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Towards Zero Emissions 2030 Action Plan

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Abbreviations

Abbreviation	Meaning
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
APVI	Australian Photovoltaic Institute
ARENA	Australian Renewable Energy Agency
BASIX	Building Sustainability Index
BAU	Business as usual
BBP	Better Business Partnership
BCA	Building code of Australia
BMS	Building management system
BRC-A	Business Renewables Centre - Australia
CCA	Climate Change Authority
CO2	Carbon Dioxide
COP	Coefficient of performance
COP21	21st Conference of the Parties
CSP	Community Strategic Plan
DCP	Development Control Plan
DPIE	Department of Planning, Industry and Environment
EV	Electric Vehicle
GDP	Gross domestic product
GHG	Greenhouse Gas

Abbreviation	Meaning
GJ	Gigajoules
GPC	Global Protocol for Community-scale Greenhouse Gas Emission Inventories
HVAC	Heating, ventilation and air conditioning
IPCC	Intergovernmental Panel on Climate Change
ISF	Institute for Sustainable Futures
KFAC	Ku-ring-gai Fitness and Aquatic Centre
LED	Light Emitting Diode
LEP	Local Environmental Plan
LGA	Local government area
LGC	Large Generation Certificate
LSPS	Local Strategic Planning Statement
MREP	Melbourne Renewable Energy Project
MSW	Municipal solid waste
MW	Megawatts
NABERS	National Australian Built Environment Rating System
NCC	National construction code
NSROC	Northern Sydney Regional Organisation of Councils
PHEV	Plug in electric hybrid
PPA	Power purchase agreement
PV	Photovoltaic
SME	Small and medium enterprise
SSROC	Southern Sydney Regional Organisation of Councils
TAI	The Australia Institute
TRP	Total Remuneration Package
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

Abbreviation	Meaning
VPP	Virtual power plant
VSD	Variable speed drive
WARR	Waste Avoidance and Resource Recovery

Background

The peak scientific body on climate change, the Intergovernmental Panel on Climate Change (IPCC) states that, “Climate change represents an urgent and potentially irreversible threat to human societies and the planet” (IPCC 2018). Climate projections indicate the world faces large scale collapse and loss of entire ecosystems (IPCC 2018, p230); severe impacts to human health - from stronger heatwaves, lower air quality, and extreme loss of food and water security (IPCC 2018, p247); increased extent of extreme weather and climate events – flooding, drought, severe storms, wildfire (IPCC 2018, p255); and severe economic loss due to aggregated and compounding impacts (Climate Council 2019a)

At 2018, global heating had reached approximately 1°C due to human induced emissions of greenhouse gases (IPCC 2018). This has coincided with a trend of increasing intensity and frequency of a number of climate and weather extremes (IPCC 2018, p177). With the scientific literature indicating the extent of drought, flooding, heat waves, and tropical cyclones will escalate if global heating is permitted to keep increasing (IPCC 2018, p210). Many observed climate and extreme weather trends have already led to catastrophic ecological responses within Australia, and around the world (Harris 2018), with extensive economic, environmental, and social costs for local communities. In Australia, preliminary estimates at January 2020, indicate the economic cost of the catastrophic 2019/20 bushfire season to be $5 billion (Westpac 2020), while projections are that Sydney could see an increase of as much as 200% in the number of “extreme” fire days, by 2050, compared to 1973 to 2007 (Lucas 2007). Further examples of catastrophic impacts to Australia, that are projected to occur from unmitigated anthropogenic climate change, include:

- A 50% fall in the value of irrigated agricultural output from the Murray Darling Basin by 2050 (Climate Council 2019a).
- Up to 49% fall in wheat output in Western Australia (note: Western Australia is responsible for half of Australia’s wheat production) (Climate Council 2019a).
- A 5 times increase in the number of days over 35°C in Western Sydney, with 17 days per year over 40°C in Richmond (TAI 2018).
- Loss of 70% to 99% of existing coral reefs (IPCC 2018).
- Annual average cost of damage from extreme weather and climate hazards to properties to rise to $85 billion in 2030, $91 billion in 2050 and $117 billion in 2100 (Climate Council 2019a).
- Cost of damages to agricultural and labour productivity reaching $4.2 trillion (Climate Council 2019a).

Council recognises that responding to the social, economic, and environmental impacts of anthropogenic climate change, requires action from all levels of government, and all sections of society (DPIE 2020). It requires action and forward planning based on the most current knowledge and science, and investment in the proven and emerging technologies that will enable zero carbon economies. This Plan outlines the steps that Council will take to play its part in that transition, and to support the community in its transition towards zero emissions.

Purpose

The Towards Net Zero Emissions - 2030 Action Plan supports Council's Climate Change Policy (2020), providing:

- A mitigation response that describes how Council intends to meet its GHG emission reduction target of 50% by 2030 (based on 2000 levels), and net zero GHG emissions by 2040, or sooner.
- A suite of emissions abatement actions that supports community efforts towards a goal of net zero GHG emissions by 2040.
- Investment pathways and abatement areas that support the mitigation response for Council GHG emissions targets, and the community emissions goal.

It also outlines progress of Council's emissions reduction against the targets in the *2015 Climate Change Policy*. This Plan builds on Council's *Greenhouse Gas Reduction Action Plan (2015)*, and the progress made to date in reducing Council's energy consumption and GHG emissions through projects funded by Council's Environmental Levy, and operational budget.

Objectives

This Plan responds to a number of objectives in Council's 2020 Climate Change Policy, which are:

- To reduce Council's greenhouse gas emissions (from fixed assets, street lighting and vehicles) to levels consistent with the international goal of limiting global heating to 1.5˚ C above pre-industrial levels, with no overshoot. Equating to -
    - A reduction in total GHG emissions of 50% by 2030 (relative to 2000 levels), or earlier.
    - A reduction in total GHG emissions to net zero by 2040, or earlier.
- To reach 100% renewable energy for all grid-sourced electricity by 2030, whilst pursuing efforts to reach 100% renewable by 2025.
- To reduce fleet emissions to net zero by 2040, or earlier(based on 2000 levels).
- To support the community in the goal of reaching net zero GHG emissions by 2040. Through the delivery of programs and initiatives that further community GHG emission reductions efforts.
- To continue to review and make accessible, Council's total GHG emissions footprint and emission reduction trajectory
- To review and make accessible the Ku-ring-gai community's total GHG emissions footprint and emission reduction trajectory.
- To reduce Council's, the community's and the natural and built environment's vulnerability to the impacts of climate change.
- To increase Council's, the community's and the natural and built environment's resilience to the impacts of climate change and associated extreme or intensified weather events.

Review of current GHG emission reduction targets

The review of Council's *Climate Change Policy* has considered Australia's commitment to the Paris Agreement and the latest climate science, including the impacts of the GHG

emissions pathways outlined by the IPCC's Special Report on 1.5°C of Global Warming (SR15). The review fulfils the objective of the 2015 Climate Change Policy,

> *To continue to review Council's greenhouse gas emission reduction targets, emissions budget and climate change mitigation and adaptation activities based on international, regional and local climate science and modelling.*

The GHG emissions targets contained in the *2015 Climate Change Policy* apply to Council's own emissions footprint, and are based on recommendations contained in the 2014 report by Australia's Climate Change Authority (CCA), *Reducing Australia's Greenhouse Gas Emissions – Targets and Progress Review*. The recommended CCA targets were developed within a context of Australia doing its fair share to limit global warming to below 2°C. The targets in the 2015 Climate Change Policy are:

- To reduce Council's greenhouse gas emissions (from Council assets, street lighting and vehicles) to levels consistent with the international goal of limiting global warming to 2° C above pre-industrial levels, equating to a reduction in GHG emissions of 20% by 2020, 50% by 2030 and 100% by 2045, based on 2000 levels.
- To limit Council's 2013-2050 emissions to 158,827 tonnes of CO2 equivalent (CO2-e), in order to achieve Council's greenhouse gas emission reduction targets.

In November 2015, the 21st Conference of the Parties (COP21) of the United Nations Framework Convention on Climate Change (UNFCCC) hosted international discussions on the state of climate change, and the threats posed by global heating. The seriousness of those threats led negotiators from 196 represented state parties (including Australia), to adopt by consensus, the language of the Paris Agreement, which includes the commitment to –

> *Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.*

In April 2016, Australia became a signatory to the Paris Agreement, and in November 2016, Australia announced its ratification of the Paris Agreement (Parliament of Australia 2017).

The findings of SR15 indicate that 1.5°C pathways with no overshoot, have the following characteristics:

- The global economy reaches the point of annual net zero emissions by 2040, or sooner (see Figure 2).
- The global economy reduces annual greenhouse emissions by 50% by 2030, or sooner (see Figure 2).
- 1.5°C pathways with no, or limited overshoot include a rapid decline in the carbon intensity of electricity, and an increase in electrification of energy end use. With a reduction in the carbon intensity of electricity of about 90% between 2020 and 2030 (see Figure 3).

On the basis of aligning Council's Climate Change with the Paris Agreement, and with consideration of the risks from 1.5°C pathways with and without overshoot, a set of internal

Council targets for GHG emissions and renewable energy have been determined. A community wide, GHG emissions goal has also been determined, which provides a means for Council to support community efforts to reduce local household and business emissions, in line with the Paris Agreement. The internal Council emissions targets, and the community emissions goals that form the objectives of the updated Policy are outlined in the previous section.

As Table 1 demonstrates, these targets also ensures there is alignment with Council's GHG emission objectives and the North District Plan, the Community Strategic Plan, and the Local Strategic Planning Statement.

TABLE 1: CLIMATE CHANGE POLICY ALIGNMENT TABLE.

Climate Change Alignment between the North District Plan, Ku-ring-gai's CSP & LSPS			
North District Plan Priorities	**Ku-ring-gai Community Strategic Plan Themes and Objectives**	**Ku-ring-gai LSPS Priorities**	**Ku-ring-gai LSPS Actions**
N21. Reducing carbon emissions and managing energy, water and waste efficiently	Theme 2: Natural Environment N4. Climate Change N4.1 A community addressing and responding to the impacts of climate change and extreme weather events. N5. Sustainable Resource Management N5.1 A community progressively reducing its consumption of resources and leading in recycling and reuse.	K38. Reducing greenhouse gas emissions by Council and the Ku-ring-gai community to achieve net zero emissions by 2045 or earlier	• Develop and implement Council's revised Climate Change Policy and Towards Net Zero Emissions Plan 2020-2030 (short term). • Revise Council's 2030 GHG emissions reduction target and net zero emissions reduction target (short term). • Develop community greenhouse gas reduction targets and design interventions that enable a continued reduction in community energy use and greenhouse gas emissions in line with these targets. (short term) • Seek to include new clauses in the LEP to reinforce the DCP requirements for green non-residential, mixed-use and large scale residential flat buildings, and to support the use of sustainable materials, finishes and landscape features across all high density built forms. (short term) • Seek to include and incentivise Design Excellence Mechanisms in the LEP and DCP to deliver sustainable dwellings, mixed use and non-residential buildings. (short term) • Facilitate the uptake of electric vehicles through provisions in the LEP / DCP (short term) • Integrate sustainability measures, incorporating minimum performance standards, into Council's asset management program (ongoing) • Continue to review Council's and the community's greenhouse gas emission reduction targets and trajectories, emissions budget and climate change mitigation activities based on the latest climate science and modeling (ongoing)

The 2020 Climate Change Policy also retains an objective for Council to regularly review and update its GHG emissions targets at regular intervals, incorporating the most recent knowledge and climate science at each interval.

Current GHG Emission Reduction Targets and Performance

Council's 2015 Climate Change Policy, requires Council to continually monitor annual GHG emissions against the relevant emissions targets. Those targets require that net Council emissions from street lighting, energy use by fixed assets, and Council fleet to be reduced to 7,319 t-CO2e by 2020.

As Table 2 and Figure 1 illustrate below, Council's growth in total GHG emissions fell below BAU between 2012 and 2016, with net emissions growth reversing from 2016 onwards. The reduction in annual emissions have been a direct result of Council's energy management program, improvements in the efficiency of street lighting, and improvements in the fuel efficiency of Council vehicles. With the energy management program targeting improvements to building performance via capital upgrades, and improvements to asset performance through enhancements of operating practices. Energy use by fixed assets makes up 49% of Council emissions, while street lighting accounts for 41% of emissions, and Council fleet is the source of 10% of emissions (Figure 2).

As Figure 1 illustrates, Council is expected to meet the 2020 GHG emissions target from the 2015 Policy, of reducing emissions by 20% by 2020, based on 2000 levels. The sourcing of approximately 30% of Council's electricity needs from the Moree Solar Farm, is expected to contribute to a significant portion of the reductions.

TABLE 2: TRENDS IN KU-RING-GAI COUNCIL GHG EMISSIONS SINCE 2000

Scope 1, 2, and 3 greenhouse gas emissions for electricity and gas for Buildings and Fixed Assets, fleet fuel and Ausgrid streetlighting (all emissions are in units of t CO_2-e)

Financial Year	Baseline (year 2000)	2020 Target (20% below 2000)	BAU Expected Emissions	Actual Emissions	Expected Emissions
2000	9,149	7,319	9,149	9,149	
2012	9,149	7,319	9560	9506	
2013	9,149	7,319	9,860	9,527	
2014	9,149	7,319	12,098	10,068	
2015	9,149	7,319	12,123	10,645	
2016	9,149	7,319	12,148	11,258	
2017	9,149	7,319	12,161	10,589	
2018	9,149	7,319	12,408	10,205	
2019	9,149	7,319	12,432	9,658	
2020	9,149	7,319	12,445		6,624

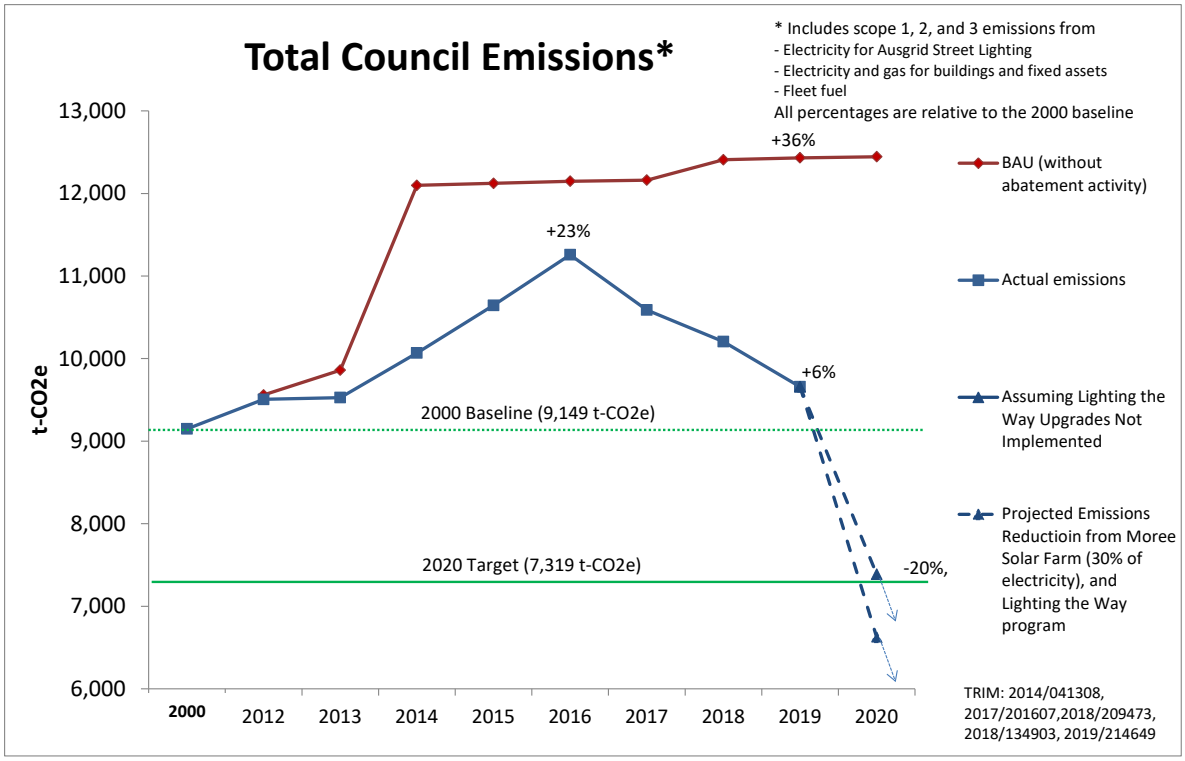


FIGURE 1: TRENDS IN KU-RING-GAI COUNCIL GHG EMISSIONS SINCE 2000

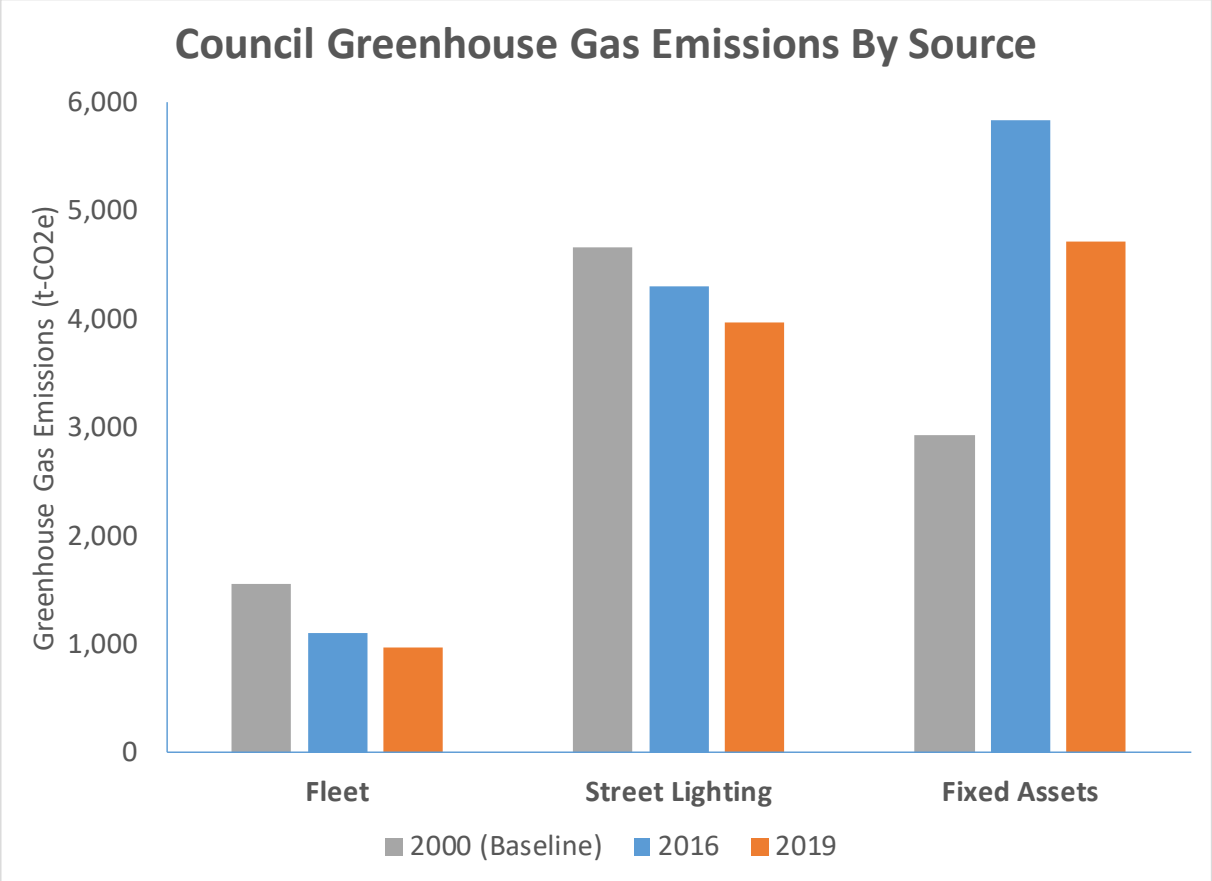


FIGURE 2: TRENDS IN KU-RING-GAI COUNCIL GHG EMISSIONS SINCE 2000 AND 2016

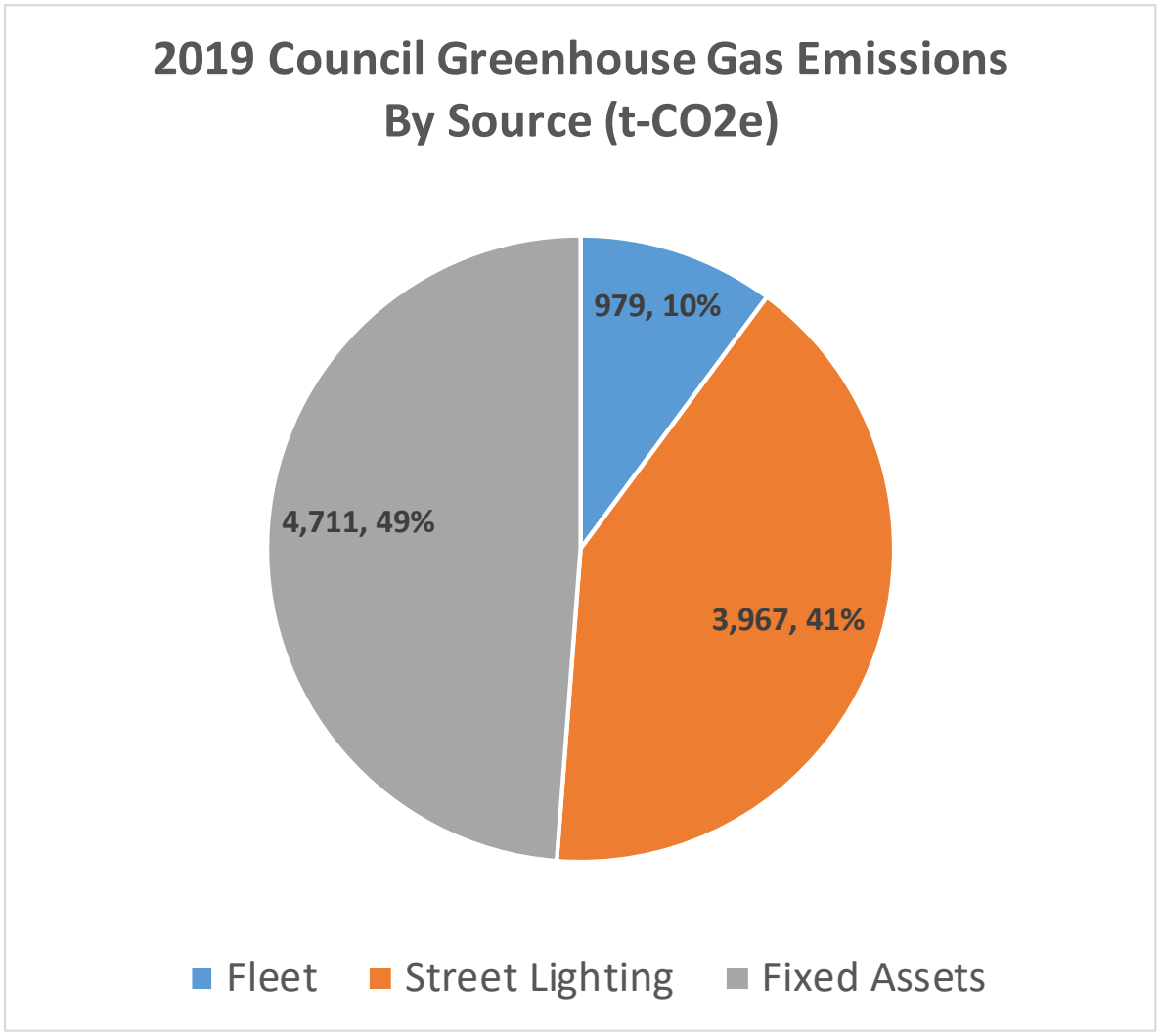


FIGURE 3: KU-RING-GAI COUNCIL GHG EMISSIONS BY SOURCE IN 2019

Pathways to Meeting Council's Targets

Council's internal GHG emissions footprint is currently made up of three key components: electricity use for street lighting, energy use by fixed assets, and fuel use by Council's fleet (Figure 3). As shown in Table 3, the reduction opportunities for these emission sources include energy efficiency measures, installation of rooftop solar PV, transitioning to grid-sourced renewable energy, fuel switching from gas to electricity, and transitioning to low and zero emissions vehicles.

TABLE 3: KEY COMPONENTS OF COUNCIL GHG EMISSIONS INVENTORY.

Fixed Assets	•Energy efficiency measures (capital & operational) •Installation of rooftop Solar PV •Transitioning to grid sourced renewable energy •Fuel switching of gas to electricity
Street Lighting	•Energy efficiency upgrades •Transitioning to grid sourced renewable energy
Fleet	•Transitioning to low and zero emissions vehicles, while transitioning to 100% renewable energy

Pathways for Fixed Assets and Street Lighting

Energy Efficiency and Rooftop Solar PV

Since 2011, Council's investment in energy efficiency and solar PV has yielded significant emissions and cost savings through the reduction of energy use in Council facilities and street lighting. In total, these measures have yielded a 17% reduction in annual energy use by Council's buildings and facilities, and a reduction in annual electricity costs of approximately $191,000 pa, compared to 2015/16, when energy consumption peaked.

Continuation of Council's energy management program is expected to see further improvements in the performance of Council assets. For the purposes of the emissions pathway analysis in this Plan, future energy efficiency improvements are assumed to further reduce emissions by 10% for fixed assets, and 50% for street lighting.

For the ten year timeframe relevant to this Plan, the key abatement activities for realising further emission reductions are identified in the following table, along with corresponding resource allocations:

TABLE 4: ENERGY EFFICIENCY ABATEMENT AREAS

Abatement Activity	Description
Solar PV maintenance	Implementation of a solar PV preventative maintenance program.
Capital works upgrades	Implementation of upgrades to building services and components like HVAC, lighting, controls, BMS, building façade, solar, storage, etc.
Operational energy efficiency measures	Building performance audits / assessments and tuning of building services.
Continuing Professional Development Program	Implementation of a training program to upskill staff in best practice, sustainable building performance. Including staff responsible for specification, design, construction, commissioning, and maintenance of Council facilities.
Sustainable Building Performance Standards	Development and implementation of building performance standards for upgrade and new building works.
Integrated asset management plans for buildings	Development and implementation of integrated asset management plans for 10 to 15 of Council's largest buildings/facilities, by energy use.
Capital works new	Implementation of enhanced building and infrastructure services for improving energy efficiency of new Council assets.
Chambers Capital Works	Implementation of sustainability and energy efficient services upgrades for the refurbishment of 818 Pacific Highway.
Reinvestment of savings (from energy efficiency measures)	Reinvest cost savings from energy efficiency measures funded through the Environmental Levy funding, into further energy efficiency and emission reduction measures.

TABLE 5: ENERGY EFFICINENCY ABATEMENT AREAS – RESOURCING TIMELINE

Funding	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30
Solar PV maintenance	$12,000	$12,279	$12,841	$13,398	$13,800	$14,214	$14,641	$15,080	$15,532	$15,998
Capital works upgrades	$360,000	$122,786	$128,411	$133,983	$138,002	$242,142	$146,407	$150,799	$155,323	$159,982
Operational energy efficiency measures	$160,000	$61,393	$64,206	$66,991	$69,001	$71,071	$73,203	$75,399	$77,661	$79,991
Continuing Professional Development Program	$15,000	$15,348	$16,051	$16,748	$17,250	$17,768	$18,301	$18,850	$19,415	$19,998
Sustainable Building Performance Standards	$10,000	$10,000								
Integrated asset management plans for buildings	$80,000	$81,857	$85,608	$89,322	$92,001	$94,762	$97,604	$100,532	$103,548	$106,655
Capital Works New				$235,000	$216,000		$150,000	$160,000	$170,000	
Chambers Capital Works	$250,000	$188,000	$174,000							

Transitioning to Grid Sourced Renewable Energy

From the 1st July 2019, approximately 30% of Council's electricity needs are served by the Moree Solar Farm under a retail contract with Origin Energy, and as illustrated in Figure 4, this will contribute to a significant step towards Council meeting its 2020 GHG emissions target. The fixed priced contract for the renewable energy, also carries the benefit of providing an element of protection to Council in the event of any electricity market price shocks. Analysis and modelling carried out by Sourced Energy (Sourced Energy 2020), for Council, indicates that procurement of 100% renewable energy would be feasible given the extent to which the market for renewable energy power purchase agreements (PPA) has matured over the past 3 years. The modelling indicates that should the shift from 30% to

100% renewable energy require some investment, this would be modest, relative to the delivered cost of electricity incurred by Council. As Table 6 illustrates, the average annual investment required to transition to 100% renewable energy is within the range of -$22,000 to $34,000 pa, for a PPA with an 8 year term. Which equates to an investment of -3% to 4% of the delivered cost of supply.

Procurement of 100% renewable energy based on GreenPower, GreenPower Connect, and LGC only strategies were also analysed by Sourced Energy (Table 6). The analysis indicates that a greater than 8 year, renewable energy PPA has the potential to provide improved budget certainty, additionality benefits (ie. additional renewable energy capacity in the grid), community co-benefits, and deliver 100% renewable energy. While analysis by Sourced Energy indicates the complexity of procurement and contract management can be high for this strategy, some of this complexity could likely be offset to a manageable level. By applying Council's experience from procurement and contract management of the existing Origin Energy PPA, and by pooling resources with other Councils via a multi-buyer procurement strategy. In their report, Sourced Energy also note that procurement complexity and outcomes may be improved in instances where the buyer is able to implement a direct negotiation procurement strategy. They note that the provision for Councils to undertake direct negotiation strategies exist in the Local Government Act, subject to certain circumstances.

TABLE 6 ANALYSIS IN SOURCED ENERGY REPORT FOR COUNCIL (TRIM: 2020/006830). *THESE FIGURES ARE THE DELIVERED COST OF SUPPLY THAT INCORPORATE ALL ENERGY SUPPLY COSTS. ^THESE FIGURES REPRESENT INVESTMENT REQUIRED FOR LGCS ONLY OR LGC + ENERGY.

	Renewable Energy Investment Required Relative to Business as Usual					
Scenario	**Business as Usual**	**GreenPower Range**	**GreenPower Connect Range**	**PPA > 5 years (8 years) Range**	**PPA < 5 years (5 years) Range**	**LGCs Range**
2022-2025 Renewable Energy Investment $/MWh Low-High Range	$67	$11 - $16	$12 - $17	$8 - $18	$16 - $26	$9 - $11

2022-2025 Avg p.a. Renewable Energy Investment $ Low-High Range	$792,000*	$64,000 - $93,000^	$70,000 - $99,000^	$9,000 - $65,000^	$64,000 - $121,000^	$50,000 - $61,000^
2022-2025 Renewable Energy Investment Low - High Range	-	8% - 12%	9% - 13%	1% - 8%	8% - 15%	6% - 8%
2022-2030 Renewable Energy Investment $/MWh Low-High Range	$72	$11 - $16	$12 - $17	$4 - $13	$16 - $26	$6 - $8
2022-2030 Avg p.a. Renewable Energy Investment $ Low-High Range	$828,000*	$64,000 - $93,000^	$70,000 - $99,000^	-$22,000 - $34,000^	$56,000 - $112,000^	$37,000 - $49,000^
2022-2030 Renewable Energy Investment Low - High Range	_	8% - 11%	8% - 12%	-0.07	4% - 66%	4% - 6%
Budget Certainty	_	Medium	Medium	Medium to High	Medium to High	Medium
Delivery Risk	_	Low	Medium	Medium	Medium	Low
Complexity	_	Low	Medium	High	High	Low
Additionality Benefits	_	Low	Medium	High	High	Low
Potential Co-Benefits	_	Low	Medium	High	High	Low

Gas Fuel Switching

As shown in Figure 4, gas usage contributes to 9% of emissions from energy use within Council's fixed assets. The major sources of this gas use is:

1. Pool water heating at the Ku-ring-gai Fitness and Aquatic Centre (KFAC)
2. Amenities hot water heating at KFAC and Suakin St Depot,
3. Use of the gas fired kiln at the Art Centre

Decarbonising these services, and potential future services, will require a fuel switching strategy, where electricity or hydrogen sourced from renewable energy is substituted for gas. As technology emerges and matures for fuel switching options, it will be necessary for Council to develop and implement such a strategy.

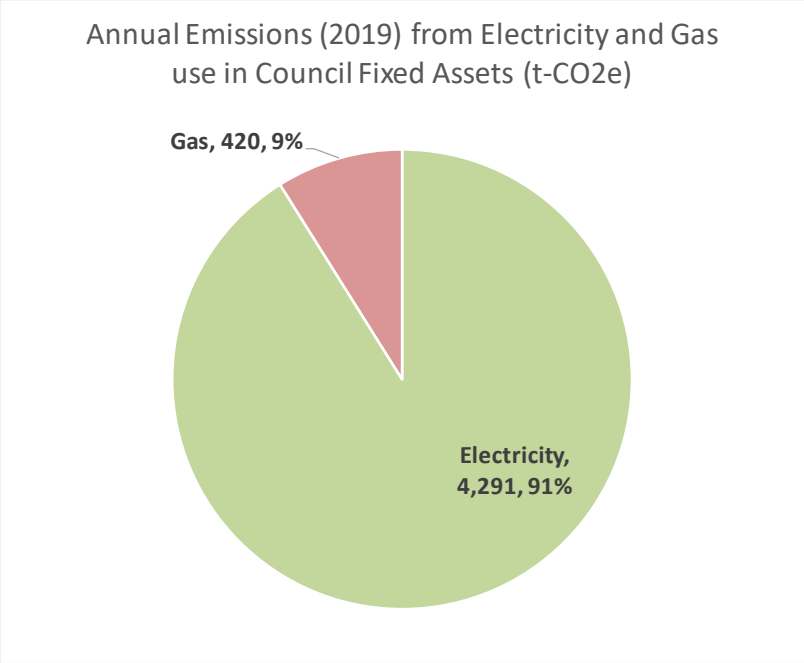


FIGURE 4: BREAKDOWN OF EMISSIONS FROM ELECTRICITY AND GAS USAGE IN COUNCIL FIXED ASSETS.

Street Lighting

Council's participation in Ausgrid's accelerated LED upgrade of residential street lighting is expected to lower annual electricity consumption by approximately 989 MWh/year[1]. Additionally, consultants for the SSROC Street Lighting Improvement program, have anticipated that LED upgrades for the entire street lighting portfolio are expected to reduce annual consumption from street lighting to approximately 2,360 MWh pa[2]. This equates to a 45% reduction in electricity consumption and emissions, relative to the 2019, and approximately $241,000 reduction in annual electricity costs for street lighting.

Residual emissions from street lighting can be reduced to zero as part of transitioning to 100% renewable energy for Council's electricity supply. Any transition to 100% renewable energy initiated prior to the upgrade of the entire street lighting portfolio, would require projections for reduced street lighting loads to be incorporated into contracted electricity volumes.

[1] Analysis of *Lighting The Way* proposal to replace residential street lights with LED's – TRIM: 2018/223482

[2] Next Energy estimate that LED upgrades will reduce street lighting consumption by 50%, relative to the 2013 baseline of 4,721 MWh - 2017/036200.

Pathways for Council Fleet

At 2019, Council's fleet contributed to 10% of the organisation's GHG emissions (Figure 2). In December 2019, Ironbark Sustainability (Ironbark Sustainability 2019) carried out modelling for Council to analyse fleet emissions pathways under a number of assumptions and scenarios. The analysis informed the suite of recommendations listed in Table 8, based on existing and emerging technologies which could be implemented over a 10 year timeline, starting from 2020. Emission impacts from implementation of the recommendations, were modelled for four scenarios, shown below.

TABLE 7: EMISSIONS PATHWAY SCENARIOS FOR COUNCIL FLEET.

Scenario	Scenario Description	GHG emissions reduction in 2030, relative to 2000 baseline
1	Council transitions to 100% renewable energy by 2025.	71%
2	Council incrementally transitions to 100% renewable energy by 2030.	65%
3	No lease back or TRP vehicles are transitioned to electric vehicles (EVs), and Council transitions to 100% renewable energy by 2025.	62%
4	No Council light trucks are transitioned to EVs or hydrogen, and Council transitions to 100% renewable energy by 2025.	51%

Scenarios 1 and 2 describe a pathway where all the recommendations in Table 8 are implemented, while scenarios 3 and 4 describe pathways where specific measures are not implemented. As Table 7 indicates, under all scenarios, fleet emissions in 2032 would be at least 50% lower than the 2000 baseline[3], and 71% lower under the best-case scenario.

In practical terms, each scenario represents a unique opportunity roadmap to guide Council investment in the fleet transition. Specific actions and corresponding investment are listed in more detail in Table 9 and Table 10, for years 2021 to 2032. Between 2025 and 2030 it is assumed that the heavy fleet and remaining passenger fleet, transition to EVs, or hydrogen fuel cell vehicles. Note, investment levels for transitioning the heavy fleet, is yet to be confirmed, as technology options for vehicles in the portion of the fleet will become clearer closer to that time.

For the purposes of this Plan, scenario 1 is used to define the adopted opportunities roadmap. Under projected abatement for this scenario, existing fleet emissions of 979 t-CO2e, are reduced by 519 t-CO2. This leaves residual emissions of 460 t-CO2e remaining, for passenger vehicles that are part of the leaseback/TRP fleet, and which are assumed to be charged with standard grid power at the relevant staff member's home. If the NSW grid electricity emissions intensity is reduced linearly, and in line with the NSW state emissions

[3] Detailed modelling for each scenario are contained in the *Fleet Transition Strategy - Ironbark Final Report* - 2019/357341

target of net zero emissions by 2050, these residual emissions could reasonably be expected to be 67% lower by 2040. The small volume of residual emissions, equating to 150 t-CO2e, could be offset in order to reach zero emissions.

TABLE 8: FLEET ABATEMENT OPPORTUNITIES.

D	Proposed Timing	Recommendation
Passenger Vehicles		
PV.1	2019/20 to 2020/21	Evaluate emerging EV/PHEV options for Ranger's passenger vehicles and vans, against fit-for-purpose criteria.
PV.2	2019/20 to 2020/21	Add more EV options to the leaseback/TRP calculator and work with the Fleet and Finance Teams to design incentives to reduce the employee salary deduction for EVs; making it more attractive to Council staff
PV.3	2020/21 to 2030/31	Re-evaluate the business case annually for replacing passenger vehicles to EVs or PHEVs, with the aim to replace all passenger vehicles to EVs by 2030
PV.4	2021/22 onwards	In the medium term (3 to 5 years), Council can consider fully or partially subsidising the installation of Level 2 chargers at staffs' residences as a part of the salary sacrifice package. This will greatly increase the viability and attractiveness of owning an EV. Before implementation address points detailed in the "**Error! Reference source not found.**" section
PV.5	2021/22 onwards	Consider the implications of home charging on carbon accounting. Investigate methods to estimate and report home charging data.
PV.6	2021/22 onwards	Advocate to the State and Federal government to a) subsidise EV purchase b) open state government purchasing opportunities to local government.
Light Commercial Vehicles		
LC.1	2019/20 to 2030/31	Gradually replace utility vehicles as per the 10-year Fleet Replacement Plan to the most fuel-efficient vehicles guided by the Green Vehicle Guide.
LC.2	Annually	Periodically research on the available options for buses and utility vehicles to identify viable low-emissions replacement options.
LC.3	2019/20 to 2024/25	Develop a business case with the objective of transitioning all existing vans to electric alternatives[4] over the next 5 years.
LC.4	2020/21 to 2021/22	Trial an electric minibus in 2020/21 and transition all minibuses to electric by 2021/22.
Heavy Vehicles, Plant & Equipment		
PE.1	Ongoing	Periodically review council and international trials on alternative fuel sources for Council trucks. Once concept is proven, develop a business case and where relevant, implement.
PE.2	Ongoing	Periodically review low emissions alternatives for plant equipment and where there is a business case, implement.
Fleet Policy		
FP.1	2019/20	Update Council's fleet policy to be best practice is aligned with Council's sustainability targets and develop vehicle procurement criteria that favours the purchase of low emissions vehicles. The fleet policy will inform fleet management decisions and should ideally be completed before finalising the fleet replacement plan.
FP.2	2019/20	Consider the establishment of a 'Business Use Incentive' for TRP and leaseback vehicles. This would be ideally underpinned by a Council fleet policy and is established to incentivise the use of lower emissions vehicles and linked to the amount of cash contribution in an employee's remuneration package. For instance, Council can provide estimated additional income for home charging to incentivise EVs.
FP.3	2019/20	Include in the fleet policy vehicle performance criteria weighted heavily towards purchasing lower emissions vehicles to ensure fleet decisions are aligned with Council's broader sustainability targets.

[4] This study has assumed all vans are replaced to the Renault Kangoo Z.E.

TABLE 9: REPRODUCED FROM IRONBARK FLEET TRANSITION STRATEGY (TRIM: 2019/357341). WITH ACTIONS MOVED BACK BY ONE YEAR TO ALLOW FOR START YEAR OF 2020/21.

Scenario 1: 100% Renewable Energy	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32	Total
Replace purchased vehicles to EV (GHG savings, tCO2e)	3.0	1.9	1.9										6.8
No. of cars replaced	1	2	2										5
Replace TRP vehicles to EV (GHG savings, tCO2e)		2.8	2.8	2.8	4.2	7.0	7.0						**26.6**
No. of cars replaced		2	2	2	3	5	5						**19**
Replace leaseback vehicles to EV (GHG savings, tCO2e)				6.2	6.2	6.2	6.2	12.4	12.4	24.8	24.8	24.8	**123.8**
No. of cars replaced (exclude hybrids)				5	5	5	5	10	10	20	20	20	**100**
% renewable energy charging vans, minibuses & trucks	30%	30%	30%	30%	30%	100%	100%	100%	100%	100%	100%	100%	
Replace minibuses to EV (GHG savings, tCO2e)		6.7	6.7	6.7									**20.0**
No. of minibuses replaced		1	1	1									**3**
Replace utility vehicles to more energy efficient option (GHG savings, tCO2e)	0.6	0.6	1.5	1.5	1.5	1.5	1.5						**8.6**
No. of utility vehicles replaced	2	2	5	5	5	5	5						**29**
Replace vans to EV (GHG savings, tCO2e)	3.0	3.0	3.0	6.0	6.0	6.0							**27.1**
No. of vans replaced	1	1	1	2	2	2							**9**
Replace light trucks to renewable fuel source (GHG savings, tCO2e)						9	18	27	27	27	37		**146.1**
No. of light trucks replaced						1	2	3	3	3	4		**16**
Replace medium trucks to renewable fuel source (GHG savings, tCO2e)							12	25	25	37	37		**136.5**
No. of medium trucks replaced							1	2	2	3	3		**11**
Replace heavy trucks to renewable fuel source (GHG savings, tCO2e)								11.9	11.9				**23.8**
No. of heavy trucks replaced								2	2				**4**
Annual GHG Savings Actioned (tCO2-e)	**6.6**	**15.0**	**15.9**	**23.2**	**17.9**	**29.8**	**45.3**	**76.5**	**76.5**	**89.4**	**98.5**	**24.8**	**519.3**
Total Ongoing GHG Savings (tCO2-e)	**6.6**	**21.6**	**37.5**	**60.6**	**78.5**	**108.3**	**153.7**	**230.2**	**306.7**	**396.1**	**494.6**	**519.3**	

TABLE 10: REPRODUCED FROM IRONBARK FLEET TRANSITION STRATEGY (TRIM: 2019/357341), WITH ACTIONS MOVED BACK BY ONE YEAR TO ALLOW FOR START YEAR OF 2020/21. NOTES: ALL COSTS ARE THE COST DIFFERENTIAL BETWEEN BUSINESS-AS-USUAL AND RECOMMENDED ACTION *A NEGATIVE COST CAN BE INTERPRETED AS A SAVING TO COUNCIL; **THE REPLACEMENT OF UTILITY VEHICLES TO MORE ENERGY EFFICIENT ALTERNATIVES ARE ASSUMED TO BE PART OF THE OPERATIONAL COST IN LINE WITH THE REPLACEMENT PROGRAM, THEREFORE THERE IS NO ADDITIONAL COST; ***ESTIMATED COST FOR COUNCIL OR CONSULTANT TO DEVELOP UPDATED FLEET POLICY

	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31	31/32	Total
Scenarios 1, 2 & 4													
Replace purchased vehicles to EV	$27,000	$54,000	$54,000										$135,000
Replace TRP vehicles to EV*		$0	$0	$0	-$1,000	-$1,000	-$1,000						-$3,000
Replace leaseback vehicles to EV*				-$1,000	-$1,000	-$1,000	-$1,000	-$2,000	-$2,000	-$4,000	-$4,000	-$4,000	-$20,000
Replace minibuses to EV		$40,000	$40,000	$40,000									$120,000
Replace utes to more energy efficient option**													$0
Replace vans to EV	$9,000	$9,000	$9,000	$17,000	$17,000	$17,000							$78,000
Update fleet policy***	$10,000												$10,000
Replace truck fleet (beyond 2025)						TBC	TBC	TBC	TBC	TBC	TBC		TBC
Total Annual Budget	**$46,000**	**$103,000**	**$103,000**	**$56,000**	**$15,000**	**$15,000**	**-$2,000**	**-$2,000**	**-$2,000**	**-$4,000**	**-$4,000**	**-$4,000**	**$320,000**
Scenario 3													
Replace purchased vehicles to EV	$27,000	$54,000	$54,000										$135,000
Replace TRP vehicles to EV													
Replace leaseback vehicles to EV													
Replace minibuses to EV		$40,000	$40,000	$40,000									$120,000
Replace utes to more energy efficient option**													$0
Replace vans to EV	$9,000	$9,000	$9,000	$17,000	$17,000	$17,000							$78,000
Update fleet policy	$10,000												$10,000
Replace truck fleet (beyond 2025)						TBC	TBC	TBC	TBC	TBC	TBC		TBC
Total Annual Budget	**$46,000**	**$103,000**	**$103,000**	**$57,000**	**$17,000**	**$17,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$343,000**

Meeting the 2030 and 2040 Targets

Over the period of 2021 to 2040, the actions in each abatement area are projected to progressively reduce GHG emission as illustrated in the waterfall chart in Figure 5. As this shows, a transition to 100% renewable energy creates the possibility of emission reductions that are rapid, and the possibility of the 2030 target being met with a significant margin.

Figure 4 also illustrates the importance of the fleet transition and gas fuel switching to meeting the goal of zero emissions, with these sources representing around 14% of total GHG emissions in 2019.

Responsibility and resourcing for the specific abatement areas are summarised in the opportunities roadmap contained in Appendix 1 and 2, respectively. While the opportunities

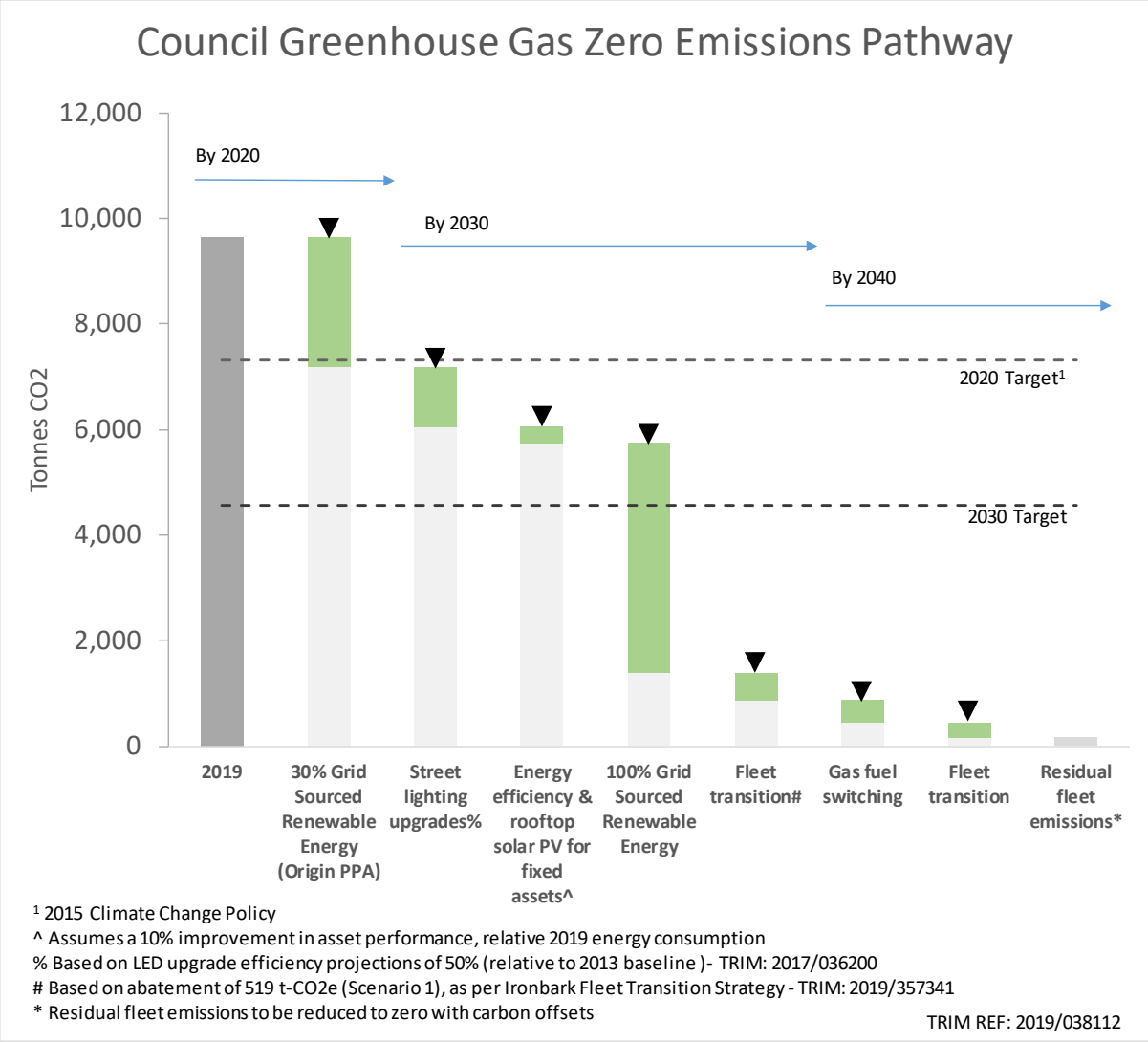


FIGURE 5: COUNCIL GHG EMISSIONS WATERFALL CHART.

roadmap provides a guide for forward planning of Council investment and resources, its implementation will also require flexibility to respond to new technology and abatement opportunities that may emerge over time.

Project financial criteria

To ensure that emission abatement measures are effective and deliver the best return on investment, the following criteria shall be used to prioritise funding of projects by the Environmental Levy, and the reinvestment of savings:

- Mitigation actions will be prioritised based on their ability to provide the best rate of return (or payback periods) while achieving a high reduction of GHG emission reductions. Projects with the cheapest cost of abatement and the greatest net abatement should be prioritised first.
- Where Environmental Levy funding is used to support a project, in general it will contribute to that portion of the project that lifts the performance outcomes above and beyond compliance, or business-as-usual.
- Where funding is available in a given year, the Environmental Levy is able to support initiatives that can a) demonstrate a payback period of 12 years, or less, and b) which have a substantial impact on the relevant asset's GHG emissions.
- For initiatives with a payback period longer than 12 years, project approval is subject to approval by the Senior Sustainability Officer or Environmental Levy Program Leader, provided a) the cost of abatement is less than or equal to $50/tCO2e, and b) there will be substantial impact on Council's total GHG emissions.
- At times there may be technologies with a cost of abatement that is higher than $50/tCO2e, but where the cost of abatement is expected to eventually decrease to below the threshold level. In such instances there may be a case for implementing a demonstration project in anticipation of the technology meeting Council's financial criteria in the coming years.

Pathways for the Community Emissions Goal

Community GHG Emissions Goals

The 2015 Climate Change Policy proposed that the 2020 Policy include an objective to support a goal of reducing community GHG emissions to net zero by 2040, through the delivery of programs and initiatives that further emission reduction efforts.

This goal brings the objectives of Council's Environmental Levy Community Engagement program into alignment with the objectives in the Community Strategic Plan, the Local Strategic Planning Statement, and the Greater Sydney Region Plan. It also ensures the Environmental Levy Community Engagement program is informed by the latest climate science, and reflects the objectives of Paris Agreement, which seeks to limit temperature increases to 1.5°C.

The Community GHG Emissions Inventory

In determining a GHG emissions inventory for the Ku-ring-gai LGA, Council engaged consultants, 100% Renewables, to apply the Global Protocol for Community-scale Greenhouse Gas Emission Inventories (GPC). The GPC framework allows cities and local governments to capture emissions that occur in city, as well as emissions that occur outside the city, but for which the city is responsible - eg. emissions from electricity consumed within the LGA, which typically occur in coal fired generators located outside of the LGA.

For the purposes of measuring Ku-ring-gai's community GHG emissions, the GPC BASIC level reporting has been applied, ensuring that emissions from key household and business activity is captured (see Table 11).

TABLE 11: KU-RING-GAI COMMUNITY GHG INVNETORY SCOPE AND KEY EMISSIONS SOURCES.

Emission source	Scope	BASIC	BASIC+
Stationary fuel combustion	1	✓	✓
In-boundary transportation	1	✓	✓
Grid-supplied electricity	2	✓	✓
Waste and wastewater generated and disposed in the city	1	✓	✓
Waste and wastewater generated in the city and disposed outside	3	✓	✓
Electricity transmission and distribution losses	3	x	✓
Out-of-boundary transportation	3	x	✓
Industrial Processes and Product Use (IPPU)	1	x	✓
Agriculture, Forestry, Land Use (AFOLU)	1	x	✓

Boundary conditions, data sources, and assumptions for the GHG inventory are detailed in the *Community Inventory and Climate Change Strategy* report (100% Renewables 2020).

For Ku-ring-gai the community inventory consists of emissions from three key sources - stationary energy (electricity and gas usage in buildings and facilities), transportation, and waste. The breakdown of emissions across these sources, and across emissions scope, is shown in Table 12.

TABLE 12 KU-RING-GAI COMMUNITY GHG EMISSIONS INVENTORY.

t CO_2-e	BASIC	Scope 1	Scope 2	Scope 3
	Stationary	46,506	419,020	
	Transportation	322,162	24,544	
	Waste	0		49,005
	TOTAL	**861,237**		

Based on the aim of limiting global temperature rise to 1.5°C, the C40 international network of cities committed to addressing climate change, has classified the required abatement pathway of cities, into four typologies – "*Steep Decline", "Steady Decline", "Early Peak",* and *"Late Peak"*[5]. Each typology is based on the level of emissions per capita, and GDP per capita, in order to reflect each cities contribution to global emissions, and each cities capacity to act.

On a per capita basis, Ku-ring-gai's emissions are 6.81 tonnes CO2-e per person (see Table 13), and GDP is $50,815 per person (100% Renewables 2020. This sees Ku-ring-gai being classified as having a *Steep Decline* typology (see Table 14).

TABLE 13: KU-RING-GAI COMMUNITY GHG EMISSIONS INTENSITY INDICATORS.

Intensity indicators	Per capita	Per unit land area (km^2)	Per unit GDP (US$m)
Emissions (t CO_2-e)	6.81	10,132	96

[5] https://www.c40.org/researches/deadline-2020

TABLE 14: CITY TYPOLOGIES USED BY C40 CITIES.

GHG / Capita	City GPR/capita	Assigned typology	Example cities
High (>5.1 tCO_2e/capita)	High (>$15,000/capita)	Steep Decline	Toronto Melbourne New York City
	Low (<$15,000/capita)	Early Peak	Cape Town Durban
Low (<5.1 tCO_2e/capita)	High (>$15,000/capita)	Steady Decline	Stockholm Seoul London
	Low (<$15,000/capita)	Late Peak	Quito Caracas Amman

The following pie charts show the contribution of the BASIC sectors to the GPC inventory, as well as the contribution by sub-sector. As can be seen, stationary energy consumption (electricity and natural gas consumption in buildings and facilities) is responsible for more than half of emissions. Transport emissions contribute 40% to the carbon footprint and waste contributes 6%.

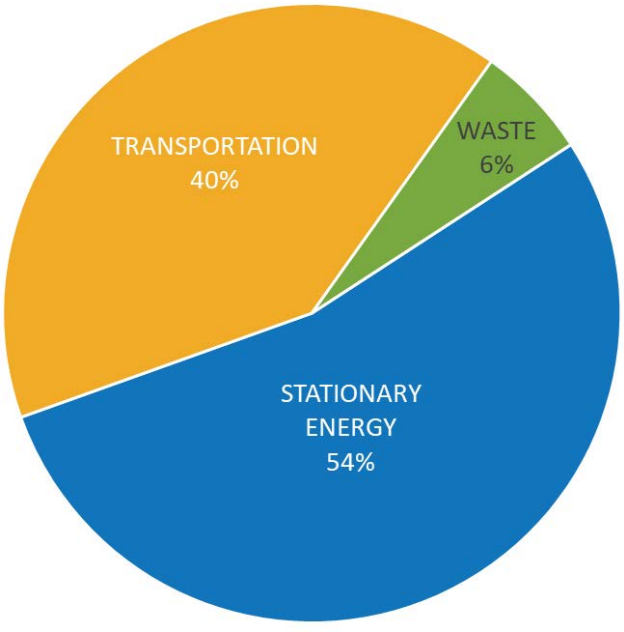


FIGURE 3: KU-RING-GAI GPC BASIC INVENTORY – CONTRIBUTION BY SECTOR

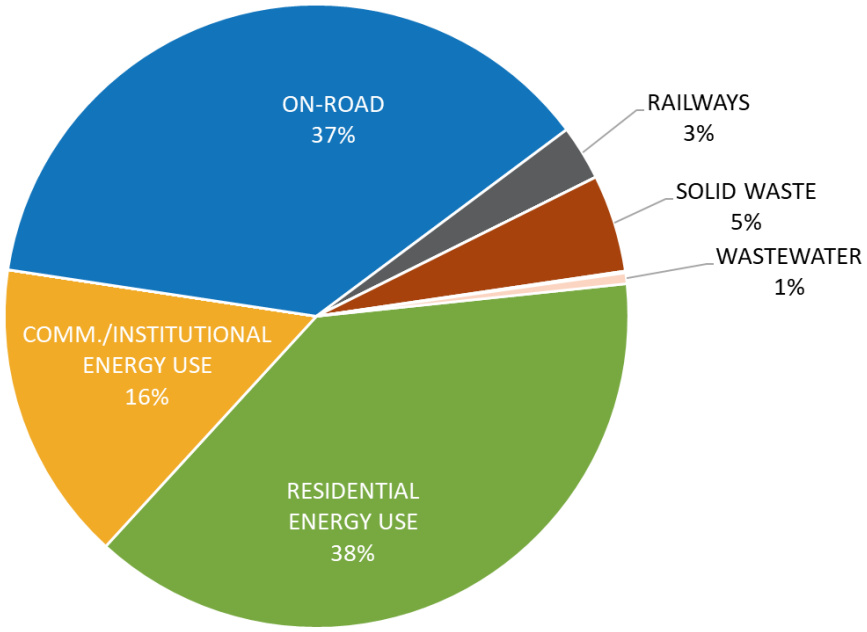


FIGURE 4: KU-RING-GAI GPC BASIC INVENTORY – CONTRIBUTION BY BASIC SUB SECTOR

Existing Community Engagement Program

The existing Environmental Levy Community Engagement program, incorporates a significant program of initiatives, focussed on supporting households and local businesses to lower their GHG emissions footprint, by reducing energy consumption, reducing waste, and adopting sustainable transport options. The program, is currently supported by approximately $280,000 of Environmental Levy funding per annum[6].

Of 67 reported outcomes from Council's programs to the end of 2018/19 a selected summary focused on energy & carbon mitigation measures and includes the following (100% Renewables 2020):

- $176,859 in rebates distributed via the Energy Smart Savers program, leveraging community investment of $891,486, since 2014/15
- 25 Smart Unit action plans developed, identifying $662,223 in annual cost savings
- 3,516 engagements via Climate Wise Communities from 2018/19, including events and website interactions
- 36,478 community engagements in environmental programs from 2012/13
- $234,931 in expected energy cost savings through Energy Smart
- 583 energy-efficient pool pumps installed since 2014/15, plus 55 energy-saving retrofits from 2017/18
- 80.4 tonnes of compost diverted from landfill; 513 compost bins distributed
- More than 30 km of walking tracks built or maintained, and 9 km of new cycleways
- Significant growth in subscribers to Council's social media, e-news and video channel

[6] Refer to TRIM: 2020/100553. Additionally, $87,000 per annum of general revenue supports the Better Business Partnership program.

Emissions Pathway Scenarios

In identifying how Council can support a community goal of zero emissions by 2040, 100% Renewables modelled three emission pathway scenarios. Each scenario includes abatement from the following areas, which are described more detail in Appendix 3:

- Grid decarbonisation,
- Buying clean energy,
- Local generation (renewable energy),
- Energy efficiency,
- Sustainable transport and
- Waste management.

For each pathway, the level of abatement achieved per year is associated with a set of specific actions undertaken by the community, government, and energy/transport/waste sectors. The three pathway scenarios are:

1. Business-as-Usual (BAU) which seeks to project emissions in future if current and expected trends are maintained,
2. A '1.5 degree C' scenario that would see abatement effort accelerated both outside and within the LGA, so that emissions in the community follow a trend consistent with that required to limit global warming to no more than 1.5°C (i.e. net zero emissions by 2040), and
3. A mid-way scenario that sees action accelerated compared with BAU

As Figure 7 illustrates, the BAU scenario would see Ku-ring-gai GHG emissions at 2040 only being approximately 50% lower than 2018 emissions, and the mid-way scenario would see 2040 emissions that are approximately 23% of 2018 emissions. Note that the 1.5°C scenario presented in this analysis is only one possible pathway out of many, which could see Ku-ring-gai emissions reach zero by 2040. The specific abatement areas assumed to occur under the 1.5°C scenario are detailed in Table 15.

In practical terms, Council has varying degrees of influence, but not control, over a number of the abatement areas. Instead responsibility for the abatement related actions in Table 15, are distributed between the community, businesses, and the three levels of government. Which underlines the point that achieving zero emissions by 2040 is dependent on action from the community, the business sector, and all levels of government.

Notably, the outcomes described under grid-decarbonisation and sustainable transport, which represent the two largest abatement areas, are directly controlled through regulation and policy settings at state and federal levels of government.

Taken together, this underscores why Council's role in a 1.5°C scenario, is best understood through the support it can provide to the community, and its influence on the policy settings within other levels of government. Those opportunities identified in the analysis by 100% Renewables, are detailed in the following section.

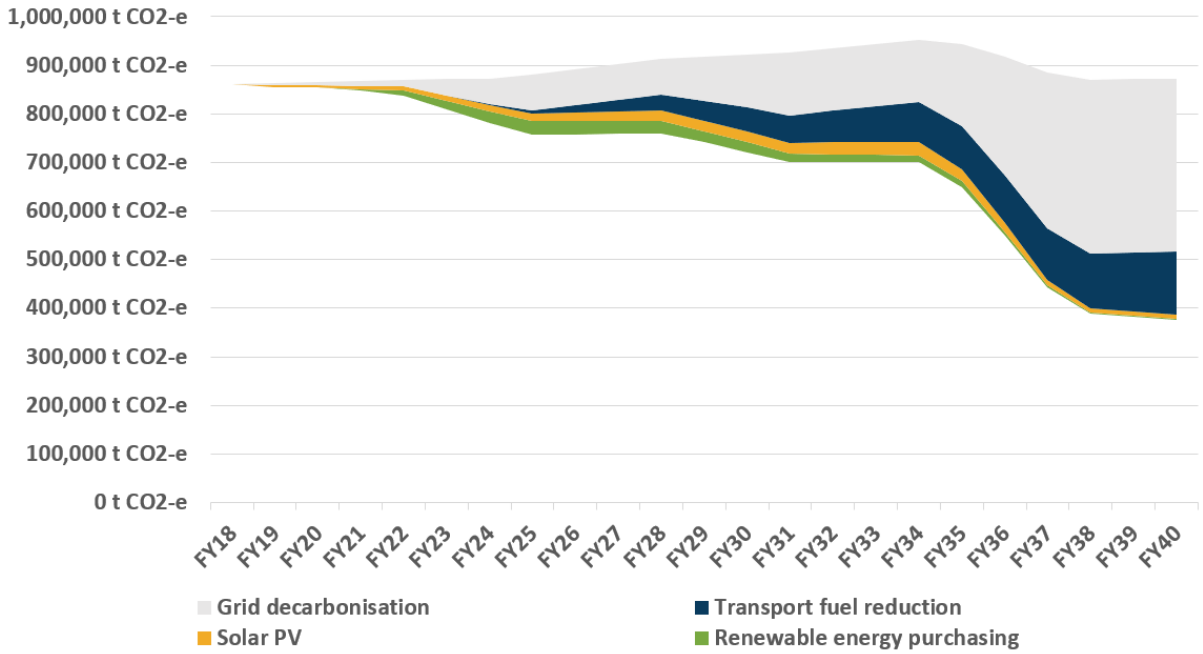


FIGURE 5: PATHWAY TO 2040 UNDER SCENARIO 1

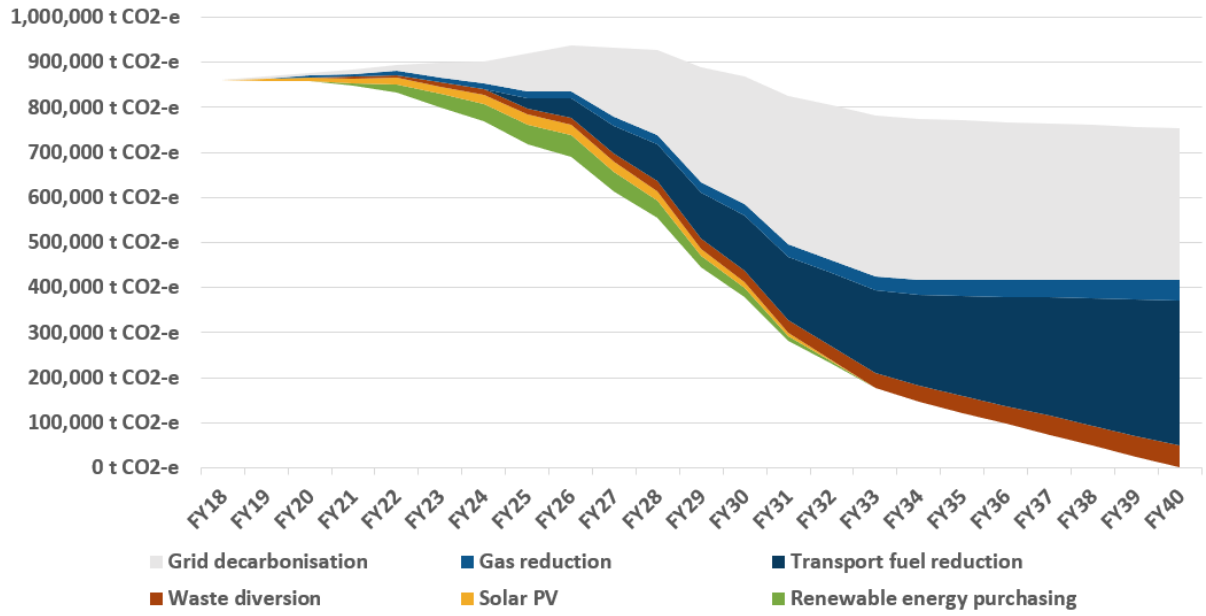


FIGURE 6: PATHWAY TO 2040 UNDER SCENARIO 2

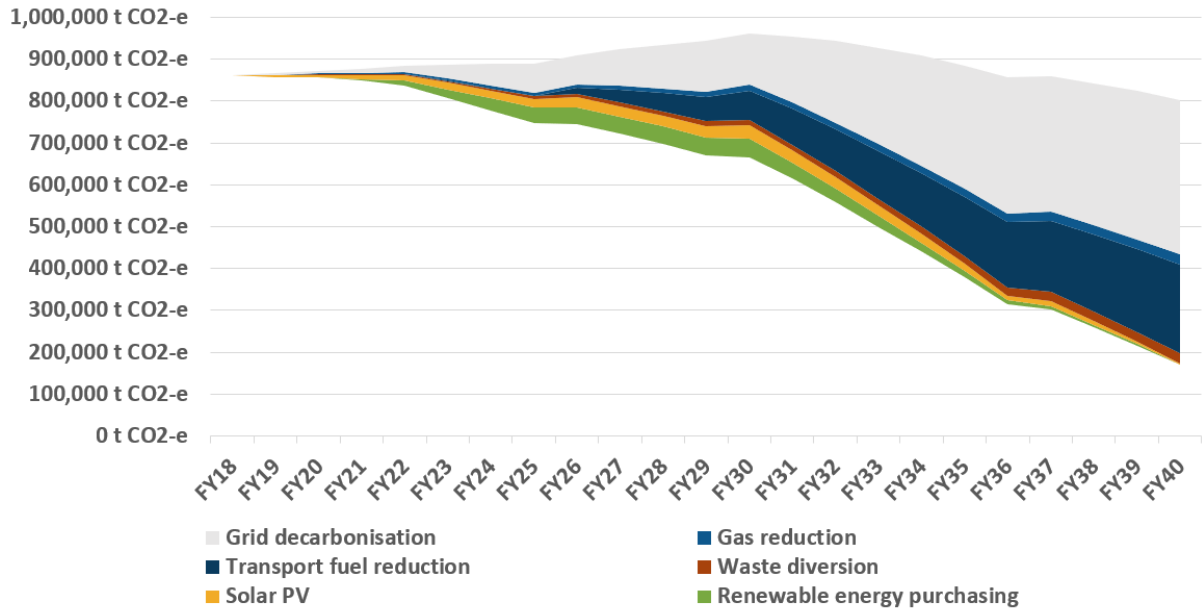


FIGURE 7: PATHWAY TO 2040 UNDER SCENARIO 3

TABLE 15: POSSIBLE EMISSIONS PATHWAY – '1.5 DEGREE C'

	Abatement area	Emissions Pathway	Equivalent to…
	Energy & renewables: Grid decarbonisation	The grid decarbonises by 2030 (3-year rolling average grid GHG intensity means there is a delay in the full emissions reduction being seen)	Closures of Liddell (2022), Vales Point B (2024), Eraring (2026), Bayswater (2028) and Mt Piper (2030), with some residual emissions assumed for interstate energy imports
	Energy & renewables: clean energy purchasing	Renewable energy purchasing is feasible for business energy users with say a 50% uptake by 2030 at 5% of energy use per year from 2020	Large and SME energy users in the LGA enter into renewable energy power purchase agreements assumed at a similar price to 'regular' grid power
	Energy & renewables: Local generation (with solar PV)	Recent trends are accelerated for solar PV systems, including capacity, average size and self-consumption levels	Average system size increases by 0.3 kW per year from 7.3 kW now. Number of installed systems increases by 2% year-on-year. Self-consumption increases from 65% now to 90% by 2040, reflecting EV and battery storage systems
	Energy & renewables: energy efficiency (incl fuel switching)	Natural gas is phased out of use in the period to 2040 on a linear basis and replaced with electricity. Current electricity demand	All gas is assumed to have a combustion efficiency of 80% and to be replaced with electric technology with an average COP of 3. Electricity changes reflect more

		declines at 1% year-on-year. Electricity demand increases to account for accelerated uptake of electric vehicles and buses	energy-efficient new buildings and accelerated upgrade to or replacement of older appliances and equipment.
	Sustainable transport: private	Retail fuel sales are little changed in NSW for several years, consumption and emissions are taken to be steady out to 2025, then decrease by 6.25% per year to reflect accelerated uptake of electric vehicles	AEMO forecasts suggest very low uptake of EVs until after 2025. This accelerated uptake would see 100% of private transport be electric by 2040. Linear 6.25% pa change in fuel use/emissions is simplistic but assumed for this model to be reasonable
	Sustainable transport: public	Buses are assumed to become all-electric by 2030 in a linear manner from 2022, and 100% rail and electric bus demand met from renewable PPA by 2025	NSW Government policy is to increase its electric bus fleet across all of the 13 bus networks. It is assumed that the State government and bus operator agreements for electricity will switch to renewable energy PPAs
	Waste management	Emissions from waste are assumed to reduce to zero by 2040 in a linear pathway from 2020	This would likely see the implementation of consumer side (i.e. waste reduction/reduced consumption, household composting/worm farms, 100% recycling rates), and post-collection side (100% organics processing, material recovery) measures.

Opportunities and Actions to Support the Community 1.5°C Pathway

Based on the analysis by 100% Renewables, this Plan outlines a suite of opportunities available for Council to support the 1.5°C community pathway. These are detailed in Appendix 4, and summarised in Box 1, for each of the abatement areas. Where these opportunities represent additional effort above and beyond the current Environmental Levy Community program, the required additional resources have been identified on a spectrum of neutral-to-low (<$20,000/year), medium (>$20,000/year), and high (>%50,000/year).

The key actions for this Plan are outlined in Table 16, below.

TABLE 16 KEY ACTIONS FOR SUPPORTING THE COMMUNITY 1.5°C PATHWAY

Key Action	Description of Key Action	Responsibility
Deter	For Council to review the existing Community Engagement program, the suite of additional opportunities (Appendix 4, and Box 1), and available funding / resources, to determine the most effective mix of initiatives that will support a community goal of net zero emissions by 2040.	Environment and Sustainability
	For Council to adopt a continuous improvement model, where the effectiveness of the program mix is reviewed every one to two years, with changes made as opportunities to improve effectiveness are identified.	Environment and Sustainability
	Develop and implement a communication plan which raises community awareness of: a) Ku-ring-gai's current community GHG emissions footprint. b) The opportunities for the community to support the 2040 goal of net zero emissions, and a 1.5°C emissions pathway. c) Ku-ring-gai's annual progress against the 2040 goal.	Communications Environment and Sustainability

Box 1 - Council Resources and additional funding (taken from 100% Renewables 2020)

Section 7 highlighted initiatives undertaken by Council in the community to help residents and business save energy, reduce emissions and save money. Several examples of Council's resource inputs and success stories are highlighted, such as:

- $100k per annum invested in the Better Business Partnership program, with 284 MWh in energy savings identified in the three years to 2016/17 and 10% of this verified as implemented,
- $176,859 in rebates distributed via the Energy Smart Savers program, leveraging community investment of $891,486, since 2014/15 (approximately $45,000 leveraging $225,000 of community investment annually),
- $234,931 in expected energy cost savings through Energy Smart, per year,
- 583 energy-efficient pool pumps installed since 2014/15, plus 55 energy-saving retrofits from 2017/18
- 80.4 tonnes of compost diverted from landfill; 513 compost bins distributed

The outcomes noted above – in terms of energy saved and renewable energy capacity installed – are one part of the community's overall story in terms of trends in energy use and uptake of renewables. Business-as-usual projections assume that current trends will be maintained, and therefore assume that Council's current initiatives will continue to have a similar level of impact.

However, under a '1.5°C scenario' climate change mitigation efforts across the community will have to accelerate well beyond current trends, even if largely external measures such as grid decarbonisation occur much faster than forecast. Based on the modelled 1.5°C scenario, the level of additional effort that may be required to reduce energy-related emissions within the community can be summarised as:

- Local generation (with solar PV)
    - Under the BAU scenario, an average of 500 new solar PV systems will be installed every year at an average capacity of 7.3 kW, continuing the trend of the last 2 years. This will add 3.7 MW of new solar every year. Overall, 80 MW of new solar PV will be added by 2040.
    - Under a 1.5°C scenario, an average of 654 new solar PV systems would be installed every year at an average capacity of 10.95 kW and would progressively include more battery storage. This would add an average of 7.2 MW of new solar every year. Overall, 154 MW of new solar PV will be added by 2040.

Continued over page

Box 1 Continued

- Buying clean energy
    - Under a BAU scenario, renewable energy purchasing would see an average of 2.3 GWh of added electricity supplied from renewables each year, above what is being supplied from the grid. This is equivalent in generation to a 1.6 MW solar PV farm.
    - Under a 1.5°C scenario, renewable energy purchasing would see an average of 6.9 GWh of added electricity supplied from renewables each year, above what is being supplied from the grid. This is equivalent in generation to a 4.6 MW solar PV farm.
- Energy efficiency
    - Under a BAU scenario, underlying electricity use is projected to remain steady until 2040, ignoring transport changes.
    - Under a 1.5°C scenario, electricity use is projected to decrease 1% year on year due to energy efficiency, ignoring both fuel switching from gas and transport EV uptake. This equates to an annual electricity reduction by 2040 of about 100 GWh. To give this context, this equates to the following beyond-BAU measures:
        - 10,000 pool pump efficiency initiatives, each saving 750 kWh per year, and
        - 400,000 36W fluorescent lights upgraded to LED, and
        - 30,000 air conditioning interventions, each saving an average of 2,000 kWh p.a., and
        - 50,000 replacement energy efficient appliances, each saving an average of 250 kWh per year
- Natural gas
    - Under a BAU scenario, underlying natural gas use is projected to remain steady until 2040.
    - Under a 1.5°C scenario, all gas will be replaced by electricity by 2040 at a rate of 4.5%. This would see a reduction of 903 TJ of natural gas consuming equipment converted into 241 GWh of electricity consuming equipment by 2040. This is the equivalent of replacing 1,800 gas hot water systems with electric heat pump hot water systems every year.
- Sustainable (private) transport
    - Under a BAU scenario, transport will see a 40% reduction in fuel consumption due to electric vehicles replacing combustion engine vehicles by 2040, starting from 2025. This is equivalent to an average of 2,300 combustion engine vehicles being replaced every year by electric vehicles until 2040.
    - Under a 1.5°C scenario, transport will see a 100% reduction in fuel consumption due to electric vehicles replacing combustion engine vehicles by 2040, starting from 2025. This is equivalent to 5,900 combustion engine vehicles being replaced every year by electric vehicles until 2040.

Continued over page

Box 1 Continued

- Waste management
    - Under a BAU scenario waste levels are assumed to remain at current levels to 2040.
    - Under a 1.5°C scenario, emissions from waste are assumed to reduce to zero by 2040 in a linear pathway from 2020. This would likely see the implementation of consumer side (i.e. waste reduction/reduced consumption, household composting/worm farms, 100% recycling rates), and post-collection side (100% organics processing, material recovery) measures.

The scale of this task is reflected in the Action Plan tables assessment of what the additional effort (cost, time and resources) by Ku-ring-gai Council might be in order to facilitate these outcomes. For the 31 action items identified across the six action categories:

- 18 are estimated to require neutral to low additional effort by Council, and are in the areas of advocacy, collaboration, strategy development, planning and education / workshops.
- 6 are estimated to require moderate additional costs, potentially more than $20,000 in added costs (direct, staff, etc) per year. Typically this will for collaboration and Council work to progress emerging or challenging opportunities such as BASIX +, Virtual Power Plants, EV planning, waste management initiatives, etc.
- 7 are estimated to require high additional costs, potentially more than $50,000 in added costs per year. Typically these costs will be for incentives (e.g. solar on strata, battery storage, energy efficiency), and the development of new infrastructure / services to support waste reduction / composting as well as electric vehicles in the community.

While the total amount of new annual funding that could potentially be required to support the acceleration of these initiatives across the community could exceed $500,000 per year, a reasonable starting point to progress high priorities as assessed by Council might be $200-250,000 per year.

Appendix 1 – Council Opportunities Roadmap - Responsibilities

TABLE 17: COUNCIL OPPORTUNITIES ROADMAP - RESPONSIBILITIES

	Description of Abatement Area	Responsibility
Fleet transition – opportunities roadmap	Adoption of zero or low emission Council vehicles, as identified in the Pathways for Council Fleet. Make available, zero and low emission options for staff lease back and TRP vehicles.	Operations Finance Environment and Sustainability
Fleet transition - EV Charge Stations	Installation of chargers for Council electric vehicles.	Operations Environment and Sustainability
Solar PV maintenance	Implementation of a solar PV preventative maintenance program.	Environment and Sustainability
Capital works upgrades	Implementation of upgrades to building services and components like HVAC, lighting, controls, BMS, building façade, solar, storage, etc.	Operations – Technical Services Environment and Sustainability
Operational energy efficiency measures	Building performance audits / assessments, tuning of building services, energy modelling, implementation of monitoring and metering systems.	Operations – Technical Services Environment and Sustainability
Building Sustainability Officer	Staff resources for implementation of Council energy management program.	Environment and Sustainability

	Description of Abatement Area	Responsibility
Continuing Professional Development Program	Implementation of a training program to upskill staff in best practice, sustainable building performance. Including staff responsible for specification, design, construction, commissioning, and maintenance of Council facilities.	Operations – Technical Services Urban & Heritage Planning Environment and Sustainability
Sustainable Building Performance Standards	Implementation of building performance standards for upgrade and new building works.	Operations – Technical Services Environment and Sustainability
Reinvestment of savings (from energy efficiency measures)	Reinvest cost savings from energy efficiency measures funded through the Environmental Levy funding, into further energy efficiency and emission reduction measures.	Finance Environment and Sustainability
Transitioning to 100% renewable energy	Investment to procure 100% renewable energy for Council electricity needs.	Environment and Sustainability
Energy procurement	Engagement of energy procurement consultants.	Environment and Sustainability
Integrated asset management plans for buildings	Development and implementation of integrated asset management plans for 10 to 15 of Council's largest buildings/facilities, by energy use.	Operations – Technical Services Environment and Sustainability

	Description of Abatement Area	Responsibility
Capital Works New	Implementation of enhanced building and infrastructure services for improving energy efficiency of new Council assets.	Operations – Technical Services Environment and Sustainability
Chambers Capital Works	Implementation of sustainability and energy efficient services upgrades for the capital works program at 818 Pacific Highway.	Operations – Technical Services Environment and Sustainability
Street Lighting Upgrades	LED and energy efficient lighting upgrades for Ausgrid street lighting.	Operations – Technical Services Environment and Sustainability

Appendix 2 – Council Opportunities Roadmap – Funding and Resourcing

TABLE 18: COUNCIL OPPORTUNITIES ROADMAP – FUNDING AND RESOURCING.

Funding	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30
Environmental Levy	$892,100	$511,388	$571,374	$585,658	$511,297	$566,390	$580,550	$595,064	$648,407	$648,407
Reinvestment of Savings	$219,700	$224,800	$235,100	$245,300	$252,659	$260,239	$268,046	$276,087	$284,370	$292,901
Total Funding Available	**$1,111,800**	**$736,188**	**$806,474**	**$830,958**	**$763,956**	**$826,629**	**$848,596**	**$871,151**	**$932,777**	**$941,308**
Investment	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**	**2026/27**	**2027/28**	**2028/29**	**2029/30**
Fleet transition – opportunities roadmap	$46,000	$103,000	$103,000	$56,000	$15,000	$207,000	$178,000	$213,000	$260,000	$260,000
Fleet transition - EV Charge Stations	$30,000	$30,000	$30,000	$30,000						
Solar PV maintenance	$12,000	$12,279	$12,841	$13,398	$13,800	$14,214	$14,641	$15,080	$15,532	$15,998
Capital works upgrades	$360,000	$122,786	$128,411	$133,983	$138,002	$242,142	$146,407	$150,799	$155,323	$159,982
Operational energy efficiency measures	$160,000	$61,393	$64,206	$66,991	$69,001	$71,071	$73,203	$75,399	$77,661	$79,991
Building Sustainability Officer	$109,000	$111,530	$109,000	$109,000	$109,000	$109,000	$109,000	$109,000	$109,000	$109,001
Continuing Professional Development Program	$15,000	$15,348	$16,051	$16,748	$17,250	$17,768	$18,301	$18,850	$19,415	$19,998
Sustainable Building Performance Standards	$10,000	$10,000								
Renewable Energy Investment			$84,000	$80,000	$94,000	$70,000	$61,000	$28,000	$22,000	$21,000
Energy procurement	$40,000									
Integrated asset management plans for buildings	$80,000	$81,857	$85,608	$89,322	$92,001	$94,762	$97,604	$100,532	$103,548	$106,655
Capital Works New				$235,000	$216,000		$150,000	$160,000	$170,000	
Chambers Capital Works	$250,000	$188,000	$174,000							
Total Investment	**$1,112,000**	**$736,193**	**$807,117**	**$830,442**	**$764,055**	**$825,957**	**$848,156**	**$870,660**	**$932,480**	**$772,625**

Appendix 3 - Measures available to reduce the community's carbon footprint

This appendix is an extract from section 7.3 of the report by 100% Renewables undertaken for Council as part of the Climate Change Policy review (100% Renewables 2020).

Ku-ring-gai Council's revised draft target for emissions reduction is for net-zero emissions to be reached by 2040 (Council operations only). If a similar goal were to be targeted for the community, this would essentially seek to reduce community emissions on a science basis aligned with a '1.5 degrees' of warming target. This would effectively give the community a 'carbon budget' and would call for rapid and continuous action across the community to reduce emissions. This carbon budget approach, as well as other emissions targets and potential pathways, are discussed in the next section.

In this section, we outline six key carbon abatement categories and actions that could possibly be implemented within these and develop estimates of the abatement capacity of each category.

FIGURE 8: SIX CATEGORIES OF ABATEMENT FOR THE KU-RING-GAI COMMUNITY

Grid decarbonisation

Description

In NSW there are currently five coal-fired power stations with combined 10,240 MW capacity that supply most of the State's electricity and make up the vast majority of electricity sector emissions in the state (Liddell, Vales Point B, Eraring, Bayswater and Mount Piper). The state is largely self-reliant for power, with this supplemented by interstate links as and when required.

Since 2010 three coal-fired power stations with 1,744 MW of capacity have closed in NSW (Wallerawang C, Redbank and Munmorah).

In recent years nearly 800 MW of large-scale solar and over 5,500 MW of wind energy generation capacity has been built in NSW, together with nearly 2,350 MW of rooftop solar PV capacity.

As more coal-fired power stations approach the end of their life – announced

closures are in 2022, 2028, 2034, 2035 and 2043 respectively for the five active stations noted above – they are most likely to be replaced with renewable energy. This is most likely to be from wind and solar PV, firmed with pumped hydro and batteries. Assuming this, the future carbon intensity of the NSW grid could look something like the chart below (note that grid emissions factors are on a 3-year rolling average, leading to an apparent lag in emissions reduction compared with the above closure dates).

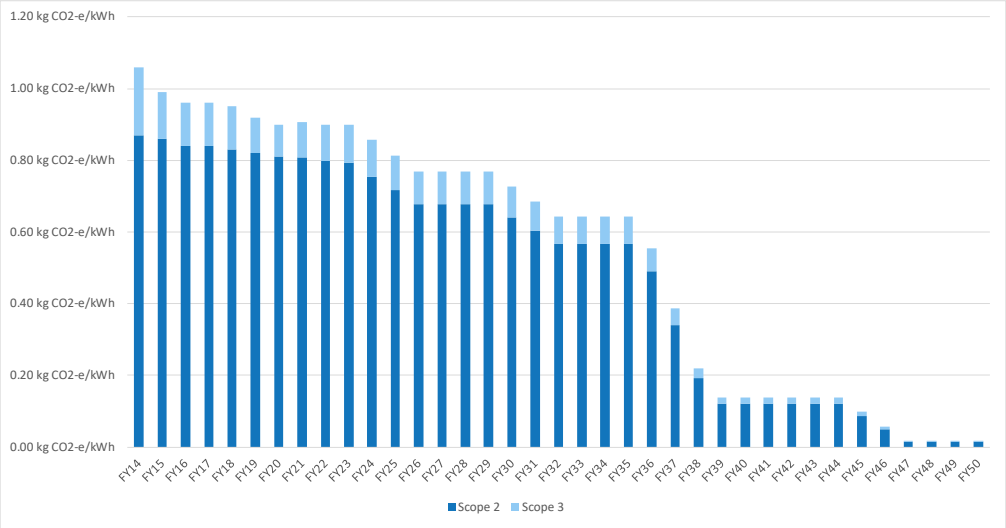


FIGURE 9: POTENTIAL GRID CARBON INTENSITY IN NSW TO 2050

Scope for abatement

The above potential change to the NSW grid carbon intensity would have a significant impact on GHG emissions in the Ku-ring-gai community, although the majority of this impact would not be seen until the late-2030s. In this scenario, significant abatement through energy efficiency and more rooftop solar locally would be required under a rapid decarbonisation scenario.

A more rapid pathway to grid decarbonisation could see early retirements of coal-fired power stations, with some reports (e.g. AEMO[7]) modelling a step-change that could see, among other impacts, fossil-fuel stations retire early, say by 2030.

Risks and mitigation

A slower change to the carbon intensity of grid electricity could see a slower rate of change in emissions intensity of grid electricity. Council has little influence over the rate of change in the grid carbon intensity, and the main risk mitigation strategy is to try and build capacity in the community to respond with local solutions to reduce emissions.

[7] AEMO, 2019, forecasting and planning scenarios, inputs, and assumptions August 2019

Buying clean energy

Description

There are multiple ways that clean energy can be purchased. The most obvious example for households and businesses is GreenPower®, although uptake has historically been low because of the added costs for this. There is also an option to purchase carbon-neutral electricity. This is achieved by the electricity retailer purchasing Australian and overseas carbon offsets (not necessarily based on renewable energy) to make their retail electricity supply carbon neutral. This option is currently only available from a few electricity retailers.

In recent years other opportunities have emerged, including renewable energy buyers' groups (such as SSROC and the Melbourne Renewable Energy Project MREP), and corporate PPAs where (typically) large corporations are entering into Power Purchase Agreements with renewable energy developers and retailers. Purchasing groups are still a new idea. Establishing a corporate PPA is complex, time-consuming and contains approaches and risks not previously considered by most consumers. These take time and resources to resolve. Retail PPAs aimed at mid-sized energy users are also emerging.

Scope for abatement

This opportunity in the Ku-ring-gai LGA should be looked at in conjunction with grid decarbonisation, since this will see all or most electricity sourced from renewables in any event in future. So, the opportunity is for customers in the LGA to elect to buy renewables in the period between now and when decarbonisation occurs.

Given the current market for PPAs, this opportunity is most likely to be available to mid to large-sized businesses in the foreseeable future (without paying a premium). Further evolution of the market for renewables will be required if renewable energy is to be readily accessible at a similar price to 'regular' power.

If all vehicles, public transport and gas-consuming appliances were also electrified and supplied with renewable energy then significant additional abatement would result.

Risks and mitigation

Risks include:

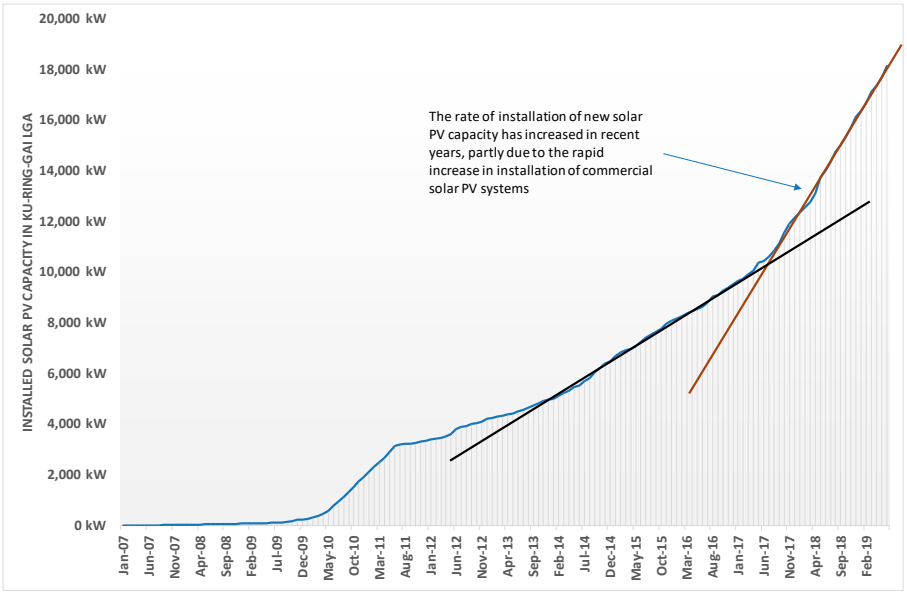
- Cost of renewable energy for smaller users such as households and small business does not fall to the same level as 'regular' electricity offers and uptake is low. This is outside the ability for Council to influence except as a buyer of renewables itself (lead by doing).
- It is very difficult to gauge the success of any initiatives to get the community to purchase renewables. Periodic surveys in the community may be the main opportunity available to Council to assess this.
- As with grid decarbonisation, there is a risk that the transition to renewables does not occur quickly, and there is slow development of new renewables.

Local generation (with renewables)

Description

There are multiple opportunities to reduce emissions in the community with local generation. Based on existing and emerging technologies:

- Solar PV uptake is at 11.6%, and the average size per residential system is 4.53 kW (new systems are larger than 7.3 kW). There is considerable scope for new solar installations, and scope for existing solar PV systems to be expanded. Commercial businesses have also begun to implement solar PV, but there are many more opportunities for new PV. Larger solar PV systems will be able to supply energy on demand, store for later use, and power electric vehicles.



- With over 42,000 dwellings as well as local businesses, many hot water services will be replaced/upgraded over the next ten years, with a significant opportunity to see solar PV, solar hot water and heat pumps become the predominant forms of energy supply for this service[8].
- More than 11,000 new residential dwellings are forecast to be built from 2016 to 2036, with potentially 17,000 built to 2045, presenting opportunities to lock in renewable energy solutions at design and planning stages.

As well as technology solutions, it is important to recognise the different types of accommodation in the community (free-standing houses and businesses, multi-unit dwellings), the potential for battery energy storage to increase the capacity of solar in the community, as well as some of the potential ways in which renewable energy solutions like solar PV can be delivered, such as peer-to-peer trading and community energy. These opportunities for solar in the community are outlined further below.

The abatement potential is mainly informed by rooftop PV estimates by APVI, with estimates made of the breakup of this potential across different building types. The local renewable energy generation potential for Ku-ring-gai was

[8] NSW Hot Water Guide for Households and Businesses: https://energy.nsw.gov.au/media/1476/download

Scope for abatement

estimated to be[9]:

- 410 MW of standalone residential solar PV generating 528 GWh per year,
- 70 MW of multi-residential solar PV generating 95 GWh per year,
- 53 MW of commercial solar PV generating 69 GWh per year,
- Approximately 700 hot water heat pumps and 1,900 solar hot water systems are installed, suggesting scope for the remaining 40,000 systems to be upgraded to these options in future years, offsetting over 320,000 GJ of energy (both gas and electricity)

Solar PV solutions for strata / multi-unit developments are emerging, involving systems serving common property only, shared roofs with separate systems for each occupant, and energy-sharing solutions with batteries and smart controls facilitating behind-the-meter solutions.

Under a '1.5 degree' scenario the abatement from solar PV should remain high in early years, and since this is also cost-effective a significant focus on this measure in the next decade is recommended. As the grid 'greens' the abatement from solar PV declines, but continued high uptake both reduces costs to users and helps the community to abate its emissions part-independent of the grid.

Risks and mitigation

Risks include:

- Capacity estimates modelling at a local level using mapping tools may indicate a different level of renewables potential. The above estimates were tested by carrying out sample solar modelling in free-standing houses, multi-unit blocks and commercial buildings across three suburbs and found to be a reasonable estimate of the PV capacity. However, the total number of premises assessed is under 100 across the LGA so may be limited.
- Estimates are based on roof area and ignore potential planning constraints such as heritage.

These factors could be addressed with further analysis at the local level.

Increase solar PV uptake in separate houses and business

Description

Houses & SMEs

Residential and SME energy rates have increased significantly in recent years and rates from 20-30c/kWh are common, with feed-in-tariffs (FiT) typically around one-third of this or less. The combination of high electricity prices, FiTs and falling solar panel prices means that the business case for solar PV is stronger than it has ever been.

Medium to large business

Commercial and government premises often have good potential for solar PV because they satisfy several 'attractiveness' criteria for solar; that is:

- Large roof spaces,
- Long-term tenure and
- High daytime energy consumption

In addition to these areas there are numerous schools, early education and aged care

[9] Source: https://pv-map.apvi.org.au/historical#4/-26.67/134.12

facilities in Ku-ring-gai. Co-benefits of schools installing PV include the education benefits that can be realised when the project outcomes are used within the education program.

Increase solar PV uptake in strata

Description

Most of the new residential dwellings in Ku-ring-gai are in medium and high-rise strata developments, and this will include both owner-occupiers as well as renters.

Strata can be well suited to solar PV. Low-rise apartment buildings often have a good roof area relative to the number of apartments and are on residential tariffs; medium to high rise buildings tend to have 24/7 common property demand.

The uptake of solar PV in strata is very low due to the multitude of stakeholders involved, poor understanding of the business case/options and low engagement. There are often competing priorities for capital works funds. However, pilot projects, early movers (with good advice) and emerging hardware and software solutions can unlock this potential.

An owners corporation may be allowed to sell electricity to its residents, or landlords to their tenants and be considered exempt sellers under AER rules. An exempt seller is different to a normal electricity or gas retailer. Exempt sellers buy the electricity and/or gas from an electricity or gas retailer and resell it to customers in a multi-dwelling building, such as an apartment building, shopping centre, caravan park or retirement village.

A range of solution providers are emerging, who are seeking to develop the solar PV potential in strata schemes (owners and tenants).

Increase solar PV uptake by renters

Description

Renters are generally left out of the solar market as they have no authority to install solar on their premises and tend to not have the security of tenure that would make this a viable investment.

Led by social enterprises such as SunTenants, progress has been made in this market, whereby owners install PV systems and see a return via increased rental payments that are lower than the cost savings made by the lessee. In this way both parties receive a benefit. In the SunTenants model, they act as the intermediary handling the metering and monitoring any payment transactions.

Models such as this may offer a way into the market for tenants in both housing and business situations.

Battery storage

Description

Battery storage allows for the implementation of larger solar PV systems, which results in greater carbon reduction. The main targets at present are residential (stand-alone, in micro-grids and in Virtual Power Plants or VPPs), and utility-scale. There may be a role for batteries (fed from off-peak electricity, as well as solar) in resolving local network and transmission-level constraints. This could further enable renewables uptake.

The current residential payback is around 10+ years. Some retailers offer $0 upfront and multi-year plans for solar & storage. The principal benefit is to increase the value of savings to the end-user and allow larger PV systems to be installed. For commercial/industrial users, batteries will be able to store and use solar, help with peak demand management, and allow cost-shifting from peak to off-peak. There is added potential for the future use of batteries for peer-to-peer (P2P) trading.

A range of options are emerging for battery storage, ranging from own-use to PPA or financed offers, to control solutions that can increase the value of each unit of energy stored via interaction with the market and other users – i.e. via P2P or in a VPP.

Water heating with renewables

Description

Water heating is a sizeable percentage of energy use and carbon emissions in residences, less so in business. Many residential water heating systems will be more than 10 years old. Ausgrid data show there were nearly 15,500 offpeak-controlled electric hot water systems installed in Ku-ring-gai in 2017-18, and the high number of gas connections suggests many homes use gas hot water (storage or instantaneous). Turnover of all stock typically happens over a ~15-year timeframe. Solar hot water and heat pumps can save 70%+ of emissions, greater if solar PV can meet daytime heating requirements. Low / zero emissions hot water heating systems are commercially viable and widely available, covering:

- Heat pumps (703 currently installed in Ku-ring-gai LGA)
- Solar hot water (1,908 currently installed in Ku-ring-gai LGA)
- Solar PV (e.g. diverter to hot water)
- Gas heating (low emissions so not part of net-zero target, this is often the most economical solution for small systems and a small number of hot water users)

Community energy

Description

Community energy projects enable communities to participate actively in response to climate change. They are renewable energy initiatives:

- instigated by the local community
- scaled to the community's own energy needs
- funded and owned by the community
- welcomed within the community
- accountable to their host community
- built and managed to maximise local jobs.

Community energy can involve energy supply projects such as renewable energy installations and storage, and energy reduction projects such as energy efficiency and demand management. Community energy can even include community-based approaches to selling or distributing energy.

Interest in community energy is high and in nearly all cases there are more subscribers than available shares. Current trends are an increasing focus on community projects where the host site is the user to maximise the value of solar energy generated.

The benefits of community energy projects are that they demonstrate leadership, make renewable energy affordable for the host and provide a fair return on investment for community investors. They provide accessibility to renewable energy

for people who cannot install solar PV. They also forge new community partnerships, provide energy education and literacy, local sustainable investment and showcase a model for further community energy projects.

The roles involved with setting up and running a renewable energy project are:

- Host
- Owner
- Developer, financier
- Operator
- Retailer, network operator
- Energy buyer

Anyone in the community can participate through:

- Volunteer or pro-bono provision of labour and services,
- Investment,
- Purchase of resultant products and services.

Community energy projects can usually be structured as a PPA or a community loan. With a PPA, renewable energy is developed and owned by the community, the host buys the energy (example: Repower Shoalhaven). With a loan, funds are raised from investors and lent to the host who builds and operates renewable energy projects. The host repays the loan (example: Lismore City Council, Farming the Sun).

There is a significant body of information and 'how-to' available through the National Community Energy Strategy, which was developed by the Coalition for Community Energy (C4CE). It is a collaboration of The Institute for Sustainable Futures (ISF), Starfish Initiatives, Community Power Agency, Embark, Alternative Technology Association (ATA), Total Environment Centre, E2Q. The Community Energy Strategy received input from numerous clean energy groups, like the Moreland Energy Foundation, Repower Shoalhaven, Clearsky Community Solar, New England Wind and Hepburn Wind.

ARENA has also sponsored a Community Renewable Energy Financing Toolkit, which was developed by Frontier Impact Group.

Peer-to-peer energy trading

Description

"Peer-to-peer" energy trading promises to enable direct trading of energy from one party (e.g. household) to another, thereby cutting out the "middleman" and allowing transparent dealings between peers.

The regulatory environment does not yet allow for peer-to-peer trading, but a number of trials using "blockchain technology" are currently being conducted. These include those by Power Ledger in Perth and Auckland; Transactive Grid in New York; Grid Singularity in Austria and AGL in Melbourne and Adelaide.

Ideally, P2P trading allows users to control the source and the destination of their power and allows them to set their own terms, especially the price. P2P trading allows producers of renewable energy to be treated the same as a power station, even if they only have a small solar PV system.

Energy efficiency

Description

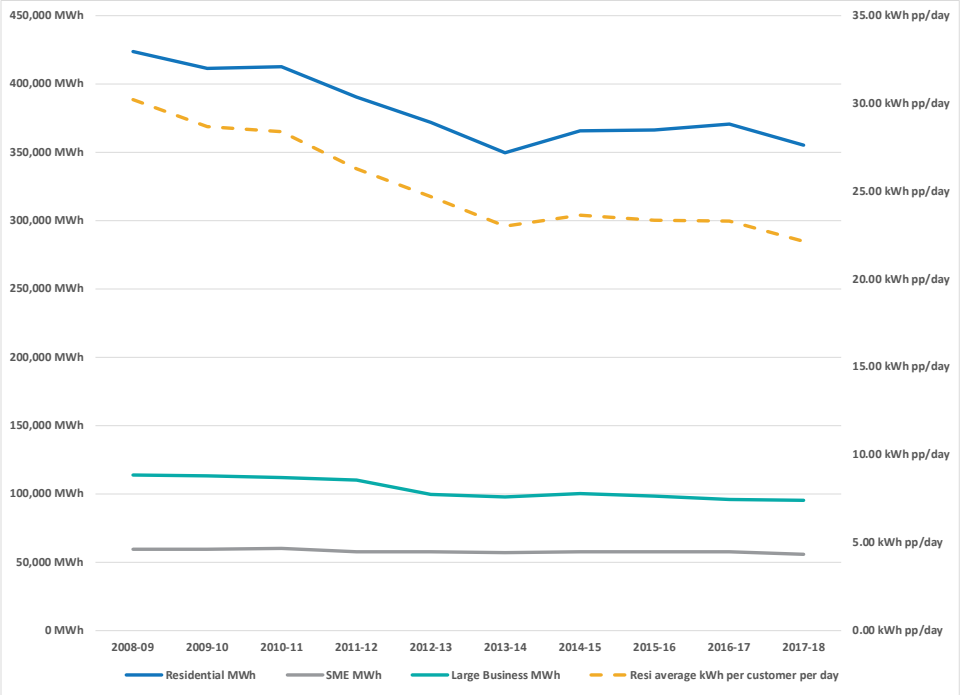
Energy efficiency remains the cheapest form of GHG abatement, and there will be opportunities across all sectors and technologies to make further gains.

- Over 11,000 new residential dwellings are forecast to be built over the next 20 years and potentially 17,000+ to 2045, presenting opportunities to lock in low energy / renewable energy solutions at design and planning stages, including through potential for Council to revise its Development Control Plan. This could be aided by changes to the Building Code of Australia that are targeting over 25% savings through efficiency and renewables, but restricted by current BASIX requirements that require lower levels of achievement in energy efficiency and emissions reduction compared with the BCA.
- As many new dwellings will be apartments the energy demand per dwelling may be much lower than for the average existing dwelling.
- Improvements in energy efficiency in existing homes and businesses will target measures such as pool pump controls, underfloor and other home heating, LED lighting, efficient air conditioning technology and controls, efficient appliances, insulation, fuel switching for cooking and heating, efficient boilers and gas technologies, and efficient air handling systems.

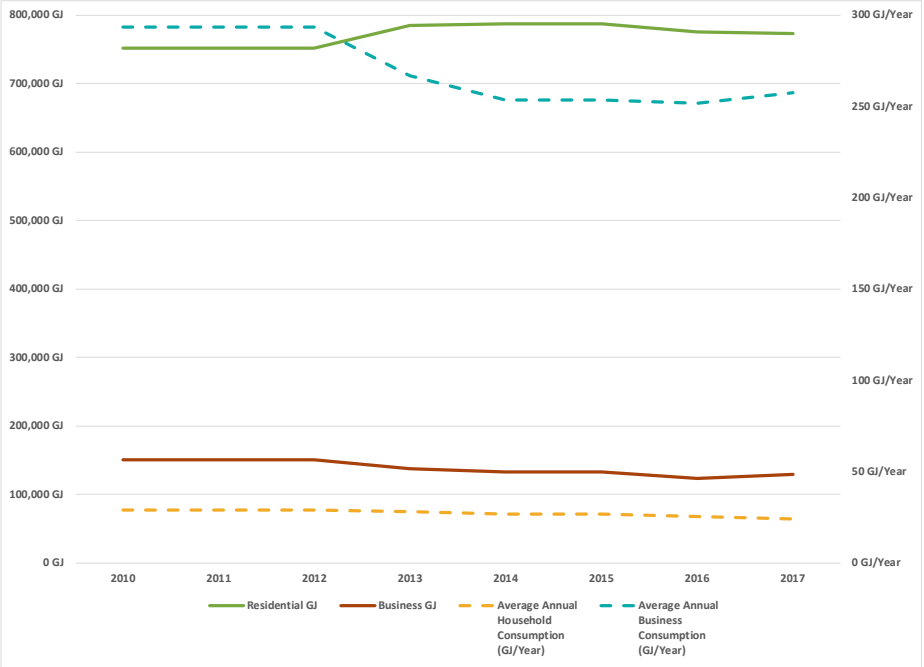
Scope for abatement

Numerous studies of commercial and residential energy efficiency have been developed at national, States and technology levels over many years. Most studies conclude that savings potential is broad, from 35% over 15 years[10] to more than 50% in the long term. Ku-ring-gai saw energy use trends for electricity reduce steeply across all users from 2008-09 to 2013-14. Despite increases in dwellings and population, measures implemented by residents and business, including as a result of participation in Council-led initiatives, have seen energy demand remain at a steady level since that time.

[10] Source: ClimateWorks Australia – http://www.asbec.asn.au/wordpress//wp-content/uploads/2016/05/160509-ClimateWorks-Low-Carbon-High-Performance-Modelling-Assumptions.pdf



Gas use trends show reduced business consumption and reduced per-customer consumption in the residential sector, but more gas customers mean overall consumption levels are largely unchanged in the last decade.



Ku-ring-gai LGA has the highest per-customer electricity and gas consumption in the Ausgrid and Jemena metropolitan network, so it is possible that savings potential is both larger than in some other LGAs (e.g. efficiency in pool pumping).

Risks and mitigation

- There are barriers to renters in houses and businesses that limit what they can do to improve their energy efficiency.
- Access to information about potential programs and incentives to support energy efficiency may be limited, particularly in small businesses and houses (Council's sustainability programs for residents and small businesses serve to address some of this gap).
- IPART's 2015 energy use survey of households clearly shows a link between higher income levels and higher energy consumption, which may indicate that energy costs are a lower priority.
- Getting access to and influencing strata committees on energy efficiency can also be very challenging.

Sustainable transport

Description

Transport, particularly private transport, is the next highest source of emissions in Ku-ring-gai after electricity consumption. Sustainable transport measures include:

- Changing to low and zero-emissions vehicles including small cars, hybrids, electric vehicles and hydrogen vehicles (passenger and commercial vehicles)
- Demand control measures like reduced car spaces per dwelling in apartments, car-pooling, car-sharing, driver education
- Improved and increased public transport
- Active transport like walking and cycling
- Purchasing lower emissions fuel such as ethanol blends

Ku-ring-gai LGA has a high uptake of EVs relative to other areas, with ABS data showing 196 registered EVs at 2018-19.

Scope for abatement

The scope for significant emissions reduction to 2040 is highly dependent on the rate of uptake of EVs and on selection of renewable energy as the fuel source, notwithstanding low emissions vehicle and demand control measures.

AEMO's most recent forecast of uptake sees low uptake of EVs to 2030, with accelerated uptake after 2030 and reaching over 11 million cars by 2050[11]. Where fuelled with regular grid power in NSW EVs currently have higher operational emissions than hybrids, whereas where fuelled from renewables this is not the case.

[11] Energeia 2019: Distributed Energy Resources and Electric Vehicle Forecasts, prepared for AEMO, 13 June 2019

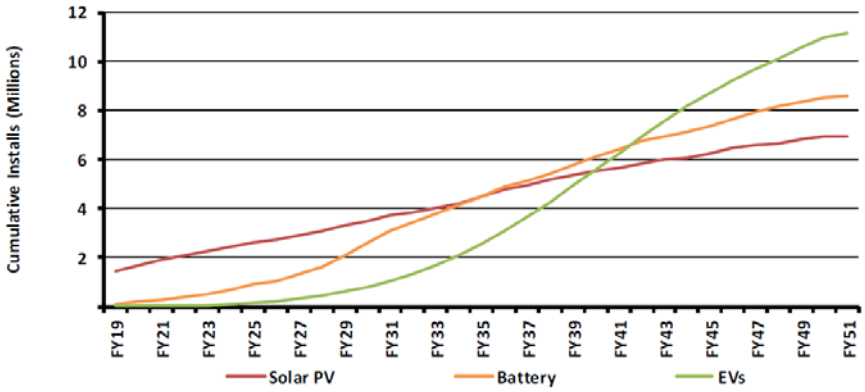


FIGURE 10: AEMO PROJECTIONS OF EV UPTAKE – APRIL 2019

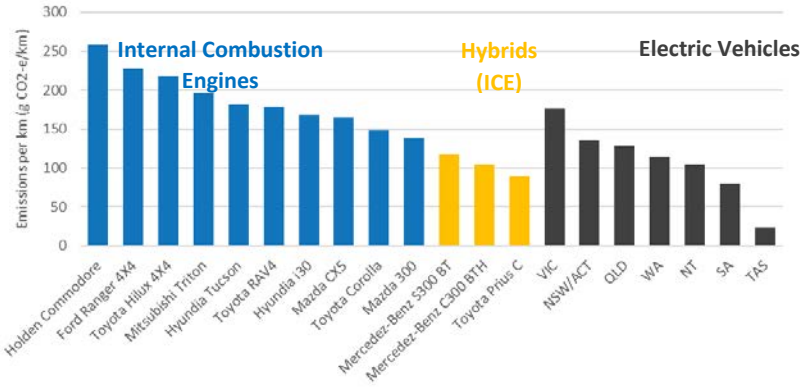


FIGURE 11: COMPARISON OF EMISSIONS PER KM FROM MOTOR VEHICLES IN AUSTRALIA[12]

Based on current forecasts it is likely that feasible emissions reduction from sustainable transport measures nationally is modest in the period to 2030, but significantly increased by 2050 as the grid greens and EV uptake increases.

Risks and mitigation

- Uptake of and incentives supporting electric vehicles are small and there is uncertainty about potential timing and rates of uptake of EVs.
- The role of other technologies – hydrogen, autonomous vehicles etc is unknown and may influence the role of EVs.
- Measurement of the abatement from transport at an LGA level is inherently difficult, and modelling at higher (State or national) levels may fail to show local successes. Other more localised measures of the success of sustainable transport measures may be required.
- While the change to EVs may be able to be tracked, it will be more difficult to know what is supplied from renewables (purchased or rooftop) v regular grid power.

[12] http://www.arnhem.com.au/how-green-are-electric-vehicles/

Waste management

Description

Council currently has a waste management (draft) strategy on exhibition until early 2020. Council's website highlights the following summary:

- *Maintain the domestic waste and recycling services.*
- *Adjust clean-up service to 4 services per year.*
- *Introduce a bulky green waste service in line with the clean-up service.*
- *Introduce waste recovery at the kerb-side for e-waste, mattresses and metals.*
- *From Council`s previous resolution in considering additional bush fire protection for residents include in the collection tender an option for a weekly green waste collection.*
- *Continue research and development into further recovery opportunities for recycling including soft plastics.*
- *Provide additional resources for community information, promotion and education.*
- *Continue with development of engineering waste recovery including road re-surfacing and other opportunities with civil project works.*
- *Continue with Council`s commercial waste and recycling services for business and schools in the local government area.*
- *Continue to improve litter and dumped waste management*.

Current collection practices and processes sees 58% of household and 70% of overall collected waste diverted from landfill. This compares with target diversion of household waste from landfill of 60%.

Scope for abatement

Among the EPA's targets for waste management (2014-2021 WARR Strategy) in NSW are the following targets for 2021–22:

- avoiding and reducing the amount of waste generated per person in NSW
- increasing recycling rates to 70% for municipal solid waste and 70% for commercial and industrial waste, and
- increasing waste diverted from landfill to 75%.

The ability for Council to achieve these goals, and to go beyond these in the long term, are partly within their influence in terms of education, recycling and collection strategies, but mostly relate to out-of-Council treatment processes that can successfully treat MSW and divert it from landfill.

Local actions would likely see the implementation of consumer side measures (i.e. waste reduction/reduced consumption, household composting/worm farms, 100% recycling rates), and post-collection side (100% organics processing, material recovery) measures.

Risks and mitigation

- Measurement of commercial waste data and associated emissions beyond Council's collection figures (Council collects waste from around one third of business taken to equate to a third of business emissions from waste, but surveys of all business may yield different estimates).
- Availability of solutions to treat waste and avoid landfilling.

Appendix 4 – Suite of Opportunities to Support Community 1.5°C Pathway

Action Plan 1: Grid decarbonisation

Council's overall objective: the main objective regarding grid decarbonisation is to keep abreast of changing trends, advocating effectively and use trends to inform future revisions to the community carbon footprint and related plans. Grid decarbonization is critical to any goal to reach net zero by 2040, so Council's role here, by itself and in collaboration with others, is important to the achievement of Council's goals.

	Action	**Action category**	**Responsibility**	**Timeframe**	**Target or metric**	**Additional total resources required under scenario 2 (+1.5°C)** Neutral to low / Moderate (>$20k/yr) / High (>$50k/yr)
1.1	Council will periodically update the community's emissions using a consistent GPC-aligned method so that future emissions in the community can be tracked and reported. This will capture the impact of grid decarbonisation and allow Council to adjust any of its forecasts to reflect changes.	Strategy	Sustainability	Periodically – e.g. from annually to every few years	Reporting of the LGA's carbon footprint to the community	Neutral to low
1.2	Council will proactively respond to and engage with – directly or via NSROC for example – advocacy to State or	Advocacy	Sustainability	As applicable	Submissions to the state and federal	Neutral to low

	Commonwealth governments regarding clean energy policies that can provide investment certainty, lead to more renewable energy and reduce energy costs to the community.				governments	

Action Plan 2: Buying clean energy

Council's overall objective: Council aims to provide the community with current information about the renewable energy market, to help accelerate the transition to clean energy. Council is aware that changing to renewable energy supply may be a cost-effective ways for the Ku-ring-gai community to reduce its emissions over the long term.

	Action	**Action category**	**Responsibility**	**Timeframe**	**Target or metric**	**Additional total resources required under scenario 2 (+1.5°C)** Neutral to low / Moderate (>$20k/yr) / High (>$50k/yr)
2.1	Develop and implement a community engagement strategy to educate and inform the community on opportunities to buy clean energy. This may include:	Education, training, workshops	Sustainability	From 2019/20 and integrated into ongoing workshop planning	Number of workshop participants. Number of	Neutral to low

	• Developing information relevant to businesses and households • Holding information sessions and workshops on buying clean energy • Links to online resources on opportunities in renewable energy sourcing, such as peer to peer energy trading, PPAs and GreenPower®				follow-through purchases of clean energy via survey.	
2.2	Engage with renewable energy buyers' organisations (e.g. Business Renewables Centre – Australia, free for buyers), so that Council is abreast of latest developments and emerging opportunities for large and small energy users to access affordable clean energy.	Strategy	Sustainability	Council is a founding BRC-A member	Membership of and/or engagement with RE buyers' organisation(s)	Neutral to low
2.3	Assess the potential for opportunities to develop or share renewable electricity generated locally at small and mid-scale, including: • Virtual Power Plants, peer-to-peer energy trading, microgrids and the like • collaboration with State government (e.g. DPIE) and suppliers of innovative solutions enabling local renewable energy sourcing	Strategy & Collaboration	Sustainability	From 2020/21	Development of one or more local energy sharing trials or projects	Moderate (>$20k/yr)
2.4	Engage with – directly or via NSROC for example – advocacy to State or	Advocacy	Sustainability	As applicable	Submissions to the state and	Neutral to low

	Commonwealth governments regarding clean energy policies and regulatory changes that can make renewable energy more accessible to the community, including via energy sharing, supporting community-based clean energy retailers.				federal governments	
2.5	Develop and disseminate case studies of successful renewable energy power purchase agreements (RE PPAs) in the community. For example, Ascham is the first school in New South Wales to sign a renewable corporate Power Purchase Agreement (PPA) (April 2019). In addition Presbyterian Ladies' College in Victoria has also committed to sourcing renewable electricity (June 2019), with an offsite RE PPA and over 500 kW of rooftop solar to deliver 130% of the school's electricity needs by 2020.	Education, training, workshops	Sustainability	Ongoing from 2020/21	Number of case studies published or linked in education materials	Neutral to low

Action Plan 3: Local generation (with renewables)

Council's overall objective: Council would like to see the uptake of renewable energy – particularly rooftop solar with battery storage – continue to accelerate well beyond today's levels.

	Action	**Action category**	**Responsibility**	**Timeframe**	**Target or metric**	**Additional total resources required under scenario 2 (+1.5°C)** Neutral to low / Moderate (>$20k/yr) / High (>$50k/yr)
3.1	Council will provide up-to-date online information resources, develop and run regular workshops on solar energy generation, and continue to support and incentivise solar and storage implementation, covering: • Houses • Solar for renters & landlords • Strata • Business • Battery storage • Emerging solar technologies	Education, training, workshops	Sustainability	Continuing current practice	Number of session attendees. Follow-up to gauge implementation by local residents and business.	High (>$50k/yr)
3.2	Council will engage with strata	Education,	Sustainability	Continuing	Number of	High (>$50k/yr)

	committees of multi-residential dwellings to help develop an understanding of the renewable energy and storage opportunities in strata, and to support initiatives to increase the uptake of solar on strata.	training, workshops, financial incentives		current engagement	session attendees. Follow-up to gauge implementation.	
3.3	Council will update its BBP online resources to include State, Federal government and other relevant grants and incentives aimed at helping business to implement renewable energy solutions.	Education, training, workshops	Sustainability	From 2020	Periodic refresh of online content.	Neutral to low
3.4	Ku-ring-gai Council has engaged with the Solar my School program, and will work with this program and Ausgrid's *Power2U - Solar and LED Lighting Incentive* project to help schools in Ku-ring-gai to develop and implement solar PV systems.	Collaboration	Sustainability	Since 2019	Number of schools with solar PV, and total installed solar PV capacity.	Moderate (>$20k/yr)
3.5	Council will evaluate solar PV mapping tools that may be useful to residents and businesses to understand their solar PV potential, and consider integrating this into Council's sustainability resources.	Collaboration, Education, training, workshops	Sustainability	From 2020	Availability of mapping services for the community to assess their solar PV potential.	Neutral to low

Action Plan 4: Energy efficiency

Council's overall objective: Council has two key climate-related targets for energy efficiency. Firstly, to achieve changes to the BASIX requirements that will see future new single and multi-unit residential developments achieve higher levels of energy and water efficiency. Secondly, Council aims to see sustained reductions in the amount of stationary energy (electricity and natural gas) consumed per resident and per business in Ku-ring-gai, as monitored via annual reporting by utilities.

	Action	**Action category**	**Responsibility**	**Timeframe**	**Target or metric**	**Additional total resources required under scenario 2 (+1.5°C)** Neutral to low / Moderate (>$20k/yr) / High (>$50k/yr)
4.1	Council will review and periodically continue to update its information resources relating to energy efficiency in houses, apartments and business, for example, BBP resources, links to the NSW DPIE's Energy Saver Program resources.	Education, training, workshops	Sustainability	Ongoing	Currency of online resources, currency of BBP materials	Neutral to low
4.2	Water heating, pool pumping, and underfloor heating are significant end-uses in local homes. Council will continue to target resources to help the community to implement measures (VSD pumps, solar hot water or heat pumps, reverse cycle	Education, training, workshops, financial incentives	Sustainability	Ongoing	Currency of online resources, financial incentives provided, measures	High (>$50k/yr)

	over underfloor heating) that can reduce their carbon footprint.				implemented, rebate uptake	
4.3	Continue to develop and implement planning controls that achieve higher energy efficiency performance in new buildings.	Planning	Urban Planning	Ongoing	Number of new or amended planning controls related to energy efficiency.	Neutral to low
4.4	Council will continue to work itself and where applicable with other local government stakeholders to advocate for a BASIX + standard for new developments that will see the energy (and water) performance of new homes significantly improve in future.	Advocacy	Urban Planning	Ongoing	Submissions to the state government. Business case for a BASIX + standard.	Moderate (>$20k/yr)
4.5	Council will develop and run regular workshops on residential energy efficiency that complements online information resources, and provide support services such as audits, covering: • Houses • Strata • NABERS for strata • Water heating and pumping • Home heating and cooling • Appliances and lighting	Education, training, workshops. Financial/ other incentives	Sustainability	Ongoing	Number of session attendees and audits booked. Follow-up to gauge implementation by attendees.	High (>$50k/yr)

Action Plan 5: Sustainable transport

Council's overall objective: Progress towards sustainable and zero-emissions transport solutions are critical if net zero emissions goals are to be achieved by 2040. Council can develop a scorecard of progress on local actions that can have a positive climate impact, including number of registered electric vehicles, kilometres travelled based on survey data, number of car share spots, number of share bikes, EV charge points, number of new public transport routes and services

	Action	**Action category**	**Responsibility**	**Timeframe**	**Target or metric**	**Additional total resources required under scenario 2 (+1.5°C)** Neutral to low / Moderate (>$20k/yr) / High (>$50k/yr)
5.1	Council will develop an electric vehicle (EV) charging infrastructure plan for the LGA. Council will seek to have public charge points powered with renewable energy.	Infrastructure/services	Strategic Traffic Engineer	From 2020	Number of Council-owned EV charge points in the community.	High (>$50k/yr)
5.2	Council will provide information and assistance to local businesses and residents seeking to install EV infrastructure for private and for public use, including as part of new	Education, training, workshops Planning	Sustainability	From 2020	Number of non-Council EV charge points in the community.	Neutral to low

	developments.					
5.3	Council will adopt controls, planning provisions, and incentives in the LEP and DCP to drive emissions reduction opportunities for transport, including demand reduction, cycling, car share, benefits of public transport, low-emissions vehicles, electric and hybrid vehicles, and potential future transport trends.	Planning	Urban Planning	From 2020	Number of sustainable transport controls and incentives in the LEP and DCP	Moderate (>$20k/yr)
5.4	Council will develop a car share policy and continue to collaborate with organisations to provide car share options to the community as it grows.	Collaboration	Strategic Traffic Engineer	Ongoing	Number of active car share spots in the community.	Neutral to low
5.5	Council will develop and update information resources for the community on emissions reduction opportunities for transport, including demand reduction, cycling, car share, benefits of public transport, low-emissions vehicles, electric and hybrid vehicles and potential future transport trends.	Education, training, workshops	Sustainability	Ongoing	Number of session attendees.	Neutral to low
5.6	Council will continue to develop resources and workshops to encourage EV and low emission vehicle adoption by households and businesses.	Education, training, workshops	Sustainability	Ongoing	Number of session attendees.	Neutral to low
5.7	Council will continue to advocate the State Government for greater access to public transport in and through	Advocacy	Strategic Traffic Engineer	Ongoing	Submissions to / engagement	Neutral to low

	Ku-ring-gai.				with the state government	
5.8	Council will lead by doing and will transition its own fleet towards zero emissions over time, including consideration of hybrid and EV passenger and operational vehicles, further renewable energy purchasing, and EV options for other vehicles and plant.	Lead by Example	Sustainability	From 2020	Make-up and energy supply sources for Council's transport fleet.	High (>$50k/yr)
5.9	Engage with – directly or via NSROC for example – advocacy to State or Commonwealth governments regarding policies, programs, emissions regulations and incentives that will support the implementation of EV infrastructure, purchase of EVs, and support to other sustainable transport measures and technologies.	Advocacy	Sustainability	As applicable	Submissions to the state and federal governments	Neutral to low

Action Plan 6: Waste Management

Council's overall objective: Council is developing a waste strategy, a draft of which is on public exhibition until February 2020. The actions noted below represent measures that could be developed that will help to reduce greenhouse gas emissions from waste, and it is recommended that these be given consideration in the development of the final waste management strategy.

	Action	Action category	Responsibility	Timeframe	Target or metric	Additional total resources required under scenario 2 (+1.5°C) Neutral to low / Moderate (>$20k/yr) / High (>$50k/yr)
6.1	Develop and/or support local organics composting solutions at household, strata and in businesses/business precincts.	Infrastructure/services	Waste/Sustainability	Ongoing	Number of household and business organics composting systems implemented	High (>$50k/yr)
6.2	Develop and/or support/promote soft plastics collection points in the	Infrastructure/services	Waste/Sustainability	Ongoing	Number of soft plastic	Moderate (>$20k/yr)

	community.				collection points	
6.3	Provide information, education to residents on re-use, recycling, composting, plastics reduction and other measures the community can implement to reduce their waste footprint.	Education, training, workshops	Waste/Sustainability	Ongoing	Number of engagement campaigns implemented for households	Neutral to low
6.4	Provide information, education to local businesses on re-use, recycling, composting, plastics reduction and other measures the business community can implement to reduce their waste footprint.	Education, training, workshops	Waste/Sustainability	Ongoing	Number of engagement campaigns implemented for local businesses	Neutral to low
6.5	Work with other councils/NSROC, state government, and fed government to trial and implement post collection waste services that increase recycling and diversion rates.	Infrastructure/services	Waste	Ongoing	Recycling and diversion rates.	Moderate (>$20k/yr)

References

100% Renewables (2020) *Community Inventory and Climate Change Strategy - Inputs to tasks supporting the review of council's climate change strategy*. TRIM:2019/383002

The Australia Institute (2018) *HeatWatch: Extreme heat in Western Sydney*. Accessed at: https://www.tai.org.au/sites/default/files/Western%20Sydney%20Heatwatch%20WEB.pdf

Climate Council (2019a) *Compound Costs: How Climate Change Is Damaging Australia's Economy*. Accessed at: https://www.climatecouncil.org.au/wp-content/uploads/2019/05/costs-of-climate-change-report-v3.pdf

Department of Planning Industry and Environment (2020) *Net Zero Plan Stage 1: 2020–2030*. Accessed at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Climate-change/net-zero-plan-2020-2030-200057.pdf

Harris R.M.B. et al. (2018) *Biological responses to the press and pulse of climate trends and extreme events*. Accessed at: https://www.researchgate.net/profile/Mike_Letnic/publication/326067239_Biological_responses_to_the_press_and_pulse_of_climate_trends_and_extreme_events/links/5b4e9dd445851507a7a9a3c2/Biological-responses-to-the-press-and-pulse-of-climate-trends-and-extreme-events.pdf

Intergovernmental Panel on Climate Change (2018) *Special Report: Global Warming Of 1.5OC*. Accessed at: https://www.ipcc.ch/sr15/

Ironbark Sustainability (2019) *Review of Council Climate Change Strategy Fleet Transition Pathway*. TRIM: 2020/010305

Lucas C. (2007) *Bushfire Weather in Southeast Australia: Recent Trends and Projected Climate Change Impacts*. Accessed at: http://www.climateinstitute.org.au/verve/_resources/fullreportbushfire.pdf

Parliament of Australia (2017) *Paris climate agreement: a quick guide* Accessed at: https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/rp1718/Quick_Guides/ParisAgreement

Sourced Energy (2020) Feasibility assessment for Ku-ring-gai Council to procure 100% renewable energy by 2030 or if possible by 2025. TRIM: 2020/006830

Westpac Economics (2020), Australia's bushfire emergency – an economic overview. Accessed at: https://westpaciq.westpac.com.au/wibiqauthoring/_uploads/file/Australia/2020/January/Bushfires-Jan-2020-final.pdf