH_4 Emissions	N_2O Emissions	Total Emissions
		tonnes CO_2-e/year			
SCOPE 1					
Fuel Combustion	Stationary energy diesel	783	1	2	786
	Stationary energy petrol	37	0	0	37
	Transport diesel	1410	4	10	1424
	Transport petrol	787	7	27	821
Fugitive Emissions	Landfill gas releases		24813		24813
SCOPE 2					
Energy Consumption	Electricity consumption	933			933
SCOPE 3					
Energy Consumption	Full fuel cycle diesel	168			168
	Full fuel cycle petrol	65			65
	Full fuel cycle electricity	150			150
Total Scope 1 Emissions		3017	24825	39	27881
Total Scope 2 Emissions		841	0	0	933
Total Scope 3 Emissions		368	0	0	383
Overall Total		**4333**	**24825**	**39**	**29197**

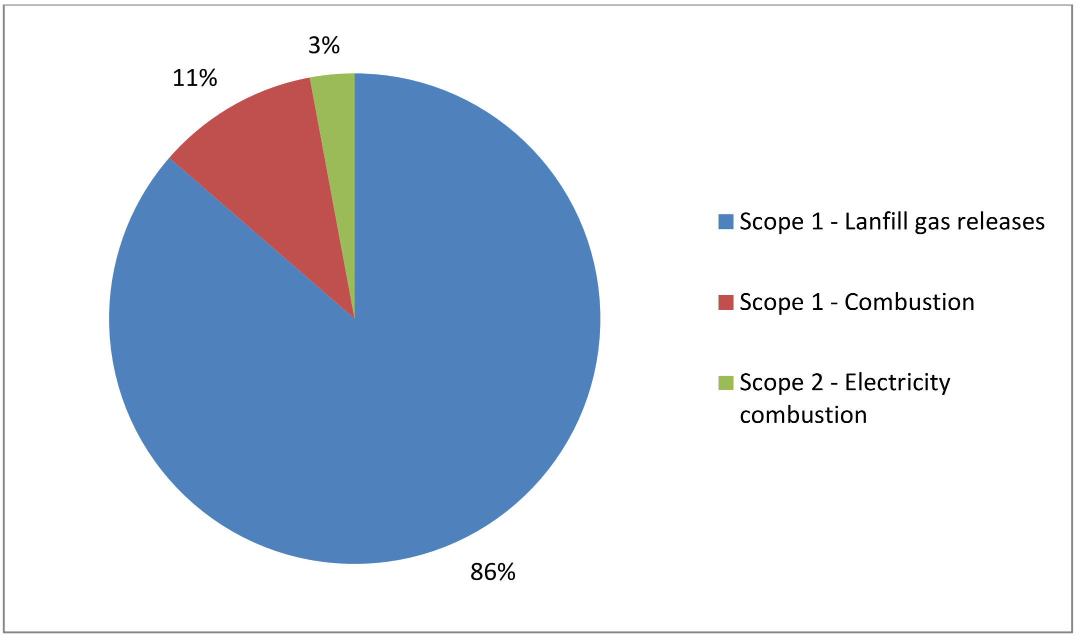

Figure 20: Source apportionment - Scope 1 and 2 emissions 01 January 2014 to 31 December 2014

4.4. Data Verification and Validation

Where possible, it is important to verify the data and processes used to undertake the energy and carbon audit of the SRRC. In order to verify the data as best as possible, assumptions and limitations are detailed were applicable while the processes used were supported and referenced back to reputable sources. By doing so, the intent is to reduce the potential number of errors in the audit.

As discussed in Section 2.11, the SRRC is part of the Cities for Climate Protection, however reporting of GHG emissions or a base line assessment from Council was not available at the time of this report.

With the audit now being completed, the next recommended step would be the undertaking of a peer review by a third party, preferably by a consultant or research body experienced in energy and carbon audits. By undertaking this review; data, processes and results can be verified and validated to improve the assessments accuracy. Due to time and monetary constraints and the lack of independent reporting available on SRRC's GHG emissions, such a process was not achievable.

CHAPTER 5: RECOMMENDATIONS

5.1. Overview

With the completion of the Carbon and Energy Audit of SRRC, the next step is to research and devise effective strategies to assist SRRC in reducing the GHG emissions. As the SRRC has made a commitment to participate in the ICLEI Cities for Climate Protection Program (CCP), the approach taken under the CCP program will be adopted.

The CCP initiative consists of five milestones which are designed to assist a council in reducing its contribution to global warming. The five milestones are:

Milestone 1: Conduct a Greenhouse Gas Emissions Analysis: Baseline Inventory and Forecast
Milestone 2: Establish a Reduction Target
Milestone 3: Develop a Climate Action Plan
Milestone 4: Implement the Climate Action Plan
Milestone 5: Monitor Progress and Report Results

SRRC are currently in the process of completing Milestone 1 and are yet to publically announce the establishment of a GHG reduction target. For the purpose of developing reduction recommendations, strategies detailed by the CCP will be reviewed in detail in order determine the suitability for these to be rolled out across the SCCR as they have a proven track record. A report published by ICLEI Global in 2006 estimated the annual global emission reduction under the CCP program equated to 60 million tonnes of CO_2-e (ICLEI, 2006). Reduction strategies from various other sources will also be reviewed for their suitability.

5.2. Establishment of GHG Emissions Reduction Target

SRRC is yet to publically announce a GHG emissions reduction target. Australia's current target is to reduce emissions to 26-28% on 2005 levels by 2030 (DEE, 2015). Unfortunately data of SRRC's GHG emissions in 2005 is unavailable; however to bring the SRRC emissions reductions to be somewhat in line with the national interest, it is proposed to adopt a GHG emissions reduction target of 20% based upon 2014 (assessed) levels.

A 20% reduction on 2014 levels equates to a total reduction of 5,925 tonnes of CO_2-e or 23,272 tonnes annually of produced CO_2-e. The strategies implemented to reduce GHG emissions must also consider the impact of the population growth expected within the region and the increased pressure this will have on the organisation's GHG emission levels.

By 2031, it is anticipated the medium projected population for the Scenic Rim Regional Council will be 80,364 (OESR, 2012) which equates to approximately a 58.6% increase in population by 2030. Should no reduction plan be put in place and assuming a linear relationship between population growth and Council emissions, it is estimated a total of 46,302 tonnes of CO_2-e emissions will be produced by 2031 therefore requiring a reduction of approximately 23,030 tonnes. See Figure 21 for details on estimated CO_2-e reductions.

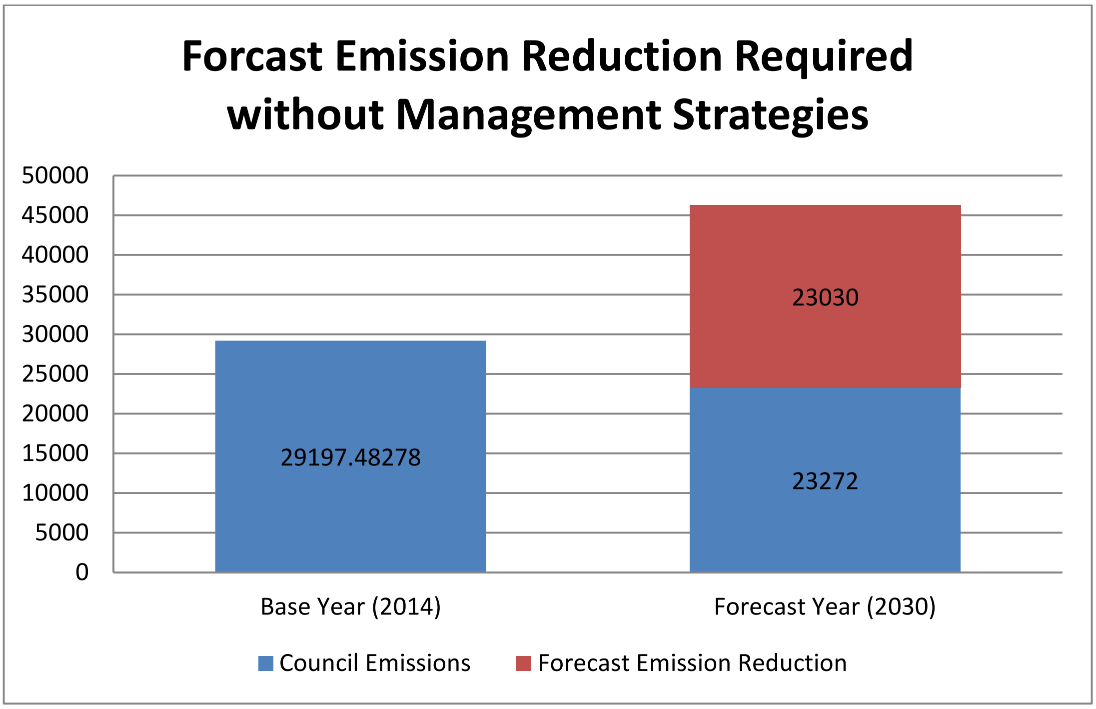

Figure 21: Forecast emissions and emission reductions require without management strategies to meet 20% reduction goal

With 15 years to deliver this considerable level of reduction, a combination of short, medium and long term strategies are required to be put in place.

5.3. Overarching GHG Emission Reduction Strategy

An overarching GHG emissions reduction strategy must first be established to determine how the reduction target will be met. By first determining the overall reduction strategy, this will assist in developing the individual initiatives to reduce the GHG emissions output by SRRC.

Due to the 14 year time frame to achieve the target, a combination of short, medium and long term strategies can be devised and implemented which will provide ongoing benefits.

The development of GHG emission reduction strategies are further broken down into four subcategories based on the strategies priority, being:

- **Priority 1: Directly avoid GHG emission production** - Directly avoiding the production of GHG emissions is the most effective measure and is achieved by increasing efficiency and/or avoiding energy consumption. Basic examples include closing down unused facilities or turning off lights when not in use.

- **Priority 2: Improve energy efficiency** - When avoiding GHG emissions is not an option or has been implemented as best as possible, the next step is to look to improve the energy efficiency of the consumer. Examples of improving energy efficiency include switching from candescent lighting to LED and review of Council fleet to ensure efficient vehicles are purchased.

- **Priority 3: Seek alternative energy sources -** The third priority in the reduction of GHG emissions is to seek alternative energy sources that have lower emissions. For example, renewable electricity can be purchased from the retailer over conventional electricity from coal or gas power plants.

- **Priority 4: Offset residual emissions** - Residual emissions that require mitigation in order to achieve the GHG reduction target can be achieved through offsetting these emissions. This is typically the last option as it tends to be the least economically viable. Examples include tree planting schemes and purchasing carbon offsets.

While developing GHG emission reduction strategies, the economic impact associated with the solutions must also be considered as the SRRC budget is finite.

Using the data collected in the carbon audit, the key areas across the SRRC's organisation boundaries which reduction strategies will be targeted are:

- Transport energy consumption (petrol and diesel)
- Electricity consumption
- Landfill emissions

The scope of the recommendations will be limited to strategies with proven effectiveness, primarily those adopted by other Councils under the ICLEI. This will ensure all strategies implemented by SRRC have a positive impact. Research into the exact quantitative effectiveness of each recommendation is beyond the scope of this assessment. A detailed feasibility study is also beyond the scope of this report; however cost implications will be broadly discussed. It is recommended SRRC undertakes their own detailed feasibility study prior to the implementation of recommendations requiring large capital expenditure.

5.4. Short Term GHG Emission Reduction Strategies

Short term measures are those that can be implemented providing immediate GHG reductions. These recommendations are anticipated to be implemented within 12 months of acceptance. The below strategies of short term measures are listed in accordance with the priority ranking system detailed in the above section.

5.4.1. Electricity Consumption

Electricity consumption accounts for 3.2% of SRRC's GHG emissions. While this is the second smallest contributor to GHG emissions, it is the area where strategies are the easiest to implement. Electricity is used across a wide range of facilities within the SRRC's organisational boundary. Some of the larger energy consumers include Councils depots, cultural centre, offices, parks and community pools.

Short term strategies that reduce GHG emissions include:

5.4.1.1. Priority 1 - Direct Avoidance

- Switching off lights and computers when not in use;
- Install automatic timers to switch off equipment such as imaging equipment, hot water systems and air conditioning systems outside of business hours;
- Adjust electronic device settings to energy efficient option;
- Review and where possible, adjust heating and cooling settings of air conditioning to reduce work load.

The above four recommendations can be implemented quickly and with little to no capital expenditure. Implementing some of these changes such as turning off lights and computers when not in use will require staff behavioural changes however will provide ongoing benefits.

5.4.1.2. Priority 2 - Improve Energy Efficiency

The first recommendation is to implement an auditing system assessing all areas of Council identified under this energy and carbon audit report. It is recommended the commissioning of a detailed energy audit to track effectiveness of existing reduction strategies, monitor the progress of strategies in the processes of being rolled out and those scheduled for the medium and long term. The audit should also seek to identify savings, success and failures and identify new opportunities to reduce costs and or emissions. The ICLEI has numerous resources available to Councils including audit guidelines and templates for Councils use. It is recommended SRRC obtain these guidelines to assist in implementing the proposed reduction strategies. The major financial obligation to implementing the audit system is the employment of a Council Officer to oversee and undertake the audit. In the early stages this would not be considered a full time role with the possibility of utilising existing resources to meet the need.

The second recommendation is the implementation of water saving shower heads to the community pool and staff facilities. Not only will water efficient shower heads reduce water consumption but also reduce the energy consumption required for heating. This strategy requires minimal capital and is recommended to be rolled out in the short term.

The third recommendation is the development and implementation of a community awareness campaign. This is envisaged to be an ongoing campaign which focuses on waste reduction and water consumption. By reducing water consumption, waste water production is therefore also reduced. This in turn reduces the operational costs and energy requirements of SRRC's pump stations and sewerage treatment plant - one of SRRC's largest electricity consumers; 22.76% of total demand. The community awareness campaign will also act as a platform to communicate and demonstrate to the community SRRC's commitment to reducing GHG emissions.

5.4.2. Transport Energy

No short term recommendations are provided to reduce transport energy consumptions. Reduction strategies to reduce transport energy requirements are detailed within the Medium term section.

5.4.3. Landfill Emissions

The implementation of the aforementioned ongoing community awareness campaign focused on waste reduction will provide ways to reduce and recycle waste; this in turn will reduce the tonnage of waste received at the SRRC waste transfer facility and therefore GHG emissions. This strategy will require behavioural change within the community which may take considerable time, even with effective campaigning, therefore it is recommended this strategy be developed and implemented within 12 months.

5.5. Medium Term GHG Emission Reduction Strategies

Medium term measures are those that can be implemented providing GHG emission reductions within a one to five year time frame upon acceptance. These recommendations typically require larger capital expenditure compared to the short term measures however tend to provide greater emission reduction potential. These medium term recommendations also generally require greater planning before they can come into effect or involve the phasing out of existing equipment or services. The below list of medium term measures are also listed in accordance with the priority ranking system.

5.5.1. Electricity Consumption

5.5.1.1. Priority 2 - Improve Energy Efficiency

It is recommended building equipment across the SRRC is phased out and replaced with new and much more efficient technology. Examples of energy efficient technology applicable to the SRRC organisation include:

- Replace existing incandescent and fluorescent lighting with equivalent LED lighting. Not only does LED lighting use approximately 75% less energy than incandescent lighting but also lasts 25 times longer (US Dept. Energy, 2016). The combination of lower power consumption and increased life span makes replacing existing lighting economically viable. It is recommended that over the next 1 to 2 years, all existing lighting is replaced with energy efficient LED lighting.
- Replace existing computers and peripherals such as monitors with more energy efficient models.
- Review and replacement of the old existing heating and cooling systems with more efficient and highly insulated ducted systems.

The replacement of technology such as computers and heating/cooling system can be quite expensive, therefore to mitigate increases in expenditure, it is recommended new energy efficient equipment is purchased when the older existing equipment is scheduled or requires replacement.

With Council heavily relying on technology for all facets of its organisation, numerous large servers drawing significant amounts of power are in place which has required specialised cooling to be installed. Through the uprising of cloud based servers, new opportunities have emerged to consolidate and reduce the number of servers required. A case study published by the CCP in 2008 found a Western Australian Council consolidated its servers by 85%, significantly reducing energy consumption (CCP, 2008). With rapidly increasing availability to technology in this space, it is foreseeable that similar, if not better results can be achieved by the SRRC. Due to the significant amount of planning and restructuring required to change over servers with minimal interruptions, it is recommended this strategy be implemented over the next two to five years.

The installation of pool blankets is another relatively low cost solution to decrease energy requirements. Pool covers reduce evaporation and heat loss to heated pools with the added benefit of reducing humidity in indoor pools, therefore requiring less ventilation. Covering a pool when it is not in use is considered the single most effective way of reducing heating costs, with savings of 50 to 70% (U.S. Dept. Energy, 2016). With the community swimming pool being one of the larger consumers of energy under the SRRC organisational control it is recommended this strategy be implemented in the next one to two years.

Street lighting is another area where energy efficiency can be improved however the way in which this asset is managed is somewhat different. The asset is owned and controlled by the distribution company (Energex); however energy bills are paid by SRRC. It is recommended an agreement with the distributor is negotiated to transition to more energy efficient lighting solutions such as LED lighting, innovative automatic timing and in built solar panels.

5.5.1.2. Priority 3 - Seek alternative Energy Sources

The installation of a large solar photovoltaic system (PV system) on building rooftops is another viable option. With the ever improving effectiveness and increasing performance of solar panels, a recent study found the net economic benefit over an average 15 year lifespan for a 3 kW solar PV system was approximately $2,000 in net present value (Wood et al, 2015). By installing a large array of PV systems across Council buildings accompanied by the ever increasing energy costs, the economy of scale and benefit of installing such a system also increases. It is recommended over the next one to five years, PV systems be rolled out across all Council facilities and continue into the future.

5.5.2. Transport Energy

Transport energy consumption relies on two fuel sources, being petrol and diesel, accounting for approximately 8% of SRRC's GHG emissions, almost 2.5 times more emissions than that resulting from electricity consumption. Transport energy is the second largest contributor to GHG emissions however fewer options to reduce emissions are available when compared to electricity consumption and they tend to be more costly to implement.

5.5.2.1. Priority 2 - Improve Energy Efficiency

The key medium term strategy to reduce GHG emissions is through the upgrading of the vehicle fleet. Improving efficiencies across the Council vehicle fleet will not only reduce emissions but also ease the pressure of rising fuel costs. Diesel vehicles are considered to be more fuel efficient than petrol vehicles (Mikler, 2009) and therefore the reaming petrol powered vehicles should be transitioned to diesel as part of the planned leasing strategy. Energy efficiencies can be further improved through the purchasing of small engine and hybrid vehicles. Opportunities also exist with the rapidly emerging electric vehicle technology and should be further assessed for the suitability of the Council fleet transitioning to electric vehicles.

5.5.3. Landfill Emissions

No medium term recommendations are provided to reduce landfill emissions. Reduction strategies to reduce landfill emissions are further detailed within the long term section.

5.6. Long Term GHG Emission Reduction Strategies

Long term measures are those that can be implemented providing GHG emission reductions within a five to ten year time frame upon acceptance. These recommendations typically require larger capital expenditure and detailed planning compared to short and medium term measures. While these strategies may take longer to implement, they do provide greater emission reduction potential. The below list of long term measures are also listed in accordance with the priority ranking system.

5.6.1. Electricity Consumption

5.6.1.1. Priority 2 - Improve Energy Efficiency

The energy efficiency of SRRC buildings can be improved through the installation of insulation in rooves and cavities. Installing insulation will significantly reduce heating and cooling energy requirements and therefore reduce GHG emissions and energy costs. There are a vast variety of insulation products on the market, ranging from reflective foil to glass wool and expanded polystyrene for use in framed walls, all of which provide varying degrees of effectiveness. Several buildings currently contain insulation however the full extent and material specification is unknown. It is recommended a consultant is engaged to fully assess any current insulation and provide a further detailed strategy with costing to improve building insulation.

Heat reflective paint or heat efficient paint is another option available to improve building efficiency by reflecting heat. Repainting buildings including rooves can be expensive. It is recommended energy efficient paints be adopted as part of the maintenance program of all buildings so that as re-coats or full re-painting is required, heat reflective paint can be applied.

5.6.2. Transport Energy

No specific long term measures are recommended to reduce GHG emissions resulting from transport energy consumption.

5.6.3. Landfill Emissions

5.6.3.1. Priority 3 - Seek alternative Energy Sources

Landfill gas released was calculated to be the largest contributor to the SRRC's GHG emissions representing 85% of total output. Once efforts have been made to minimise the total amount of waste entering the Bromelton facility, it is recommended the residual waste be processed with methane (CH_4) emissions being captured and flared. Methane also has a much greater impact on global warming, having an estimated GWP of 21 times greater than CO_2 (EPA, 2016). When methane is burned, the following reaction $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ (methane + oxygen → carbon dioxide and water) occurs. While CO_2 is still produced, the global warming potential is significantly less. Economical benefits can also be achieved through the capturing and burning of methane, such as electricity generation for onsite use or to sell back into the grid and direct gas to by nearby industrial boilers. While capturing methane for electricity production is not widely adopted there are still a number of councils across Australia utilising this technology including Hobart City Council, Hume City Council, Gladstone Regional Council and Tamworth Regional Council.

Gladstone Regional Council (GRC) has a population of 57,587 which is approximately 45% greater than the current SRRC population however 30% less than the projected SRRC by 2030. The GRC landfill gas abatement initiative was announced publically in 2008 with construction completed in 2014 at a cost of $1.9 million. With the system now operational, it now destroys 1140 tonnes of CH_4 annually, an equivalent of abating approximately 240,000 tonnes of CO_2 with plans to commence electricity production in the near future to further reduce GHG emissions produced by GRC (GRC, 2013).

It is recommended SRRC engage a suitably qualified consultant to assist with determining the best strategy to implement a methane capture and power generation project. Not only will this project significantly reduce SRRC's CO_2-e emissions it will also provide further offsets. Due to the planning and funding requirements in addition to construction time frames, it is recommended this initiative be implemented as a long term strategy i.e. five to ten years.

5.7. Community & Organisational Development

As detailed in the above section, there are a number of options available to directly reduce GHG emissions, improve energy efficiency and alternative energy sources which also reduce GHG emissions. There are also a number of indirect initiatives that can be implemented to assist in reducing GHG emissions of the SRRC organisational boundary and its commitment to the broader community to assist in GHG emission reduction. Recommended initiatives include:

- Continual development of local government strategies, policies and planning codes to support and encourage industries to reduce GHG emissions;
- Implementation of funding structures to support GHG emission reduction initiatives;
- Planning and construction of a regional bicycle network to encourage less vehicle travel;
- Improve access to public transport to also encourage less personal vehicle travel;
- Roll out of awareness programs to schools and community detailing ways in which energy consumption and waste generation can be minimised;
- Business grants to encourage investment into "green" solutions through changes to planning policy which reduces "red tape" and infrastructure charges; and
- Waste reduction through subsidising compost bins.

5.8. Offsetting Residual Emissions

Offsetting residual emissions being Priority 4 tends to be the least desired way to reduce GHG emissions due to the minimal benefit and typically high associate costs.

Biosequestration is the process of reducing GHG emissions through planting of trees which consume and reduce the amount of carbon dioxide in the atmosphere acting as a "sink". Not only does this reduce GHG emissions, it also provides additional environmental benefits such enhancing regional ecosystem values and erosion reduction; however, the downside to this strategy is the absorption rate is typically low, a temporary solution and difficult to measure. The average native Australian tree if allowed to fully develop will sequence approximately 322 kg of CO_2 when allowed to establish a trunk of 1 m circumference (O'Brien, 2008).

SRRC currently commits to giving away 5,000 trees per annum to residential taxpayers providing an estimated offset of 1,610 tonnes of CO_2 over 20 years or approximately a 0.25% offset to current GHG emission levels each year. In order to achieve a notable impact, vast areas of tree planting is required. It is recommended the current initiative continue however more development in this area is unlikely to provide significant reductions.

Following the implementation of all the aforementioned recommendations, should the GHG emission levels remain above the target of 23,272 CO2-e tonnes per year, it is recommended renewable energy is purchased from the grid which will directly reduce the total GHG emissions generated by electricity consumption. Should this strategy still fall short of the reduction target, the final recommendation is to purchase carbon credits.

The purchasing of carbon offset credits in order to meet the target does not directly lead to any long-term reductions of the actual GHG emission production of the SRRC and is an expensive solution. Carbon offset prices have varied significantly over the past years with rates of \$22/t CO_2-e for Australian Carbon Credit Units (ACCUs) in July 2014 and most recently \$10.23 /t CO_2-e of ACCUs as of April 2016 Australian Government Clean Energy Regulator Emissions Reduction Fund auction (CER, 2016). It is important to note carbon credits must be purchased from reputable organisations with accreditations such as those under the Australian Government Greenhouse Friendly initiatives. Depending on the cost of offsetting, this can encourage investment in other reduction methods which may prove more cost effective and/or lead to expansion of existing initiatives.

5.9. Associated Financial Costs in the Reduction of GHG Emissions

The above strategies briefly address the financial costs associated with the various GHG emission reduction strategies however a much more useful tool being the Marginal Abatement Cost Curve (MACC) is the preferred option. The MACC assists in determining the right GHG emission reduction strategies to implement by providing a simple graph which identifies the strategies most effective per unit of CO_2-e abated per \$ and which strategies provide the greatest abatement potential (WALGA, 2014). The MACC assessment considers the project lifetime, full project costs, project savings and emissions abated. The Western Australia Local Government Association defines the marginal abatement costs as:

$$\text{Marginal Abatement Cost } (\$/t\ CO_2e) = \frac{-\ \text{Net Present Value } (\$)}{\text{Total GHG emissions abated over the life of the project}}$$

Where,

$$\text{Net Present Value} = \frac{\text{Total project costs} - \text{Total project savings}}{(1 + \text{discount rate})^{\text{project lifetime}}}$$

(WALGA, 2014).

The formulation of a detailed abatement cost curve is beyond the scope of this report. It is recommended Council undertake their own assessment or alternatively engage a suitable qualified consultant to prepare the assessment.

McKinsey & Company is a global consulting firm working for businesses, government, non-governmental organisation and not for profit organisations to help them with their improvement and performance goals; establishment and analysis of GHG abatement cost curves forms part of their skill set (McKinsey & Co, 2016). In 2008, McKinsey & Company released the Australian Cost Curve for Greenhouse Gas Reduction. A part of this report included a marginal abatement cost curve relating to measures applicable to reducing an organisations building emissions, see below Figure 22.

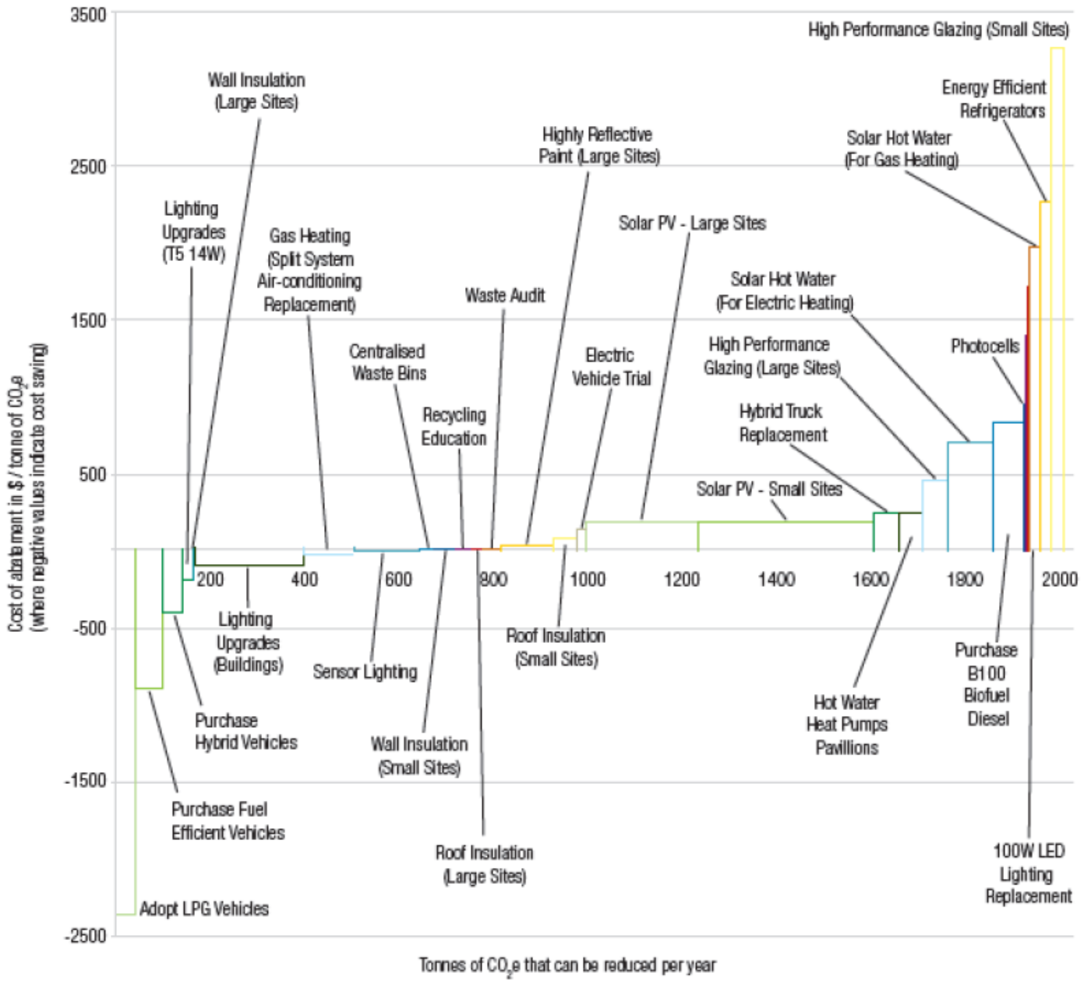

Figure 22: Marginal GHG Abatement Cost Curve for GHG emission reduction (McKinsey & Co, 2008)

For the purpose of this assessment, the MACC derived by McKinsey will be adopted to aid in assessing and prioritising the proposed abatement measures.

5.10. Emission Reduction Strategy Matrix

To summarise the number of GHG emission abatement strategies proposed, the following matrix has been developed; see Table 24.

Table 24: Emission reduction strategy matrix

Reduction Strategy	Abatement Type	Time Frame	Cost	Abatement Potential
Transport Energy Consumption				
Upgrading of vehicle fleet to diesel	I	M	$-$$	L
Purchasing of small engine and hybrid vehicles	I	M	$-$$	L-M
Purchasing of electric vehicles	I	L	$-$$	M
Electricity Consumption				
Switch off lighting when not in use through installation of sensors	D	S	$	M
Switch off computers when not in use including screens	D	S	-	M
Install automatic timers to switch off equipment such as imaging equipment, hot water systems and air conditioning systems outside of business hours	D	S	$	M
Adjust electronic device settings to energy efficient option	D	S	-	L
Review and where possible, adjust heating and cooling settings of air conditioning settings to reduce work load	D	S	$	L
Installation of water saving shower heads to community pool and staff facilities	I	S	$	M
Phase out and replace existing equipment with new and much more efficient technology e.g. LED lighting, computer peripherals and the heating/cooling systems	I	M	$	L-M
Server consolidation	I	M	$$	M
Installation of pool blankets	I	M	$	M
Improve energy efficiency of street lighting	I	M	$$	M
Installation of a large solar photovoltaic system of building rooftops	A	M	$$$	H
Install roof insulation	I	L	$-$$	L-M
Install wall insulation	I	L	$$	L-M
Apply heat reflective paint to building exterior	I	L	$$	M
Purchase of "green" energy	A	L	$-$$$	H
Landfill Emissions				

Reduction Strategy	Abatement Type	Time Frame	Cost	Abatement Potential
Capture GHG emissions from landfill and either flare, produce electricity or on-sell gas.	A	L	$$$	L
Note: Some reduction strategies listed below will also reduce landfill emissions	-	-	-	-
Other				
Implementation of auditing system to assess and monitor the effectiveness of existing reduction strategies and to identify potential improvements	-	S	$$	L-H
Development and implementation of a community awareness campaign which focuses on waste reduction and water consumption.	-	S	$$	L-H
Continual development of local government strategies, policies and planning codes to support and encourage industries to reduce GHG emissions	-	M-L	$	L-H
Implementation of funding structures to support GHG emission reduction initiatives	-	M-L	$-$$$	L-H
Planning and construction of a regional bicycle network to encourage less vehicle travel	-	M-L	$$	L-M
Improve access to public transport	-	M-L	$$-$$$	L-M
Roll out of awareness programs to schools and community detailing ways in which energy consumption and waste generation can be minimised	-	M-L	$$	L-H
Business grants to encourage investment into "green" industries and reduce "red tape" and infrastructure charges around such initiatives	-	M-L	$$-$$$	L-H
Biosequestration through planting of trees	O	S-L	$$	L
Purchase of carbon offset credits in order to meet reduction target	O	L	$$$	H

Reduction Strategy Matrix Legend

Abatement Type
D = Direct Avoidance
I = Improve Energy Efficiency
A = Seek alternative Energy Sources
O = Offset residual emissions

Time Frames
S = Short Term (within 12 months)
M = Medium Term (1 to 5 years)
L = Long Term (5 to 10 years)

Cost
$ = low cost
$$ = medium cost
$$$ = large cost

Abatement Potential (Tonnes of CO_2e that can be reduced per year)
L = Low
M = Medium
H = High

5.11. Summary

Table 24 above sets out the various strategies available to reduce SRRC's energy consumption and GHG emissions. Ideally, direct avoidance is the preferred approach however there are little solutions which provide significant GHG abatement while being reasonably financially feasible. Improving the energy efficiency within the SRRC's operational boundary is likely to provide the greatest GHG abatement with manageable financial costs. Seeking alternative energy sources also provides considerable GHG emission reductions however tend to come at a higher price. The last option to consider is offsetting residual emissions. Offsetting is an expensive means of reaching the emission reduction target and provides no real benefit to the community.

When identifying the right strategies to implement the abatement potential must be considered. Some low cost strategies provide very little reduction in GHG emissions, where as some expensive initiatives provide large GHG emission reductions.

While it is important to consider the way in which emissions are being addressed and the abatement potential of the solutions, ultimately a financial cost is almost always associated with the reduction of GHG emissions and must be taken into consideration. As the SRRC has finite funding it is crucial to ensure money invested into reducing GHG emissions provides the greatest return possible.

It is strongly recommended SRRC engages a suitably qualified consultant to develop a MACC with solutions which strive to meet the GHG emission reduction target. It is also important that ongoing and routine auditing is undertaken. The implementation of an auditing system should assess all areas of Council identified under this energy and carbon audit report. The audit will track the effectiveness of existing reduction strategies, monitor the progress of strategies in the process of being rolled out and those scheduled for the medium and long term. The audit should also seek to identify savings, success and failures and identify new opportunities to reduce costs and or emissions in order to provide continual improvement.

Ultimately SRRC's goal with regards to GHG emissions should be sustainability. It is important that a well thought out plan is developed and executed that is suitable with respects to SRRC's financial funding while considering their environmental obligation including the GHG emissions reduction target.

CHAPTER 6: DISCUSSION

6.1. Research Overview

In recent years, climate change has become a widely accepted reality by the scientific community, with the consensus being over 97% (Cook J, et al, 2013). Countries around the world, including Australia are beginning to take responsibility to mitigate the impacts of global warming through reduction their GHG emission levels. Local Government also has a role to play through reducing emissions at an organisation and local community level.

A robust and comprehensive Energy & Carbon Audit of the SRRC has been prepared through extensive research, data collection and using best practice methods for the assessment and calculation of CO_2-e emissions. Data was analysed which allowed a number of appropriate GHG emission abatement strategies to be detailed for implementation or further development. Chapter 6 will review the above process and outcomes, evaluate the assessment methodology, discuss the cost and benefits associated with GHG emission reduction and table ways in which the process can be bettered to improve data quality and the accuracy of the audit.

6.2. SRRC GHG Footprint

In order to undertake and assessment of the SRRC GHG emissions, the operational boundary was broken down into three scopes:

- Scope 1 emissions represented direct GHG emissions from sources that are owned or controlled by SRRC. Examples include petrol and diesel consumption and fugitive emissions such as methane gas release from the Bromelton Waste Transfer Facility.
- Scope 2 emissions result from energy product use by the SRRC and are considered indirect e.g. the GHG emissions from generation of purchased electricity.

- Scope 3 emissions represented other indirect GHG emissions resulting from energy consumption by the SRRC. Scope 3 emissions include emissions associated with the production, extraction and transport of energy sources such as petrol, diesel and electricity.

Scope 1 emissions (fuel consumption and waste) accounted for 95.5% (27881 tonnes CO_2-e) of all GHG emissions however, fugitive emissions from the landfill facility accounted for 89.0% (24813 tonnes CO_2-e) of all Scope 1 emissions. Scope 2 emissions (electricity consumption) accounted for 3.2% (933 tonnes CO_2-e) of all GHG emission while Scope 3 emissions (full fuel cycle) only accounted for 1.3% (368 tonnes CO_2-e) of all emissions. Overall, the SRRC GHG emissions footprint equated to 29197 tonnes CO_2-e.

A study of 12 Queensland local Councils in 2013 found emissions resulting from landfill accounted for an average of 57% of the Councils GHG emissions (Zeppel, 2013). Fugitive emissions resulting from landfill gas releases accounts for 85.0% of the SRRC GHG emissions which is substantially higher. The study also found that the average emissions from electricity energy were 37% compared to SRRC's significantly lower 2.8%. This comparable low ratio of energy consumption is likely due to SRRC being very much a rural Council with minimal facilities compared too much larger regional towns and cities. The SRRC carbon dioxide emissions equate to 0.77 tonnes CO_2-e per capita based upon 2011 population. Minimal data was available from similar sized rural Councils in order to compare these results. In contrast, the Mornington Peninsular Shire Council (MPSC) located south east of Melbourne was recently studied and was found their carbon footprint equated to 0.17 tonnes CO_2-e per capita (Baxter, 2014). The MPSC has significant lower per capita emissions however a much more urbanised area with a population density is 22.7 times greater than the SRRC. As Council services are shared amongst a greater number of people, the emissions per capita are also much less.

The study identified that particular sources of emissions produce much greater quantities of CO_2-e than others. The Bromelton Waste Transfer Facility was identified to be the single greatest source of GHG emissions accounting for 85.0% of all SRRC emissions. Should the SRRC commit to reducing their carbon footprint, implementing strategies to reduce emissions associated with landfill such as those recommended in Section 5.10 Table 24 will be critical.

6.3. Evaluation of Assessment Methodology

To date, SRRC do not have in place any specific means to collect data relating to GHG emissions, calculate their carbon footprint or review their footprint in order to develop appropriate reduction strategies. In 2013, SRRC made a commitment to reduce GHG emissions through joining the CCP program. Currently SRRC are in the process of conducting a greenhouse gas emissions analysis consisting of a baseline inventory and forecast however at the time of preparing this report no further information was available. Commitment to the CCP program was announced in 2012 however federal funding for the CCP program has since been withdrawn leaving uncertainty of the way in which SRRC will manage their GHG emissions.

With the uncertainty surrounding the future of SRRC's involvement in the CCP, an alternative approach can be taken using the National Greenhouse Reporting (NGER) Act (2007) which incorporates the NGER Determination 2008 in association with the NGER Technical Guidelines 2014 as per this carbon footprint audit. The key objective of the NGER is to introduce a single national reporting framework for the reporting and dissemination of information related to greenhouse gas emissions, greenhouse gas projects, energy consumption and the energy production of corporations (NGER Act (2007), Sect 3). The NGER provides a robust and detailed tool for measuring and reporting CO_2-e which is reasonably user friendly and its technical guidelines are regularly updated to ensure CO_2-e are accurately calculated.

The first step in the NGER approach is to determine the organisational boundary which defines all facilities and entities operated and controlled by the SRRC. Once the organisation boundary is determined the operational boundary can be defined. The operation boundary was broken down into three scopes to capture all direct and indirect emissions for operations that fall within the established organisational boundary.

Data was then collected as per the requirements of each scope. The data collected was electricity consumption from assets within SRRC organisational boundary via energy retailer bills providing quarterly kWh usage per facility. Fuel consumption data for transport purposes was collected via a fuel card register which tracks usage. Fuel consumption for stationary purposes was obtained via delivery dockets which recorded volume delivered. The mass of waste received at the Bromelton Waste Transfer Facility was obtained from weigh bridge records.

A considered approach was taken when establishing the organisation and operational boundary to ensure a significant scope of GHG emissions sources were identified while ensuring readily available and reasonably accurate data was accessible. Areas excluded from the assessment included construction/repair works to Council infrastructure such as bridge repair/replacement and road works. While the fuel consumption of equipment owned and operated by Council was captured, the full fuel cycle of construction material was not considered nor was emissions generated by contractors engaged by Council. Due to the way in which Council currently record data, some adjustments were required; for example, electricity is billed quarterly by the retailer and billing periods did not always fall between January - December, therefore some assumptions and adjustments were required in order to provide the best representation of the assessed year. For each area of assessment under the three Scopes, assumptions and limitations were clearly set-out to provide accountability of the report and transparency to the end user.

An excel spreadsheet was developed based upon the formula outlined in the NGER whereby the consumption data and associated emission factors were entered. With the data logged in the excel spreadsheet, CO_2-e was calculated for each of the various sources. The set out of the spreadsheet allows for future users to simply update the consumption data and/or add additional facilities and scope.

By developing the carbon footprint analysis in accordance with the NGER, the methodology allows for compliance with the GHG Protocol, specifically The Corporate Standard ISO 14064-1 which consists of 3 parts.

Part 1: Conducting greenhouse gas emission inventories
Part 2: Quantification and reporting of emission reductions
Part 3: Verification of greenhouse gas emission statements

Validation and accuracy of the results significantly depends on the quality of data used. The data collection process was extensive and involved gathering data from various areas within Council as described above. Ultimately the output results are only as accurate as the data entered into the system. There are various software packages and add-ons available to streamline the data collection process in order to improve accuracy. Two commercially available tools that can be implemented include AusFleet Fuel which is a fleet management software package tracking fuel costs, consumption and emissions reporting and also included multiple validations for improved accuracy and data quality (AusFleet, 2016). Power Tracker is another system that can be retrofitted to Council buildings which provides real time monitoring of power usage and allows for services to be remotely shut down (Power Tracker, 2016).

As fugitive emissions associated with the waste transfer facility, it is important to ensure the data collected is accurate in order to prevent over/under reporting. It is recommended routine audits are undertaken to assess the composition of waste received in order to develop SRRC own waste mix ratio rather than relying of the Queensland average set out in the DCCEE. By implementing such systems the accuracy of the carbon footprint assessment will be improved.

6.4. Cost vs. Benefit of GHG Emission Reduction

Typically, reducing GHG emissions is perceived to be an expensive exercise however with increasing energy prices and decreasing cost for renewable energy or "green technology", there comes a point where the benefits outweigh the costs or, the "greener" alternative is in fact a more viable option. In real terms, Queensland has seen an increase in electricity prices of 107% over the past 10 years (Swoboda, 2013).

With all monetary and policy decisions made by Council, the cost and benefit of any change needs to be considered; one of the most common ways to undertake the assessment is via a cost vs. benefit analysis. By plotting the marginal abatement cost (MAC) and the marginal abatement benefit (MAB) the two curves will cross over providing the optimal point. Referring to Figure 23, as the current GHG emissions abatement increased so too does the cost associated with the reduction (Banks et al, 1991). Therefore expensive reduction strategies do not necessarily provide the greatest benefits; similarly, low cost strategies cannot be dismissed as having minimal abatement. The misalignment of a strategies cost vs. abatement potential highlights the need to undertake a thorough marginal abatement cost curve analysis as per Section 5.9.

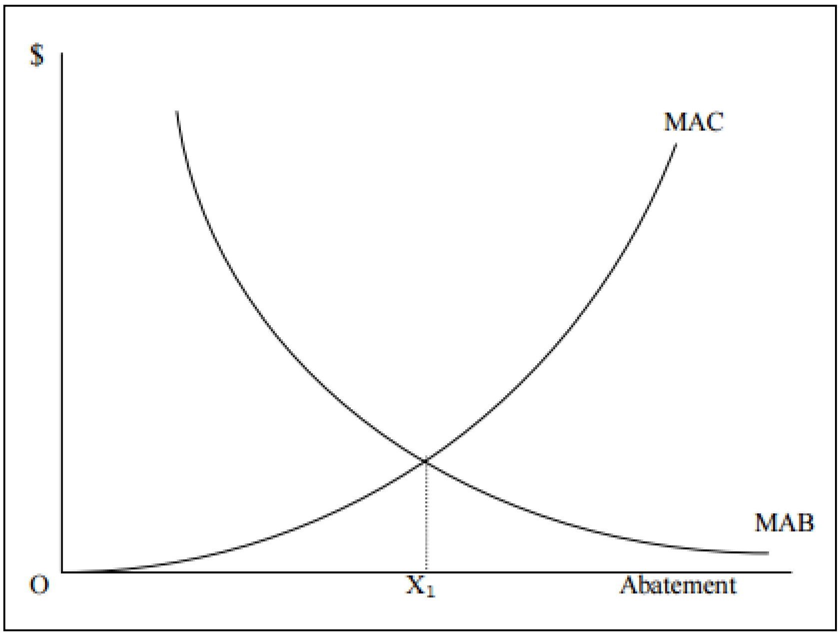

Figure 23: GHG Emission Abatement Cost vs. Benefit Curve (Banks et al, 1991)

Council also needs to consider the cost of not acting. Should no action be taken, Council will likely see ever increasing power expenses and greater expense should a carbon tax be reintroduced. Furthermore, SRRC has made a commitment to reduce its GHG emissions; therefore, not taking action will adversely impact community sentiment. It can also be argued Council has an ethical responsibility and a key role to play in assisting Australia to meet its GHG emission reduction target.

6.5. Further Development

Due to time constraints, there were some areas which may have been beneficial to cover however were excluded from the scope of this assessment. Further investigation into ways in which GHG emissions could be reduced was limited to proven strategies. With ever changing technology, it would be beneficial to investigate new and upcoming abatement strategies. A detailed feasibility study was also outside of the scope of the assessment. Before SRRC commit to any major initiatives or reform, it is recommended a comprehensive feasibility study is undertaken including the development of a marginal abatement cost curve analysis.

The SRRC organisation and operational boundary can also be expanded to include capital and maintenance works undertaken by Council such as transport infrastructure i.e. roads and bridges. Lastly, the assessment can be expanded to include the community such as housing energy consumption and the carbon footprint associated with new dwellings; likewise this can also be applied to local businesses and their carbon footprint.

Data quality can also be improved through the implementation of AusFleet and Power Tracker as per discussion in Section 6.3. Furthermore, investigation can be undertaken to gain a better understanding of the composition of waste received at the Bromelton Waste Transfer Facility. For the current assessment, the waste composition ratio set out in the NGER was assumed to be reflective of SRRC however due to its rural setting, the waste composition may differ. Depending upon the true waste composition the fugitive emissions may be significantly more or less. Given this landfill facility accounts for 85.0% of SRRC emissions, it is therefore important to ensure this data is accurately collected, calculated and presented.

The SRRC should also strive for continual improvement of their assessment strategy and emission reduction should they wish to achieve their target. Ongoing annual assessment and auditing will significantly aid in this continual improvement process. The implementation of an auditing system will track the effectiveness of existing reduction strategies, monitor the progress of strategies in the process of being rolled out and those scheduled for the medium and long term. The audit should also seek to identify savings, success and failures and identify new opportunities to reduce costs and or emissions in order to provide the best long term outcome possible.

6.6. The Big Picture

Australia is the 15th largest emitter of GHG emissions and the largest polluter per capita (The Climate Institute, 2011). Australia's current GHG emission reduction target is to achieve a 26-28% reduction on 2005 levels by 2030. It can be argued the SRRC also has a role to play in meeting the national target and a responsibility to act as a leader to the local community. Implementing the right combination of strategies and local government planning policies will greatly assist in encouraging both the community and local businesses to move towards a more sustainable direction and assisting Council in achieving their emission reduction target.

CHAPTER 7: CONCLUSION

While there is no longer a legal requirement for Queensland Councils to report GHG emissions following the abolishment of The Clean Energy Act (2011), there is a growing demand from the community to provide transparency of GHG emissions and for Councils to take initiative in reducing their carbon footprint. This research investigated the impacts of anthropogenic greenhouse gas emissions, undertook an assessment of the SRRC GHG emission footprint and proposed several strategies which would allow the SRRC to reduce their carbon footprint.

In recent years, anthropogenic climate change has become widely accepted as a reality by the scientific community. Chapter 2 explores anthropogenic climate change in detail with regards to the greenhouse effects, the impacts to Australia and the SRRC, a review of policies standards and guidelines associated with the reduction of GHG emissions and the benefits of undertaking a carbon footprint assessment. While Australia is only responsible for approximately 1.3% of all global GHG emissions, the per capita tonnes CO_2-e (28.1 tonnes/year) is the highest of all OECD counties. Impacts to Australia include increasing average temperatures, rising sea levels, increased ocean acidification, increases in severe weather events, changes to rainfall patters and reduced rainfall runoff. Australia recognises it has a responsibility to reducing global GHG emission levels and has recently re-committed its efforts to reduce its GHG emissions by 26-28% on 2005 levels by 2030. Local Government also has a growing role to play in the reduction GHG emissions in an effort to limit the impacts of global warming.

The Scenic Rim Regional Council is located approximately 60 km south of Brisbane and 40 km west of the Gold Coast in Queensland. The region is predominantly zoned as Rural Use and encumbers an area of 4248 sq km. The LGA is home to over 37,780 and is supported by businesses with the predominant sector being Agriculture, Forestry and Fishing (27.3%), followed by Construction (16.2%). In 2003, the SRRC made a commitment to reducing its GHG emission through jointing the CCP program however are still in the early stages of this process. The undertaking of an energy and carbon audit to develop a baseline inventory will not only help the SRRC achieve the first milestone of the CCP, but also assist in the development of strategies to reduce their GHG emissions.

The National Greenhouse Emissions Reporting (NGER) Act (2007) which incorporates the NGER Determination 2008 and the NGER Technical Guidelines 2014 is the most widely accepted methodology for determining an organisations carbon footprint as complies with ISO 14064-1. Chapter 3 reviewed the NGER in detail allowing the establishment of the organisation and operational boundary of the SRRC and identification of the various emission sources. By identifying the various emissions sources, data was then collected allowing for an energy and carbon footprint audit of the SRRC to be established. This audit determined the GHG emissions associated with fuel combustion for stationary and transport purposes, fugitive emissions from landfill, electricity usage and indirect emissions as a consequence of the activities.

Chapter 4 detailed the total fuel and electricity consumption and the waste received at the landfill transfer centre. This investigation found the SRRC overall GHG emission footprint equated to 29,090 tonnes of CO_2-e in the year 2014. Scope 1 emissions accounted for 95.5% (27881 tonnes CO_2-e) of all GHG emissions however, fugitive emissions from the landfill facility accounted for 89.0% (24813 tonnes CO_2-e) of all Scope 1 emissions or 85.0% of all SRRC emissions. Scope 2 emissions (electricity consumption) accounted for 3.2% (933 tonnes CO_2-e) of all GHG emission while Scope 3 emissions only accounted for 1.3% (368 tonnes CO_2-e) of all emissions. With the emissions baseline determined, an appropriate reduction target could be set, being a 20% reduction of 2014 levels by 2031.

In order to achieve the above target, mitigation strategies were researched, assessed and proposed. As outlined in Chapter 5, an emission abatement strategy matrix was also developed to clearly identify the various ways to reduce GHG emissions and their respective cost, implementation time frame and abatement type (i.e. direct, improve, alternative or offset) and their respective abatement potential. The cost and benefit associated with GHG emission was also discussed including the importance of developing a marginal abatement cost curve specifically for the SRRC. It is believed that should the SRRC takes appropriate steps to introduce the proposed strategies, it is feasibly the 20% reduction target could be achieved by 2031.

An evaluation of the assessment methodology was also carried out whereby data limitations were discussed and ways in which the accuracy of data could be improved were identified; such recommendations include the implementation of AusFleet and Power Tracker. Chapter 6 also explored the importance of assessing the cost vs. benefit of reducing GHG emissions. It was recommended a detailed marginal abatement cost curve analysis is to be undertaken in order to identify the best possible combination of reduction strategies which will yield the highest emission abatement for the least possible amount of money.

Through this research project, the full primary project specification was met, providing the SRRC with an energy and carbon footprint audit. Furthermore a useful tool was developed allowing the SRRC to undertake their own carbon footprint assessment into the future allowing ongoing auditing. This assessment tool is also intended for future use by other Councils looking to undertake a carbon footprint assessment. Similarly, the reduction strategies put forward can be also implemented by other Councils looking to reduce their GHG emissions however further assessment before doings so is recommended.

It is anticipated that should the SRRC follow through with introducing the proposed reduction strategies and recommendations coupled with ongoing auditing and continuous improvement, the reduction target can be met, setting a strong example of their commitment to the environment and the community while also potentially generating new business opportunities for the region.

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APPENDIX

Appendix A: Project Specification

University of Southern Queensland

FACULTY OF ENGINEERING AND SURVEYING

ENG 4111/4112 Research Project
PROJECT SPECIFICATION

STUDENT NAME: Jason Gauld

TOPIC: Energy and Carbon Audit of the Scenic Rim Regional Council

SUPERVISORS: Dr Guangnan Chen

SPONSORSHIP: Nil

PROJECT AIM: This project aims to assess the greenhouse gas emission footprint of the Scenic Rim Regional Council, review existing mitigation strategies and offset measures implemented and to provide further recommendations as to how the current initiatives can be made more efficient and/or new initiatives to be implemented.

PROGRAMME:

1. Literature review of current greenhouse gas emission legislation, mitigation strategies and their effectiveness
2. Determine the level of detail required to conduct the audit based on the information available.
3. Obtain data and assess available data
4. Analyse data and determine existing greenhouse gas emissions
5. Provide practical recommendations to reduce carbon footprint

As time permits,

6. Analyse and assess historical data
7. Compare greenhouse gas emission growth to Council's region population growth
8. Discuss potential future impacts and provide further recommendations based on these findings

AGREED

__________ (Student) __________, __________ (Supervisors)

__/__/__ 11/10/16 __/__/__

Appendix B: NGER Waste Tool

Australian Government
Clean Energy Regulator

CLEAN ENERGY REGULATOR

Facility name (optional)	

Before using this calculator we recommend you read "Solid Waste Disposal on Land User Guide" for important information on:
- the landfill facility activities that must be reported (energy/emissions)
- how to use this calculator

Techniques for calculating opening stock of degradable organic carbon for the first reporting period in accordance with S5.13 of the Determination.   Please review and select the technique used.
1) The annual amount of solid waste disposed of in landfill for all years prior to the first reporting period was evidenced by invoices; or
2) The annual amount of solid waste disposed of in landfill for all years prior to the first reporting period was measured according to State or Territory legislation applying to the landfill; or
3) The annual amount of solid waste disposed of in landfill for all years prior to the first reporting period was directly measured using equipment calibrated to a measurement requirement; or
4) The annual amount of solid waste disposed of in landfill for all years prior to the first reporting period was estimated in accordance with industry estimation practices in line with the NGER principles of a) transparency, b) comparability, c) accuracy and d) completeness; or
5) The estimated average annual tonnage of solid waste disposed of in the landfill was estimated from the years for which data was available, and this average was applied to all years prior to first reporting; or
6) The estimated average annual tonnage of solid waste disposed of in the landfill was estimated by dividing the product of the landfills volume and density factor by the number of years the landfill was running prior to the first year of reporting; and this figure was applied to all years prior to first

Please select the technique used to estimate opening stock of degradable organic carbon:	3		✔

Please enter the number of sub facility zones are in the landfill:	Sub Facility 1	Please leave Sub Facility 2 blank	Please leave Sub Facility 3 blank	Please leave Sub Facility 4 blank	
1					✔
Enter Sub Facility opening year (financial year ending):	2002				✔
Enter the year the landfill first reported under NGERs (financial year ending):	2009				✔
Input state/territory from drop-down list:	QLD				✔
Input state/territory or climate zone from drop-down list:	QLD				✔

Note: This calculator is only valid for the 2014/2015 Reporting Period.

References: NGER Determ.	NGER Determ. Section 5.5 INPUT	NGER Determ. Section 5.4, Section 5.22B		
		Input Parameters: Qcap, Qflared and Qtr		
	Please enter total waste entering landfill, excluding homogenous waste streams (t) *Note: prior to first year of reporting, only report waste disposed of in landfill. On and after first year of reporting, report waste received at the landfill. Ensure opening stock of carbon is correcly estimated.*	Q_{cap} (CH_4 only) (m^3)	Q_{flared} (CH_4 only) (m^3)	Q_{tr} (CH_4 only) (m^3)
2002	25,365	0	0	0
2003	43,483	0		0
2004	43,483	0	0	0
2005	43,483	0	0	0
2006	40,166	0	0	0
2007	40,196	0	0	0
2008	38,952	0	0	0
2009	38,622	0	0	0
2010	42,624	0	0	0
2011	44,090	0	0	0
2012	44,870	0	0	0
2013	44,735	0	0	0
2014	46,557	0	0	0

Calculator Outputs

Total emissions (CO_2-e) (t)	Legacy emissions (CO_2-e) (t)	Non-legacy emissions (CO_2-e) (t)	Total captured ($Q_{cap}+Q_{tr}+Q_{flared}$) ($CO_2$-e) (t)	Legacy capture ($Q_{cap}+Q_{tr}+Q_{flared}$) ($CO_2$-e) (t)	Non-legacy capture ($Q_{cap}+Q_{tr}+Q_{flared}$) ($CO_2$-e) (t)
0	0	0	0	0	0
3,359	3,359	0	0	0	0
8,226	8,226	0	0	0	0
11,838	11,838	0	0	0	0
14,576	14,576	0	0	0	0
16,260	16,260	0	0	0	0
17,627	17,627	0	0	0	0
18,594	18,594	0	0	0	0
19,384	19,384	0	0	0	0
20,612	20,612	0	0	0	0
21,817	21,817	0	0	0	0
22,915	22,915	0	0	0	0
23,810	17,885	5,925	0	0	0

NGER Determ. Section 5.10			NGER Determ. Section 5.11								
Waste streams (percentages of total) Note: defaults can be overridden in accordance with NGER Determination			**Waste mix types - Municipal Solid Waste (percentages of total) Note: defaults can be overridden in accordance with NGER Determination**								
Municipal Solid Waste	Commercial and Industrial	Construction and Demolition (calculated by deduction)	Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert Material
43%	14%	43%	35.0%	13.0%	16.5%	1.0%	1.5%	0.0%	4.0%	1.0%	28.0%
43%	14%	43%	35.0%	13.0%	16.5%	1.0%	1.5%	0.0%	4.0%	1.0%	28.0%
43%	14%	43%	35.0%	13.0%	16.5%	1.0%	1.5%	0.0%	4.0%	1.0%	28.0%
43%	14%	43%	35.0%	13.0%	16.5%	1.0%	1.5%	0.0%	4.0%	1.0%	28.0%
43%	14%	43%	35.0%	13.0%	16.5%	1.0%	1.5%	0.0%	4.0%	1.0%	28.0%
43%	14%	43%	35.0%	13.0%	16.5%	1.0%	1.5%	0.0%	4.0%	1.0%	28.0%
43%	14%	43%	35.0%	13.0%	16.5%	1.0%	1.5%	0.0%	4.0%	1.0%	28.0%
43%	14%	43%	35.0%	13.0%	16.5%	1.0%	1.5%	0.0%	4.0%	1.0%	28.0%
43%	14%	43%	35.0%	13.0%	16.5%	1.0%	1.5%	0.0%	4.0%	1.0%	28.0%
43%	14%	43%	35.0%	13.0%	16.5%	1.0%	1.5%	0.0%	4.0%	1.0%	28.0%
43%	14%	43%	35.0%	13.0%	16.5%	1.0%	1.5%	0.0%	4.0%	1.0%	28.0%
43%	14%	43%	35.0%	13.0%	16.5%	1.0%	1.5%	0.0%	4.0%	1.0%	28.0%
43%	14%	43%	35.0%	13.0%	16.5%	1.0%	1.5%	0.0%	4.0%	1.0%	28.0%

NGER Determ. Section 5.11								
Waste mix types - Commercial and Industry (percentages of total) Note: defaults can be overridden in accordance with NGER Determination								
Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert Material
21.5%	15.5%	4.0%	12.5%	4.0%	1.5%	0.0%	3.5%	37.5%
21.5%	15.5%	4.0%	12.5%	4.0%	1.5%	0.0%	3.5%	37.5%
21.5%	15.5%	4.0%	12.5%	4.0%	1.5%	0.0%	3.5%	37.5%
21.5%	15.5%	4.0%	12.5%	4.0%	1.5%	0.0%	3.5%	37.5%
21.5%	15.5%	4.0%	12.5%	4.0%	1.5%	0.0%	3.5%	37.5%
21.5%	15.5%	4.0%	12.5%	4.0%	1.5%	0.0%	3.5%	37.5%
21.5%	15.5%	4.0%	12.5%	4.0%	1.5%	0.0%	3.5%	37.5%
21.5%	15.5%	4.0%	12.5%	4.0%	1.5%	0.0%	3.5%	37.5%
21.5%	15.5%	4.0%	12.5%	4.0%	1.5%	0.0%	3.5%	37.5%
21.5%	15.5%	4.0%	12.5%	4.0%	1.5%	0.0%	3.5%	37.5%
21.5%	15.5%	4.0%	12.5%	4.0%	1.5%	0.0%	3.5%	37.5%
21.5%	15.5%	4.0%	12.5%	4.0%	1.5%	0.0%	3.5%	37.5%
21.5%	15.5%	4.0%	12.5%	4.0%	1.5%	0.0%	3.5%	37.5%

NGER Determ. Section 5.11

Waste mix types - Construction and Demolition (Percentages of total)
Note: defaults can be overridden in accordance with NGER Determination

Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert Material
0.0%	3.0%	2.0%	6.0%	0.0%	0.0%	0.0%	0.0%	89.0%
0.0%	3.0%	2.0%	6.0%	0.0%	0.0%	0.0%	0.0%	89.0%
0.0%	3.0%	2.0%	6.0%	0.0%	0.0%	0.0%	0.0%	89.0%
0.0%	3.0%	2.0%	6.0%	0.0%	0.0%	0.0%	0.0%	89.0%
0.0%	3.0%	2.0%	6.0%	0.0%	0.0%	0.0%	0.0%	89.0%
0.0%	3.0%	2.0%	6.0%	0.0%	0.0%	0.0%	0.0%	89.0%
0.0%	3.0%	2.0%	6.0%	0.0%	0.0%	0.0%	0.0%	89.0%
0.0%	3.0%	2.0%	6.0%	0.0%	0.0%	0.0%	0.0%	89.0%
0.0%	3.0%	2.0%	6.0%	0.0%	0.0%	0.0%	0.0%	89.0%
0.0%	3.0%	2.0%	6.0%	0.0%	0.0%	0.0%	0.0%	89.0%
0.0%	3.0%	2.0%	6.0%	0.0%	0.0%	0.0%	0.0%	89.0%
0.0%	3.0%	2.0%	6.0%	0.0%	0.0%	0.0%	0.0%	89.0%
0.0%	3.0%	2.0%	6.0%	0.0%	0.0%	0.0%	0.0%	89.0%

NGER Determ. Section 5.11

Waste mix type proportions (adjusted for licensing restrictions if applicable) of total waste stream.
Note: these values are calculated and no input is required

Food	Paper and paper board	Garden and park	Wood and wood waste	Textiles	Sludge	Nappies	Rubber and Leather	Inert Material
18.06%	9.05%	8.52%	4.76%	1.21%	0.21%	1.72%	0.92%	55.56%
18.06%	9.05%	8.52%	4.76%	1.21%	0.21%	1.72%	0.92%	55.56%
18.06%	9.05%	8.52%	4.76%	1.21%	0.21%	1.72%	0.92%	55.56%
18.06%	9.05%	8.52%	4.76%	1.21%	0.21%	1.72%	0.92%	55.56%
18.06%	9.05%	8.52%	4.76%	1.21%	0.21%	1.72%	0.92%	55.56%
18.06%	9.05%	8.52%	4.76%	1.21%	0.21%	1.72%	0.92%	55.56%
18.06%	9.05%	8.52%	4.76%	1.21%	0.21%	1.72%	0.92%	55.56%
18.06%	9.05%	8.52%	4.76%	1.21%	0.21%	1.72%	0.92%	55.56%
18.06%	9.05%	8.52%	4.76%	1.21%	0.21%	1.72%	0.92%	55.56%
18.06%	9.05%	8.52%	4.76%	1.21%	0.21%	1.72%	0.92%	55.56%
18.06%	9.05%	8.52%	4.76%	1.21%	0.21%	1.72%	0.92%	55.56%
18.06%	9.05%	8.52%	4.76%	1.21%	0.21%	1.72%	0.92%	55.56%
18.06%	9.05%	8.52%	4.76%	1.21%	0.21%	1.72%	0.92%	55.56%

Data Input to EERS

INSTRUCTIONS FOR ENTERING WASTE DATA IN EERS

##

Scroll down to the bottom of the Activities & Emissions screen and click on the 'Modify Waste Mix Percentages' link.
In the Waste Mix Type Percentages screen, click on the modify link for each waste mix type. You will have the option to use the default values or enter your own. Each waste mix type will need to add up to either 0 or 100 percent. Remember to click on the 'Save' button after entering the percentages for each waste type. The waste mix type percentages need to be entered BEFORE
In the Activities and Emissions screen, click on the 'Add Activity' button. Select 'Waste' as the source category, 'Solid waste disposal on land' as the source and then the appropriate activity.
Under the CH_4 Methane heading, select a Method from the drop-down menu in the 'Method' field.
A list of required Matters to be identified (MTBIs) will appear above the 'Method' field under the MTBIs heading.
Each MTBI field will require data to be entered and, where required, a unit of measurement to be selected.
Where data is available in the solid waste calculator, this can be entered in the appropriate MTBI field in EERS.
Where data is not available in the solid waste calculator, reporters will need to determine appropriate data to be entered in the MTBI fields in EERS in accordance with the relevant legislation.
Once complete, enter data in the 'Emissions released during the year (CO_2-e tonnes)' field and click the 'Save Changes' button.

Emissions summary	
Legacy (tonnes CO_2.e)	14,296
Non Legacy (tonnes CO_2-e)	10,518
Biological Treatment emissions (tonnes CO_2.e)	0

**For CFI Purposes only	Sub Facility 1	Sub Facility 2	Sub Facility 3	Sub Facility 4
2015 CH_4gen (tonnes CO_2-e)	27,570	0	0	0
2015 CH_4* (tonnes CO_2-e)	27,570	0	0	0

**For CFI Purposes only	Total
2015 CH_4gen (tonnes CO_2-e)	27,570
2015 CH_4* (tonnes CO_2.e)	27,570

Waste Type - Method 1 MTBI (g)	Municipal Waste	Commercial & Industrial	Construction and demolition	Shredder flock
Food	0.0%	0.0%	0.0%	0.0%
Paper	0.0%	0.0%	0.0%	0.0%
Garden	0.0%	0.0%	0.0%	0.0%
Wood	0.0%	0.0%	0.0%	0.0%
Textiles	0.0%	0.0%	0.0%	0.0%
Sludge	0.0%	0.0%	0.0%	0.0%
Nappies	0.0%	0.0%	0.0%	0.0%
Rubber and leather	0.0%	0.0%	0.0%	0.0%
Inert waste	0.0%	0.0%	0.0%	0.0%

MTBI's for METHOD 1 - Refer to Part 6 of Schedule 3 of the *NGER Regulations 2008*	
(a) The location of the landfill by State or Territory or by landfill classification specified in the Determination	QLD
(b) The number of years in operation	12
(c) The average annual amount (in tonnes) of disposal of solid waste over the lifetime of the landfill facility prior to the first year of reporting	39,304
(d) The total tonnes of waste entering the landfill	0
(e) The tonnes of waste entering the landfill from each of the following:	
(i) municipal sources;	0
(ii) commercial and industrial sources;	0
(iii) construction and demolition sources;	0
(iv) alternative waste treatment facilities;	0
(v) shredder flock;	0
(vi) inert waste	0
(f) The tonnes of waste received at the landfill facility for each of the following:	
(i) transfer to an external recycling or biological treatment facility;	0
(ii) recycling or biological treatment onsite;	0
(iii) construction purposes, daily cover purposes, intermediate cover purposes or final capping and cover purposes(inert waste only)	0
(h) The opening stock of degradable organic carbon, in tonnes	10,418
(i) The emissions from decomposition of waste	24,813
(k) The tonnes of methane (CO_2-e) captured for combustion	0
(l) The tonnes of methane (CO_2-e) captured and transferred offsite	0
(m) The tonnes of methane (CO_2-e) flared	0
(n) The tonnes of waste treated by each of the following methods:	
(i) composting;	0
(ii) anaerobic digestion	0
(o) The tonnes of Methane (CO_2 -e) captured from each of the following:	
(i) composting (NOTE: please enter zero if appropriate)	
(ii) anaerobic digestion (NOTE: please enter zero if appropriate)	0

Appendix C: GHG Emissions Inventory

FUEL COMBUSTION - STATIONARY

Diesel		
Input		
Q	293	kL/year
EC	38.6	GJ/KL
CO_2 EF_{joxec}	69.2	kg CO_{2-e}/GJ
CH_2 EF_{joxec}	0.1	kg CO_{2-e}/GJ
N_2O EF_{joxec}	0.2	kg CO_{2-e}/GJ
Output		
CO_2	783	t CO_{2-e}/year
CH_2	1	t CO_{2-e}/year
N_2O	2	t CO_{2-e}/year
Total CO_{2-e}		
786		

Petrol		
Input		
Q	16	kL/year
EC	34.2	GJ/KL
CO_2 EF_{joxec}	66.7	kg CO_{2-e}/GJ
CH_2 EF_{joxec}	0.2	kg CO_{2-e}/GJ
N_2O EF_{joxec}	0.2	kg CO_{2-e}/GJ
Output		
CO_2	36.5	t CO_{2-e}/year
CH_2	0.1	t CO_{2-e}/year
N_2O	0.1	t CO_{2-e}/year
Total CO_{2-e}		
37		

FUEL COMBUSTION - TRANSPORT

Diesel		
Input		
Q	528	kL/year
EC	38.6	GJ/KL
CO_2 EF_{joxec}	69.2	kg CO_{2-e}/GJ
CH_2 EF_{joxec}	0.2	kg CO_{2-e}/GJ
N_2O EF_{joxec}	0.5	kg CO_{2-e}/GJ
Output		
CO_2	1410	t CO_{2-e}/year
CH_2	4	t CO_{2-e}/year
N_2O	10	t CO_{2-e}/year
Total CO_{2-e}		
1425		

Petrol		
Input		
Q	345	kL/year
EC	34.2	GJ/KL
CO_2 EF_{joxec}	66.7	kg CO_{2-e}/GJ
CH_2 EF_{joxec}	0.6	kg CO_{2-e}/GJ
N_2O EF_{joxec}	2.3	kg CO_{2-e}/GJ
Output		
CO_2	787	t CO_{2-e}/year
CH_2	7	t CO_{2-e}/year
N_2O	27	t CO_{2-e}/year
Total CO_{2-e}		
821		

ELECTRICITY CONSUMPTION

Facilities Under SRRC's Operational Control	Electricity Purchased from the Grid (kWh/year) 2014	Energy (GJ/year)	Emissions (t CO_2-e/year)
Beaudesert depot	197768	712	160
Beaudesert library	39872	144	32
Bicentennial park/Boonah information centre	5183	19	4
Boonah admin building	79823	287	65
Boonah district cultural centre/Boonah library	193332	696	157
Canungra depot	2642	10	2
Canungra information centre/Canungra library	14836	53	12
Canungra pool	58749	211	48
Central place	7082	25	6
Council chambers/offices	114582	412	93
Council depot Lot 234	60032	216	49
Gallery walk toilets	12843	46	10
Central landfill	11853	43	10
Moogerah caravan park	179734	647	146
Mt Tamborine library	35492	128	29
Nursery	4532	16	4
Rathdowney depot	1801	6	1
State emergency service	10199	37	8
Tamborine Mountain information centre	7495	27	6
Street lighting	114371	412	93
Total kWh	**1152221**	**4148**	**933**

Coefficients		
Q	0.0036	kWh/year
EF_{S2}	0.81	kg CO_2-e/GJ

FULL FUEL CYCLE EMISSIONS

Diesel		
Total Consumed	821	kL/year
Energy Content Factor	38.6	GJ/kL
Emission Factor	5.3	kg CO_2-e/GJ
Scope 3 Emissions	168	t CO_2-e/year
Petrol		
Total Consumed	361	kL/year
Energy Content Factor	34.2	GJ/kL
Emission Factor	5.3	kg CO_2-e/GJ
Scope 3 Emissions	65	t CO_2-e/year
Electricity		
Total Consumed	1152221	kWh/year
Emission Factor	0.13	kg CO_2-e/GJ
Scope 3 Emissions	150	t CO_2-e/year
TOTAL		
383		

RESULT SUMMARY

Category	Activity	CO_2 Emissions	CH_4 Emissions	N_2O Emissions	Total Emissions
		tonnes CO_2-e/year			
SCOPE 1					
Fuel Combustion	Stationary energy diesel	782.6	1.1	2.3	786.0
	Stationary energy petrol	36.5	0.1	0.1	36.7
	Transport diesel	1410.4	4.1	10.2	1424.6
	Transport petrol	787.0	7.1	27.1	821.2
Fugitive Emissions	Landfill gas releases		24813		24813
SCOPE 2					
Energy Consumption	Electricity consumption	933			933
SCOPE 3					
Energy Consumption	Full fuel cycle diesel	168.0			168.0
	Full fuel cycle petrol	65.4			65.4
	Full fuel cycle electricity	149.8			149.8
Total Scope 1 Emissions		3016.5	24825.4	39.7	27881.6
Total Scope 2 Emissions		933.3	0.0	0.0	933.3
Total Scope 3 Emissions		383.2	0.0	0.0	383.2
Overall Total		**4333.0**	**24825.4**	**39.7**	**29198.1**