Greenhouse gas emissions profile and mitigation report

Background report

City of Greater Dandenong

29 October 2019

EY
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1. Executive summary

The City of Greater Dandenong (CoGD) is a Local Government Area (LGA) located in the south-east region of Melbourne, Victoria. The CoGD is the most culturally diverse municipality in Victoria, with residents from over 160 different countries and over half of the population being born overseas. The proposed Local Government Bill 2018 includes Council responsibilities to act in the long-term interest of residents in relation to climate change. The CoGD Council (Council) have engaged Ernst and Young (EY) to develop the CoGD Climate Change Strategy and Action Plan to help CoGD take a leadership role in climate change mitigation and adaptation in the state of Victoria.

This Mitigation Report is one of four Background Reports prepared by EY to inform the development of a Climate Change Strategy and Action Plan for the City of Greater Dandenong (CoGD). This report aims to prepare a corporate inventory and community emissions profile for the City of Greater Dandenong, and identify emissions abatement actions and pathways, based on timeframes out to 2030 and 2050. These years were selected as they are aligned to the C40 Climate Action Planning Framework, and generally match International Panel for Climate Change (IPCC) timeframes for modelling and targeting emissions abatement in line with the Paris Agreement. They also provide time frames for asset lifecycle planning.

Key findings

- The CoGD council's corporate emissions inventory has reduced from approximately 16,000[1] tonnes of carbon dioxide equivalent (tCO_2-e) in 2007/08 to around 14,000 tCO_2-e in 2016/17 (including scope 1 direct and scope 2 indirect emissions). This was driven by annual savings in stationary emissions from buildings. Meanwhile, annual transport and waste emissions have remained at similar levels.

- The CoGD's community emissions profile is estimated to be approximately 3,598,000 tCO_2-e in 2016/17 including scope 1 and 2 emissions; with an additional 366,000 tCO_2-e in scope 3 emissions from waste. The emissions profile split of 78% stationary emissions, 12% transport and 10% waste reflects similar profiles developed for other local government areas in Victoria.

- The CoGD community per capita emissions were 24.2 tCO_2-e in 2017. By 2030 this would need to drop to a target of:

    - 7.6 tCO_2-e per capita under the 'accelerated action' scenario. Down to 0.1 tCO_2-e per capita by 2050.

    - 12.5 tCO_2-e per capita under the 'moderate action' scenario. Down to 0.3 tCO_2-e per capita by 2050.

- One of these scenarios is required to be adopted. Otherwise, under business as usual, the City of Greater Dandenong community will have used its 2020-2050 carbon budget of 39.5 $MtCO_2$-e early by the year 2030, based on the community's current emissions at 3.9$MTCO_2$-e per annum.

- The accelerated action scenario would provide the quickest emissions abatement in line with the Paris Agreement, and allow the community to minimise exposure to potential future carbon regulation and costs, such as from more stringent building regulations, a carbon price and carbon offsetting.

- While the Council is already acting - such as with its ESD Policy and Sustainability Strategy, taking further action will provide benefits to the local community while further positioning the City as a leader.

- EY suggests that the CoGD adopt key objectives that can set the community on the path to rapid emissions abatement, as shown in Table 1.These high-level objectives are supported by more detailed actions in Appendix A, which focus on how to drive community scale emissions abatement. The focus of efforts needs to be on how council can drive community emissions abatement, while showing leadership by where possible adopting similar objectives for its own corporate emissions.

Table 1 - Key objectives for addressing corporate and community emissions

Category	Key objectives for addressing community emissions	Key objectives for addressing corporate emissions
Buildings	Council to advocate for all new buildings to be carbon neutral* by 2030 with Federal and State Government.	New council buildings to aspire to be carbon neutral by 2030, aiming for NABERS 5 Star ratings where possible.
	Advocate for all existing buildings to be carbon neutral by 2050 with Federal and State Government.	All existing council buildings to be carbon neutral* by 2050.
	Plan and partner for electrification of energy supply to the community**.	

[1] All tonnes of carbon dioxide equivalent in this report have been rounded to the nearest 1000

Category	Key objectives for addressing community emissions	Key objectives for addressing corporate emissions
Energy	Facilitate resident's uptake of renewable energy products.	Facilitate more efficient behaviour and use of more energy efficient equipment such as lighting, controls and equipment for heating, ventilation and air conditioning.
	Facilitate corporate PPA's (Power Purchasing Agreements).	Facilitate corporate PPA's (Power Purchasing Agreements) for council energy use.
	Incentivise innovative renewable energy technologies.	Encourage and support uptake of innovative renewable energy technologies.
	Advocate for a more ambitious renewable energy target (RET).	Advocate for a more ambitious Victorian and Federal Government renewable energy targets (RET).
Transport	Promote a mode shift from driving to walking and cycling.	Plan and partner for electrification of energy supply to council assets**.
	Advocate for all public transport to be powered by renewable energy.	Encourage and support staff and contractors to increase sustainable transport mode choices.
	Advocate for lower emissions intensity of motor vehicles and support the City's transition to electric vehicles.	Council fleet to be powered by renewable energy/electricity by 2050.
Waste	Work to reduce emissions from commercial and industrial waste.	
	Work to reduce emissions from residential waste.	Work to reduce emissions from council waste.
	Work to reduce emissions from construction and development waste.	New council buildings to aspire to be carbon neutral by 2030, aiming for NABERS 5 Star ratings where possible.

** A Carbon Neutral building can be defined as one with significantly reduced energy consumption combined with renewable energy sources and offsets to meet remaining demand.*

- The detailed actions have been scored and listed in Appendix A using a multi-criteria analysis. It was informed by EY's previous work on Local Government emissions profiles and an in-depth literature review covering relevant C40 research. The actions are sorted from highest scoring for each category.

- The actions can be implemented with different levels of ambition. In this report three scenarios or pathways of ambition have been modelled, referred to as: accelerated, moderate and minor.

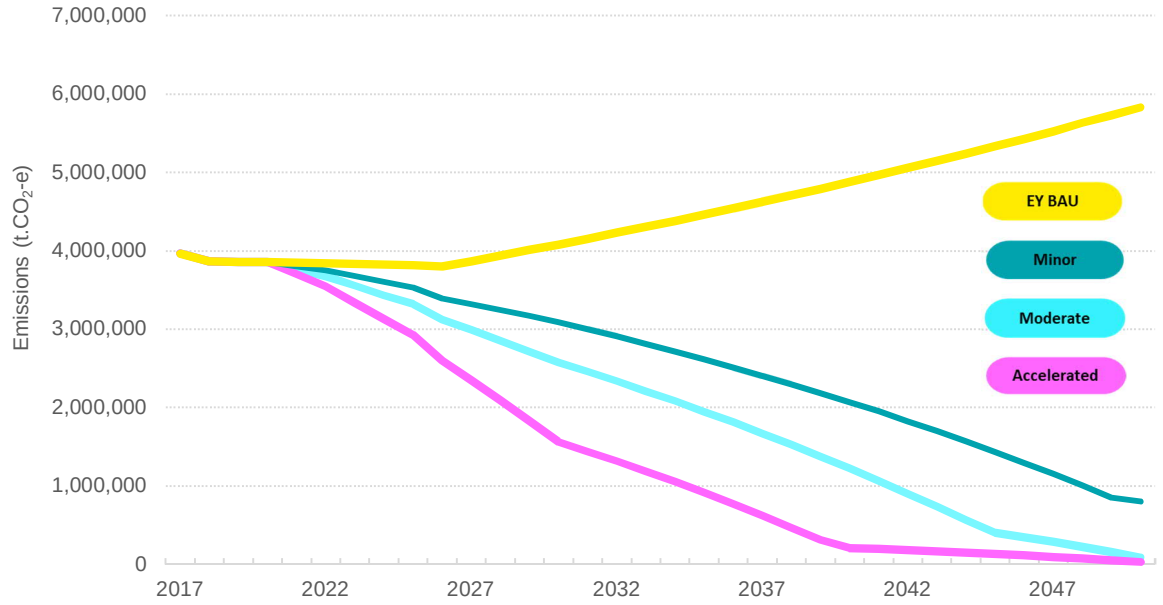


Figure 1 - Scenarios for emissions abatement

- Marginal Abatement Cost Curves (MACCs) have been developed to identify potential energy efficiency and solar PV opportunities in the CoGD community - for existing residential, commercial and industrial buildings. These can be used for finer grained guidance of technology specific opportunities, in addition to the objectives and actions suggested in the report. The main conclusions drawn from the MACC analysis are:
    - The Residential sector of the City of Greater Dandenong has the technical potential to reduce carbon dioxide equivalent (tCO_2-e) emissions by 230,000 tonnes/year. This scenario is based on the combination of 22 different emissions abatement opportunities (See Appendix B for further details) that would require an investment of more than $1.7 billion, paid back over approximately 20 years. If only 9 of the more cost effective opportunities are selected, then investment of approximately $400 million is required to reduce emissions by 158,000 tonnes/year, with an average 7-year payback. There was a population of 164,148 in the CoGD in 2017.
    - The Industrial sector has the technical potential to reduce carbon dioxide equivalent (tCO_2-e) emissions by 503,000 tonnes/year. This scenario is based on the combination of 36 different emissions abatement opportunities (see Appendix B for further details) that would require an investment of $387 million, paid back over approximately 5 years. The industrial sector includes 1,421 manufacturing businesses in 2017 as per ABS statistics.
    - The Commercial sector has the technical potential to reduce carbon (tCO_2-e) emissions by 149,000 tonnes/year. This scenario is based on considering 31 different emissions abatement opportunities (see Appendix B for further details) that would require an investment of $153 million, paid back over approximately 4 years. The commercial sector includes approximately 8,100 businesses in 2017 as per ABS statistics.
- Socio-economic co-benefits have been identified and mapped for the CoGD across the action categories of Buildings, Energy, Transport and Waste. Further analysis of the Socio-economic co-benefits undertaken by EY is contained in a separate Social Impact Analysis Report.

Structure of the report

The Greenhouse gas emissions and mitigation report is structured as follows:

- Section 2 provides the **context** for the report at an international, national and local level.
- Section 3 provides the **corporate emissions inventory** for the CoGD Council operations. This is called an inventory as it is based off actual consumption data for Council operations provided by CoGD and its suppliers.
- Section 4 provides the **community emissions profile** for the CoGD community. This is a 'profile' rather than an inventory as the emissions are estimated due to a lack of actual data. Emissions have been modelled using different city, state and federal sources of data, using CoGD population, business numbers, transport infrastructure and waste infrastructure data, to proxy down to the CoGD level.
- Section 5 provides suggested **emissions reduction targets** for the CoGD community in line with the latest climate science.
- Section 6 identifies **corporate emissions abatement actions** including key objectives and identified energy management actions.
- Section 7 identifies **community scale emissions abatement actions.**
- Section 8 provides **pathways to achieving the targets** under accelerated, moderate and minor pathway scenarios.
- Section 9 maps **socio economic co-benefits** from the identified key objectives and actions.
- Section 10 provides a **conclusion and summary of key findings.**

2. Context

2. Context

Ernst and Young (EY) has prepared a Literature Review as one of four Background Reports supplementing the development of this Mitigation Report. Some key findings of that Literature Review, relevant to this Mitigation Report, are outlined below.

2.1 The climate challenge

A review of the scientific literature on climate change shows unequivocally that human-induced warming of the atmosphere and oceans is causing significant changes in the Earth's climate. These changes can have catastrophic impacts on every facet of life such as food security, health and the economy.

The historic 2015 Paris Agreement aims to limit global warming to 2 degrees and to pursue efforts to keep warming to within 1.5 degrees above pre-industrial levels. However, the world is not currently on track to meet this goal. The Intergovernmental Panel on Climate Change (IPCC) estimates that global warming has already increased by 1.0 degrees Celsius above pre- industrial levels[2] and if warming continues at the current rate, is likely to reach 1.5 degrees Celsius between 2030 and 2052.

The IPCC also outlined that the climate-related risks for natural and human systems (including risks to health, livelihoods, food security, water supply, human security, economic growth, species loss and extinction) are significant even at 1.5 degrees Celsius[3]. Avoiding exceeding the 1.5 degrees Celsius threshold requires an increase in the scale and ambition of emission reduction action. This reinforces the urgent need to reduce emissions (climate change mitigation) and prepare for the unavoidable consequences of climate change (climate change adaptation).

2.2 The Australian context

As a signatory of the 2015 Paris Agreement, Australia has committed to reducing emissions by 26-28% below 2005 levels by 2030. To help to address this, Australia has developed key government policies including the Emissions Reduction Fund, Renewable Energy Target, National Energy Production Plan and National Climate Resilience and Adaptation Strategy. There has been significant change at the federal level with regards to climate change policy and renewable energy targets, which has caused uncertainty and is likely to have contributed to Australia's growing emissions on a quarterly basis since 2013[4].

Based on current policies and available data researched, EY expects Australian emissions in 2030 to be around 40% higher than its commitment under the Paris Agreement[5]. This points to why it is so important for local governments to continue their leadership role and actions to address climate change.

[2] Intergovernmental Panel on Climate Change (IPCC) 2018, 'Global Warming of 1.5°C
[3] Intergovernmental Panel on Climate Change (IPCC) 2018, 'Global Warming of 1.5°C
[4] Department of the Environment and Energy, Quarterly Update of Australia's National Greenhouse Gas Inventory: March and June 2018
[5] EY analysis, 2018

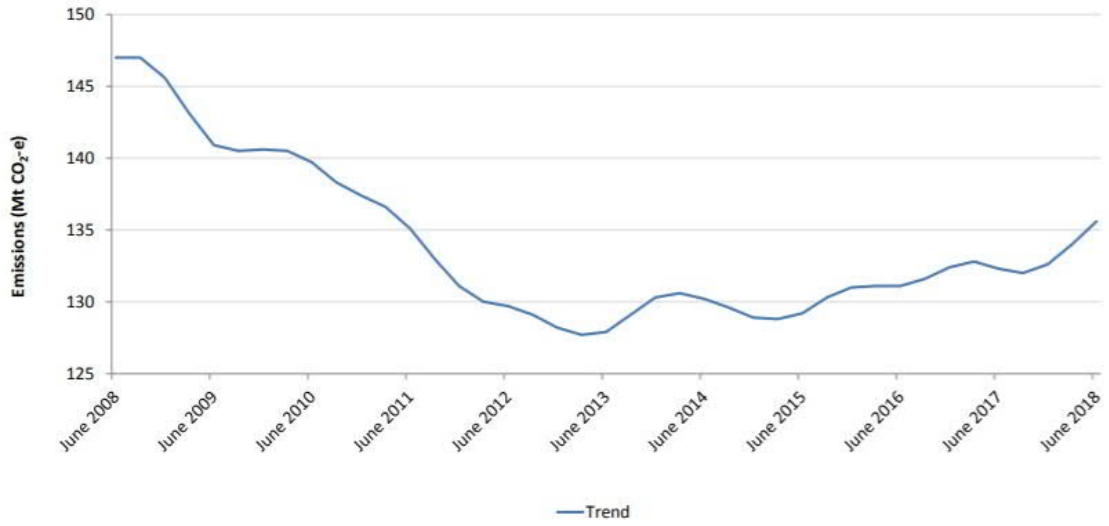


Figure 2 - Australia's quarterly emissions to June 2018[6]

At the state level, the Victorian government has implemented a number of policies that support climate change mitigation and adaptation. The TAKE2 Climate Change Pledge launched in 2016 saw government agencies, businesses and organisations pledge commitments to keeping global warming below 2 degrees, and was followed up by the Climate Change Act (2017) that provides a legislative framework for the state to manage climate-related risks, and sets the net zero emissions target for 2050.

At the local level, the proposed Local Government Bill (2019) increases the responsibilities for Councils and Mayors in relation to reporting on progress on Council Plans to the local community, as well as explicit reference to climate change. This sets the expectation of local government to act in the long-term interests of its community by planning to reduce emissions and improve the resilience of the local community and economy to the impacts of climate change.

2.3 City of Greater Dandenong's role

Local governments play a pivotal role in leading the response to address climate change. The City of Greater Dandenong (CoGD) has demonstrated leadership with its current Sustainability Strategy and the aim of being one of Australia's most sustainable cities by 2030. It is amongst a leading group of local governments globally who are beginning to develop a Climate Action Plan for mitigating emissions, in line with the requirements of the Paris Agreement (1.5ºC to 2 ºC warming) and the guidance of local government leadership group C40, with its Climate Action Planning Framework.

The CoGD is uniquely positioned as one of the most culturally diverse municipalities in Australia, with residents from over 160 different countries. It also has a relatively large manufacturing sector, and a growing population, with an expected 27% increase in population by 2031. A key challenge that the City of Greater Dandenong faces in responding to this population growth is the introduction of rate capping, which means that the Council will have to regularly review their ability and available resources to deliver on the commitments in its Climate Change Strategy and Action Plan.

The City of Greater Dandenong's *Sustainability Strategy* looks forward to 2030, with considerations relevant to climate change planning, including the Council Plan, Imagine 2030, the Risk Management Strategy and Policy, and the Municipal Emergency Management Plan. The *Sustainability Strategy* has the most explicit focus on climate change and emissions mitigation opportunities. The Climate Change Strategy and Action plan will build on these existing plans.

[6] Source: Department of the Environment and Energy, 2018

3. Corporate emissions inventory

3. Corporate emissions inventory

A 'corporate' emissions inventory is presented for the City of Greater Dandenong organisation that aligns with the Greenhouse Gas Protocol - Corporate Accounting and Reporting Standard. This is a widely used greenhouse gas accounting standard developed to measure and report on greenhouse gas (GHG) emissions.

The Corporate Inventory details emissions from buildings, vehicles, lighting and waste sources controlled by the Council. Please note: This is called an 'inventory' as it is based on actual consumption data for Council operations provided by CoGD and its suppliers, whereas community emissions have been developed as a 'profile' due to the limited availability of data. Measuring the Council's emissions allows the CoGD to track progress and identify new opportunities to mitigate emissions. Emissions are reported each year in the CoGD Council's annual sustainability report to enable monitoring of progress.

Benefits of such reporting include that it:

- Allows the CoGD Council to frame the scale, scope and focus of carbon emissions mitigation actions.
- Provides a summary of the key sources of emissions across Council's operations – as well as key opportunity areas for focus, considering existing work such as the Energy Management Plan.
- Can be built upon and updated over time as new data becomes available.
- Provides a standard approach – enabling comparison with other councils.
- Is required for certain local government climate change programs (for example, the Global Covenant of Mayors for Climate & Energy).

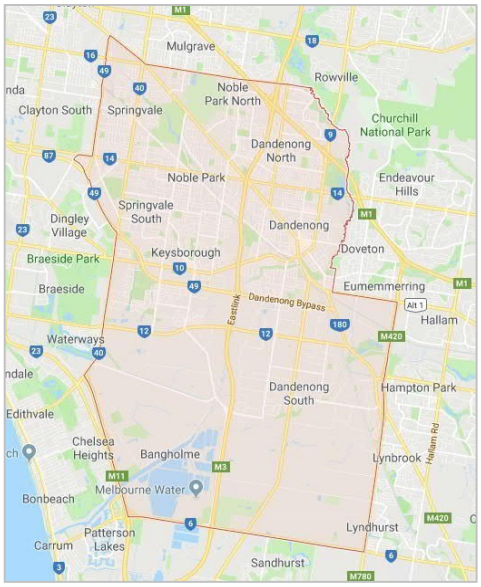


Figure 3 - Map of City of Greater Dandenong

3.1 Scope, boundary and sources of emissions

The Greenhouse Gas Protocol defines an approach for setting the physical boundary for the emissions profile (See Figure 3 for the CoGD). Table 2 provides an overview of key features of the Corporate Inventory such as the Scope, Boundary and Sources of Data.

Table 2 - Corporate inventory - scope, boundaries and sources

Parameters	Specification
Calculation and Reporting Protocol	Greenhouse Gas Protocol - A Corporate Accounting and Reporting Standard. The reporting template used is that of the City Profile Reporting and Information System (CIRIS) – C40 Cities Tool. The CIRIS Tool aligns to the requirements of the Greenhouse Gas Protocol as well as the Global Protocol for Community-scale Greenhouse Gas Emission Inventories (GPC) used for the Community emissions profile.
Assumptions	► Stationary Energy is made up of electricity and natural gas consumed within the city boundary, and balanced by the electricity transmission and distribution losses from grid supplied energy ► Transport is made up of on-road transportation emissions, with railways, waterborne and airborne transportation not included as these are not tracked for CoGD ► Waste is an amalgamation of solid waste disposal from residential bins and sporting field bins ► Source data provided by CoGD through CarbonetiX Report 2007-2018 ► See Appendix C for full break-down of data methodologies and sources
Organisational Boundary	Sites, vehicles and waste (assets) under the City of Greater Dandenong Council's operational control
Geography	City of Greater Dandenong municipal boundary (see Figure 3)
Profile Period and Emissions Covered	July 1st 2016 – June 30th 2017 (2016/17 Financial Year)
Scope 1	3,332 tCO_2-e Tonnes CO_2-e (all Scope 1 sources) (Note: Scope 1 emissions are direct emissions by emitters burning of fuel). Figure 4 shows how Scope 1 emissions are directly emitted by the emitter.

Parameters	Specification
Scope 2	10,503 tCO_2-e Tonnes CO_2-e (all Scope 2 sources) (Note: Scope 2 emissions are indirect emissions produced by the electricity consumed and purchased by the emitter). Figure 4 shows how Scope 2 emissions are indirectly emitted by the emitter.
Total Scope 1 and 2	13,835 tCO_2-e Tonnes CO_2-e (all Scope 1 & 2 sources)
Scope 3	Scope 3 emissions are indirect emissions produced by the emitter activity but owned and controlled by a different emitter from the one who reports on the emissions. Figure 4 shows how Scope 3 emissions are indirectly emitted by other parties, as a result of the emitter's activity. Scope 3 emissions are excluded due to insufficient data.
Supporting Documents	► Australian Census Data (2016), Australian Bureau of Statistics ► Counts of Australian Businesses, including Entries and Exits (Jun 2013 – Jun 2017), Australian Bureau of Statistics ► Victoria in Future Major Regions ERP Households Dwelling (2016), Department of Environment, Land, Water & Planning ► Manufacturing Snapshot Greater Dandenong Economy (2017), City of Greater Dandenong Council ► GHG-Emissions per site 2007-2018 (2018), City of Greater Dandenong Council ► CarbonetiX Report – Overall – 2007-2018 (2018), CarbonetiX ► Sustainable Greater Dandenong – Master Workbook (2018), CarbonetiX ► CoGD waste data. This includes for waste to landfill such as for household, commercial and industrial waste; green waste and hard rubbish collections ► Note that the CIRIS spreadsheet tool contains further details of the Corporate Inventory including emissions factors. Refer to Appendix C for a detailed breakdown of emissions

Figure 4 illustrates geographic boundaries and scopes under the Greenhouse Gas Protocol from the perspective of corporate accounting and reporting of emissions.

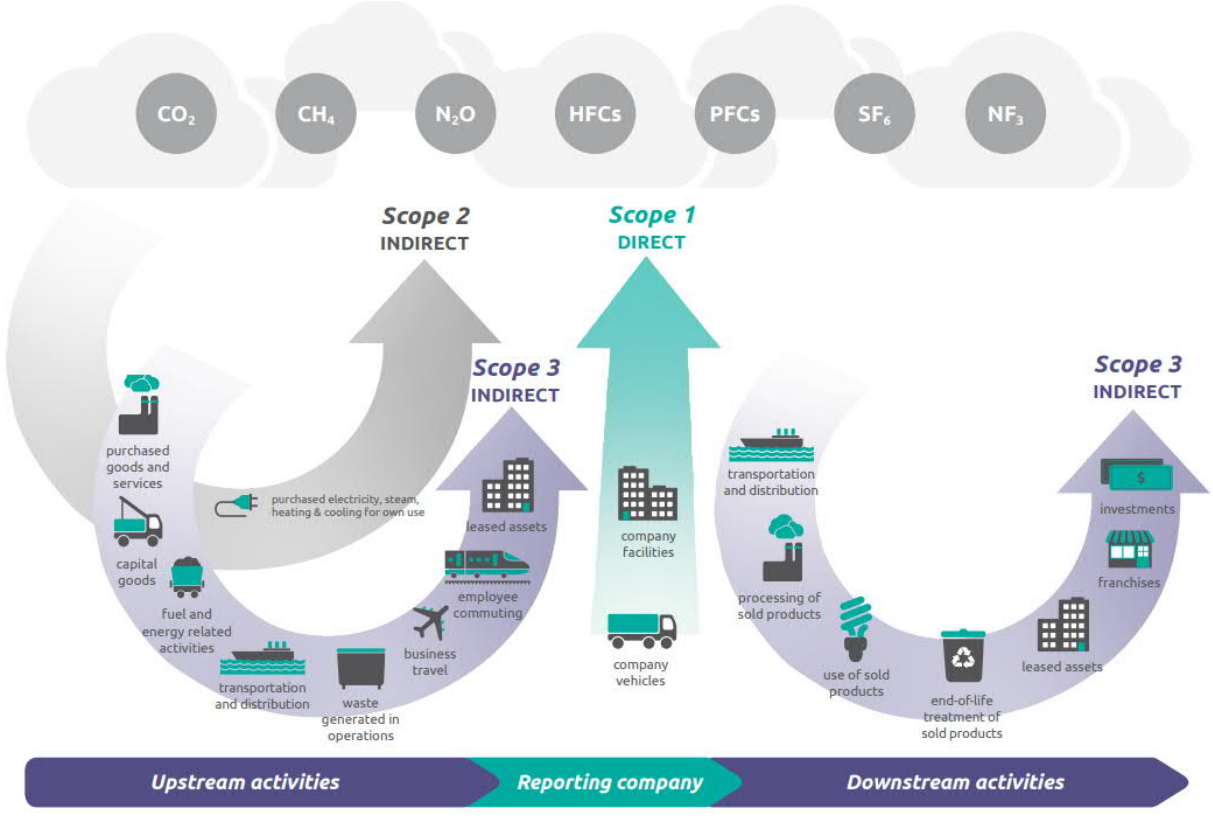


Figure 4 - Geographic boundaries and scopes[7]

[7] Source: Greenhouse Gas Protocol

3.2 Greater Dandenong corporate emissions inventory

The 2016/17 corporate emissions inventory for COGD council was 13,835 tonnes of greenhouse gas emissions in carbon dioxide equivalent (tCO_2-e). Table 2 provides an overview of the emissions inventory broken down by source and scope 1 and 2.

Table 3 - City of Greater Dandenong corporate emissions inventory scope breakdown

Source	Scope 1 (tCO_2-e)	Scope 2 (tCO_2-e)
Stationary	184	10,503*
Transport	1,390	
Waste	1,758	
Total (tCO_2-e)	**13,835**	

**Scope 2 stationary energy (electricity) is expected to be dominated by electricity for buildings and street lighting.*
Note that the number of significant figures provided is not an indication of the precision of the estimates.

Figure 5 summarises the total corporate emissions breakdown, with buildings, streetlights and other public lighting falling under 'Stationary'.

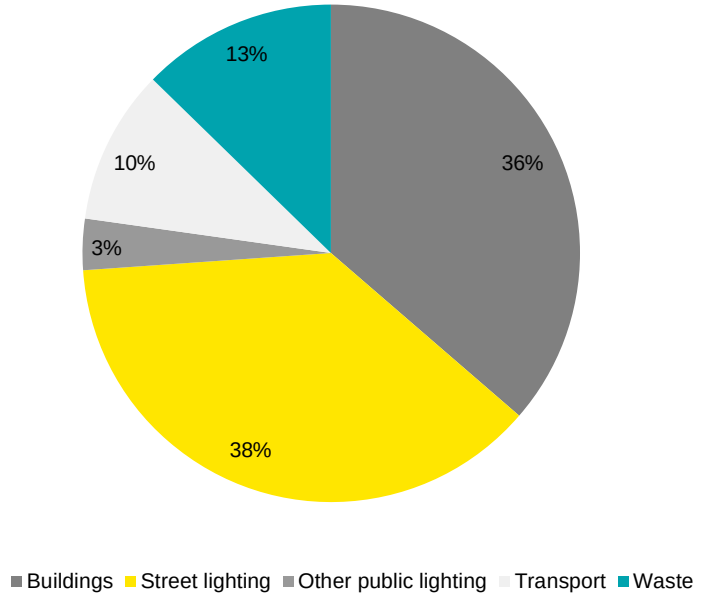


Figure 5 - Total corporate emissions breakdown

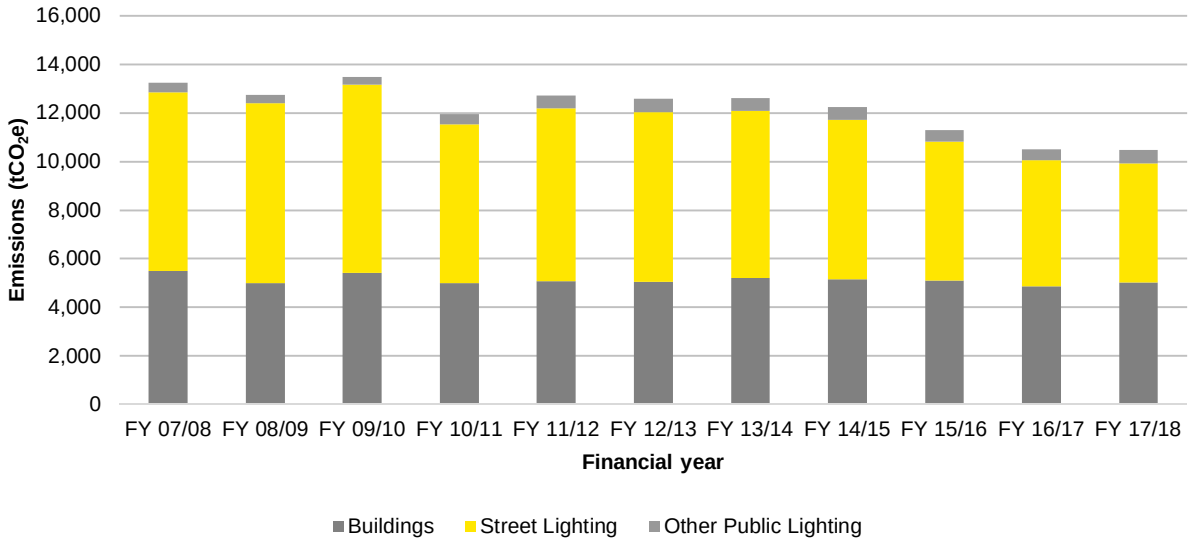


Figure 6 - Stationary emissions by source

Based on the emissions included in the inventory, Figure 7 illustrates that there has been a steady decrease in total corporate emissions since 2013.

The annual emissions reductions reflect the Council's actions to reduce emissions across its corporate operations and services. Current emissions mitigation actions are documented in the Sustainability Strategy 2016-2030 and reported under the Annual Sustainability Report.

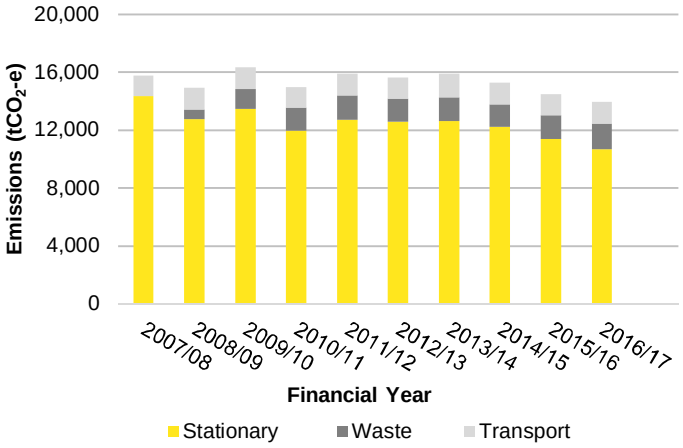


Figure 7 - Total corporate emissions by financial year.

Figure 8, Figure 9 and Figure 10 show the corporate emissions by source. Energy and transport data was sourced from the COGD's utility consumption data. This has been managed by the Council with assistance from Carbonetix through their Embedded Officer Program and their online SmartPortal system, which enables Council to track and report energy use and greenhouse emissions), based on billing data.

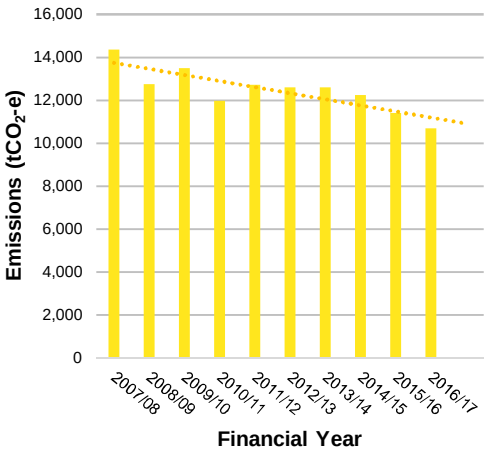


Figure 8 - Corporate stationary emissions by year

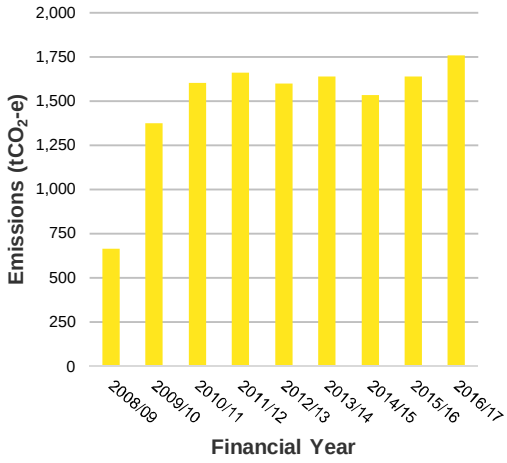


Figure 9 - Corporate waste emissions by year

Stationary emissions are the major contributor to corporate emissions, with reductions most years shown in Figure 5.

In contrast, corporate transport emissions have been steady at around 1500 tCO_2-e since 2013, while waste emissions have increased.[8]

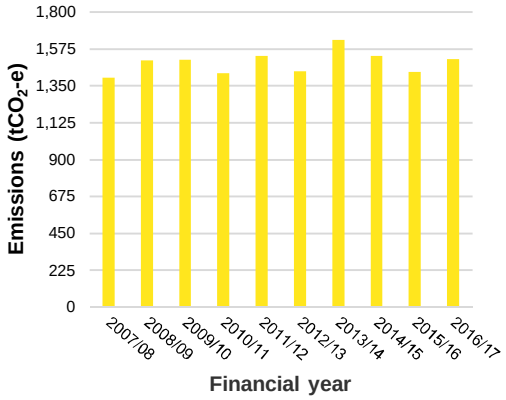


Figure 10 - Corporate transport emissions by year

[8] Analysis based on CarbonetiX data

4. Community emissions profiles

4. Community emissions profiles

The Community Profile provides an understanding of the key sources of emissions from the community of the City of Greater Dandenong. It has been prepared based on the requirements of the Global Protocol for Community-scale Greenhouse Gas Emission Inventories (GPC).

Benefits of such reporting include that it:

- Provides the basis for the CoGD to frame the scale, scope and focus of actions required to abate community emissions.
- Provides a summary of the key sources of emissions across the community and Council's operations (followed by opportunity areas for focus).
- Can be built upon and updated over time as new data becomes available.
- Provides a standard approach – enabling comparison with other councils.
- Enables the City to position itself as a progressive leader amongst other Cities.

4.1 Scope, boundary and sources of emissions

Table 4 provides an overview of key features of the Community Profile in terms of the Scope, Boundary and Sources of Data. It can be built on and updated over time as updated data or data sources become available.

Table 4 - Community emissions profile

Parameter	Specification
Calculation and Reporting Protocol	City Profile Reporting and Information System (CIRIS) – C40 Cities Tool. The CIRIS Tool aligns to the requirements of the Global Protocol for Community-scale Greenhouse Gas Emission Inventories (GPC).
Assumptions	► Stationary electricity calculated using data provided by CoGD's electricity provider, United Energy ► Stationary gas calculated using publicly available data to determine CoGD's population as a % of Victoria's total, and employment from the commercial and industrial sectors as a % of Victoria's total, to determine the % of Victoria's total gas consumption that is consumed in CoGD ► Transport calculated using publicly available data to Determine COGD's number of passenger cars and train users as %s of Victoria's total, and the % share of residents using buses, to determine the % of Victoria's transport emissions that comes from CoGD ► Waste calculated using municipal, commercial and industrial tonnes of waste from publicly available data ► Wastewater calculated using publicly available data to determine the average litres per household per day ► See Appendix D for full break down of data methodologies and sources.
Boundary/Geography	City of Greater Dandenong municipal boundary (see Figure 3).
Profile Period	July 1st 2016 – June 30th 2017 (2016/17 Financial Year) Please Note: to ensure consistency with community profile, 2016/17 data has been used as it is latest available data for the community emissions profile.
Scope 1	1,193,000 tCO_2-e (Tonnes CO_2-e) (Note: Scope 1 emissions are direct emissions by emitters burning of fuel). For a community, this means all emissions from sources located within the city boundary.
Scope 2	2,404,000 tCO_2-e (Note: Scope 2 emissions are indirect emissions produced by the electricity consumed and purchased by the emitter). For a community, this means all emissions occurring as a result of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary.
Total Scope 1 and 2	3,598,000 tCO_2-e
Scope 3 (waste)	366,000 tCO_2-e Note: Scope 3 emissions are indirect emissions produced. Scope 3 Waste emissions have been incorporated in in the Community Emissions Profile in accordance with GPC BASIC Reporting)

Parameter	Specification
Supporting documents	Appendix C provides a detailed breakdown of emissions sources. The key supporting documents used to calculate the emissions profile were: ► Australian Census Data (2016), Australian Bureau of Statistics ► Counts of Australian Businesses, including Entries and Exits (Jun 2013 – Jun 2017), Australian Bureau of Statistics ► Victoria in Future Major Regions ERP Households Dwelling (2016), Department of Environment, Land, Water & Planning ► Manufacturing Snapshot Greater Dandenong Economy (2017), City of Greater Dandenong Council ► GHG-Emissions per site 2007-2018 (2018), City of Greater Dandenong Council ► CarbonetiX Report – Overall – 2007-2018 (2018), CarbonetiX ► Sustainable Greater Dandenong – Master Workbook (2018), CarbonetiX ► United Energy's Electricity Data for CoGD.

This represents the first assessment of community emissions for CoGD. The community profile is estimated based on energy consumption data for buildings, transport and waste that EY has used to model emissions in the City of Greater Dandenong, in alignment with the Global Protocol for Community-scale Greenhouse Gas Emission Inventories (see Appendix D for list of data sources).

The aim of the Community Profile is to enable Council to identify and focus on areas where there is greater potential impact in terms of emissions abatement. While the Corporate Inventory is based on actual billing data, and therefore provides a high level of confidence in in the calculations of emissions, the Community energy consumption and emissions data is produced based on estimates rather than actual data depending on availability of information, which results in lower level of confidence in the emissions calculated.

It therefore needs to be recognised that with this lower level accuracy, the Community Emissions Profile is useful in communicating the need for action and identifying areas to focus on, but they are less useful for monitoring the outcomes of actions. Figure 11 illustrates geographic boundaries and scopes under the Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC).

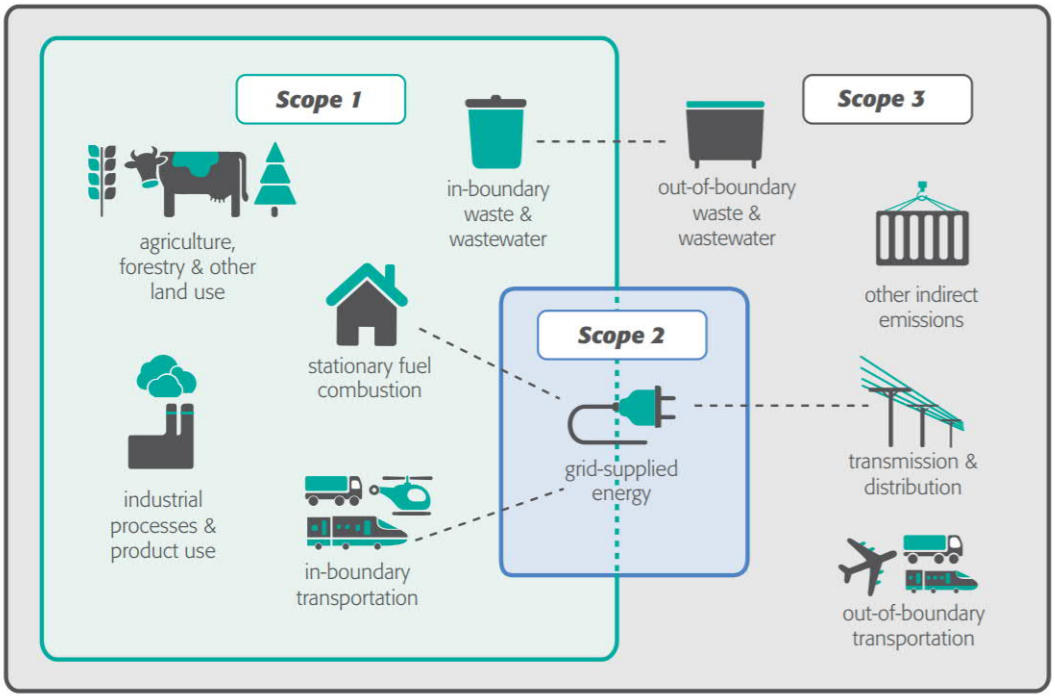


Figure 11 - Geographic boundaries and scopes[9]

[9] Source: Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC)

4.2 Greater Dandenong community emission profile

Table 5 provides an overview of the emissions profile broken down by source and scope 1,2 and 3, in accordance with the Global Protocol for Community-scale Greenhouse Gas Emission Inventories BASIC Reporting approach (See Appendix C for further details). This is delved into further in Figure 12.

Table 5 - Community emissions by scope

Source	Scope 1 (tCO_2-e)	Scope 2 (tCO_2-e)	Scope 3 (tCO_2-e)	% of total emissions
Stationary	696,000	2,387,000	NA (in accordance with GPC BASIC Reporting)	78%
Transport	476,000	17,000	NA (in accordance with GPC BASIC Reporting)	12%
Waste	21,000	NA (in accordance with GPC BASIC Reporting)	366,000	10%
Total (tCO_2-e) scopes 1 & 2		3,599,000	366,000	
Total (tCO_2-e) scopes 1, 2, 3			3,965,000[10]	

**Note the number of significant figures does not indicate the precision of these estimates. Based on GPC BASIC reporting.*

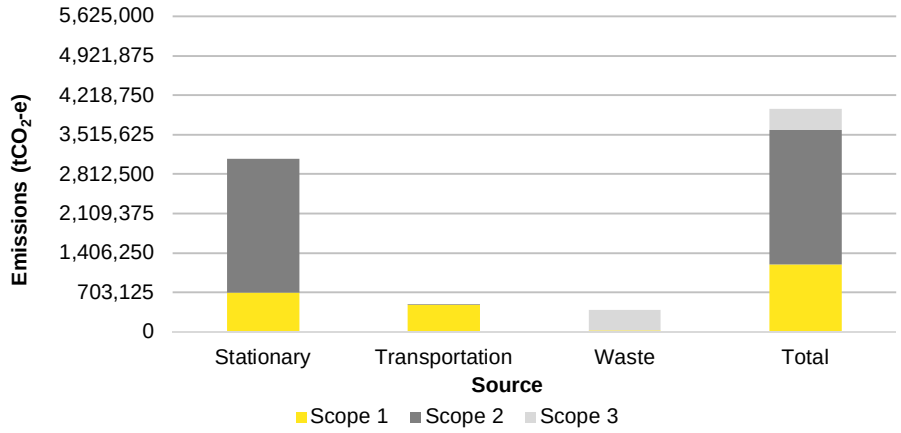


Figure 12 - Total Greater Dandenong community emissions by scope of emissions

Stationary energy represents the largest proportion of emissions, at approximately 78% of total Community emissions, with 12% emissions from transport, and 10% from waste (Figure 13). In comparison:

- The City of Greater Geelong has 71% stationary emissions, 26% transport and 2.6% waste.
- The City of Melbourne has 81% stationary emissions, 15% transport and 4% waste.

[10] Note that the total emissions is not the exact sum of the components in Table 5 due to rounding

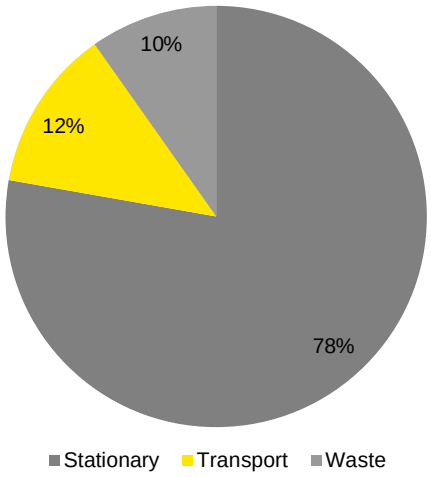


Figure 13 - Total Greater Dandenong community emissions by source (tCO_2-e)

A further breakdown of emissions by sub sector is provided in Figure 14, taken from the CIRIS emissions profile developed by EY for the CoGD. The Community emissions profile is produced from a combination of actual electricity consumption data, and on estimates based on the limited availability of information, which results in a lower level of confidence in the emissions calculated when compared with the Corporate Inventory. It therefore needs to be recognised that with this lower level of accuracy, the Community Emissions Profiles are useful in communicating the need for action and identifying areas to focus on, but they are less useful for monitoring the outcomes of actions.

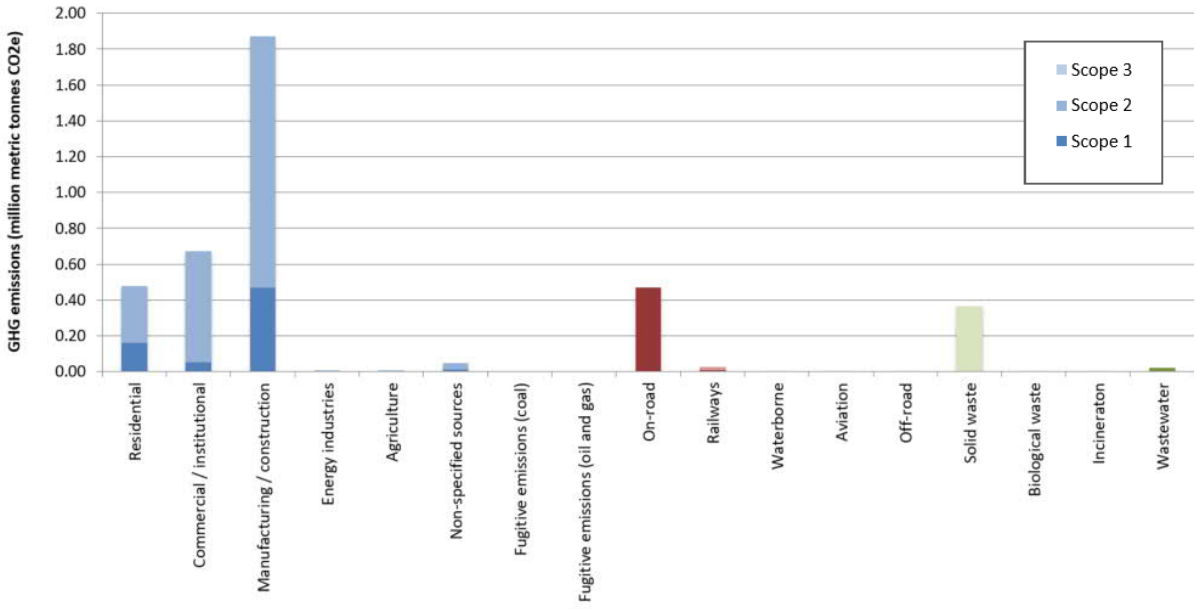


Figure 14 - Total community emissions by sub sector (GPC Inventory)[11]

A comparison of community emissions per capita is provided in Figure 15. Note that emissions data is not reported consistently between local government areas and the data covers varying years, therefore this chart is intended as an indicative overview of how CoGD compares to neighbouring communities in terms of emissions per capita.

[11] Source: City inventory reporting and information system (CIRIS), prepared by EY, 2019. See Appendix C for a detailed table of emissions sources

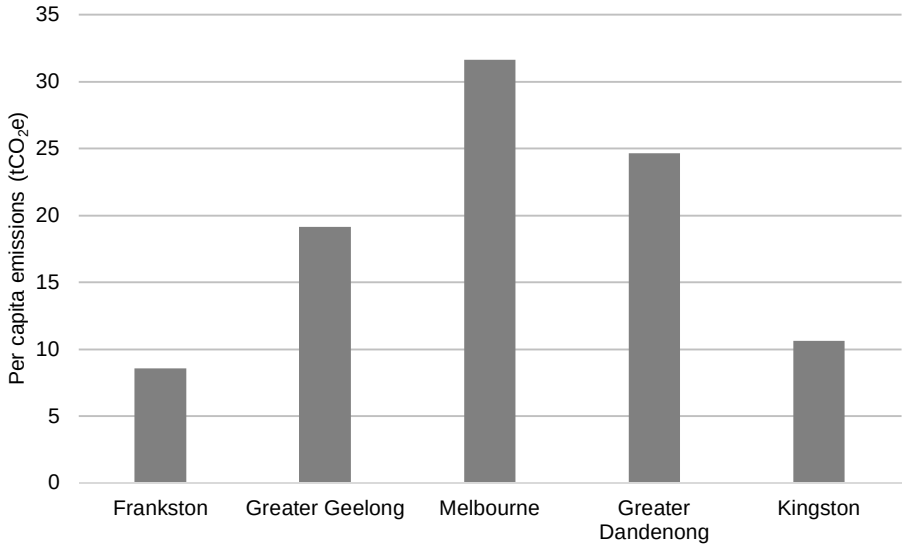


Figure 15 - Community emissions per capita of selected local government areas (LGA)

The data used to generate the comparison of local government areas is summarised in Table 6. The variance in emissions across local government areas can be explained by the wide variance in local characteristics such as the population, economy, types of buildings, transport and waste infrastructure.

Table 6 - Community emissions by local government area

LGA	Population (2016)	Emissions (tCO_2-e)	Emissions per capita (tCO_2-e)	Source
Frankston	139,511	1,192,720	9	Frankston City Council, 2013 – 'Municipal Map CO_2e per Suburb'
Greater Geelong	238,603	4,559,000	19	City of Greater Geelong, 2015, 'Zero Carbon Emissions Strategy - Measuring emissions'
Melbourne	148,039	4,681,136	32	EY analysis 2018
Greater Dandenong	160,952	3,965,000	24	EY analysis 2019
Kingston	151,389	1,610,000	10.6	Kingston City Council, 'population' website and Climate_Change_Strategy_draft_2018

5. Emissions reduction targets

5. Emissions reduction targets

To deliver the Paris Agreement, climate action planning needs to shift to new levels of ambition, driving rapid and systemic change on the ground. Cities urgently need to position themselves on an ambitious emissions reduction trajectory to achieve emissions neutrality by 2050. Zero net emissions means reducing carbon emissions to as low as possible and then compensating for the remaining amount by investing in carbon reduction projects to offset these emissions such as from buying carbon credits.

To align to the internationally accepted Paris Agreement goal of restricting global temperature rise to well below 2˚C, there are two complementary approaches that could be adopted to guide an emissions reduction trajectory in alignment to this goal:

- Setting a long-term target to achieve zero net emissions (by 2050 or before).
- Establishing interim emission reduction targets based on a carbon budget.

The Paris Agreement includes an aim of reaching zero net emissions in the second half of this century, which is often interpreted as an aim to reach net zero emissions by 2050. This is supported by the recent IPCC Special Report on Global Warming of 1.5°C[12] which for a scenario in which limiting global warming to 1.5°C is likely, global emissions reach net zero 'around 2050'.[13] This target is also enshrined in Victoria's Climate Change Act (2017) which established the Victorian Government's long-term target of net zero greenhouse gas emissions by 2050. Recognising the need to reduce their emissions, Australian businesses and other organisations are already taking significant action as part of their efforts to play their part in reducing global emissions, as well ensuring they remain competitive in a low emission future. Many are also choosing to demonstrate leadership and corporate responsibility by achieving zero net emissions or carbon neutrality.

Some of Australia's best-known businesses and organisations have become certified Carbon Neutral through the Australian Government's National Carbon Offset Program. This includes banks, property groups, universities and local governments and small businesses[14].

While there is considerable variation in the corporate emission targets established by Australian local governments, those that are demonstrating leadership in this area include the six councils certified to be Carbon Neutral (Cities of Sydney, Melbourne, Brisbane, Randwick, Moreland and Yarra).[15]

5.1 Corporate emission reduction targets

Council's 2016 Sustainability Strategy established a corporate greenhouse gas emission reduction target of 20% by 2020 for its buildings, street lights and facilities from its 2007/08 baseline. In 2017/18, Council exceeded this target, achieving a 21% reduction. This was primarily a result of:

- A 35% reduction in emissions associated with street lights.
- A 10% reduction in emissions associated with its buildings.

For the purposes of developing a Corporate Emissions Reduction Target as part of the Climate Change Strategy, to ensure it aligned with local and international practices, this target would be involve setting a long-term target of zero net emissions. The timeframe for this target would then be based on Council's commitment to achieve zero net corporate emissions:

- Before 2050
- By 2050
- After 2050.

[12] Intergovernmental Panel on Climate Change (IPCC) 2018, 'Global Warming of 1.5°C', available at: https://www.ipcc.ch/sr15/
[13] Intergovernmental Panel on Climate Change (IPCC) 2018, 'Global Warming of 1.5°C: Summary for Policymakers', p. 14, available at: https://www.ipcc.ch/site/assets/uploads/sites/2/2018/07/SR15_SPM_High_Res.pdf
[14] https://www.environment.gov.au/climate-change/government/carbon-neutral
[15] https://www.environment.gov.au/climate-change/government/carbon-neutral

For Council to achieve its stated ambitions of becoming one of Australia's most sustainable cities by 2030, this will require a strong commitment towards reducing its carbon emissions, which would necessitate Council setting a Corporate Emissions Reduction Target of Zero Net Emissions Before 2050.

5.2 Community emission reduction targets

If City of Greater Dandenong were to adopt the long-term community target of net zero emissions by 2050 then the concept of carbon budgets (see Box 1) can guide the level of action required to manage the transition towards this target.

The Climate Change Authority (CCA) states a global carbon budget, for a 67% probability of limiting global temperature increase to 2°C, of 1,700 $GtC0_2e$ from 2000 to 2050[16].

The CCA proposes that Australia's 'fair share' of this global carbon budget is 10.1 $GtCO_2e$ from 2013 to 2050 and 4.19 $GtCO_2e$ for the period 2013–2020[17]. This leaves a national carbon budget of 5.91 $GtCO_2e$ for the period 2020-2050.

There are a number of options for downscaling and dividing this national carbon budget to derive a carbon budget for the City of Greater Dandenong. One option is to share the carbon budget equally amongst all Australians and derive City Greater Dandenong's share by multiplying the per person allocation by the population of City of Greater Dandenong.

The socio-economic context of the city could also be taken into account (for example, with socio-economically advantaged communities taking on a high proportion of the mitigation effort[18]). Whilst City of Greater Dandenong may benefit from an adjusted (i.e. increased) carbon budget due to its socio-economic status, Victorian cities may also be expected to take on greater action than the national average due to Victoria's relatively high historical emissions resulting from high emissions intensity of the electricity grid.

Box 1: The concept of carbon budgets

A carbon budget is the estimated amount of emissions (tCO_2e) we are 'allowed' to emit whilst still having a likely a chance of meeting the 2°C goal.

There are several approaches to sharing this budget amongst the global community. It is commonly accepted that those countries with historically high emissions and the capacity (relatively high GDP) to curb emissions should emit less (have a smaller future share of the permissible carbon budget) than developing countries with historically low emissions and relatively low GDP. This means that countries like Australia are expected to reduce emissions more steeply and sooner than less developed nations.

A down-scaled carbon budget for City of Greater Dandenong helps to establish the scale of emissions reductions and defines shape of the emissions reduction curve. For example, a more ambitious emissions reduction pathway would use less of the remaining carbon budget.

Historical emissions at the local level could also be considered (for example those cities with higher historical emissions may be expected to take on more of the mitigation effort as the abatement potential in these areas may be higher). However, taking both socio-economic circumstance and historical emissions into account requires each local government area in Australia to provide an emissions inventory to ensure the carbon budgets are achievable in the context of the current emissions profile. This information is not currently available.

The calculation for a potential carbon budget for the City of Greater Dandenong is presented in Table 7 below.

[16] Commonwealth of Australia (Climate Change Authority) 2014, Reducing Australia's Greenhouse Gas Emissions: Targets and Progress Review, Final Report, p.117, available at: http://climatechangeauthority.gov.au/files/files/Target-Progress-Review/Targets%20and%20Progress%20Review%20Final%20Report.pdf

[17] Commonwealth of Australia (Climate Change Authority) 2014, Reducing Australia's Greenhouse Gas Emissions: Targets and Progress Review, Final Report, p.117, available at: http://climatechangeauthority.gov.au/files/files/Target-Progress-Review/Targets%20and%20Progress%20Review%20Final%20Report.pdf

[18] Australian Bureau of Statistics, Socio-Economic Indexes for Australia (SEIFA) 2016, available at: http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/2033.0.55.0012016?OpenDocument

Table 7 - Potential carbon budget

Carbon Budget	Output	Unit
Global Carbon budget (2000-2050)[19]	1,700	Gt CO_2-e
National Carbon Budget for Australia (2013-2050)[20]	10.1	Gt CO_2-e
National Carbon Budget for Australia (2013-2020) [21]	*4.19*	Gt CO_2-e
National Carbon Budget for Australia (2020-2050)	*5.91*	Gt CO_2-e
Australian population (2020)[22]	*25,873,480*	persons
2020-2050 carbon budget/person (2020)	228.30	tCO_2-e
CoGD resident population (2020)	173,000	persons
CoGD % of Australian population (2020)	0.67%	percent
CoGD carbon budget (2020 population)	**39,496,465**	tCO_2-e

Note for Table 7: based on the assumption that Australia's "fair share" emissions target is shared equally across the population and area, population ratios remain constant through to 2050. This carbon budget is consistent with the CCA's analysis of a likely 2°C global warming outcome; the carbon budget will be less if striving for a 1.5 degree increase. This budget is based on the Commonwealth of Australia (Climate Change Authority) 2014, Reducing Australia's Greenhouse Gas Emissions: Targets and Progress Review, Final Report, and does not take into account Council's actual emissions since then.

Under business as usual the City of Greater Dandenong community would have exceeded its 2020-2050 carbon budget of 39.5 $MtCO_2$-e by the year 2030. By 2050, the City would have emitted more than triple the amount of the budget. The estimated BAU emissions at 2030 and 2050 are summarised in Table 8. This highlights urgency in addressing emissions.

Table 8 - CoGD community carbon budget usage based on BAU

CoGD carbon budget versus BAU	tCO_2-e
CoGD carbon budget 2020-2050	39,496,465
Cumulative BAU emissions 2020-2030	42,730,937
Cumulative BAU emissions 2020-2050	141,710,668

An additional way to measure progress towards a long-term goal and chosen level of ambition is to set interim targets. Based on the trajectories modelled, potential emissions reduction targets for monitoring progress have been derived from the abatement analysis. These potential targets, outlined in the Table 9 and Table 10 below, indicate the level of ambition of each scenario.

The Moderate and Accelerated Action scenarios represent varied level of ambition across priority actions identified to reduce emissions from energy supply, buildings, transport and waste. The Accelerated and Moderate scenarios can both meet C40's suggested target for Cities of near carbon neutrality by 2050 with a very small amount of remaining emissions that could be offset to achieve absolute net zero. However, the accelerated action scenario would provide the quickest emissions abatement in line with the Paris Agreement, and allow the community to minimise exposure to potential future carbon regulation and costs, such as from a carbon price and carbon offsetting.

[19] Commonwealth of Australia (Climate Change Authority) 2014, Reducing Australia's Greenhouse Gas Emissions: Targets and Progress Review, Final Report, p.47, available at: http://climatechangeauthority.gov.au/files/files/Target-Progress-Review/Targets%20and%20Progress%20Review%20Final%20Report.pdf.

[20] Commonwealth of Australia (Climate Change Authority) 2014, Reducing Australia's Greenhouse Gas Emissions: Targets and Progress Review, Final Report, p.117, available at: http://climatechangeauthority.gov.au/files/files/Target-Progress-Review/Targets%20and%20Progress%20Review%20Final%20Report.pdf.

[21] Commonwealth of Australia (Climate Change Authority) 2014, Reducing Australia's Greenhouse Gas Emissions: Targets and Progress Review, Final Report, p.9, available at: http://climatechangeauthority.gov.au/files/files/Target-Progress-Review/Targets%20and%20Progress%20Review%20Final%20Report.pdf.

[22] Australian Bureau of Statistics, Population Projections, Australia (Series B). Available at: http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3222.02017%20(base)%20-%202066?OpenDocument.http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3222.02017%20(base)%20-%202066?OpenDocument

Table 9 - Potential targets for CoGD community under the moderate scenario

	Baseline	Moderate Action		
	2017	2025	2030	2050
Absolute Emissions	3.9	3.3	2.6	0.1
	$MTCO_2$-e	$MTCO_2$-e	$MTCO_2$-e	$MTCO_2$-e
% reduction on 2017	-	15%	33%	97%
Per Capita Emissions	24.2	19	12.5	0.3
	TCO_2-e/resident	TCO_2-e/resident	TCO_2-e/resident	TCO_2-e/resident

Table 10 - Potential targets for CoGD community under the accelerated scenario

	Baseline	Accelerated Action		
	2017	2025	2030	2050
Absolute Emissions	3.9	2.9	1.6	0.03
	$MTCO_2$-e	$MTCO_2$-e	$MTCO_2$-e	$MTCO_2$-e
% reduction on 2017	-	26%	69%	99%
Per Capita Emissions	24.2	17	7.6	0.1
	TCO_2-e/resident	TCO_2-e/resident	TCO_2-e/resident	TCO_2-e/resident

6. Corporate emissions abatement actions

6. Corporate emissions abatement actions

6.1 Approach to energy and carbon management

ISO 50001:2011 provides a best practice framework for energy management. The key elements include to:

- Understand the corporate energy consumption of the whole organisation, as per the City's inventory of annual energy consumption and emissions.
- Develop an energy policy on energy management. This is currently reflected in the City's Sustainability Strategy, including with the aim to:
    1. Reduce Council's CO_2-e emissions from street lighting, buildings and facilities by at least 20% by 2020.
    2. Reduce Council's energy consumption from street lighting, buildings and facilities by at least 20% by 2020.
    3. Increase the percentage of energy consumed by Council obtained from renewable sources.

The City's Energy Management Plan and forthcoming Climate Change Strategy are relevant to fulfilling on these aims.

- Review energy consumption to identify significant energy use activities and set up energy baseline, as well as energy performance indicators. The City reports on its annual energy consumption and emissions, with a review included in the Energy Management Plan.
- Set up energy objectives, targets, and implementation plans. The Energy Management Plan is the main plan at present, with this Mitigation Report providing information.

The energy hierarchy provides a useful approach to prioritising energy and emissions abatement opportunities. It identifies the most cost-effective options to generally be 1. Reduce energy use through behaviour change, 2. Improve energy efficiency, 3. Renewable energy and 4. Carbon offsets.

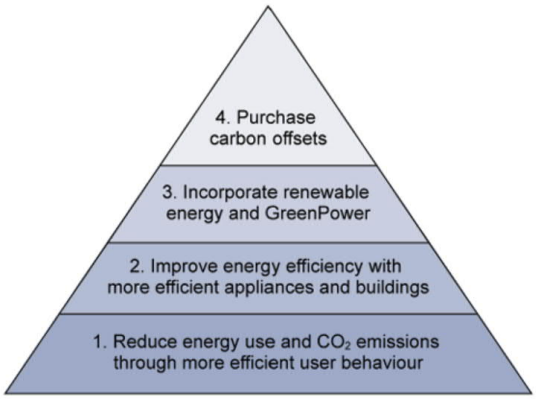


Figure 16 - Energy hierarchy[23]

[23] Source: Commonwealth of Australia, 'Carbon zero, carbon positive', 2013

6.2 Key objectives for corporate climate actions

Key objectives for high-impact emissions abatement actions are outlined in Table 11. These can be scaled to an ambitious 'accelerated' pathway of action, in line with net zero emissions by 2050. The framework for these pathways and objectives is further detailed in section 8 of this report (which focuses the objectives of the Community emissions Profile). We present below a similar set of actions to enable the Council to align its own corporate emissions abatement objectives with those of the community emissions abatement objectives.

Table 11 - Key objectives for Council

Category	Key objectives
Buildings and Facilities	New council buildings to aspire to be carbon neutral by 2030, aiming for NABERS 5 Star ratings where possible
	All existing council buildings to be carbon neutral* by 2050
Energy	Facilitate more efficient behaviour and use of more energy efficient equipment such as lighting, controls and equipment for heating, ventilation and air conditioning
	Facilitate corporate PPA's (Power Purchasing Agreements) for council energy use
	Encourage and support uptake of innovative renewable energy technologies
	Advocate for a more ambitious Victorian and Federal Government renewable energy targets (RET)
	Plan and partner for electrification of energy supply to council assets**
Transport	Encourage and support staff and contractors to increase sustainable transport mode choices.
	Council fleet to be powered by renewable energy/electricity by 2050
Waste	Work to reduce emissions from council waste
	Work to reduce emissions from construction and development waste

** A Carbon Neutral building can be defined as one with significantly reduced energy consumption combined with renewable energy sources and offsets to meet remaining demand*

*** Electrification means increasing use of electricity for vehicles, heating and other functions that have traditionally relied on fossil fuels*

6.3 Energy efficiency and onsite renewables

In 2017, CoGD developed a Building Energy Management Plan (BEMP) across most of the portfolio of Council Buildings. This identified and quantified building improvement opportunities to achieve reductions in greenhouse gas emissions, energy costs and other operational and maintenance costs associated with facility management.

The energy audits examined 18 buildings across the CoGD portfolio. Each energy audit, through analysis of building operations, energy and equipment data analysis, staff consultation, day and night audits and documentation reviews resulted in the development of a series of recommended Energy Conservation Measures (ECMs) for consideration, as follows:

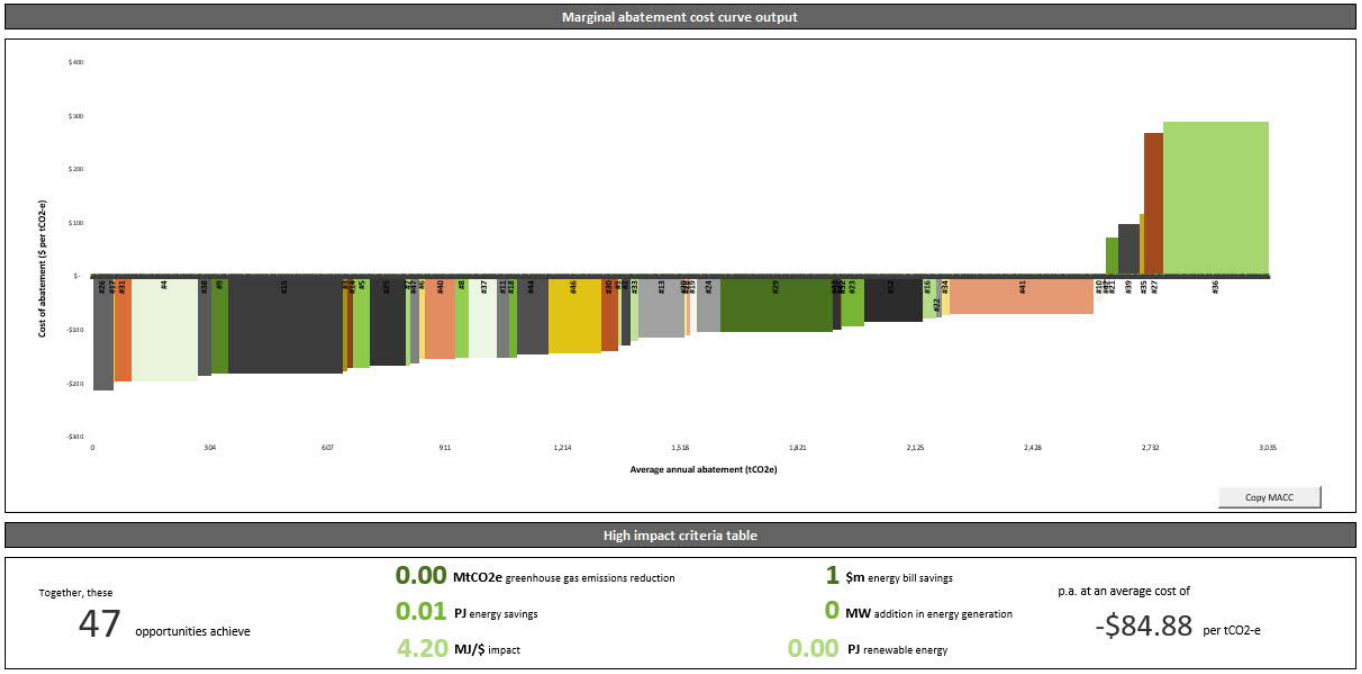
Table 12 - Identified opportunities from Building Energy Management Plan

Technology	Investment ($)	Annual Savings ($)	GHG Savings (t GHG)	NPV ($)	Simple Payback (Years)
Controls	75,609	34,191	251	403,290	2.21
Lighting	1,432,821	382,810	1,307	2,908,758	3.74
Mechanical	131,860	38,844	372	424,028	3.39
Other	42,500	9,812	36	103,514	4.33
Solar	3,359,455	326,576	3,327	1,293,239	10.29
Total	**5,042,245**	**792,233**	**5,294**	**5,132,829**	**6.36**

Source: City of Greater Dandenong Building Energy Management Plan, 2017

EY has also mapped out a more comprehensive set of opportunities against the CoGD's corporate stationary energy consumption (in buildings). Figure 17 shows a Marginal Abatement Cost (MAC) curve for a long list of opportunities, based on EY's experience. The MACC is explained further in the Appendices to this report. This shows a range of low cost abatement opportunities across lighting, controls, boilers and building energy management systems. Sorted by abatement cost, the following opportunities stand out:

- Lighting – Upgrading to LED lighting is an effective strategy for cost reduction.
- Controls – Improved controls of variables such as timing and temperature, identified particularly for compressed air systems, refrigeration and cooling, Heating, Ventilation and Air Conditioning (HVAC) and IT equipment.
- Upgrades to high efficiency boilers, used to produce hot water and for some larger sites, steam.
- Building management system controls.



- Each bar represents a greenhouse- gas emissions abatement opportunity across the City of Greater Dandenong.
- The width of the bar represents the potential annual greenhouse gas emissions abatement for this opportunity, on average over the opportunity life.
- The horizontal axis presents the cumulative greenhouse- gas emissions abatement in tonnes of carbon dioxide equivalent (tCO_2-e) aggregating all the abatement opportunities from the lowest to highest cost.
- The height of the bar represents the cost to reduce the greenhouse- gas emissions by one tonne of carbon dioxide equivalent (tCO_2-e) with this opportunity.
- The abatement opportunities are plotted left to right in order from lowest to highest cost of abatement.
- Note that the tCO_2e is 3,035 thus why the $MtCO_2e$ is showing 0.00 (as it only shows to 2 decimal places).

Figure 17 - CoGD corporate marginal abatement cost curve

Table 13 describes the types of measures identified for the CoGD portfolio of buildings.

Table 13 - Identified energy conservation measures from CoGD Energy Management Plan

Energy conservation measures	Specification
Building Controls Optimisation	Building Controls Optimisation involves improving equipment performance efficiency to reduce operational costs through the Building Management System (BMS). Examples of this can include ► Increasing zone and temperature set point dead bands ► Optimising heating and cooling schedules to better reflect zone utilisation ► Improving operational synergies between building mechanical and electrical equipment. These upgrades often involve BMS programming works and sensor installations, and generally do not require substantial physical modifications.
HVAC Scheduling	HVAC Scheduling involves improving building air-conditioning and heating schedules to optimise air-conditioner operation to building demand through the BMS. This ensures that HVAC equipment is only operating when required, with operation reflecting occupancy requirements within each zone. Upgrades involve BMS programming works do not require substantial physical modifications.
Pump & Fan Optimisation	Pump and Fan Optimisation generally involves reducing the energy consumption of pump and fan motors through the installation of Variable Frequency Drives (VFDs). VFDs allow motors to operate more efficiently by only operating at speeds that are required during part-load conditions. This measure can also incorporate scheduling improvements for smaller motors where VFDs are not feasible; to reduce unnecessary usage. VFD upgrades will require some physical modification, while scheduling improvements will be programming only.
AC Economy Cycle Upgrade	The AC Economy Cycle Upgrade involves retrofitting motors to existing air-conditioning outside air dampers. This provides the capability to make use of outside air when it is within the desired set point temperature range for the space it is cooling. As the outside air is already at the desired temperature no additional energy needs to be used to cool it. The default strategy uses the minimum quantity of outside air required by standards and recirculates the remainder which requires cooling.
Parallel Pumping Strategy	This recommendation involves transitioning the pumping operation for the water pumps serving buildings from duty-standby to a parallel strategy. This allows the pumps to operate together at a lower speed, producing significant energy savings. These upgrades often involve BMS programming works and may require some pipe modifications.
Power Factor Correction	Power Factor Correction technology improves the power factor and therefore the quality of incoming electricity, resulting in electricity demand savings. Some buildings have an existing power factor as low as 0.84, with the ideal Power Factor being 1. This involves installing power factor correction units on incoming grid electricity to reduce the ratio of real power (useable) to reactive power (unusable). This only applies to buildings with a kVa demand charge which is generally for larger sites.
Solar Photovoltaics	Rooftop Solar photovoltaics provide significant energy cost reductions through localised electricity generation. Solar installations are best suited to buildings with the following: ► Unencumbered roof space ► Minimal to no shading from nearby buildings or trees ► North facing or flat roofs. If solar energy is generated in excess of building demand, this can either be exported back to the electricity grid for a monetary return or used in conjunction with a battery system to load-shift to off-peak periods. Solar installations generally involve the installation of solar panels, inverters and potentially switchboards depending on existing electrical infrastructure. While no battery systems were considered feasible during the energy audits, it should be noted that both solar PV and battery technologies are relatively new and rapidly decreasing in price. Therefore, if these options are revisited in a couple of years they are likely to be significantly cheaper to implement.

Energy conservation measures	Specification
LED Lighting Upgrades	LED lighting replacements can provide savings of 50% over current fluorescent lighting technology, in addition to possessing a lifetime of approximately 50,000 hours. Generally, about 5x longer than compact fluorescent lamps and 2.5 for linear fluorescent lamps This recommendation generally involves replacement of existing non-LED lighting with high efficiency LED lighting in addition to the installation of occupancy and daylight sensors where applicable. Sensors ensure that lighting is only in operation when required. Lighting that has already been upgraded to LED will only undergo sensor upgrades if not already in place.
Pool Covers	Installing pool covers on indoor pools will result in reduced water evaporation and chemical use, as well as a reduction in energy consumption due to more efficient space air conditioning. This upgrade involves installing a new pool cover and in the case of the Noble Park Aquatic Centre utilising the existing pool cover winch for pool cover removal.
Contract Negotiation	This measure, while not technically energy saving, involves negotiations with the energy utility to ensure that off-peak energy is not purchased by CoGD. Off-peak energy supplied by Cogent is sold at a significant premium to grid supplied off-peak energy and should only be supplied if requested by CGD. This measure will save money and prevent future unnecessary expense.

7. Community emissions abatement actions

7. Community emissions abatement actions

Ambitious emissions reductions are required to meet the ambition of the Paris Agreement of limiting global temperature rise to well below 2°C above pre-industrial levels, to pursue efforts to limit the temperature increase even further to 1.5°C, and to achieve net zero emissions by the end of this century.

This section of the report summarises the abatement modelling conducted by EY, illustrating potential emission reduction pathways for the City of Greater Dandenong.

7.1 Climate action scenarios

Three emissions reductions scenarios were modelled relative to a business-as-usual (BAU) baseline. These scenarios, illustrated in the chart below, are:

- Business-as-usual (BAU).
- Minor action.
- Moderate action.
- Accelerated action.

The BAU takes into consideration a limited number of existing and planned policies, and forecasts annual emissions for the municipality to 2050. As with any future forecasts over this length of time there is a high degree of uncertainty associated with the BAU trajectory.

The Moderate and Accelerated Action scenarios represent varied level of ambition across priority actions identified to reduce emissions from energy supply, buildings, transport and waste. The Accelerated and Moderate scenarios can both meet C40's suggested target for Cities of near carbon neutrality by 2050 with a very small amount of residual emissions that would need to be offset in order to achieve absolute net zero. However the Accelerated Action scenario would provide the quickest emissions abatement in line with the Paris Agreement, and allow the community to minimise exposure to potential future carbon regulation and costs, such as from a carbon price and carbon offsetting.

The Minor action scenario assumes less ambitious climate action which would later increase the need and cost to offset the emissions inventory in a given year. This scenario is not compliant with C40's Climate Action Planning Framework, which considers the use of offsets as a last resort to cover residual emissions only after a concerted effort has been made to reduce emissions within the City boundary. The figure below shows the different scenarios, which are explained further in the Section 8 of this report.

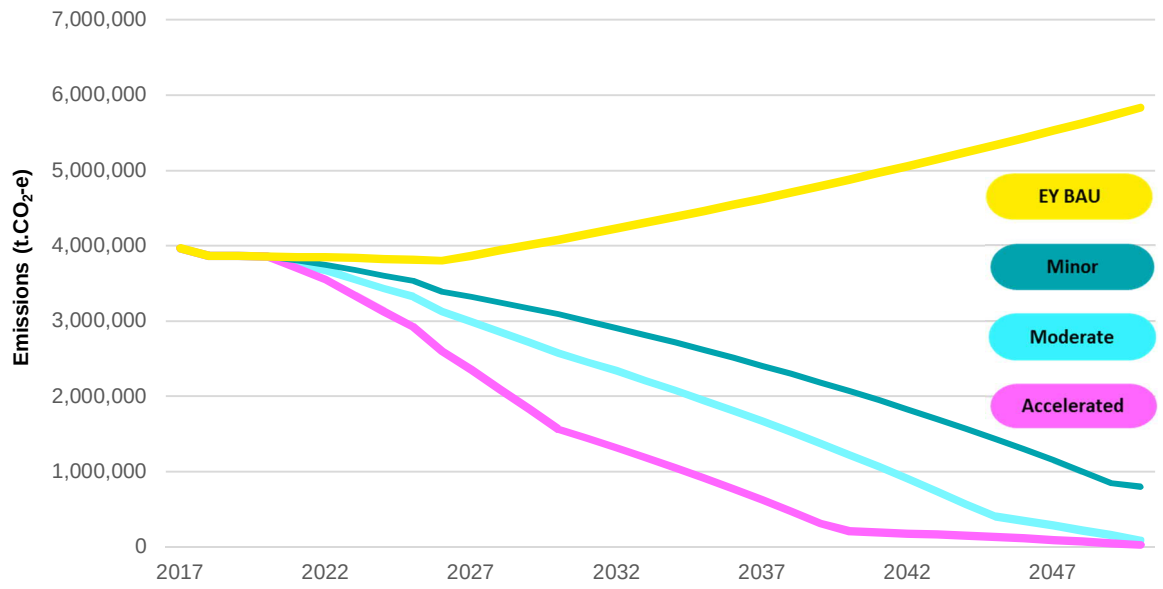


Figure 18 - Scenarios for emissions abatement

7.2 Prioritisation of climate actions

EY prioritised climate actions using a multi criteria assessment, to suggest actions that work towards the 1.5°C to 2°C goal. The assessment used a framework to evaluate the impact of emissions abatement, Council powers, action scalability, and co-benefits relating to the socioeconomic priorities and obstacles for the City of Greater Dandenong. It was informed by EY's previous work on Local Government emissions profiles and an in-depth literature review covering relevant C40 research and beyond.

The framework is designed to ensure each of the City's climate actions is assessed in terms of **climate impact, feasibility, power, scalability, and co-benefit creation.** These five pillars are described below in Table 14.

Table 14 - Five pillars of prioritisation for climate actions

Climate Impact	Climate Impact captures information relating to what impact will the action have in terms of: ► Climate Change Mitigation – emissions reductions potential (tCO_2-e) ► Climate Change Adaptation – improved resilience or risk reduction potential.	
Feasibility	Information relating to financial costs or financial savings are used to determine the cost per tonne of abatement. Other financial metrics such as Net Present Value (NPV) and simple or discounted pay-back periods can be calculated using this information. The Feasibility section also covers the potential risks and barriers to implementation.	
Power	The Power section assigns a level of authority to indicate City of Greater Dandenong's ability to influence successful implementation of each action. The level of authority is calculated based whether the City: ► Owns/operates ► Sets/enforces policies and regulation ► Controls budget ► Sets vision. It takes into account the roles and responsibilities of the City of Greater Dandenong vis-à-vis other levels of government is relation to the delivery mechanism associated with the action.	
Scalability	Scalability looks at to what extent and within what timeframes could the intervention be scaled up from a pilot scale to a city-wide intervention. It captures information relating to lead in times and phased level of ambition.	
Co-benefit Creation	What impact (positive or negative) does the action have in relation to other city priorities regarding social, economic and environmental value creation.	
	► **Social** ► Physical health ► Mental health ► Citizen participation ► Social capital ► Affordability, access and inclusion ► Safety ► Attractiveness and heritage ► Education.	► **Economic** ► Economic prosperity ► Employment ► Economic innovation. ► **Environmental** ► Biodiversity ► Air quality.

7.3 Objectives for community climate actions

Objectives are proposed for each category in Table 15. These objectives can be scaled to an ambitious 'accelerated' pathway of action, in line with net zero emissions by 2050.

Each objective is supported with more specific climate actions that help to facilitate the realisation of the objectives. Suggested Enabling Actions are outlined in Appendix A.

The approach considered the major sources of emissions in the community emissions profile and grouped under four main categories:

- Buildings
- Energy
- Transport
- Waste (including Food).

Table 15 - Key objectives for Council to address community emissions

Category	Headline objectives
Buildings	Council to advocate for all new buildings to be carbon neutral* by 2030 with Federal and State Government
	Advocate for all existing buildings to be carbon neutral by 2050 with Federal and State Government
	Plan and partner for electrification of energy supply to the community**
Energy	Facilitate residents' uptake of renewable energy products
	Facilitate corporate PPA's (Power Purchasing Agreements)
	Incentivise innovative renewable energy technologies
	Advocate for a more ambitious renewable energy target (RET)
Transport	Promote a mode shift from driving to walking and cycling
	Advocate for all public transport to be powered by renewable energy
	Advocate for lower emissions intensity of motor vehicles and support the City's transition to electric vehicles
Waste	Work to reduce emissions from commercial and industrial waste
	Work to reduce emissions from residential waste
	Work to reduce emissions from construction and development waste

** A Carbon Neutral building can be defined as one with significantly reduced energy consumption combined with renewable energy sources and offsets to meet remaining demand*

*** Electrification means increasing use of electricity for vehicles, heating and other functions that have traditionally relied on fossil fuels*

7.3.1.1 Buildings

In the City of Greater Dandenong, buildings represent a significant proportion (around 78%) of the community emissions profile.

For the CoGD to move towards a 1.5-degree future aligned to the Paris Agreement, is likely to require carbon neutrality for new and existing buildings by 2050. This requires a collaborative effort by the Council, the community and its businesses to implement the high-impact headline actions identified below. Aiming for best practice with an accelerated pathway would align to the Green Buildings Council of Australia's (GBCA) Carbon Positive Roadmap which aims for best practice with all new buildings to be carbon neutral by 2030 and all existing buildings by 2050[24]. This can be achieved through low, moderate and accelerated levels of action, which are outlined in Table 16 below.

The table below provides examples of key objectives for each level of ambition.

[24] GBCA Media Release, Carbon Positive Roadmap. Available at: https://new.gbca.org.au/news/gbca-media-releases/carbon-positive-roadmap-will-pave-way-climate-action/

Table 16 - Buildings - Key objectives for Council to support reduction of community emissions, by scenario

Objectives	Minor	Moderate	Accelerated
Advocate for all **new** buildings to be carbon neutral by 2030	40% by 2030 80% by 2050	50% by 2030 100 % by 2050	100% by 2030 100% by 2050
Advocate for all **existing** buildings to be carbon neutral by 2050	15% by 2030 80% by 2050	20% by 2030 100% by 2050	50% by 2030 100% by 2050
Plan and partner for **electrification** of energy supply to the community[25]	20% by 2030 70% by 2050	50% by 2030 99% by 2050	70% by 2030 63% by 2050

Key Assumptions

- A Carbon Neutral building can be defined as one with significantly reduced energy consumption combined with renewable energy sources and offsets to meet remaining demand)
- Electrification means increasing use of electricity for vehicles, heating and other functions that have traditionally relied on fossil fuels
- Moderate/Accelerated Energy Supply actions are achieved before achieving these actions
- 40% of estimated building emissions abatement is associated with energy efficiency improvement; the remaining 60% of buildings emissions abatement is represented in the trajectories as relating to energy supply
- GBCA Carbon Positive Roadmap targets carbon neutrality for 100% of new buildings by 2030 and 100% of existing buildings by 2050 (this is modelled in the Accelerated Action scenario). These targets have been applied to both commercial and residential buildings despite the GBCA roadmap targeting commercial buildings only. GBCA are intending to release a road map for residential buildings in the future.
- Existing building stock energy intensity is calculated based on electricity consumption and floor space area data.
- Floor space provided by CoGD in 2018, extrapolated to 2050 for residential, commercial, industrial and other space. The proportion of new floor space was indexed by population.
- Gas to electric substitution assumes gas is being replaced with renewable electricity.
- Scoring is summarised in the Appendix A.

Each figure below indicates the abatement potential associated with each Key Objective under the Low, Moderate and Accelerated Intervention Scenarios. For i) Residential and ii) Commercial (and Industrial) buildings.

Commercial/industrial buildings represent the larger share of consumption and abatement potential (refer to the Marginal Abatement Cost analysis in this report). There are significant GHG & financial savings to be made for the community if these targets were to be aimed for / reached. Providing win-win solutions and making the community increasingly resilient.

Residential buildings represent an increasingly significant abatement opportunity as new residential building are built to accommodate the forecast increase in resident population. Electrification of buildings is also assumed. This is represented on the figures as an action to support the transition from natural gas to electricity.

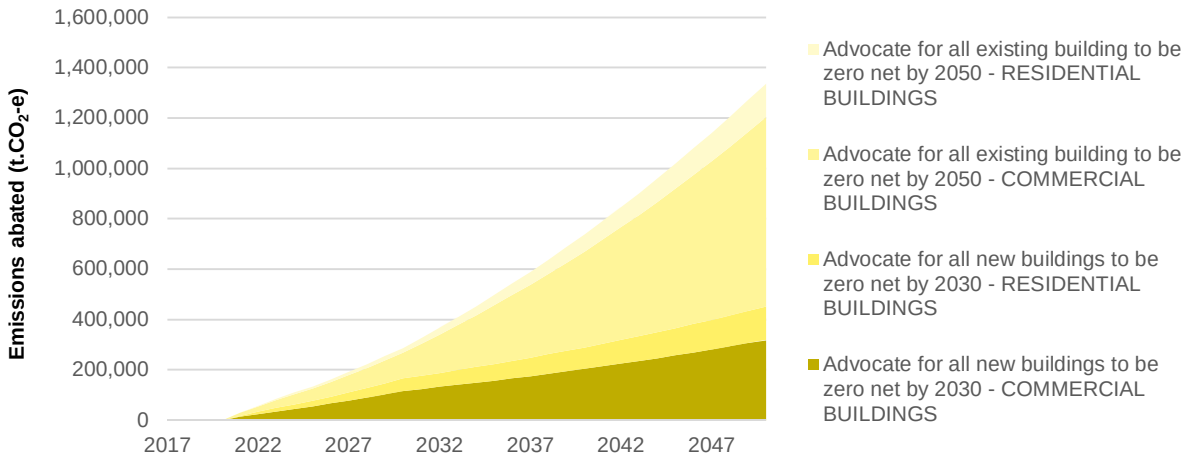


Figure 19 - Buildings minor intervention scenario

[25] Percentages may vary according to the trajectories for objectives under different scenarios.

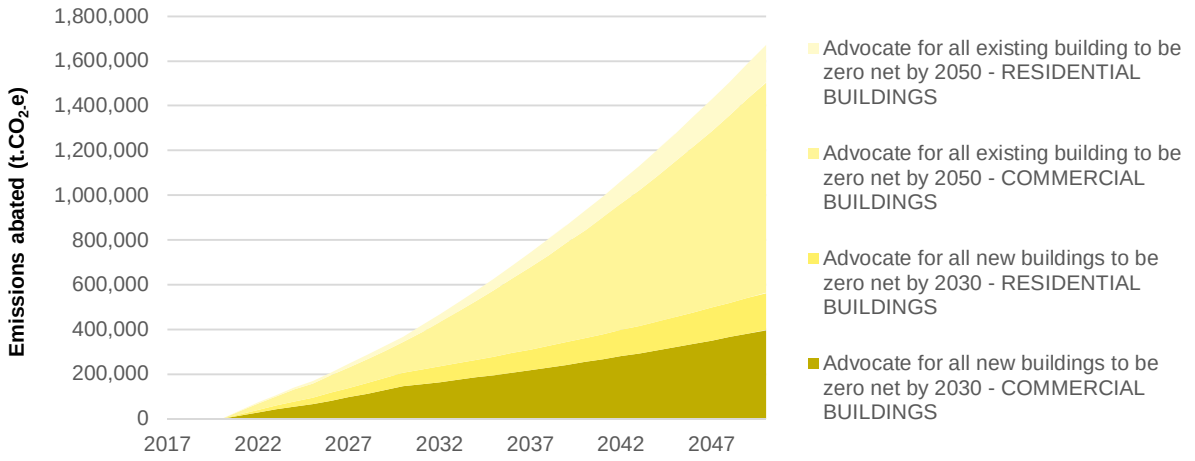


Figure 20 - Buildings moderate intervention scenario

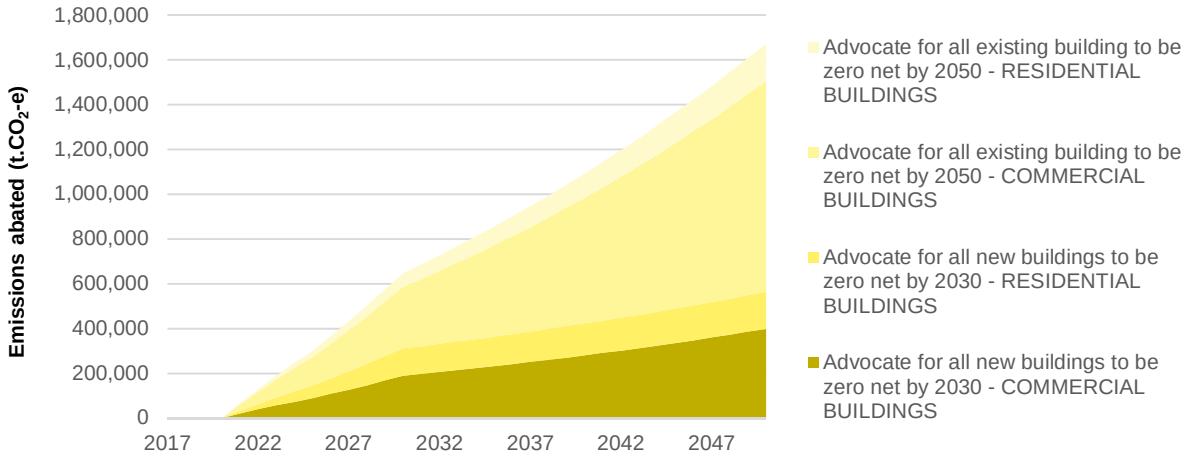


Figure 21 - Buildings accelerated intervention scenario

While we model the effect of the Renewable Energy Target on business as usual emissions, we do not assume a full phase out of coal under the business as usual scenario.

7.3.1.2 Energy

As a result of a high reliance on coal, the Victorian electricity grid has the highest emissions intensity of any Australian state or territory of 1.18 t.CO_2-e/GJ (Scope 2 and 3 emissions inclusive). Therefore, decarbonisation of the electricity grid is an important contributor to the City of Greater Dandenong's vision to be one of the most sustainable cities in Australia by 2030. The energy-related actions have been broken down into four key objectives in Table 17.

Table 17 - Energy - Key objectives for Council to support reduction of community emissions, by scenario

Objectives	Minor	Moderate	Accelerated
Set out an ambitious Greater Dandenong community renewable energy target (CoGD RET) while advocating for more renewable energy from State (VRET) and Federal government.	2.5% renewable energy target annual growth rate beyond 2025	3% renewable energy target annual growth rate beyond 2025	4% renewable energy target annual growth rate beyond 2025
Facilitate Corporate **Power Purchase Agreements**	100 GWh by 2050 (50% achieved by 2030)	200 GWh by 2050 (50% achieved by 2030)	300 GWh by 2050 (50% achieved by 2030)
Incentivise innovative **renewable energy** technologies to supply electricity across all sectors	25 GWh by 2050 (20% achieved by 2030)	50 GWh by 2050 (20% achieved by 2030)	100 GWh by 2050 (60% achieved by 2030)
Facilitate CoGD residents' uptake of **renewable energy** products	10 GWh by 2050 (45% achieved by 2030)	20 GWh by 2050 (50% achieved by 2030)	40 GWh by 2050 (63% achieved by 2030)
Key Assumptions			
► The Renewable Energy Target achieves 40% renewables by 2025, i.e. the target is achieved in full ► Energy demand under a more ambitious Renewable Energy Target excludes supply from other actions ► Scale of ambition of PPAs is 1 to 3.5 times (from low to accelerated scenarios) the size of the Melbourne Renewable Energy Project (MREP). The 14 MREP members (including City of Melbourne, City of Port Philip and City of Yarra) have committed to purchase 88 GWh of electricity per year from a long-term Power Purchasing Agreement[26].			

Opportunities include for the CoGD to:

► Set out an ambitious renewable energy target (RET) while advocating for more renewable energy from State and Federal government. This will signal to businesses and residents the clear intentions of Council. This action has the highest abatement potential under the Energy category of actions.

► Partner to help to facilitate Power Purchase Agreements (PPAs), effectively lowering utility costs and monetising assets, working with the industrial and commercial business community.

► Help to transform parking lots, roofs and properties into a new source of renewable energy development. This could include incentivising key industry stakeholders to increase their uptake of renewable and low-carbon technology.

► Leverage existing incentive programs and State and Federal run initiatives to support this transformation.

► Additional actions identified in Appendix 1, such as to facilitate increased awareness amongst residents and businesses of energy efficiency opportunities.

The RET provides the greatest opportunity for emissions abatement. Currently, the Victorian State Government is the policy maker for the RET. Contributions to decarbonising the grid could come through the CoGD leading by example with target setting, advocacy and facilitation of PPAs across all sectors (residential, commercial and industrial), promoting residential purchasing of renewable energy, or supporting green infrastructure such as smart grids. EY modelling includes some accounting to avoid double counting of PPAs and a more ambitious renewable energy target. Figure 22 to Figure 24 below indicate the abatement potential associated with each priority Energy action under the Low, Moderate and Accelerated Intervention Scenarios.

[26] City of Melbourne, 2018, 'Melbourne Renewable Energy Project: A new generation of energy'

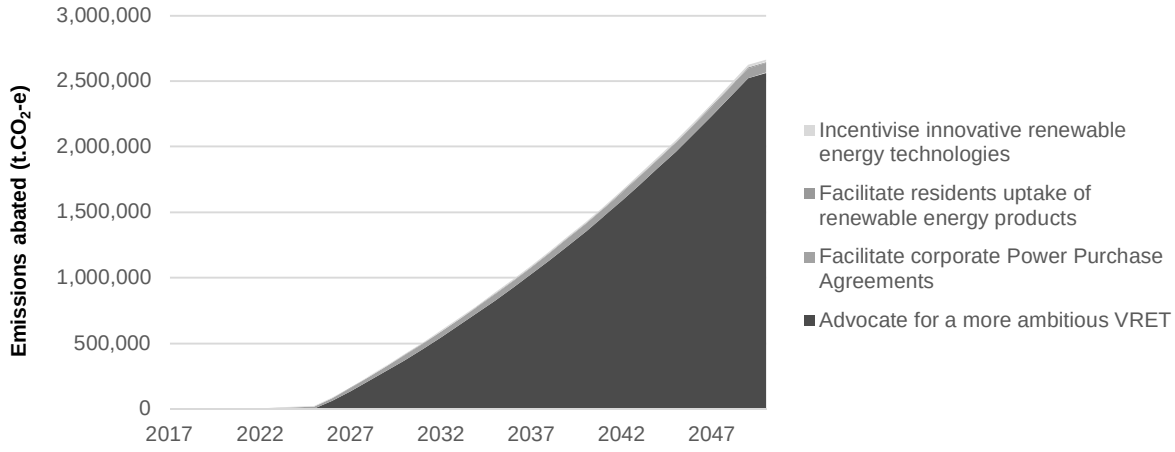


Figure 22 - Energy minor intervention scenario

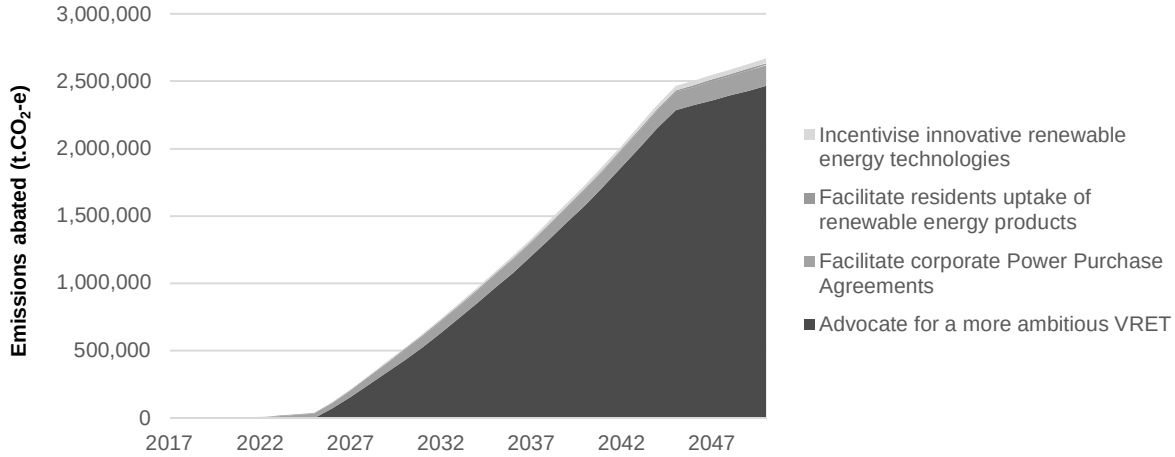


Figure 23 - Energy moderate intervention scenario

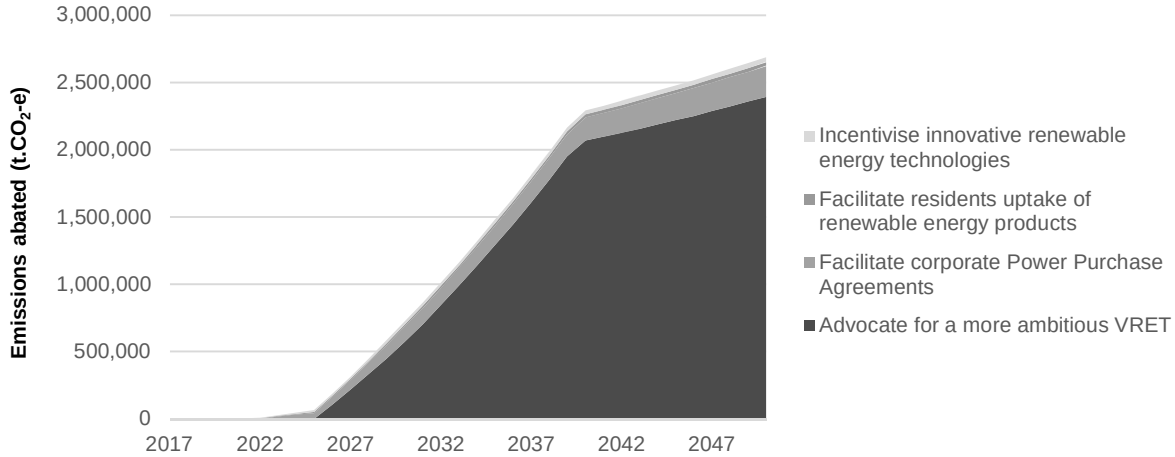


Figure 24 - Energy accelerated intervention scenario

7.3.1.3 Transport

Transport-related objectives are broken down into sub-categories in Table 18.

Table 18 - Transport - Key objectives for Council to support reduction of community emissions, by scenario

Objectives	Minor	Moderate	Accelerated
Promote a mode shift from driving to walking and cycling	10% by 2030 20% by 2050	15% by 2030 25% by 2050	30% by 2030 40% by 2050
Advocate (such as to state government) to improve public transport options including to be powered by renewable energy	25% by 2030 100% by 2050	40% by 2030 100% by 2050	80% by 2030 100% by 2050
Advocate for lower emissions intensity of motor vehicles and support the City's transition to electric vehicles	15% decrease in emissions intensity by 2030 75% decrease in emissions intensity by 2050	20% decrease in emissions intensity by 2030 80% decrease in emissions intensity by 2050	50% decrease in emissions intensity by 2030 100% decrease in emissions intensity by 2050
Key Assumptions			
► Moderate/Accelerated Energy actions are achieved ► 2% annual improvement in private vehicle fuel efficiency.			

The Figures below show the abatement potential associated with each Transport action using the Low, Moderate and Accelerated Intervention Scenarios.

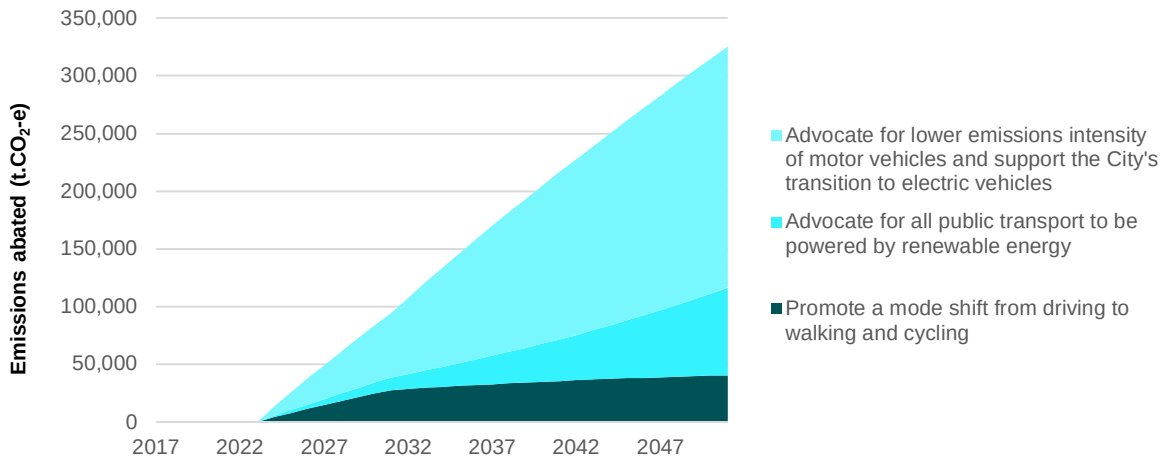


Figure 25 - Transport minor intervention scenario

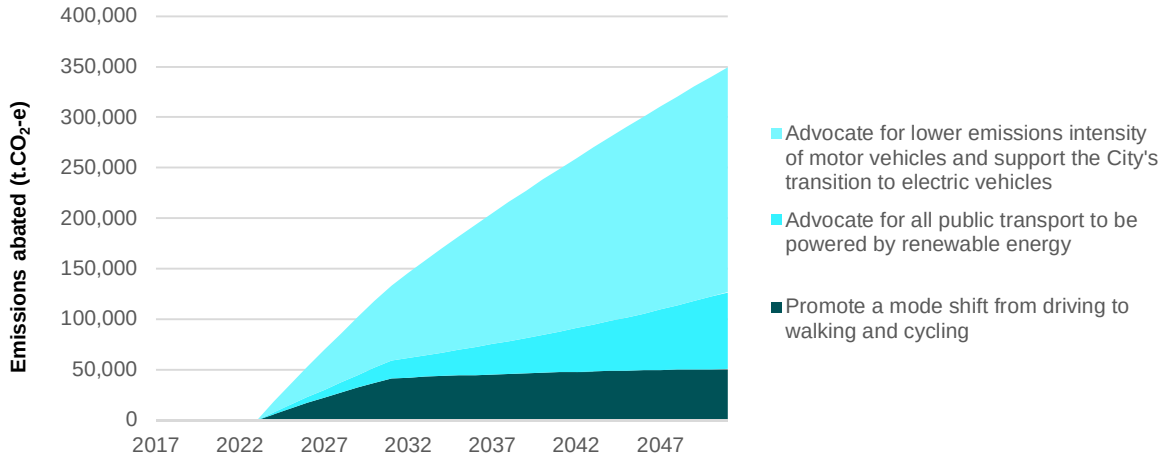


Figure 26 - Transport moderate intervention scenario

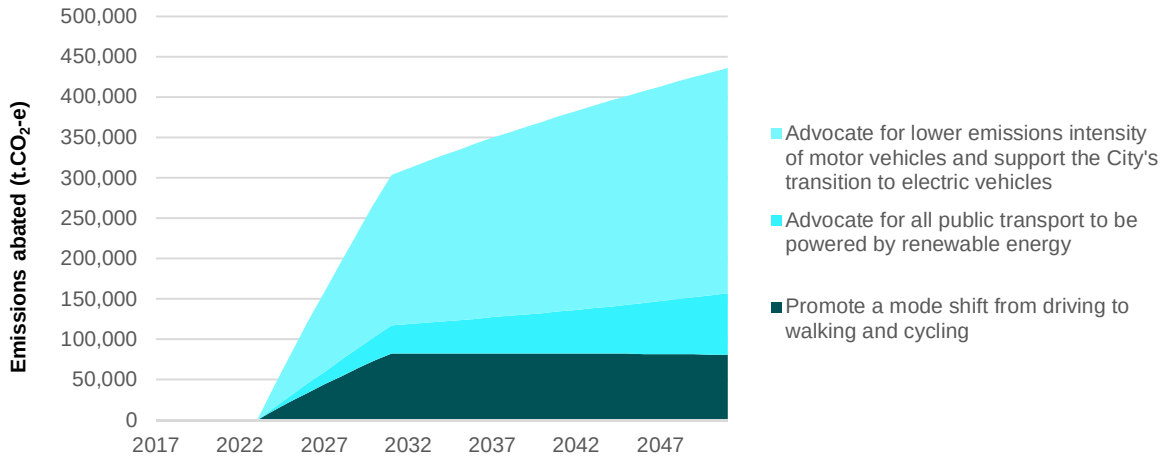


Figure 27 - Transport accelerated intervention scenario

7.3.1.4 Waste

Waste means waste to landfill such as household, commercial and industrial waste, green waste and hard rubbish collections. Emissions from waste account for approximately 13% of total corporate emissions and approximately 10% of total Community emissions for the City of Greater Dandenong.

The waste-related actions have been broken down into three headline actions (refer to Table 19). Actions such as decreasing landfill waste, prolonging the longevity of food and promoting healthy and sustainable agricultural practices are helpful to reduce long-term waste.

Table 19 - Waste - Key objectives for Council to support reduction of community emissions, by scenario

Objectives	Minor	Moderate	Accelerated
Work to reduce emissions from commercial and industrial waste	75% by 2030 80% by 2050	80% by 2030 85% by 2050	90% by 2030 90% by 2050
Work to reduce emissions from residential waste	40% by 2030 65% by 2030	45% by 2030 80% by 2050	65% by 2030 90% by 2050
Work to reduce emissions from construction and development waste	80% by 2030 85% by 2050	85% by 2030 90% by 2050	95% by 2030 95% by 2050
Key Assumptions			
► Waste stream composition is assumed to be constant ► Baseline diversion rate for commercial and industrial waste is 72% in FY17 ► Baseline diversion waste is 30% in FY17 ► Baseline diversion rate for construction and development waste is 76% in FY17.			

The Figures below show the emissions abatement potential associated with each waste objective under the Low, Moderate and Accelerated Intervention scenarios.

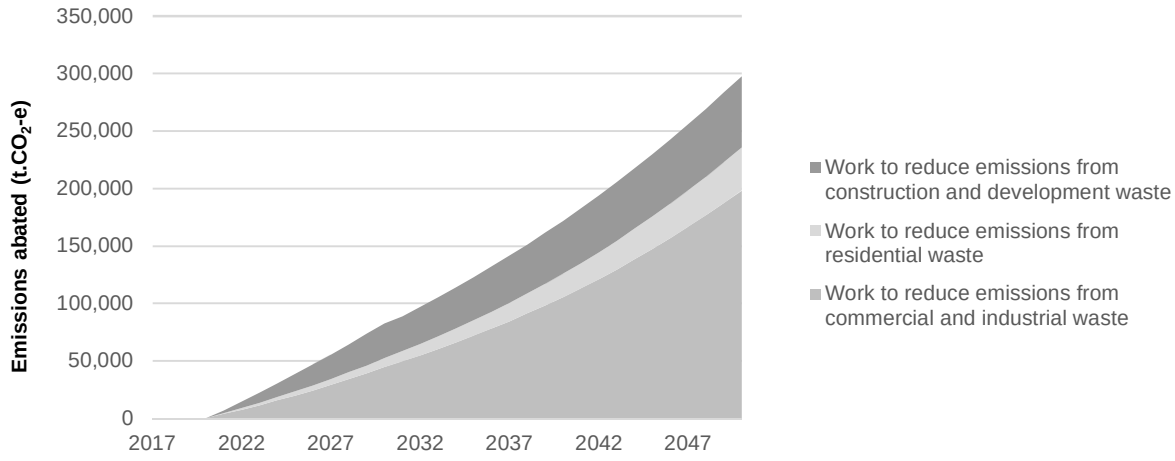


Figure 28 - Waste minor intervention scenario

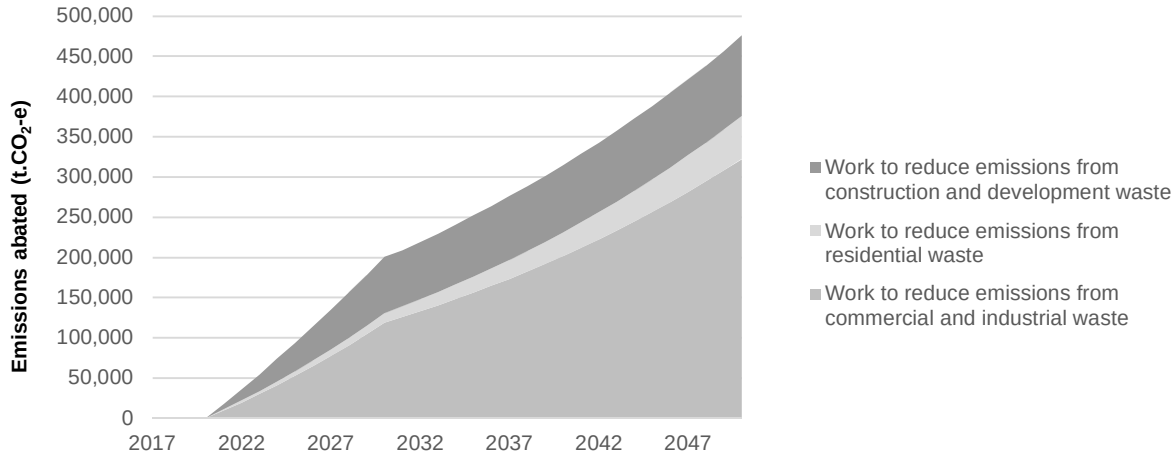


Figure 29 - Waste moderate intervention scenario

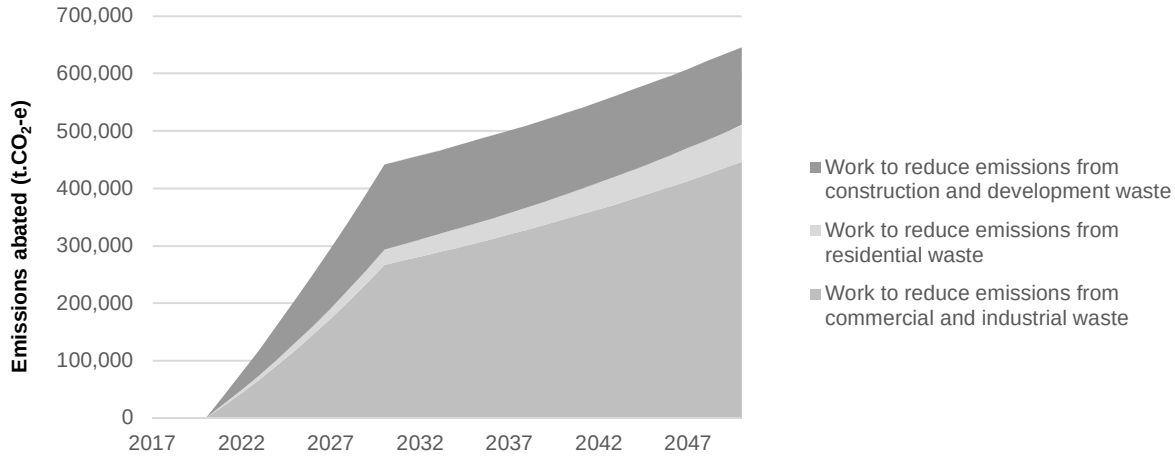


Figure 30 - Waste accelerated intervention scenario

7.3.2 Barriers to climate actions

In considering what climate actions the CoGD could undertake, it is useful to consider common barriers to local government that could impede progress. Addressing these barriers can then enable effective action. ICLEI's Local Government Climate Review (2018) identifies key challenges for Local Government to be:

- **A lack of funding and resourcing** as the most significant barriers to reducing emissions in both corporate and community efforts. A large number of councils have **no budget officially allocated** to reduce emissions.
    - Enablers to budgeting include informing councils about the challenges of climate change and opportunity for climate action planning, to seek budget allocation for the coming financial years.
- Councils and communities **need state and federal support** to deliver effective strategies to reduce community emissions.
    - Working in partnership with State and potentially Federal Government, as well as community stakeholders, can help to share the resourcing requirements and provide support to deliver effective strategies to reduce community emissions.
- The **scale of investment, related costs** and emissions outcomes are **not well understood.**
    - Studies to estimate the scale of costs and benefits, such as through more detailed social and economic assessments, can help to address this challenge.
- Emissions reduction budgets are correlated to overall population and economic profiles. This sets limits on resources.
    - Successful climate action at the community scale requires partnership with community and government stakeholders to drive action. The list of climate actions in the Appendix provide examples of how Council can drive change.
- The institution of local government also presents some challenges, such as with the short-term horizon of elected members.
    - This will require gradual change over time, aided by increased partnerships as identified above, to support local government in addressing such big issues as climate change.

Market barriers

Key market barriers that EY has identified that relate to energy efficiency and renewables include:

- **Limited availability and/or access to information** relating to climate change mitigation because the benefits of this information extend far beyond the geographical and operational boundaries of Council investment. The City of Sydney however has shown how local government can target barriers to energy efficiency investment.
- **Inability to transform community awareness into action** due to economic and cultural constraints within the community.
- **Externalities of progress** whereby investing in improved road infrastructure and constructing waste recovery and management centres actually results in a greater emissions output due to construction.
- **Split incentives** between tenants and owners. This has a strong presence in office and retail building types.
- **Motivation** where energy efficiency might not be perceived a priority. Particularly in less competitive property markets e.g. for industrial buildings.
- **Capital constraints** such as access to finance.

With these barriers comes opportunities for addressing them. The Commonwealth and State Government are actively working to address such barriers (EY is currently working at both levels) and there is a question as to what is Local Government's role to best support addressing such barriers. The City of Sydney has developed some leading sector strategies, focussed on reducing energy use and emissions in key buildings sectors. Underpinned by a Theory of Change approach to using different policy options for driving energy and emissions reductions. This serves as an example that CoGD could follow. City of Melbourne has also taken the lead in applying C40's Climate Action Planning framework, which we draw upon in this report. The proposed actions in Appendix 1 identify some specific actions for CoGD that can help to better identify and address barriers to energy reductions in the CoGD community.

7.4 Abatement modelling

Further detailed analysis is presented to support the previous findings and provide additional perspectives on abatement actions. This includes:

- Multi-criteria analysis of climate actions.
- Analysis of technology specific energy efficiency and solar PV opportunities via a Marginal Abatement Cost Curve (MACC).
- Analysis of a potential science-based target.

7.4.1 MACC analysis

The purpose of the Marginal Abatement Cost Curve (MACC) analysis was to provide a separate analysis of technology- specific energy efficiency and solar PV opportunities, by sector, for the community emissions of the CoGD. The focus is on identifying the abatement potential of these technologies in the existing building stock.

The analysis was focused on the City's industrial, commercial and residential sectors, which fits under the broader Community (emissions) Profile actions heading of 'buildings'. The emissions abatement analysis outlined in this section establishes an indication of the abatement potential and costs for emissions reduction initiatives and energy saving activities.

The MACC provides estimates of key headline metrics that include:

- Return on Investment
- Payback
- Emissions reductions (annual)
- $ Cost per tCO_2e of abatement
- Number of opportunities by sector.

The MACC charts illustrate that there is a large potential for the City of Greater Dandenong to reduce its GHG emissions associated with the operation of buildings in the industrial, commercial and residential sectors. They present the average annual amount of emissions reduction in tonnes of carbon dioxide equivalent (tCO_2-e) as a function of the discounted cost of reducing one tonne of emissions (expressed in $ per tCO_2-e); associated with the emissions reductions attainable by different opportunities at a given point in time.

7.4.1.1 Key MACC observations

Table 20 - Summary of key MACC observations

City of Greater Dandenong Building Sub-Sector	No. of opportunities	GHG Emission reduction	Energy Savings	Impact	Energy Bill Savings	Addition in Energy Generation	Renewable Energy	Average Cost p.a.
	#	$MtCO_2$-e	PJ	MJ/$	$M	MW	PJ	$/tCO_2e$
Residential	22	0.23	2.22	1.26	86	145	0.51	104.35*
Industrial	36	0.50	3.83	9.90	77	51	0.18	-42.55
Commercial	31	0.15	0.71	4.66	35	24	0.09	-75.78

**Note that Residential opportunities include high payback opportunities which affects the total $/tCO₂e. There are a number of cost effective opportunities identified in the detailed MACC tables. Potential duplicate technologies have been deselected.*

Main conclusions drawn are:

- The Residential sector of the City of Greater Dandenong has the technical potential to reduce carbon dioxide equivalent (tCO_2-e) emissions by 230,000 tonnes/year. This scenario is based on the combination of 22 different emissions abatement opportunities (See Appendix B for further details) that would require an investment of more than $1.7 billion, paid back over approximately 20 years. If only 9 of the more cost effective opportunities are selected, then investment of approximately $400 million is required to reduce emissions by 158,000 tonnes/year, with an average 7-year payback. There was a population of 164,148 in the CoGD in 2017.

- The Industrial sector has the technical potential to reduce carbon dioxide equivalent (tCO_2-e) emissions by 503,000 tonnes/year. This scenario is based on the combination of 36 different emissions abatement opportunities (see Appendix B for further details) that would require an investment of $387 million, paid back over approximately 5 years. The industrial sector includes 1,421 manufacturing businesses in 2017 as per ABS statistics.

- The Commercial sector has the technical potential to reduce carbon (tCO_2-e) emissions by 149,000 tonnes/year. This scenario is based on considering 31 different emissions abatement opportunities (see Appendix B for further details) that would require an investment of $153 million, paid back over approximately 4 years. The commercial sector includes approximately 8,100 businesses in 2017 as per ABS statistics.

7.4.1.2 Technology types

Specific abatement opportunities modelled for the City of Greater Dandenong's are outlined below in Table 21.

Table 21 - Descriptions of emissions abatement opportunities (MACC inputs)

Emissions abatement opportunity	Description
Appliances	Upgrade of ageing appliance to more efficient technology (e.g. refrigerators, dishwashers)
Building infiltration sealing	Window film, building sealing to improve building thermal properties
Compressed air systems	Compressed air systems maintenance, upgrade and installation of VSDs, i.e. to aerators or for lab equipment
Controls	Various equipment, timer and sensor control improvements
HVAC	Heating, ventilation, and air conditioning equipment maintenance, upgrade and installation of VSDs
Insulation	Ceiling, floor and wall insulation to improve building shell thermal properties
IT equipment	Upgrade of ageing IT infrastructure to more efficient technology, i.e. data centre racks, low energy PCs and monitors
Lighting	Different types of lighting upgrades including halogen, LED, fluorescent, and delamping
Metering	Implementation of sub-metering to raise energy usage awareness
Monitoring	Monitoring and management to reduce energy demand
Motors, fans and pumps	Upgrade of aging motors. Fans typically upgraded to EC fans, pumps to high efficiency motors
Pool covers/heating	Installation of pool covers, timers and reduction of set points
Power factor correction	Installation of power factor correction to increase the power factor and hence power quality utilising capacitors to offset inductive loads
Process equipment	Upgrade, maintenance and other measures to improve the efficiency of specific process industrial equipment
Process heat and steam	Boiler, kiln and furnace upgrades, i.e. atmospheric boilers to condensing type boilers, as well as heat recovery from process
Refrigeration and cooling	Chiller, package unit and split unit upgrades to efficient technology. Often VFD driven compressors with EC fans utilised
Solar PV	Rooftop solar PV of different sizes and types, also includes BIPV
Solar thermal	Installation of solar thermal technology to generate thermal or electrical energy
Ventilation	Improved ventilation to reduce the demand for HVAC
Voltage optimisation	Installation of voltage optimisation to regulate the incoming power supply in order to reduce the voltage supplied to the optimum level
Water heating measures	Various high efficiency and fuel-switching measures to improve the efficiency of heating water
Window frames, glazing and shading	Shading, glazing and window treatment to reduce the demand for HVAC

7.4.1.3 Opportunities by sector

Commercial sector opportunities

The Commercial Sector features a range of low cost abatement opportunities across lighting, controls, boilers and building/energy management systems. Sorted by abatement cost, the following opportunities stand out:

- Lighting – Upgrading to LED lighting is an effective strategy for cost reduction. Generally, fluorescent bulbs producing the same amount of light (in Lumens) may last approximately 8,000 hours, while an equivalent LED bulb may last around 25,000 hours. Further, even though LED's are costlier, the energy saved in the long-term pays off in comparison to fluorescent bulbs.

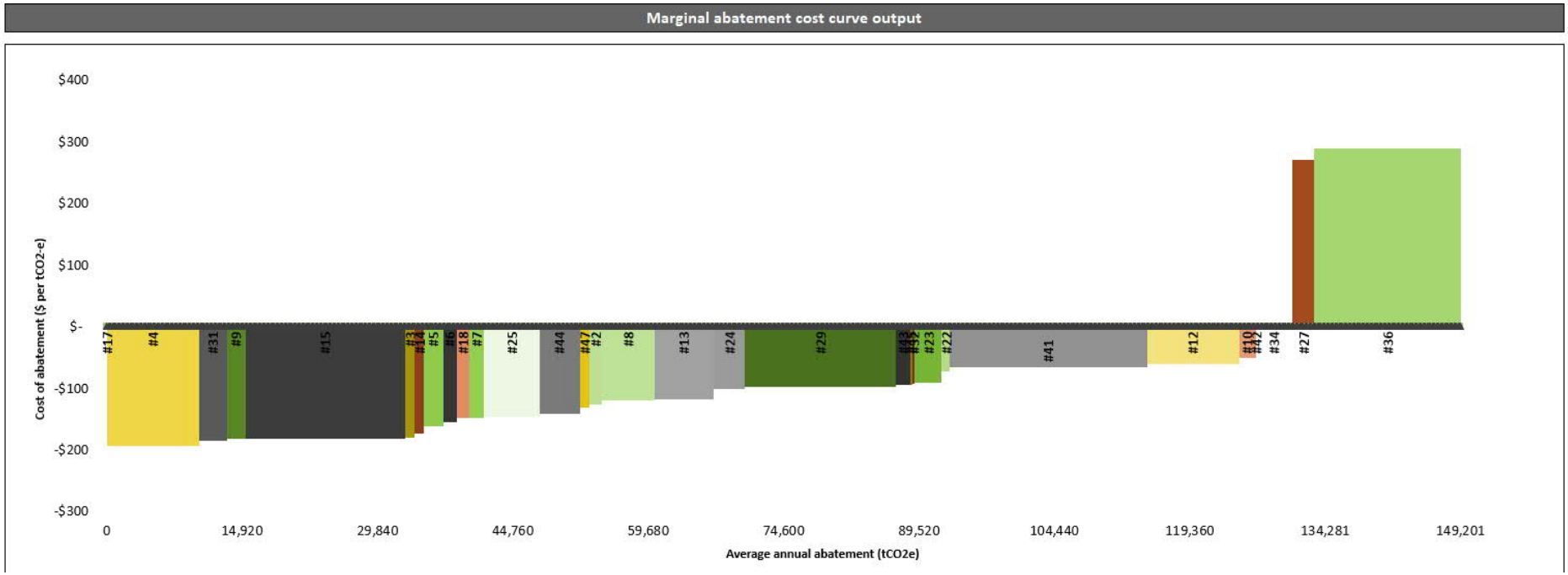
- Controls – Improved controls of variables such as timing and temperature, identified particularly for compressed air systems, refrigeration and cooling, Heating, Ventilation and Air Conditioning (HVAC) and IT equipment. For example, regular water, steam and air flow metering and monitoring can measure HVAC system efficiency and identify leaky valves or other potential system inefficiencies.

- Upgrades to high efficiency boilers, used to produce hot water and for some larger sites, steam.

- Building management system controls, which can complement and link to establishing an automated energy management platform (commonly cloud based) for medium to larger sized businesses.

Figure 31 below indicates the MACC Curve output for the Commercial sector.

Marginal abatement cost curves present the average annual amount of emissions reduction in tonnes of carbon dioxide equivalent (tCO_2e) as a function of reducing one tonne of emissions (expressed in $ per tCO_2e) associated with the emissions reductions achievable by different opportunities at a given point in time. Each bar on the MACC represents one emissions abatement technology opportunity.



The commercial sub-sector greenhouse gas abatement cost curve:

- Each bar represents a greenhouse- gas emissions abatement opportunity across the City of Greater Dandenong.
- The width of the bar represents the potential annual greenhouse gas emissions abatement for this opportunity, on average over the opportunity life.
- The horizontal axis presents the cumulative greenhouse- gas emissions abatement in tonnes of carbon dioxide equivalent (tCO_2-e) aggregating all the abatement opportunities from the lowest to highest cost.
- The height of the bar represents the cost to reduce the greenhouse- gas emissions by one tonne of carbon dioxide equivalent (tCO_2-e) with this opportunity.
- The abatement opportunities are plotted left to right in order from lowest to highest cost of abatement.

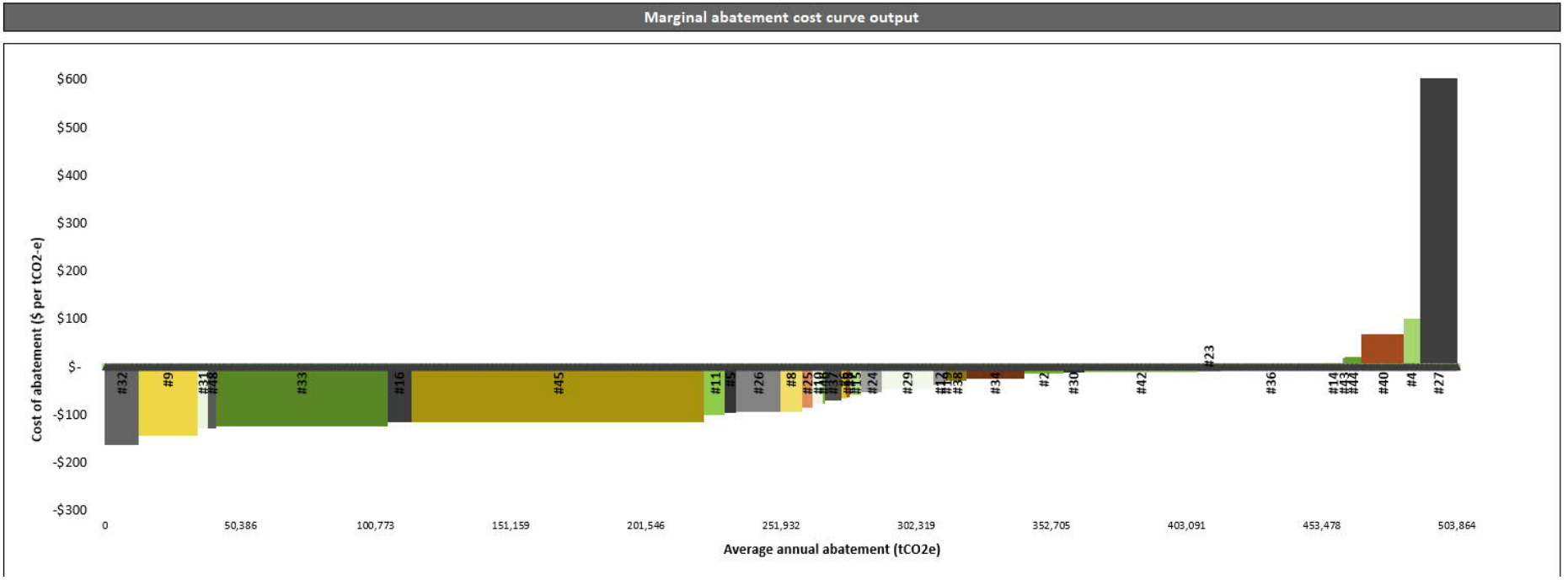
Figure 31 - Commercial sector marginal abatement cost curve

Industrial sector opportunities

The industrial sector can feature large process- heat and steam loads, particularly for energy intensive industrial sub sectors such as manufacturing and mining. There are relatively low abatement costs associated with upgrades to these systems, together with other technology categories associated with heat loads – such as water heating, insulation, and solar thermal. Further, metering and monitoring opportunities can help to drive low- cost energy and emissions abatement, adding controls to the industrial process. The following opportunities are sorted by abatement cost:

- Process heat and steam efficiencies, including:
  - Furnace efficiency upgrades.
  - Controls upgrades to improve the timing and staging of processes. Additional control upgrades opportunities for Variable Speed Drives (VSDs), compressed air systems, Process equipment and refrigeration/cooling.
  - Boiler upgrades.
  - Heat recovery initiatives to re-use waste heat, such as to potentially pre-heat hot water and steam systems.
- Water heating measures such as boiler and controls upgrades.
- Insulation improvements, such as to hot water/steam distribution pipes.
- Solar thermal, utilising roof or ground space to help to service the heat loads.
- Metering and Monitoring, to drive cost effective energy saving opportunities.

Figure 32 below provides a screenshot from the MACC Tool for the Industrial sector opportunities.



The industrial sub-sector greenhouse gas abatement cost curve:

- Each bar represents a greenhouse- gas emissions abatement opportunity across the City of Greater Dandenong.
- The width of the bar represents the potential annual greenhouse- gas emissions abatement for this opportunity, on average over the opportunity life.
- The horizontal axis presents the cumulative greenhouse- gas emissions abatement in tonnes of carbon dioxide equivalent (tCO_2-e) aggregating all the abatement opportunities from the lowest to highest cost.
- The height of the bar represents the cost to reduce the greenhouse gas emissions by one tonne of carbon dioxide equivalent (tCO_2-e) with this opportunity.
- The abatement opportunities are plotted left to right in order from lowest to highest cost of abatement.

Figure 32 - Industrial sector marginal abatement cost curve

Residential sector opportunities

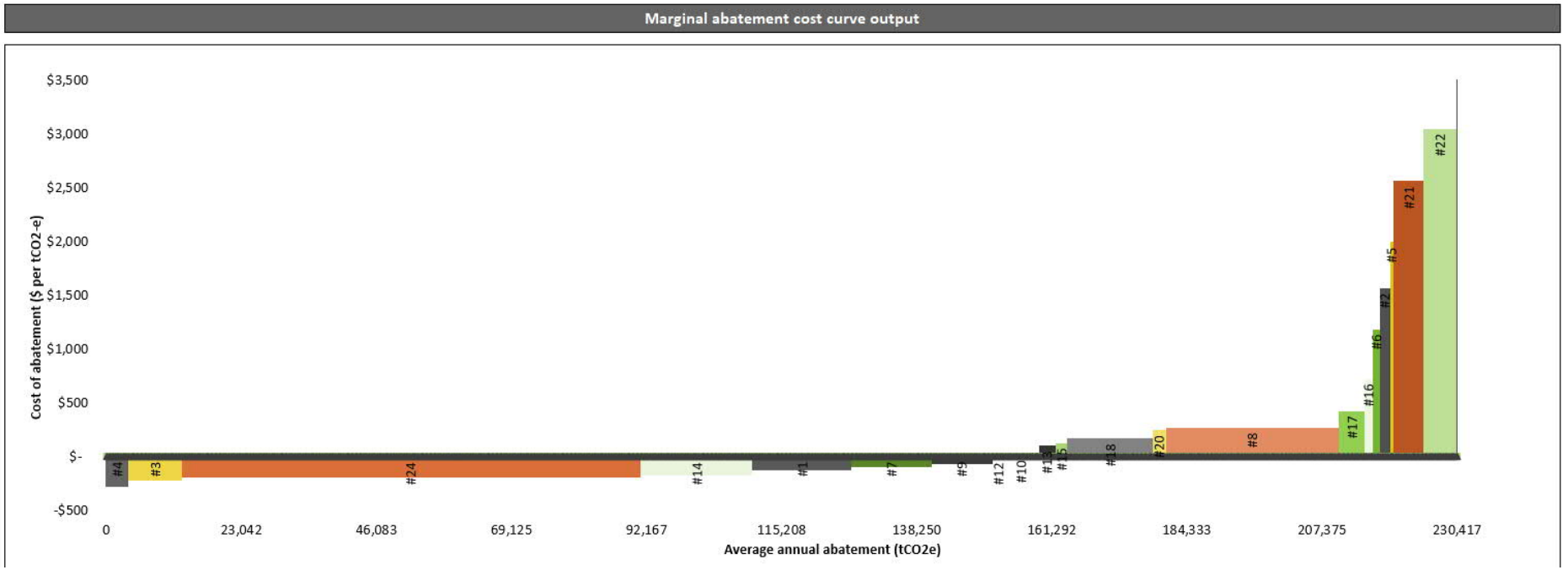
The Australian Energy Update (2018) noted that residential energy consumption showed little to no increase and was relatively flat in 2016/17. The Report notes that this is due to higher electricity prices and the widespread adoption of more energy efficient practices, appliances and building structures. The former is evidenced by the growth in retail electricity prices for households by 6% in 2016/17 and by 12% in 2017/18.[27]

However, the MACC Tool still identified a number of cost-effective opportunities, including:

- Water heating measures
- More efficient lighting
- Building infiltration sealing - air sealing
- Solar PV - 3 kW system size
- HVAC - space heating.

Figure 33 below provides a screenshot of the Residential MACC output.

[27] Department of Environment and Energy, *Australian Energy Update 2018*, pg. 14.



The residential sub-sector greenhouse gas abatement cost curve:

- Each bar represents a greenhouse- gas emissions abatement opportunity across the City of Greater Dandenong.
- The width of the bar represents the potential annual greenhouse -gas emissions abatement for this opportunity, on average over the opportunity life.
- The horizontal axis presents the cumulative greenhouse- gas emissions abatement in tonnes of carbon dioxide equivalent (tCO_2-e) aggregating all the abatement opportunities from the lowest to highest cost.
- The height of the bar represents the cost to reduce the greenhouse- gas emissions by one tonne of carbon dioxide equivalent (tCO_2-e) with this opportunity.
- The abatement opportunities are plotted left to right in order from lowest to highest cost of abatement.

Figure 33 - Residential City of Greater Dandenong

7.4.1.4 Opportunity groups

The opportunities can also be categorised into Low, Medium and High Cost abatement opportunities (arranged by payback):

Low cost abatement opportunities

The lower cost technology based opportunities for the City of Greater Dandenong include:

- Low flow shower roses which can reduce water heating requirements for residential dwellings.
- LED lighting opportunities in the residential sector.
- Controls of various types in the commercial sector – including compressed air systems, refrigeration and cooling (such as is common in the food and beverage and retail sub-sectors) and HVAC.
- Building management system (BMS) controls and IT equipment. These can be complementary, with modern energy management IT software able to connect to onsite meters and management systems BMS's.
- Refrigeration and cooling upgrades and the integration of variable speed drives (VSDs).

The opportunities with larger annual abatements include:

- Controls for commercial compressed air – operational controls for the timing and staging of compressor.
- Residential solar PV 3 kW.
- Sealing building air infiltrations in residential buildings.

Medium cost abatement opportunities

The medium cost abatement opportunities are mostly dominated by industrial sector technologies/upgrades, with fewer commercial and residential opportunities:

- Industrial Controls – such as for process equipment.
- Industrial HVAC improvements captured under maintenance, which can complement ventilation upgrades.
- Industrial sector improved metering, which can complement controls improvements such as to refrigeration and cooling and lighting.
- Industrial sector lighting (focussed on LED upgrades).

The opportunities with larger annual abatements include:

- Commercial and industrial solar PV < 50 kW system.
- Residential high efficiency gas water heaters, particularly through central heating systems as opposed to separate room heating systems.
- Industrial – Process heat and steam upgrades. The energy load from process heating can be significant, especially on larger industrial sites. The opportunity includes upgrades to the boiler/heat generation system as well to the distribution system.

High cost abatement opportunities

Similar to the medium cost opportunities, the high cost opportunities mainly focus on the industrial and commercial sectors within the City of Greater Dandenong:

- Commercial – refrigeration and cooling upgrades.
- Industrial – solar PV – both 100+ and 50 to 100 kW system sizes.
- Industrial – refrigeration and cooling upgrades.
- Residential – television appliance replacements (which could be particularly challenging for low-income households).
- Commercial power factor correction – which is only applicable to some sites that suffer from reactive power issues and poor power factors. This is also relevant to the Industrial sector.
- Industrial – refrigeration and cooling upgrades.
- Industrial – controls – building management system.

The opportunities with larger annual abatements include:

- Residential – wall insulation
- Residential – solar thermal water heater
- Commercial – chiller upgrades.

7.4.1.5 Description of the project inputs and modelling parameters

Table 22 shows the type of modelling parameters used for the MACC curves.

Table 22 - Modelling parameters included in the settings tab of the EY MACC

Parameter category	Modelling parameters
General financial parameters	Model baseline year
	Weighted Average Cost of Capital
Co-benefit parameters	Job creation factor
	Avoided health costs factor
Energy cost forecast parameters	Grid electricity price scenarios (Low/Mid/High)
	Natural gas price scenarios (Low/Mid/High)
	Fuels prices scenarios (Low/Mid/High)
Emissions factors	Grid electricity emissions factors by state/year
	Natural gas emissions factors by state/year
	Fuels emissions factors by state/year
Emissions scope	Scope 1 & 2 (electricity & gas)

7.4.1.6 MACC limitations

- The MACC curves provide a static snapshot of annual abatement opportunities for the City of Greater Dandenong.
- The MACC tool focuses on opportunities for emissions abatement from existing buildings. It does not focus on new buildings.
- The savings and costs are based on EY analysis of average data per technology and sector.
- The MACC information is provided for indicative purposes only and does not constitute investment grade information to base investment decisions. Quotations should be sought from suppliers for investment in particular equipment.

8. Pathways to achieving targets

8. Pathways to achieving targets

8.1 Climate action scenarios

To support City of Greater Dandenong's climate action planning, four emissions trajectories with three scenarios were modelled relative to a business-as-usual (BAU) baseline. The four trajectories are:

- Business-as-usual (BAU) – no changes to the current operating model
- Minor intervention (customisable)
- Moderate intervention
- Accelerated intervention.

The figure below illustrates these scenarios.

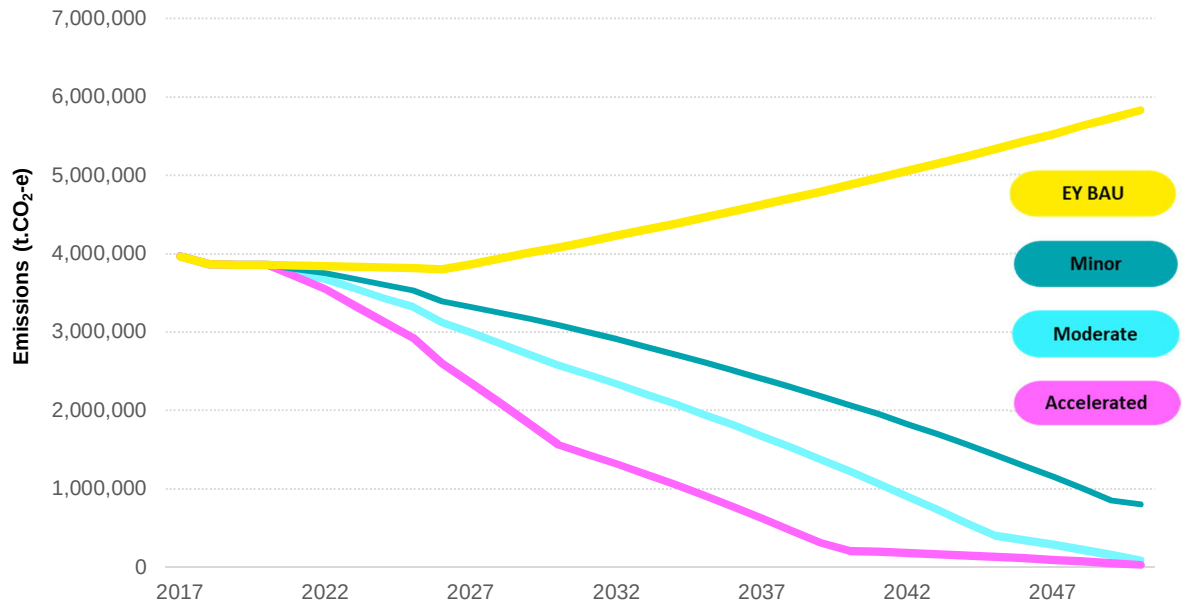


Figure 34 - Scenarios for emissions abatement

8.2 Business as usual (BAU) scenario

The baseline year for this report is the 2016/17 financial year. This aligns with the Deadline 2020 baseline year and is appropriate in the context of climate change action as 2017 marked a year of deep droughts and heavy rains in Australia and hurricanes in other parts of the world.

The City of Greater Dandenong's Community Emissions Profile for financial year 2016-2017 was used as the data source for baseline emissions. The BAU covers the financial year (1 July 2016 to 30 June 2017) which is considered to be the most reliable and recent set of emissions and energy consumption data.

The BAU was developed considering the City of Greater Dandenong's projected population growth and existing and planned Government policies to mitigate emissions. Specifically, it includes the impact of:

- Planned updates to the National Construction Code (NCC) due to take effect in 2019
- The Victorian Renewable Energy Target (VRET) of 40% by 2025
- A phase out of coal and transition to gas and renewables beyond 2025.

Development of the BAU also assumed that these existing and planned policies will remain in place and will be achieved. However, it does not assume any additional actions under the BAU scenario. As with any future forecasts there is a high degree of uncertainty associated with the BAU trajectory. The BAU scenario represents the emissions trajectory for the City of Greater Dandenong if no further actions are undertaken to reduce the corporate and community's emissions.

The potential abatement from priority actions was subtracted from the BAU trajectory to determine potential emissions pathways. In addition to the BAU Scenario described in the preceding section, three additional scenarios were considered based on different levels of ambition for the priority actions.

Following the BAU trajectory, the CoGD emissions decrease up to 2026. This is followed by an increase thereafter as the impact of increased population outweighs the impact of existing planned local and state policies. However, it should be noted that modelling an emissions trajectory out to 2050 has a high degree of uncertainty associated with it as there are multiple factors that may significantly impact the validity of the forecasting. For example, technological advancement and the subsequent reduction in cost of those technologies, could impact the trajectory.

As with any future forecasts there is a high degree of uncertainty associated with the BAU trajectory.

8.3 Minor intervention scenario

This scenario represents a minor level of ambition for all actions and results in near net zero emissions not being met by 2050 for the City of Greater Dandenong.

The Minor Intervention scenario, illustrated in the chart below, represents a lower level of ambition than the Moderate and Accelerated Action scenarios. It achieves carbon neutrality after the Deadline 2020's target of 2050 and so would not be aligned with international expectations under the Paris Agreement.

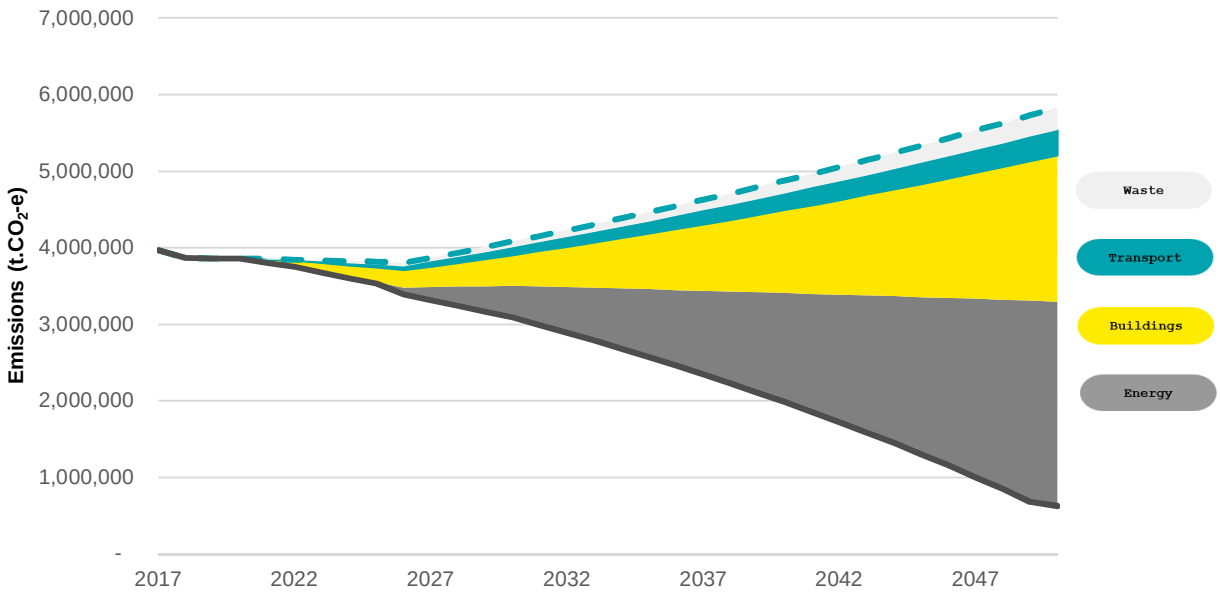


Figure 35 - Minor pathway for emissions abatement

8.4 Moderate intervention scenario

This scenario represents a moderate level of ambition for all actions and results in a near zero net emissions by 2050 for the City of Greater Dandenong.

C40's Deadline 2020 Report outlines an expectation in its 1.5ºC scenario that cities such as the City of Greater Dandenong, which have high per capital emissions (>5.1 tCO_2-e/capita) and high Gross Local Product (>$15,000/capita) should pursue an accelerated 'Steep Decline' Trajectory in which immediate and significant effort is taken to reduce emissions, as shown in Figure 36 below.[28]

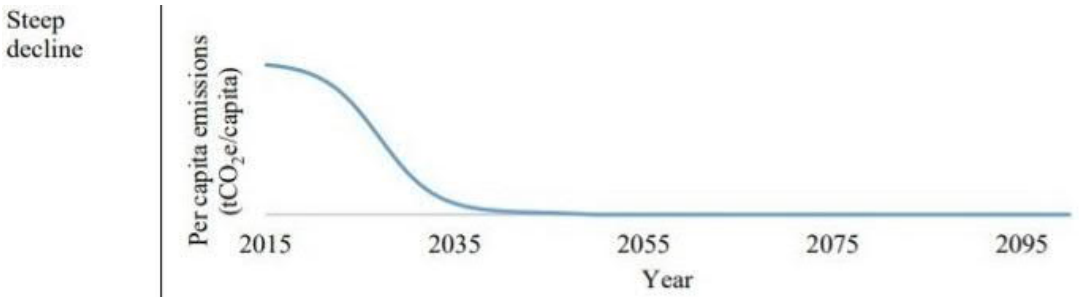


Figure 36 - Deadline 2020 'Steep Decline' trajectory

Deadline 2020 also details an aspiration that the average per capita emissions of all cities would converge in 2030 with 2.9 tCO_2-e per capita and a further assumption of net zero emissions by 2050.

The Moderate Action scenario, illustrated in Figure 37 below, represents a moderate level of ambition for all actions and results in near zero net emissions by 2050.

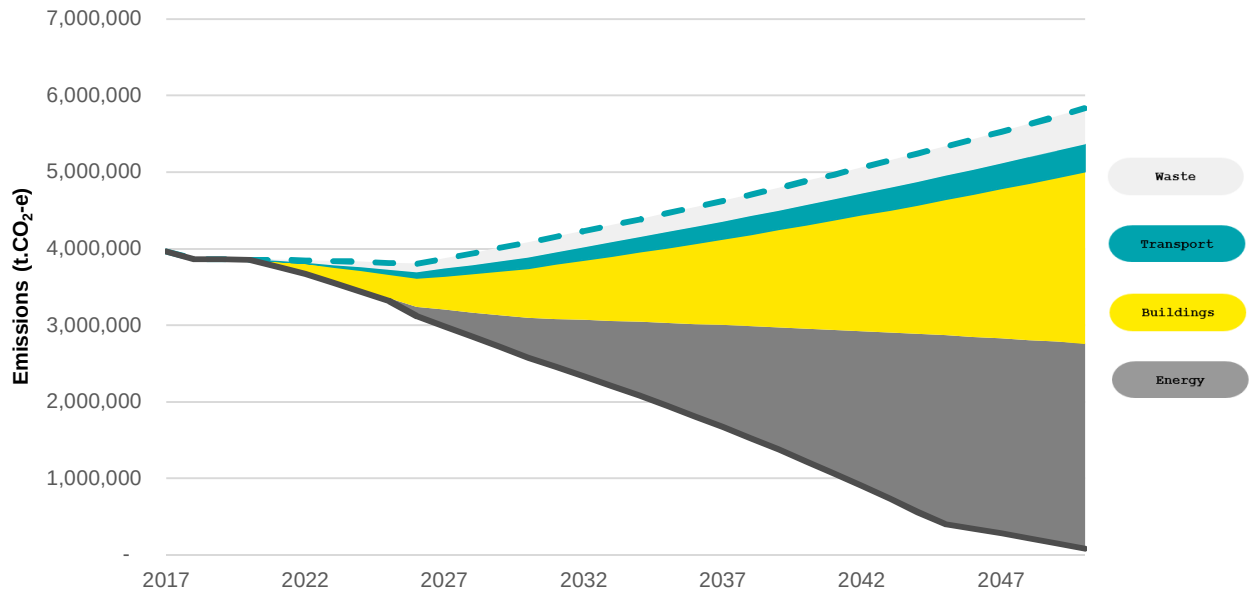


Figure 37 - Moderate pathway for emissions abatement

To reach carbon neutrality there may be a small amount of residual emissions offset through the purchase of carbon offsets.

[28] Figure 36 is taken from C40 cities, Arup, *Deadline 2020 Method Report*, available at: http://www.c40.org/other/deadline_2020 , p.26.

8.5 Accelerated (Major) intervention scenario

This scenario is more ambitious than the Moderate Intervention scenario and aims to achieve carbon neutrality by 2050, in line with C40's '2020 Deadline' which sets a 2050 Target for carbon neutrality.

The Accelerated Action scenario, illustrated in the chart below, represents a high level of ambition (in terms of both scale and pace) for all actions. It represents a scenario that is more ambitious than the Moderate Action scenario and aims to achieve near carbon neutrality in line with Deadline 2020's 2050 target. As a result it reaches near zero net emissions by 2050. An advantage of following this scenario is that it better positions the City for the situation where, as is likely, international targets will be tightened as the full impact of climate change becomes more apparent. This can then become part of a risk management strategy for the City that is forward looking.

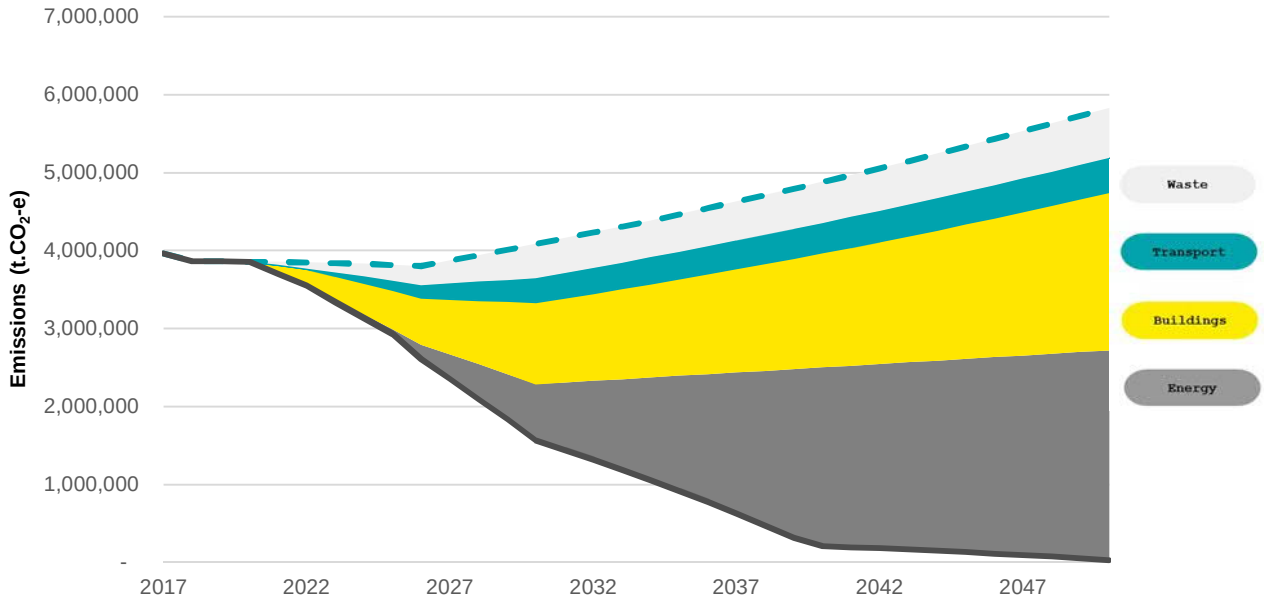


Figure 38 - Accelerated pathway for emissions abatement

The Accelerated Action scenario has a steeper trajectory to 2040 than the Moderate Action Scenario and predominantly includes actions focused on addressing residual emissions from the period of 2040 until 2050.

9. Socioeconomic co-benefit mapping

9. Socioeconomic co-benefit mapping

9.1 Scope of socioeconomic mapping

A bespoke co-benefit framework is set out based on C40's framework and the articulation of priorities in the City's *Sustainability Strategy* and broader Council Plans and Policies. The framework is outlined in Table 23 below.

EY aimed to provide a qualitative, and where possible, quantitative analysis of the social co-benefits for the City of Greater Dandenong's potential climate actions, using C40's co-benefit measurement framework. This analysis is based on the emissions trajectory scenarios identified in the climate modelling:

- BAU
- Minor intervention
- Moderate intervention
- Accelerated intervention.

Preliminary co-benefit pathways were mapped using:

- C40's taxonomy table from the C40 Benefits Research
- City of Greater Dandenong's 'Community Wellbeing Plan', and
- City of Greater Dandenong's 'Economic Development Strategy'.

Table 23 - City of Greater Dandenong's C40 Co-Benefit Framework

Theme	Impact group	Impact	Example indicators	United nations sustainable development goal aligned with#
Social	Health & wellbeing	Physical Health	► Mortality risk	2, 3
		Mental Health	► Depression and anxiety indicators	3
	Community engagement	Citizen participation ("Having a voice")	► Citizens' participation in civic associations	10, 11
		Social Capital (community connection)	► Feeling of belonging	10, 11
	Equity and quality of life	Affordability	► Cost of services relative to cost of living	11
		Access and inclusion	► Distribution and access to infrastructure and services	1, 3, 5, 10, 11
		Safety	► Crime rates	11
		Attractiveness	► Visitors to the city	11
		Education	► Proximity to affordable educational institutions, facilities and resources	
Economic	Wealth and economy	Economic prosperity	► Total city income (GDP) ► GDP per job ► Economic production	1, 8
		Employment	► Unemployment rate ► Earnings quality	1, 8, 9, 11
		Economic innovation	► Number of start-ups (appearance and growth of new sectors and industries)	8, 9
Environmental	Environmental quality	Biodiversity	► Proportion of natural areas under protection	11, 14, 15
		Air quality	► Outdoor air pollution in cities	3, 11, 15

#Note: Sustainable Development Goals are commonly used by organisations as a framework for sustainability reporting.

The main pathway impacts were developed in conjunction with the preliminary climate actions analysis. These pathways supported the identification of bridging actions required for the City of Greater Dandenong to achieve its Science-based target. An initial 'heat map' was conducted to identify significance (high, medium, low or negligible), underpinned by a defined set of initial qualitative indicators, and primarily based on:

- Magnitude of impact
- Confidence in the data
- The indicators' validity in representing the selected outcome area.

After identifying the existing co-benefit research in the heat scan, EY sought more detailed social impact modelling around the four main categories of actions: Buildings, Energy, Transport and Waste. An assessment was undertaken to give an indicative picture of the benefits or harms which may occur from selected actions, informed by EY's BAU trajectory and research.

Using the DSF, EY undertook a socioeconomic cost/benefit impact analysis of the priority actions. The socioeconomic impact analysis supplements the initial assessment by performing a socioeconomic impact modelling exercise on the proposed climate actions. This assessment clearly signifies the amount of benefit or cost that residents, asset owners (such as Council or businesses) and other stakeholder groups may experience. The socioeconomic analysis successfully reviewed the affordability, access and inclusion of the proposed climate actions, deconstructing key local, state and federal policy considerations to ensure that actions are implemented fairly for all citizens.

The additional social impact and inclusion analysis work to be undertaken by EY (separate to this report) will support the CoGD to ensure the co-benefits and risks of climate actions are managed in a way that is fair, minimises harm and maximises benefits to the community. This additional analysis will enable CoGD to:

- Gain a broad picture on the socio-economic co-benefits for the community
- Identify vulnerable sub-groups within the CoGD, and
- Consider options for how to maximise inclusivity of the climate actions.

9.2 Co-benefits by category

The mitigation relating to Buildings, Energy, Transport and Waste have several distinct socioeconomic co-benefits. While emissions reductions can be modelled according to clear standards, recent studies[29] have outlined the variability in methods and indicator quality for modelling co-benefits. This analysis is indicative only and more detailed benchmark work should be established around any actions ultimately executed.

The following Sections outline proposed indicators and modelling assumptions for the City of Greater Dandenong's prioritised actions in the building, energy, transport and waste sectors. One priority action from each category was modelled to indicate co-benefits.

While less tangible, there is also an opportunity to improve community engagement (civic participation and sense of belonging) for the Greater Dandenong community. Getting buy-in from the community into becoming one of Australia's most sustainable cities would assist in increasing residents' sense of pride in their municipality.

9.2.1 Buildings

Research indicates that transitioning to more energy efficient or carbon neutral buildings amplified a range of mental and physical benefits. These benefits include improved living conditions and thermal comfort, greater productivity, higher staff engagement and better staff retention. It may also offer improved access, inclusion and affordability for citizens from a lower socioeconomic standing. On the other hand, poor heating, ventilation and cooling can result to poor indoor air quality and lead to long-term chronic health issues. One study suggests that health benefits of improved heating and cooling can be more than 10 times the value of energy savings.[30]

[29] See for example C40 Cities and LSE Cities, 2016, Co-benefits of urban climate action: A Framework for Cities
[30] Gouldson. A, Sudman. Khreis. H, and Papargyropoulou, E, (2018) The Economic and Social Benefits of Low-Carbon Cities: A Systematic Review of the Evidence, Coalition for Urban Transitions.

Although many studies outline these socioeconomic co-benefits, EY concluded that too many assumptions would have to be made to accurately determine the quantification of benefits for the City, including:

Key assumptions

- Definition of a carbon neutral building and what exactly will be advocated by the City of Greater Dandenong.
- City of Greater Dandenong-specific dangerous heat or cold patterns and how much of any mortality findings are related to Heating, Ventilation and Air Conditioning (HVAC) factors (study specific). We did not find any studies that we felt confident enough to model this upon.
- Current green standards of the building and levels/extent of improvements due to carbon neutral advocacy.
- Current turnover/ employee engagement rates within the City.
- The quality and age of the current building stock within the City.

Summary of qualitative finding

Table 24 summarises the qualitative co-benefits rising from the transition to carbon neutrality for existing buildings.

Table 24 - Summary of qualitative co-benefit findings for buildings

Action	Impact areas	Indicator(s)	Outcomes
Advocate for all new buildings to be carbon neutral by 2030 and existing buildings by 2050	Physical health Air quality Productivity	Levels of respiratory diseases, allergies, asthma, mental health problems, increased morbidity	Improved indoor environmental quality Improved Productivity
		Level of productivity	
	Air quality	Reduction in fossil fuel energy from the grid	Improved outdoor air quality
	Affordability	Energy costs to households and businesses	Improved equity and quality of life for residents Lower costs to businesses

Data limitations

EY recognised that some co-benefits or proposed climate actions in the buildings sector have been extensively researched and their value presented in financial terms. For example, indoor and outdoor air pollution in cities have been studied widely, as has the productivity impacts of energy efficiency investments in buildings. A number of studies have also successfully investigated the employment impacts of climate change mitigation investments in buildings, especially in developed countries. However, in order to undertake further modelling, the aforementioned assumptions would need to be considered in greater detail. City of Greater Dandenong should clearly define the classifications of carbon neutral buildings. Although finer particulate matter can travel great distances, the local community suffers the most to this exposure. For example, citizens who live within 50 kms of a coal-fired power station face a risk of premature death as much as 3-4 times that of people living further away.[31] Consequently, modelling on the health co-benefits of switching from fossil fuels is mostly relevant for populations close to generators.

[31] David Shearman, *Why Coal-Fired Power Stations Need to Shut on Health Grounds*, 2016, The Conversation https://theconversation.com/why-coal-fired-power-stations-need-to-shut-on-health-grounds-68809.

9.2.2 Energy

EY found that only energy actions related to the facilitation of residential renewable energy had the potential to impact residents, visitors and workers within the City of Greater Dandenong. While the switching to renewable or low-carbon energy suppliers for the City means fewer emissions from detrimental air pollutants, this co-benefit is experienced primarily by those who come in contact with significant concentrations of the pollutants near power stations.

Summary of qualitative findings

Table 25 identifies the qualitative co-benefits resulting from switching energy to renewables.

Table 25 - Qualitative co-benefits of renewables

Action	Impact area	Indicator(s)	Outcomes
Facilitate the purchase of corporate and residential renewable energy	Physical health Air quality	Reduction in fossil fuel energy from the grid	Improved outdoor air quality
	Affordability	Energy costs to households and businesses	Improved equity and quality of life for residents Lower costs to businesses, improved economic growth
	Employment	Local job creation	Employment in growth sector (renewable energy) Increased employment
	Innovation	Employment and GDP in renewable energy sector	Development of growth industries such as in renewable energy*

** Given Dandenong's strong manufacturing sector, there is an opportunity to grow the renewable energy sector.*

Data limitations

The co-benefits in terms of the impact of grid scale emissions from the closure of coal-fired power stations would most likely be realised outside the City of Greater Dandenong's boundary. In order to fully understand these co-benefits more widely, the following key data would need to be assessed in the region surrounding each power station:

- $PM_{2.5}$ and NO_x emissions in tonnes per year for regional grid.
- Likely population size impacted in light of active fossil fuel power plants.
- Temporal estimates of when the health improvements will accrue.

9.2.3 Transport

Transport opportunities tend to focus on mode shifts towards public transport, walking, cycling and limiting emissions from vehicles. This also presents co benefits in terms of lifestyle and reducing related diseases.

The primary aim of the transport action modelling was to understand the health impacts of mode shifting from private vehicles towards alternative transport within the City and the impacts of transitioning to electric vehicles. Changing the community's behaviour towards alternative transport modes including cycling, walking and public transport is beneficial for the environment and for the individual. Transport mode shifts can lead to improved local air quality and help the community engage in physical activity.

Replacing private vehicle travel with more active modes of transport can significantly improve physical activity rates, effectively slowing down the incidence of obesity, diabetes and depression.[32] Research also indicates that using active transport involves a relatively low upfront implementation cost, with substantially improved public health benefits.[33]

[32] Armstrong, F 2012.
[33] Cambridge Systematics 2009.

Summary of outcomes

Table 26 below indicates the qualitative co-benefits resulting from implementing transport mode shifts within the community.

Table 26 - Qualitative co-benefits of transport mode shifts

Action	Impact area	Indicator(s)	Outcomes
Reallocate road space to cyclists and pedestrians	Physical health Air quality	Levels of respiratory diseases, mental health problems, increased morbidity; chronic diseases Number of increased cycling and walking hours per year Level of physical activity MET hours) expended by mode choice per hour Change in travel-related MET hours per year Quality Adjusted Life Year(QALY) per 1 MET hour Value of QALY 2018	Greater physical activity levels Reduced road trauma Reduced traffic-related air pollution (PM2.5)
Increase road usage/ parking pricing for motor vehicles	Physical health Air quality	PM2.5 emission levels	Reduced road trauma Reduced traffic-related air pollution (PM2.5)
Advocate for trains, trams and cars to be powered by renewable energy	Physical health Air quality		Reduced traffic-related air pollution (PM2.5)
Transition to electric vehicles	Physical health Air quality		Reduced traffic-related air pollution (PM2.5)
Advocate to increase the community's access and usage of public transport	Physical Health Air Quality Access an inclusion Affordability	Accessibility to public transport Cost of transport	Reduced Road Trauma Reduced traffic-related air pollution Improved access and inclusion by community members Reduced cost of travel

Data limitations

EY used a range of existing studies across a variety of disciplines to evaluate the transport action co-benefits as part of this analysis; noting specifically that these studies often generalised correlation rather than presenting a causal relationship between two variables (or indicators).

9.2.4 Waste

Climate actions to improve waste management not only reduce harmful emissions, but they also have the potential to facilitate a range of important co-benefits for health, education and inclusion in the City of Greater Dandenong. Studies consistently indicate socioeconomic co-benefits for low-carbon investments in the waste sector in cities.[34] Health scholars reiterate that a number of diseases such as asthma and other forms of respiratory dysfunction are more common for citizens exposed to waste and landfill. Therefore, shifting towards more integrated and de-centralised waste management systems, including promoting residential composting, has the opportunity for improved civic duty and engagement for the City of Greater Dandenong.

Smart and sustainable waste management plays an increasingly important role in achieving the goal of being one of Australia's most sustainable cities by 2030. The City recently released a Waste and Litter Strategy 2015-2020, proposing a range of priorities, actions and outcomes to improve resource recovery and recycling generated by residents, businesses and construction activities and the Council's own activities. Although the commercial sector generates the most waste in the City, the impacts are felt by all citizens and visitors. As such, EY analysed the co-benefits resulting from improving waste management and resource recovery for the residential and commercial sectors.

[34] Rashidi et al. 2017.

Summary of qualitative findings

Table 27 below indicates the qualitative co-benefits resulting from driving actions within the residential and commercial waste sectors. Specifically, EY's analysis considered waste diversion from landfill. Four co-benefit areas were identified including increased citizen participation, education and awareness, enhanced social capital and improved physical health.

Table 27 - Qualitative co-benefits of waste diversion

Action	Impact area	Indicator(s)	Outcomes
Diversion of commercial and residential waste from landfill	Citizen participation Education	Citizens' awareness and behaviour with regard to waste, including littering, recycling habits, home composting, and others.	Improved waste education
	Social capital (Community cohesion)	Levels of citizen engagement for climate actions. Levels of citizen satisfaction with waste amenity impacts (noise, congestion, odour, vermin).	Greater citizen engagement Neighbourhood connections
	Physical health	Levels of methane and carbon dioxide produced in waste management area.	Improved outdoor air quality
	Affordability	Cost of food expenditure.	Reduced costs of food consumption

10. Summary of findings

10. Summary of findings

- While the Council is already acting (such as with its ESD Policy and Sustainability Strategy), taking further action will provide benefits to the local community while further positioning the City as a leader.

- The CoGD's corporate emissions inventory have reduced from approximately 16,000 tonnes of carbon dioxide equivalent (tCO_2-e) in 2007/08 to around 14,000 tCO_2-e in 2016/17 (including scope 1 direct and scope 2 indirect emissions).

- The CoGD's community emissions profile is estimated to be approximately 3,598,000 tCO_2-e in 2016/17 including scope 1 and 2 emissions; with an additional 366,000 tCO_2-e in scope 3 emissions from waste.

- The CoGD's community per capita emissions were 24.2 tCO_2-e in 2017. By 2030 this would need to drop to a target of:

  - 7.6 tCO_2-e per capita under the 'accelerated action' scenario. Down to 0.1 tCO_2-e per capita by 2050.

  - 12.5 tCO_2-e per capita under the 'moderate action' scenario. Down to 0.3 tCO_2-e per capita by 2050.

- One of these scenarios is required to be adopted. Otherwise, under business as usual, the community will have used its 2020-2050 carbon budget of 39.5 $MtCO_2$-e early, by the year 2030, based on the community's current emissions at 3.9$MTCO_2$-e per annum.

- The accelerated action scenario would provide the quickest emissions abatement in line with the Paris Agreement, and allow the community to minimise exposure to potential future carbon regulation and costs, such as from a carbon price and carbon offsetting.

- EY suggests that the CoGD adopt key objectives that can set the community on the path to rapid emissions abatement. See the table below. The focus of efforts needs to be on how council can drive community emissions abatement, while showing leadership by where possible adopting similar objectives for its own corporate emissions.

Table 28: Summary of objectives

Category	Key objectives for addressing community emissions	Key objectives for addressing corporate emissions
Buildings	Advocate for all new buildings to be carbon neutral* by 2030 with Federal and State Government.	New council buildings to aspire to be carbon neutral by 2030, aiming for NABERS 5 Star ratings where possible.
	Advocate for all existing buildings to be carbon neutral by 2050 with Federal and State Government.	All existing council buildings to be carbon neutral* by 2050.
	Plan and partner for electrification of energy supply to the community**	
Energy	Facilitate residents' uptake of renewable energy products.	Facilitate more efficient behaviour and use of more energy efficient equipment such as lighting, controls and equipment for heating, ventilation and air conditioning.
	Facilitate corporate PPA's (Power Purchasing Agreements).	Facilitate corporate PPA's (Power Purchasing Agreements) for council energy use.
	Incentivise innovative renewable energy technologies.	Encourage and support uptake of innovative renewable energy technologies.
	Advocate for a more ambitious renewable energy target (RET).	Advocate for a more ambitious Victorian and Federal Government renewable energy targets (RET).

Category	Key objectives for addressing community emissions	Key objectives for addressing corporate emissions
Transport	Promote a mode shift from driving to walking and cycling	Plan and partner for electrification of energy supply to council assets**
	Advocate for all public transport to be powered by renewable energy	Encourage and support staff and contractors to increase sustainable transport mode choices.
	Advocate for lower emissions intensity of motor vehicles and support the City's transition to electric vehicles	Council fleet to be powered by renewable energy/electricity by 2050
Waste	Work to reduce emissions from commercial and industrial waste	
	Work to reduce emissions from residential waste	Work to reduce emissions from council waste
	Work to reduce emissions from construction and development waste	New council buildings to aspire to be carbon neutral by 2030, aiming for NABERS 5 Star ratings where possible

** A Carbon Neutral building can be defined as one with significantly reduced energy consumption combined with renewable energy sources and offsets to meet remaining demand). Note that these high-level objectives are supported by more detailed actions in Appendix A, which focus on how to drive community scale emissions abatement.*

- The detailed actions have been scored and listed in Appendix A using a multi-criteria analysis. This was informed by EY's previous work on Local Government emissions profiles and an in-depth literature review covering relevant C40 research and beyond. The actions are sorted from highest scoring for each category.

- The actions can be implemented with different levels of ambition. In this report three scenarios or pathways of ambition have been modelled, referred to as titled: accelerated, moderate and minor.

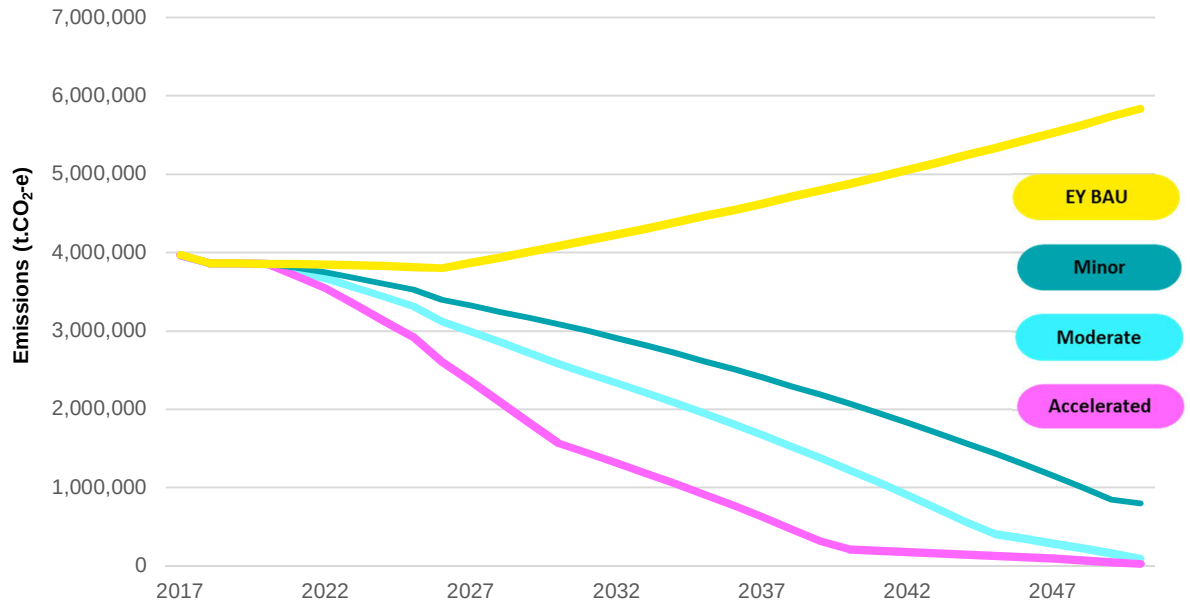


Figure 39 - Scenarios for emissions abatement

- Marginal Abatement Cost Curves (MACCs) have been developed to identify potential energy efficiency and solar PV opportunities in the CoGD community - for existing residential, commercial and industrial buildings. These can be used for finer grained guidance of technology specific opportunities, in addition to the objectives and actions suggested in the report. Main conclusions drawn from the MACC analysis are:

  - The Residential sector of the City of Greater Dandenong has the technical potential to reduce carbon dioxide equivalent (tCO_2-e) emissions by 230,000 tonnes/year. This scenario is based on the combination of 22 different emissions abatement opportunities (See Appendix B for further details) that would require an investment of more than $1.7 billion, paid back over approximately 20 years. If only 9 of the more cost effective opportunities are selected, then investment of approximately $400 million is required to reduce emissions by 158,000 tonnes/year, with an average 7-year payback. There was a population of 164,148 in the CoGD in 2017.

- The Industrial sector has the technical potential to reduce carbon dioxide equivalent (tCO_2-e) emissions by 503,000 tonnes/year. This scenario is based on the combination of 36 different emissions abatement opportunities (see Appendix B for further details) that would require an investment of $387 million, paid back over approximately 5 years. The industrial sector includes 1,421 manufacturing businesses in 2017 as per ABS statistics.

- The Commercial sector has the technical potential to reduce carbon (tCO_2-e) emissions by 149,000 tonnes/year. This scenario is based on considering 31 different emissions abatement opportunities (see Appendix B for further details) that would require an investment of $153 million, paid back over approximately 4 years. The commercial sector includes approximately 8,100 businesses in 2017 as per ABS statistics.

- The high-level socio-economic co-benefits have been mapped and identified for the CoGD. This identifies a number of co-benefits across the action categories of Buildings, Energy, Transport and Waste. The additional work being undertaken by EY through the social impact and inclusion analysis being will provide further information.

- This report has identified pathways that the CoGD can take to support it to further demonstrate leadership in supporting the community to mitigate its emissions, and to pursue similar ambitious objectives in mitigating its own corporate emissions.

- This analysis is indicative only and more detailed benchmark work should be established around any actions ultimately executed.

Appendices

Appendix A Decision support framework and actions

Table 29 - Actions for buildings

No.	CGD Sustainability Strategy Objectives	Focus Area	Actions / Priorities - what we will do over next five years to achieve our objectives
Corporate			
CC-1.1	Establish internal programs that help to create a culture of sustainability	Cultural Behaviour change	Work to create a culture within Council focussed on reducing GHG emissions and energy use through increased awareness and education
CE-1.1	Reduce Council's CO_2e emissions from streetlighting, buildings and facilities	Reducing emissions - existing buildings	Continue to reduce Council's existing Buildings GHG emissions by increase energy efficiency and reducing energy use and consumption, supported by the Asset Management Plan.
		Reducing emissions - streetlights /other	Continue to reduce Council's GHG emissions from its street lighting and other infrastructure by reducing energy use and increasing energy efficiency
		Maintenance	Ensure effective maintenance of Council's buildings fixtures, appliances and control systems to optimise energy use
		Electrification	Commence transitioning of Council's energy usage currently reliant on gas to electricity, supported by the Building Energy Management Plan.
		Monitoring	Continue and enhance Council's monitoring of its buildings and infrastructure's GHG emissions as well as energy use and performance
		Offsets	Consider use of offsets to supplement energy efficiency and increasing use of renewable energy
BP-1.2	New Council buildings designed, constructed and operated to meet best practice Environmentally Sustainable Design (ESD) standards	Reducing emissions - new buildings	Council's new buildings to be designed to minimise energy use and GHG emissions in accordance with the Sustainable Buildings Policy
Community			
CE-2.1	Engage, advocate and empower the community to enable the reduction in CO_2e emissions from the built environment	Energy efficient buildings	Work with key stakeholders to facilitate increased awareness amongst residents and businesses of their energy consumption profiles and the benefits from reducing energy use and increasing energy efficiency. E.g. City of Sydney has developed strategies for sustainability in community scale office and accommodation buildings – and CoGD could do the same such as for Industrial buildings.
			Advocate for building regulations to promote carbon neutrality by 2030 in line with guidance such as Green Building Council of Australia (GBCA) Carbon Positive Roadmaps
CE-2.5	Work with partners to increase community awareness on benefits of energy efficiency and renewables	Increase awareness - options / incentives	Work with key stakeholders to facilitate increased awareness amongst residents and businesses of possible energy efficiency incentives available. For example, Energy Upgrade Agreements present an opportunity for the CoGD to help to drive financing for energy efficiency.
BP-2.4	New developments within the city to incorporate best practice Ecologically Sustainable Design (ESD) standards.	New Buildings - CGD Planning Scheme	Facilitate reductions in GHG emissions from residents and businesses new buildings through the Greater Dandenong Planning Scheme's statutory and non-statutory processes.
CE-2.4	Help the community to incorporate best practice energy initiatives through planning processes	New Buildings - Collaborate / advocacy for stronger planning controls / Higher building standards	Ongoing collaboration and advocacy with other local governments and regulatory authorities to appropriately incorporate best practice ESD principles into building regulations and land-use planning outcomes (e.g. CASBE membership)
BP-2.1	With the support of key stakeholders, help the community reduce energy consumption in existing buildings	Existing Buildings & equipment	Work with key stakeholders to help facilitate residents and businesses to minimise their energy use and GHG emissions from existing buildings and equipment

No.	CGD Sustainability Strategy Objectives	Focus Area	Actions / Priorities - what we will do over next five years to achieve our objectives
CE-2.2	Help the community reduce energy consumption within the built environment.	Support disadvantaged households / business	Identify, consider, and implement opportunities to assist disadvantaged households and businesses to minimise their energy use and costs. We note that some councils provide incentives for incremental NABERS improvements (e.g. City of Sydney)
BE-2.2	Work in partnership to support all types of businesses throughout Greater Dandenong save money by reducing their energy consumption.	Support business	Promote actions to local businesses which encourage the transition to lower-impact fuels and alternative energy sources, supported by the Sustainability Awards.
		Reducing barriers	Work with key stakeholders to identify and address key barriers to minimising the communities' energy use and GHG emissions, supported by the Climate Change Strategy.
		Support business	Investigate opportunities to support larger commercial and industrial businesses to increase implementation of emissions abatement opportunities. Including energy efficiency opportunities for larger, more energy intensive companies.
		Support business	Consider how development contribution plans can assist with the transition to a low carbon energy future that helps provide essential infrastructure to help cope with the growing population and changing climate
		Transition to electrification	Promote and advocate to local developers and building owners the rationale for the transition of energy use from gas to electricity. For example, by combining renewable energy supply with shifts from gas heating to electric heating.
		Support business	Support and promote activities which assist local innovative businesses to take up new low carbon technologies and research and development opportunities. Supported by the Sustainability Awards.

Table 30 - Actions for energy supply

No.	CGD Sustainability Strategy Objectives	Focus Area	Actions - what we will do over next five years to achieve our objectives
Corporate			
	Advocate for strengthened Commonwealth and Victorian renewable energy targets	Advocacy for State & Federal targets	Advocate for the strengthening of the Commonwealth and Victorian Governments' Renewable Energy Targets (VRET & RET)
CE-1.3	Increase the percentage of energy consumed by Council obtained from renewable energy	Council direct generation renewable energy	Increase Council's direct generation and use of renewable energy across its operations
		Council leadership	Demonstrate leadership to the community through its generation and use of renewable energy
		Council innovation	Identify and consider opportunities to demonstrate innovation through Council's council use of renewable energy generation and battery storage
		Council purchasing renewable energy	Consider opportunities for Council to purchase energy from renewable sources (e.g. purchased through energy contracts, Power Purchase Agreements etc.)

No.	CGD Sustainability Strategy Objectives	Focus Area	Actions - what we will do over next five years to achieve our objectives
Community			
CE-2.5	Work with partners to increase community awareness on the benefits of energy efficiency and renewables	Increase Community awareness	Facilitate an increase in the community's knowledge and awareness of renewable energy. A pathway to this could be to develop an understanding of key barriers to investment from CoGD Industrial, Commercial and Residential sectors. Which requires understanding key criteria such as the types, age and tenure of the buildings – which will affect the barriers and opportunities for energy savings. And then provide information that provides solutions for addressing these barriers, including sign posting to existing support programs from State Government.
		Community awareness / advocacy for VRET	Facilitate community awareness, support and advocacy for the strengthening (and local implementation) of the Commonwealth and Victorian Governments' Renewable Energy Targets (VRET & RET). There could be opportunities to position the CoGD as a leader in renewable energy, such as through PPAs or large onsite solar PV installations on industrial roof space or ground mounted areas.
		Collaborate with state government on VRET	Discuss with State Government plans for VRET, how the City can best support implementation and what funding support mechanisms could be sourced
CE-2.4	New developments within the City to incorporate best practice energy initiatives		Facilitate new developments with energy generation, storage and use of renewable energy. This links to the action below.
			Consider making planning requirements and decisions sympathetic to renewable energy technology
CE-2.3	Help the community increase use of renewable energy	Community generation of renewable energy	Support businesses and households across the municipality to increase their direct generation of renewable energy
		Community purchase of renewable energy	Facilitate households and businesses increased awareness of the benefits and opportunities from purchasing renewable energy (e.g. purchased through energy contracts, Power Purchase Agreements etc.), supported by the Sustainability Awards.
		Support disadvantaged households / business	Identify, consider, and where appropriate, implement opportunities to assist less represented sectors to increase their awareness and uptake of renewable energy opportunities
		Collaborate with key stakeholders to increase	Collaborate with key stakeholders (e.g. Government authorities, United Energy, SEMMA etc) to facilitate and support Council's efforts to increase the community's renewable energy uptake
			Consider opportunities for Council to support the establishment of a local Community Energy Scheme led by the community to develop and benefit from a renewable energy resource
			Investigate opportunities to support larger commercial and industrial businesses to increase implementation of emissions abatement opportunities. Including renewable energy opportunities for larger, more energy intensive companies.

Table 31 - Actions for transport

No.	CGD Sustainability Strategy Objectives	Focus Area	Actions / Priorities - what we will do over next five years to achieve our objectives
Corporate			
TM-1.1	Support Council staff to increase levels of active transport - such as walking and cycling	Increased use by Council staff of active and sustainable low carbon transport options	Reducing transport utilisation through use of appropriate technology (such as car-pooling, public transport and electric vehicles)
			Support Council staff to increase levels of active travel – such as walking and cycling
TM-1.2	Support Council staff to increase use of low carbon and sustainable transport options		Support Council staff to increase use of low carbon and sustainable transport options
TM-1.3	Reduce emissions and costs associated with the operation of Council's fleet	A reduction in GHG emissions from Council's fleet	Reduce emissions and costs associated with the operation of fleet – Council and contractors
			Review the Council's vehicle procurement policy to identify opportunities for low-emissions vehicles
TM-1.4	Improve connectivity and accessibility of the walking and cycling networks throughout CoGD	Improved walking and cycling networks throughout CoGD	Work with key partners to improve connectivity and accessibility of the walking and cycling networks throughout CoGD
			Expand CoGD's cycling network
Community			
TM-2.5	Increase community awareness on the benefits of sustainable transport options	Increase community awareness on the benefits of sustainable transport	Reducing transport utilisation through use of appropriate technology
			Increase community awareness on the benefits of sustainable and active transport to reduce reliance on cars
TM-2.1	Work with partners to encourage the community to increase their use of active travel – such as walking and cycling	Increased travel by walking and cycling within the municipality	Work with partners to encourage the community to increase their use of active travel – such as walking and cycling
			Work with key partners to help increase the walk-ability of our suburbs
TM-2.2	Work with partners to encourage the community to increase their use of low carbon and sustainable transport – such as public transport and electric vehicles	Increased use of public transport within the municipality	Work with partners to encourage the community to increase their use of low carbon and sustainable transport – such as public transport and electric vehicles
TM-2.3	With our partners, work towards providing safe, connected and well serviced public transport options for the community		With partners, provide support for the provision of safe, connected and well serviced Public Transport options for the community
			Advocate to the Victorian Government for improved public transport infrastructure and services for the region
TM-2.4	New developments within the city to incorporate best practice sustainable transport initiatives		Facilitate an increase in use of active, public and low carbon transport options through the Greater Dandenong Planning Scheme's statutory and non-statutory processes
	Public transport powered by renewable energy	Increased community uptake of low emission vehicles	Develop Multi Modal Transport Infrastructure Plans for areas subject to significant change
			Support increased community use of share cars
			Support the community's uptake of electric and hydrogen vehicles through opportunities to facilitate improve required infrastructure
			Advocate to the Victorian Government for energy efficient public transport powered by renewable energy
			Advocate to the Australian Government for best practice emission standards for petrol and diesel engines
			Engage with the public transport authority to identify opportunities to trial electric/hybrid buses to replace traditional petrol/diesel fuel engines
			Identify opportunities to provide or widen footpaths in CoGD for increased walkability
			Engage with the Victorian State Government to identify opportunities to increase the % of trips to and from CoGD using sustainable transport

Table 32 - Actions for waste

No.	CGD Sustainability Strategy Objectives	Focus Area	High Level Actions / Priorities - what we will do over next five years to achieve our objectives
Corporate			
WR-1.1	Reduce the amount of waste sent to landfill from Council's offices and facilities	Reduce Council's waste to landfill	Reduce waste sent to landfill from Council facilities
WR-1.2	Increase Council's reuse and recycling of materials	Increase Council's reuse and recycling of materials	Increase material recovered for re-use and recycling across Council's operations
		Council direct support for recycling industry (i.e. use / purchase of recycled products)	Support and promote an increase in the use of recycled materials across Council operations
		Council - Sustainable procurement	Encourage Council's use of products which have minimal impact on the environment and encourage suppliers to adopt good environmental practices Actively promote green procurement throughout Council's supply chain and where possible consider selection which has minimum environmental impact Identify opportunities to influence and monitor green purchasing across Council (from CGD Waste Strategy)
		Council's waste collection services	Provide waste collection services to the community that aim to increase resource recovery and reduce waste to landfill
Community			
WR-2.5	Increase community awareness on waste and resources and benefits of reduce, re-use and recycle	Collaborative approach to increase community awareness	Work with key stakeholders to increase community awareness of waste and resource management and the benefits of smart consumption, re-use and recycling
		Council's Effective Council education resources	Ensure community waste education programs, resources and communication tools are accessible and effective
		Improved product stewardship	Advocate to the Federal and State Governments for reduced waste through improved product stewardship and packaging
WR-2.1	Work in partnership with our community to reduce the amount of waste sent to landfill	Working in collaboration with key partners to reduce the community's waste to landfill	Work with partners to reduce waste to landfill
WR-2.2	Work in partnership with the community to increase recycling rates across the city	Reduce waste to landfill & increase resource recovery - primarily households	Work with households to increase resource recovery and reduce waste to landfill through Council's kerbside collection service
		Reduce waste to landfill & increase resource recovery - businesses	Work with businesses to reduce generation rates and improve diversion of waste from landfill
		Reduce food waste - households	Work with households to reduce food waste in collaboration with key stakeholders
		Reduce food waste - businesses	Work with businesses to reduce food waste in collaboration with key stakeholders

No.	CGD Sustainability Strategy Objectives	Focus Area	High Level Actions / Priorities - what we will do over next five years to achieve our objectives
WR-2.5	New developments to incorporate best practice waste and resource management	New developments - best practice	Facilitate new developments within the city to incorporate best practice waste and resource management through the planning process (e.g. BESS, 5-Star Green Star + Rating)
		Future	Work with state government and regional partners to help facilitate the planning and delivery of future waste management infrastructure
		Support communities recycling industry / waste to energy	Support Council and community based programs/companies that enable resource recovery and reuse

Appendix B MACC opportunities by sector

Table 33 - Corporate opportunities

Opportunity Name	Implementation Cost ($, excl. GST)	Annual Energy Savings (MJ)	Annual Energy Bill Savings ($ excl. GST)	Discounted Payback (yrs)	Annual Renewable Energy Generated (MJ)	Energy Generation Capacity Added (kW)	Average Annual Abatement (tCO_2-e)	Abatement Cost ($/$tCO_2$-e)	Co-Benefit: Direct Employment Creation
Pool covers/heating	1,531	207,984	12,098	1			51	-211	0.01
Lighting-Delamping	134	3,700	249	1			1	-200	0.00
Process heat and steam - Boiler	6,846	187,753	11,846	1			48	-194	0.03
Controls - Compressed air systems	24,506	608,726	41,004	1			172	-194	0.12
Refrigeration and cooling - Maintenance	6,842	132,315	8,913	1			37	-188	0.03
Controls - Refrigeration and cooling	7,601	132,373	8,917	1			37	-184	0.04
IT equipment	60,579	1,052,063	70,868	1			297	-184	0.30
Controls - Building management system	4,367	69,562	4,686	1			20	-181	0.02
Insulation	6,916	60,193	4,055	2			16	-173	0.03
Controls - HVAC	9,944	129,332	8,038	2			34	-168	0.05
Metering	29,471	375,142	22,381	2			95	-165	0.15
Controls - Process equipment	4,528	103,166	3,603	2			16	-164	0.02
Water heating measures	4,435	65,885	3,001	2			13	-162	0.02
Controls - Lighting	10,045	94,313	6,353	2			27	-156	0.05
Refrigeration and cooling - VSDs	27,582	255,073	17,182	2			72	-155	0.14
Controls - Process heat and steam	9,621	403,504	8,103	2			38	-153	0.05
Refrigeration and cooling - Insulation and sealing	29,921	266,084	17,924	2			75	-152	0.15
HVAC - Maintenance	9,076	80,038	5,391	2			23	-151	0.05
Lighting - Floodlight to LED	9,661	82,974	5,589	2			23	-150	0.05
Solar thermal	50,340	280,463	18,892	4			76	-142	0.25
Voltage optimisation	84,582	525,806	35,419	3			147	-140	0.42
Process equipment - VSDs	20,450	123,703	8,333	4			35	-138	0.10
Compressed air systems - Maintenance	6,001	38,911	2,621	3			11	-127	0.03
Compressed air systems - Upgrade	17,365	91,319	6,151	4			25	-127	0.09

Opportunity Name	Implementation Cost ($, excl. GST)	Annual Energy Savings (MJ)	Annual Energy Bill Savings ($ excl. GST)	Discounted Payback (yrs)	Annual Renewable Energy Generated (MJ)	Energy Generation Capacity Added (kW)	Average Annual Abatement (tCO_2-e)	Abatement Cost ($/$tCO_2$-e)	Co-Benefit: Direct Employment Creation
Process heat and steam - Maintenance	4,694	516,342	4,389	2			27	-123	0.02
HVAC - VSDs	83,416	398,130	26,818	5			111	-118	0.42
Lighting - Fluorescent upgrade	3,483	19,760	1,331	4			6	-115	0.02
Process equipment - Maintenance	5,616	25,831	1,740	5			7	-114	0.03
Lighting - Fluorescent to LED	15,889	84,401	5,685	4			24	-108	0.08
Lighting - Public lighting	41,182	210,489	14,179	4			59	-103	0.21
Process equipment - Upgrade	255,614	1,011,307	68,123	6			282	-99	1.28
Solar PV - 50 to 100 kW system	27,951	93,305	6,285	8	93,305.43	26.38358	25	-97	0.14
Ventilation	5,578	21,590	1,454	6			6	-96	0.03
Process heat and steam - Insulation	313	12,987	110	4			1	-94	0.00
Lighting - Multiple to LED	39,448	183,984	12,393	5			52	-92	0.20
HVAC - Upgrade	188,580	654,638	37,199	9			152	-80	0.94
Lighting	28,033	115,361	7,771	6			33	-75	0.14
Lighting - High Bay to LED	12,527	50,643	3,411	6			14	-73	0.06
Process heat and steam - Upgrade	30,101	274,323	6,793	8			31	-70	0.15
Solar PV - <50 kW system	518,327	1,362,165	91,757	11	136,2165	385.1737	369	-67	2.59
HVAC - Insulation	29,800	104,617	7,047	7			30	-51	0.15
Solar PV - 100+ kW system	3,924	7,917	533	17	7,917.109	2.238687	2	-23	0.02
Lighting - Halogen to LED	49,619	99,220	6,684	> Opportunity life			28	76	0.25
Refrigeration and cooling - Upgrade	118,517	217,326	14,639	> Opportunity life			61	102	0.59
Process heat and steam - VSDs	31,837	203,738	2,659	> Opportunity life			14	117	0.16
Power factor correction	124,524	149,667	10,082	> Opportunity life			42	270	0.62
Refrigeration and cooling - Chiller	830,205	963,580	64,908	> Opportunity life			272	288	4.15
Total	**2,891,518**	**12,151,704**	**727,610**	**165**	**1,463,388**	**414**	**3,035**		**14**

Table 34 - Commercial opportunities

Opportunity Name	Implementation Cost ($, excl. GST)	Annual Energy Savings (MJ)	Annual Energy Bill Savings ($ excl. GST)	Discounted Payback (yrs)	Annual Renewable Energy Generated (MJ)	Energy Generation Capacity Added (kW)	Average Annual Abatement (tCO_2-e)	Abatement Cost ($/$tCO_2$-e)	Co-Benefit: Direct Employment Creation
Commercial - Lighting - Delamping	7,899	218,009	14,685	1			56	-200	0
Commercial - Controls - Compressed air systems	1,443,736	35,862,403	2,415,731	1			10,126	-194	7
Commercial - Process heat and steam - Boiler	576,119	13,890,632	721,955	1			2,964	-186	3
Commercial - Controls - Refrigeration and cooling	447,760	7,798,605	525,323	1			2,202	-184	2
Commercial - IT equipment	3,568,975	61,981,076	4,175,114	1			17,501	-184	18
Commercial - Controls - Building management system	257,261	4,098,144	276,056	1			1,157	-181	1
Commercial - Insulation	407,438	3,546,215	238,877	2			916	-173	2
Commercial - Controls - HVAC	633,697	9,999,008	493,793	2			2,118	-163	3
Commercial - Controls - Lighting	591,810	5,556,336	374,281	2			1,569	-156	3
Commercial - Lighting - Floodlight to LED	569,194	4,888,287	329,280	2			1,380	-150	3
Commercial - Controls - Process equipment	362,491	17,897,842	312,736	2			1,543	-149	2
Commercial - Metering	2,328,056	32,305,062	1,405,291	2			6,099	-147	12
Commercial - Solar thermal	2,965,704	16,523,123	1,113,016	4			4,473	-142	15
Commercial - Water heating measures	474,971	8,956,224	219,958	3			1,017	-131	2
Commercial - Compressed air systems - Upgrade	1,023,023	5,379,935	362,398	4			1,501	-127	5
Commercial - Controls - Process heat and steam	1,919,859	91,157,381	1,050,147	3			5,722	-121	10
Commercial - HVAC - VSDs	4,914,353	23,455,337	1,579,978	5			6,543	-118	25
Commercial - Lighting - Public lighting	2,426,182	12,400,697	835,325	4			3,501	-103	12
Commercial - Process equipment - Upgrade	15,059,222	59,579,973	4,013,373	6			16,621	-99	75
Commercial - Solar PV - 50 to 100 kW system	1,646,698	5,496,979	370,283	8	5,496,979	1,554	1,488	-97	8
Commercial - Ventilation	328,638	1,271,976	85,682	6			355	-96	2
Commercial - Process heat and steam - Insulation	83,498	3,465,155	29,454	4			179	-94	0
Commercial - Lighting - Multiple to LED	2,324,058	10,839,219	730,142	5			3,061	-92	12
Commercial - Lighting - High Bay to LED	738,022	2,983,555	200,976	6			842	-73	4

Opportunity Name	Implementation Cost ($, excl. GST)	Annual Energy Savings (MJ)	Annual Energy Bill Savings ($ excl. GST)	Discounted Payback (yrs)	Annual Renewable Energy Generated (MJ)	Energy Generation Capacity Added (kW)	Average Annual Abatement (tCO_2-e)	Abatement Cost ($/$tCO_2$-e)	Co-Benefit: Direct Employment Creation
Commercial - Solar PV - <50 kW system	30,536,590	80,250,367	5,405,754	11	80,250,367	22,692	21,723	-67	153
Commercial - HVAC - Upgrade	13,543,076	62,933,081	2,398,638	11			10,182	-63	68
Commercial - HVAC - Insulation	1,755,592	6,163,389	415,173	7			1,740	-51	9
Commercial - Solar PV - 100+ kW system	231,176	466,427	31,419	17	466,427	132	126	-23	1
Commercial - Process heat and steam - Upgrade	5,436,783	57,437,536	751,047	> Opportunity life			3,975	5	27
Commercial - Power factor correction	7,336,169	8,817,473	593,955	> Opportunity life			2,490	270	37
Commercial - Refrigeration and cooling - Chiller	48,910,540	56,768,184	3,823,968	> Opportunity life			16,029	288	245
Commercial - Lighting - Delamping	7,899	218,009	14,685	1			56	-200	0
Commercial - Controls - Compressed air systems	1,443,736	35,862,403	2,415,731	1			10,126	-194	7
Commercial - Process heat and steam - Boiler	576,119	13,890,632	721,955	1			2,964	-186	3
Commercial - Controls - Refrigeration and cooling	447,760	7,798,605	525,323	1			2,202	-184	2
Commercial - IT equipment	3,568,975	61,981,076	4,175,114	1			17,501	-184	18
Commercial - Controls - Building management system	257,261	4,098,144	276,056	1			1,157	-181	1
Commercial - Insulation	407,438	3,546,215	238,877	2			916	-173	2
Commercial - Controls - HVAC	633,697	9,999,008	493,793	2			2,118	-163	3
Commercial - Controls - Lighting	591,810	5,556,336	374,281	2			1,569	-156	3
Commercial - Lighting - Floodlight to LED	569,194	4,888,287	329,280	2			1,380	-150	3
Commercial - Controls - Process equipment	362,491	17,897,842	312,736	2			1,543	-149	2
Commercial - Metering	2,328,056	32,305,062	1,405,291	2			6,099	-147	12
Commercial - Solar thermal	2,965,704	16,523,123	1,113,016	4			4,473	-142	15
Commercial - Water heating measures	474,971	8,956,224	219,958	3			1,017	-131	2
Commercial - Compressed air systems - Upgrade	1,023,023	5,379,935	362,398	4			1,501	-127	5
Total	**152,848,586**	**712,387,631**	**35,293,806**	**122**	**86,213,773**	**24,378**	**149,201**	**-3,000**	**764**

Table 35 - Industrial opportunities

Opportunity Name	Implementation Cost ($, excluding. GST)	Annual Energy Savings (MJ)	Annual Energy Bill Savings ($ excluding. GST)	Discounted Payback (yrs)	Annual Renewable Energy Generated (MJ)	Energy Generation Capacity Added (kW)	Average Annual Abatement (tCO_2-e)	Abatement Cost ($/$tCO_2$-e)	Co-Benefit: Direct Employment Creation
Industrial - Process heat and steam - Furnace	935,340	232,219,926	2,447,091	1			12,133	-162	5
Industrial - Controls - Process heat and steam	5,234,058	422,292,984	4,471,972	2			22,268	-145	26
Industrial - Process heat and steam - Boiler	1,391,055	69,222,099	743,953	3			3,735	-130	7
Industrial - Water heating measures	707,935	46,846,390	619,987	2			3,519	-130	4
Industrial - Process heat and steam - Heat recovery	12,997,484	779,868,394	10,911,092	2			63,574	-125	65
Industrial - Insulation	1,282,004	70,305,133	1,409,042	1			8,817	-117	6
Industrial - Solar thermal	1,259,899	403,764,397	15,062,655	1			109,293	-115	6
Industrial - Controls - VSDs	964,036	27,854,308	1,039,120	1			7,771	-102	5
Industrial - Controls - Compressed air systems	585,475	14,418,719	537,898	2			4,071	-97	3
Industrial - Monitoring	2,602,510	58,621,594	2,186,911	2			16,552	-95	13
Industrial - Controls - Process equipment	1,333,007	28,671,932	1,069,622	2			8,096	-93	7
Industrial - Metering	871,701	14,448,621	539,014	2			4,080	-85	4
Industrial - Controls - Refrigeration and cooling	839,770	11,697,413	436,378	3			3,303	-79	4
Industrial - Ventilation	355,995	3,963,272	147,852	3			1,106	-77	2
Industrial - Refrigeration and cooling - Chiller	2,349,435	22,215,406	828,758	4			6,198	-70	12
Industrial - Controls - HVAC	615,508	7,518,795	244,495	4			1,814	-67	3
Industrial - Lighting - Delamping	531,490	3,366,103	125,574	7			870	-64	3
Industrial - Controls - Lighting	230,850	2,321,941	86,621	4			656	-62	1
Industrial - HVAC - VSDs	1,917,539	14,944,143	557,500	5			4,169	-60	10
Industrial - Lighting - Multiple to LED	3,034,176	26,392,646	984,592	5			7,452	-53	15
Industrial - Process equipment - Upgrade	13,774,813	173,888,230	2,991,403	8			18,906	-48	69
Industrial - HVAC - Insulation	2,335,503	16,863,416	629,099	6			4,762	-39	12
Industrial - Lighting - Floodlight to LED	344,828	2,261,175	84,354	7			638	-31	2
Industrial - Refrigeration and cooling - Insulation and sealing	4,041,477	25,747,749	960,534	7			7,270	-29	20

Opportunity Name	Implementation Cost ($, excluding. GST)	Annual Energy Savings (MJ)	Annual Energy Bill Savings ($ excluding. GST)	Discounted Payback (yrs)	Annual Renewable Energy Generated (MJ)	Energy Generation Capacity Added (kW)	Average Annual Abatement (tCO_2-e)	Abatement Cost ($/$tCO_2$-e)	Co-Benefit: Direct Employment Creation
Industrial - Process heat and steam - Insulation	20,189,724	223,102,627	3,503,885	11			21,426	-26	101
Industrial - Compressed air systems - Upgrade	9,187,246	51,140,781	1,907,835	9			14,440	-15	46
Industrial - Process equipment - VSDs	6,946,529	29,626,586	1,105,236	13			8,265	-12	35
Industrial - Solar PV - <50 kW system	42,968,356	155,274,745	5,792,611	17	155,274,745	43,906	42,030	-12	215
Industrial - Lighting - High Bay to LED	5,415,271	28,955,299	1,080,194	9			8,176	-11	27
Industrial - Process heat and steam - Upgrade	42,412,903	684,682,805	7,506,282	> Opportunity life			38,302	4	212
Industrial - HVAC - Upgrade	9,276,572	27,719,791	1,034,102	> Opportunity life			7,503	10	46
Industrial - Solar PV - 100+ kW system	777,435	2,190,708	81,726	> Opportunity life	2,190,708	619	593	17	4
Industrial - Solar PV - 50 to 100 kW system	8,610,458	23,792,419	887,589	> Opportunity life	23,792,419	6,728	6,440	20	43
Industrial - Refrigeration and cooling - Upgrade	23,336,393	56,522,893	2,108,618	> Opportunity life			15,768	68	117
Industrial - Controls - Building management system	7,883,526	20,827,281	776,973	> Opportunity life			5,881	102	39
Industrial - Power factor correction	149,696,434	49,547,478	1,848,396	> Opportunity life			13,990	1653	748
Total	**387,236,735**	**3,833,098,200**	**76,748,966**	**143**	**181,257,872**	**51,254**	**503,864**	**-277**	**1,936**

Table 36 - Residential opportunities

Opportunity Name	Implementation Cost (excl. GST)	Annual Energy Savings (MJ)	Annual Energy Bill Savings ($ excl. GST)	Discounted Payback (yrs)	Annual Renewable Energy Generated (MJ)	Energy Generation Capacity Added (kW)	Average Annual Abatement (tCO_2-e)	Abatement Cost ($/$tCO_2$-e)	Co-Benefit: Direct Employment Creation
Residential - Water heating measures - LF shower rose	3,806,308	62,012,958	1,579,051	3			3,903	-278	19
Residential - Lighting	16,420,969	34,387,360	3,164,592	6			8,885	-220	82
Residential - Solar PV - 4kW system size	154,962,106	289,344,158	26,627,700	6	512,113,554	144,808	78,321	-194	775
Residential - Building infiltration sealing - Air sealing	42,603,263	329,879,481	7,897,211	6			19,108	-168	213
Residential - HVAC - Space heating	61,416,281	285,505,051	6,951,104	10			16,900	-120	307
Residential - Water heating measures - Water heater - HE gas	36,343,031	64,991,564	4,557,124	9			13,632	-92	182
Residential - Appliances - Fridge	40,476,499	38,192,037	3,514,728	13			10,543	-76	202
Residential - Appliances - Clothes dryer - Std	5,626,571	5,655,171	520,433	12			1,594	-17	28
Residential - Appliances - TV	32,261,854	22,109,324	2,034,672	> Opportunity life			6,137	20	161
Residential - Insulation - Ceiling insul (easy)	31,919,157	46,934,408	1,140,358	> Opportunity life			2,737	100	160
Residential - Building infiltration sealing - Seal wall cavity	22,214,831	38,060,710	906,086	> Opportunity life			2,176	128	111
Residential - Insulation - Wall insul	197,508,479	256,523,415	6,076,216	> Opportunity life			14,497	171	988
Residential - Insulation - Ceiling insul (top up)	36,679,464	41,481,628	985,000	> Opportunity life			2,351	246	183
Residential - Solar thermal - Water heater - solar	233,964,436	392,558,549	11,431,718	> Opportunity life			29,420	273	1,170
Residential - Insulation - Underfloor insul	92,968,606	85,914,508	1,923,754	> Opportunity life			4,527	426	465
Residential - Building infiltration sealing - Reduce SF ventilation	31,595,925	24,684,775	576,416	> Opportunity life			1,376	724	158
Residential - Appliances - Dishwasher	18,927,759	3,558,832	327,511	> Opportunity life			1,003	1,183	95
Residential - HVAC - Air conditioning	51,699,822	7,130,186	656,175	> Opportunity life			2,004	1,571	258
Residential - Appliances - Clothes washer	10,975,787	4,794,227	141,759	> Opportunity life			366	1,996	55

Opportunity Name	Implementation Cost (excl. GST)	Annual Energy Savings (MJ)	Annual Energy Bill Savings ($ excl. GST)	Discounted Payback (yrs)	Annual Renewable Energy Generated (MJ)	Energy Generation Capacity Added (kW)	Average Annual Abatement (tCO_2-e)	Abatement Cost ($/$tCO_2$-e)	Co-Benefit: Direct Employment Creation
Residential - Window frames, glazing and shading - Drapes	83,631,834	92,956,361	2,202,015	> Opportunity life			5,312	2,562	418
Residential - Window frames, glazing and shading - Double glazing	498,909,984	96,296,737	2,308,852	> Opportunity life			5,524	3,053	2,495
Residential - Window frames, glazing and shading - Ext shading	60,494,684	354,849	32,656	> Opportunity life			101	112,355	302
Total	**1,765,407,651**	**2,223,326,287**	**85,555,132**	**65**	**512,113,554**	**144,808**	**230,417**	**123,641**	**8,827**

Appendix C Detailed corporate emissions inventory and sources

GPC ref No	GHG Emissions Source (By Sector and Sub-sector)	Total GHGs (metric tonnes CO_2e)			
		Scope 1	Scope 2	Scope 3	Total
I	STATIONARY ENERG				
I.1	Residential buildings	NO	NO	NE	
I.2	Commercial and institutional buildings and facilities	184	10,503	1	10,687
I.3	Manufacturing industries and construction	NO	NO	NE	
I.4.1/2/3	Energy industries	NO	NO	NE	
I.4.4	Energy generation supplied to the grid	NE			
I.5	Agriculture, forestry and fishing activities	NO	NO	NE	
I.6	Non-specified sources	NO	NO	NE	
I.7	Fugitive emissions from mining, processing, storage, and transportation of coal	NO			
I.8	Fugitive emissions from oil and natural gas systems	NO			
SUB-TOTAL	(city induced framework only)	184	10,503	1	10,687
II	TRANSPORTATION				
II.1	On-road transportation	1,390	NO	NE	1,390
II.2	Railways	NE	NE	NO	
II.3	Waterborne navigation	NO	NO	NO	
II.4	Aviation	NE	NE	NO	
II.5	Off-road transportation	NO	NO	NO	
SUB-TOTAL	(city induced framework only)	1,390			1,390
III	WASTE				
III.1.1/2	Solid waste generated in the city	1,758		NO	1,758
III.2.1/2	Biological waste generated in the city	NE		NE	
III.3.1/2	Incinerated and burned waste generated in the city	NE		NE	
III.4.1/2	Wastewater generated in the city	NE		NE	
III.1.3	Solid waste generated outside the city	NO			
III.2.3	Biological waste generated outside the city	NE			
III.3.3	Incinerated and burned waste generated outside city	NE			
III.4.3	Wastewater generated outside the city	NE			
SUB-TOTAL	(city induced framework only)	1,758			1,758
IV	INDUSTRIAL PROCESSES and PRODUCT USES				
IV.1	Emissions from industrial processes occurring in the city boundary	NE			
IV.2	Emissions from product use occurring within the city boundary	NE			
SUB-TOTAL	(city induced framework only)				
V	AGRICULTURE, FORESTRY and OTHER LAND USE				
V.1	Emissions from livestock	NE			
V.2	Emissions from land	NE			
V.3	Emissions from aggregate sources and non-CO2 emission sources on land	NE			
SUB-TOTAL	(city induced framework only)				
VI	OTHER SCOPE 3				
VI.1	Other Scope 3			NE	
TOTAL	(city induced framework only)	3,331	10,503	1	13,835

Table 37 - CIRIS tool inputs and methodology for the corporate inventory

Input	Methodology	Source
Stationary Energy (Electricity)	Council activity is categorised within I.2 as an Institutional Building. Therefore, only the all Commercial and Institutional Buildings and Facilities category is used in CIRIS, and all other categories have not been covered.	► Transmissions and distribution losses from grid-supplied electricity sourced from CarbonetiX Report - Overall-2007-2018 ► Emissions from grid-supplied electricity consumed within the city boundary sourced from GHG emissions per site 2007-2018 provided by CoGD.
Stationary Energy (Gas)	Council activity is categorised within I.2 as an Institutional Building. Therefore, only the all Commercial and Institutional Buildings and Facilities category is used in CIRIS, and all other categories have not been covered.	Emissions from natural gas used within the city boundary sourced from CarbonetiX Report - Overall-2007-2018.
Transportation	On road transportation data was used to calculate corporate transport emissions. The transport calculation did not include the following, as they are not tracked for CoGD: ► Railway transport ► Waterborne transport ► Airborne transport.	CarbonetiX Report - Overall-2007-2018
Waste	Waste values are an amalgamation of solid waste disposal from residential bins and sporting field bins.	CarbonetiX Report - Overall-2007-2018

Appendix D Detailed community emissions profile and sources

GPC ref No.	GHG Emissions Source (By Sector and Sub-sector)	Total GHGs (metric tonnes CO_2e)			
		Scope 1	Scope 2	Scope 3	Total
I	STATIONARY ENERGY				
I.1	Residential buildings	159,573	317,645	NE	477,218
I.2	Commercial and institutional buildings and facilities	54,278	618,744	NE	673,022
I.3	Manufacturing industries and construction	468,846	1,401,732	NE	1,870,578
I.4.1/2/3	Energy industries	1,675	3,606	NE	5,281
I.4.4	Energy generation supplied to the grid				
I.5	Agriculture, forestry and fishing activities	1,690	6,657	NE	8,347
I.6	Non-specified sources	9,994	39,381	NE	49,375
I.7	Fugitive emissions from mining, processing, storage, and transportation of coal	NO			
I.8	Fugitive emissions from oil and natural gas systems				
SUB-TOTAL	(city induced framework only)	**696,056**	**2,387,765**		**3,083,821**
II	TRANSPORTATION				
II.1	On-road transportation	468,104		NE	468,104
II.2	Railways	7,943	17,166	NE	25,109
II.3	Waterborne navigation			NE	
II.4	Aviation		NO	NE	
II.5	Off-road transportation	NO	NO	NE	
SUB-TOTAL	(city induced framework only)	**476,047**	**17,166**		**493,213**
III	WASTE				
III.1.1/2	Solid waste generated in the city			366,146	366,146
III.2.1/2	Biological waste generated in the city				
III.3.1/2	Incinerated and burned waste generated in the city				
III.4.1/2	Wastewater generated in the city	21,387			21,387
III.1.3	Solid waste generated outside the city				
III.2.3	Biological waste generated outside the city				
III.3.3	Incinerated and burned waste generated outside city				
III.4.3	Wastewater generated outside the city				
SUB-TOTAL	(city induced framework only)	**21,387**		**366,146**	**387,533**
IV	INDUSTRIAL PROCESSES and PRODUCT USES				
IV.1	Emissions from industrial processes occurring in the city boundary	NE			
IV.2	Emissions from product use occurring within the city boundary	NE			
SUB-TOTAL	(city induced framework only)				
V	AGRICULTURE, FORESTRY and OTHER LAND USE				
V.1	Emissions from livestock	NE			
V.2	Emissions from land	NE			
V.3	Emissions from aggregate sources and non-CO2 emission sources on land	NE			
SUB-TOTAL	(city induced framework only)				
VI	OTHER SCOPE 3				
VI.1	Other Scope 3			NE	
TOTAL	(city induced framework only)	**1,193,490**	**2,404,931**	**366,146**	**3,964,567**

Table 38 - CIRIS tool inputs and methodology for community emissions profile

Input	Methodology	Source
Stationary Energy (Electricity)	United Energy's electricity data from 2016 was used to estimate Stationary Energy Emissions. United Energy supplies the majority of electricity for City of Greater Dandenong. ► Electricity was converted to tCO_2e using Victoria's electricity conversion factor. United Energy's electricity data is broken down into Residential, Commercial and Industrial ► United Energy do not supply electricity to a small area of Greater Dandenong, which is instead supplied by Ausnet. This area is used for industrial manufacturing. Therefore, a 1% increase was applied to United Energy's industrial electricity consumption to make up for this area that is not captured in their data. Based on discussions with United Energy.	► Extracted 2016 electricity data from United Energy ► Emissions factor sourced from National Greenhouse Accounts Factors[35]
Stationary Energy (Gas)	Stationary Gas emissions were estimated by multiplying the Victorian gas consumption by: ► The number of CoGD residents as a % of Victoria's total population, to produce the amount of residential gas CoGD consumes ► The commercial employment as a % of Victoria's total commercial employment population, to produce the amount of gas consumed by the CoGD commercial sector ► The industrial employment as a % of Victoria's total industrial employment population, to produce the amount of gas consumed by the CoGD industrial sector ► Gas consumption figures entered into CIRIS which applies an emissions factor to produce emissions.	► Victorian gas consumption sourced from Australian Energy Statistics ► Victoria population sourced from Population Australia[36] ► Victoria employment sourced from Australian Bureau of Statistics[37] ► Dandenong population sourced from Community Profile[38] ► Dandenong employment sourced from Economy Profile[39]
Transportation	Transport emissions for Victoria were sourced from the Australian Energy Outlook. These were proportioned to Dandenong by using publicly available data to calculate: ► The number of passenger cars in CoGD as a % of total passenger cars in Victoria ► Number of train users in Dandenong as a % of total Victorian train users ► The % share of CoGD residents using the bus compared with the Victoria total	► Number of cars in CoGD and Victoria sourced from the 2016 census ► Number of residents using the bus in CoGD and Victoria sourced from 2016 Methods of transport to work[40] ► Number of train users in Dandenong and Victoria sourced from FY14 entries PTV[41] ► Emissions from cars, buses and trains sourced from the Australian Energy Outlook
Waste	Waste emissions were calculated using publicly available data. ► Municipal, industrial and commercial waste were standardised for FY17 by applying a compounded annual growth rate, multiplied by the number of businesses as a % of the Victoria total ► Tonnes of waste figures entered into the CIRIS tool which applies an emissions factor to produce emissions.	► Municipal waste data sourced from CoGD Household Kerbside Waste Data for 2017-18 ► Industrial and commercial waste data sourced from FY15 waste data in Australian National Waste Report 2016

[35] Australian Government, Department of the Environment and Energy. 2018. National Greenhouse Accounts Factors. https://www.environment.gov.au/system/files/resources/80f603e7-175b-4f97-8a9b-2d207f46594a/files/national-greenhouse-accounts-factors-july-2018.pdf
[36] http://www.population.net.au/population-of-victoria/
[37] https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8165.0Jun+2013+to+Jun+2017
[38] Greater Dandenong Community Profile https://www.communityprofile.com.au/greaterdandenong/population/age#!bar-chart;i=0
[39] Greater Dandenong Economy Profile https://www.economyprofile.com.au/greaterdandenong/industries/employment
[40] http://www.greaterdandenong.com/document/18464/statistical-data-for-victorian-communities

[41] https://transport.vic.gov.au/about/data-and-research/patronage

Input	Methodology	Source
Wastewater	Wastewater emissions were calculated using publicly available data. ► Residential litres were calculated by multiplying litres per day per household by the CoGD population as a % of Victoria's total ► Industrial and commercial litres were calculated by multiplying litres per day by the number of CoGD business as a % of Victoria's total ► Wastewater figures entered into CIRIS tool which applies an emissions factor to produce emissions	► Victoria population sourced from Population Australia[42] ► Quantity of wastewater generated sourced from Melbourne Water's website[43]

[42] http://www.population.net.au/population-of-victoria/
[43] https://www.melbournewater.com.au/community-and-education/about-our-water/sewerage/eastern-treatment-plant

Appendix E MAC curves tables

Table 39 - Corporate scale opportunities

MACC #	Opportunity name	Implementation cost ($ exc GST)	Annual energy savings (MJ)	Annual energy bill savings ($ exc GST)	Discounted payback (years)	Annual renewable energy generated (MJ)	Energy generation capacity added (kW)	Average annual abatement (tCO_2e)	Abatement cost ($/tCO_2e$)	Co-benefit: Direct employment creation	Co-benefit: Avoided health costs from other pollutants
26	Commercial - Pool covers/heating	$1,531	$207,984	$12,098	1	-	-	51	-$211	-	2,492
17	Commercial - Lighting - Delamping	$134	$3,700	$249	1	-	-	1	-$200	-	130
31	Commercial - Process heat and steam - Boiler	$6,846	$187,753	$11,846	1	-	-	48	-$194	-	4,907
4	Commercial - Controls - Compressed air systems	$24,506	$608,726	$41,004	1	-	-	172	-$194	-	8,529
38	Commercial - Refrigeration and cooling - Maintenance	$6,842	$132,315	$8,913	1	-	-	37	-$188	-	1,854
9	Commercial - Controls - Refrigeration and cooling	$7,601	$132,373	$8,917	1	-	-	37	-$184	-	1,855
15	Commercial - IT equipment	$60,579	$1,052,063	$70,868	1	-	-	297	-$184	-	14,741
3	Commercial - Controls - Building management system	$4,367	$69,562	$4,686	1	-	-	20	-$181	-	975
14	Commercial - Insulation	$6,916	$60,193	$4,055	2	-	-	16	-$173	-	2,108
5	Commercial - Controls - HVAC	$9,944	$129,332	$8,038	2	-	-	34	-$168	-	1,663
25	Commercial - Metering	$29,471	$375,142	$22,381	2	-	-	95	-$165	-	4,618
7	Commercial - Controls - Process equipment	$4,528	$103,166	$3,603	2	-	-	16	-$164	-	1,059
47	Commercial - Water heating measures	$4,435	$65,885	$3,001	2	-	-	13	-$162	-	909
6	Commercial - Controls - Lighting	$10,045	$94,313	$6,353	2	-	-	27	-$156	-	1,321
40	Commercial - Refrigeration and cooling - VSDs	$27,582	$255,073	$17,182	2	-	-	72	-$155	-	3,574
8	Commercial - Controls - Process heat and steam	$9,621	$403,504	$8,103	2	-	-	38	-$153	-	2,878
37	Commercial - Refrigeration and cooling - Insulation and sealing	$29,921	$266,084	$17,924	2	-	-	75	-$152	-	3,728
11	Commercial - HVAC - Maintenance	$9,076	$80,038	$5,391	2	-	-	23	-$151	-	1,121
18	Commercial - Lighting - Floodlight to LED	$9,661	$82,974	$5,589	2	-	-	23	-$150	-	1,163
44	Commercial - Solar thermal	$50,340	$280,463	$18,892	4	-	-	76	-$142	-	7,859
46	Commercial - Voltage optimisation	$84,582	$525,806	$35,419	3	-	-	147	-$140	-	11,051

MACC #	Opportunity name	Implementation cost ($ exc GST)	Annual energy savings (MJ)	Annual energy bill savings ($ exc GST)	Discounted payback (years)	Annual renewable energy generated (MJ)	Energy generation capacity added (kW)	Average annual abatement (tCO_2e)	Abatement cost ($/tCO_2e$)	Co-benefit: Direct employment creation	Co-benefit: Avoided health costs from other pollutants
30	Commercial - Process equipment - VSDs	$20,450	$123,703	$8,333	4	-	-	35	-$138	-	2,600
1	Commercial - Compressed air systems - Maintenance	$6,001	$38,911	$2,621	3	-	-	11	-$127	-	545
2	Commercial - Compressed air systems - Upgrade	$17,365	$91,319	$6,151	4	-	-	25	-$127	-	1,919
33	Commercial - Process heat and steam - Maintenance	$4,694	$516,342	$4,389	2	-	-	27	-$123	-	781
13	Commercial - HVAC - VSDs	$83,416	$398,130	$26,818	5	-	-	111	-$118	-	8,367
20	Commercial - Lighting - Fluorescent upgrade	$3,483	$19,760	$1,331	4	-	-	6	-$115	-	277
28	Commercial - Process equipment - Maintenance	$5,616	$25,831	$1,740	5	-	-	7	-$114	-	543
19	Commercial - Lighting - Fluorescent to LED	$15,889	$84,401	$5,685	4	-	-	24	-$108	-	1,183
24	Commercial - Lighting - Public lighting	$41,182	$210,489	$14,179	4	-	-	59	-$103	-	2,949
29	Commercial - Process equipment - Upgrade	$255,614	$1,011,307	$68,123	6	-	-	282	-$99	1	21,254
43	Commercial - Solar PV - 50 to 100 kW system	$27,951	$93,305	$6,285	8	93305	26	25	-$97	-	2,615
45	Commercial - Ventilation	$5,578	$21,590	$1,454	6	-	-	6	-$96	-	454
32	Commercial - Process heat and steam - Insulation	$313	$12,987	$110	4	-	-	1	-$94	-	33
23	Commercial - Lighting - Multiple to LED	$39,448	$183,984	$12,393	5	-	-	52	-$92	-	2,578
12	Commercial - HVAC - Upgrade	$188,580	$654,638	$37,199	9	-	-	152	-$80	1	15,297
16	Commercial - Lighting	$28,033	$115,361	$7,771	6	-	-	33	-$75	-	1,616
22	Commercial - Lighting - High Bay to LED	$12,527	$50,643	$3,411	6	-	-	14	-$73	-	710
34	Commercial - Process heat and steam - Upgrade	$30,101	$274,323	$6,793	8	-	-	31	-$70	-	1,893
41	Commercial - Solar PV - <50 kW system	$518,327	$1,362,165	$91,757	11	1362165	385	369	-$67	3	38,171
10	Commercial - HVAC - Insulation	$29,800	$104,617	$7,047	7	-	-	30	-$51	-	1,466
42	Commercial - Solar PV - 100+ kW system	$3,924	$7,917	$533	17	7917	2	2	-$23	-	222

MACC #	Opportunity name	Implementation cost ($ exc GST)	Annual energy savings (MJ)	Annual energy bill savings ($ exc GST)	Discounted payback (years)	Annual renewable energy generated (MJ)	Energy generation capacity added (kW)	Average annual abatement (tCO_2e)	Abatement cost ($/tCO_2e$)	Co-benefit: Direct employment creation	Co-benefit: Avoided health costs from other pollutants
21	Commercial - Lighting - Halogen to LED	$49,619	$99,220	$6,684	> Opportunity life	-	-	28	$76	-	1,390
39	Commercial - Refrigeration and cooling - Upgrade	$118,517	$217,326	$14,639	> Opportunity life			61	$102	1	3,045
35	Commercial - Process heat and steam - VSDs	$31,837	$203,738	$2,659	> Opportunity life			14	$117	-	615
27	Commercial - Power factor correction	$124,524	$149,667	$10,082	> Opportunity life			42	$270	1	2,097
36	Commercial - Refrigeration and cooling - Chiller	$830,205	$963,580	$64,908	> Opportunity life			272	$288	4	13,501

Table 40 - Community scale opportunities

MACC #	Opportunity name	Implementation cost ($ exc GST)	Annual energy savings (MJ)	Annual energy bill savings ($ exc GST)	Discounted payback (years)	Annual renewable energy generated (MJ)	Energy generation capacity added (kW)	Average annual abatement (tCO_2e)	Abatement cost ($/tCO_2e$)	Co-benefit: Direct employment creation	Co-benefit: Avoided health costs from other pollutants
17	Commercial - Lighting - Delamping	$7,899	$218,009	$14,685	1			56	-$200	0	7,636
4	Commercial - Controls - Compressed air systems	$1,443,736	$35,862,403	$2,415,731	1			10,126	-$194	7	502,473
31	Commercial - Process heat and steam - Boiler	$576,119	$13,890,632	$721,955	1			2,964	-$186	3	294,817
9	Commercial - Controls - Refrigeration and cooling	$447,760	$7,798,605	$525,323	1			2,202	-$184	2	109,267
15	Commercial - IT equipment	$3,568,975	$61,981,076	$4,175,114	1			17,501	-$184	18	868,426
3	Commercial - Controls - Building management system	$257,261	$4,098,144	$276,056	1			1,157	-$181	1	57,420
14	Commercial - Insulation	$407,438	$3,546,215	$238,877	2			916	-$173	2	124,216
5	Commercial - Controls - HVAC	$633,697	$9,999,008	$493,793	2			2,118	-$163	3	100,389
6	Commercial - Controls - Lighting	$591,810	$5,556,336	$374,281	2			1,569	-$156	3	77,851
18	Commercial - Lighting - Floodlight to LED	$569,194	$4,888,287	$329,280	2			1,380	-$150	3	68,490

MACC #	Opportunity name	Implementation cost ($ exc GST)	Annual energy savings (MJ)	Annual energy bill savings ($ exc GST)	Discounted payback (years)	Annual renewable energy generated (MJ)	Energy generation capacity added (kW)	Average annual abatement (tCO_2e)	Abatement cost ($/tCO_2e$)	Co-benefit: Direct employment creation	Co-benefit: Avoided health costs from other pollutants
7	Commercial - Controls - Process equipment	$362,491	$17,897,842	$312,736	2			1,543	-$149	2	80,287
25	Commercial - Metering	$2,328,056	$32,305,062	$1,405,291	2			6,099	-$147	12	282,352
44	Commercial - Solar thermal	$2,965,704	$16,523,123	$1,113,016	4			4,473	-$142	15	463,016
47	Commercial - Water heating measures	$474,971	$8,956,224	$219,958	3			1,017	-$131	2	61,205
2	Commercial - Compressed air systems - Upgrade	$1,023,023	$5,379,935	$362,398	4			1,501	-$127	5	113,069
8	Commercial - Controls - Process heat and steam	$1,919,859	$91,157,381	$1,050,147	3			5,722	-$121	10	305,460
13	Commercial - HVAC - VSDs	$4,914,353	$23,455,337	$1,579,978	5			6,543	-$118	25	492,954
24	Commercial - Lighting - Public lighting	$2,426,182	$12,400,697	$835,325	4			3,501	-$103	12	173,748
29	Commercial - Process equipment - Upgrade	$15,059,222	$59,579,973	$4,013,373	6			16,621	-$99	75	1,252,175
43	Commercial - Solar PV - 50 to 100 kW system	$1,646,698	$5,496,979	$370,283	8	5,496,979.43	1,554.36	1,488	-$97	8	154,038
45	Commercial - Ventilation	$328,638	$1,271,976	$85,682	6			355	-$96	2	26,733
32	Commercial - Process heat and steam - Insulation	$83,498	$3,465,155	$29,454	4			179	-$94	0	8,735
23	Commercial - Lighting - Multiple to LED	$2,324,058	$10,839,219	$730,142	5			3,061	-$92	12	151,870
22	Commercial - Lighting - High Bay to LED	$738,022	$2,983,555	$200,976	6			842	-$73	4	41,803
41	Commercial - Solar PV - <50 kW system	$30,536,590	$80,250,367	$5,405,754	11	80,250,366.79	22,692.06	21,723	-$67	153	2,248,799
12	Commercial - HVAC - Upgrade	$13,543,076	$62,933,081	$2,398,638	11			10,182	-$63	68	950,322
10	Commercial - HVAC - Insulation	$1,755,592	$6,163,389	$415,173	7			1,740	-$51	9	86,356
42	Commercial - Solar PV - 100+ kW system	$231,176	$466,427	$31,419	17	466,427.14	131.89	126	-$23	1	13,070
34	Commercial - Process heat and steam - Upgrade	$5,436,783	$57,437,536	$751,047	> Opportunity life			3,975	$5	27	173,961
27	Commercial - Power factor correction	$7,336,169	$8,817,473	$593,955	> Opportunity life			2,490	$270	37	123,543
36	Commercial - Refrigeration and cooling - Chiller	$48,910,540	$56,768,184	$3,823,968	> Opportunity life			16,029	$288	245	795,387

MACC #	Opportunity name	Implementation cost ($ exc GST)	Annual energy savings (MJ)	Annual energy bill savings ($ exc GST)	Discounted payback (years)	Annual renewable energy generated (MJ)	Energy generation capacity added (kW)	Average annual abatement (tCO_2e)	Abatement cost ($/tCO_2e$)	Co-benefit: Direct employment creation	Co-benefit: Avoided health costs from other pollutants
32	Industrial - Process heat and steam - Furnace	$935,340	$232,219,926	$2,447,091	1			12,133	-$162	5	488,032
9	Industrial - Controls - Process heat and steam	$5,234,058	$422,292,984	$4,471,972	2			22,268	-$145	26	454,360
31	Industrial - Process heat and steam - Boiler	$1,391,055	$69,222,099	$743,953	3			3,735	-$130	7	159,521
48	Industrial - Water heating measures	$707,935	$46,846,390	$619,987	2			3,519	-$130	4	165,587
33	Industrial - Process heat and steam - Heat recovery	$12,997,484	$779,868,394	$10,911,092	2			63,574	-$125	65	3,185,049
16	Industrial - Insulation	$1,282,004	$70,305,133	$1,409,042	1			8,817	-$117	6	993,485
45	Industrial - Solar thermal	$1,259,899	$403,764,397	$15,062,655	1			109,293	-$115	6	11,314,402
11	Industrial - Controls - VSDs	$964,036	$27,854,308	$1,039,120	1			7,771	-$102	5	585,406
5	Industrial - Controls - Compressed air systems	$585,475	$14,418,719	$537,898	2			4,071	-$97	3	202,023
26	Industrial - Monitoring	$2,602,510	$58,621,594	$2,186,911	2			16,552	-$95	13	821,356
8	Industrial - Controls - Process equipment	$1,333,007	$28,671,932	$1,069,622	2			8,096	-$93	7	401,727
25	Industrial - Metering	$871,701	$14,448,621	$539,014	2			4,080	-$85	4	202,442
10	Industrial - Controls - Refrigeration and cooling	$839,770	$11,697,413	$436,378	3			3,303	-$79	4	163,894
46	Industrial - Ventilation	$355,995	$3,963,272	$147,852	3			1,106	-$77	2	83,295
37	Industrial - Refrigeration and cooling - Chiller	$2,349,435	$22,215,406	$828,758	4			6,198	-$70	12	466,895
6	Industrial - Controls - HVAC	$615,508	$7,518,795	$244,495	4			1,814	-$67	3	87,918
18	Industrial - Lighting - Delamping	$531,490	$3,366,103	$125,574	7			870	-$64	3	117,907
7	Industrial - Controls - Lighting	$230,850	$2,321,941	$86,621	4			656	-$62	1	32,533
15	Industrial - HVAC - VSDs	$1,917,539	$14,944,143	$557,500	5			4,169	-$60	10	314,077
24	Industrial - Lighting - Multiple to LED	$3,034,176	$26,392,646	$984,592	5			7,452	-$53	15	369,791
29	Industrial - Process equipment - Upgrade	$13,774,813	$173,888,230	$2,991,403	8			18,906	-$48	69	1,115,826
12	Industrial - HVAC - Insulation	$2,335,503	$16,863,416	$629,099	6			4,762	-$39	12	236,276
19	Industrial - Lighting - Floodlight to LED	$344,828	$2,261,175	$84,354	7			638	-$31	2	31,682
38	Industrial - Refrigeration and cooling - Insulation and sealing	$4,041,477	$25,747,749	$960,534	7			7,270	-$29	20	360,755

MACC #	Opportunity name	Implementation cost ($ exc GST)	Annual energy savings (MJ)	Annual energy bill savings ($ exc GST)	Discounted payback (years)	Annual renewable energy generated (MJ)	Energy generation capacity added (kW)	Average annual abatement (tCO_2e)	Abatement cost ($/tCO_2e$)	Co-benefit: Direct employment creation	Co-benefit: Avoided health costs from other pollutants
34	Industrial - Process heat and steam - Insulation	$20,189,724	$223,102,627	$3,503,885	11			21,426	-$26	101	1,188,945
2	Industrial - Compressed air systems - Upgrade	$9,187,246	$51,140,781	$1,907,835	9			14,440	-$15	46	716,541
30	Industrial - Process equipment - VSDs	$6,946,529	$29,626,586	$1,105,236	13			8,265	-$12	35	622,654
42	Industrial - Solar PV - <50 kW system	$42,968,356	$155,274,745	$5,792,611	17	155,274,745	43,906	42,030	-$12	215	4,351,154
23	Industrial - Lighting - High Bay to LED	$5,415,271	$28,955,299	$1,080,194	9			8,176	-$11	27	405,697
36	Industrial - Process heat and steam - Upgrade	$42,412,903	$684,682,805	$7,506,282	> Opportunity life			38,302	$4	212	860,465
14	Industrial - HVAC - Upgrade	$9,276,572	$27,719,791	$1,034,102	> Opportunity life			7,503	$10	46	776,772
43	Industrial - Solar PV - 100+ kW system	$777,435	$2,190,708	$81,726	> Opportunity life	2,190,708	619	593	$17	4	61,389
44	Industrial - Solar PV - 50 to 100 kW system	$8,610,458	$23,792,419	$887,589	> Opportunity life	23,792,419	6,728	6,440	$20	43	666,718
40	Industrial - Refrigeration and cooling - Upgrade	$23,336,393	$56,522,893	$2,108,618	> Opportunity life			15,768	$68	117	1,187,926
4	Industrial - Controls - Building management system	$7,883,526	$20,827,281	$776,973	> Opportunity life			5,881	$102	39	291,814
27	Industrial - Power factor correction		$49,547,478	$1,848,396	> Opportunity life			13,990	$1,653	748	694,217
4	Residential - Water heating measures - LF shower rose	$3,806,308	$62,012,958	$1,579,051	3			3,903	-$278	19	102,404
3	Residential - Lighting	$16,420,969	$34,387,360	$3,164,592	6			8,885	-$220	82	1,204,516
24	Residential - Solar PV - 4kW system size		$289,344,158	$26,627,700	6	512,113,554	144,808	78,321	-$194	775	8,108,085
14	Residential - Building infiltration sealing - Air sealing	$42,603,263	$329,879,481	$7,897,211	6			19,108	-$168	213	451,421
1	Residential - HVAC - Space heating	$61,416,281	$285,505,051	$6,951,104	10			16,900	-$120	307	577,184
7	Residential - Water heating measures - Water heater - HE gas	$36,343,031	$64,991,564	$4,557,124	9			13,632	-$92	182	775,456
9	Residential - Appliances - Fridge	$40,476,499	$38,192,037	$3,514,728	13			10,543	-$76	202	909,694
12	Residential - Appliances - Clothes dryer - Std	$5,626,571	$5,655,171	$520,433	12			1,594	-$17	28	95,083
10	Residential - Appliances - TV	$32,261,854	$22,109,324	$2,034,672	> Opportunity life			6,137	$20	161	495,643

MACC #	Opportunity name	Implementation cost ($ exc GST)	Annual energy savings (MJ)	Annual energy bill savings ($ exc GST)	Discounted payback (years)	Annual renewable energy generated (MJ)	Energy generation capacity added (kW)	Average annual abatement (tCO_2e)	Abatement cost ($/tCO_2e$)	Co-benefit: Direct employment creation	Co-benefit: Avoided health costs from other pollutants
13	Residential - Insulation - Ceiling insul (easy)	$31,919,157	$46,934,408	$1,140,358	> Opportunity life			2,737	$100	160	168,349
15	Residential - Building infiltration sealing - Seal wall cavity	$22,214,831	$38,060,710	$906,086	> Opportunity life			2,176	$128	111	102,283
18	Residential - Insulation - Wall insul		$256,523,415	$6,076,216	> Opportunity life			14,497	$171	988	847,479
20	Residential - Insulation - Ceiling insul (top up)	$36,679,464	$41,481,628	$985,000	> Opportunity life			2,351	$246	183	138,173
8	Residential - Solar thermal - Water heater - solar		$392,558,549	$11,431,718	> Opportunity life			29,420	$273	1170	1,097,842
17	Residential - Insulation - Underfloor insul	$92,968,606	$85,914,508	$1,923,754	> Opportunity life			4,527	$426	465	232,178
16	Residential - Building infiltration sealing - Reduce SF ventilation	$31,595,925	$24,684,775	$576,416	> Opportunity life			1,376	$724	158	62,164
6	Residential - Appliances - Dishwasher	$18,927,759	$3,558,832	$327,511	> Opportunity life			1,003	$1,183	95	59,836
2	Residential - HVAC - Air conditioning	$51,699,822	$7,130,186	$656,175	> Opportunity life			2,004	$1,571	258	129,873
5	Residential - Appliances - Clothes washer	$10,975,787	$4,794,227	$141,759	> Opportunity life			366	$1,996	55	13,886
21	Residential - Window frames, glazing and shading - Drapes	$83,631,834	$92,956,361	$2,202,015	> Opportunity life			5,312	$2,562	418	61,437
22	Residential - Window frames, glazing and shading - Double glazing		$96,296,737	$2,308,852	> Opportunity life			5,524	$3,053	2495	331,084
23	Residential - Window frames, glazing and shading - Ext shading	$60,494,684	$354,849	$32,656	> Opportunity life			101	$112,355	302	2,486

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