CarbonetiX
TOTAL ENERGY & RESOURCE SOLUTIONS

Trajectory to Carbon Neutrality for Council's Corporate Emissions

Monash City Council

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About CarbonetiX

CarbonetiX is a multi-disciplinary energy and resource optimisation company. It is our mission to improve our clients' energy and resource management by utilising expertise and leading-edge technologies to deliver practical, cost effective solutions that enhance environmental performance.

We specialise in the design, delivery, implementation and monitoring of cost-effective energy and water efficiency measures across a broad range of commercial, industrial and government facilities throughout Australia. We provide beginning to end practical solutions, tailored to reduce your sites energy and water use.

Executive Summary

This report provides an analysis and evaluation of Council's corporate emissions inventory for the 2018/19 financial year, and models multiple trajectories to 2025, 2030 & 2040, which council could follow to achieve carbon neutrality.

Emissions have been categorised into the following 3 scopes:

- **Scope 1 emissions** are generated as a direct result of activities in Council owned facilities and assets.
- **Scope 2 emissions** are the indirect emissions generated via consumption of energy in Council owned facilities and assets. This primarily includes the emissions generated during electricity production.
- **Scope 3 emissions** are indirect emissions generated both up and down the supply chain of an organisation and, as such, there is a Scope 3 emission associated with each Scope 1 emission source.

Monash City Council's emissions data was collected from retailer reports, CarbonMetriX, staff surveys, liaising with various Council departments and various other internal council databases. The table below shows a summary of the total emissions for Monash City Council.

Type	Carbon Emissions (tCO_2e)
Scope 1	4,427
Scope 2	9,168
Scope 3	9,215
Total	**22,811**

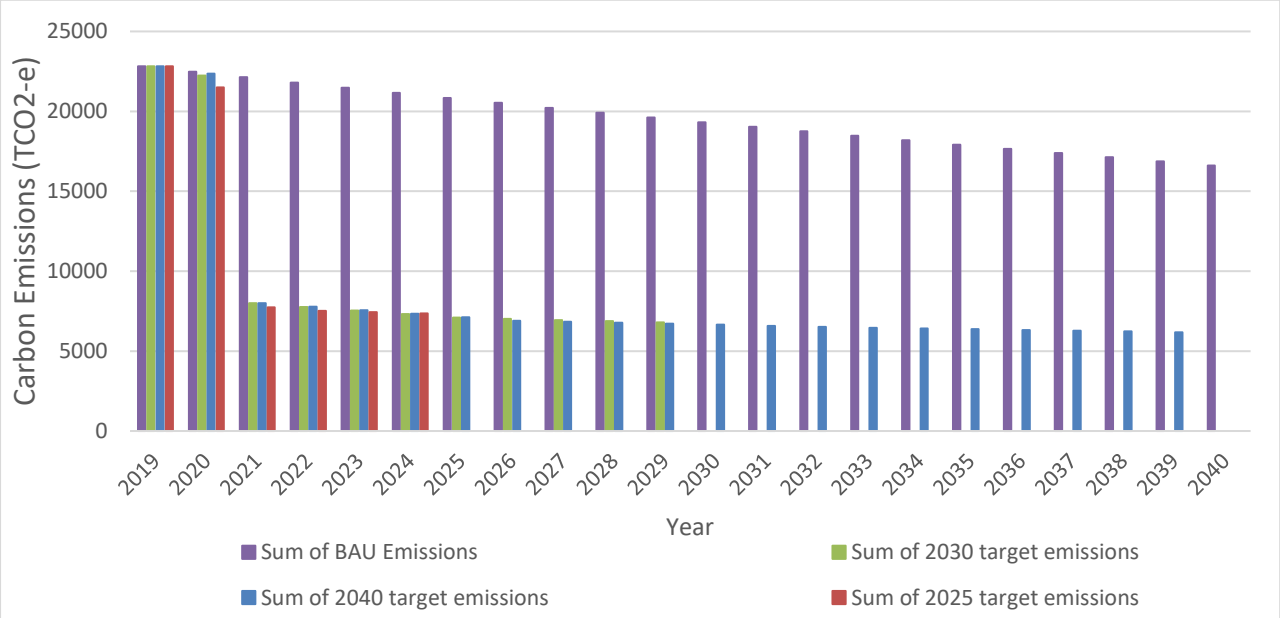
Monash City Council currently have a wide range of opportunities that they are pursuing to move toward achieving carbon neutrality by 2025, 2030 or 2040. This report examines 6 quantifiable emissions reduction initiatives currently being undertaken by Council, 5 quantifiable recommendations that both build on as well as supplement current Council initiatives and 10 unquantified emission reduction initiatives that Council may choose to undertake in future. Each initiative's quantified initiatives were financially simulated to determine their net present value for the period of 2019- 2040. These results are presented in the table below.

Initiative #	Initiative Name	2025 target NPV	2030 target NPV	2040 target NPV
5.1.1	LG PPA	$914,528	$914,528	$914,528
5.1.2	Energy Monitoring Solutions	$274,317	$233,683	$233,683
5.1.3	LED Major Road Lighting Replacement	$1,377,293	$1,218,358	$907,733
5.1.4	EPC	$1,252,138	$1,751,886	$2,008,475
5.2.1	Fleet electrification	$812,381	$812,381	$812,381
5.2.2	Paperless office & Carbon Neutral Paper	$119,903	$119,903	$119,903
5.2.3	Small scale solar	$672,373	$615,067	$443,073
5.2.4	Energy Efficiency Initiatives	$75,206	$53,051	-$43,186
5.2.5	LED Residential Street Lighting Replacement	$102,688	-$67,580	-$136,287

Financial outcomes of each initiative vary based the carbon neutral target year. This is due to variations in capital cost, cost savings achieved and implementation timelines for the 2025, 2030 and 2040 carbon neutral trajectories. The cumulative capital cost, cumulative cost savings, cumulative offset cost and net cumulative cash flow for each carbon neutral target at 2025, 2030 and 2040 are shown in the table below. The cost for council to be carbon neutral by 2025, 2030 and 2040 (including offsets) has also been highlighted and bolded for each carbon neutral target year below.

Target Year	Year	Cumulative Capital cost ($)	Cumulative Offset Cost ($)	Cumulative Cost savings ($)	Net Cumulative Cash Flow ($)
2025	**2025**	**$9,667,556**	**$103,953**	**$6,463,802**	**-$3,307,707**
	2030	$11,494,756	$609,640	$13,284,288	$1,690,231
	2040	$12,258,102	$1,557,681	$28,857,469	$16,507,859
2030	2025	$10,316,793	$0	$5,598,178	-$4,718,616
	2030	**$13,530,444**	**$96,579**	**$13,668,321**	**$137,876**
	2040	$14,293,790	$1,018,746	$31,597,179	$17,303,389
2040	2025	$8,926,898	$0	$4,747,264	-$4,179,634
	2030	$14,428,962	$0	$13,073,878	-$1,355,083
	2040	**$15,289,784**	**$87,329**	**$32,130,753**	**$16,753,640**

All initiatives examined in this report cause emission reductions for Council. This can be highlighted by examining a business as usual (BAU) case which simulates the emissions of Monash City Council for 2019- 2040 if no emissions reduction initiatives are implemented. The BAU case gives simulated emissions of Monash City Council based on this report's 2018/19 carbon inventory figures with a 1.5% annual degradation. The following graph presents the BAU case along with the reduction in emissions (including offsets) that may be achieved through implementation of the 2025, 2030 and 2040 carbon neutral targets presented in this report.



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1 Introduction

CarbonetiX was engaged by Monash City Council to undertake a carbon accounting and modelling project to support their endeavours to achieve carbon neutrality. This involved developing a verified corporate emissions inventory for the 2018/19 financial year and modelling multiple trajectories to 2025, 2030 & 2040 which Council could follow to achieve carbon neutrality.

2 Project Scope

The service is delivered in two stages, with the *'Trajectory to Carbon Neutral for Council's Corporate Emissions'* report a key deliverable of stage one.

The scope of stage one, and hence the content of this report, is to encompass the following:

- Confirm the measurement boundary for corporate Scope 1, Scope 2 and Scope 3 emissions (such as utilities, paper, waste, business travel and commuting).
- Define and verify a greenhouse gas emissions inventory for corporate operations in FY18/19
- Review Council's carbon budget
- Compare current and previous emissions baselines, utilising National Greenhouse and Energy Reporting Scheme (NGERS) or other best practice methodologies.
- Verify how council can achieve zero net emissions by years 2025, 2030, 2040, or another relevant targets.
- State the environmental benefits and financial costs to Council to reach each target as compared to normal operations.

Stage two of the engagement will focus on supporting Council's capacity to draft and deliver recommendations.

The information ascertained through this project will support the development of a whole of Council strategy for tackling climate change, as referred to in the Environmental Sustainability Strategy 2016-2026, with an aim to have it presented to Council by September 2020 (this actual strategy is outside of the scope of this project).

3 Methodology

The following steps were undertaken in delivery of stage 1 of this project:

1. Initial kick-off meeting between consulting team and Council stakeholders to:
    a. discuss project delivery
    b. commence defining the emissions measurement boundary and:
    c. discuss data collection strategy
2. Collection of available data on key corporate emissions sources within the reporting period (FY18/19).
3. Verification and organisation of collected data.
4. Calculation of annual emissions for each emissions source, commensurate with NGERS methodology and best practice resources (NGA Factors 2019, EPA VIC 2012-13 etc).
5. Determine emissions reduction initiatives to be included in trajectory modelling (primarily from Ironbark Sustainability's ER Report 2019).
6. Resolve financial model inputs.

7. Perform financial analysis to determine net present value (NPV) and internal rate of return (IRR) for each initiative using known parameters.
8. Repeat financial analysis for each target year for Council to reach carbon neutrality.

Stage 2 will commence after the delivery of this stage 1 report.

4 Corporate Greenhouse Gas Emissions

4.1 Greenhouse Gas Emissions Inventory Summary

Monash City Council's emissions data was collected from retailer reports, CarbonMetriX, staff surveys, liaising with various Council departments and various other internal council databases. The table below shows a summary of the total emissions for Monash City Council. All emission sources shown are considered within the scope of this report.

Table 1 Monash City Council Greenhouse Gas Emissions Inventory summary

Scope	Category	Source	Emissions (tCO_2e)	Percentage of Scope
Scope 1	Transport Fuel Combustion	Fleet Vehicles	1,404	32%
	Stationary Fuel Combustion	Natural Gas	2,844	64%
	Fugitive Emissions	Refrigerants	179	4%
		Scope 1 Total	**4,427**	
Scope 2	Grid-Sourced Electricity	Electricity	9,168	100%
		Scope 2 Total	**9,168**	
Scope 3	Grid-Sourced Electricity	Public Lighting	4,515	49%
	Grid-Sourced Electricity	Leased assets	148	2%
	Grid-Sourced Electricity	Transmission Losses	676	7%
	Natural gas	Transmission Losses	215	2%
	Fugitive Emissions	Waste	422	5%
	Materials	Asphalt and Concrete	1,675	18%
	Materials	Paper	87	1%
	Transport Fuel Combustion	Employee Commute	1,392	15%
	Fleet Vehicles	Transmission Losses	72	1%
	Transport Fuel Combustion	Business travel	14	0.1%
		Scope 3 Total	**9,215**	
Total			**22,811**	

Monash's carbon inventory revealed that most of Council's carbon emissions are emitted via electricity generation for Council owned facilities and assets (scope 2) as well as indirect (scope 3) emissions. Figure 1 shows a breakdown of emissions by scope.

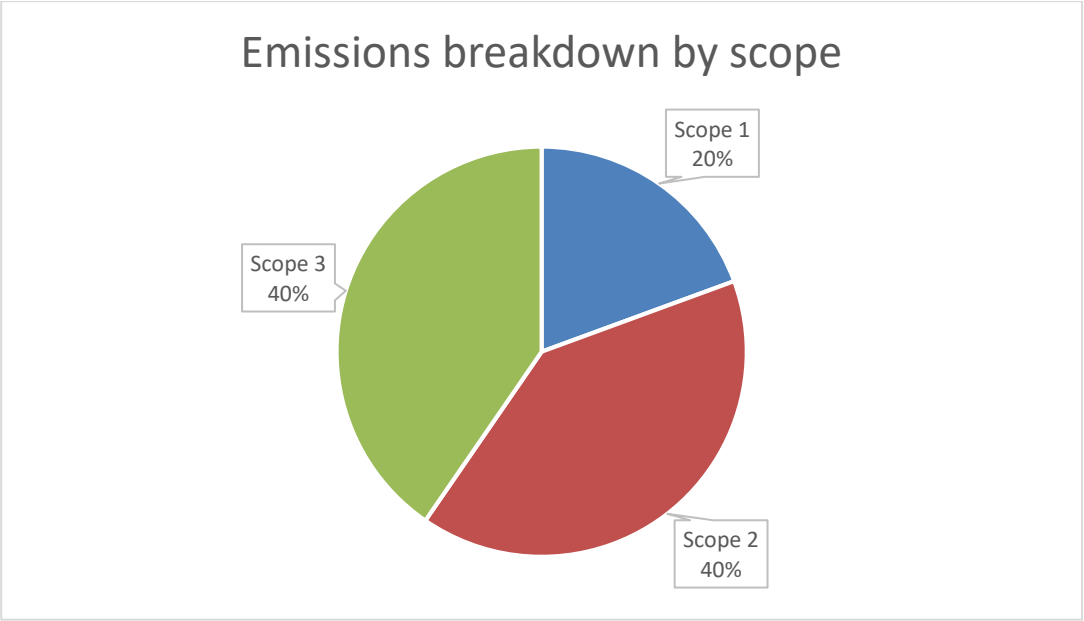

Figure 1 Total emissions breakdown by scope

Further examination into each scope shows that electricity usage through direct or indirect Council operations generates the highest amount of greenhouse gas emissions. Figures 2 and 3 show the emissions breakdowns by scope.

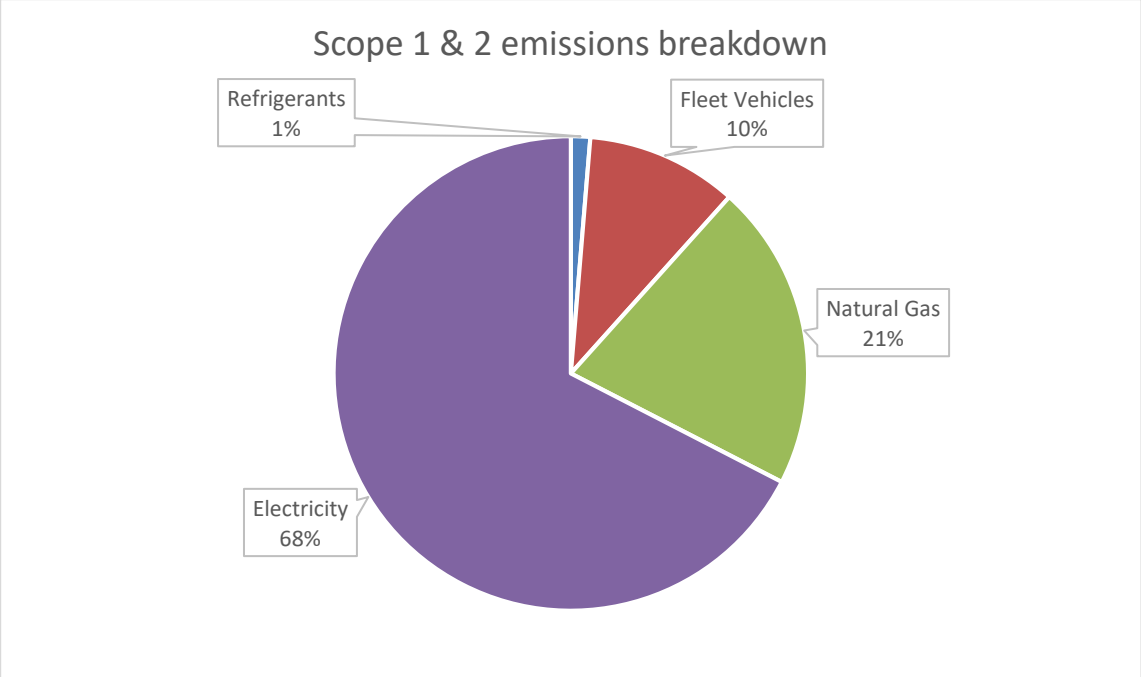

Figure 2 Scope 1 & 2 emissions breakdown

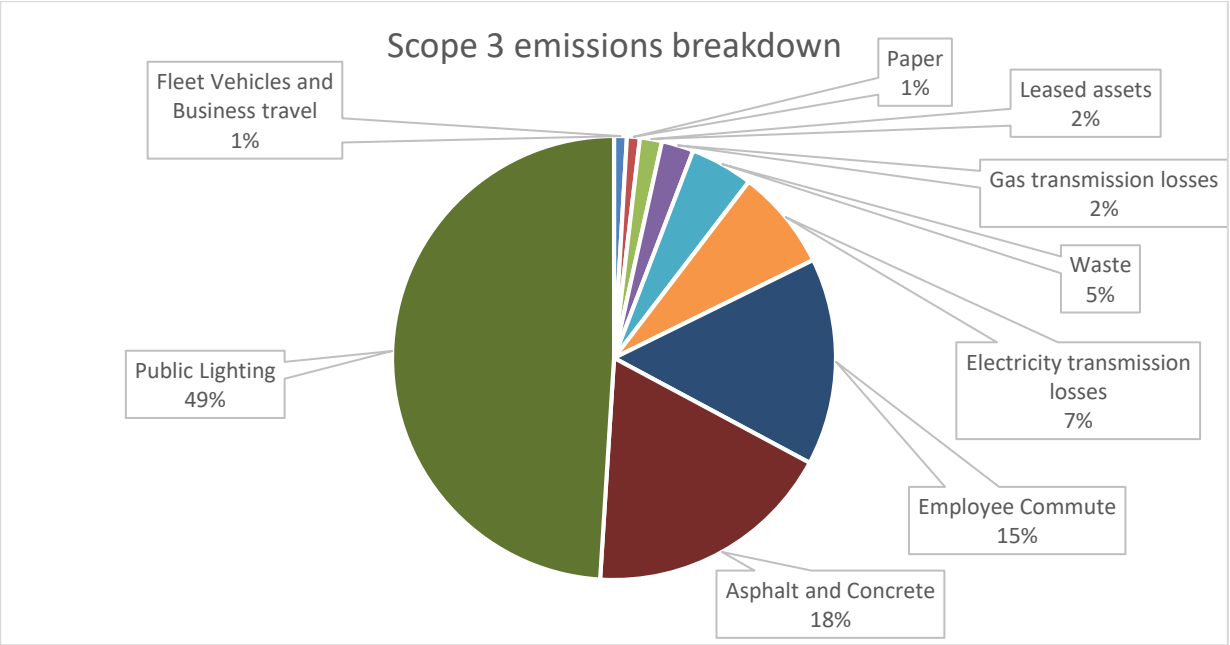

Figure 3 Scope 3 emissions breakdown

4.2 Measurement Boundary & Emissions Scope

The measurement boundaries which define the sources of emissions to include in our calculations was determined using the National Carbon Offset Standard (NCOS) for Organisations and National Greenhouse and Energy Reporting Scheme (NGERS) standard for carbon accounting. According to these standards, emissions sources are considered under an organisation if it is both, material and deemed to be under Council's operational control.

Operational control is defined as any property or asset where Council has the authority to develop operating, environmental, or health and safety policies. A source of emissions is material if it accounts for over 1% of the total organisational emissions. Any sources under 1% are able to be excluded, but the combination of excluded emissions cannot exceed 5%. All emissions within the measurement boundary have been included assuming the emissions are material.

Included emissions have been categorised into the following 3 scopes:

- **Scope 1 emissions** are those generated as a direct result of activities in Council owned facilities and assets.
- **Scope 2 emissions** are the indirect emissions generated via consumption of energy in Council owned facilities and assets. This primarily includes the emissions generated during electricity production.
- **Scope 3 emissions** are indirect emissions generated both up and down the supply chain of an organisation and, as such, there is a Scope 3 emission associated with each Scope 1 emission source.

For some emissions sources we were unable to obtain accurate or complete data. In order to include these emissions, we have used estimates based on similar asset types within CarbonMetriX or using industry standards. We have stated where any estimates or assumptions have been used to calculate emissions for a specific source and have provided recommendations for ways to improve data content for the emission type. It is important that Council attempts to implement these recommendations going

forward to allow for consistent and accurate data reporting over time. Emissions were calculated using the National Greenhouse Accounts Factors (NGAF) August 2019 report published by the Department of Environment and Energy.

Individual emissions sources are detailed below:

4.2.1 Scope 1 Emissions

4.2.1.1 Stationary Fuel Combustion - Natural Gas

Scope 1 stationary fuel combustion emissions are primarily generated by the combustion of natural gas used for heating Council buildings. This data was obtained directly from energy retailers AGL and Origin.

4.2.1.2 Transport Fuel Combustion

Scope 1 transport fuel combustion emissions are those that arise from the use of Council's fleet vehicles. There are a variety of fuel types including standard and premium unleaded petrol, diesel, ethanol blend petrol and LPG gas. Fuel data was supplied directly by Council (using their fleet fuel card database) which included the total litres consumed for each fuel type.

4.2.1.3 Fugitive Emissions - Refrigerants

Fugitive emissions result from the escape of greenhouse gases from equipment, with the main source in Local Governments being caused by refrigerant leakage from air conditioning systems. A typical system will lose approximately 9% of its total refrigerant gas each year, which is significant considering Council has hundreds of systems across their facilities. While refrigerants are an essential component in producing chilled air, they also have a significant impact on climate change, with most refrigerants having a 100-year global warming potential (GWP) over 1000 times greater than CO_2. The most common refrigerant found in Council's systems is R410/R410A, which has a GWP of 2,087 times that of CO_2.

Refrigerant data was provided directly by Council after an audit of their HVAC systems. This data was not 100% complete so the average amount of refrigerant per kW was calculated and extrapolated across all of Council's HVAC systems. Refer to section 4.3.1 for recommendations on improving data collection for this emissions source.

4.2.2 Scope 2 Emissions – Grid Purchased Electricity

Scope 2 emissions include the emissions generated during the production of energy that is then used directly on council-controlled sites, including carbon emissions of leased properties as per Council's request. This primarily applies to emissions from the burning of coal and gas in electricity generation. The data for this source was obtained directly from Council's contracted energy retailers ERM, Origin and AGL.

4.2.3 Scope 3 (Indirect) Emissions

4.2.3.1 Public Lighting

While Councils pay for public lighting accounts, the streetlights are typically owned by the electricity distributers. This leads to emissions generated via electricity production for public lighting are considered scope 3 emissions it is an indirect emission generated by a service Council provides. Public lighting includes street lighting and ornamental lighting. Data for public lighting was obtained directly from Council's contracted energy retailers ERM, Origin and AGL.

4.2.3.2 Employee Commuting

Employee commuting includes all emissions generated from the various transport methods employees take on their commute to and from work. This data was obtained via a survey sent out to all employees of Monash City Council. The survey included questions relating to mode of transport, vehicle make and age, and kilometres travelled.

Approximately 1,000 council employees were sent the survey which achieved a response rate of over 30%. Based on these responses, the proportion of each mode of transport was calculated, as well as average emissions per person for each mode. The result was then extrapolated to account for all employees across the entire Council.

4.2.3.3 Business Travel of Employees

Business travel emissions include emissions generated from taxis as well as domestic and international flights taken by Council workers for business purposes. Taxi data was obtained from Cab Charges receipts which included total costs for the financial year. Costs were converted to kms travelled using average distance and cost data for taxis. A list of flights taken through the financial year was provided by Council which included destinations and numbers of trips. Using this information, flights were separated into short and long-haul categories and total distances were calculated for each flight type.

Emissions were calculated using the greenhouse gas (GHG) inventory management plan 2018-2019 report published in November 2019 by Environment Protection Authority (EPA) Victoria.

4.2.3.4 Paper Use

Emissions from paper use are due to the generation of the paper products. Paper type is split into recycled and virgin (non-recycled) paper, with virgin paper having a higher emissions factor. Council provided its total purchases of paper reams which was used to determine its annual paper use.

Emissions factors were obtained from the EPA GHG inventory management plan and are based around the weight of paper. Sustainability Victoria's report: Organisational Carbon Accounting for Local Governments used the assumption that a typical 500-page ream of A4 paper weighs 2.5kg, A3 sized reams weighing 5kg and A5 sized reams weighing 1.25kg. These assumptions were also used for emissions calculations in this report.

4.2.3.5 Fugitive Emissions – Waste

Fugitive emissions from waste occur due to the emissions generated from corporate waste sent to landfill. We were unable to obtain accurate corporate waste data, so waste figures given in Ironbark Sustainability's Emissions Reduction Report 2019 were used for this report. As per that report, waste generated by Monash Council's operations includes waste from offices and public facilities including community buildings, parks and gardens. Residential waste is the responsibility of residents and is therefore not included under Council operations. Refer to section 4.3.2 for recommendations on improving data collection for this emissions source.

4.2.3.6 Contractor Emissions

Contractor emissions primarily include emissions generated via transport fuel use of waste disposal companies. Both commercial and residential waste collection is considered under this category as it is under Monash City Council's operational control through supply contracts. Total litres of fuel consumed as well as fuel type are tracked and supplied to council directly from the contractors. Fuel usage for the collection of waste by trucks is usually a significant contributor to transport emissions, however,

Monash City Council has been able to zero emissions from this source through their waste collection contract.

Council's current contract with waste collection contractor, Solo, stipulates that the company will offset 200% of its own transport carbon emissions from waste collection. This effectively means that all contract fuel usage (from waste collection) will be reduced to zero for Monash Council. This is provided at no extra charge to Council and will be achieved through purchasing carbon offsets from their partner Trellis Technologies. The current contract is expected to be active for 7 years but has been modelled with the expectation that this will be renewed once the end of the contract term is reached. Furthermore, Solo will be trialling an EV collection truck and utilise two hybrid vehicles (to Council) which will minimise emissions even if offsets are not purchased.

4.2.3.7 Asphalt and Concrete Production

Emissions from asphalt are those generated from the production and mixing of asphalt. Monash provided total tonnages of concrete and asphalt used for road maintenance and construction for FY18/19.

Emissions associated with these materials are attributed to the embodied energies of aggregate and clinker used in these mixtures. It was conservatively assumed that 70% of concrete is comprised of clinker by volume. Similarly, the emissions factor of aggregate was applied to the weight of asphalt reported by Council as they were assumed to be proportional to one another. Emissions were calculated using comparative figures from a certified NCOS emissions report for Melbourne City Council.

4.2.4 Exclusions

4.2.4.1 Water Use

Emissions from water consumption are typically included within scope 3 emissions, however, Melbourne Water already has its emissions offset. As the supplier for both Yarra Valley Water and South East Water, Melbourne Water has 14 mini hydro electricity generators throughout Melbourne with a total capacity of 22.58MW. These are currently producing more electricity than is consumed during the transmission of water within Melbourne. Therefore, water use within Monash does not generate scope 3 emissions.

4.2.4.2 Landfill

Monash has multiple decommissioned landfill sites within their municipal boundaries. These sites have gone through varying levels of remediation making it difficult to estimate fugitive emissions from these sites without thorough on-site assessments. Since the fugitive from this site will not be consistently captured, they have been excluded from the scope of this report.

4.2.4.3 Transmission losses - Refrigerant

Council HVAC system cause greenhouse gas emissions through refrigerant leakage (which has been considered and quantified as per section 4.2.1.3). During regular maintenance and servicing of Council's HVAC equipment leaked refrigerant is replaced. Some losses occur during transportation and transmission of this refrigerant to site, however, the carbon emissions from this are negligible and impossible to calculate. It is for those reasons that emissions from refrigerant transmission losses have been excluded from this report.

4.3 Recommendations for improving carbon accounting

The accuracy of Council's carbon accounting is heavily dependent on availability and quality of data relating to Council operations. To improve carbon accounting/ reporting capabilities, Council needs to accurately log and store data relating to its operational emissions. In some cases, this can be achieved using technology to automatically capture operational data which improves data collection. In other cases where this is unfeasible and/or not possible, Council should implement measures and procedures to facilitate and maximise the accuracy of manual data capturing.

Currently, Monash City Council mostly succeeds in good data availability and quality. Two key areas, however, were identified during the compilation of this report as having the potential to improve. Recommendations for improving data capture and quality were interspersed through section 4.2 and are summarised below:

4.3.1 Fugitive Emissions - Refrigerants

The main source of equipment leakage for Local Government is refrigerant leakage during HVAC operation. Given the difficulties in directly measuring leakage from a system, it is recommended that the amount of refrigerant replaced should be logged during regular maintenance. Contractors should record data on refrigerant type and amount used during regular HVAC servicing and maintenance work then include within maintenance report for capture by Council. This will allow Council more accuracy in determining each HVAC units' refrigerant leakage.

4.3.2 Fugitive Emissions – Waste

Fugitive emissions from waste occur due to the emissions generated from corporate waste sent to landfill. Council currently tracks and documents all waste totals with waste being separated as commercial and residential waste collection. This data was considered but was unable to be used since Council should only be considering fugitive emissions resulting from its own corporate waste (excluding other commercial and residential entities).

To accurately report on Council's fugitive waste emissions, it is recommended that Council separate and capture their own corporate waste totals. This can be achieved by separate collection of Council's corporate waste by changing collection procedures or Council may consider separating waste contractors for community and corporate waste collection. Separating corporate waste will allow for accurate emissions reporting in future.

5 Emissions Reduction Initiatives

Monash City Council currently have a wide range of opportunities that they are pursuing to move toward achieving carbon neutrality. Several emission reduction opportunities (initially proposed in the Emissions Reduction Report 2019 by Ironbark Sustainability) have been explored to determine their feasibility to be undertaken by Monash City Council. This report examines 6 quantifiable emissions reduction initiatives currently being undertaken by Council, 5 quantifiable recommendations that both build on as well as supplement current Council initiatives and 10 unquantified emission reduction initiatives that Council may choose to undertake in future.

5.1 Current Council Initiatives (Quantified)

This section provided a summary of initiatives that Council is currently undertaking, prior to any recommendations included in this report. All these initiatives are included in the financial and emissions reduction models.

5.1.1 Local Government Power Purchase Agreement (LG PPA)

Monash City Council is currently involved in the multi-council Local Government Power Purchase Agreement coordinated by the Victorian Greenhouse Alliances and the Municipal Association of Victoria. This will allow all of Council's electricity accounts to be supplied from renewable energy sources. This initiative will eliminate emissions from grid sourced electricity which will cover all public lighting, large sites and small sites. It should be noted that after the implementation of the LG PPA the financial case for some other initiatives will be affected (due to the reduced cost of electricity), however Council should still reduce electrical demand as this will still result in overall energy and financial benefits. The agreement is currently on track to begin in 2021.

5.1.2 Energy Monitoring Solutions

Monitoring building energy performance can reveal various energy saving and optimisation opportunities. This should be addressed with both technological upgrades and ongoing monitoring by facility managers. Through Energy Performance Contracts (EPCs, refer to Section 5.1.4 below), Council intends to address energy monitoring solutions for their larger facilities by:

1. Installing or upgrading building management systems (BMS) on larger facilities that are currently lacking this system.
2. Installing sub-metering to improve monitoring capabilities of energy intensive sites/ equipment.

Installing these technologies would allow Council staff to accurately monitor the energy usage of larger facilities. It may be beneficial to utilise building rating tools (such as NABERS assessments) on an ongoing basis to measure the performance of buildings. Alternatively, internal benchmarks and reviews can be used to measure and verify a building's energy performance. This may be particularly useful in cases of buildings that have less standardised energy consumption footprints. Council will be utilising Certified Measurement & Verification Professionals (CMVPs) for this process, to have confidence in assessing building energy performance.

Monash is also currently developing processes whereby energy monitoring and optimization is systematically overseen by Council staff. It is imperative that Council ensures this process encourages collaboration between energy monitoring staff and operations and maintenance staff. This cohesion will ensure that issues are identified and resolved efficiently and effectively. The formalisation of this process is projected to be completed within a year.

For the purposes of the financial modelling, Energy Monitoring Solutions have been separated from EPCs.

5.1.3 LED Major Road Lighting Replacement

Council is considering upgrading all public lighting on major roads to low energy LED technology which will lead to significant reductions in energy use and carbon emissions for Council. The duration of this project is dependent on budgeting (as Council requires a suitable cost sharing agreement between VicRoads) and selection of target year for carbon neutrality. This initiative is intended to also support the implementation of a Smart Lighting (refer to section 5.3.6 for further details).

5.1.4 Energy Performance Contracts (EPC)

Council is considering utilising Energy Performance Contracts (EPCs) for their larger facilities in order to reduce their carbon emissions, though this is highly dependent on available budget. The structure of EPCs dictate that the initial capital investment for the projects are to be replenished by the savings achieved as a result of these contracts. EPCs also guarantee costs savings as a result of measures that are implemented which are to be verified and quantified by Certified Measurement & Verification Professionals (CMVP).

Council is in the early stages of implementing EPCs. A detailed facility study has been completed in 2019 and Council officers are currently waiting on funding in the next financial year to commence work on four major sites, although some work may be able to be achieved through renewal activities. Some work is on hold due to development of integrated site plans. It is presently proposed that the energy performance and savings will be quantified over two years after the EPC's implementation, though this may be extended as capital/ budget increases. These contracts intend to result in major energy efficient technology upgrades for targeted facilities including efficient LED lighting upgrades and HVAC installation. This initiative is scheduled to run for 2-5 years dependent on the carbon neutrality target year trajectory. A delayed carbon neutral target will allow for more projects to be added to the EPC which will increase the budget and duration of works.

5.1.5 Fleet Electrification & Optimisation

Council owns and maintains a fleet of internal combustion engine (ICE) vehicles. This report focuses primarily on fleet optimisation and the electrification of light vehicles within Council's fleet (excluding those marked as privately owned vehicles on Council's fleet database). Monash Council currently has 156 light vehicle class cars, and Council replaces their entire fleet approximately every seven years. This equates to slightly over 20 new vehicles purchased per year. Through this process, Council intends to gradually replace all light fleet ICE vehicles initially with hybrids followed by Electric Vehicles (EVs) over the years, achieving complete electrification by 2035. The electrification of the fleet entails the replacement of ICE vehicles with EVs, as well as the installation of additional EV charging stations as the number of EVs increases within Council's fleet.

It was found in a recent Australian study that EVs produce 20% less lifecycle emissions in the vehicle's entire service life than comparable ICE vehicles when using grid-sourced electricity in Australia. The Green Vehicle Guide published by the Australian Government also indicates that, compared with ICE vehicles, hybrid vehicles can produce 50% less fuel emissions, and EVs produce 35% less fuel emissions. This is due to Australia's reliance on fossil fuels in electricity generation. However, the overall emissions of EVs operated by Monash could be reduced to zero after implementation of the LG PPA when charged at Council facilities as electricity will be derived from renewable energy sources.

5.1.6 Paperless office & Carbon Neutral Paper

In mid-2019, Council introduced a secure follow-me printing system which has assisted to reduce paper use through eliminating the need to print jobs in the queue that were submitted by mistake or are no longer required. Staff physically log in at a printer (using their building access card or a pin) each time they choose to print. Monash is also moving people from desktops to laptops as well as providing tablets for staff to work remotely where the software supports this functionality as part of our digital strategy. Planners have introduced digital planning approvals and outdoor workers can reduce the need for printing within the office. Furthermore, all paper used within Council is 100% recycled and carbon neutral.

5.2 Proposed Emissions Reduction Initiatives (Quantified)

This section includes emissions reductions initiative that are proposed in addition to those which council is currently undertaking. For some of these initiatives, this represents an extension of a measure which Council is already undertaking. All of these initiatives have been included in the financial and emissions reduction models.

5.2.1 Fleet Electrification & Optimisation

High capital costs of purchasing EVs over standard ICE vehicles as well as installing added charging stations leads to an infeasible business case for Council to completely electrify their light fleet by 2025 or 2030, as this requires several million dollars of annual investments. However, Council has plans to upgrade their fleet to hybrid vehicles which will significantly reduce Council's fleet emissions with much lower added costs. As such, since Council replaces 23 vehicles on average each year, it is recommended that Council replaces 22 vehicles with hybrids and one vehicle with an EV for the first several years, and the number of EVs acquired each year will rapidly increase as EV prices decline after 2026. This roll-out schedule will enable Council to completely electrify their light fleet by 2035, as per Council's current initiative. All carbon neutral target models have been simulated according to Council's current fleet electrification initiative (refer to appendix section 10.3 for 2040 electrification alternative).

Apart from light vehicles, Council's fleet includes various commercial vehicles (such as vehicles over 4.5 tonnes and specialised equipment). While these vehicles may not have a petrol option, and hybrid or electric equivalents are still in relatively early stages of development, diesel vehicles have better fuel economy and efficiency compared with petrol vehicles. However, particulate matters from diesel exhaust are known to have health effects. Modern diesel vehicles are equipped with diesel particulate filters (DPF) in their exhaust systems to remove particulate matters from the exhaust. In addition to DPF, modern diesel vehicles employ additives (Adblue) to further treat exhaust gases and remove harmful pollutants, such as NOx (oxides of nitrogen). To ensure these systems are operating correctly, Council must ensure that vehicles are correctly serviced to manufacture's specifications and DPFs regularly refreshed (usually through an automated on-board system). Furthermore, Council should only purchase diesel vehicles that conform to the latest European emission standards (Euro 6 as of January 2020) that are more stringent than Australian Standards, and actively seek to replace the diesel fleet as hybrid/electric options become available to the market.

Council's fleet could be further optimised through continued driver training, fleet-wide GPS tracking, and an improved fleet booking system. Council has previously trialled the EcoDriver training program with a small number of staff to promote fuel-efficient driving techniques. This program should be continued and expanded to raise staff awareness of fuel-efficient driving. Council has already implemented GPS tracking to monitor its Waste Fleet, this could be further expanded fleet-wide to

optimise fleet operations. An improved fleet booking system should also be implemented to enable access of detailed fleet utilisation data. These programs and platforms are projected to be introduced through a five-year period, beginning in 2020.

5.2.2 Paperless Office & Carbon Neutral Paper

Council currently has a strong digital strategy in place to move towards a paperless office. It is recommended that Council continues with the valuable initiatives already in place such as providing laptops to all staff and using recycled content and carbon neutral paper in the office, while also considering new initiative such as establishing a cloud-based server. This allows employees to access documents from any location without having to physically bring a laptop or printed document with them. It is also recommended that Council ensures all externally printed documents, such as the bulletin and waste calendars are printed using carbon neutral paper. This requirement should be included in any new contracts for printing contractors. These initiatives are projected to require a two-year implementation period, modelled to begin in 2021.

5.2.3 Small scale solar

Small sites (excluded as part the EPCs) are also recommended to have solar installed on them to decrease Council's dependence on grid-sourced electricity. Council has clearly expressed the desire to install small scale solar systems on its owned properties as well as leased sites to aid in reducing carbon emissions in the community. EAGA has developed a program called Scaling Up Solar to aid member Councils with the installation of solar across smaller sites. The Scaling Up Solar program has identified nine key sites in Monash to prioritise solar installation, namely:

- Halcyon Day Centre
- Clayton Hall
- Jack Edwards Reserve
- Wellington Reserve Community Centre
- Brine Street Child Care Centre
- Electra Community Centre
- Mount Waverley Community Centre
- Hughesdale Community Centre
- Euneva Car Park

We recommend Council follows the guidance of the Scaling Up Solar program initially but continues to install solar at a larger number of sites as there will be added benefits with expanding the program past nine sites.

It is recommended that Council systematically install and increase the size of solar systems over a 5-7 year period (dependent on carbon neutral target year option). This will provide benefit to building users and clubs in assisting to reduce their grid electricity consumption. Furthermore, considerations should be made towards installing more PV-battery systems as there are ever-increasing financial feasibility for those systems.

5.2.4 Energy Efficiency Initiatives

Monash Council has the opportunity to achieve significant carbon reduction through ongoing energy efficiency projects for their smaller facilities. This process should be initiated by conducting energy audits of Council's smaller sites and facilities to understand the energy profiles of their facilities. The

outcome of these audits would be the identification of cost and energy saving opportunities upon which a business case can be made. Energy audits should be conducted to the Standard AS/NZS 3958:2014 which outlines three potential audit types. The audit type used for each site should be determined according to building sizes and average energy usage. This initiative is modelled as beginning in 2020 for the 2025 and 2035 target or beginning in 2025 for the 2040 target with ongoing energy and cost savings for the foreseeable future.

5.2.5 LED Residential Street Lighting Replacement

Council has previously conducted lighting upgrades installing fluorescents on all street lighting in 2015. This aided in reducing Council's electricity usage and carbon emissions. By comparing a sample of public lighting accounts on CarbonMetriX, it was found that Council experienced an approximate 37% and 39% reduction in greenhouse gas emissions and cost, respectively, due to the fluorescent changeover. Currently, Council plans to install LED lights in newly developed areas with no plan to perform another street lighting upgrade. United Energy also has an agreement with Council to replace the lights with LED at each light's end of life.

It is recommended, however, that Council should upgrade all residential street lighting with low energy LED technology to accelerate Council toward carbon neutrality. This will result in a significant reduction in greenhouse gas emissions (ignoring the LG PPA) and to lower electrical usage and demand (even with consideration for the LG PPA) as lighting is the greatest contributor of electrical usage and carbon emissions for Council. It is planned to occur over a 2-year process beginning 2024, 2026 or 2027 (depending on the carbon neutrality target year chosen).

5.3 Additional Emissions Reduction Initiatives (Unquantified)

This section includes a combination of initiatives that Council are currently undertaking as well as some additional recommendations for further emissions reductions. These initiatives remain unquantified and have not been included in the financial and emissions reduction models.

5.3.1 Energy Equipment Procurement Policy

It is recommended that Council procurement policies are further developed to include specific energy efficiency objectives and standards that can be applied to a range of standard equipment and material purchases. Once implemented, the policy will systematically reduce equipment-based energy in Council by dictating requirements in energy performance of new equipment. An updated energy equipment policy should address both consumer level appliances as well as other commercial and industrial equipment utilised by Council. Since it is unknown what and how much equipment will be replaced and/or upgraded under this policy, Council's reduction in greenhouse gas emissions from this initiative remains unquantifiable in this report.

5.3.2 ESD Policy

Monash Council is involved with Eastern Alliance for Greenhouse Action (EAGA) who are currently working with member Councils to facilitate the development of improved ESD guidelines for future building projects. This will ideally result in Council implementing policy recommendations outlined by this process. The group work towards producing new comprehensive and enforceable ESD policies which take a holistic view of buildings, including a range of specific measures as well as overall minimum ratings standards. These standards can be linked to existing energy rating tools (such as NABERS assessments) which already provides comprehensive guides on sustainable ESD practices. It will ensure all new builds are constructed with consideration given to all aspects of sustainability.

Incorporating ESD into building standards policy will allow for emissions reductions measures to be considered and costed at the earliest planning stages rather than seen as a secondary concern. This will also encourage new builds within the community to incorporate better designs.

We have not quantified savings for this measure as once the ESD policy has been developed, all new builds will be fitted with added ESD features which will reduce emissions and save costs. However, each new build will have an unquantifiable increased cost associated with the build to incorporate the new features. Council may then track all new builds and model ESD vs non-ESD builds to measure the additional cost and benefits associated with ESD builds.

5.3.3 Optimise Waste Streams

Waste is an increasingly important aspect of an organisations scope 3 emissions, and many Councils lack detailed data in this area. As such, it is recommended that Council implement measures to improve waste monitoring and reporting (see section 4.3.2 for further details). This is an ongoing initiative with no capital cost associated.

The new Solo contract stipulates that they will offset their emissions to the amount of 200%, meaning there will be no fuel consumption emission concerns for waste contractors from the commencement of the new contract. Corporate waste, however, will still generate scope 3 emissions. It is recommended that Council requires contractors to separate corporate waste data from community waste. Corporate waste includes waste generated by leased sites such as childcare centres and scout halls and are often difficult to calculate without accurate reporting from contractors.

5.3.4 Phase out old refrigerants

Australia has committed to phasing out of hydrofluorocarbons (HCFCs) as part of their commitment under the Montreal Protocol on Substances that Deplete the Ozone Layer. Under the Montreal Protocol, no new systems will be able to use R22 by 2020, and by 2030 the only R22 that will be able to be used will be reclaimed refrigerant from other systems. Monash has been phasing out R22, but there are still a significant number of systems using this refrigerant.

The most readily available replacements for R22 are R427A and R438A, however they both have a higher global warming potential than R22. R32 has a much lower global warming potential than R22, however it requires Council to upgrade to new equipment that utilise it instead. Council have the option to replace R22 refrigerants in current equipment or upgrade to new equipment to tackle this issue.

Council is currently in the process of replacing R22 systems with R32 systems as this will meet Council's requirements under the Montreal Protocol also reducing Council's fugitive emissions. It is the more expensive option but will produce better environmental outcomes. The exact benefits are difficult to quantify as data on refrigerants are limited. As such, this measure has been left as unquantifiable.

5.3.5 Revegetation

In 2018, Monash adopted the Monash Urban Landscape and Canopy Vegetation Strategy, which aims to increase percentage canopy cover of vegetation from 19% to 30% by 2040. Council currently utilise the i-Tree software tool which allows vegetation analysis across the entire Council, which also maintains a tree registry. A key part of this measure is community engagement through programs such as the Monash Gardens for Wildlife program which educates residents and promotes establishing habitat in their private gardens.

This strategy will result in a significant increase in vegetation within Monash, which will ultimately increase carbon sequestration. While it is technically possible to gain offset credits for this revegetation, the process is complicated and there are not currently any local metropolitan councils undertaking this. To obtain offsets, Council would be required to surrender Australian Carbon Credit Units (ACCUs) under the Emissions Reduction Fund (ERF). However, there are several eligibility requirements that a project needs to meet – especially in this case, the concept of additionality – which would make it unlikely Monash's revegetation works would be eligible. Despite this, it is recommended Council continues with increased canopy cover revegetation works as they will provide both a social and environmental benefit to the community, including improving air quality and reducing summer air temperatures.

5.3.6 Smart Lighting

The LED Major Road Lighting Replacement initiative is intended to also support the implementation of a Smart Lighting as new and/or upgraded lights will be connected to Council's Smart Lighting network. Smart lighting technology gives its users access to a myriad of features that allow for better oversight, control and monitoring of street lighting. Users of this technology can have the operation of their lights linked to surrounding lighting levels and traffic flows. On average, this reduces light operation resulting in less maintenance requirements. Smart lighting may also provide users with useful information about the light including light status, surrounding air quality and temperature.

Smart lighting is currently being trialled in Oakleigh where Council is utilising the occupancy and temperature sensing features for data collection over the technology's energy efficiency features. The implementation of this technology will likely lead to a reduction in streetlight usage resulting in both environmental and financial benefits for Council, though is unquantifiable at this point. Council will be able to quantify these savings as the technology matures and plans are developed to capture the data.

5.3.7 Facility Water Efficiency Projects

Council has completed a water feasibility study to obtain a picture of how to optimise their water usage. Currently, Council is scoping the scale of water efficiency projects that may be rolled out to various facilities meaning the emissions from water reduction initiatives are unquantifiable. Since emissions generated by water retailers are presently being offset by Melbourne Water, emission reductions from lowered water usage will be achieved indirectly by lowering Council's electricity and gas consumption used in water heating and pumping. The overall reduction in water consumption will depend on how much water is heated and/or pumped at each facility. Council may achieve additional reductions from upgrades to selected faucets (taps) to efficient mixer type models and from switching to less water intensive equipment where applicable. Other initiatives such as rainwater harvest opportunities exist though are yet to be quantified.

5.3.8 Reducing Emissions from Staff Commute

As part of the Monash Travel Survey, staff were asked for their ideas on ways Council could promote more sustainable methods for staff to commute to work. The top responses were:

- Upgrades to end of trip facilities such as bike storage and showers
- Flexible work times
- Establishing a carpool program
- Discounts for public transport tickets

Implementing these strategies would encourage more staff to utilise low or zero emissions travel methods which will help to reduce Council's scope three emissions, while also providing health benefits

to those staff who take up these options through increased physical activity. There are a number of ways that the success of this initiative can be managed, ranging from regular commuter surveys to use of commuter tracking apps which are available for smart phones.

5.3.9 Electrification of Small-Scale Gas Equipment

With the implementation of the LG PPA providing Council with 100% renewable electricity, there is an excellent opportunity for Council to convert gas heating systems and appliances with electric equipment. This includes installing split systems in pavilions to replace gas heaters and installing electric stoves to replace gas stoves and ovens. This should be implemented across any pavilions and halls which still have gas equipment. Implementing these upgrades will require a feasibility study to identify and prioritise sites with gas equipment and to ensure that any new electric infrastructure is appropriately sized for each building's unique size and requirements. The Monash Aquatic and Recreation Centre (MARC) has been excluded from this initiative as it is included with in the EPC initiative (Section 5.1.4 above). Furthermore, Council may consider including electrification of gas equipment as part of their EPCs.

5.3.10 Recycled Content in Asphalt and Concrete

In October 2019, Monash began trials to add recycled content to asphalt which will reduce the amount of aggregate used. Council is also considering the use of geopolymer concrete for use in Council roads and footpaths. Geopolymer concrete includes fly ash, a by-product of coal fired energy production, which reduces the emissions intensity of the concrete mix. Considering that these trials are in their early stages with varying amounts of asphalt and concrete used annually, this initiative has remained unquantified.

6 Purchasing Carbon Offsets

Although scope 1 and 2 emissions may be reduced through the emissions reduction initiatives covered in the report, scope 3 emissions are not directly within Council's control. Therefore, carbon offsets may be required to supplement the implementation of any other carbon reduction initiatives. Carbon offsets are generated from activities that prevent or reduce GHG emissions or remove current GHGs from the atmosphere which compensate for emissions occurring elsewhere. This report demonstrates the business cases where Council uses carbon offsets after the implementation of their emissions reductions initiatives to achieve carbon neutrality by each target year.

Carbon offsets can be purchased from either local or international organisations. International offsets are generally cheaper, costing approximately $6.50 per tonne of emissions offset compared with $22 per tonne from an Australian company (as per January 2020). However, there is less regulation and monitoring of international organisations meaning there is less certainty that the offsets will produce verifiable emissions reductions. Monash City Council may also need to consider their wider community's perspective on sourcing offsets from local or international suppliers as their social and/or political viewpoints may affect the decision. Some organisations choose to use a combination of local and international offsets to save costs, with combined offsets costing approximately $14 per tonne. There are Australian organisations that will put together 'mixed' portfolios that are in tune with Council's needs.

It is recommended that for any offsets Council chooses to buy they seek out an organisation which is Gold Standard certified. The Gold Standard is a trusted international framework which ensures development projects deliver genuine and verifiable outcomes. It is also recommended that any

organisation chosen considers the indigenous biodiversity of the potential revegetated land in order to replicate natural habitat types, rather than simply following a plantation model of revegetating with a limited number of species.

Alternatively, Council may desire reallocating carbon offset costs towards capital costs for further emissions reduction initiatives. In this case, Council should still note carbon offset costs associated with each carbon neutral trajectory to have a clear picture the budget available for reallocation. Further methods to reduce Council's carbon emissions (to reduce the number of offsets required) beyond each carbon neutral target presented in this report are to be covered in Stage 2 of this project.

7 Emissions Reduction Modelling

7.1 Model Input Assumptions

The following tables outline the values and assumptions used in the emissions reductions modelling. Figures were primarily sourced from Ironbark Sustainability's ER Report 2019 and were adjusted for the target year and measures being considered. All figures are from 2019 and were adjusted for inflation accordingly during financial analysis. All initiatives were modelled in the period of 2019- 2040 as this is the maximum carbon model considered within the scope of this report. It was also considered that any financial analysis beyond 2040 will have a high degree of uncertainty as inflation rates, degradation rates and other market changes would not be accurately simulated. Net present values calculated in this report are as of 2040 for all carbon neutral trajectories. Hence, it should be noted that a negative net present value for any initiative indicates that the particular initiative requires a longer analysis period (beyond 2040) to recoup its capital investment.

Table 2: Quantified Emissions Reduction Initiatives

Initiative #	Category	Initiative Name	Capital Cost ($)	Annual Cost Savings ($)	Annual Emissions Reduction (t-CO2-e)[1]	Emission Source
5.1.1	Procurement	Renewable Energy LG PPA	-	-	14,359	Grid-sourced electricity
5.1.2	Facilities	Energy Monitoring Solutions	$100,000	$86,000	190	Grid-sourced electricity and natural gas
5.1.3	Street Lighting	LED Major Road Lighting Replacement	$2,200,000	$300,000	1,100	Grid-sourced electricity
5.1.4	Facilities	EPC	**2025 target:** $2,45,530 **2030 target:** $4,998,000 **2040 target:** $5,975,305	**2025 target** $316,520 **2030 target:** $522,585 **2040 target:** $614,259	**2025 target** 1,313 **2030 target:** 2,018 **2040 target:** 2,476	Grid-sourced electricity and natural gas
5.2.1	Fleet	EVs/ Hybrids and charging stations	$3,040,000	$327,849 (varies)	308 (varies)	Transport Fuel
		Fleet Optimisation	$220,000			
5.2.2	Paper	Paperless office & Carbon Neutral Paper	$160,000	$39,372	39	Office Paper Use
5.2.3	Facilities	Small scale solar	$520,000	$86,667	600	Grid-sourced electricity
5.2.4	Facilities	Energy Efficiency Initiatives	$400,000	$86,022	190	Grid-sourced electricity and natural gas
5.2.5	Street Lighting	LED Residential Street Lighting Replacement	$2,300,000	$160,000	450	Grid-sourced electricity

It should be noted that emissions given in the 'Annual Emissions Reduction' column are not cumulative as the LG PPA eliminates all grid-sourced electricity emissions from other initiatives (refer to appendix section 10.4 for emission reductions achieved excluding LG PPA). Energy reductions achieved after the

[1] First year fully implemented

implementation of the LG PPA may still provide financial benefits to Council as a result of decreased electricity costs. Many initiatives listed above, once implemented, may also replace current ongoing budgets or programs and would result in reduced operating costs for Council. The cost effectiveness of each initiative can be viewed in the table below.

Table 3 Cost effectiveness of all quantified initiatives (Capital cost/ Annual TCO2-e abated or avoided)

Initiative #	Initiative Name	Cost per tonne of CO2-e abated or avoided
5.1.1	Renewable Energy LG PPA	$0
5.1.2	Energy Monitoring Solutions	$526
5.1.3	LED Major Road Lighting Replacement	$2,000
5.1.4	EPC	**2025 target:** $187 **2030 target:** $2,477 **2040 target:** $2,413
5.2.1	EVs/ Hybrids and charging stations	$10,584
	Fleet Optimisation	
5.2.2	Paperless office & Carbon Neutral Paper	$4,103
5.2.3	Small scale solar	$867
5.2.4	Energy Efficiency Initiatives	$2,105
5.2.5	LED Residential Street Lighting Replacement	$5,111

The following table shows the implementation timeline currently projected for each quantified initiative. The timelines were realistically assumed in consultation with Council for each carbon neutral target year. A Gantt chart for each carbon neutral target year is given as an appendix (section 10.6).

Table 4 Quantified Emissions Reduction Initiatives implementation timelines

Initiative #	Category	Initiative Name	2025 target	2030 target	2040 target
5.1.1	Procurement	Renewable Energy LG PPA	2021- 2040	2021- 2040	2021- 2040
5.1.2	Facilities	Energy Monitoring Solutions	2020	2022	2022
5.1.3	Street Lighting	LED Major Road Lighting Replacement	2021- 2023	2022- 2024	2024- 2026
5.1.4	Facilities	EPC	2020- 2021	2021- 2024	2021- 2025
5.2.1	Fleet	EVs/ Hybrids and charging stations	Ongoing	Ongoing	2020- 2035
		Fleet Optimisation	2020- 2025	2020- 2025	2020- 2025
5.2.2	Paper	Paperless office & Carbon Neutral Paper	2021- 2022	2021- 2022	2021- 2022
5.2.3	Facilities	Small scale solar	2020- 2024	2020- 2026	2022- 2028
5.2.4	Facilities	Energy Efficiency Initiatives	2020- 2024	2020- 2027	2025- 2032
5.2.5	Street Lighting	LED Residential Street Lighting Replacement	2024- 2025	2026- 2027	2027- 2028

Initiatives such as the LG PPA, fleet optimisation and Paperless office & carbon neutral paper have consistent start and end dates with each target while other initiatives such as LED Major Road Lighting Replacement start at a staggered rate though maintain the same duration. These similarities will cause similar patterns to emerge among target years. Other initiatives, namely the EPC and small-scale solar, begin at similar times while lasting longer for later target years which creates variation in the amount of savings achieved and offsets required for each target.

Unquantified initiatives were all assumed to begin in 2020 and would be ongoing through to 2040 for all carbon neutral target years. Each unquantified emission reduces the emission source that it addresses by a factor between 0.5-5% each year beginning in 2020 to account for minute reductions in carbon emissions.

Table 5: Unquantified Emissions Reduction Initiatives

Initiative #	Category	Initiative Name	Emission Source Addressed
5.3.1	Procurement	Energy Equipment Procurement Policy	Grid-sourced electricity and natural gas
5.3.2	Capital Works	ESD Policy	Grid-sourced electricity and natural gas
5.3.3	Waste	Optimise Waste Streams	Fugitive Emissions - waste
5.3.4	Maintenance	Phase out old refrigerants	Fugitive Emissions - refrigerants
5.3.5	Offsets	Revegetation	Offsets
5.3.6	Street lighting	Smart lighting	Grid-sourced electricity
5.3.7	Facilities	Facility water projects	Water use
5.3.8	Council staff	Reducing emissions from staff commute	Transport Fuel Combustion
5.3.9	Facilities	Electrification of small-scale gas equipment	Grid-sourced electricity and natural gas
5.3.10	Capital Works	Recycled content in asphalt and concrete	Asphalt and Concrete Production

The model incorporated current electricity prices for each initiative. Prices were assumed to be consistently applied to all accounts within the same category (ie. Small market, large market, street lighting, etc.)

Table 6: Tariff Rate Assumptions

Fuel Type – Category	Weighted tariff
Small Market Electricity c/kWh	$0.16367 /kWh
Large Market Electricity c/kWh	$0.18040 /kWh
Combined Small & Large Market Electricity c/kWh	$0.16517 /kWh
Street Lighting Electricity c/kWh	$0.17176 /kWh
Natural Gas (Small & Large Market)	$12.00 /GJ
Transport Fuel (all fuel types) $/L	$1.50 /L

Inflation, discount and escalation rates were applied annually to capital investments, fuel and utility prices to emulate realistic market forces annually through to each target year. Based on current financial forecasts, the financial figures given in the following table were chosen:

Table 7: Financial Analysis Assumptions

Financial parameter	Value
Inflation Rate	1.5%
Nominal Discount Rate	5%
Electricity Price Escalation Rate	1%
Natural Gas Price Escalation Rate	1%
Transport Fuel Price Escalation Rate	1.5%
Analysis period (years)	2020-2040

Similarly, current emissions factors were initially used for each initiative. These were then scaled according to forecasts of future emissions intensities from various sources. The electricity grid is expected to gradually decarbonise due to the introduction of a greater proportion of renewable energy from energy distributors, as well as private and public entities. Furthermore, natural gas distributors are gradually introducing hydrogen into the natural gas pipeline also causing a decline in emissions intensity for gas consumption. Current emissions factors as well as the assumed escalation or degradation rates that have been assumed are given in the following table:

Table 8: Emissions Factor Assumptions

Emissions Source	Emission Factor	Escalation (+) or Degradation (-) rate
Electricity (Scope 2)	1.02	-2%
Electricity (Scope 3)	0.9	-2%
Natural Gas (Scope 1)	51.53	-0.1%
Natural Gas (Scope 3)	3.9	-0.1%
All Fuels (Scope 1)	5.82 (tonnes/kL)	-1%
All Fuels (Scope 3)	0.54 (tonnes/kL)	-1%

Current carbon offset pricing was assumed to remain fixed across all models. These pricing assumptions are given in the following table:

Table 9: Purchased Carbon Offset Price Assumptions (2020)

Offset Type	$ t-CO2-e
Domestic – Gold Standard	$22.00
International – VCU	$6.50
Mixed (50-50)	$14.25

7.2 Financial Outcomes

Calculating the Net Present Value (NPV) and Internal Rate of Return (IRR) for a project is a common method used to determine the profitability of a project. NPV determines the current value of all future cash flows generated by a project, including the initial capital investment. During this analysis, future cash flows are discounted as the value of money decreases over time. The discount rate that causes the NPV of all cash flows from a project to reach zero is known as the internal rate of return (IRR). The higher a project's NPV and IRR, the more profitable it is to undertake.

Based on all given parameters and assumptions stated in section 7.1, NPVs and IRRs for each initiative and each target year were calculated. The results of these analyses are given in the tables below.

Table 10 Financial Outcomes for 2025, 2030 and 2040 carbon neutral targets

Reference	Initiative	2025 Target			2030 Target			2040 Target		
		Simple Payback Period (yrs)	Net Present Value ($)	Internal Rate of Return (%)	Simple Payback Period (yrs)	Net Present Value ($)	Internal Rate of Return (%)	Simple Payback Period (yrs)	Net Present Value ($)	Internal Rate of Return (%)
5.1.1	LG PPA	-	$914,528	-	-	$914,528	-	-	$914,528	-
5.1.2	Energy monitoring solutions	3.8	$274,317	30%	3.7	$233,683	32%	3.7	$233,683	32%
5.1.3	Major roads LED upgrade	7.6	$1,377,293	13%	7.6	$1,218,358	13%	7.5	$907,733	12%
5.1.4	EPC	9.4	$1,252,138	10%	8.6	$1,751,886	10%	8.3	$2,008,475	10%
5.2.1	Fleet electrification	9.5	$812,381	14%	9.5	$812,381	14%	9.5	$812,381	14%
5.2.2	Paperless office	5.1	$119,903	8%	5.1	$119,903	8%	5.1	$119,903	8%
5.2.3	Small scale solar	4.9	$672,373	25%	4.6	$615,067	25%	5.7	$443,073	22%
5.2.4	Energy efficiency initiatives	9.6	$75,206	8%	9.0	$53,051	7%	11.5	-$43,186	2%
5.2.5	Residential LED streetlighting upgrade	11.8	$102,688	6%	11.7	-$67,580	4%	11.6	-$136,287	4%

Generally, a higher Net Present Value (NPV) and Internal Rate of Return (IRR) indicate a more desirable investment. It should be noted, however, that direct comparisons of each initiative's NPV and IRR is complex due to the varying data inputs for each model. Different capital costs and implementation timelines should be considered when directly comparing the same initiative's NPV and IRR across different carbon neutral target years.

From the results shown in the above table, some initiatives such as Energy monitoring solutions, Major roads LED upgrade, Small scale solar, Energy efficiency initiatives and Residential LED streetlighting upgrade, experience the highest NPV when implemented for the 2025 target. This can be attributed to the timelines of these projects as the 2030 and 2040 targets have these initiatives rolling out both later and over a longer period of time in comparison to the 2025 target. Other initiatives such as the EPCs and Fleet electrification have higher NPVs for later target years as additional time is allowed to recuperate more savings as a result of those initiatives. Furthermore, the Energy efficiency initiatives and Residential LED streetlighting upgrade experience a positive NPV for the 2025 target but reduce (towards negative) for the later target years. This indicates that the given scenario to roll-out these initiatives for those later target years is not a desirable investment and it is recommended that those initiatives are rolled out earlier, as evident from the results.

Furthermore, Council may explore several funding options to cover capital costs for these initiatives. In their 2018/19 budget, Monash City Council made a commitment to long-term financial sustainability, including being debt free in the short-term and maintaining a Working Capital Ratio (Current Assets/Current Liabilities) at above 150 per cent over the life of their 4 Year Strategic Resource Plan (SRP). This means that Council may utilise internal funding and/or government grants to avoid causing accrual of debt. Council may also attempt internal capital raising (involving raising rates to accumulate capital for projects) though this would require State Government approval and may be unlikely to succeed. Alternatively, Council may be able to utilise upfront loans for initiatives with low payback periods as long as it does not violate their current SRP. It is recommended that Council's internal financial managers should be consulted to determine the optimal strategy to use for funding these initiatives.

It is recommended that Council use this analysis to compare the complete business case for implementing all initiatives presented in this report to achieve carbon neutrality by the specified target year. Each target is analysed in more detail in section 8.

8 Carbon Neutrality Model Trajectories

Each initiative presented in this report was considered for the modelling of a 2025, 2030 and 2040 carbon neutral trajectory. Under a 2040 carbon neutral trajectory it is recommended that Council implement all measures as described. Under a 2025 or 2030 trajectory it is recommended that Council implement all measures by the target year except fleet electrification as the capital costs to switch over the entire fleet and install the required infrastructure in such a short period of time are too high, so this will be an ongoing measure. Emissions savings from the LG PPA eliminate all grid-sourced electricity emissions (other than off-site fleet vehicle charging in the 2040 target) as electricity will be sourced from renewables. For example, the emissions reduction initiatives that will be affected by the implementation of the LG PPA include: Energy monitoring solutions, Major roads LED upgrade, EPC, Fleet electrification, Small scale solar, Energy efficiency initiatives, Residential LED streetlighting upgrade. These initiatives will reduce energy consumption regardless of the implementation of the LG PPA, however, will not provide carbon emissions reductions once the LG PPA is implemented as all

electricity come from renewable sources. The projected emissions and cashflow requirements are analysed for each carbon neutral target year in sections 8.1- 8.3.

8.1 2025 Target Model

The following graphs shows the potential emissions reductions Council could achieve if they were to implement all measures as modelled for a 2025 carbon neutral trajectory. Each figure gives a snapshot of the trajectory at 2025, 2030 and 2040 (refer to appendix section 10.1 for all data points).

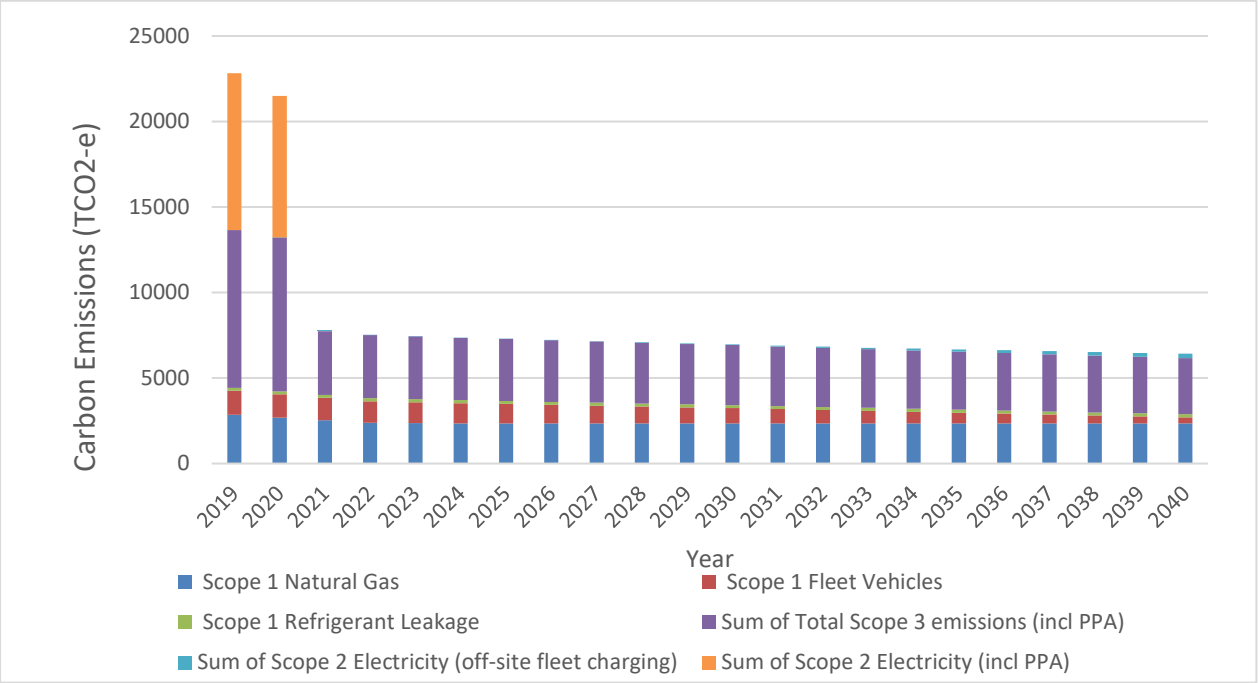

Figure 4 Monash City Council's projected carbon emissions for 2025 carbon neutrality target modelled to 2040

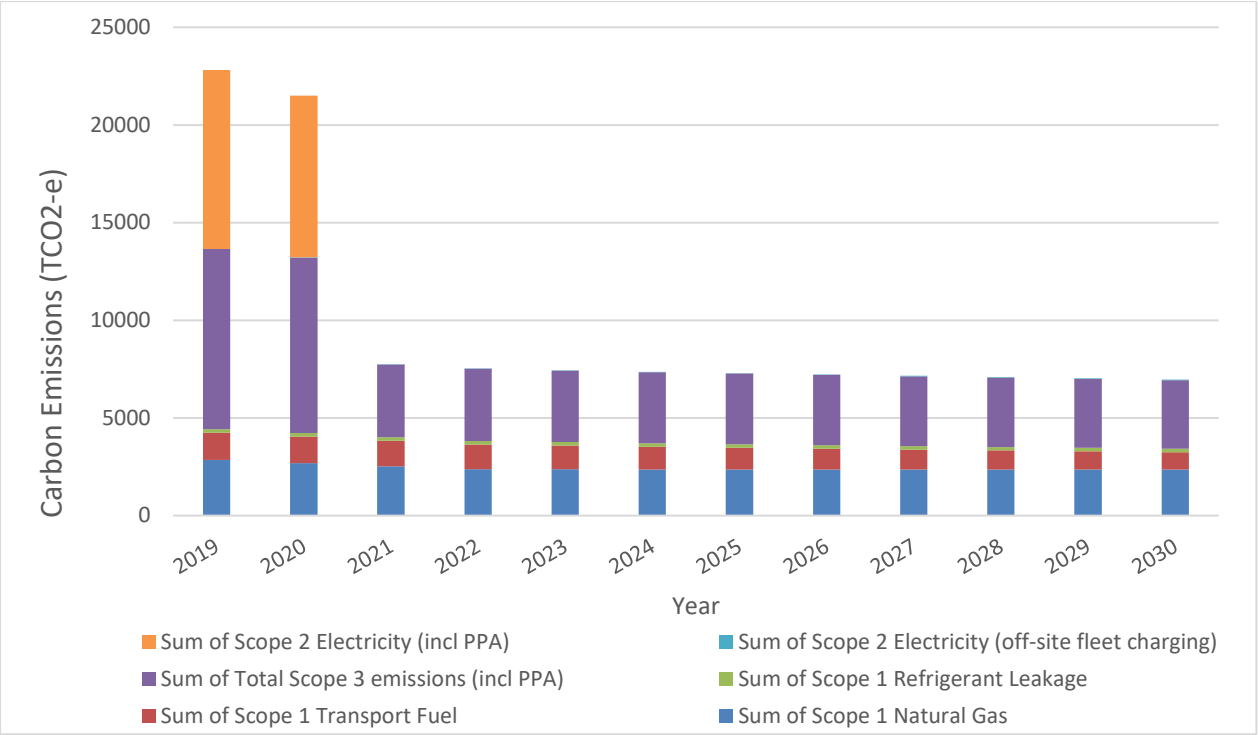

Figure 5 Monash City Council's projected carbon emissions for 2025 carbon neutrality target modelled to 2030

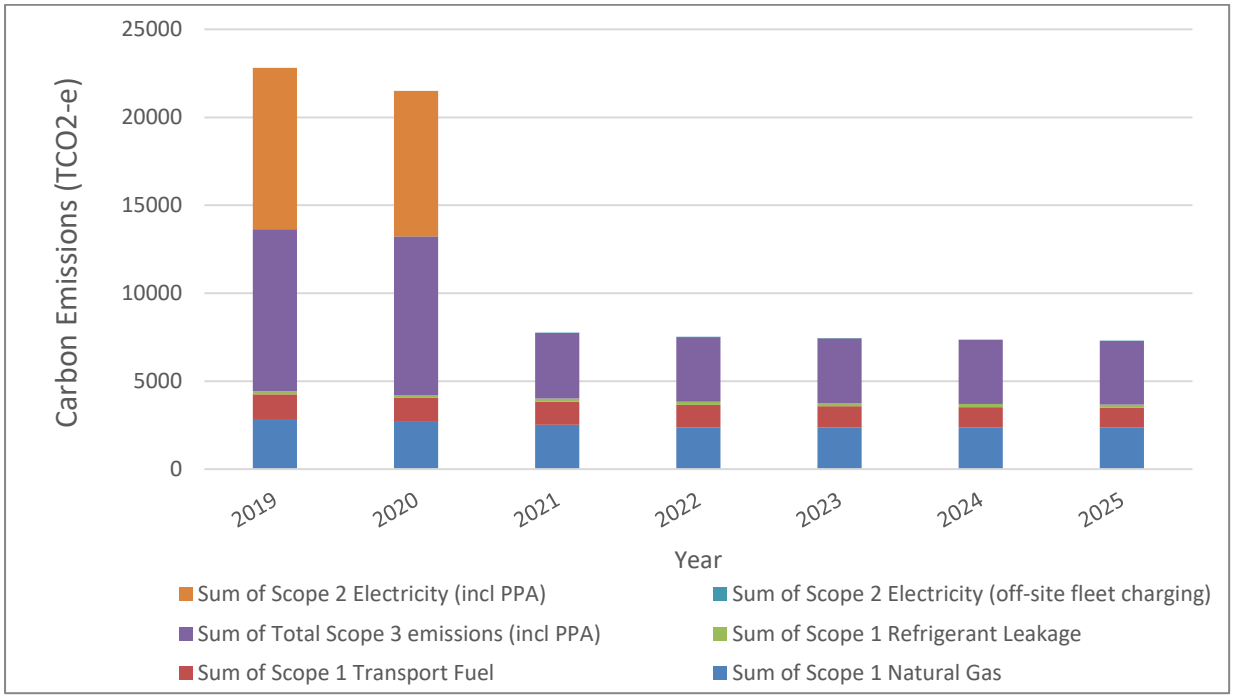

Figure 6 Monash City Council's projected carbon emissions for 2025 carbon neutrality target modelled to 2025

There is a significant reduction in emissions achieved through the implementation of all carbon neutral initiatives for a 2025 target year. The data shows that Council will achieve a 68% reduction by 2025 compared to 2018/19 levels with slower reduction after due to some ongoing measures and a predicted reduction in emissions intensity from most energy sources in the future (refer to appendix section 10.2 for all data points).

The amount of carbon offsets required (and modelled for this trajectory) are shown in the graph below. The bars showing positive carbon emissions represent Council's total emissions after all the emissions reduction measures are in place, with different colours indicating the different emissions sources. The bars showing negative carbon emissions represent the amount of emissions that are needed to be offset in order for Council to achieve carbon neutrality.

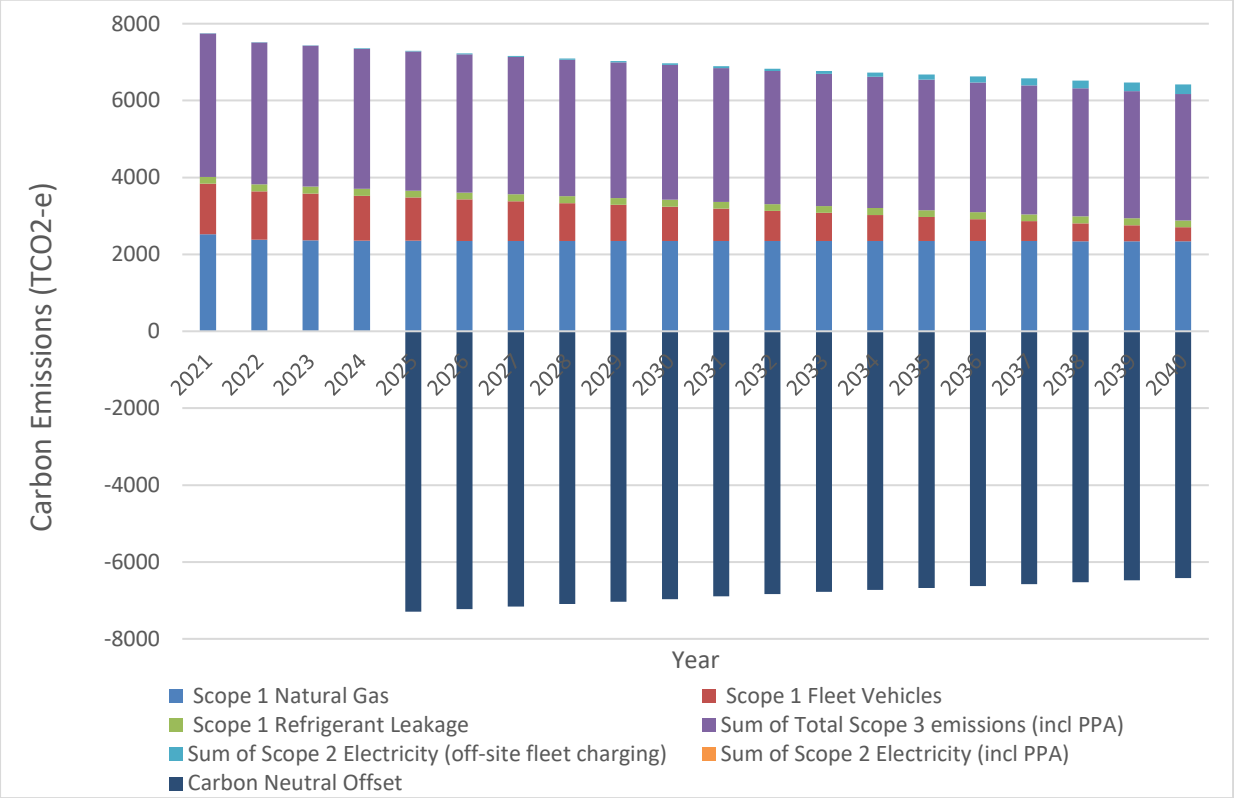

Figure 7 Monash City Council's projected carbon emissions and offset purchases for 2025 carbon neutrality target

The table below shows the exact figures represented in the above graph for the projected amount and cost of carbon emissions for this target.

Table 11 Monash City Council's projected amount and cost of carbon offsets required for 2025 carbon neutrality target

Year	Offsets amount (tCO_2e)	Offset Cost ($)
2019-2024	0	$0
2025	7,295	$103,953
2026	7,228	$102,998
2027	7,162	$102,055
2028	7,096	$101,125
2029	7,032	$100,207
2030	6,969	$99,301
2031	6,896	$98,268
2032	6,831	$97,343
2033	6,773	$96,522
2034	6,727	$95,854
2035	6,680	$95,187
2036	6,628	$94,445
2037	6,576	$93,706
2038	6,524	$92,970
2039	6,473	$92,238
2040	6,422	$91,509

The main source of emissions reduction comes from the implementation of the LG PPA since it zeroes all electricity emissions from 2021 onwards. In this case, initiatives such as Energy monitoring solutions, Major roads LED upgrade, EPC, Fleet electrification, Small scale solar, Energy efficiency initiatives, Residential LED streetlighting upgrade provide more of a financial benefit to Council.

The graph below shows the total annual capital costs (red), cost savings (blue) and carbon offset costs (green), (beginning in 2025) for all the initiatives through to 2040. Red bars indicate the annual capital costs associated with the recommended measures. Blue bars indicate the annual financial savings which are projected to arise due to reduced energy consumption. The green bars represent the annual ongoing costs for purchased offsets after 2025.

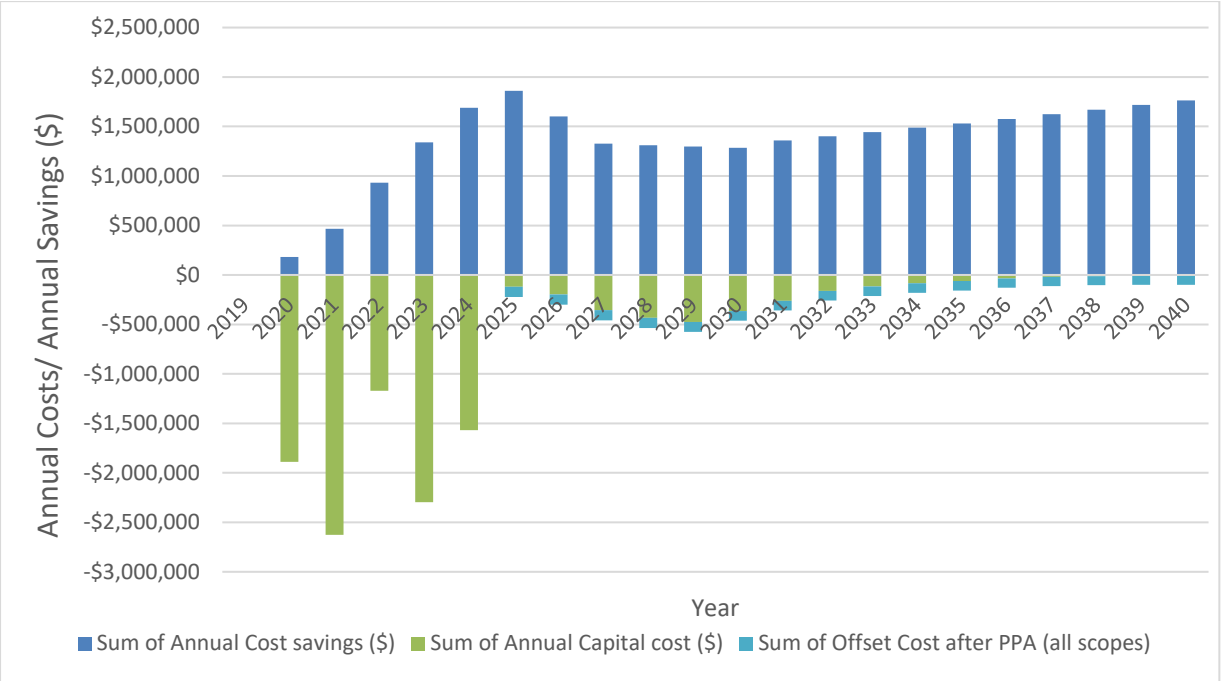

Figure 8 Total projected annual capital costs and cost savings for 2025 carbon neutrality trajectory

The data used in the above graph has also been tabulated below. Cells are highlighted in green from 2025 onwards to represent the time which Council will be carbon neutral.

Table 12 Annual cost savings, annual captial costs and carbon offset cost for each year in the 2025 carbon neutral target up to 2040

Year	Annual Capital cost ($)	Offset Cost ($)	Annual Cost savings ($)	Net cash flow ($)
2019	$0	$0	$0	$0
2020	$1,889,118	$0	$180,880	-$1,708,238
2021	$2,625,092	$0	$465,765	-$2,159,327
2022	$1,169,312	$0	$931,202	-$238,110
2023	$2,297,084	$0	$1,338,292	-$958,792
2024	$1,568,865	$0	$1,687,784	$118,919
2025	$118,085	$103,953	$1,859,879	$1,637,841
2026	$197,248	$102,998	$1,602,540	$1,302,294
2027	$355,933	$102,055	$1,325,565	$867,576
2028	$433,882	$101,125	$1,310,508	$775,501
2029	$476,187	$100,207	$1,297,713	$721,318
2030	$363,948	$99,301	$1,284,161	$820,911
2031	$260,352	$98,268	$1,358,240	$999,621
2032	$160,946	$97,343	$1,400,574	$1,142,285
2033	$116,172	$96,522	$1,443,617	$1,230,922
2034	$84,388	$95,854	$1,487,372	$1,307,130
2035	$61,833	$95,187	$1,531,843	$1,374,823
2036	$34,553	$94,445	$1,577,034	$1,448,036
2037	$17,892	$93,706	$1,622,945	$1,511,347
2038	$11,186	$92,970	$1,669,581	$1,565,425
2039	$8,523	$92,238	$1,716,943	$1,616,183
2040	$7,501	$91,509	$1,765,032	$1,666,023

Given the above data, the committing to the 2025 carbon neutral target set out in this report would have the following financial outcomes:

Table 13 Cumulative financial outcomes for 2025 carbon neutral target initiatives

Year	Cumulative Capital cost ($)	Cumulative Cost savings ($)	Cumulative Offset Cost	Net cumulative cash flow ($)
2025	$9,667,556	$6,463,802	$103,953	-$3,307,707
2030	$11,494,756	$13,284,288	$609,640	$1,690,231
2040	$12,258,102	$28,857,469	$1,557,681	$16,507,859

The 2025 target trajectory at one point has the highest initial costs since all initiatives need to be completed by 2025, where practical. After this date there will only be smaller ongoing costs involved for continuous upgrades and improvement. Despite the costs of offsets, analysis shows that significant cost savings may still be achieved.

8.2 2030 Target Model

The following graph shows the potential emissions reductions Council could achieve if they were to implement all measures as modelled for a 2030 carbon neutral trajectory. Each figure gives a snapshot of the trajectory at 2025, 2030 and 2040 (refer to appendix section 10.1 for all data points).

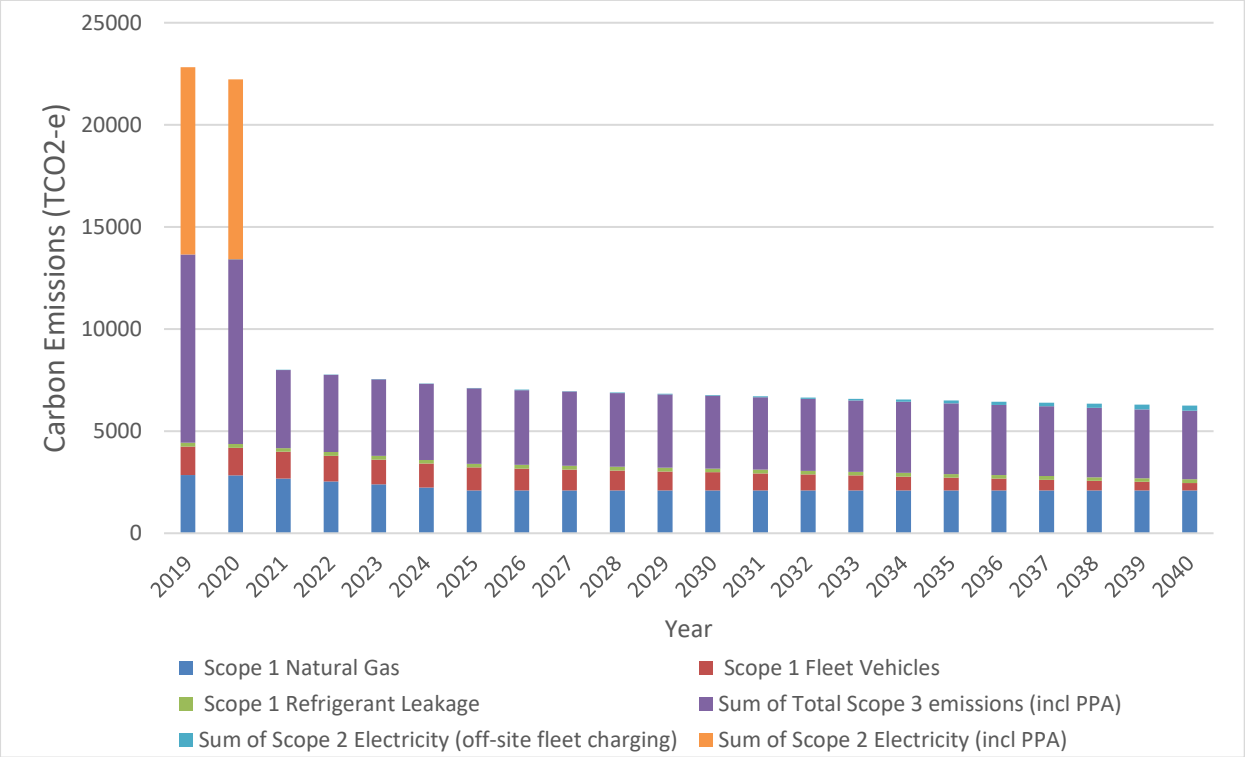

Figure 9 Monash Council's projected carbon emissions for 2030 carbon neutrality target modelled to 2040 target

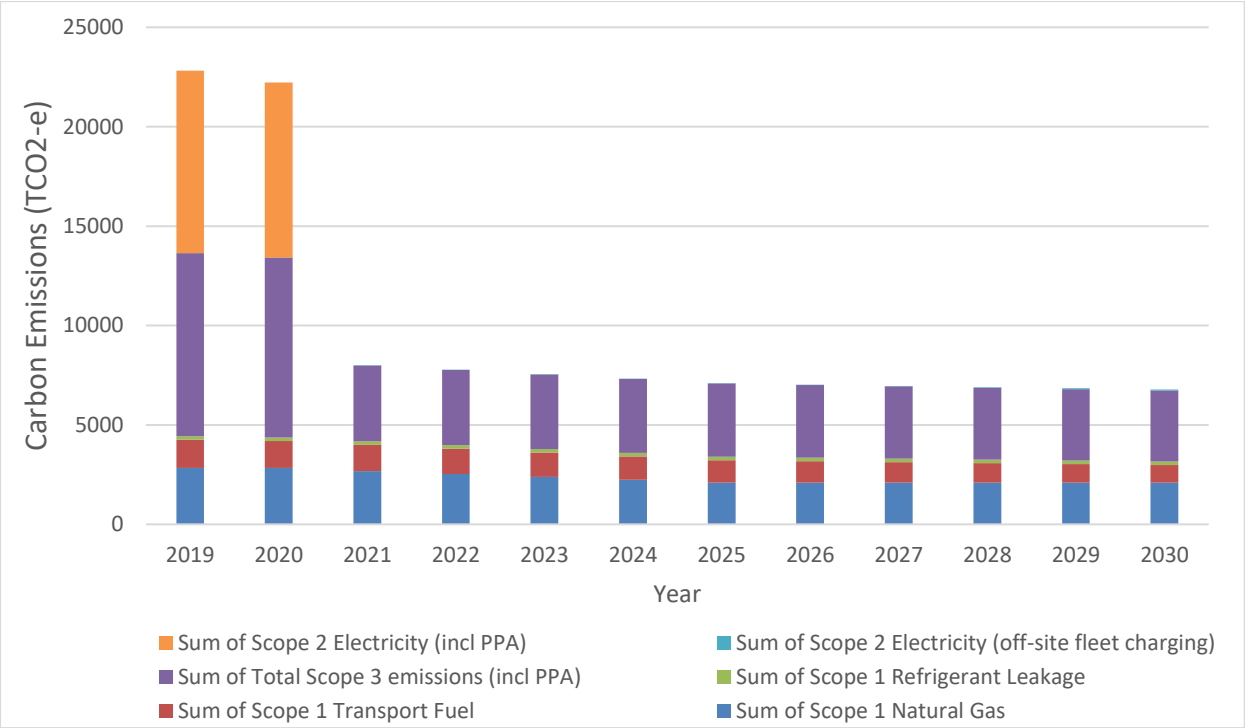

Figure 10 Monash City Council's projected carbon emissions for 2030 carbon neutrality target modelled to 2030

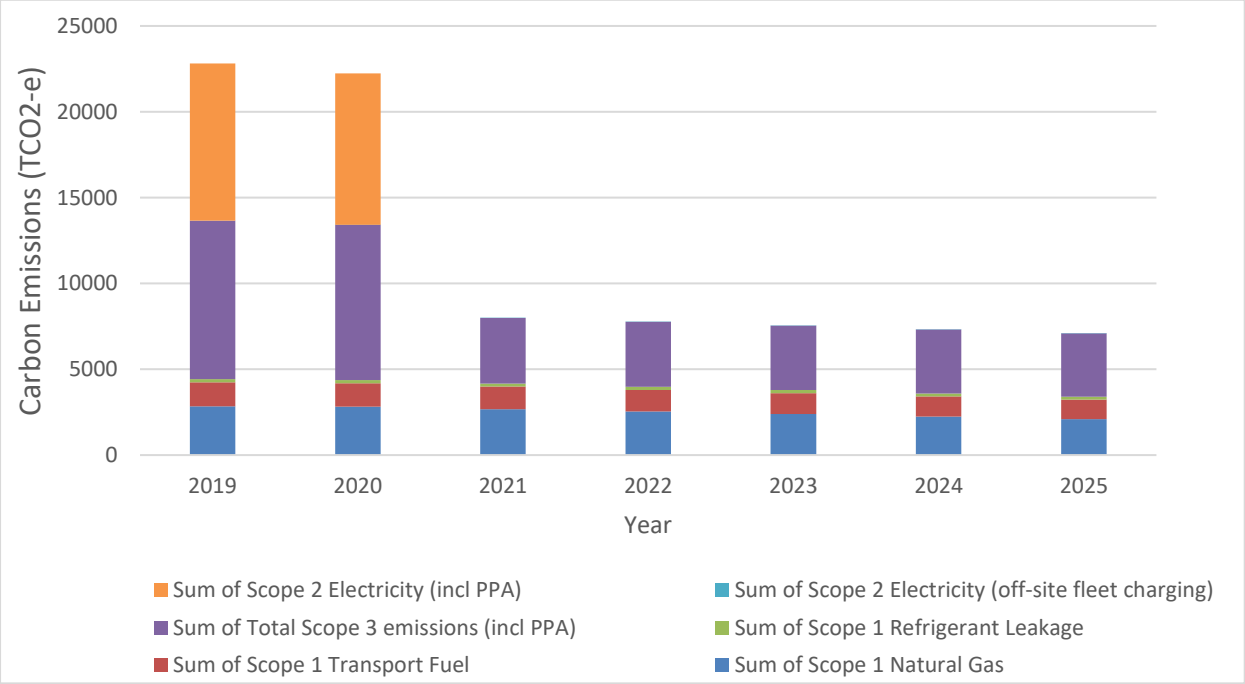

Figure 11 Monash City Council's projected carbon emissions for 2030 carbon neutrality target modelled to 2025

In comparison to the 2025 trajectory, there is a 69% reduction in emissions in 2025 and a 70% reduction in emissions seen in 2030 compared to 2018/19 levels (see appendix section 10.2 for all data points). There is a slower reduction in emissions beyond 2030 due to ongoing measures and a predicted reduction in emissions intensity from most energy sources in the future. The amount of carbon offsets required (and modelled for this trajectory) are shown in the graph below. The bars showing positive

carbon emissions represent Council's total emissions after all the emissions reduction measures are in place, with different colours indicating the different emissions sources. The bars showing negative carbon emissions represent the amount of emissions that are needed to be offset for Council to achieve carbon neutrality.

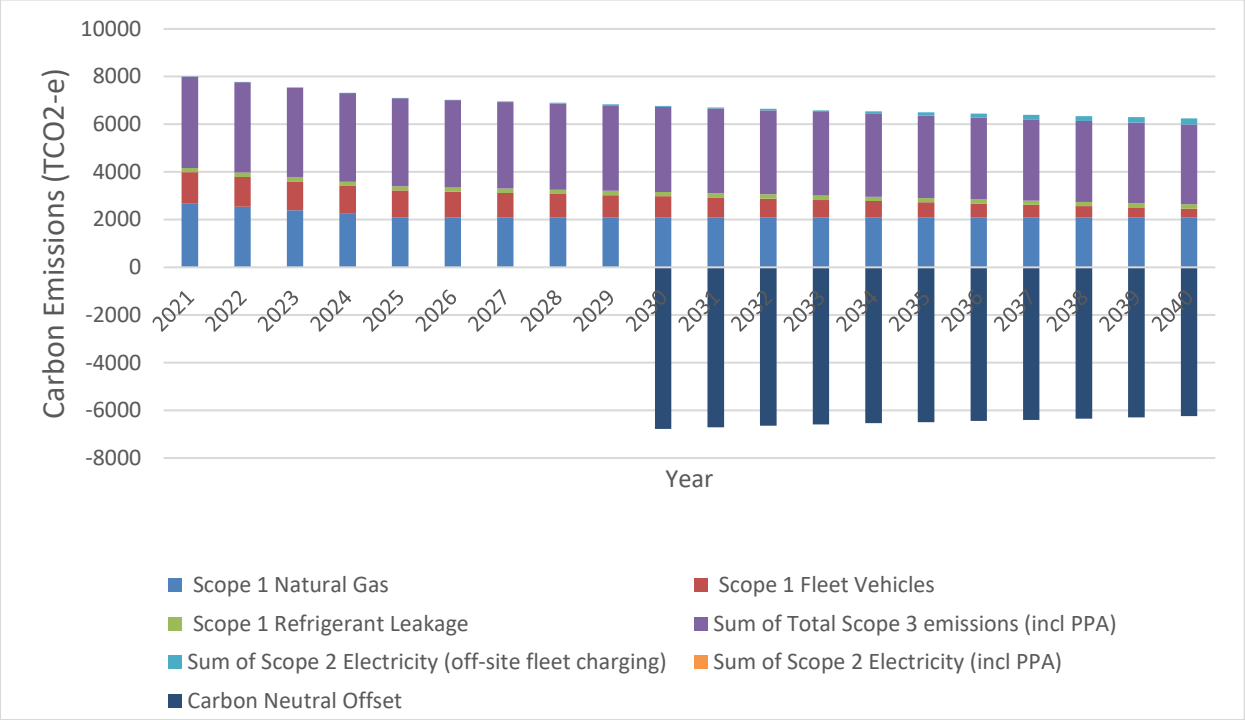

Figure 12 Monash City Council's projected carbon emissions and offset purchases for 2030 carbon neutrality target

The table below shows the exact figures represented in the above graph for the projected amount and cost of carbon emissions for this target.

Table 14 Monash City Council's projected amount and cost of carbon offsets required for 2030 carbon neutrality target

Year	Offsets amount (tCO_2e)	Offset Cost ($)
2019-2029	0	$
2030	6,778	$96,579
2031	6,707	$95,571
2032	6,644	$94,671
2033	6,588	$93,875
2034	6,543	$93,231
2035	6,497	$92,588
2036	6,447	$91,870
2037	6,397	$91,155
2038	6,347	$90,443
2039	6,297	$89,734
2040	6,248	$89,029

The main source of emissions reduction comes from the implementation of the LG PPA since it zeroes all electricity emissions from 2021 onwards. In this case, initiatives such as Energy monitoring solutions, Major roads LED upgrade, EPC, Fleet electrification, Small scale solar, Energy efficiency initiatives, Residential LED streetlighting upgrade provide more of a financial benefit to Council.

The graph below shows the total annual capital costs (red), cost savings (blue) and carbon offset costs (green), (beginning in 2030) for all the initiatives through to 2040. Red bars indicate the capital costs associated with the recommended measures. Blue bars indicate the financial savings which are projected to arise due to reduced energy consumption. The green bars represent the ongoing costs for purchased offsets after 2025.

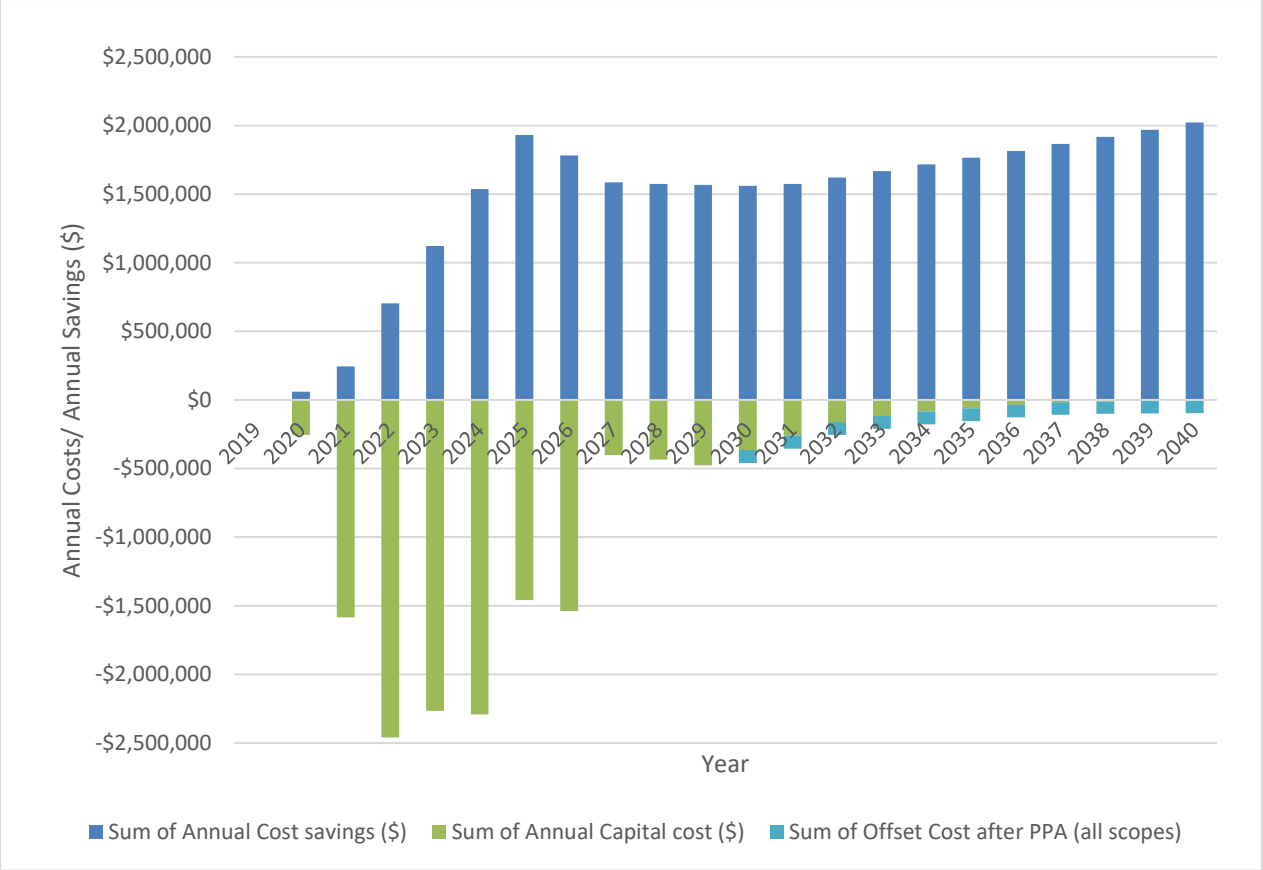

Figure 13 Total projected annual capital costs and cost savings for 2030 carbon neutrality trajectory

The data used in the above graph has also been tabulated below. Cells are highlighted in green from 2030 onwards to represent the time which Council will be carbon neutral.

Table 15 Annual cost savings, annual captial costs and carbon offset cost for each year in the 2030 carbon neutral target up to 2040

Year	Annual Capital cost ($)	Offset Cost ($)	Annual Cost savings ($)	Net cash flow ($)
2019	$0	$0	$0	$0
2020	$254,243	$0	$59,216	-$195,027
2021	$1,585,624	$0	$244,988	-$1,340,636
2022	$2,459,608	$0	$704,700	-$1,754,908
2023	$2,265,311	$0	$1,121,137	-$1,144,174
2024	$2,292,591	$0	$1,536,205	-$756,385
2025	$1,459,417	$0	$1,931,931	$472,514
2026	$1,538,499	$0	$1,781,859	$243,359
2027	$401,134	$0	$1,585,344	$1,184,210
2028	$433,882	$0	$1,575,423	$1,141,541
2029	$476,187	$0	$1,567,864	$1,091,677
2030	-$363,948	$96,579	$1,559,652	$1,099,125
2031	-$260,352	$95,571	$1,573,607	$1,217,684
2032	-$160,946	$94,671	$1,620,198	$1,364,581
2033	-$116,172	$93,875	$1,667,582	$1,457,535
2034	-$84,388	$93,231	$1,715,764	$1,538,145
2035	-$61,833	$92,588	$1,764,750	$1,610,329
2036	-$34,553	$91,870	$1,814,543	$1,688,120
2037	-$17,892	$91,155	$1,865,149	$1,756,102
2038	-$11,186	$90,443	$1,916,571	$1,814,942
2039	-$8,523	$89,734	$1,968,814	$1,870,557
2040	-$7,501	$89,029	$2,021,881	$1,925,351

Given the above data, committing to the 2030 carbon neutral target set in this report would have the following financial outcomes:

Table 16 Given above data, committing to 2030 carbon neutral target set in this report gives the following financial outcomes:

Year	Cumulative Capital cost ($)	Cumulative Offset Cost	Cumulative Cost savings ($)	Net cumulative cash flow ($)
2025	$10,316,793	$0	$5,598,178	-$4,718,616
2030	$13,530,444	$96,579	$13,668,321	$137,876
2040	$14,293,790	$1,018,746	$31,597,179	$17,303,389

The 2030 target trajectory has relatively high initial costs for capital investment and carbon offset purchases since all initiatives will need to be completed by 2030, where practical. Similar to the 2025 trajectory, after the target year there will only be smaller ongoing costs involved for continuous upgrades and improvement.

Achieving carbon neutrality would require Council to purchase offsets equivalent to Council's total emissions from 2030 onwards. The costs for these offsets are also included in the above graph. It is noteworthy that analysis reveals significant savings may still be achieved after carbon offsets are purchased.

8.3 2040 Target Model

The following graph shows the potential emissions reductions Council could achieve if they were to implement all measures as modelled for a 2040 carbon neutral trajectory. Each figure gives a snapshot of the trajectory at 2025, 2030 and 2040 (refer to appendix section 10.1 for all data points). All initiatives, including the fleet electrification and optimisation initiative, were modelled for this target (as per section 5.2.1).

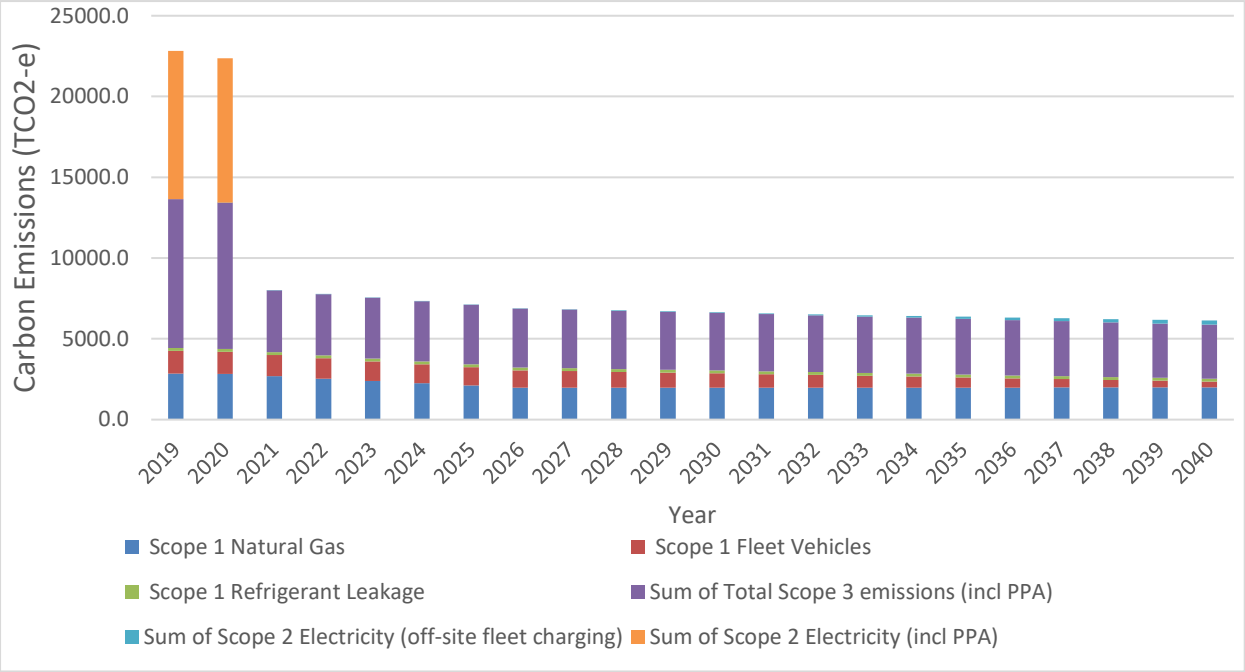

Figure 14 Monash City Council's projected carbon emissions for 2040 carbon neutrality target modelled to 2040

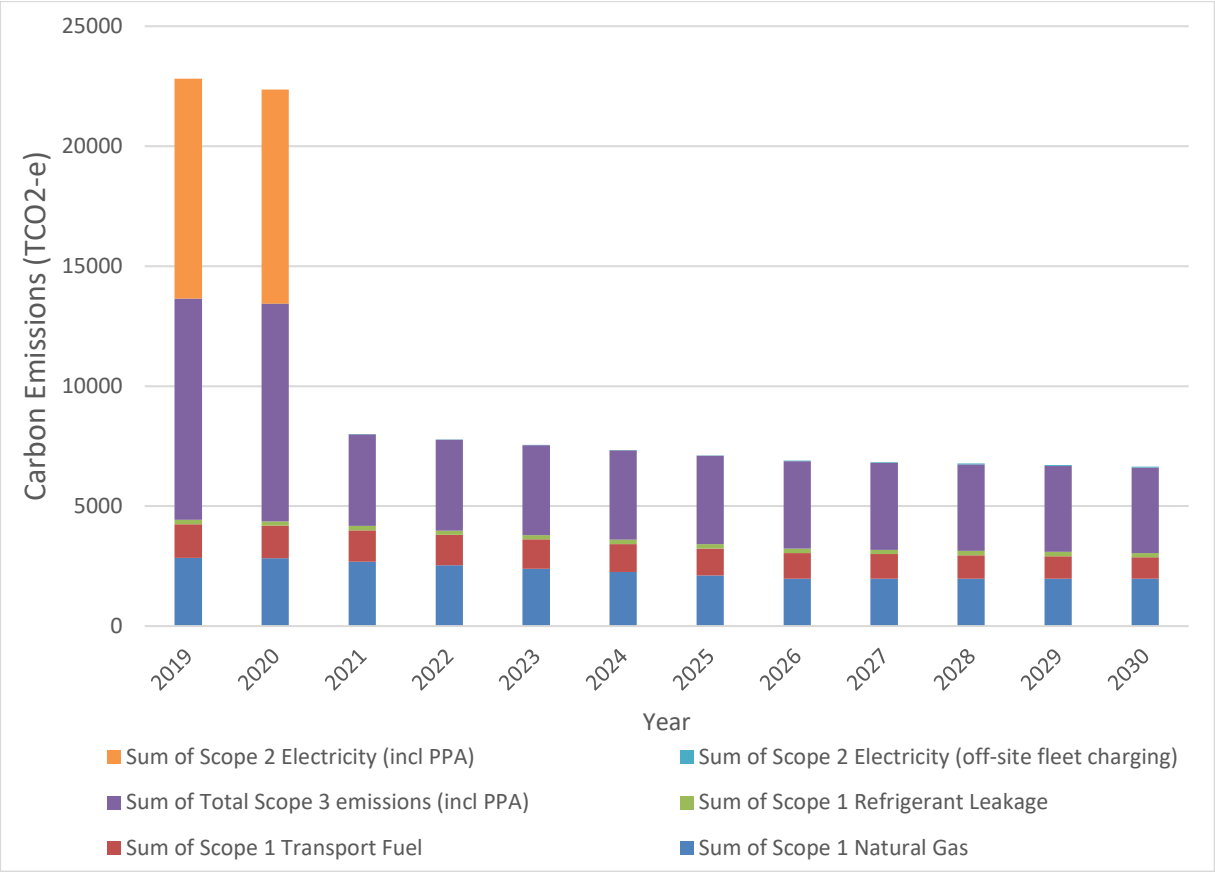

Figure 15 Monash City Council's projected carbon emissions for 2040 carbon neutrality target modelled to 2030

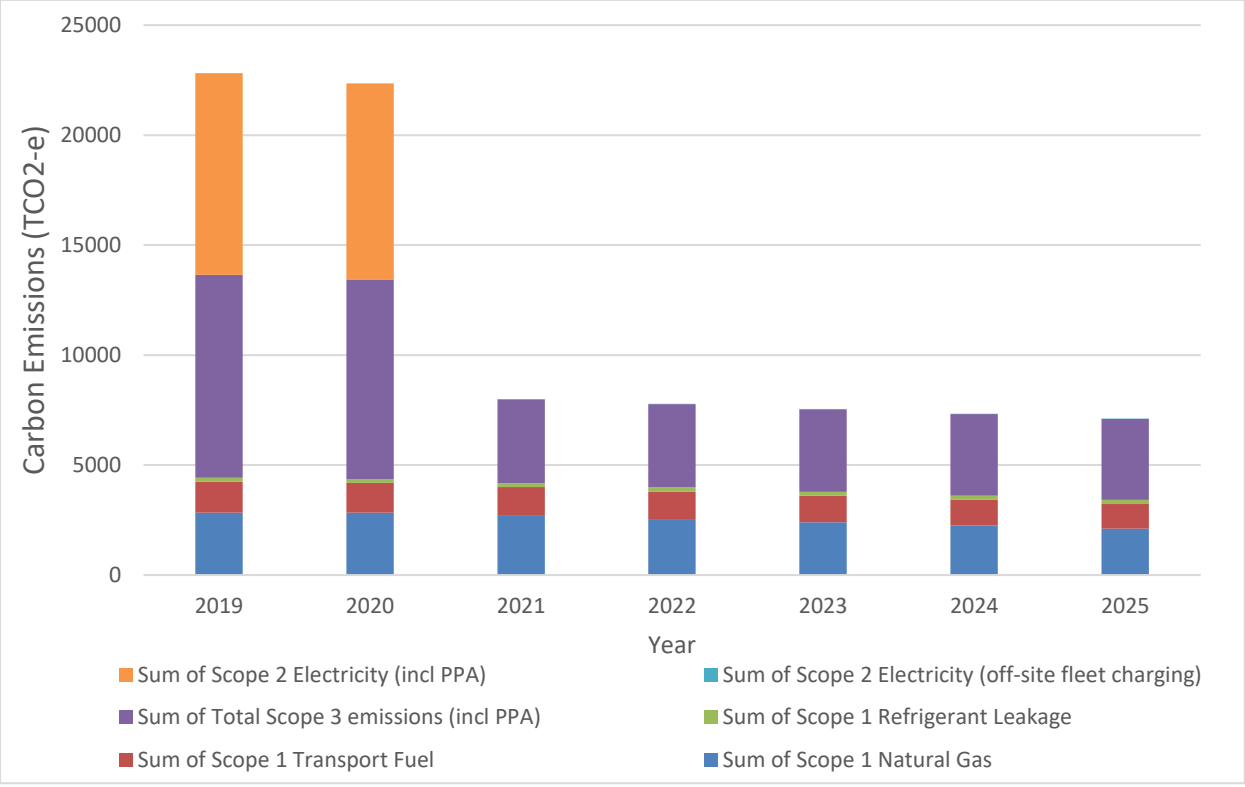

Figure 16 Monash City Council's projected carbon emissions for 2040 carbon neutrality target modelled to 2025

Emissions are reduced by 69% by 2025, 71% by 2030 and 73% by 2040 in comparison to 2018/19 emission levels (see appendix section 10.2 for all data points).

The amount of carbon offsets required (and modelled for this trajectory) are shown in the graph below. The bars showing positive carbon emissions represent Council's total emissions after all the emissions reduction measures are in place, with different colours indicating the different emissions sources. The bars showing negative carbon emissions represent the amount of emissions that are needed to be offset for Council to achieve carbon neutrality.

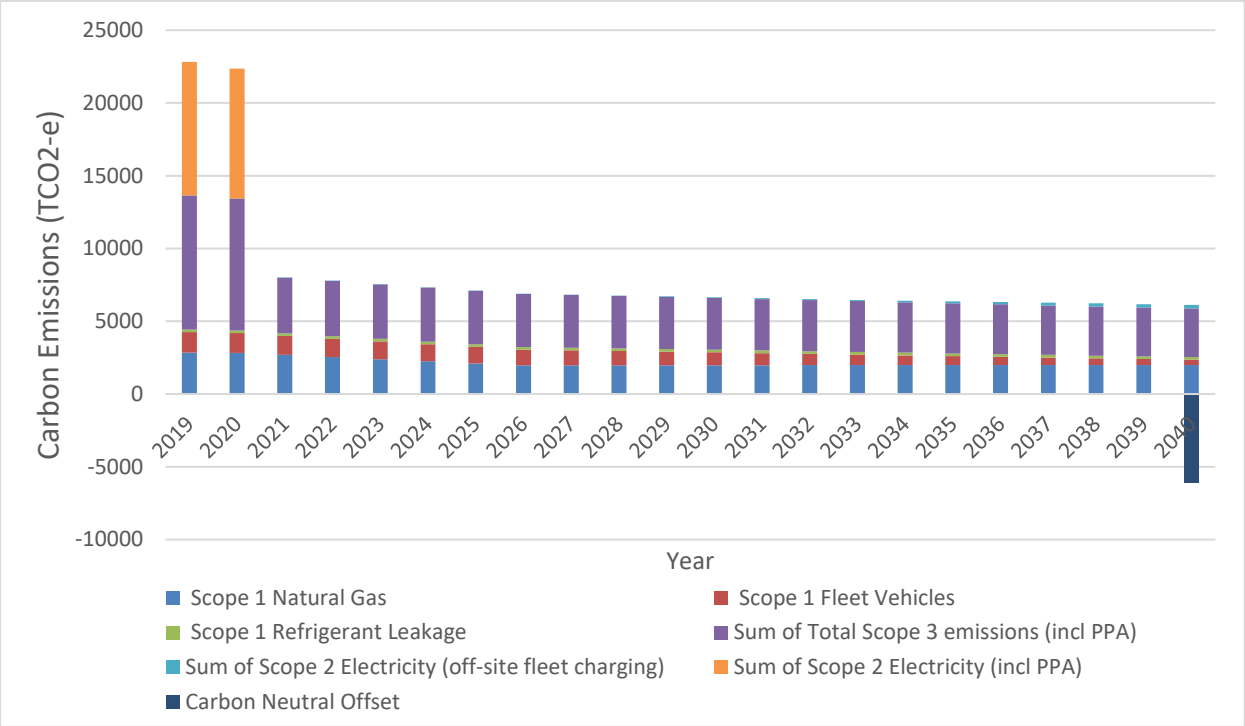

Figure 17 Monash City Council's projected carbon emissions and offset purchases for 2040 carbon neutrality target

The table below shows the exact figures represented in the above graph for the projected amount and cost of carbon emissions for this target.

Table 17 Monash City Council's projected amount and cost of carbon offsets required for 2040 carbon neutrality target

Year	Offsets amount (tCO_2e)	Offset Cost ($)
2019-2039	0	$0
2040	6128	$87,329

The main source of emissions reduction comes from the implementation of the LG PPA since it zeroes all electricity emissions from 2021 onwards. In this case, initiatives such as Energy monitoring solutions, Major roads LED upgrade, EPC, Fleet electrification, Small scale solar, Energy efficiency initiatives, Residential LED streetlighting upgrade provide more of a financial benefit to Council.

The graph below shows the total annual capital costs (red), cost savings (blue) and carbon offset costs (green) for all the initiatives. Since the analysis period in this report only extends to 2040, only the initial carbon offset required to achieve carbon neutrality in 2040 is shown. Red bars indicate the annual

capital costs associated with the recommended measures. Blue bars indicate the annual financial savings which are projected to arise due to reduced energy consumption. The green bars represent the annual ongoing costs for purchased offsets after 2025.

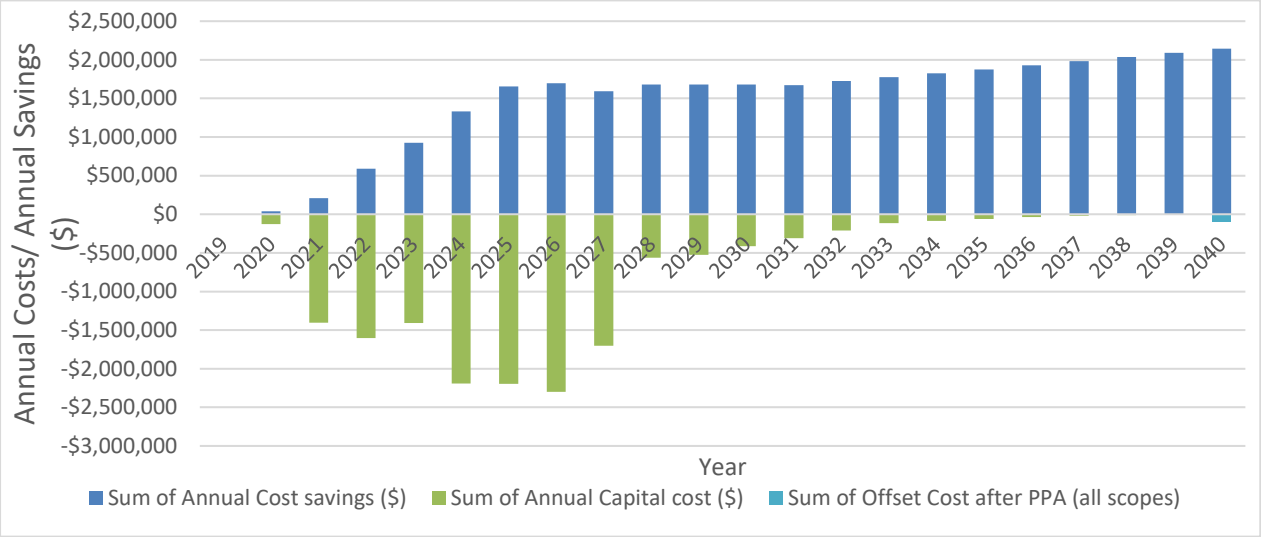

Figure 18 Total projected annual capital costs and cost savings for 2040 carbon neutrality trajectory

The data used in the above graph has also been tabulated below. Cells at 2040 are highlighted in green to represent the time which Council will be carbon neutral.

Table 18 Annual cost savings, annual captial costs and carbon offset cost for each year in the 2040 carbon neutral target up to 2040

Years	Annual Capital cost ($)	Offset Cost ($)	Annual Cost savings ($)	Net cash flow ($)
2019	$0	$0	$0	$0
2020	$128,093	$0	$39,729	-$88,364
2021	$1,405,130	$0	$206,773	-$1,198,357
2022	$1,601,294	$0	$588,669	-$1,012,626
2023	$1,406,997	$0	$925,417	-$481,580
2024	$2,189,775	$0	$1,331,866	-$857,910
2025	$2,195,609	$0	$1,654,812	-$540,797
2026	$2,300,199	$0	$1,696,074	-$604,124
2027	$1,703,303	$0	$1,593,364	-$109,940
2028	$560,601	$0	$1,679,315	$1,118,714
2029	$525,142	$0	$1,679,179	$1,154,037
2030	$412,818	$0	$1,678,681	$1,265,864
2031	$309,135	$0	$1,672,827	$1,363,692
2032	$209,640	$0	$1,725,734	$1,516,095
2033	$116,172	$0	$1,775,213	$1,659,041
2034	$84,388	$0	$1,825,531	$1,741,143
2035	$61,833	$0	$1,876,694	$1,814,861
2036	$34,553	$0	$1,928,708	$1,894,155
2037	$17,892	$0	$1,981,578	$1,963,686
2038	$11,186	$0	$2,035,309	$2,024,123
2039	$8,523	$0	$2,089,907	$2,081,384
2040	$7,501	$87,329	$2,145,374	$2,050,544

Given the above data, committing to the 2025 carbon neutral target set in this report would have the following financial outcomes:

Table 19 Cumulative financial outcomes for 2040 carbon neutral target initiatives

Year	Cumulative Capital cost ($)	Cumulative Offset Cost	Cumulative Cost savings ($)	Net cumulative cash flow ($)
2025	$8,926,898	$0	$4,747,264	-$4,179,634
2030	$14,428,962	$0	$13,073,878	-$1,355,083
2040	$15,289,784	$87,329	$32,130,753	$16,753,640

As with other trajectories, the 2040 trajectory has relatively high initial costs for capital investments and carbon offset purchases though there is significantly more time available to implement initiatives, which may be advantageous for Council. Furthermore, there is more time for initiatives to build up on cost savings which creates a better business case.

9 Discussion

This report presents a wide variety of parameters that may be used to judge the suitability and feasibility of implementing each initiative and/or target. It may be useful to first view the emissions reduction achieved by each target compared against Monash City Council's emissions if Council were to conduct "Business as usual" by not implementing any of the initiatives presented in this report.

The business as usual (BAU) case shows the expected emissions of Monash City Council based on this report's 2018/19 carbon inventory figures with a 1.5% annual degradation. This degradation figure was based on both the trend in emissions seen between the 2015/16 and 2018/19 financial years and the expected decrease in carbon intensity for electricity and gas consumption. The average between these fluctuations conservatively results in a 1.5% annual decrease in carbon emissions for Monash City Council. The following graph presents the BAU case along with the emissions reductions that may be achieved through implementation of the 2025, 2030 and 2040 targets presented in this report.

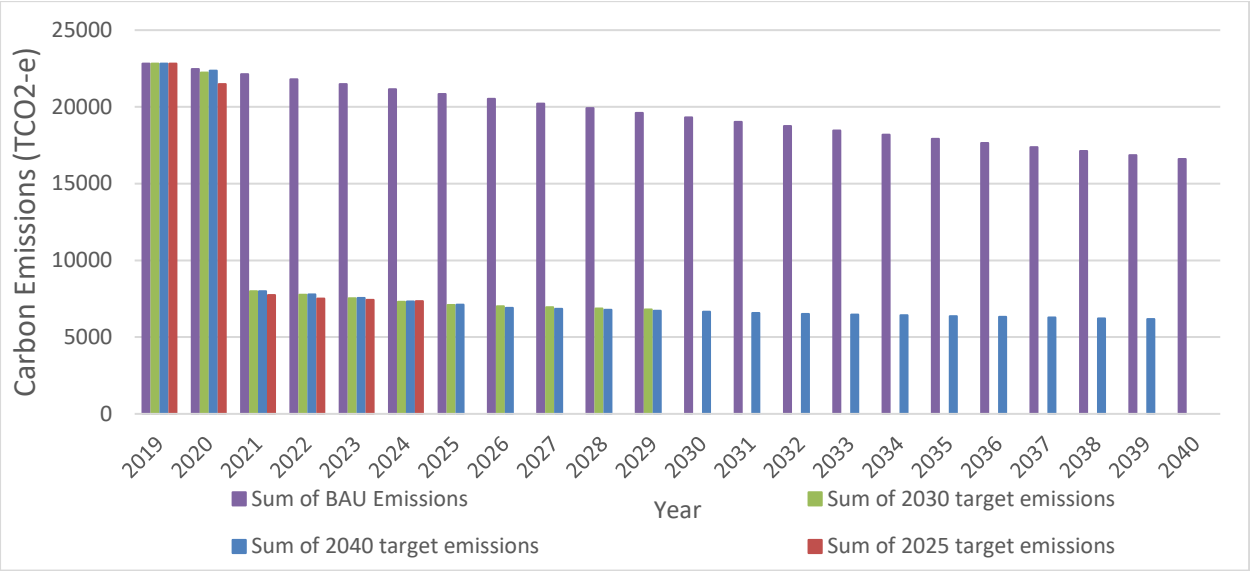

Figure 19 Business as usual case (no initiatives implemented) compared against 2025, 2030 and 2040 carbon neutral trajectory emissions

It should be noted that the BAU emissions considers that Council will decrease its emissions by 1.5% from 2018/19 emission levels annually. The percentage of emission reductions achieved by each carbon neutral target and BAU case compared against 2018/19 emissions levels are shown graphically below.

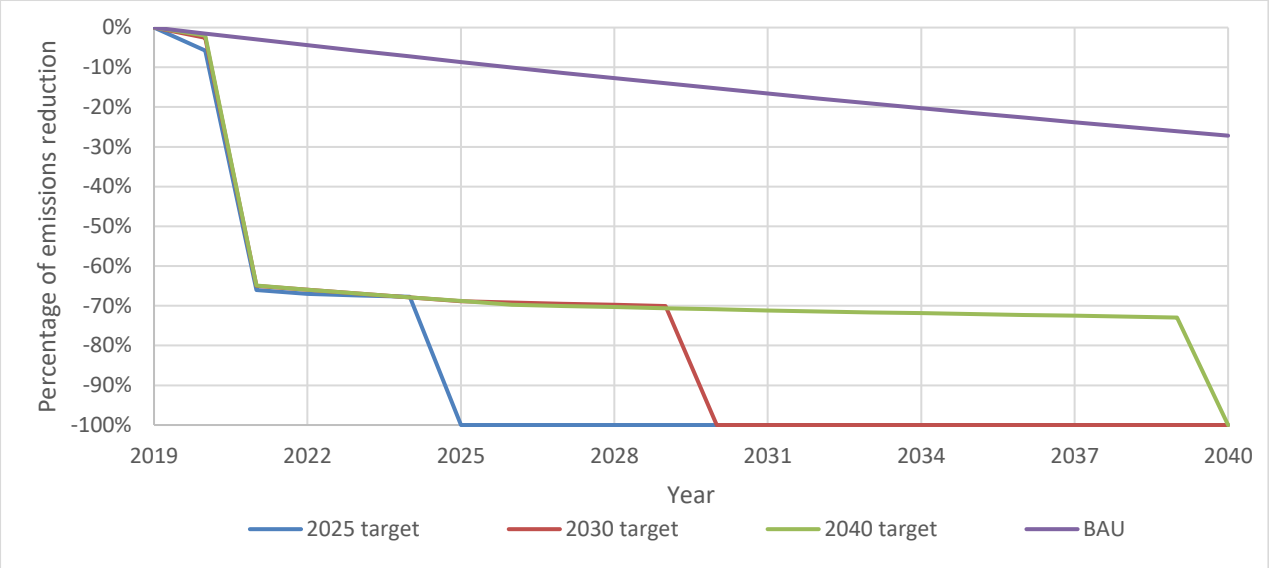

Figure 20 Percentage of emissions reduction achieved through 2025, 2030 and 2040 carbon neutral models compared to BAU emissions

Since each target year shares similar parameters for each of its initiatives, overall emissions reductions follow the same pattern. Initiatives such as the LG PPA, fleet optimisation and Paperless office & carbon neutral paper have consistent start and end dates with each target year while other initiatives such as LED Major Road Lighting Replacement start at a staggered rate yet maintain the same duration. These similarities maintain a consistent pattern of emissions reduction evident in the above graph. Other initiatives such as the EPC and small-scale solar begin at similar times while lasting longer for later target years which creates variation in the amount of savings achieved and offsets required.

In comparison, the analysis performed on each carbon neutral trajectory revealed that since costing figures were similar across each separate target, the duration and timing of when initiatives were implemented had a significant bearing on the NPV and IRR for each initiative. Furthermore, earlier implementation of initiatives creates more time for projects to accumulate cost savings for Council even with larger capital investment projects.

Financial analyses of these targets and initiatives reveal that some initiatives such as Energy monitoring solutions, Major roads LED upgrade, Small scale solar, Energy efficiency initiatives and Residential LED streetlighting upgrade, experience the highest NPV when implemented for the 2025 target. This can be attributed to the timelines of these projects as the 2030 and 2040 targets have these initiatives rolling out both later and over a longer period of time in comparison to the 2025 target. Other initiatives such as the EPCs and Fleet electrification have higher NPVs for later target years as additional time can recuperate more savings as a result of those initiatives. Furthermore, the Energy efficiency initiatives and Residential LED streetlighting upgrade experience a positive NPV for the 2025 target but do not perform so well for the later target years. This indicates that those initiatives should be rolled-out earlier.

Overall, each target accrues and accumulates its own capital costs, cost savings and carbon offset costs at individual rates. The following graph shows the net cumulative cash flow for each target.

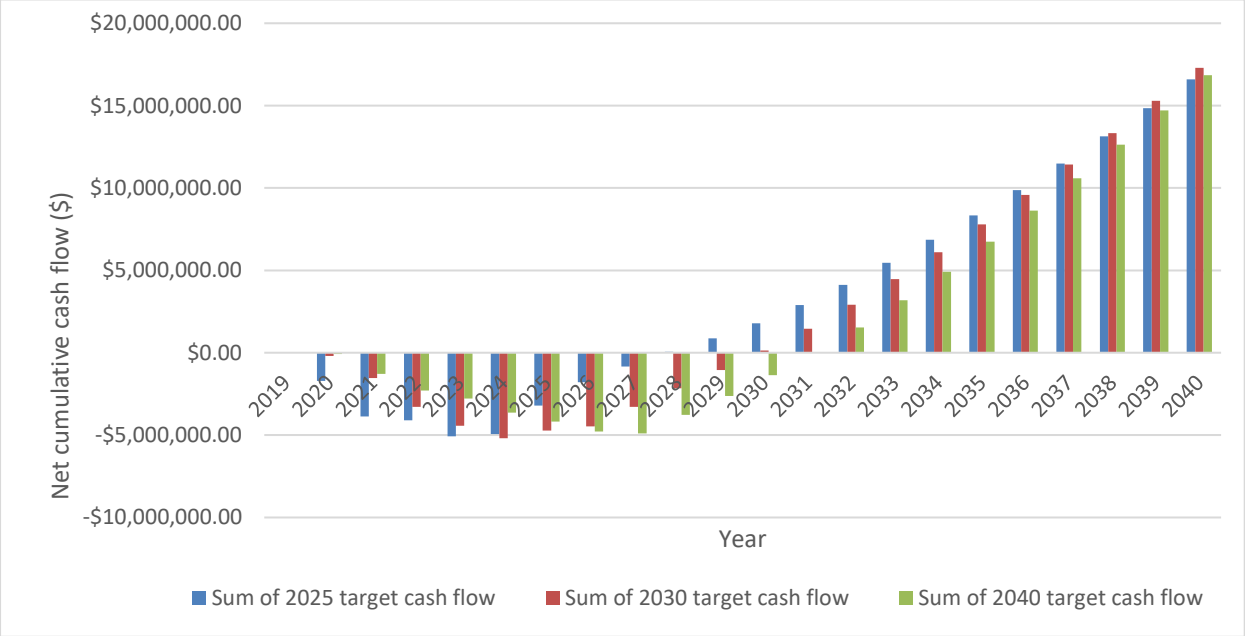

Figure 21 Net cumulative cash flow for 2025, 2030 and 2040 target

It may be useful to judge the suitability and feasibility of implementing each initiative and/or target by examining the net cumulative cash flows for each target at key points through each trajectory. The table below shows a summary of the cumulative capital costs, cost savings and offset cost at 2025, 2030 and 2040 for each of the carbon neutral targets in this report. The cost for council to be carbon neutral by 2025, 2030 and 2040 (including offsets) has also been highlighted and bolded for each carbon neutral target year below.

Table 20 Summary of cumulative financial outcomes for 2025, 2030 and 2040 carbon neutral targets

Target Year	Year	Cumulative Capital cost ($)	Cumulative Offset Cost	Cumulative Cost savings ($)	Net cumulative cash flow ($)
2025	**2025**	**$9,667,556**	**$103,953**	**$6,463,802**	**-$3,307,707**
	2030	$11,494,756	$609,640	$13,284,288	$1,690,231
	2040	$12,258,102	$1,557,681	$28,857,469	$16,507,859
2030	2025	$10,316,793	$0	$5,598,178	-$4,718,616
	2030	**$13,530,444**	**$96,579**	**$13,668,321**	**$137,876**
	2040	$14,293,790	$1,018,746	$31,597,179	$17,303,389
2040	2025	$8,926,898	$0	$4,747,264	-$4,179,634
	2030	$14,428,962	$0	$13,073,878	-$1,355,083
	2040	**$15,289,784**	**$87,329**	**$32,130,753**	**$16,753,640**

The figures given in the above table can be used to assess the financial standpoint of implementing initiatives according to the parameters given in this report. This may aid Council in deciding on the direction best suited to undertake and roll-out the examined emissions reduction initiatives.

Examining these figures reveals that each target year is financially strongest at 2040 (according to net cumulative cash flow presented in the table above) where each initiative has had the maximum time allowable to accumulate savings. The 2025 target is found to have the lowest cumulative capital cost while also achieving the lowest cumulative cost savings and highest cumulative offset cost. The 2040 target, however, has the highest cumulative capital cost and highest cumulative cost savings associated with it. A 2040 target would also minimise the amount of carbon offsets purchased to achieve carbon neutrality while a 2030 target would ensure the highest net cumulative cash flow by 2040.

The 2030 target has the highest net cumulative cash flow based primarily on the added EPC works and reduced number of offsets required when compared to the 2025 target. Though measures in the 2025 target are initiated earlier and have a longer time to accrue cost benefits, the added EPC works in the 2030 target will result in significantly larger cost savings for Council. The 2040 model has further EPC works on top of the 2030 model, however due to the measures starting later the payback on these is not realised to the same extent as in the 2030 model.

It should be noted that the 2025 target provides the lowest net cumulative cash flow mainly based on the expectation that all quantified emission reduction initiatives will end (and their annual emissions reductions will be fully realised) by 2025. This may change as it can be expected that even with a 2025 target chosen, Council may not halt all energy saving measures at year 2025. Therefore, it may be reasonably assumed that measures such as the EPC could be expanded past 2025 for a 2025 carbon neutral target, and in that case the 2025 model is capable of producing the greatest benefits to Council, both financially and environmentally.

All trajectories provide a significant environmental benefit by vastly reducing Council's carbon footprint. It is recommended that Council take note of the capital costs, net present values, internal rate of return and implementation timelines associated with each carbon neutral trajectory to decide which option best suits its capabilities and priorities. Monash City Council is also encouraged to use the results presented in this report as a guide to create a unique carbon neutral trajectory using any combination of measures and implementation strategies.

10 Appendices

10.1 Carbon emissions for 2025, 2030 and 2040 target

The following tables show the calculated carbon emissions for the 2025, 2030 and 2040 models. These values take into consideration the emissions reduction achieved by all initiatives in the target year. It shows, in detail, the emissions reductions broken down by the emissions source, where possible.

Table 21 All carbon emissions for 2025 target (tCO_2e)

Year	Scope 1 Natural Gas	Scope 1 Fleet Vehicles	Scope 1 Refrigerant Leakage	Scope 2 Electricity	Scope 2 Electricity (off-site fleet charging)	Scope 3 emissions
2019	2844	1404	179	9168	0	9222
2020	2685	1356	179	8279	2	8995
2021	2528	1309	179	0	3	3727
2022	2381	1262	179	0	7	3692
2023	2367	1216	179	0	10	3668
2024	2354	1171	179	0	13	3644
2025	2353	1127	179	0	15	3621
2026	2353	1078	179	0	21	3597
2027	2352	1030	179	0	27	3574
2028	2351	983	179	0	32	3551
2029	2351	936	179	0	37	3529
2030	2350	891	179	0	42	3507
2031	2350	836	179	0	48	3484
2032	2349	782	179	0	60	3461
2033	2348	729	179	0	78	3439
2034	2347	677	179	0	106	3416
2035	2347	627	179	0	133	3395
2036	2346	572	179	0	159	3372
2037	2345	518	179	0	183	3351
2038	2345	465	179	0	207	3329
2039	2344	413	179	0	229	3308
2040	2343	363	179	0	251	3286
Total	**52733**	**19745**	**3937**	**17447**	**1661**	**88167**

Table 22 All carbon emissions for 2030 target (tCO_2e)

Year	Scope 1 Natural Gas	Scope 1 Fleet Vehicles	Scope 1 Refrigerant Leakage	Scope 2 Electricity	Scope 2 Electricity (off-site fleet charging)	Scope 3 emissions
2019	2844	1404	179	9168	0	9222
2020	2832	1356	179	8809	2	9053
2021	2682	1309	179	0	3	3822
2022	2534	1262	179	0	7	3787
2023	2388	1216	179	0	10	3753
2024	2244	1171	179	0	13	3719
2025	2101	1127	179	0	15	3685
2026	2093	1078	179	0	21	3661
2027	2092	1030	179	0	27	3638
2028	2093	983	179	0	32	3615
2029	2094	936	179	0	37	3593
2030	2095	891	179	0	42	3571
2031	2096	836	179	0	48	3548
2032	2097	782	179	0	60	3525
2033	2098	729	179	0	78	3503
2034	2099	677	179	0	106	3481
2035	2100	627	179	0	133	3459
2036	2100	572	179	0	159	3437
2037	2101	518	179	0	183	3415
2038	2102	465	179	0	207	3394
2039	2103	413	179	0	229	3373
2040	2104	363	179	0	251	3352
Total	**49093**	**19745**	**3937**	**17977**	**1661**	**89607**

Table 23 All carbon emissions for 2040 target (tCO_2e)

Year	Scope 1 Natural Gas	Scope 1 Fleet Vehicles	Scope 1 Refrigerant Leakage	Scope 2 Electricity	Scope 2 Electricity (off-site fleet charging)	Scope 3 emissions
2019	2844	1404	179	9168	0	9222
2020	2834	1356	179	8924	2	9063
2021	2686	1309	179	0	3	3823
2022	2539	1262	179	0	7	3788
2023	2394	1216	179	0	10	3753
2024	2251	1171	179	0	13	3719
2025	2110	1127	179	0	15	3686
2026	1970	1078	179	0	21	3652
2027	1972	1030	179	0	27	3629
2028	1973	983	179	0	32	3606
2029	1975	936	179	0	37	3584
2030	1977	891	179	0	42	3562
2031	1979	836	179	0	48	3539
2032	1980	782	179	0	60	3517
2033	1982	729	179	0	78	3494
2034	1983	677	179	0	106	3472
2035	1985	627	179	0	133	3451
2036	1987	572	179	0	159	3429
2037	1988	518	179	0	183	3407
2038	1990	465	179	0	207	3386
2039	1991	413	179	0	229	3364
2040	1993	363	179	0	251	3343
Total	**47382**	**19745**	**3937**	**18092**	**1661**	**89488**

10.2 Percentage of emissions reduction achieved

The following table shows the percentage of all emission reduction initiatives compared against 2018/19 carbon emission levels for Monash City Council. The point at which each target reaches carbon neutrality is highlighted. The BAU case is also compared against Monash City Council's carbon emissions for 2018/19.

Table 24 Percentage of emissions reduction achieved by BAU case, 2025, 2030 and 2040 carbon neutral targets when compared against 2018/19 carbon emission levels

Year	2025 target	2030 target	2040 target	BAU
2019	0%	0%	0%	0%
2020	-6%	-3%	-2%	-1%
2021	-66%	-65%	-65%	-3%
2022	-67%	-66%	-66%	-4%
2023	-67%	-67%	-67%	-6%
2024	-68%	-68%	-68%	-7%
2025	-100%	-69%	-69%	-9%
2026	-100%	-69%	-70%	-10%
2027	-100%	-69%	-70%	-11%
2028	-100%	-70%	-70%	-13%
2029	-100%	-70%	-71%	-14%
2030	-100%	-100%	-71%	-15%
2031	-100%	-100%	-71%	-17%
2032	-100%	-100%	-71%	-18%
2033	-100%	-100%	-72%	-19%
2034	-100%	-100%	-72%	-20%
2035	-100%	-100%	-72%	-21%
2036	-100%	-100%	-72%	-23%
2037	-100%	-100%	-72%	-24%
2038	-100%	-100%	-73%	-25%
2039	-100%	-100%	-73%	-26%
2040	-100%	-100%	-100%	-27%

10.3 Fleet electrification by 2035 (Current Council initiative) vs 2040 (Moderate alternative)

All financial models for the 2025, 2030 and 2040 carbon neutral targets were produced to simulate Council achieving complete electrification by 2035 as per their current fleet electrification initiative. It was noticed that Council is required to purchase EVs at a high rate to achieve fleet electrification by 2035. An alternative scenario for Council to achieve fleet electrification by 2040 may also be proposed with a slower rate of EV uptake as it would be less capital intensive for Council. This more 'moderate' alternative has been examined and presented for Council's consideration.

Currently, Monash Council has 156 light vehicle class cars, and Council replaces their entire fleet approximately every seven years. As such, since Council replaces 23 vehicles on average each year, it has been recommended that Council replaces 22 vehicles with hybrids and one vehicle with an EV for the first several years, and the number of EVs acquired each year will rapidly increase as EV prices decline after 2026. This roll-out schedule will enable Council to completely electrify their light fleet by 2035, as per Council's current initiative. The following figure shows the composition of Council's light fleet for the current 2035 fleet electrification target.

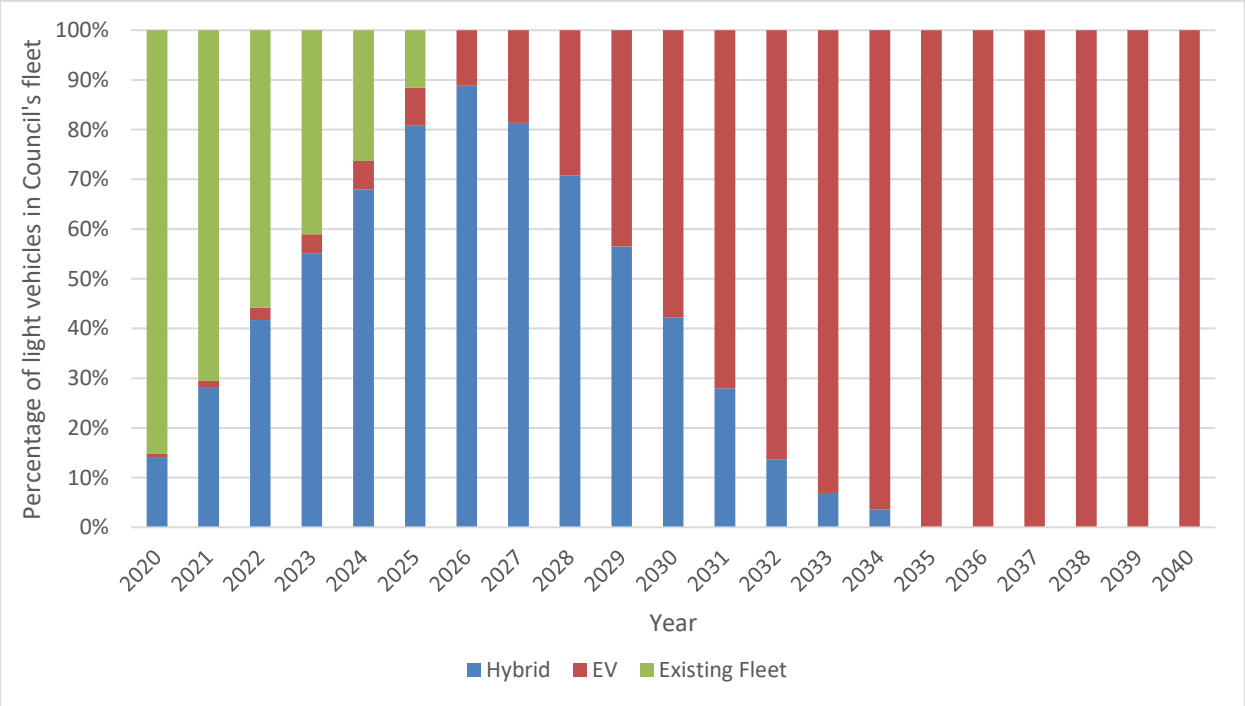

Figure 22 Composition of Council's light fleet for the current 2035 fleet electrification target

An alternative moderate scenario to the above would be to complete light fleet electrification by 2040. This scenario assumes a slower uptake of EVs throughout the next decade and is less sensitive to unexpected adverse market conditions as it requires less capital investment over the next ten years. Council's adoption rate of EVs ultimately depends on several external factors, including market availability, infrastructure and legislation changes. The following figure shows the composition of Council's light fleet for the proposed 2040 moderate fleet electrification target.

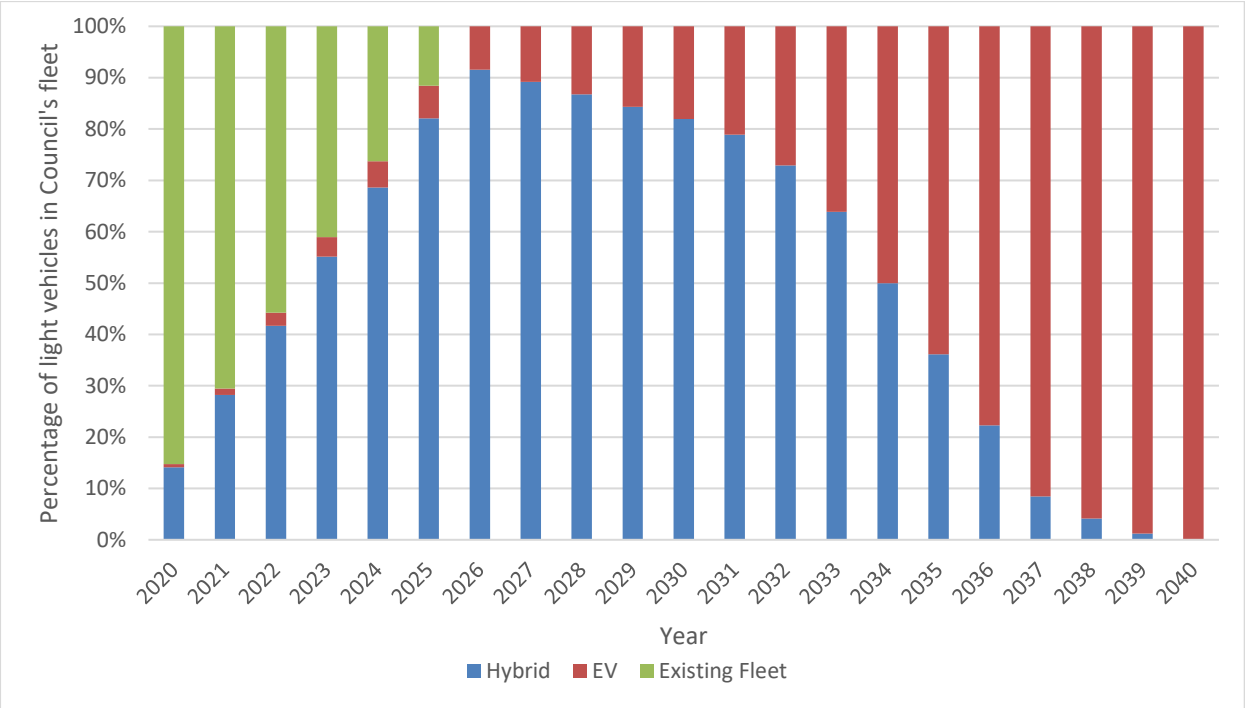

Figure 23 Composition of Council's light fleet for the proposed 2040 moderate fleet electrification target

The financial simulations of both the current scenario and moderate scenario are compared in the following table.

Table 25 Financial Outcomes for fleet electrification by 2035 (Current Council initiative) and fleet electrification by 2040 (Moderate alternative)

Reference	Initiative	Fleet electrification by 2035 (Current Council initiative)			Fleet electrification by 2040 (Moderate alternative)		
		Simple Payback Period (yrs)	Net Present Value ($)	Internal Rate of Return (%)	Simple Payback Period (yrs)	Net Present Value ($)	Internal Rate of Return (%)
5.2.1	Fleet electrification	9.5	$812,381	14%	3.9	$1,514,645.23	27%

The cumulative capital cost, cumulative cost savings and net cumulative cash flow for the current scenario (2035 fleet electrification target) and moderate scenario (2040 fleet electrification target) is tabulated below.

Table 26 Cumulative cash flow figures for both 2035 and 2040 fleet electrification scenarios

Fleet Electrification Target Year	Year	Cumulative Capital cost ($)	Cumulative Cost savings ($)	Net Cumulative Cash Flow ($)
2035	2025	$808,873	$626,194	$44,302
	2030	$2,607,904	$1,801,910	$414,768
	2035	$3,261,249	$3,513,640	$783,810
	2040	$3,308,213	$5,747,251	$3,085,953
2040	2025	$748,997	$624,698	$102,682
	2030	$1,238,518	$1,740,640	$893,348
	2035	$1,566,831	$3,121,106	$2,085,695
	2040	$1,613,795	$4,995,961	$4,029,081

The carbon offsets required for all carbon neutral targets for the current scenario (2035 fleet electrification target) and moderate scenario (2040 fleet electrification target) is tabulated below. The difference in cost savings is also provided below to show the amount that the moderate scenario (2040 fleet electrification target) may save Council.

Table 27 Cumulative offsets figures for both 2035 and 2040 fleet electrification scenarios

Target year	Year	Cumulative offset costs for 2035 fleet electrification model	Cumulative offset costs for 2040 fleet electrification model	Cost savings from 2040 model
2025	2025	$35,880.19	$35,836.42	$43.78
	2030	$205,364.67	$202,332.95	$3,031.72
	2035	$360,561.81	$348,588.14	$11,973.66
	2040	$499,302.64	$478,740.69	$20,561.96
2030	2025	$0.00	$0.00	$0.00
	2030	$32,893.69	$31,647.19	$1,246.50
	2035	$188,090.83	$177,902.39	$10,188.45
	2040	$326,831.67	$308,054.93	$18,776.74
2040	2025	$0.00	$0.00	$0.00
	2030	$0.00	$0.00	$0.00
	2035	$0.00	$0.00	$0.00
	2040	$26,387.85	$24,738.89	$1,648.97

It should be noted that though financial analyses for both scenarios are independent of a carbon neutral target year. However, the amount and cost for carbon offsets for each scenario are highly dependent on the target year chosen.

10.4 Emissions reduction models excluding LG PPA

The LG PPA beginning for Monash City Council in 2021 eliminates all emissions from electricity consumption, as shown in this report. Furthermore, all financial results shown in the report include all these initiatives in combination with one another. However, emissions reduction achieved initiatives such as Energy monitoring solutions, Major roads LED upgrade, EPC, Fleet electrification, Small scale solar, Energy efficiency initiatives, Residential LED streetlighting upgrade are not graphically represented as they all cause a reduction in electricity.

Since this is the case, there is a need to highlight the emissions reduction caused by all initiatives excluding the LG PPA in the event that it is not adopted by Council for any reason. The following section shows emissions reduction achieved by all initiatives excluding the LG PPA for the 2025, 2030 and2040 carbon neutral models.

10.4.1 2025 model excluding LG PPA

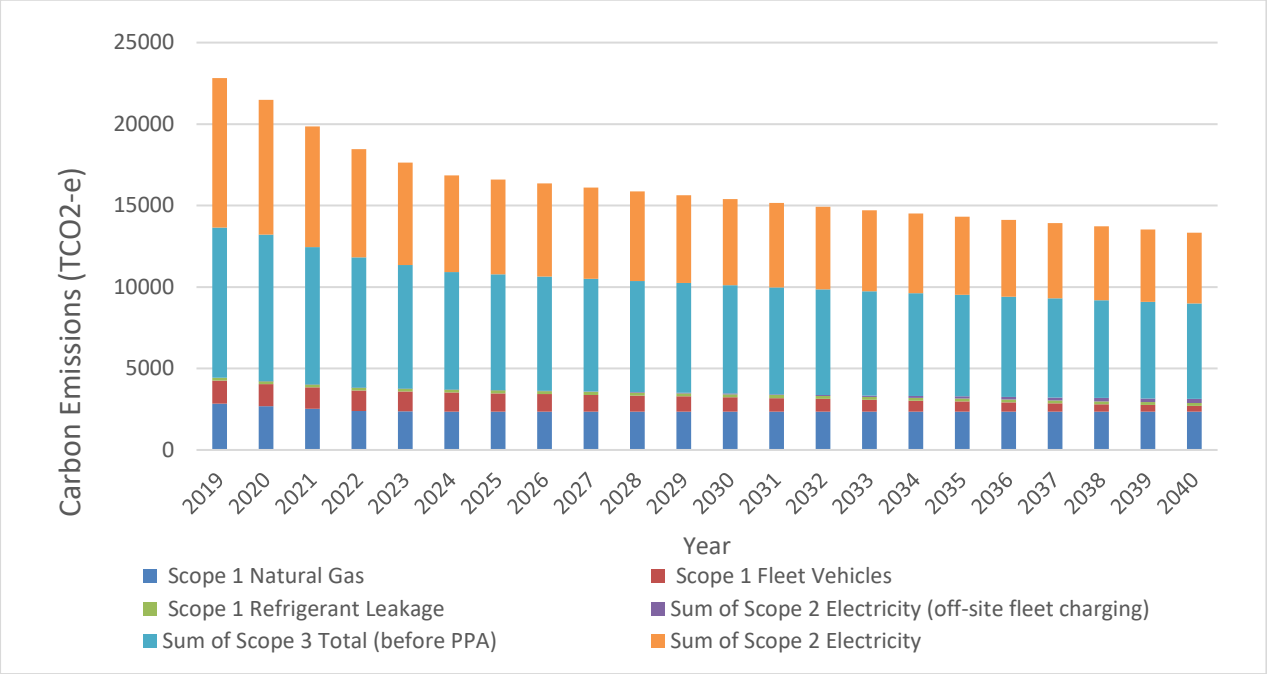

Figure 24 Monash City Council's projected carbon emissions for 2025 carbon neutrality target modelled to 2040 (excluding LG PPA)

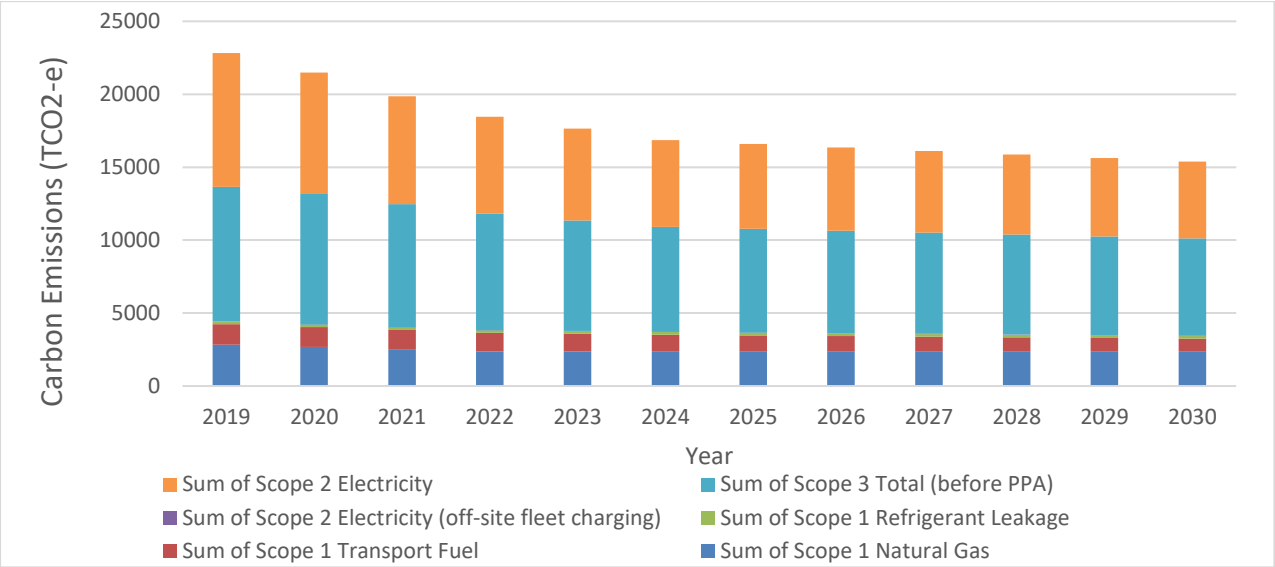

Figure 25 Monash City Council's projected carbon emissions for 2025 carbon neutrality target modelled to 2030 (excluding LG PPA)

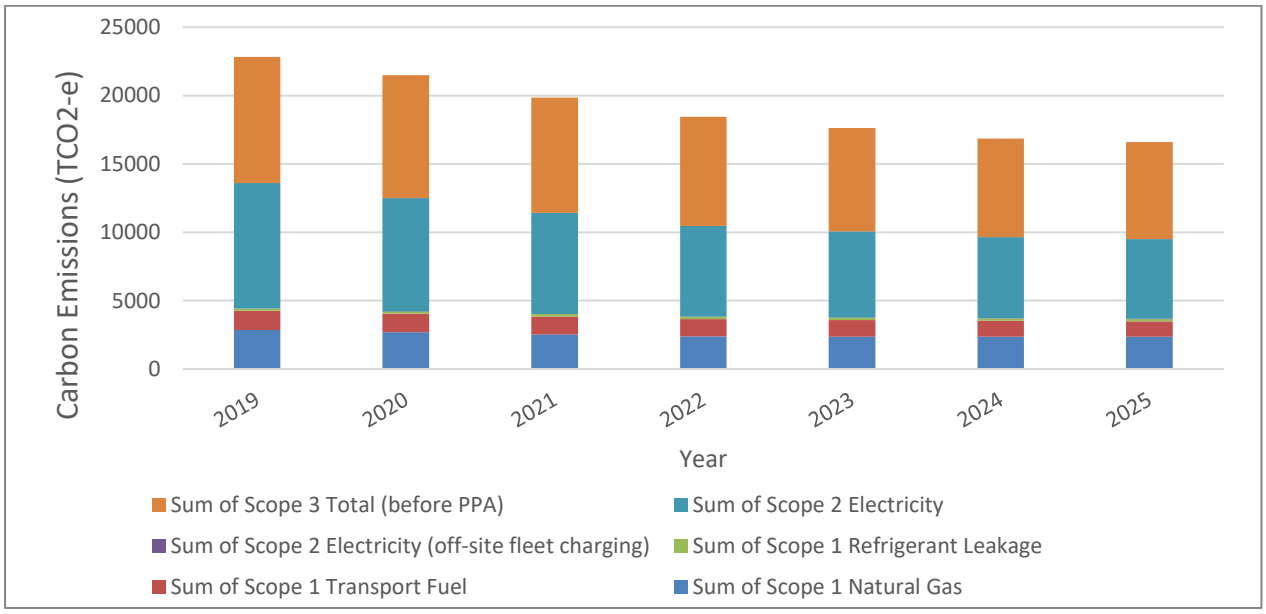

Figure 26 Monash City Council's projected carbon emissions for 2025 carbon neutrality target modelled to 2025 (excluding LG PPA)

10.4.2 2030 model excluding LG PPA

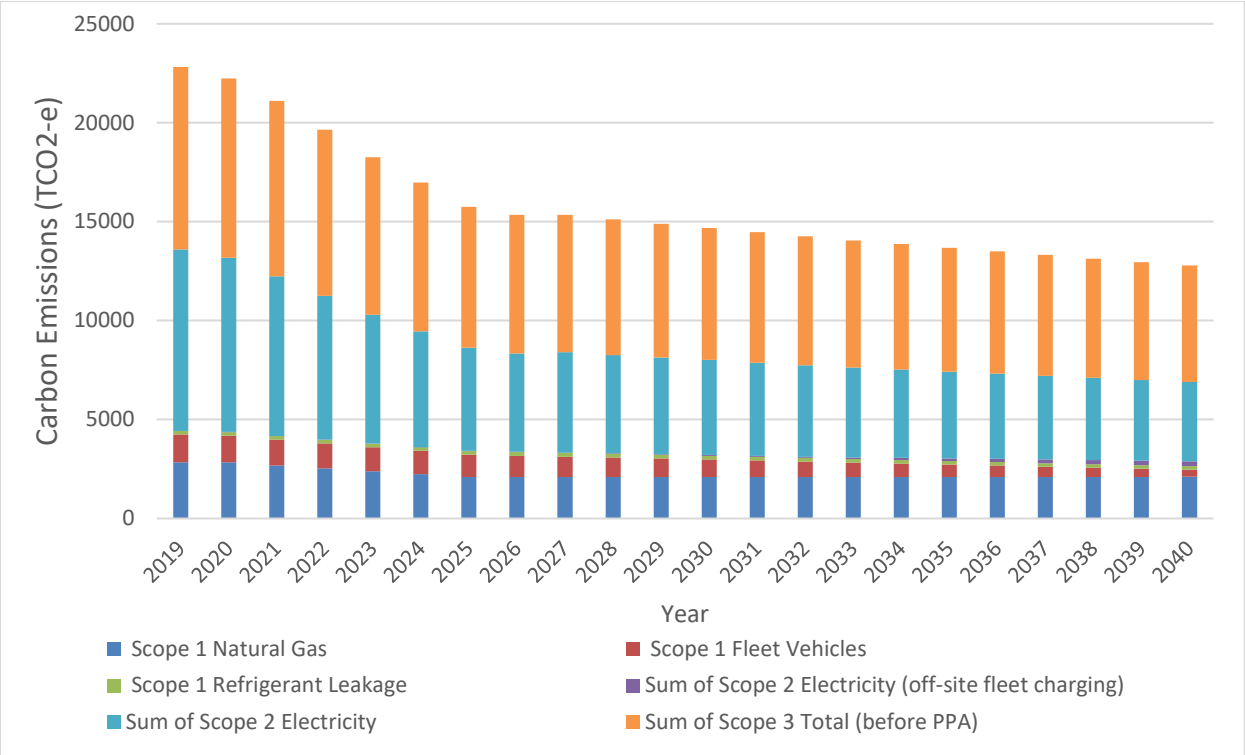

Figure 27 Monash City Council's projected carbon emissions for 2030 carbon neutrality target modelled to 2040 (excluding LG PPA)

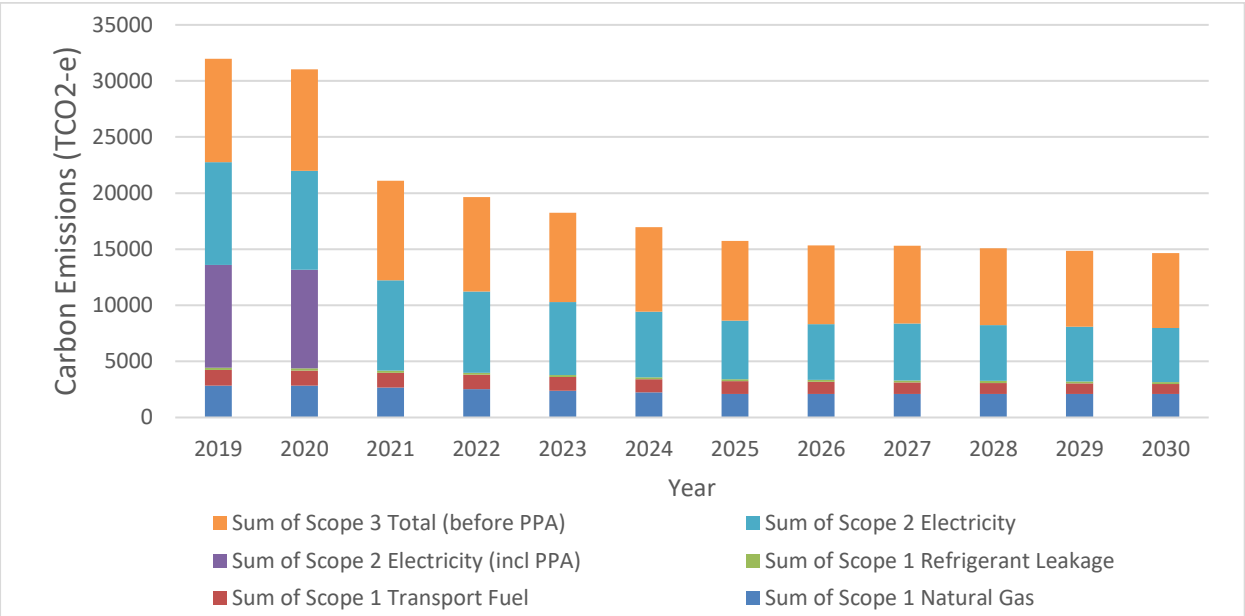

Figure 28 Monash City Council's projected carbon emissions for 2030 carbon neutrality target modelled to 2030 (excluding LG PPA)

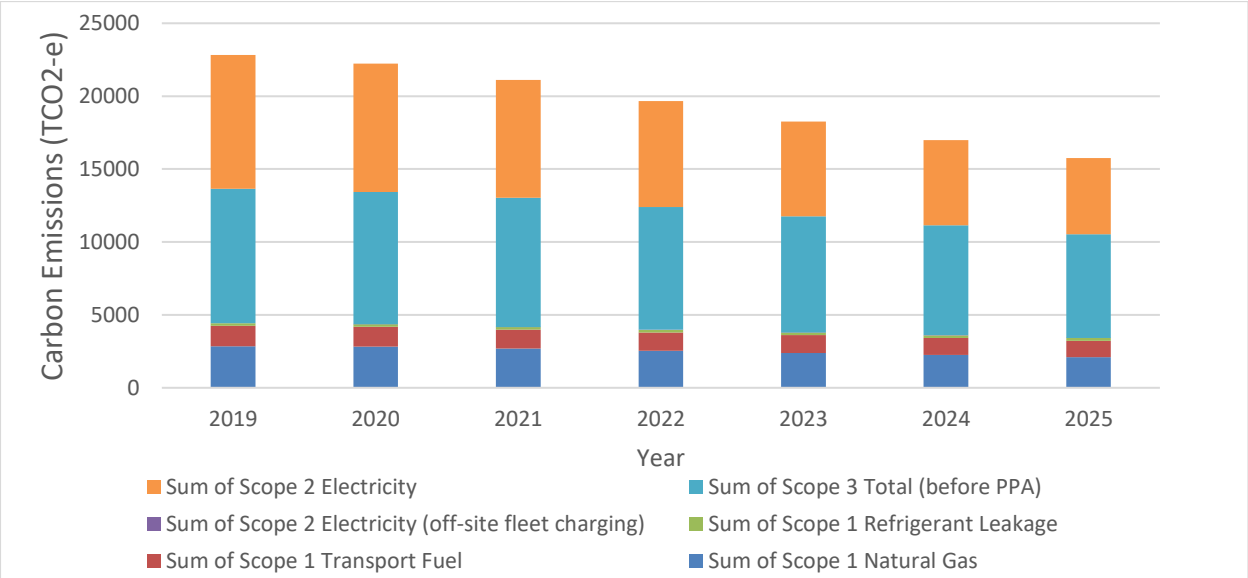

Figure 29 Monash City Council's projected carbon emissions for 2030 carbon neutrality target modelled to 2025 (excluding LG PPA)

10.4.3 2040 model excluding LG PPA

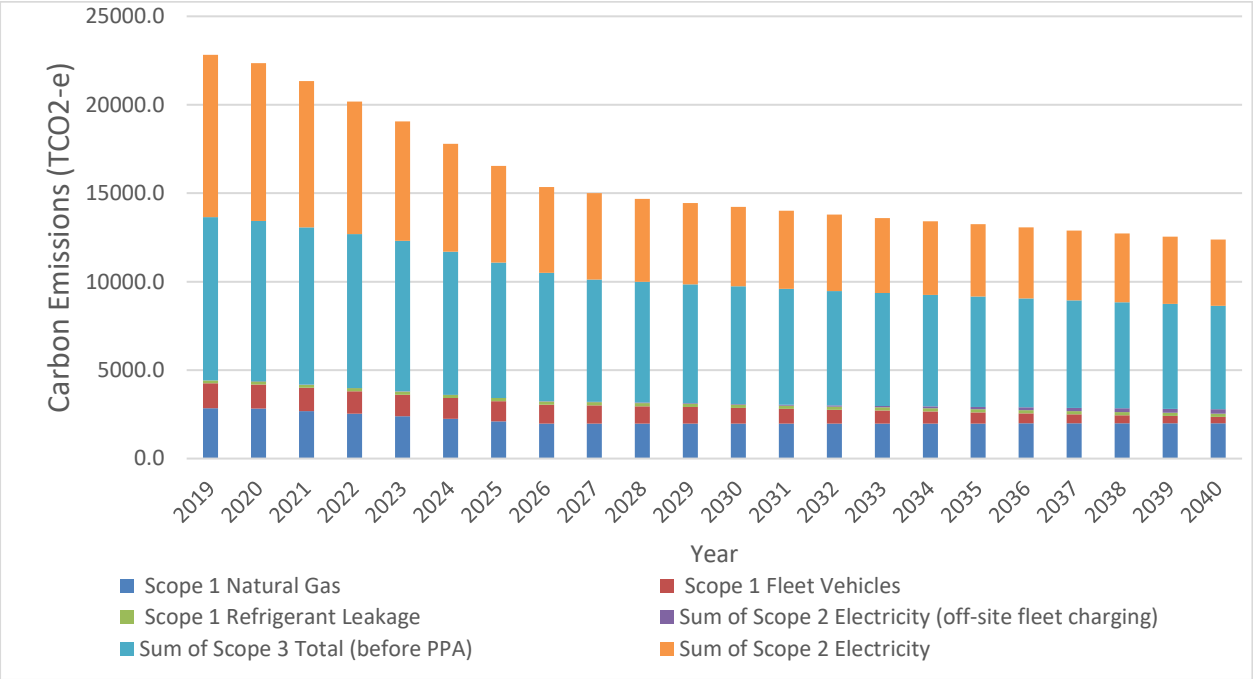

Figure 30 Monash City Council's projected carbon emissions for 2040 carbon neutrality target modelled to 2040 (excluding LG PPA)

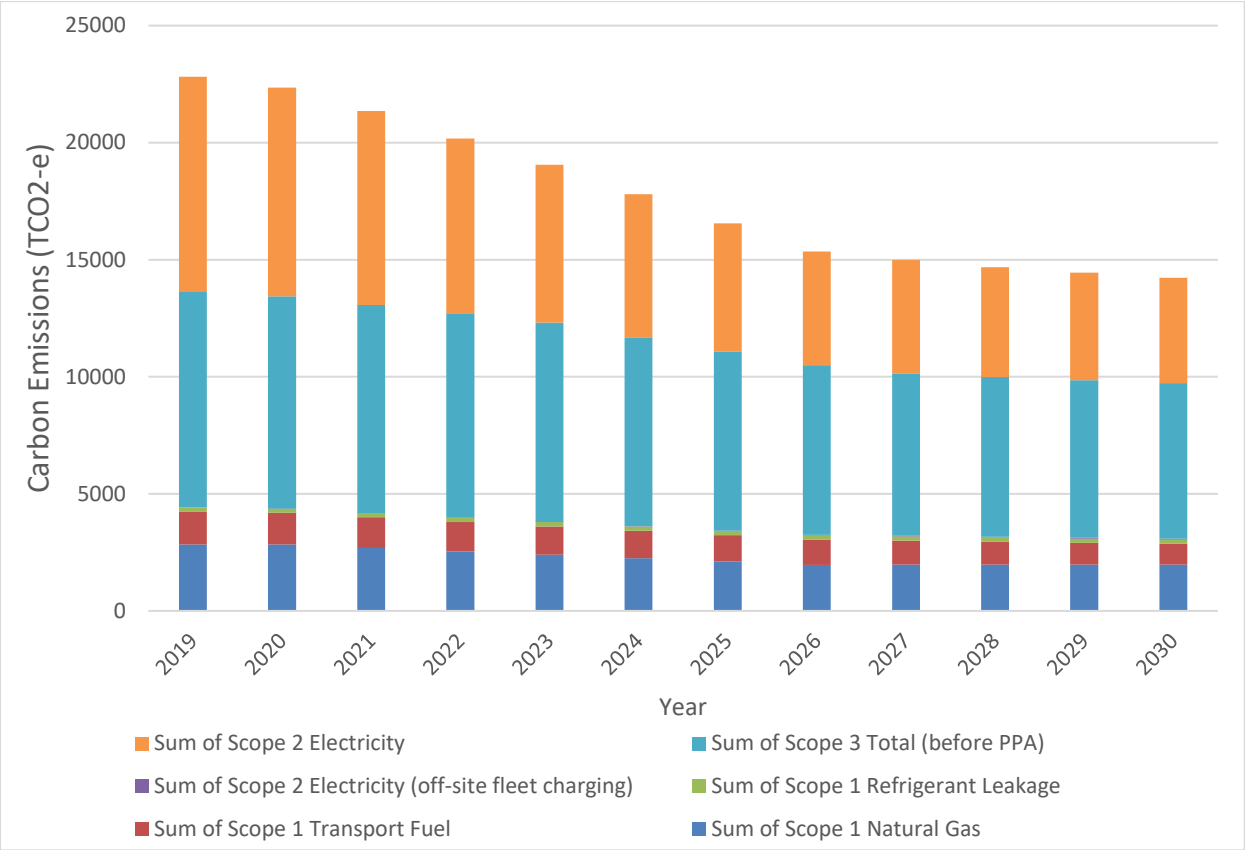

Figure 31 Monash City Council's projected carbon emissions for 2040 carbon neutrality target modelled to 2030 (excluding LG PPA)

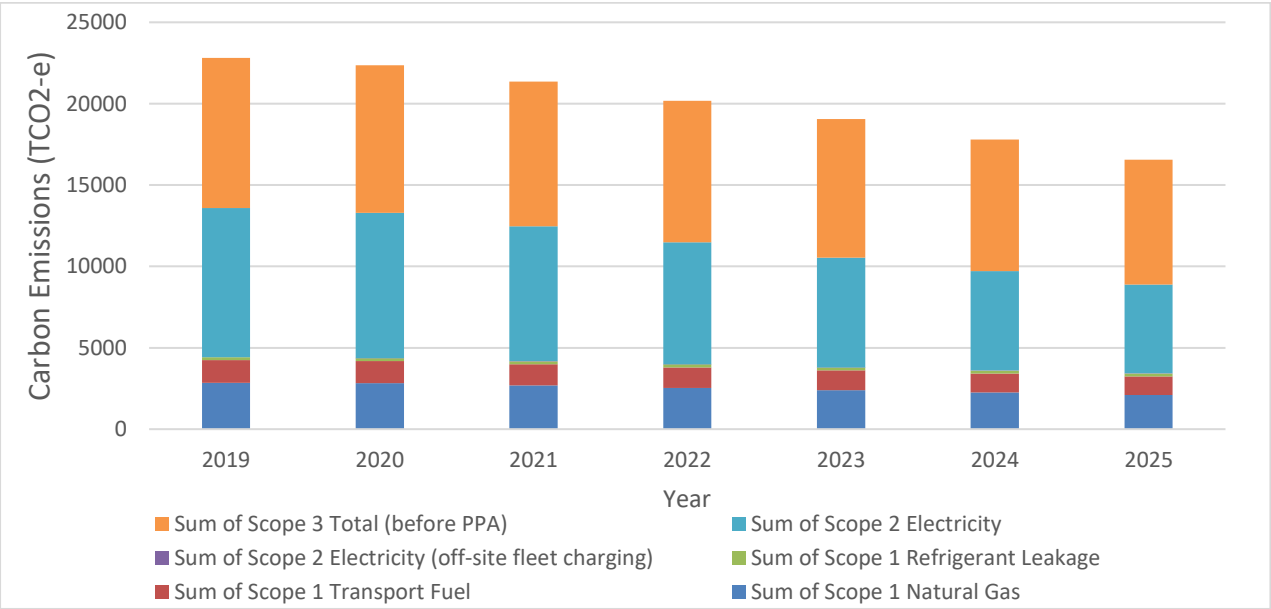

Figure 32 Monash City Council's projected carbon emissions for 2040 carbon neutrality target modelled to 2025 (excluding LG PPA)

10.4.4 Percentage emissions reduction achieved excluding LG PPA

The percentage of emission reductions achieved by each carbon neutral target (excluding LG PPA) and BAU case compared against 2018/19 emissions levels are shown graphically and tabulated below.

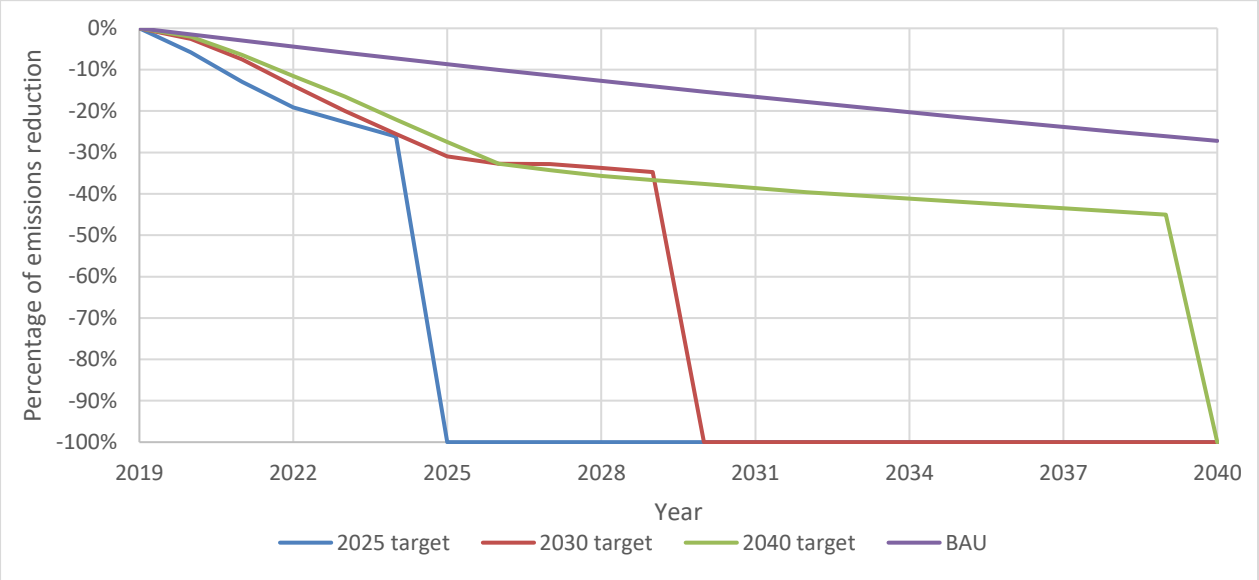

Figure 33 Percentage of emissions reduction achieved through 2025, 2030 and 2040 carbon neutral models (excluding LG PPA) compared to BAU emissions

Table 28 Percentage of emissions reduction achieved by BAU case, 2025, 2030 and 2040 carbon neutral targets (excluding LG PPA) when compared against 2018/19 carbon emission levels

Year	2025 target	2030 target	2040 target	BAU
2019	0%	0%	0%	0%
2020	-6%	-3%	-2%	-1%
2021	-13%	-8%	-6%	-3%
2022	-19%	-14%	-12%	-4%
2023	-23%	-20%	-16%	-6%
2024	-26%	-26%	-22%	-7%
2025	-100%	-31%	-27%	-9%
2026	-100%	-33%	-33%	-10%
2027	-100%	-33%	-34%	-11%
2028	-100%	-34%	-36%	-13%
2029	-100%	-35%	-37%	-14%
2030	-100%	-100%	-38%	-15%
2031	-100%	-100%	-39%	-17%
2032	-100%	-100%	-40%	-18%
2033	-100%	-100%	-40%	-19%
2034	-100%	-100%	-41%	-20%
2035	-100%	-100%	-42%	-21%
2036	-100%	-100%	-43%	-23%
2037	-100%	-100%	-43%	-24%
2038	-100%	-100%	-44%	-25%
2039	-100%	-100%	-45%	-26%
2040	-100%	-100%	-100%	-27%

10.5 Carbon offset cost trend

Total costs for carbon offsets will correlate with Council's emissions. Therefore, the cost for carbon offsets will be highest at the carbon neutral target year and should gradually decrease as more energy efficiency initiatives are realised. Hence, the cost of carbon offsets to Council should be in proportion to Council's carbon emissions (decreasing over time). The annual cost and trend for each carbon neutral trajectory is shown graphically below.

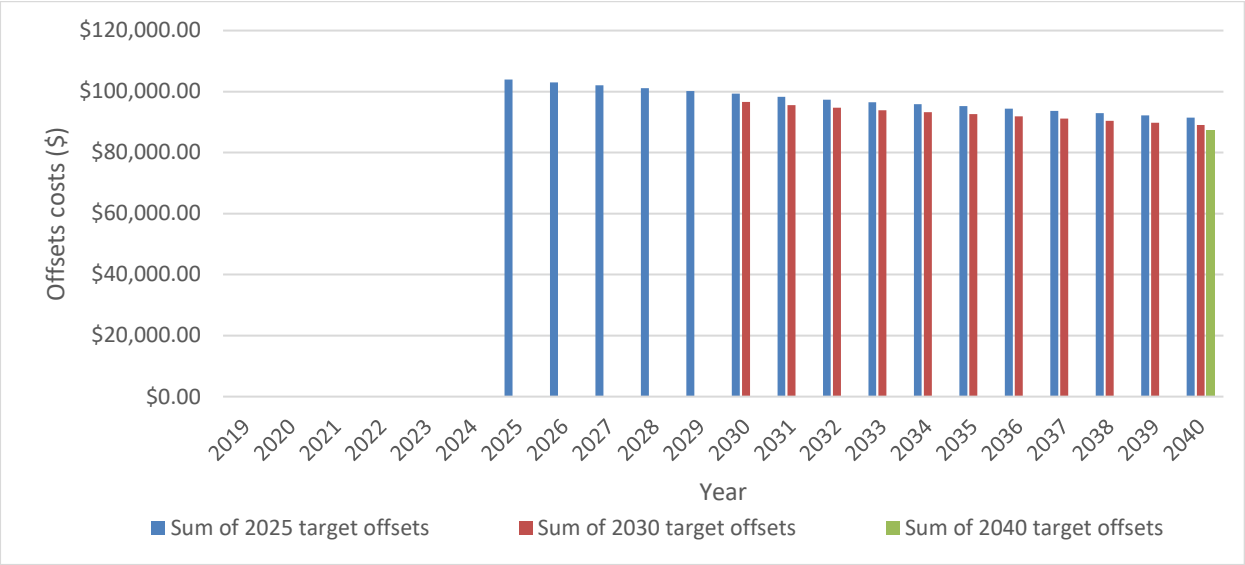

Figure 34 Annual carbon offset costs for 2025, 2030 and 2040 carbon neutral targets

10.6 Implementation strategies

Monash City Council requires an implementation plan to guide delivery on objectives. The following section suggests an implementation strategy for each quantified emissions reduction initiative.

10.6.1 LG PPA

Ensure that all Council sites and electricity accounts are covered by the LG PPA agreement. Council should undertake audits regularly to ensure new electricity accounts are correctly setup within the LG PPA agreement.

10.6.2 Energy Monitoring Solutions

Utilise building benchmark tools to develop a Sustainable Building Policy. Develop a Building Energy Management Plan to facilitate adoption of Sustainable Building Policy and enable facility managers to undertake ongoing monitoring of energy consumption at Council facilities.

10.6.3 LED Major Road Lighting Replacement

Coordinate with EAGA to identify upgrade opportunities. Ensure all new installations and infrastructures are LEDs. Upgrade existing major road lighting if budget allows.

10.6.4 EPC

Detailed facility study completed in 2019. Work to commence on four major sites, and savings quantified two years after implementation. Ensure measurement and verification processes and procedure are in place. If contract extends, coordinate with Facility Managers to identify extra sites for detailed facility study and develop business case.

10.6.5 Fleet electrification

Replace light fleet with hybrids and gradually introduce EVs in current fleet replacement cycle (until 2026). Install at least 1 charging station per EV. Accelerate electrification as EV prices decrease rapidly post-2026.

10.6.6 Fleet Optimisation

Introduce driver training (Eco Driver Program) to improve fuel economy. Install GPS tracking for route optimisation. Implement fleet booking system with detailed utilisation data to increase staff car-pooling. Develop specifications to transition diesel heavy/specialised fleet to Euro 6 emissions standards.

10.6.7 Paperless office & Carbon Neutral Paper

Purchase additional staff laptops and digital devices to complete transition remaining staff. Establish cloud-based storage to improve document access. Develop procurement and contractor policies for publishing on 100% carbon neutral paper. Develop staff training to raise awareness.

10.6.8 Small scale solar

Develop business case for initial 9 sites. Perform energy audits to identify potential sites and coordinate with EAGA to expand program. Systematically assess performance of solar systems over 5 or 7-year periods.

10.6.9 Energy Efficiency Initiatives

Coordinate with facility managers to identify high energy consumption sites and engage consultants to perform energy audits to AS/NZS 3958:2014 standards. Develop policy and training to raise staff

awareness about energy efficiency. Ensure measurement and verification processes and procedures are in place to track results achieved.

10.6.10 LED Residential Street Lighting Replacement

Identify large sites for upgrade opportunities ignoring those that are close to end-of-life to take full advantage of United Energy's agreement to replace those lights with LEDs. Ensure all new installations and infrastructures are LEDs. Upgrade existing residential street lighting if budget allows.

10.7 Target year trajectory Gantt chart

Table 29 Gantt chart for 2025 carbon neutral target

5.1.1	LG PPA																							
5.1.2	Energy Monitoring Solutions																							
5.1.3	Major Road LED																							
5.1.4	EPC																							
5.2.1	Fleet Electrification	EVs/ Hybrids and charging stations																						
		Fleet Optimisation																						
5.2.2	Paperless & Carbon Neutral																							
5.2.3	Small scale solar																							
5.2.4	Energy Efficiency Initiatives																							
5.2.5	Residential LED streetlighting																							
Year			2020				2025		2030															2040

Table 30 Gantt chart for 2030 carbon neutral target

5.1.1	LG PPA		
5.1.2	Energy Monitoring Solutions		
5.1.3	Major Road LED		
5.1.4	EPC		
5.2.1	Fleet Electrification	EVs/ Hybrids and charging stations	
		Fleet Optimisation	
5.2.2	Paperless & Carbon Neutral		
5.2.3	Small scale solar		
5.2.4	Energy Efficiency Initiatives		
5.2.5	Residential LED streetlighting		
Year			2020 2025 2030 2040

Table 31 Gantt chart for 2040 carbon neutral target

5.1.1	LG PPA		
5.1.2	Energy Monitoring Solutions		
5.1.3	Major Road LED		
5.1.4	EPC		
5.2.1	Fleet Electrification	EVs/ Hybrids and charging stations	
		Fleet Optimisation	
5.2.2	Paperless & Carbon Neutral		
5.2.3	Small scale solar		
5.2.4	Energy Efficiency Initiatives		
5.2.5	Residential LED streetlighting		
Year			2020 2025 2030 2040

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The success and realisation of the proposed initiatives will be dependent upon the commitment of the design team, the development of the initiatives through the life of the design and also the implementation into Council operations. Without this undertaking the proposed targets may not be achieved.