Muswellbrook Shire Council

ORDINARY COUNCIL MEETING

SUPPLEMENTARY BUSINESS PAPER

1 FEBRUARY 2022

Order of Business

14 NOTICES OF MOTION / RESCISSION

14.2 NET ZERO 2050 ROADMAP

Attachments: **A. Net Zero Roadmap - Council Report 28 Sept 2021⇩**
B. Net Zero Roadmap Technical Report⇩

Responsible Officer: **Fiona Plesman - General Manager**

I, Cr Graeme McNeill, give Notice of Rescission of the following resolution of Council passed on 28 September, 2021 regarding Item No. 10.3 – Net Zero 2020 Roadmap as follows:

10.3 NET ZERO 2050 ROADMAP

89 RESOLVED on the motion of Crs Woodruff and Eades that:

Council:

1. *Adopts the Muswellbrook Shire Council Net Zero Roadmap Strategy in Attachment A for implementation;*
2. *Commits to a 35% reduction in operational greenhouse gas emissions by 2030 from a 2005 baseline and commits to net zero operational greenhouse gas emissions by 2050;*
3. *Requests Council staff to create an action plan over the next 12 months, to be submitted for Council's approval, with a timeline and target dates for completion of projects and annual updates on approved projects to ensure actions and targets are being achieved; and*
4. *Agrees to annual funding of a minimum of $250,000 (with annual CPI increases) to implement actions identified in the Net Zero Roadmap Strategy. Any unspent funds are to be retained in Reserve for allocation in future budgets.*

MOTION

The resolution of Council on 28 September, 2021 regarding Item 10.3 – Net Zero 2020 Roadmap be rescinded to allow the new council to consider the roadmap against budgets & their priorities

Moved: _____ **Seconded:** _____

RESPONSE BY GROUP MANAGER

A copy of the report that was presented to the Council meeting on 28 Sept 2021, as well as the Net Zero Roadmap Strategy, are attached as background information.

10.3 NET ZERO 2050 ROADMAP

Attachments: **A. Net Zero Roadmap Technical Report**

Responsible Officer: **Derek Finnigan - Deputy General Manager**

Author: **Tracy Ward - Sustainability Officer**
Sharon Pope - Executive Manager - Environment and Planning

PURPOSE

The NSW government released the Net Zero Plan Stage One: 2020-2030 plan in March 2020 as part of its Net Zero Strategy. The NSW government has committed to a 35% reduction in the state's greenhouse gas (GHG) emissions by 2030 from a 2005 baseline and has committed to net zero emissions for NSW by 2050.

Currently there is no mandate that councils must take action to help achieve the NSW Government commitment. However, staff have observed new legislation and regulations being introduced that do implement the target in various ways, such as the future waste management requirements, and initiatives such as reductions in stamp duty on purchase of electric vehicles. A mandate is expected to follow in the near future, particularly as a consequence of the Intergovernmental Panel on Climate Change 'Climate Change 2021' report.

Council staff have been participating in a Net Zero Pilot project being run by the Department of Planning, Industry and Environment. The outcome has been a roadmap for Council's operations transitioning towards net zero emissions by 2050.

OFFICER'S RECOMMENDATION

Council:

1. **Adopts the Muswellbrook Shire Council Net Zero Roadmap Strategy in Attachment A for implementation;**
2. **Commits to a 35% reduction in operational greenhouse gas emissions by 2030 from a 2005 baseline and commits to net zero operational greenhouse gas emissions by 2050;**
3. **Requests Council staff to create an action plan over the next 12 months, to be submitted for Council's approval, with a timeline and target dates for completion of projects and annual updates on approved projects to ensure actions and targets are being achieved; and**
4. **Agrees to annual funding of a minimum of $250,000 (with annual CPI increases) to implement actions identified in the Net Zero Roadmap Strategy. Any unspent funds are to be retained in Reserve for allocation in future budgets.**

Moved: _____ **Seconded:** _____

BACKGROUND

Council was invited to participate in the Net Zero Pilot Program being run by the Department of Planning, Industry and Environment. The program assisted Council to compile necessary data and identify challenges to meeting a Net Zero Emissions target by 2050.

Whilst Council does not currently have a net zero emissions commitment, Council adopted a Greenhouse Reduction Strategy on 10 February 2003. Several of the actions have been completed or are part of current business as usual operations, but many have also not been actioned.

Council staff have collaborated with thirty organisations in a pilot project to develop a net zero emissions roadmap. The roadmap was developed on the basis that Council would be interested in setting

greenhouse gas reduction targets in line with the NSW Government commitments of 35% below 2005 baseline levels by 2030 and net zero by 2050.

Emissions are divided into three scopes:

- Scope 1 emissions are direct emissions which, for Muswellbrook Shire Council includes emissions from the waste facility and fuel combustion from fleet vehicles.
- Scope 2 emissions are indirect emissions from electricity purchased and used by Council.
- Scope 3 emissions are all other indirect emissions, and include the emissions created by other organisations that Council uses or purchases products from, and includes transport for waste services, and electricity used at the recycling plant where the Shire's recycling is sorted.

The roadmap focuses on the two scopes within Council's control, Scope 1 and Scope 2, although Council does have the ability to make purchasing decisions that preference companies who demonstrate lower emissions in the production or transport process or incorporate reused/recycled materials in their products.

CONSULTATION

Jonathan Wood – Sustainability Advantage.

James Wilkinson and James Moore – Jacob's Consulting

Senior Coordinator Waste Operations

Operations Manager Water and Wastewater

Manager Roads, Drainage and Technical Services

Senior Works Coordinator

MANEX

CONSULTATION WITH COUNCILLOR SPOKESPERSON

A copy of the report has been forwarded to the Mayor Councillor Scholes, the Deputy Mayor, Councillor Ledlin, and the Councillor Spokesperson for Infrastructure, Councillor Woodruff, for review.

REPORT

A key component of developing a roadmap to net zero emissions is understanding what an organisation's business as usual (BAU) operations emissions footprint is (that is, without the implementation of a net zero roadmap), and how this is expected to change over time. The graph below shows Council's BAU projections, the Net Zero commitment and the likely outcome of the Muswellbrook Net Zero Roadmap Strategy provided in Attachment A.

Figure 1. Emission outcomes from BAU and the net zero emissions roadmap.

Based on the adoption of each of the presented opportunities (with the exception of energy from waste), there is a considerable reduction in emissions achieved, however there are some residual emissions present. This requires both an ongoing refinement of mitigation strategies over time and offsetting to achieve the 2050 target of net zero.

Council had been making inroads towards a net zero emissions target before the NSW State Government announced this program, with a 40% Renewable Energy Target set in 2015/16.

The three main areas Council will need to act on in order to effectively reduce emissions are:

1. waste management and electricity use (100% renewables required);
2. fuel consumption; and
3. procurement.

Waste reduction is necessary because waste emissions continue long past the day an item is added to landfill. This is due to the methane generated by the breakdown of organic material in the void. Methane is 21 times as harmful to the atmosphere as carbon dioxide and limiting its production is vital to reducing emissions. Many processes can be implemented to convert methane to carbon dioxide including composting and methane capture. Removing putrescibles from the waste stream through a Food Organics and Garden Organics collection service will reduce future methane emissions.

As Council doesn't adequately record methane gas generated at the waste management facility, it is difficult to determine if this would be cost effective at this time, however the NSW government has indicated it may be required as part of approval of new or expanded operations in the future.

With or without flaring, the waste facility is likely to require some type of offset strategy. The quantum would change based on the absence/presence of flaring.

Fleet vehicles contribute substantially to Council's emissions, and Council should begin preparing for the electrification of some of its fleet vehicles.

Next Steps

The implementation of the roadmap strategy will require ongoing management. The actions for implementation over the short, medium and long term are presented below.

1–3 years

1. Begin collecting more detailed data for missing emissions sources to develop inventory:
   (i) Require procurement teams to keep records of materials (concrete, steel, asphalt, aggregates, etc), water treatment chemicals, and similar, in physical units (e.g. tonnes or m3);
   (ii) Require construction teams to report on land clearing and land use changes as part of projects;
   (iii) Integrate requirement for regular reporting of fuel, electricity and materials internally, and also require this information to be reported in external contracts; and
   (iv) Heating, ventilation and air-conditioning (HVAC) servicing contractors to provide records of refrigerant top-ups in kg of refrigerant.
2. Refine resourcing plan for waste management to address priority actions, including:
   (i) Undertake waste auditing to improve waste composition records for landfill;
   (ii) Develop Council response plan to address actions within the National Waste Policy Action Plan 2019, NSW Waste and NSW Sustainable Materials Strategy 2041 and other relevant strategies;
   (iii) Identify funding and/or grant opportunities as part of National and State strategies for waste reduction, diversion or similar;
   (iv) Investigate opportunities for improved food organics garden organics (FOGO) diversion rates and expansion to commercial FOGO collection;
   (v) Audit landfill gas monitoring results and investigate areas for improvement;
   (vi) Investigate landfill gas capture opportunities and source funding for feasibility studies and detailed costings; and
   (vii) Potential initiation of a Council Waste Management Strategy to address above priorities.
3. Arrange high level energy audits to identify further retrofit opportunities for key buildings, including Muswellbrook Marketplace, Tertiary Education Centre (TEC) Annexe, Bridge St Library, and Council Administration Centre.
4. Integrate improved energy efficiency requirements into the design for new Council buildings, including the Entertainment Centre and Bridge St mixed use development.
5. Investigate opportunities for biofuel (B5) procurement and storage at Council depot and transition all petrol and diesel to be replaced with E10 and B5 for Council works where compatible (and integrate requirement into construction contracts for third parties).
6. Undertake FY2020 and FY2021 updates of emissions inventory using provided tool and National Greenhouse and Energy Reporting (NGER) Calculator.

3-6 years

1. Ongoing updates of emissions inventory, including additional detailed emissions source information.
2. Prepare detailed costings of emissions reduction strategies and integrate into Council budget forecasts to identify opportunities for National and/or State funding and grant opportunities.
3. Integrate emissions reduction Key Performance Indicators (KPIs) into construction contracts and identify emissions reduction opportunities for construction works.
4. Review opportunities for further construction works emissions reduction in collaboration with contractors, including opportunities for the use of sustainability rating systems (for example, Infrastructure Sustainability Council of Australia for infrastructure and Green Star for buildings).

5. Implementation of waste reduction programs and domestic and commercial FOGO systems.

6. Undertake design and implementation of energy efficiency retrofit opportunities.

7. Undertake detailed design, tendering and construction for landfill gas capture and generation system.

8. Investigate opportunities for increased renewable energy uptake (distributed, large scale and/or Power Purchase Agreements as appropriate).

9. Produce a Green Fleet Strategy to identify detailed opportunities and requirements for transition of Council's plant and equipment fleet to electric (and potentially hydrogen) as appropriate.

2030 and beyond

1. Finalise procurement and/or lease agreements for remaining fleet electrification.

2. Continued collaboration with construction contractors to identify opportunities for further emissions reductions.

3. Review progress against emissions reduction targets (50% below 2019 levels by 2030) and refine strategy for further mitigation as required.

4. Begin investigating offset opportunities and consider development of an offset strategy where mitigations are unable to stay on track with targets.

5. Review ambition for net zero targets (potential to bring forward) and or potential for third-party certifications such as 'Carbon Neutral' under the Climate Active Standard.

OPTIONS

Council may:

Option 1

Commit to a 35% reduction in operational greenhouse gas (GHG) emissions by 2030 from a 2005 baseline and commit to net zero emissions operational greenhouse gas by 2050, adopt and commence implementation of the Muswellbrook Shire Council Net Zero Roadmap Strategy; The preferred pathway for achieving net zero emissions should follow an emissions reduction hierarchy which prioritises mitigation before compensation. A number of opportunities are available for emissions reduction through to 2050. These are expected to have different financial impacts and costs of abatement.

Option 2

Not adopt an emissions reduction target or a strategy for emissions reduction. Council will only act when legislation or regulations require action. This is expected to be a more expensive approach in the long-run as when action is required it will be in relatively short time-frames, with potential significant impacts to the annual budget, where Council will be operating in essentially a 'sellers' market. Offsets will become more expensive/difficult to procure over time.

CONCLUSION

The Net Zero Road Map Strategy gives Council a plan to follow to achieve Net Zero. The actions in this plan are achievable and, with some offsetting, Council should be able to reach the 2050 target.

SOCIAL IMPLICATIONS

Committing to a Net Zero plan communicates to the community that Council cares about the impacts of climate change and will take action to mitigate this change. As an area that has experienced weather extremes, Council committing to climate change resilience through future projects that will assist in mitigating some of these extremes demonstrates commitment to the community's wellbeing now and into

the future.

FINANCIAL IMPLICATIONS

There will be costs associated with implementing this plan but a lot of these costs come with long term savings, such as savings in fuel costs from electrifying the fleet to reducing energy costs by retrofitting existing buildings with energy efficient devices, installing solar panels and building 5 star energy efficient buildings when constructing new facilities.

Financial implications have not been calculated at this stage. Some actions can be delivered with current resources. Over time, it is expected that achieving Net Zero by 2050, or earlier, will be mandated by State and/or Federal Government.

The main message being conveyed is that the longer an organisation takes to commence moving on a net zero transition, the more expensive and logistically intensive it becomes to implement and achieve Council's objectives within the designated timeframes.

To enable the initial actions to commence it is recommended that Council set aside a minimum of $250,000 in each budget (adjusted annually by CPI). Any funds not spent in a given year are to be held in Reserve to accumulate toward future years' projects.

Given the intergenerational benefits of transitioning to Net Zero it may be appropriate to borrow funds for specific approved projects.

POLICY IMPLICATIONS

A Commitment to a 35% reduction in operational greenhouse gas (GHG) emissions by 2030 from a 2005 baseline and commitment to net zero emissions operational greenhouse gas by 2050 would become a Council Policy that will need consideration in the operational decisions of Council staff.

STATUTORY IMPLICATIONS

There are currently no known statutory implications.

LEGAL IMPLICATIONS

Nil known.

OPERATIONAL PLAN IMPLICATIONS

The Operational Plan 2021/2022 includes preparing pathways for Net Zero by 2050 and Climate Change resilience as one of its key deliveries in Environmental Sustainability. Future Operational Plans are likely to include specific actions to implement the roadmap.

RISK MANAGEMENT IMPLICATIONS

Climate change resulting from global warming is a considerable risk to organisations and communities. Adopting a net zero target and commencing actions to achieve this transition enables Council to do what is practicably possible in order to mitigate the risk.

WASTE MANAGEMENT IMPLICATIONS

The Net Zero strategy has substantial implications on waste management and encourages the implementation of further waste reduction strategies, including education and implementing FOGO.

COMMUNITY CONSULTATION/MEDIA IMPLICATIONS

The community will be consulted prior to implementation of aspects of the roadmap where there is a direct impact on the community and not just impacts on Council's operations.

Jacobs

Net Zero Roadmap

Roadmap Technical Report

IA210700-MSC-REP-0001 | 3

15 July 2021

Muswellbrook Shire Council

NSW GOVERNMENT

In collaboration with

SUSTAINABILITY ADVANTAGE

Net Zero Roadmap

Project No: IA210700
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Document No.: IA210700-MSC-REP-0001
Revision: 3
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Client Name: Muswellbrook Shire Council

Project Manager: James Moore
Author: James Wilkinson
File Name: IA210700-MSC-REP-0001 - Muswellbrook NZ Roadmap Technical Report

Jacobs Group (Australia) Pty Limited
ABN 37 001 024 095
Level 4/12 Stewart Ave,
Newcastle West
NSW 2302
02 4979 2600
02 4979 2666
www.jacobs.com

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
0.1	04/03/21	Draft for review and approval	JW	JM	JM	JM
1	25/05/21	Update for baseline results and opportunities	JW	JM	JM	JM
2	28/06/21	Final roadmap update for review	JW	JM	JM	JM
3	15/07/21	Update following revised landfill closure plan	JW	JM	JM	JM

Contents

Executive Summary

The Net Zero Pilot Project is an initiative of the Sustainability Advantage Program of the Department of Planning, Industry & Environment. Muswellbrook Shire Council (MSC) is one of 30 participating businesses in the pilot project, assisted by Jacobs in the development of a net zero roadmap. Muswellbrook Shire Council does not currently have a net zero commitment but is interested in setting greenhouse gas reduction targets in line with NSW Government commitments of 35% below 2005 levels by 2030 and net zero by 2050.

A key component of developing a roadmap to net zero emissions is understanding what an organisation's business as usual (BAU) operations emissions footprint is (i.e. without the implementation of a net zero roadmap) and how this is expected to change over time. Only through fully understanding a baseline trajectory of emissions can interventions be effectively planned and executed for shifting and accelerating that trajectory towards a future point of net zero.

This document aims to establish a series of assumptions for the development of such a baseline through to the 2050 target year. These assumptions are based on prior engagement with and data provided by Muswellbrook Shire Council and are to be reviewed and agreed prior to the development of a baseline model to ensure efficiency and accuracy.

It has been agreed that the boundary of assessment will include Scope 1, 2 and 3 emissions, however, some Scope 3 emissions estimating has only been undertaken through financial based metrics as part of this initial assessment with the goal of collecting better Scope 3 data in the short to medium term.

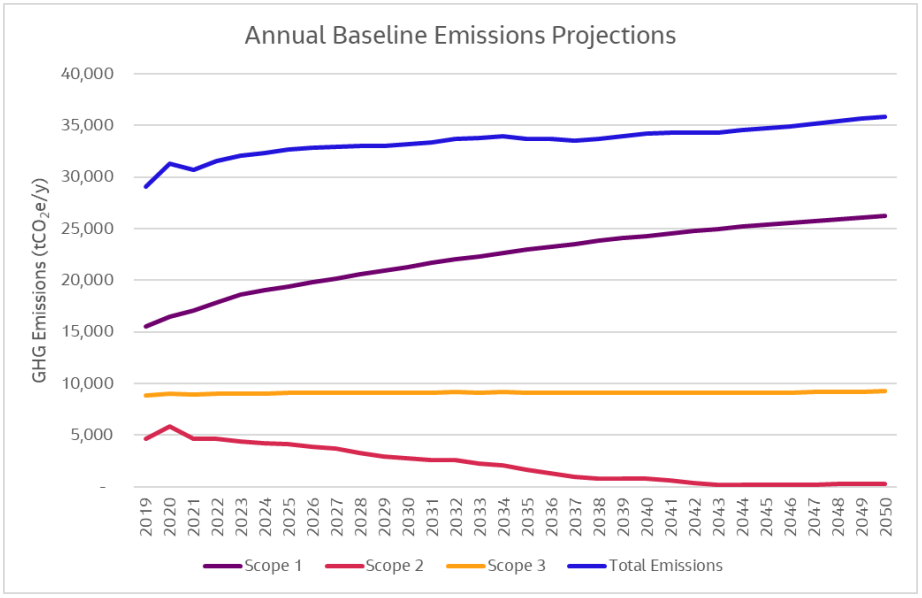
The baseline year considered is that of the most recent typical reporting year, being July 2018 to June 2019, which is designated as 'Year 0'. This year is prior to the impacts of the Covid-19 pandemic and is considered to be more representative of a typical year than FY19-20.

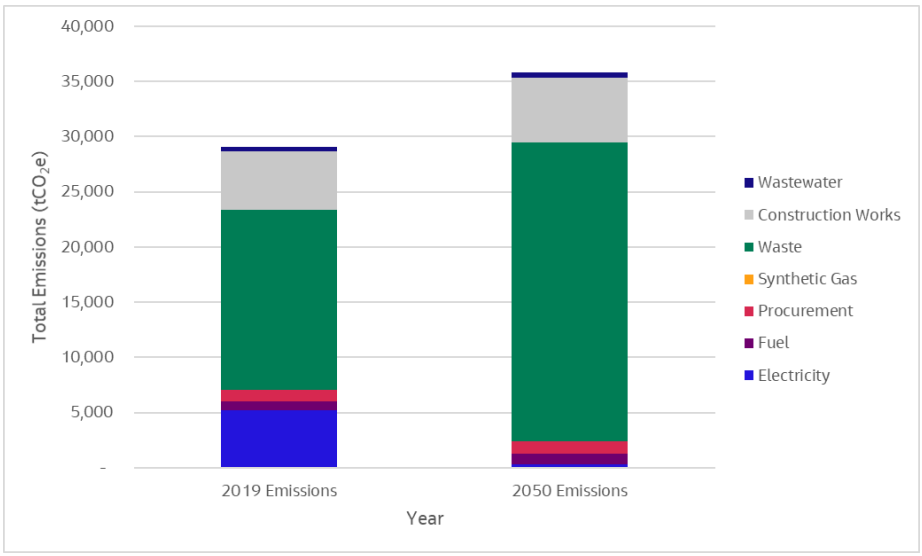
Projections of baseline emissions is forecasted on an annual basis through to the target year of 2050 to coincide with the current target for a net zero commitment. A summary of assumptions that provide the foundation for modelling and forecasting are presented in the table below.

Relevant Area	Key Assumption
Population growth	Population served by Council within the shire is assumed to grow consistent with the 2019 NSW Department of Planning, Industry and Environment (DPIE) projections for Muswellbrook Shire Council It is assumed that this growth in population directly correlates with all emissions inventory data hence quantities of fuel, landfill waste, goods, etc will grow by an equivalent rate per annum to population (resulting in a total increase of 11% by 2050 compared to the 'Year 0' levels).
New facilities	A 'stepped' increase in Councils annual energy consumption (in addition to that increased with Population Growth) of 3,429 MWh per year is expected to be experienced between 'Year 0' (FY18-19) and 'Year 5' (FY23-24). This consists of: • Recycled Water Treatment Plant with 2,626 MWh per year from Feb 2020 • Upgrade of Muswellbrook Swimming Pool with 224 MWh per year from March 2021

	• Animal shelter and sustainability hub with 81 MWh per year from December 2021 • Tertiary education centre with 58 MWh per year from December 2021 • New depot with an additional 26 MWh per year from March 2022 • Entertainment centre with 260 MWh per year from December 2022 • Food Organics and Garden Organics (FOGO) system with immaterial electricity usage from July 2023 • Bridge St retail development with 154 MWh per year from July 2023
Solar Power	An average solar power generation rate of 1,730 kWh/annum/kWp installed has been assumed based on the average output of solar panel systems at MSC. An additional 1,480 kWh of solar generation is planned.
Energy sources	Electricity procurement is expected to remain predominantly from the NSW grid with the exception of the known solar installations currently installed or proposed to be installed. It is assumed that new facilities will not utilise diesel or gas generators/boilers and will be fully electrically powered. Proportions of biofuels in the fuel mix for Council fleet is not expected to change, and no electrification of fleet is expected in the baseline scenario.
Waste composition	The baseline composition of landfill waste is assumed to follow the standard NSW composition from the National Greenhouse and Energy Reporting (Measurement) Determination 2008. This includes 27% construction and demolition waste, 42% commercial and industrial waste and 31% municipal solid waste. The composition of municipal solid waste is then based on municipal solid waste class II (as a dedicated garden waste bin is provided to residents).
Food Organics and Garden Organics (FOGO)	The FOGO service is assumed to divert 38% of available food organics from the red bin (landfill) to composting.

Under a business as usual scenario, Muswellbrook Shire Councils total emissions are projected to continue to increase through to the net zero target year of 2050. Within this, however, Scope 2 emissions are expected to decline due to decarbonisation of the NSW electricity grid.





Opportunities

Evidently, the upwards trajectory of emissions under a business as usual scenario is inconsistent with the MSC net zero commitments, and emissions reduction opportunities are required to track towards this goal.

The preferred pathway for achieving net zero emissions should follow an emissions reduction hierarchy for best practice which prioritises mitigation before compensation

A number of opportunities are available for emissions reduction through to 2050. These are expected to have different financial impacts and costs of abatement. Opportunities and their potential scale of impact on emissions reduction were provided for MSC review and comment prior to implementation in a roadmap scenario. It is noted that the year of adoption has been assumed to inform emissions reduction potentials.

Initiative	Year of Adoption	First Year Emissions Savings (t CO_2e)	Total Cumulative Emissions Savings (to 2050) (t CO_2e)
Waste reduction programs	2022	527	76,206
Landfill gas capture and flaring^	2025	11,491	317,238
Landfill gas capture and electricity generation^	2025	12,900	330,630
Energy from waste^#	2025	-10,290*	60,975 111,407 with electricity offset
Energy from waste (EFW) with landfill gas capture and flaring^#	2025	1,201	167,263
Energy efficiency retrofits	2025	940	8,763
Energy efficiency for new builds	2022	141	1,506
Renewable energy~	2025	4,608	43,915
Biofuels	2022	10	85
Fleet electrification	2030	227	5,474 5,807 with 100% renewables
Construction works and procurement	2022	334	69,030

*The negative emissions savings represents an increase in emissions for the first year, before landfill avoidance savings are realised. This would break even around 2032 from which point the use of EFW would see annual emissions reductions by comparison to waste reduction programs alone

^Emissions savings of all waste initiatives are compared to the waste reduction programs alone, which are assumed to be implemented in all scenarios

#Energy from waste savings are not including indirect impacts from offset of energy from the electricity grid, as this effect would be unlikely to be directly accounted for in MSCs future emissions inventories

~Renewable energy savings do not include the energy efficiency program, and would be less if all energy efficiency projects were pursued

Initiative	Capital Cost ($)	Average Annual Cost Saving ($)#	Cost of Abatement ($ / t CO_2e)
Waste reduction programs	Not estimated	Not estimated	Not estimated
Landfill gas capture (flaring)	$1,936,518	-$67,917	$11
Landfill gas capture (generation)	$3,214,209	$686,809	-$28
Energy from waste	Not estimated	Not estimated	Not estimated
Building efficiency retrofits	Not estimated	$294,242	Not estimated
Streetlight efficiency retrofits	$0*	$53,112	-$183
Energy efficiency in new builds	Not estimated	$76,950	Not estimated
Renewable energy	$4,484,159	$2,073,243	-$622
Biofuels	$0	$0	$0
Fleet electrification	$0	$267,136	-$231
Construction works mitigations	Not estimated	Not estimated	Not estimated

#A negative cost saving represents an increase in costs

*No capital cost as the upgrades are paid through a 10-year annuity program, included in annual cost savings

Net Zero Roadmap Outcomes

Based on the adoption of each of the presented opportunities (with the exception of energy from waste), there is a considerable reduction in emissions achieved, however there is some residual emissions present. This requires both an ongoing refinement of mitigation strategies over time and offsetting to achieve the 2050 target of net zero.


40,000
35,000
30,000
25,000
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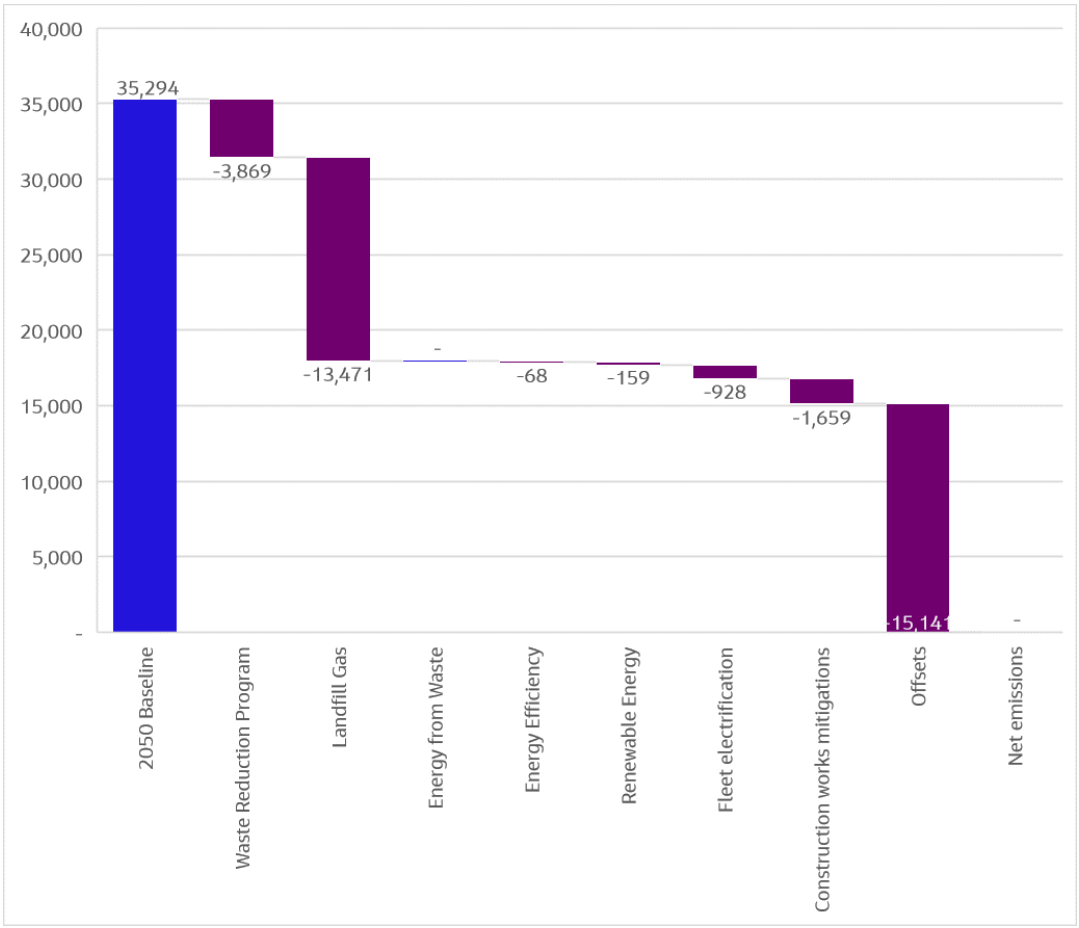
GHG Emissions (tCO_2e/y)
2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050
Total Roadmap Emissions
Target Emissions
Total Baseline Emissions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-15,141
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2050 Baseline
Waste Reduction Program
Landfill Gas
Energy from Waste
Energy Efficiency
Renewable Energy
Fleet electrification
Construction works mitigations
Offsets
Net emissions

Next Steps

The implementation of the roadmap strategy will require ongoing management. The actions for implementation over the short, medium and long term are presented below.

12 months

- Begin collecting more detailed data for missing emissions sources to develop inventory
    - Require procurement teams to keep records of materials (concrete, steel, asphalt, aggregates, etc), water treatment chemicals and similar in physical units (e.g. tonnes or m^3)
    - Require construction teams to report on land clearing and land use changes as part of projects
    - Integrate requirement for regular reporting of fuel, electricity and materials use information into external contracts
    - HVAC servicing contractors to provide records of refrigerant top-ups in kg of refrigerant
- Refine resourcing plan for waste management to address priority actions, including:
    - Undertake waste auditing to improve waste composition records for landfill
    - Develop Council response plan to address actions within the National Waste Policy Action Plan 2019, NSW Waste and NSW Sustainable Materials Strategy 2041 and other relevant strategies
    - Identify funding and/or grant opportunities as part of National and State strategies for waste reduction, diversion or similar
    - Investigate opportunities for improved FOGO diversion rates and expansion to commercial FOGO collection
    - Audit landfill gas monitoring results and investigate areas for improvement
    - Investigate landfill gas capture opportunities and source funding for feasibility studies and detailed costings
    - Potential initiation of a Council Waste Management Strategy to address above priorities
- Arrange energy audits to identify retrofit opportunities for key buildings including Muswellbrook Marketplace, Tertiary Education Centre (TEC) Annex, Bridge St Library and Council Administration
- Integrate improved energy efficiency requirements into the design for new Council buildings including the Entertainment Centre and Bridge St mixed use development
- Investigate opportunities for biofuel (B5) procurement and storage at Council depot and transition all petrol and diesel to be replaced with E10 and B5 for Council works where compatible (and integrate requirement into construction contracts for third parties)
- Undertake FY2020 and FY2021 updates of emissions inventory using provided tool and NGERs Calculators

3-6 years

- Ongoing updates of emissions inventory including additional detailed emissions source information

- Prepared detailed costings of emissions reduction strategies and integrate into Council budget forecasts
    - Identify opportunities for National and/or State funding and grant opportunities
- Integrate emissions reduction Key Performance Indicators (KPIs) into construction contracts and identify emissions reduction opportunities for construction works
- Review opportunities for further construction works emissions reduction in collaboration with contractors, including opportunities for the use of sustainability rating systems (e.g. Infrastructure Sustainability Council of Australia for infrastructure and Green Star for buildings)
- Implementation of waste reduction programs and domestic and commercial FOGO systems
- Undertake design and implementation of energy efficiency retrofit opportunities
- Undertake detailed design, tendering and construction for landfill gas capture and generation system
- Investigate opportunities for increased renewable energy uptake (distributed, large scale and/or Power Purchase Agreements as appropriate)
- Produce a Green Fleet Strategy to identify detailed opportunities and requirements for transition of Councils plant and equipment fleet to electric (and potentially hydrogen as appropriate)

2030

- Finalise procurement and/or lease agreements for remaining fleet electrification
- Continued collaboration with construction contractors to identify opportunities for further emissions reductions
- Review progress against emissions reduction targets (50% below 2019 levels by 2030) and refine strategy for further mitigation as required [Drafting note: interim target to be confirmed by MSC]
- Begin investigating offset opportunities and consider development of an offset strategy where mitigations are unable to stay on track with targets
- Review ambition for net zero targets (potential to bring forward) and or potential for third-party certifications such as 'Carbon Neutral' under the Climate Active Standard

Important note about your report

The sole purpose of this report is to document the assumptions used in modelling undertaken as part of the Net Zero Pilot Project, in accordance with the scope of services set out in the contract between Jacobs and the Department of Planning, Industry & Environment.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by Muswellbrook Shire Council, the Department of Planning, Industry & Environment and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced by Muswellbrook Shire Council and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, the Department of Planning, Industry & Environment and its Sustainability Advantage Member Muswellbrook Shire Council, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Department of Planning, Industry & Environment. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

Relevant Definitions

The following definitions to key terms referenced in this document are aligned with definitions provided by Sustainability Advantage and are hence adopted for the Net Zero Pilot Project.

"Net Zero Emissions (NZE)

Economic activities that result in the achievement of zero total net impact of human-induced Greenhouse Gas (GHG) emissions. NZE refers to achieving an overall balance between GHG emissions produced and GHG emissions taken out of the atmosphere. An organisation may achieve net zero by reducing its emissions through operational efficiency or avoidance measures and offsetting those remaining emissions through purchasing certified carbon offsets.

Carbon Neutral vs Net Zero Emissions

Becoming carbon neutral and achieving net zero emissions is effectively the same thing. They both refer to achieving an overall balance between GHG emissions produced (scope 1, 2 and 3) and GHG emissions taken out of the atmosphere.

100% Renewable

Achieving 100% Renewables refers to all energy being delivered from renewable sources. This could include on-site sources such as solar PV and biogas or procurement of off-site renewable energy through Power Purchase Agreements. Going 100% renewable differs from carbon neutrality/net zero emissions as it only covers emissions associated with energy consumption and typically ignores all scope 3 emissions (excluding from electricity transmission) such as those generated from waste, transport and procurement.

Science-Based Targets

Science-based targets provide companies with a clearly defined pathway to future-proof growth by specifying how much and how quickly they need to reduce their greenhouse gas emissions. Targets are considered "science-based" if they are in line with what the latest climate science says is necessary to meet the goals of International Agreements such as the Paris Agreement[1]. E.g. a company may set a science-based target to reduce scope 1, 2 and 3 emissions by 60% by 2035, however, this would not be considered carbon neutral or net zero emissions. https://sciencebasedtargets.org/what-is-a-science-based-target/

[1] The Paris Agreement is an international agreement made as part of the Paris Climate Conference of Parties 21 (COP21) in 2015, under which signatories agreed to a number of goals including keeping global warming well below 2.0 degrees Celsius, with an aspirational goal of 1.5 degrees Celsius

1. Introduction

The Net Zero Pilot Project is an initiative of Sustainability Advantage, Department of Planning, Industry & Environment.

The NSW Government has committed to a 35% reduction in the state's greenhouse gas (GHG) emissions by 2030 from a 2005 baseline and has committed to net zero emissions for NSW by 2050. Currently, there are varying levels of business maturity in commitments and pathways to align with these commitments. Through the Net Zero Pilot Project, Sustainability Advantage aims to accelerate the transition towards net zero emissions by creating a consistent approach to net zero pathway development and close the gap in organisational knowledge to ensure that such pathways are met.

Muswellbrook Shire Council (MSC) is one of 30 participating organisations in the pilot project, assisted by Jacobs in the development of a net zero roadmap. Muswellbrook Shire Council does not currently have a net zero commitment but is interested in setting greenhouse gas reduction targets in line with NSW Government commitments of 35% below 2005 levels by 2030 and net zero by 2050.

A key component of developing a roadmap to net zero emissions is understanding what an organisation's emissions footprint is and how this is expected to change over time under business as usual (BAU) operations. Only through fully understanding a baseline trajectory of emissions can interventions be effectively planned and executed for shifting and accelerating that trajectory towards a future point of net zero.

This document aims to establish a series of assumptions for the development of such a baseline through to the 2040 target year. These assumptions are based on prior engagement with and data provided by Muswellbrook Shire Council and are to be reviewed and agreed prior to the development of a baseline model to ensure efficiency and accuracy.

Following the development of a baseline model, this document has been updated to capture assumptions regarding potential initiatives and recommendations for activities that can be undertaken by the organisation for reducing emissions over time.

The structure of this document includes:

- The development of a scope and boundary, methodology and baseline activity data (Section 2)
- A summary of assumptions used in projecting the most recent typical operational emissions forward in time based on a BAU approach (Section 3)
- The baseline forecast (Section 4)
- The roadmap forecast (details of the emissions reduction opportunities (Section 5)
- Next steps (Section 6)
- References (Section 8)

2. Baseline GHG Inventory

This section provides an overview of the establishment of GHG inventory data which will form the benchmark for projecting future baseline emissions trajectories, including the establishment of a 'Year 0' organisational emissions footprint. This includes the establishment of a Scope and Boundary for the assessment, a high-level methodology for collecting and collating inventory data and presentation of the 'Year 0' inventory.

2.1 Guiding Documents and Principles

The carbon accounting methodology follows the principles set out in the following documents:

- The Greenhouse Gas Protocol (GHG Protocol)(2004) Corporate Accounting and Reporting Standard by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI)
- The GHG Protocol (2011) Corporate Value Chain (Scope 3) Accounting and Reporting Standard by the WBCSD and the WRI
- ISO 14064-1 (2018) Greenhouse gases - Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals

The GHG inventories for this assessment have been calculated in accordance with the principles of the internationally accepted GHG Protocol. According to the GHG Protocol, GHG emissions are split into three categories, known as 'Scopes'. Scopes 1, 2 and 3 are defined by the GHG Protocol and can be summarised as:

- Scope 1 – Direct emissions of GHGs from sources that are owned or operated by a reporting organisation (examples – combustion of diesel in company owned vehicles or used in on-site generators)
- Scope 2 – Indirect Emissions associated with the import of energy from another source (examples – import of electricity from the grid, or heat)
- Scope 3 – Other indirect emissions – other than energy imports (above) which are a direct result of the operations of the organisation, but from sources not owned or operated by them (examples include production of procured materials and third party contracted services).

An overview of Scope 1, 2 and 3 emissions are demonstrated in Figure 2-1.

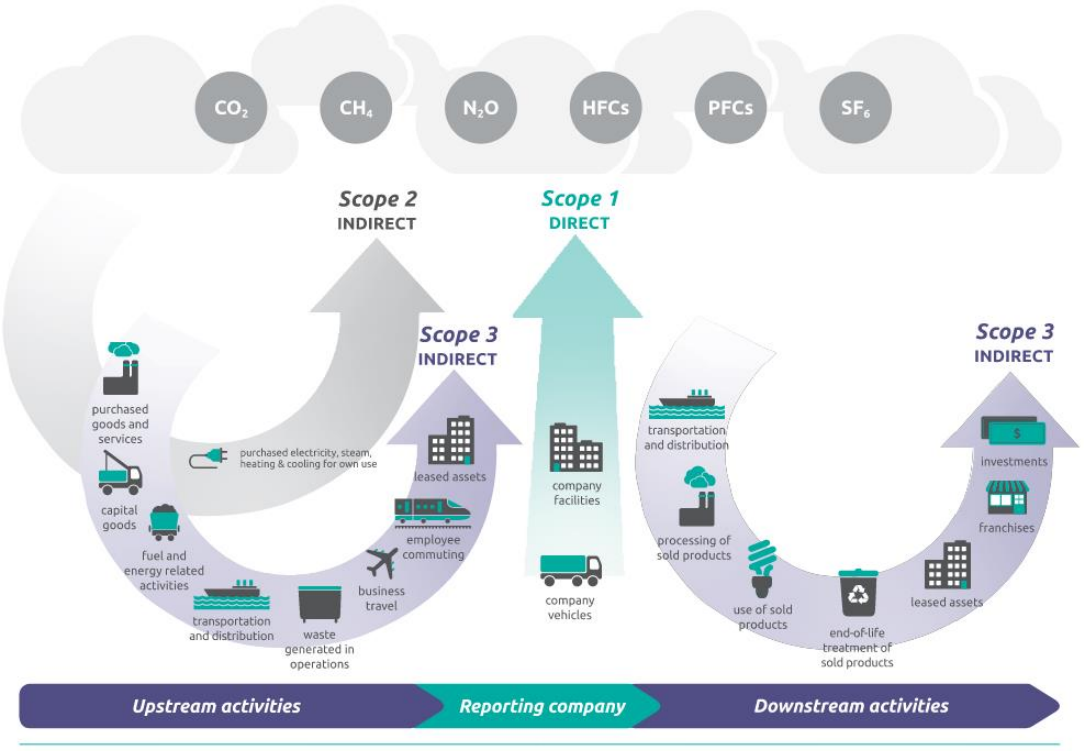

Figure 2-1: Overview of GHG Protocol scope and emissions sources (WBCSD and WRI, 2011)

2.2 Scope and Boundary

The GHG Protocol (and many other reporting schemes) requires the reporting of all Scope 1 and 2 sources, whilst reporting of Scope 3 sources is optional. The reporting of 'significant Scope 3 emissions sources' is recommended by the GHG Protocol if they represent a material contribution to overall organisational GHG footprint. That is, the contribution of a Scope 3 emissions source is typically not considered to be 'material' if it represents less than one per cent of the total organisational GHG emissions. This approach is consistent with reporting under the NGER scheme – with the exception that Scope 3 GHG emissions are not reported under the NGER Scheme (but can be used under Australia's National Greenhouse Accounts).

The Climate Active Carbon Neutral Standard for Organisations (Commonwealth of Australia, 2020) requires accounting for all relevant and material emissions sources, which includes Scope 3. Sustainability Advantage defines achieving net zero emissions as effectively equivalent to Carbon Neutral and hence is inclusive of Scope 3 emissions sources.

This project will focus heavily on the achievement of Scope 1 and 2 emissions reductions, however, baseline projections for Scope 3 emissions sources are to be estimated and high-level aspirational goals for improved accounting and reductions in these emissions sources will be made. No inclusion of community emissions has been proposed, this would require an entirely separate assessment and is not considered to be part of the Scope 3 boundary for Council but would rather be assessed separate under the GHG Protocol for Cities.

An overview of GHG emissions sources which will be included in the boundary of baseline and roadmap emissions modelling is shown in Table 2-1.

Table 2-1: System boundary: sources of direct and indirect GHG emissions to be modelled

Source of GHG emission	Activity	Included in inventory?	Direct	Indirect	
			Scope 1	Scope 2	Scope 3
Stationary fuel	Fuel consumed by permanent equipment and facilities (e.g. diesel use in generators and maintenance plant)	✓	●		●
Transport fuel	Fuel consumed by the company vehicle fleet	✓	●		●
Wastewater	Council owned treatment of wastewater	✓	●		
Fugitive emissions	Leakage of refrigerants	✓	●		
Waste	Emissions from landfill facilities	✓	●		
Purchased electricity	Electricity consumed for operation of assets which are owned by or in the control of Council	✓		●	●
Construction materials*	Procurement of materials for capital and maintenance works	✓			●
Contracted services*	Emissions associated with contracted maintenance and capital works	✓			●
Transport fuel	Contracted transportation of waste	✓			●
Waste recycling	Emissions associated with the operation of third-party recycling facility	✓			●
Transport fuel	Employee commute	✗			●

*These emissions sources will only be based on high-level combined financial metrics for the purposes of this assessment due to a lack of specific data available so will not be able to be separated by specific emissions source (i.e. materials or fuel and electricity). High level discussion will be provided for expected compositions and a key goal will be further data gathering and refinement in the short to medium term

The baseline year considered will be that of the most recent typical Muswellbrook Shire Council reporting year, being July 2018 to June 2019, which will be known as 'Year 0'. This year is considered to be representative of normal operations, noting that the conclusion of the data is prior to the impact of the Covid-19 global pandemic.

Projections of these baseline emissions are forecasted on an annual basis through to the target year of 2050 to coincide with the currently desired date of net zero commitment. This is generally done on the basis of linear scaling rates with the exception of known stepwise changes in emissions sources, further described in Section 3.

2.3 Method

The emissions inventory data used for 'Year 0' is based on data provided by Muswellbrook Shire Council including:

- Annual fuel and electricity consumption data for FY18-19
- Landfill data for legacy emissions and FY18-19 waste received
- Solar energy generation data for FY19-20
- Wastewater treatment quantities for Muswellbrook and Denman treatment plants for FY18-19
- Council FY18-19 financial statements

No further manipulation of raw data has been undertaken for 'Year 0'.

Inventory activity data will be combined with emissions factors to establish the baseline GHG footprint. These emissions factors have been derived from a number of sources with a preference for factors aligned with the National Greenhouse and Energy Reporting Act 2007 (NGER Act) where available including National Greenhouse Accounts Factors 2020 (NGA Factors, Department of Industry, Science, Energy and Resources).

Emissions resulting from landfill operation and wastewater treatment will be accounted for through National Greenhouse and Energy Reporting (Measurement) Determination 2008 Parts 5.2 and 5.3 respectively.

Other emissions factors include financial based input-output data for construction services. Whilst it is acknowledged that there is uncertainty in the level of accuracy of these emissions factors, it has been advised that process-based activity data is not available. These emissions factors are considered appropriate for determining the scale of contribution of Scope 3 sources at this point in time and a key recommendation for the roadmap is actions for sourcing improved emissions data from suppliers to refine the accuracy of these over time.

2.4 Initial GHG Activity Data

A summary of the activity data for 'Year 0' (2018-2019) is presented in Table 2-2. This data will be combined with emissions factors as described in Section 2.3 to produce the total emissions footprint.

Table 2-2: 'Year 0' Greenhouse Gas Inventory Activity Data

Emissions Source	Quantity	Unit
Diesel	253	kL
Petrol	26	kL
E10	22.8	kL
Purchased Electricity (Grid)	5,783	MWh
Generated renewable electricity	576	MWh
Wastewater treated	933,334	kL

Landfill waste received	19,378	tonnes
Total landfill emissions	15,106	t CO_2e
Legacy landfill emissions	7,482	t CO_2e
Organic waste Processed	1,515	tonnes
Recycling collected	999	tonnes
Construction spend (new assets)	25,269,000	$AUD
Construction spend (renewals/replacements)	12,978,000	$AUD
Construction spend (maintenance)	7,106,000	$AUD
Plant and equipment spend	2,205,000	$AUD
Waste collection spend	1,089,000	$AUD
Office equipment spend	316,000	$AUD
Furniture and fittings spend	192,000	$AUD

It is noted that no information has been provided for refrigerant stocks or quantities recharged post leakage, and it is recommended that as part of improved greenhouse gas inventory data collection going forward, this information is collated, and emissions estimates updated. Depending on the refrigerant types used, this may be a material emissions source.

3. Business as Usual Forecast - Assumptions

Before developing interventions for moving towards net zero, it is critical to develop a picture of how emissions are expected to change in the future with a 'do nothing' approach so that it is clear what the expected contributions to future emissions would be.

Business as usual (BAU) operations are essentially considered the current pathway where the only changes are a result of existing organisational strategy and external factors beyond the organisations control. An example of the former could be additional facility upgrades which have been confirmed, the latter could be a greater increasing prevalence of renewable energy in the electricity market.

This section contains all assumptions which will be captured as part of the baseline development, for review and agreement by MSC prior to undertaking the modelling. Whilst this is not an exhaustive list of changes which may impact emissions into the future, it is considered to cover the most significant known changes that would have the greatest influence. Similarly, there may be other external factors which cannot be predicted at this time, but it is expected that over time such modelling can be revised and updated to more accurately capture a changing operational environment.

3.1 Population

Population served by Council within the shire is assumed to grow consistent with the NSW Department of Planning, Industry and Environment (DPIE) 2019 projections for Muswellbrook Shire Council as shown in Table 3-1.

Table 3-1: Population Projections for Muswellbrook Shire Council

	2016	2019	2021	2026	2031	2036	2041	2050*
Total Population	16,450	16,850^	17,100	17,600	17,950	18,200	18,350	18,700*
Average Annual Growth Rate (%)	0.8	0.8	0.6	0.4	0.3	0.2	0.2	0.2*

^Population for 2019 has been inferred from 2016 based on the population growth rate to be used as the 'Year 0' population
*The period from 2041 to 2050 is not contained in NSW Department of Planning projections and so the growth rate has been assumed to remain consistent from the prior period.

While the COVID-19 pandemic is expected to have some impact on population which is not contained in the 2019 projections, it is noted by NSW DPIE (2020) that COVID-19 is expected to impact cities more than regions. The difference in pre and post COVID-19 population projections for the 'Rest of NSW' (i.e. outside of Sydney) are shown to be negligible. As such, no allowance has been made for changes in population growth due to COVID-19.

It is assumed that this growth in population will be directly correlated with all emissions inventory data presented in Table 2-2 and hence quantities of fuel, landfill waste, goods, etc will grow by an equivalent rate per annum to population as shown in Table 3-4 (resulting in a total increase of 11% by 2050 compared to the 'Year 0' levels).

It is noted that there is likely to be a combination of baseload and variable load and some systems may not have linear growth in alignment with population. In reality, increases in activity data may occur in stepwise changes rather than consistent growth and any future upgrades to increase capacity may be more efficient than existing systems. This means the gradual 1:1 scaling with population growth assumed is a conservative assumption but considered appropriate for the level of assessment required.

The exception to this linear increase will be in electricity use which is expected to grow by only the known changes referenced in Section 3.2 until 2023, following which the growth in electricity will be limited to alignment with population growth rates.

3.2 New Facilities and Expected Upgrades

Energy use for new facilities is calculated using a kWh/m^2/annum basis due to a lack of further information available at the time of assessment and is generally based on minimum practice (i.e. no design for greater efficiency beyond compliance), however all energy has been assumed to be provided through electricity with no allowance for gas or similar. These rates are summarised in Table 3-2.

Table 3-2: Standard energy intensity for new buildings

Building Type	Energy Intensity (kWh/m^2/annum)	Source
Retail	134	NABERS Reverse Calculator 2020, Shopping Centres 2.5 Stars, assumed open 8AM-5PM, 6 days/week and 360 days per year
Education	61	Beyond Zero Emissions (2013), Zero Carbon Australia Buildings Plan Education building average
Warehouses	108	Beyond Zero Emissions (2013), Zero Carbon Australia Buildings Plan Warehouse building average
Office	262	NABERS Reverse Calculator 2020, Offices 2.5 Stars, assumed occupied 40 hours/week
Cinema	109	Beyond Zero Emissions (2013), Zero Carbon Australia Buildings Plan Cinema building average

An average solar power generation rate of 1,730 kWh/annum/kWp[2] has been assumed based on the average output of the solar panel systems vs their nominal power for the existing systems provided.

Known facility upgrades include:

- The Muswellbrook Sewage Treatment Works was upgraded to become a Recycled Water Treatment Plant in 2020. The change associated with this was a decrease of 145 MWh per year for the Muswellbrook Sewage Treatment Works but an uplift of 1,239 MWh for the additional Recycled

[2] kilowatts peak (kWp) is the nominal power of the solar system under standard test conditions and is typically the rated power advertised. This is generally not the power achieved under actual conditions.

Water Treatment Plant infrastructure, i.e. a net increase of 1,094 MWh. This facility was only commissioned in February 2020, meaning it was only operating for 5 months in the data provided so requires adjustment. Hence the average annual operations are expected to result in **an increase of 2,626 MWh per year**.

- Upgraded swimming pool opening in March 2021. The upgrade includes a new heated indoor pool, new entrance and foyer, kiosk, function room, sauna and spa including 25kWp of solar power. The upgrade is assumed to require an additional 50% energy usage on top of the existing pool, for **an increase of 224 MWh per year**. The **solar panels are assumed to provide an additional 43.3 MWh per year**.

- An animal shelter and sustainability hub opening in December 2021 which will include 150m^2 non-airconditioned space and 385m^2 of airconditioned space as well as including 25kWp of solar power. The air-conditioned space is assumed to be equivalent to 'Offices' energy use while the non-airconditioned space is assumed to be equivalent to 'Warehouses' energy use for a total of **an additional 81 MWh per year**. The **solar panels are assumed to provide an additional 43.3 MWh per year**.

- Tertiary education centre (Stage 2) and Loxton House retrofit opening in December 2021 including an additional 984m^2 of floor area. The energy use is assumed to be based on 'Education' for a total **additional electricity use of 58 MWh per year.**

- Opening of new depot (and closure of existing depot) in March 2022. The new depot will include 525m^2 airconditioned space (plus lift), 350 m^2 non-airconditioned workshop, 260 m^2 storage shed. The existing facility has 330 m^2 airconditioned demountable offices, 300 m^2 non-airconditioned workshop and 375 m^2 non-airconditioned store. It is assumed that the majority of energy use is attributed to the air-conditioned space and hence the new depot will result in a 60% increase in energy use compared to the existing facility for **an additional 26 MWh/year** (70 MWh/year up from 44 MWh/year). The facility is less than 1% of Councils electricity use so this assumption is assumed not to be critical.

- Entertainment centre opening in December 2022 with 2,380m^2 of floor area. The energy use is assumed to be equivalent to 'Cinema' for a **total energy use of 260 MWh per year**.

- Food organics and garden organics (FOGO) upgrade beginning operation in July 2023. Electricity usage for this system is expected to be negligible compared to the total electricity usage across the Council asset portfolio and has not been included in projections.

- Bridge Street mixed-use development opening in July 2023 consisting of 1,150 m^2 commercial/retail space and 455 m^2 residential floor space. The retail space is assumed to have a **total energy usage of 154 MWh per year**. The residential floor space has not been allocated to the Council footprint as it is assumed this power will be attributed to the occupants.

- Denman Tourist Park and Thermal baths opening in December 2023. The current feasibility assessment has proposed for the power requirements to be provided through a solar thermal combined heat and power system and hence **the greenhouse gas impact of the proposal has been assumed to be negligible and is not included in the projections**.
- A proposed 800kW solar system at the Muswellbrook Recycled Water Treatment Plant and 5kW at Denman recreation area to be constructed in 2021. The **solar panels are assumed to provide an additional 1,393 MWh per year**.

Whilst there are inevitably likely to be further facility upgrades that occur following 2023 under a business as usual scenario, increases to inventory data as a result of these are expected to be captured approximately through the linear scaling in alignment with population growth as presented in Section 3.1.

3.3 Energy Sources

Electricity procurement is expected to remain predominantly from the NSW grid with the exception of the known solar installations currently installed or proposed to be installed in Section 3.2.

It is assumed that new facilities will not utilise diesel or gas generators/boilers and will be fully electrically powered.

Proportions of biofuels in the fuel mix for Council fleet is not expected to change, and no electrification of fleet is expected in the baseline scenario.

3.4 Waste

It is assumed that existing waste treatment processes and external waste processing remains consistent, with no changes to current practices with the exception of the FOGO project proposed for July 2023.

The **baseline composition of landfill waste is based on the provided composition for 2018/19.** This includes:

- 3% construction and demolition waste
- 43% commercial and industrial waste
- 54% municipal solid waste.

The composition of municipal solid waste is assumed to follow the standard composition from the National Greenhouse and Energy Reporting (Measurement) Determination 2008. This is based on municipal solid waste class II (as a dedicated garden waste bin is provided to residents). No detailed waste composition results were available for Muswellbrook.

The FOGO service is assumed to divert 38% of available food organics from the municipal solid waste stream, based on the average diversion across Councils found in Rawtec, 2018 (Analysis of NSW Food and Garden Bin Audit Data). The composition of municipal solid waste prior to and after the implementation of FOGO collection services is shown in Table 3-3. After FOGO implementation, the composition of landfill waste is expected to be:

- 3.3% construction and demolition waste
- 46.9% commercial and industrial waste
- 49.9% municipal solid waste.

Table 3-3: Assumed municipal solid waste composition prior to and after implementation of FOGO

Waste Stream	Proportion prior to FOGO (%)	Proportion after FOGO (%)
Food	40.3	29.5
Paper and cardboard	15.0	17.7
Garden and park	3.9	4.6
Wood and wood waste	1.2	1.4
Textiles	1.7	2.0

Sludge	0.0	0.0
Nappies	4.6	5.4
Rubber and Leather	1.2	1.4
Inert waste	32.1	37.9

Waste quantities are expected to increase aligned with population growth presented in Section 3.1.

3.5 Capital Works and Procurement

Procurement and capital works costs are expected to increase aligned with population growth presented in Section 3.1.

3.6 Summary

A summary of the relevant assumptions which have been used in the baseline model is presented in Table 3-4.

Table 3-4: Summary of baseline model assumptions

Relevant Area	Key Assumption
Population growth	Population served by Council within the shire is assumed to grow consistent with the 2019 NSW Department of Planning, Industry and Environment (DPIE) projections for Muswellbrook Shire Council It is assumed that this growth in population will be directly correlated with all emissions inventory data hence quantities of fuel, landfill waste, goods, etc will grow by an equivalent rate per annum to population (resulting in a total increase of 11% by 2050 compared to the 'Year 0' levels).
New facilities	A total increase in Councils annual energy consumption of 3,429 MWh per year is expected to become operational between 'Year 0' (FY18-19) and 'Year 5' (FY23-24). This consists of: • Recycled Water Treatment Plant with 2,626 MWh per year from Feb 2020 • Upgrade of Muswellbrook Swimming Pool with 224 MWh per year from March 2021 • Animal shelter and sustainability hub with 81 MWh per year from December 2021 • Tertiary education centre with 58 MWh per year from December 2021 • New depot with an additional 26 MWh per year from March 2022 • Entertainment centre with 260 MWh per year from December 2022 • FOGO system with immaterial electricity use from July 2023

	• Bridge St retail development with 154 MWh per year from July 2023
Solar Power	An average solar power generation rate of 1,730 kWh/annum/kWp has been assumed based on the average output of the solar panel systems vs their nominal power for the existing systems provided. An additional 1,480 kWh of solar generation is planned.
Energy sources	Electricity procurement is expected to remain predominantly from the NSW grid with the exception of the known solar installations currently installed or proposed to be installed. No stationary energy use for facilities through diesel, gas or similar is expected. Proportions of biofuels in the fuel mix for Council fleet is not expected to change, and no electrification of fleet is expected in the baseline scenario.
Waste composition	The baseline composition of landfill waste is based on the provided composition for 2018/19. This includes: ▪ 3% construction and demolition waste ▪ 43% commercial and industrial waste ▪ 54% municipal solid waste. The composition of municipal solid waste is assumed to follow the standard composition from the National Greenhouse and Energy Reporting (Measurement) Determination 2008. This is based on municipal solid waste class II (as a dedicated garden waste bin is provided to residents).
FOGO	The FOGO service is assumed to divert 38% of food organics

4. Baseline Forecast

Under a business as usual scenario, Muswellbrook Shire Council's total GHG emissions are projected to continue to increase through to the net zero target year of 2050, as shown in Figure 4-1.

This upwards trend is predominantly due to an ongoing increase in Scope 1 emissions, the largest contribution of which is a result of landfill operations. These landfill emissions are expected to grow faster than population growth, due to the effect of increasing legacy emissions year on year as the total amount of waste within the landfill increases over time.

Scope 2 emissions are expected to undergo a small initial increase due to the addition of new facilities, followed by an ongoing decline due to both increasing on-site renewable energy use and a gradual decline in the emissions intensity of the NSW electricity grid. Under current projections for the NSW grid, there is still expected to be some residual Scope 2 emissions by 2050, however, these are expected to only be less than 7% of existing Scope 2 emissions and less than 1% of total emissions by this time.

Scope 3 emissions are expected to undergo only a gradual increase, slower than population growth. While some Scope 3 emissions sources are expected to increase aligned with population, this is partially countered by a decrease in Scope 3 emissions associated with electricity use, due to factors equivalent to the decline in Scope 2 emissions.

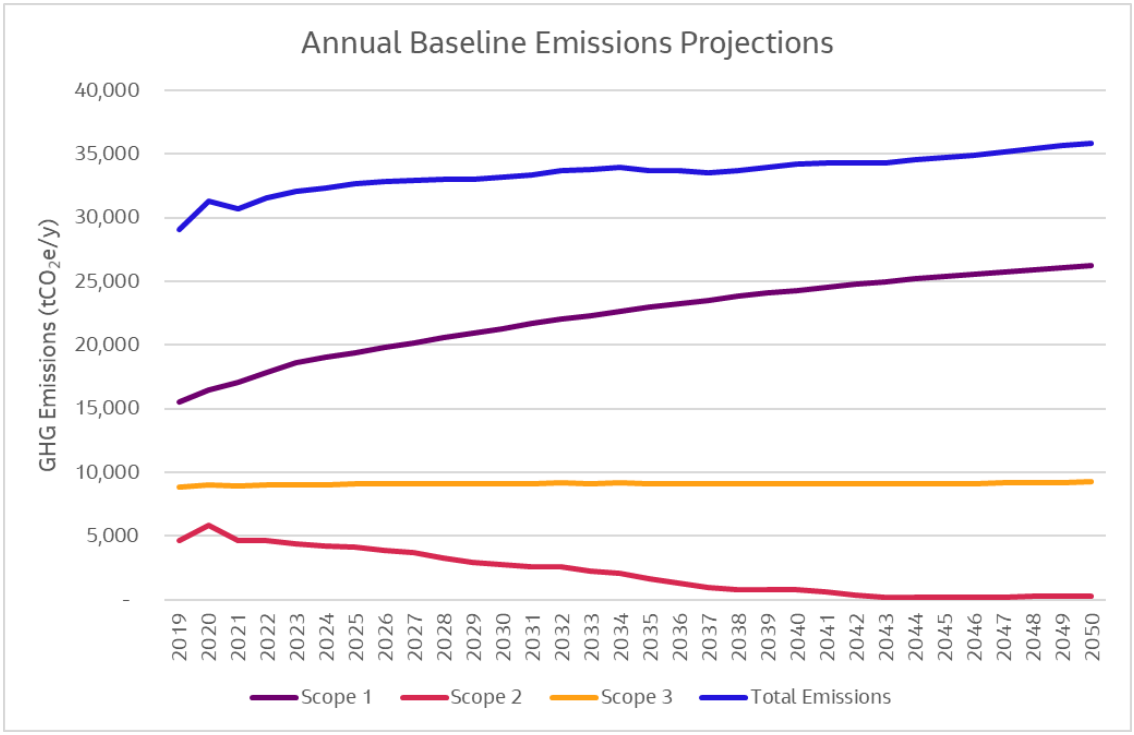

Figure 4-1: Baseline emissions trajectory to 2050 (All Scopes)

A detailed breakdown of emissions contributions by source is shown in Figure 4-2 and Figure 4-3.

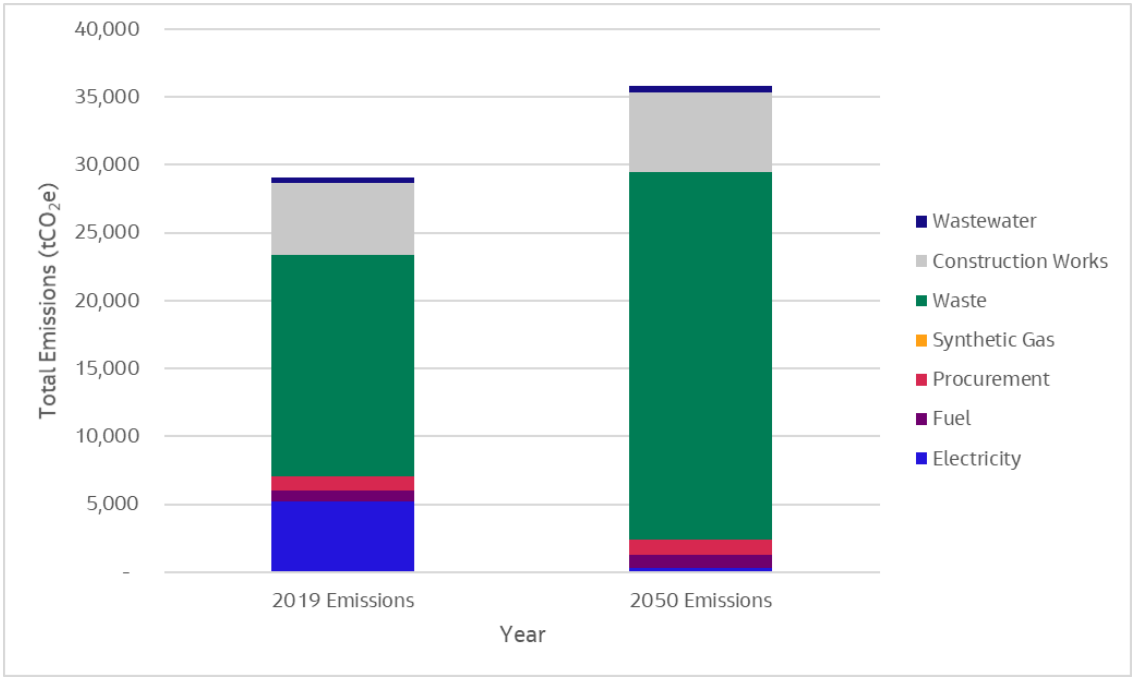

Figure 4-2: Relative emissions contribution for 2019 and 2050

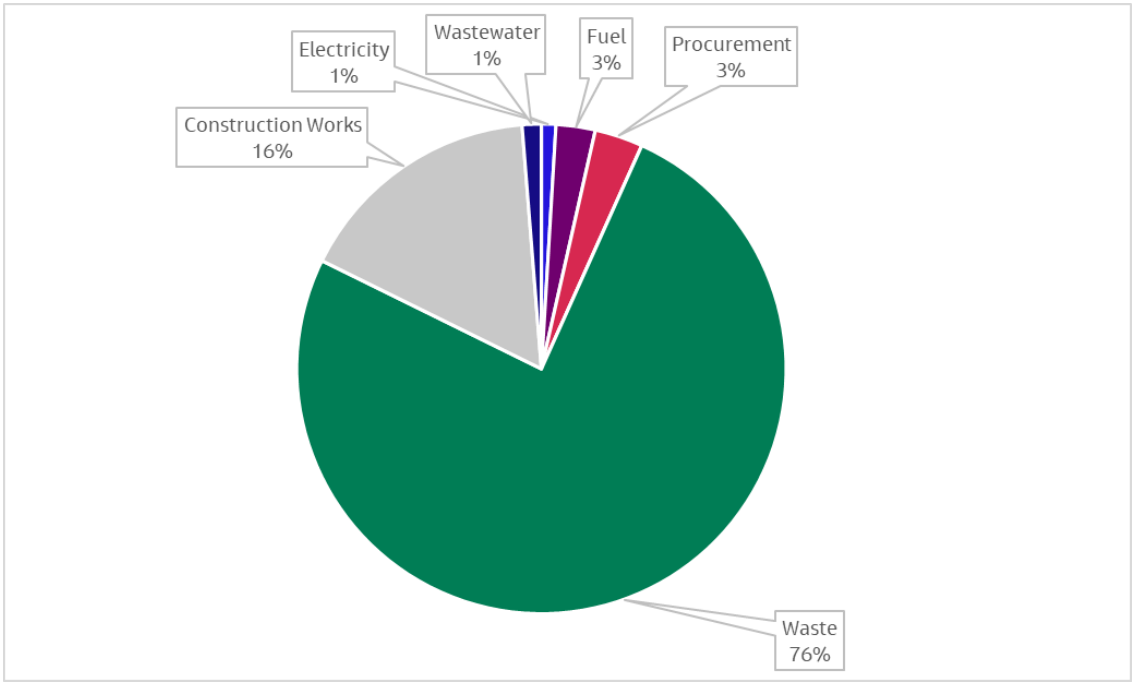

Figure 4-3: 2050 Total Emissions contribution by source (All Scopes)

5. Roadmap Forecast – Emissions Reduction Opportunities

Evidently, the upwards trajectory of emissions under a business as usual scenario is inconsistent with a net zero 2050 commitment, and further emissions reduction opportunities are required to track towards this goal.

The preferred pathway for achieving net zero emissions should follow an emissions reduction hierarchy for best practice which prioritises mitigation before compensation (Pineda et al, 2020). This hierarchy is often presented differently, although contains common themes of avoidance, reduction and then offset (WBCSD, 2019). A more detailed hierarchy of use is that developed for the Victorian EPA carbon management principles (Victorian EPA, 2017), as summarised in Figure 5-1.

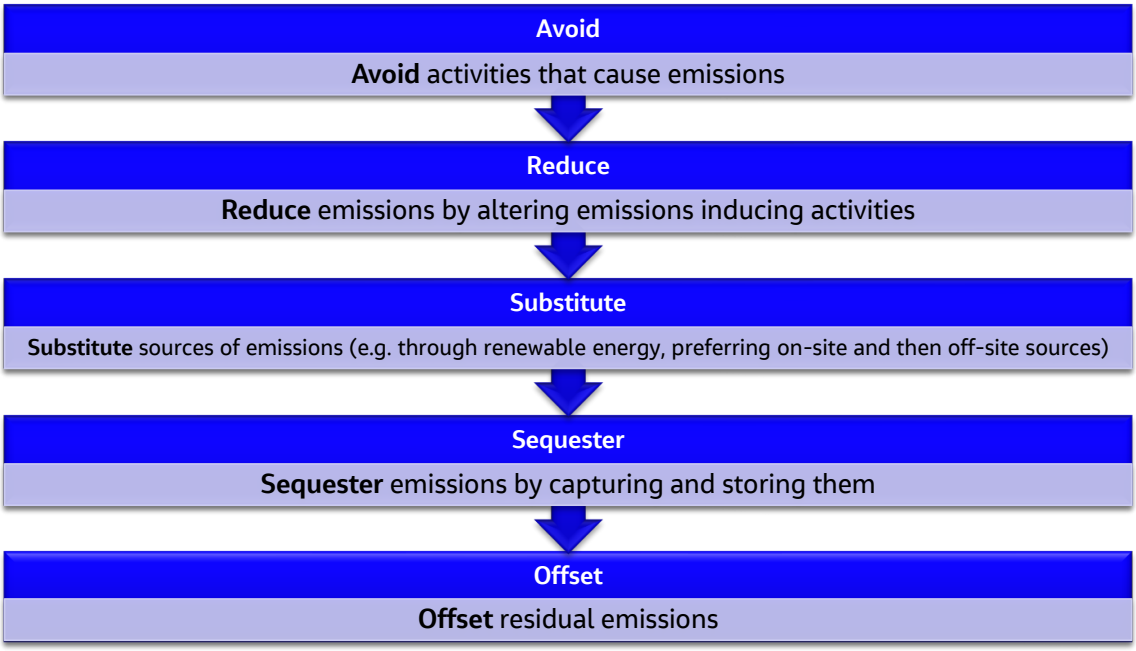

Figure 5-1: Emissions reduction hierarchy (Victorian EPA, 2017)

This section contains all assumptions which have been used as part of the roadmap development. Whilst this is not an exhaustive list of initiatives which may be implemented to reduce emissions into the future, it is considered to cover the most significant feasible opportunities that would have the greatest influence.

It is noted that the priority for emissions reduction opportunities as part of the net zero roadmap has been focused on residual emissions sources identified in the baseline model. Energy efficiency measures for electricity saving are generally not covered due to Muswellbrook Shire Council's plan for zero emissions electricity sourcing, however, these opportunities are still considered to be worthwhile and best practice from an emissions reduction hierarchy and economics perspective. Muswellbrook Shire Council may continue to identify and implement energy efficiency or on-site renewables opportunities where they are feasible and economical in the future, in addition to the emissions reduction opportunities identified.

5.1 Waste and Landfill Operation

Given the large proportion of Council emissions profile associated with landfill operations, the treatment of waste presents the largest opportunity for emissions reduction. Some opportunities are presented in this section which have been considered at a high level, however each would require detailed feasibility studies of their own in the future, prior to implementation.

5.1.1 Waste Reduction Programs

A number of waste reduction actions and programs are available for Council to implement to reduce waste generated and being sent to landfill.

National Waste Policy Action Plan

One opportunity for improving landfill emissions, is to undertake a targeted wate avoidance and recycling intervention program, utilising best practice to improve landfill diversions and hence reduce waste quantities.

The National Waste Policy Action Plan 2019 has set a target of a 10% reduction in per person waste generation by 2030. For the purposes of the roadmap, it is assumed that MSC will support priority actions under the plan where within its control to support the achievement of this target. This includes supporting the following relevant actions taken from the plan:

- Support the Fight Food Waste campaign, to divert foodstuffs from landfill
- Report on lessons learned and options to support waste reduction in the commercial and industrial, and construction and demolition waste streams
- Deliver targeted programs to build businesses' capability to identify and act on opportunities to avoid waste and increase materials efficiency and recovery
- Support community-based reuse and repair centres, enabling communities to avoid creating waste
- Support and promote circular economy principles in urban planning, infrastructure and development projects
- Align community education efforts to reduce food waste, to maximise impact and reduce confusion
- Undertake research to better understand the contributing factors of household contamination of kerbside recycling collection, to inform future interventions

Under the roadmap, it is assumed that Council support for such initiatives, alongside actions by others, will result in the achievement of the National Waste Policy Action Plans target such that the current waste generation will reduce linearly to a 10% per person reduction achieved by 2030 and maintained from then on.

Costs of such actions have not been estimated, however, are considered predominantly to require only additional Council resourcing as well as some minor marketing/consultancy costs and potentially grant programs.

Kerbside FOGO Improvement Program

For the business as usual scenario, an average efficiency of the proposed FOGO service of 38% of available food organics from the municipal solid waste stream has been adopted. It is noted, however, that waste collection and community education interventions, timed to coincide with the FOGO service implementation, can increase the diversion rates.

Analysis undertaken by Rawtec (2018) found that food waste diversion rates of up to 78% had been observed, showing that there is the potential for the success of FOGO schemes to be enhanced. This analysis also found that Councils that utilised only fortnightly, rather than weekly general waste collection, whilst providing smaller general waste bins (120/140 litre) and weekly FOGO collection, had food waste diversion efficiencies of on average 54%.

It was also found that a large proportion of households (45-55%) had no food waste in their FOGO bins, suggesting that the best improvements could be achieved through targeted efforts on encouraging greater participation for those that are not currently using the service.

Whilst generally the configuration and time of service had influence on the food waste diversion efficiencies, there was still variation within these which suggested that factors such as waste education are expected to be important for improving food waste diversion outcomes.

For the purposes of the roadmap, it is assumed that the implementation of the FOGO service will coincide with:

- Optimising the kerbside waste collection configuration with
    - Weekly FOGO collection services and;
    - The provision of a smaller (120/140 litre) general waste bin, only collected fortnightly
- Implementation of an ongoing waste education program aimed at improving compliance
- Auditing of households and encouraging those with low levels of compliance to improve their practices (e.g. through bin tagging programs[3])

Following implementation of these interventions, a long-term domestic food waste diversion rate of 54%, coinciding with the best performing configuration in Rawtec (2018) has been adopted for the roadmap. It is noted however, that the best performing Council was able to achieve rates of up to 78%, which could be a long term stretch target when developing detailed intervention plans.

Costs of such actions have not been estimated and are outside of the scope of this assessment, however, are considered to require additional Council resourcing as well as cost of waste bin changes and changes to waste collection agreements with third party contractors.

Commercial and Industrial Waste Diversion Improvements

Whilst the existing FOGO scheme has been proposed for kerbside municipal waste collection, there is the opportunity to provide a similar scheme for Commercial and Industrial waste, to facilitate diversion of food organics from such facilities. This would require the development of a food organics waste service for commercial and industrial facilities within the LGA, and advocacy and education to encourage uptake. An important aspect would be ensuring cost competitiveness with existing third-party waste services for such facilities, to improve uptake, and could be incentivised through cheaper gate fees for separated food waste for composting or similar.

Under the roadmap scenario, it is assumed that this would begin trials at the same time as the kerbside municipal FOGO system, with increasing prevalence up to 2030 where diversion rates are assumed to be aligned with the National Waste Policy Action Plan 2019 target of a 50% reduction in organic waste to landfill by 2030.

A commercial FOGO system has been considered to be cost neutral as costs would be recovered through waste charges for users, and could even become a new income source for Council if the system could be operated in a competitive way to regular landfill services.

5.1.2 Landfill Gas Capture

Despite best efforts for waste avoidance and minimisation, there will be ongoing greenhouse gas emissions at the landfill from both legacy waste and newly generated waste. Whilst landfill gas comprises of both methane and carbon dioxide in approximately equal amounts, the carbon dioxide is considered to be derived from biomass sources and is not typically accounted for (NGA, 2020). To avoid the release of methane to the atmosphere, it is possible to capture and combust it which converts the methane (CH_4 with a global warming

[3] https://www.cleanaway.com.au/sustainable-future/bin-tagging-reduce-contamination/

potential[4] (GWP) of 28) to carbon-dioxide (CO_2 with a GWP of 1) and hence dramatically reducing its contribution to global warming.

It is not financially practical to capture all emissions from the landfill, but landfill gas collection systems can capture a reasonable amount. Landfill gas collection efficiency depends on site conditions and management practices. The Global Methane Initiative (GMI, 2012), estimates the following maximum collection efficiencies are achievable:

- At active non-engineered landfill sites: 50 percent in wet climates and 60 percent in dry climates.
- At closed non-engineered landfill sites: 70 percent.
- At active engineered landfills: 75 percent in wet climates and 80 percent in dry climates.
- At closed engineered landfills: 85 percent.

As it utilises a past coal mine void (Muswellbrook Shire Council, 2015), the existing landfill is assumed not to be an 'engineered landfill' for the purposes of this assessment, and hence would have a maximum achievable collection efficiency of 60% while active. It is understood that the existing facility expected to be progressively staged with capping of each stage at approximately 6 year intervals, with the capping of Stage 2 occuring in 2025.

It is assumed that after capping from 2025 onwards, 65% of landfill gas could be captured on average between the existing (then closed) stages and the active stage. It's noted that engineering the caps and new stages to optimise landfill gas capture could potentially pursue higher rates of collection; however, Jacobs experience is that historically, landfill methane capture projects have underdelivered greenhouse gas reductions compared to modelled predictions globally, and hence a slightly more conservative estimate has been used for this assessment.

For the purposes of this assessment, it is assumed that the existing landfill stage is capped, with landfill gas capture installed alongside the construction of the new stage becoming active from 2025. From 2025 it is assumed that both the existing and the new landfill stages will have landfill gas capture capabilities operating at an average 65% capture rate.

There are two opportunities for the treatment of the gas captured: flaring or energy generation. The first involves combusting to turn the methane into carbon dioxide without utilising the energy generated, whilst the latter involves treatment of the gas to be used in a biogas generator, to generate electricity which can be used on site or fed into the grid. Whilst setting the project up for biogas electricity generation may have additional capital cost, it provides the added benefit of enabling a lower carbon energy source to replace electricity from the grid, whilst also providing an operational cost incentive through energy savings and/or feed-in tariffs.

Capital and maintenance costs of landfill gas projects have been estimated following advice received from Jacobs Waste Management team in the UK with experience in similar projects. Capital and maintenance costs for landfill gas collection and flaring are based on cost guidance from SEPA (2016) whilst capital and maintenance costs for gas generation systems are based on US EPA (2021).

A gas collection and flaring project would be estimated to cost approximately $5.2M to cover both the existing 19.4 ha site and the expanded 32.4 ha site, with operation and maintenance costs of over $480k per year. The installation of a landfill gas generator system would be expected to cost an additional $1.3M and require additional operation and maintenance costs of approximately $45k per year.

Generation of electricity from the latter would be able to save approximately $809,000 per year through the generation of approximately 2,400 MWh from the first year of operation. This would be equivalent to over 4

[4] Global Warming Potential (GWP) is a metric used to compare the ability of gases to absorb heat in the atmosphere and is based on the equivalent mass of carbon-dioxide over a 100 year period

times the existing renewable energy generation through existing solar systems and would significantly reduce the size of a renewable energy system required to achieve 100% renewables as discussed in Section 5.2.2.

There is also the opportunity for receiving ongoing financial support for a landfill gas project through the generation of Australian Carbon Credit Units (ACCUs) which can be sold to the Clean Energy Regulator (CER) or to third parties through a separate carbon credit market. The generation of ACCUs through a landfill gas project requires adherence to the Carbon Credits (Carbon Farming Initiative—Landfill Gas) Methodology Determination 2015. It is noted that such detailed investigations are outside the scope of this assessment, and hence only high-level estimates have been provided.

The crediting period for ACCUs can be for up to 12 years for flaring only and up to 7 years for electricity generation[5]. The ACCU price assumed to be achieved is equivalent to that included in Section 5.5.1 for ACCU purchase. Based on this, landfill gas capture has the potential to generate up to almost $2.6M of income from ACCUs for flaring and $1.5M for electricity generation. It's noted that this does not include administrative costs for facilitating the ACCUs through the CER each year.

Both flaring and generation options would be expected to result in a negative Net Present Value (NPV) after ACCU income and electricity savings at a discount rate of 3% and so would come at an overall cost, although generation would become positive at a non-discounted NPV. The relative costs of abatement are $11/$tCO_2e$ and -$28/$tCO_2e$ respectively, with the latter representing a net cost saving associated with the project.

It's noted that costs are indicative only to compare costs of abatement and are very high level. A more detailed feasibility and costing study would be required to refine feasibility and costings to inform investment decisions.

5.1.3 Energy from waste

It is understood that MSC is working with industry to identify the opportunity for an energy from waste facility within the region. Being able to combust residual waste streams for energy rather than being sent to landfill presents the opportunity for emissions savings in the longer term, as the combustion of waste would be expected to result in lower greenhouse gas emissions compared to allowing gradual breakdown in landfill. It would also, in the short to medium term, replace more intensive energy generation from the existing NSW electricity grid.

Utilising a third-party energy from waste facility would result in an emissions shift from Scope 1 emissions at the Council owned and operated landfill site, to Scope 3 emissions associated with the combustion of the waste at the contracted facility. As the emissions associated with waste breakdown are delayed from the year of landfill receival, the use of an energy from waste facility would result in an initial uplift in emissions compared to a business as usual scenario, as waste is combusted before it would have decomposed. Over the longer term, the impact would break even as the decomposition emissions exceed the combustion emissions. This effect can be seen in Figure 5-2.

For the purposes of the modelling, the emissions associated with energy from waste have been based on a linear scaling of publicly available data for a proposed facility in Victoria, with Australian Paper (Jacobs, 2018). This includes emissions associated with waste incineration, gas and diesel combustion. Whilst these emissions would vary based on the composition of the waste being incinerated, these figures are considered broadly appropriate for a high-level comparison of options in this assessment.

It is assumed for the EFW option that all waste that would have been sent for landfill, is instead sent to the EFW facility from 2025 onwards, as this is when it is understood that the existing landfill will reach capacity (Muswellbrook Shire Council, 2015).

[5] http://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-industry/landfill-and-alternative-waste-treatment-methods/Capture-and-combustion-of-landfill-gas

5.1.4 Summary of Waste Opportunities

Different combinations of waste intervention options are possible, with each resulting in different success in terms of emissions reduction. No options available would reach a net zero emissions standpoint by 2050 and hence would require offsets to achieve the target.

The adoption of a waste reduction program has been considered fundamental and is assumed to be adopted in all roadmap scenarios, to align with the mitigation hierarchies for waste and greenhouse gas which prioritise avoidance and reduction prior to other options. There are interdependencies which means that without the waste reduction program, results for the other option would differ from those presented here (e.g. less food waste present in the waste mix would result in less methane to capture and flare).

Of the options available, the adoption of a waste reduction program combined with a landfill gas capture and electricity generation system is considered the best option from a greenhouse gas emissions reduction perspective, as seen in Figure 5-3. This would achieve a cumulative emissions reduction of 61% compared to the baseline.

Compared to a waste reduction program alone, over the period up to 2050, the adoption of an energy from waste facility would only be expected to result in a 10% reduction in cumulative emissions. This would be increased to 19% when accounting for the effects of offsetting grid electricity, however, is still not comparable to landfill gas options.

All intervention options presented will result in residual emissions for the landfill in the long term. Moving towards a circular economy and drastic waste reduction/diversion beyond that presented within this report is considered the only currently feasible option for significant landfill emissions reduction in the long term. Continued investigation and improvement in waste avoidance, reduction and diversion will be required to minimise landfill emissions as far as reasonably practical.

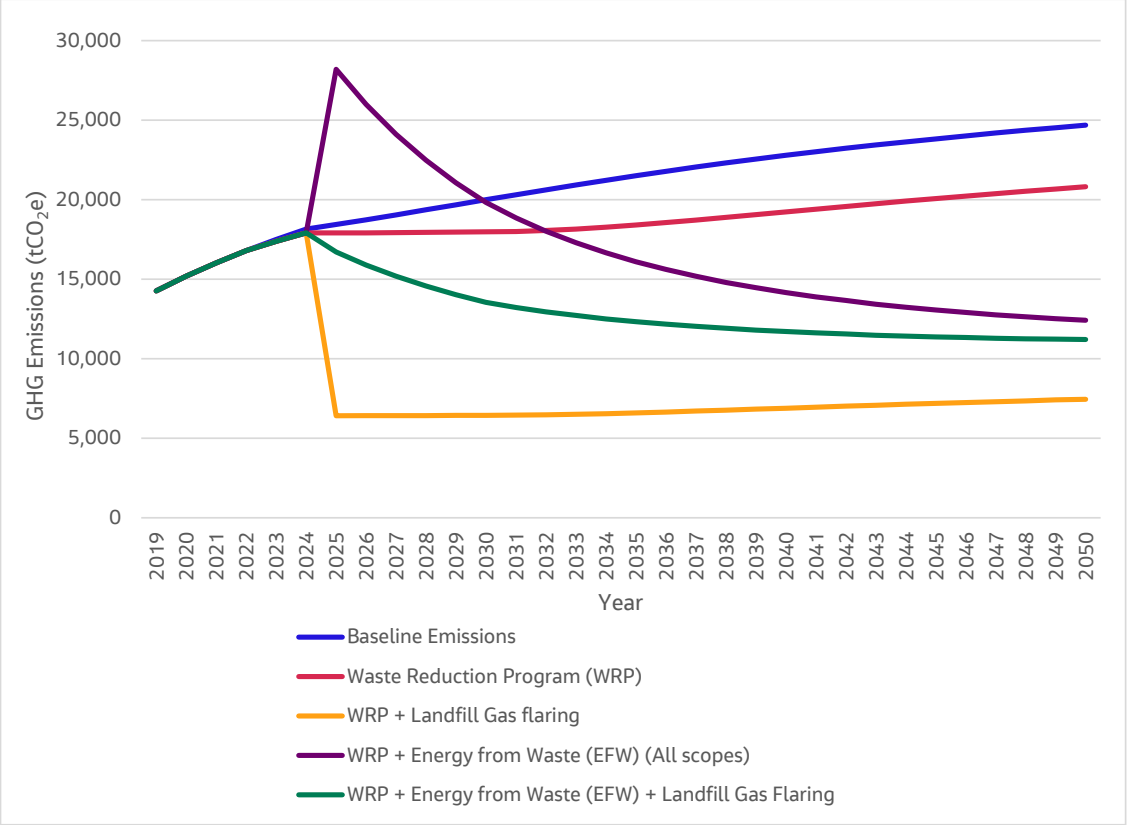

Figure 5-2: Annual GHG emissions comparison of different waste intervention options

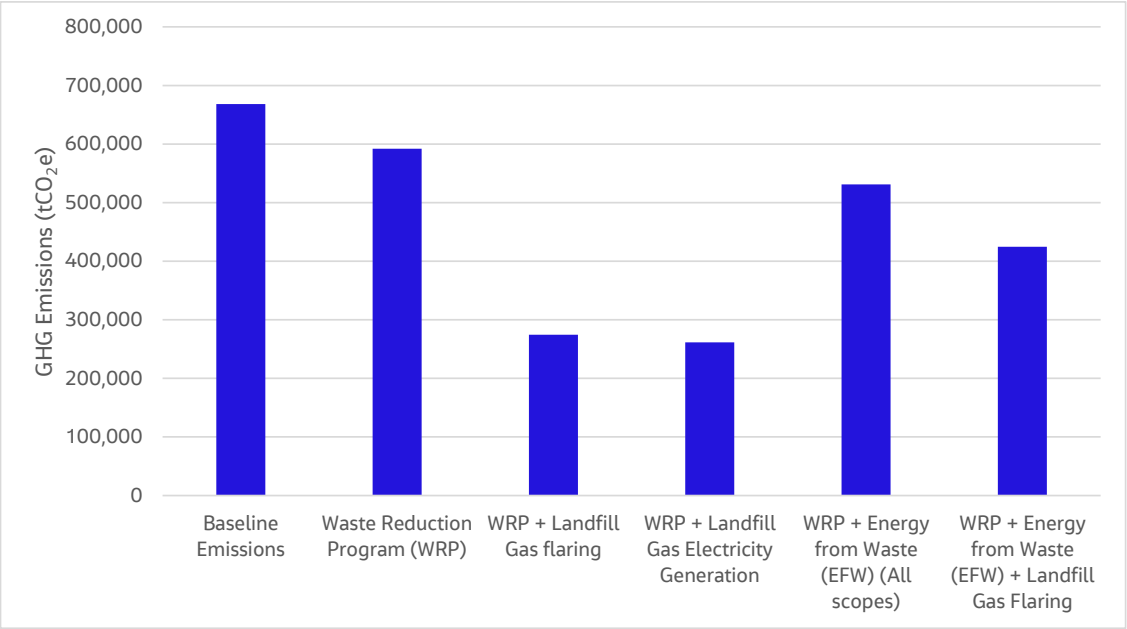

Figure 5-3: Cumulative GHG emissions comparison of different waste intervention options (2019-2050)

5.2 Electricity

5.2.1 Energy Efficiency

Whilst the decarbonisation of the existing electricity grid would be expected to reasonably align with a net zero 2050 commitment (residual emissions would remain although <1% of the baseline footprint), best practice in terms of the GHG mitigation hierarchy requires avoidance and reduction of emissions sources prior to substitution such as renewable energy penetration.

This means that energy efficiency projects should still be explored to align with best practice. As climate change is more of a function of cumulative emissions than emissions at a single point in time, decarbonisation pathways should generally prioritise earlier reductions. Energy efficiency projects provide the opportunity to achieve interim reductions of electricity use emissions whilst also lowering Council's cumulative emissions to 2050.

Two types of energy efficiency initiatives exist:

- Retrofitting of existing energy uses
- Increasing energy efficiency standards for new Council projects

Efficiency Retrofits

Energy efficiency retrofits would be best targeted at Councils largest energy uses where the savings achievable would best justify the level of effort. For the purposes of the roadmap, retrofits are limited to the top 5 electricity uses which are well suited to retrofit initiatives:

- Muswellbrook Marketplace
- Street lighting
- Tertiary Education Centre (TEC) Annex
- Bridge St Library
- Council Administration

These facilities cumulatively accounted for approximately 47% of Councils electricity use during 2019. It's noted that the Muswellbrook Recycled Water Treatment Plant and Water Works and Intake Treatment are also each major energy uses (33% together) where interventions could be explored, however these would require more detailed energy audits outside of the scope of this assessment.

Of the existing facilities considered, only the Bridge St Library has had an energy audit undertaken (Essential Energy, 2013) which identified only limited opportunities related to lighting with the potential to save approximately 6% of electricity use.

A comprehensive study of the potential for energy savings in Australia's existing building stock (Beyond Zero Emissions, 2013) identified the opportunity for retrofits of retail centres to be able to achieve efficiency gains of up to 35% with significant retrofit, offices built between 1980-2000 savings up to over 75% and education buildings from 1970-2013 savings up to over 75%.

Pursuing deep energy retrofits to the greatest extent possible, would have the potential for energy savings as shown in Table 5-1.

Table 5-1: Existing energy uses and the assumed energy efficiency retrofit potential

Electricity source	Assumed Reduction Achievable (%)	Electricity Savings (MWh/year)
Muswellbrook Marketplace	35%	512
Tertiary Education Centre (TEC) Annex	75%	153
Bridge St Library	75%	107
Council Administration	75%	97

Together, from 2025 the energy efficiency retrofits would have the potential to achieve first year emissions savings of 512 tCO_2e and cumulative savings of 4,774 tCO_2e to 2050.

Some retrofit options will likely present the most attractive payback periods to take advantage of the 'low hanging fruit' and most economical opportunities, following which there would likely be diminishing returns for further reductions. Detailed costings for retrofits are outside of the scope of this assessment and should be undertaken for each building to better understand the scale and attractiveness of retrofit opportunities.

As an indication, across a broad range of building portfolios assessed in Beyond Zero Emissions (2013), over a 30 year building life, the investment in retrofits would be expected to result in a lower net present cost for 3% and 5% discount rates when considering upgrade costs vs energy cost savings.

Streetlight Retrofits

At approximately 15% of Councils electricity use, the retrofit of older street lighting to LEDs also presents a significant opportunity for energy savings as well as saving costs on maintenance due to the longer life of LEDs compared to traditional alternatives and income from Energy Saving Certificates (ESCs).

The retrofit opportunity has been investigated and costed by Ausgrid, with the opportunity for over 1,500 luminaires that are currently a mix of compact fluorescent, high pressure sodium and metal halide to be replaced with LED variants. This retrofit program has the potential for electricity savings of approximately an average of 62%, saving up to 566 MWh per year, equivalent to 388 t CO_2e for 2022.

This program would be paid for over 10 years at an annual cost of $96,907, with a once off income of $220,515 for the sale of ESCs and ongoing cost savings of $90,539 from reduced electricity use.

Energy Efficient New Builds

Opportunities for improved energy efficiency of new projects are presented for:

- Entertainment centre opening in December 2022
- Bridge Street mixed-use development opening in July 2023

For the Bridge Street mixed-use development, an upgrade of the design from a 2.5 star NABERs rated development to a 5 star development would present the opportunity to save 56% of energy use, a saving of 86 MWh/year[6]. Assuming a similar savings potential for the entertainment centre through an equivalent standard of

[6] https://www.nabers.gov.au/reverse-calculators

design (entertainment centres are not rated by NABERs), would equate to a saving of up to 146 MWh. These two design improvements would have the potential for savings of up to 141 tCO_2e from 2024 and up to 1,506 tCO_2e cumulatively to 2050.

Other known new facilities are expected to be built too soon to still be within the sphere of influence, however subsequent developments also present opportunities for improved energy efficiency. This could be through mandating the demonstration of a performance beyond the National Construction Code minimum requirements as part of the projects design (e.g. 20% below Section J compliance) and/or requiring a high level of achievement in building rating schemes such as NABERs or Green Star.

Increasing the efficiency of new building design and construction may have a marginal increase in construction capital costs, however, this would be expected to be paid back through energy savings over the building's lifetime. More detailed cost comparisons for achieving different levels of efficiency should be estimated as part of the building design services.

5.2.2 Renewable Energy

Whilst it was discussed within prior workshops that renewable electricity generation would be the preferred source of emissions reduction, under the baseline scenario emissions associated with electricity usage are expected to decline significantly without significant intervention. This is due predominantly to external factors associated with changes in the emissions intensity of NSW electricity grid.

As with energy efficiency, it is still considered preferable, from both an emissions reduction hierarchy and a cumulative emissions perspective, that on-site renewable energy projects would be explored and adopted early where possible. Adoption of 100% renewable energy from 2025 onwards, would result in emissions savings of over 43,900 tCO_2e through to 2050 compared to the baseline, or almost 1.4 times the 2019 total MSC footprint.

There are four primary opportunities for the supply of renewable energy for Council

- Establishment of a Power Purchase Agreement (PPA) with an existing third-party supplier of renewable energy
- Construction and operation of a large (MW scale) solar or wind facility on Council owned land, sufficient to cover all Council electricity use
- Construction and operation of a number of distributed commercial scale (up to 100kW) solar facilities on Council owned land and rooftops
- Purchase of Large-scale Generation Certificates (LGCs) to offset Councils electricity use

Establishing a PPA would have an initial cost associated with setting up the agreement contract, however the ongoing cost of electricity supply would be expected to be competitive with current prices, if not cheaper. The purchase of LGCs for offset would be an ongoing cost, and with the current price of LGCs at around $35/MWh[7], would be an increase in electricity costs of almost 40% compared to current industrial electricity pricing[8]. Therefore, in the long term, the most cost-effective means of electricity supply, and best for community support (based on advice from MSC) would be the construction of Council owned and operated renewable energy projects.

Based on the residual grid energy demand from Council assets from 2024 onwards (following the installation of all currently planned renewable energy projects), meeting the needs of all electricity use through solar photovoltaics would require generation of 7,780 MWh. Based on the generation efficiency of the existing Council owned panels, this would be equivalent to the installation of approximately 4,500 kWp of new panels (~4.5MW). Undertaking energy efficiency projects identified in Section 5.2.1 would be expected to reduce this by up to 23%.

[7] http://greenmarkets.com.au/
[8] https://energy.nsw.gov.au/sites/default/files/2020-12/NSW%20Electricity%20Infrastructure%20Roadmap%20-%20Detailed%20Report.pdf

This provision of solar power and/or storage could be provided through a single, large, dedicated site, or through multiple distributed projects across Council assets.

For large scale installations, optimising the efficiency may require a slightly smaller system. For comparison of scale, existing operating solar farms in NSW range between 10-162 MW of capacity[9]. Based on a similar land use to the 11MW Narromine Solar Farm at Dubbo solar hub, meeting the needs of all residual MSC assets would require approximately 11.6 ha. At a rough cost of approx. $1.1M for a 1MW solar system[10], this would require an investment of up to approximately $5M as a very rough guide for a single large system. For multiple systems of a scaling of approx. 100kW, this would be expected to be closer to $4.2M[11] and hence may be preferable.

Whilst wind power would also be possible, typically wind power is built at much larger scales of at least 50MW to hundreds of MW, and hence the economics at such a small scale are unlikely to be favourable compared to solar. As an indicative example, a similar scale 4.1MW wind system consisting of just two turbines exists at the Hepburn Community Wind Park in Leonards Hill, Victoria. This project cost $12.9M[12], significantly more than an equivalent scale solar system would be expected to cost for MSC. Whilst the efficiency of such a system may mean that the power generated could be higher than the same capacity solar system (2,715 MWh/annum/MW for the Hepburn project compared to 1,730 MWh/annum/MWp for existing MSC solar) this depends on the site selection and strength/consistency of wind at the site, and is unlikely to be significant enough to justify the difference in capital cost, at least in the short-medium term.

It is noted, however, that cost figures presented are very high-level indications and such financial comparisons should undergo more detailed feasibility study and financial estimate prior to any firm commitments being made. This does not account for supply/demand match and is based on offsetting night-time uses through export during the day, nor does it account for future demand growth. To improve the match of supply and demand, the use of battery systems would be required, and to account for future growth through to 2050, oversizing of at least approximately 7.5% would be required (based on scaling with population growth). This oversizing would increase to around 11% if it was to also account for electrification of the plant and vehicle fleet as discussed in Section 5.3.2.

5.3 Fuel

Fuel usage for MSC plant and fleet form part of the baseline Scope 1 emissions and present the opportunity to switch to a greater proportion of biofuel in the shorter term and in the longer term switch vehicles and plant from internal combustion engines (ICE) to electric vehicles, with charging provided through a combination of on-site renewable energy and grid purchased electricity.

5.3.1 Biofuels

In the shorter term, prior to fleet electrification, a greater use of biofuels in MSC plant and fleet presents the opportunity for marginal emissions reduction.

Currently, E10 makes up approximately 46% of all petrol use for Council, whilst there is no existing use of biodiesel. Scaling this up to 100% E10 for all petrol applications, and 100% B5 for all diesel applications would be expected to result in emissions reductions of 4.4 tCO_2e and 6.0 tCO_2e respectively in 2022.

Generally, E10 would be expected to be compatible with most plant and fleet without modification, however, should be confirmed with manufacturer data. Regular diesel can contain up to 5% biodiesel without labelling, however the use of B5 guarantees the proportion, and hence there would not be expected to be any compatibility issues with existing diesel plant using B5 fuels compared to regular diesel. Switching to a greater use of E10 and B5 biofuels would be expected to have negligible cost implications and as such has not been estimated as part this assessment.

[9] https://energy.nsw.gov.au/renewables/renewable-generation/solar-energy
[10] https://www.solarchoice.net.au/blog/1mw-solar-pv-systems-compare-prices-and-installer-options/
[11] https://www.solarchoice.net.au/commercial-solar-power-system-prices
[12] http://chepstowewindfarm.com.au/downloads/Business_Models_For_Enabling_Sustainable_Precincts_Case_Study_Hepburn.pdf

5.3.2 Fleet Electrification

The upfront cost of electric vehicles is expected to reach an equivalent price to ICE vehicles from 2030, based on the central scenario from CSIRO projections[13]. It's assumed that from 2030, the cost of switching leases from ICE vehicles to electric vehicles will have no upfront cost impact and is therefore assumed to be the year of adoption for the purposes of the roadmap. Similarly, it is assumed that by 2030, electric options for other plant and equipment will be available and cost competitive.

Due to the complexity of Councils fleet, a full fleet electrification strategy would require a separate piece of work outside of the scope of this roadmap. It is likely that a staged approach involving early electrification of some plant and later electrification of others would be more suitable, however, 2030 is considered a reasonable mid-point for the purposes of this roadmap.

Whilst electric vehicles can be charged from existing electrical outlets, access to these for the Council fleet may be restricted and depending on schedules of use, fast charging could be required. Without adequate planning this could be a limitation for adoption. It's therefore recommended that investigations are held for future proofing of new Council buildings, in particular the depot, as a priority to save additional costs associated with future retrofits of electrical systems. Fast chargers can range from $1,700 – 50,000[14] depending on the size, speed and number of charging points, so costs for a full fleet are not expected to be insignificant. Based on significant uncertainties at this point in time, however, charging infrastructure costs have not been estimated as part of this assessment, and as such, the cost of abatement presented within this report is expected to be an optimistic representation. Some network charging infrastructure may be provided by others (e.g. public charging points), however convenience and logistics is likely to require some extent of charging infrastructure at Council sites. Future works on fleet electrification could update these figures with more accurate costs.

Energy conversion for fuels is based on comparative efficiencies of ICE and electric cars, assuming 11.6 L/100km for diesel passenger vehicles, 10.7L/100km for petrol passenger vehicles[15] and 11.7 kWh/100km for electric vehicles[16]. The relative fuel to electric conversion adopted for the transition is therefore effectively 1 kWh per 1 L of diesel and 1.1 kWh per 1L of petrol.

If charging of electric vehicles was undertaken directly from the grid, this could facilitate emissions savings of up to 227 tCO_2e for the first year of adoption and 5,474 tCO_2e through to 2050. If this charging was combined with renewable energy supply through an option as discussed in Section 5.2.2 this cumulative benefit would be increased to 5,807 tCO_2e.

Based on comparative electricity costs vs petrol and diesel costs, electrification of Councils fleet would be expected to result in annual cost savings of up to $330,000 from the first year. Whilst not built into the roadmap, it is encouraged that options for investment in electric vehicle and plant alternatives are explored sooner than 2030 based on life-cycle ownership costs (i.e. with consideration to fuel cost savings that may offset any increases in purchase or lease costs incurred prior to price parity) which would hasten the transition.

5.4 Construction Works and Procurement

The first step required for reducing emissions in construction, is the collection of detailed data from construction contractors for capital and maintenance works. It should be integrated into contracts, that Council is to be provided with annual data on as a minimum, fuel, electricity, materials used, and waste generated. This can be used to build a more accurate inventory of Scope 3 emissions associated with contracted construction works.

There are a number of methods to lower the Scope 3 emissions contribution to Councils GHG emissions. Firstly, emissions reduction targets could be integrated into construction contracts, with contracts over a certain value to

[13] Graham, P.W. and Havas, L. 2020, Projections for small-scale embedded technologies, CSIRO, Australia.
[14] https://www.mav.asn.au/__data/assets/pdf_file/0007/21877/Electric-Vehicle-Charging-Infrastructure-for-LG-Fleets-Questions-and-Answers-05dec18.pdf
[15] 92080D0001_1202201810 Survey of Motor Vehicle Use, Australia, 12 months ended 30 June 2018
[16] Future Fuels Strategy: Discussion Paper, Australian Government Department of Industry, Science, Energy and Resources 2021.

demonstrate achievement of emissions reductions of an agreed percentage compared to a business as usual approach. This is becoming prevalent on larger construction projects, particularly those rated under schemes such as the Infrastructure Sustainability Council of Australia (ISCA) IS Rating Scheme. Smaller contractors, however, may require ongoing management and assistance to achieve such reductions, and the preparation of tools to assist with carbon accounting and decision-making frameworks for emissions reduction could ensure a robust process. Initiatives such as increased electrification of contractor construction fleet, requiring the use of a proportion of GreenPower and biofuels, or incentivising the use of more efficient design and construction methodologies could assist in reducing the emissions of construction works.

Council procurement teams should also be requested to keep records of physical quantities of materials purchased, such as concrete, asphalt, aggregates, piping, steel and other major materials sources. This materials information can be combined with greenhouse gas emissions factors for each material to build up a more accurate picture of major emissions contributors in the supply chain. Targeted interventions such as the use of lower carbon materials can then be developed, such as requiring the use of supplementary cementitious materials in concrete, Reclaimed Asphalt Pavements (RAP) laid as a warm mix, and the use of recycled aggregates. A preference for such materials can also be integrated into contracts with third party construction works so that Councils contractors are also using lower carbon materials.

The Infrastructure Sustainability Council of Australia measures best practice GHG mitigation in construction (energy and materials) as up to a 30% improvement compared to 'business as usual' (BAU). If we consider the existing construction practice of MSC as equivalent to a BAU approach, an improved GHG management in construction works would be expected to be able to achieve 'best practice' across their portfolio by 2030 as a conservative estimate. This may start with trials on larger projects, with lessons learnt shared across smaller projects to the point where over time, 'best practice' becomes BAU across all MSC projects.

Assuming that interventions would begin in 2022 and success would gradually build to 2030, emissions savings would be 334 tCO_2e for the year after adoption (assuming the first year would be focused on building skills and improved accounting with limited savings), growing to 2,746 tCO_2e by 2030. From this point it is conservatively assumed that savings would flatline at 30% below existing practice, however further savings could and should be pursued. Total cumulative savings to 2050 would be up to 69,030 tCO_2e.

The cost of reducing contractor emissions has not been assessed in detail and is outside of the scope of this assessment. There may be some additional labour/resourcing costs associated with ongoing management of contractor GHG emissions, and potentially some costs where more innovative materials are preferentially selected to traditional ones. Any offset requirements built into construction contracts would also come at a cost, however, otherwise, it is considered that such reductions could be facilitated with either neutral cost impacts or even potentially cost savings where resource use reductions or construction efficiencies can be identified that otherwise would not be.

5.5 Offsets

It is considered unlikely that all emissions (Scope 1, 2 and 3) will be feasibly able to be reduced to zero within the target dates set (and some residual emissions sources within the supply chain may be permanently unavoidable). In order to reach net zero emissions, the residual emissions (once emissions reduction strategies have been implemented) must be offset.

An offset is a project which reduces or removes greenhouse gas emissions from the atmosphere through natural or technological methods e.g. through reforestation, energy efficiency or renewable energy projects. This is completed through projects outside of the organisational boundary, although similar projects can be undertaken by partnering within the supply chain (e.g. co-sponsoring initiatives) which is referred to as 'insetting' and is effectively a Scope 3 reduction.

Offsets must follow several integrity principles to ensure that they are genuine emissions reductions, with the following principles taken from the Climate Active Carbon Neutral Standard for Organisations:

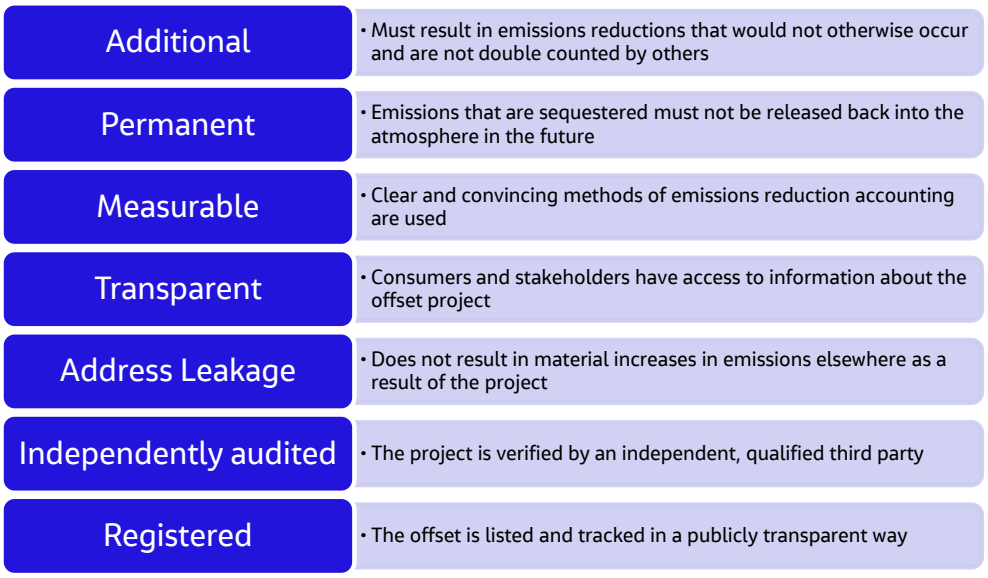

Figure 5-4: Offset project integrity principles (Climate Active Carbon Neutral Standard for Organisations, Commonwealth of Australia 2020)

A range of offset units are available for purchase which are deemed to meet the above integrity principles and are accepted under the Climate Active Carbon Neutral Standard. The use of such offsets is considered important both to align with best practice but also such that Muswellbrook Shire Council may be eligible to pursue Carbon Neutral verification in the future if desired. These include:

- Australian Carbon Credit Units (ACCUs)
- Certified Emissions Reductions (CERs)
- Removal Units (RMUs)
- Verified Emissions Reductions (VERs) issued by the Gold Standard
- Verified Carbon Units (VCUs) issued by the Verified Carbon Standard

Once a carbon offset is purchased, it must then be 'retired', which effectively prevents any future sale, transfer or double counting of the offset.

A wide variety of offset projects are available and can be browsed through an offset marketplace such as the Carbon Market Institutes 'Australian Carbon Marketplace'. Domestic offsets often include projects such as:

- reforestation
- indigenous burning
- changes to agricultural practices
- landfill gas capture
- other projects as available

International offsets such as those available through the Gold Standard often include:

- renewable energy projects
- clean cookstove and clean water projects
- reforestation projects
- other projects as available

Often, additional environmental and social benefits can be facilitated through offsets other than purely the emissions reduction or removals themselves. The Gold Standard, for instance, requires that projects also make multiple contributions to the UN Sustainable Development Goals (UN SDGs) and are designed to safeguard from specific adverse outcomes such as human rights abuses. While these best-practice offset projects are generally more expensive, they can provide significant additional value such as the example shown in Figure 5-5 for cleaner cookstove projects. These projects include providing access to cleaner cooking technologies in developing countries, to replace biomass cooking through open fires or traditional stoves with more efficient cookstove technologies and fuel sources, providing both greenhouse gas and health benefits.

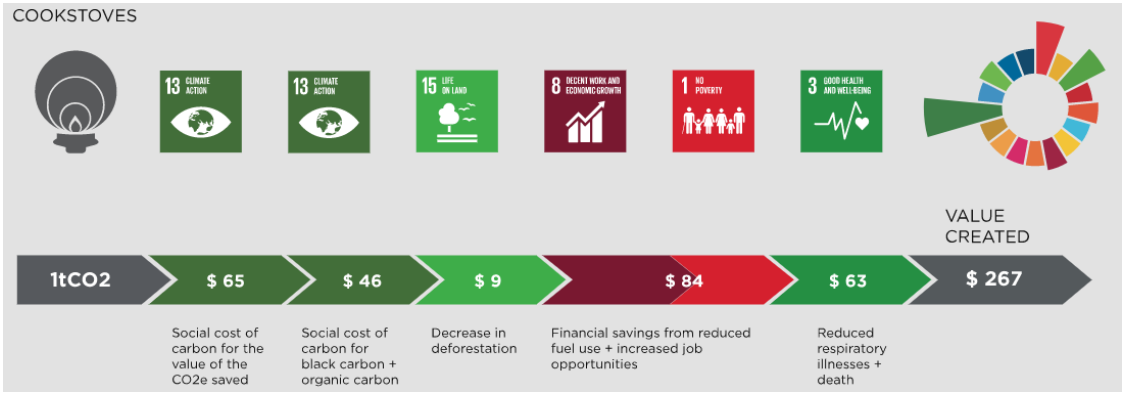

Figure 5-5: Example extended value chain of an offset project for provision of cleaner cookstoves (Gold Standard)

It is recommended that a corporate strategy is undertaken with engagement of employees and stakeholders for targeting insetting and offsetting projects to align with the Corporate Social Responsibility (CSR) strategy.

5.5.1 Offset Pricing

Prices of emissions offsets vary significantly by project type and offset standard, with ongoing market fluctuations meaning that long-term predictions of offset pricing is difficult.

The price of ACCUs has reached $18.50/tCO$_2$e earlier in 2021[17], and projects under other offset standards such as VCUs vary between as low as approx. $16/tCO$_2$e to as high as $44/tCO$_2$e[18].

The pricing of offsets going forward is highly dependent both on the policy context and the combination of regulatory and voluntary demand, however expectations are for price rises for ACCUs of between $20-45/tCO$_2$e by 2030[19] and could reach between $30-100 by 2040[20].

Integrating carbon pricing into investment decision making is known as shadow pricing and involves consideration to a potential future cost associated with an organisation's emissions. In the context of

[17] https://www.reputex.com/research-insights/alert-co2-spot-price-hits-record-high-of-18-50-t-up-12-ytd/
[18] https://market.southpole.com/home/offset-emissions
[19] https://www.reputex.com/research-insights/recording-scenarios-for-australian-carbon-offset-price-development-under-net-zero-emissions-fy21-30/
[20] https://www.reputex.com/research-insights/co2-offset-price-of-100-t-for-australia-to-reach-and-maintain-net-zero-emissions/

Muswellbrook, even without regulatory restrictions or any form of carbon tax, this could include consideration of potential offset costs from 2050 onwards, to meet the organisations net zero commitments (or earlier if interim targets were unable to be met). Through the use of carbon shadow pricing, financial decision making for whether or not to invest in an emissions reduction project would include consideration to the avoided cost of offsets. Cost savings to be presented within this report do not include such a shadow price, however this could be a consideration for Muswellbrook Shire Council going forward. Whilst not common budgeting practice in the public sector at this time, it may be worthwhile for consideration in light of state commitments.

5.6 Summary of opportunities

A number of opportunities are available for emissions reduction with varying costs of abatement. A summary of the emissions potential for all opportunities is presented in Table 5-2 and the corresponding costs of abatement (where available) are presented in Table 5-3 and Figure 5-6.

Table 5-2: Summary of emissions reduction opportunities

Initiative	Year of Adoption	First Year Emissions Savings (t CO_2e)	Total Cumulative Emissions Savings (to 2050) (t CO_2e)
Waste reduction programs	2022	527	76,206
Landfill gas capture and flaring^	2025	11,491	317,238
Landfill gas capture and electricity generation^	2025	12,900	330,630
Energy from waste^#	2025	-10,290*	60,975 111,407 with electricity offset
Energy from waste with landfill gas capture and flaring^#	2025	1,201	167,263
Building energy efficiency retrofits	2025	512	4,774
Streetlight energy efficiency retrofits	2022	388	4,774
Energy efficiency for new builds	2022	141	1,506
Renewable energy~	2025	4,608	43,915
Biofuels	2022	36	292
Fleet electrification	2030	753	18,047 19,095 with 100% renewables

Construction works and procurement	2022	192	39,621

*The negative emissions savings represents an increase in emissions for the first year, before landfill avoidance savings are realised. This would break even around 2032 from which point the use of EFW would see annual emissions reductions by comparison to waste reduction programs alone

^Emissions savings of all waste initiatives are compared to the waste reduction programs alone, which are assumed to be implemented in all scenarios

#Energy from waste savings are not including indirect impacts from offset of energy from the electricity grid, as this effect would be unlikely to be directly accounted for in MSCs future emissions inventories

˜Renewable energy savings do not include the energy efficiency program, and would be less if all energy efficiency projects were pursued

Table 5-3: Summary of abatement cost estimates

Initiative	Capital Cost ($)	Average Annual Cost Saving ($)#	Cost of Abatement ($ / t CO_2e)
Waste reduction programs	Not estimated	Not estimated	Not estimated
Landfill gas capture (flaring)	$1,936,518	-$67,917	$11
Landfill gas capture (generation)	$3,214,209	$686,809	-$28
Energy from waste	Not estimated	Not estimated	Not estimated
Building efficiency retrofits	Not estimated	$294,242	Not estimated
Streetlight efficiency retrofits	$0*	$53,112	-$183
Energy efficiency in new builds	Not estimated	$76,950	Not estimated
Renewable energy	$4,484,159	$2,073,243	-$622
Biofuels	$0	$0	$0
Fleet electrification	$0	$267,136	-$231
Construction works mitigations	Not estimated	Not estimated	Not estimated

#A negative cost saving represents an increase in costs

*No capital cost as the upgrades are paid through a 10-year annuity program, included in annual cost savings

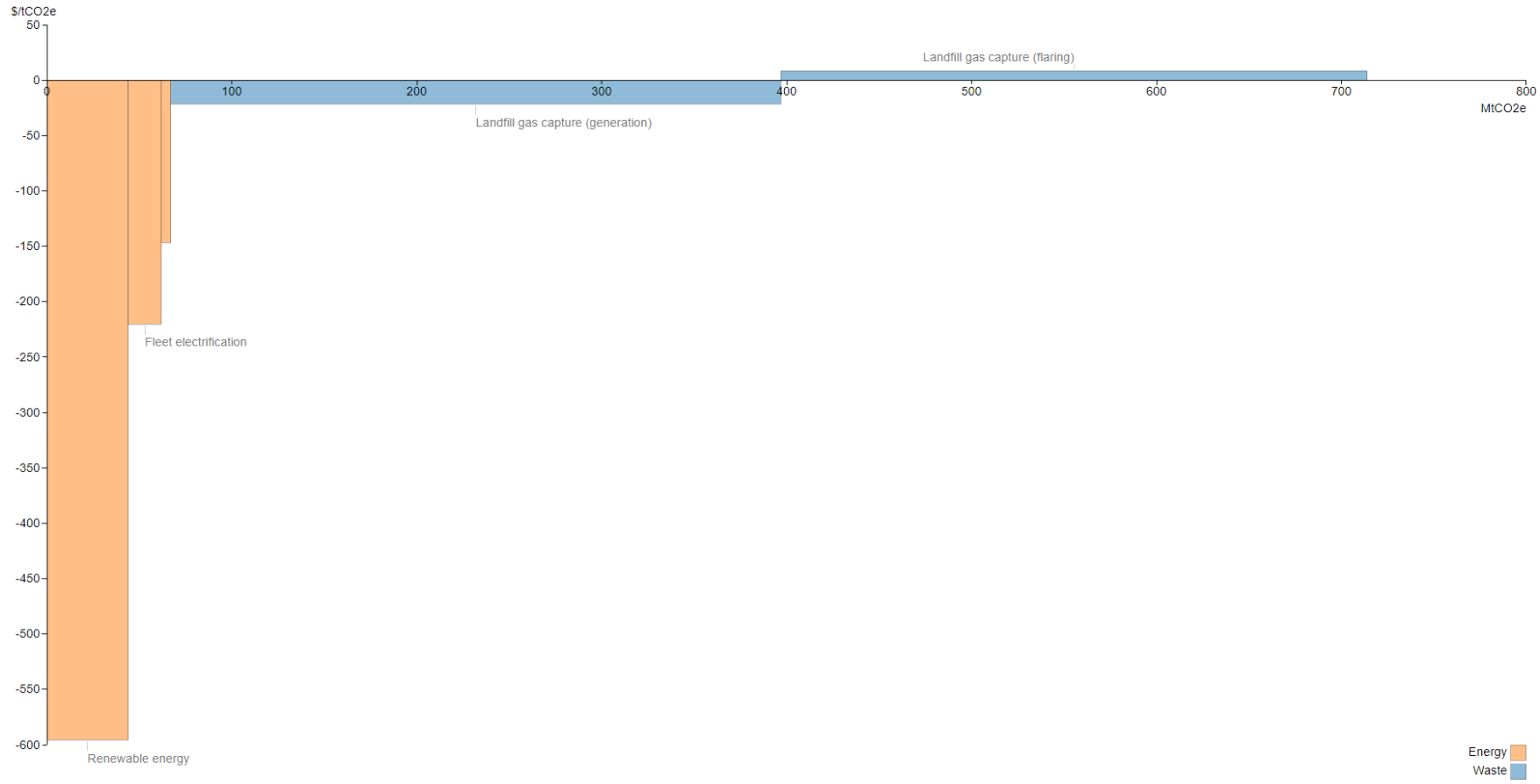

Figure 5-6: Marginal abatement cost curve (MACC)

6. Roadmap Forecast – Net Zero Pathway Results

Based on the adoption of each of the presented opportunities (with the exception of energy from waste), there is a considerable reduction in emissions achieved, however there are residual emissions present. This requires both an ongoing refinement of mitigation strategies over time and offsetting to achieve the 2050 target of net zero. Projections of annual emissions pre and post roadmap implementation are presented in Figure 6-1, with reductions in annual emissions for the target year shown in Figure 6-2.

At 2030 it is expected that the emissions will be over 50% below 2019 levels. Whilst no 2005 baseline exists for MSC for comparison to state interim targets, assuming that trends in MSC emissions are similar to that of NSW (i.e. have been falling since 2005[21]), a 50% reduction on 2019 levels may exceed a 35% reduction on 2005 levels. **[Drafting note: interim target to be confirmed by MSC]** If MSCs emissions have been increasing since 2005, however, as projected in the forward focused baseline scenario, this may not be the case and only the establishment of a 2005 baseline of equivalent boundary could confirm.

It is noted that whilst the year of adoption will not impact the annual emissions profile at 2050 (provided all are adopted by then), the cumulative emissions reduction achieved will differ, and should adoption be delayed, roadmap emissions will more closely track against baseline emissions for an extended period. This would result in higher cumulative emissions over the period between now and 2050, and hence urgency of adoption is considered important for minimising net contribution to global warming.

Figure 6-1: Roadmap total emissions vs target trajectory

From 2035 the residual emissions are expected to exceed the target trajectory without further reductions. Strategies to continually reduce construction emissions and to further reduce waste emissions should be refined over time to realign the actual emissions after this point. Where this is not possible and residual emissions remain, procurement of offsets will be required.

[21] https://www.soe.epa.nsw.gov.au/all-themes/climate-and-air/greenhouse-gas-emissions

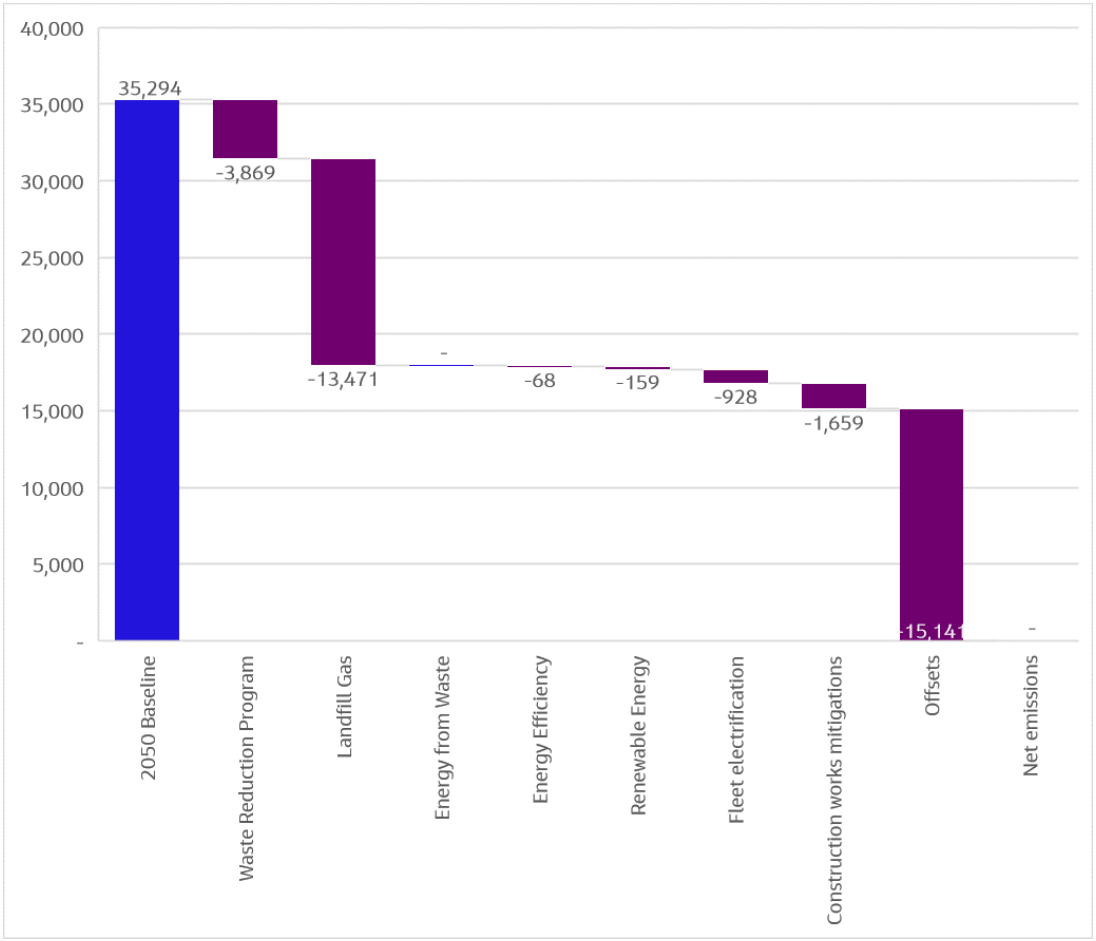

Figure 6-2: Emissions reductions in 2050 under the roadmap

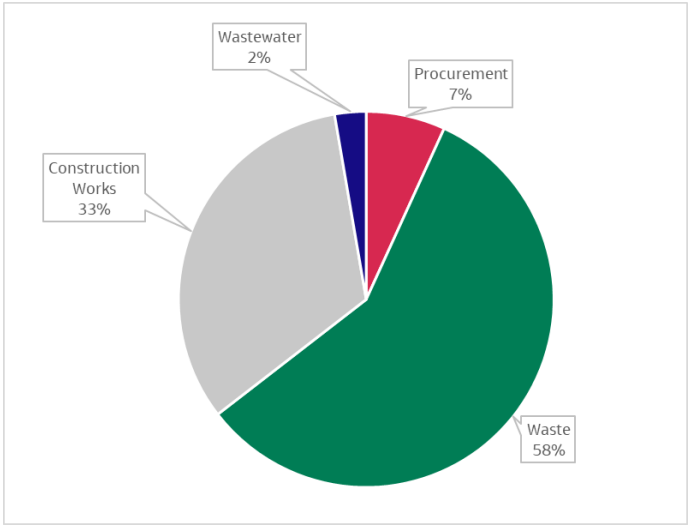

Figure 6-3: Roadmap residual emissions proportions 2050

7. Next Steps

The implementation of the roadmap strategy will require ongoing management. The actions for implementation over the short, medium and long term are presented below.

12 months

- Begin collecting more detailed data for missing emissions sources to develop inventory
    - Require procurement teams to keep records of materials (concrete, steel, asphalt, aggregates, etc), water treatment chemicals and similar in physical units (e.g. tonnes or m^3)
    - Require construction teams to report on land clearing and land use changes as part of projects
    - Integrate requirement for regular reporting of fuel, electricity and materials use information into external contracts
    - HVAC servicing contractors to provide records of refrigerant top-ups in kg of refrigerant
- Refine resourcing plan for waste management to address priority actions, including:
    - Undertake waste auditing to improve waste composition records for landfill
    - Develop Council response plan to address actions within the National Waste Policy Action Plan 2019, NSW Waste and NSW Sustainable Materials Strategy 2041 and other relevant strategies
    - Identify funding and/or grant opportunities as part of National and State strategies for waste reduction, diversion or similar
    - Investigate opportunities for improved FOGO diversion rates and expansion to commercial FOGO collection
    - Audit landfill gas monitoring results and investigate areas for improvement
    - Investigate landfill gas capture opportunities and source funding for feasibility studies and detailed costings
    - Potential initiation of a Council Waste Management Strategy to address above priorities
- Arrange energy audits to identify retrofit opportunities for key buildings including Muswellbrook Marketplace, Tertiary Education Centre (TEC) Annex, Bridge St Library and Council Administration
- Integrate improved energy efficiency requirements into the design for new Council buildings including the Entertainment Centre and Bridge St mixed use development
- Investigate opportunities for biofuel (B5) procurement and storage at Council depot and transition all petrol and diesel to be replaced with E10 and B5 for Council works where compatible (and integrate requirement into construction contracts for third parties)
- Undertake FY2020 and FY2021 updates of emissions inventory using provided tool and NGERs Calculators

3-6 years

- Ongoing updates of emissions inventory including additional detailed emissions source information
- Prepared detailed costings of emissions reduction strategies and integrate into Council budget forecasts
    - Identify opportunities for National and/or State funding and grant opportunities
- Integrate emissions reduction Key Performance Indicators (KPIs) into construction contracts and identify emissions reduction opportunities for construction works
- Review opportunities for further construction works emissions reduction in collaboration with contractors, including opportunities for the use of sustainability rating systems (e.g. Infrastructure Sustainability Council of Australia for infrastructure and Green Star for buildings)
- Implementation of waste reduction programs and domestic and commercial FOGO systems
- Undertake design and implementation of energy efficiency retrofit opportunities
- Undertake detailed design, tendering and construction for landfill gas capture and generation system
- Investigate opportunities for increased renewable energy uptake (distributed, large scale and/or Power Purchase Agreements as appropriate)
- Produce a Green Fleet Strategy to identify detailed opportunities and requirements for transition of Councils plant and equipment fleet to electric (and potentially hydrogen as appropriate)

2030

- Finalise procurement and/or lease agreements for remaining fleet electrification
- Continued collaboration with construction contractors to identify opportunities for further emissions reductions
- Review progress against emissions reduction targets (50% below 2019 levels by 2030) and refine strategy for further mitigation as required [Drafting note: interim target to be confirmed by MSC]
- Begin investigating offset opportunities and consider development of an offset strategy where mitigations are unable to stay on track with targets
- Review ambition for net zero targets (potential to bring forward) and or potential for third-party certifications such as 'Carbon Neutral' under the Climate Active Standard

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