Clarence Valley Council

Greenhouse Gas Emissions reduction and Renewable Energy targets

Final Report

Date: 13 September 2018

Contents

1 Executive Summary and recommended targets

Clarence Valley Council's climate change policy (2016) commits Council to meet a number of commitments, among these being:

- ***develop greenhouse gas emission reduction and renewable energy targets by August 2018 and the matter be reported back to Council***

This report responds to this commitment and is aimed at helping Council consider and take informed decisions on appropriate targets. The recommended targets in this report are developed based on:

- Analysis of Council's energy demand and greenhouse gas emissions, and changes to 2030,
- Visits to Council sites to assess energy efficiency and renewable energy opportunities,
- Analysis of street lighting proposal to upgrade eligible local road lighting to LED technology,
- Modelling of the potential for solar PV and battery storage at multiple sites,
- Evaluation of all opportunities in consultation with CVC staff,
- Analysis of the market for mid-scale renewable energy projects and renewable energy Power Purchase Agreements (PPAs) that could supply Council's electricity from renewables, and
- Assessment of the cost of carbon offsets to achieve higher abatement

1.1 Recommended targets and timing

For both renewable energy and carbon emissions a staged approach to achieving long term targets is recommended. Based on the measures assessed and the cost benefit analysis of opportunities, feasible targets for Clarence Valley Council include:

- Renewable energy:
  - 50% of Council's electricity demand to be met from renewable energy sources by 2030, and earlier if feasible, principally through onsite solar and renewable energy PPAs,
  - Long term goal to source all electricity from renewable energy
- Carbon emissions:
  - Greenhouse gas emissions for Council's operations to be at least 40% lower than 2016/17 levels by 2030, not including emissions from landfill,
  - Long term goal to reach zero net emissions in line with NSW State government aspirations

Other objectives that Council should pursue in the period to 2030 include:

- Evaluate long term solutions to waste management, potentially including greater diversion of organic waste from landfill, collection of higher levels of gas and energy generation from landfill gas.
- Evaluate long term solutions to transport emissions, including passenger electric vehicle uptake, future options for heavy vehicles including biofuels, hydrogen and electric technologies.
- Analysis of renewable energy PPA options, plus local or regional renewable energy project development including refurbishment of the Nymboida hydro power station among other options such as regional partnering to build a renewable energy project.
- Investigation of Shannon Creek Dam 100 Ha replantation opportunity in the context of Council's abatement targets.

1.2 Impact of actions on Council's energy and carbon footprint

The recommended targets are based on an assessment of opportunities for renewable energy and carbon abatement across Council's operations. Implementation of all assessed onsite opportunities as well as renewable energy purchasing (PPA) would have a significant impact on Clarence Valley Council's grid electricity consumption as well as its greenhouse gas emissions. Changes over time to the mix of generation in the grid will also impact on Council's greenhouse gas emissions.

The chart below highlights the potential change to electricity demand and supply mix based on implementation of all measures evaluated. Key points include:

- Energy efficiency can reduce demand for electricity by 1,481 MWh per year by 2030,
- Onsite solar PV and storage can meet 1,865 MWh of remaining electricity demand by 2030,
- This would still leave Council with grid demand of 6,871 MWh, meaning that efficiency and onsite renewables can reduce grid electricity supply by one third,
- The projection below highlights the impact of a 50% renewable energy PPA displacing part of the balance of fossil fuel power, though Council may be able to purchase more than this or may elect to purchase less. At 50% renewable energy procurement of remaining grid supply, Council could source two thirds of its future power needs via efficiency and renewables

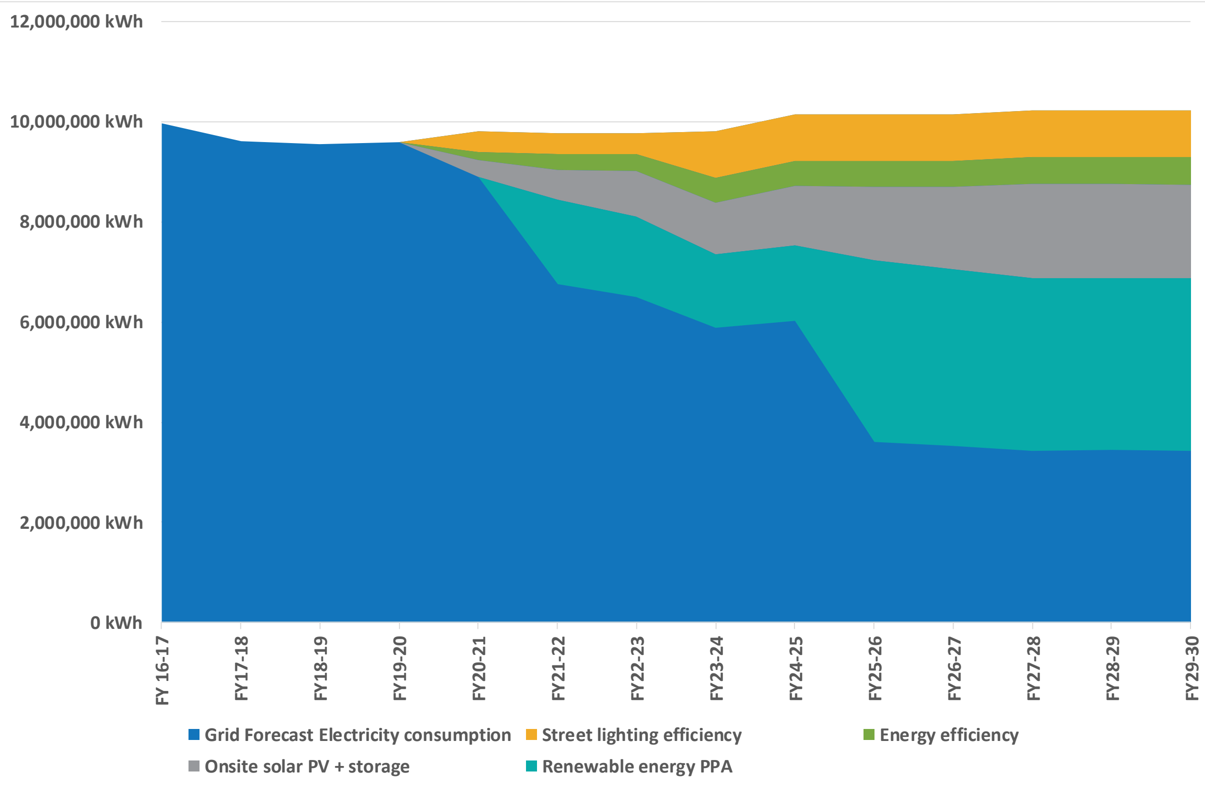

FIGURE 1: CVC POTENTIAL CHANGES TO ELECTRICITY DEMAND AND SUPPLY MIX TO 2030

The impact on Council's energy-related emissions is closer to a 40% reduction from these measures, and this underpins the recommended abatement target. This is illustrated below.

Clarence Valley Council has already achieved significant carbon abatement from flaring of landfill gases. No new abatement measures were modelled for transport energy, landfill or STP emissions, with abatement opportunities for these (other than offsets) being less viable at this time. This limits the impact of abatement measures on Council's total emissions, as also illustrated below.

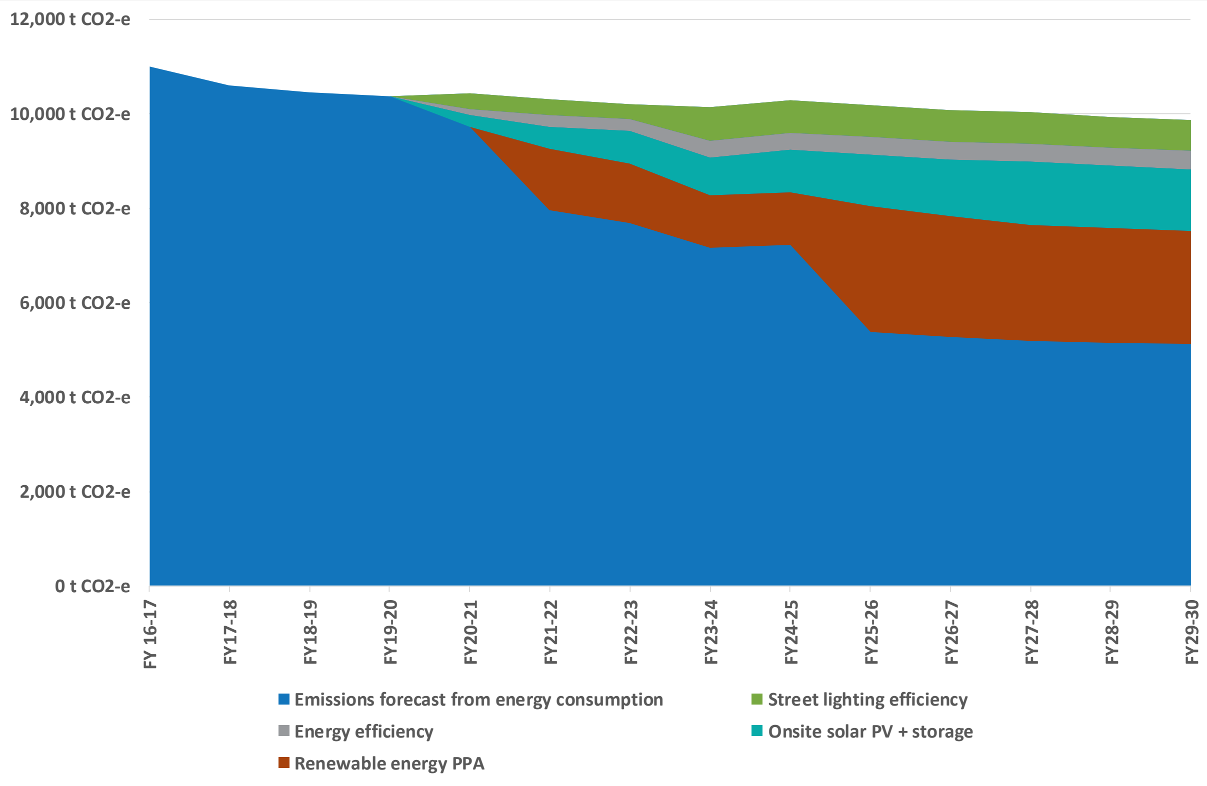

FIGURE 2: CVC POTENTIAL CHANGES TO CARBON EMISSIONS 2030 ENERGY-ONLY

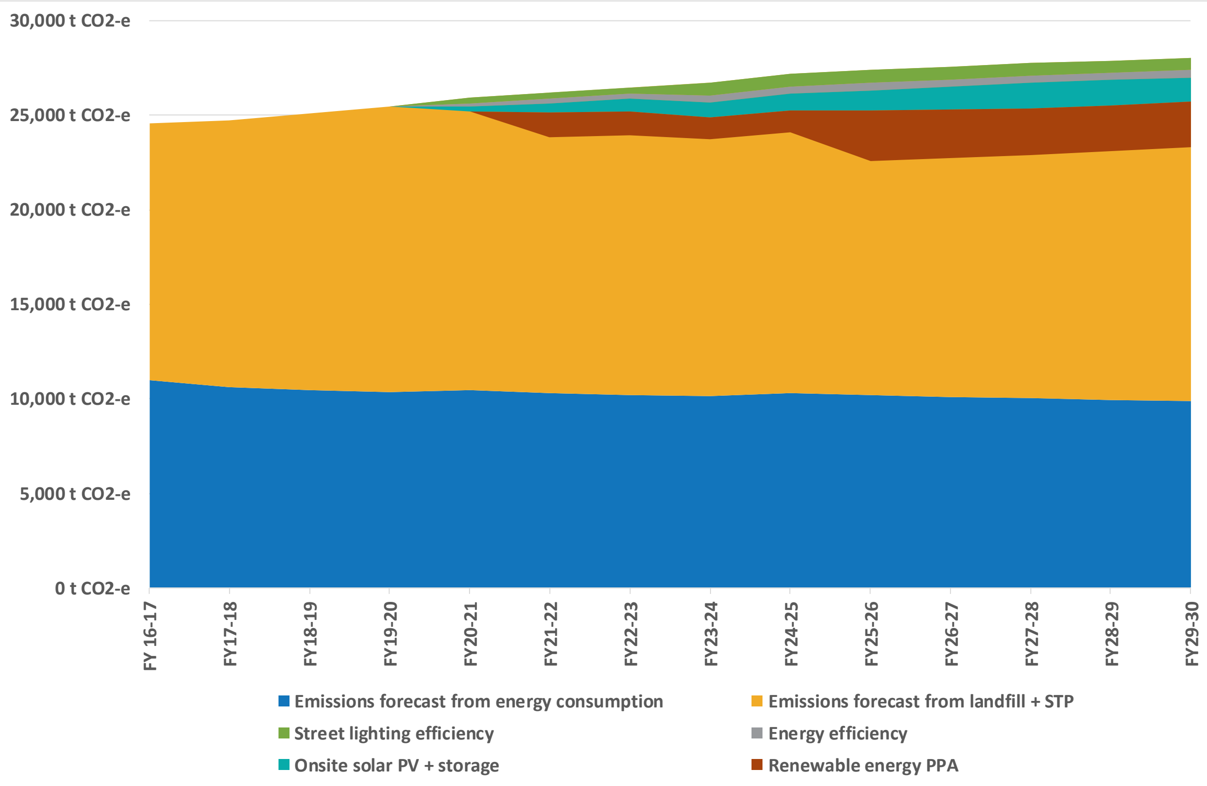

FIGURE 3: CVC POTENTIAL CHANGES TO CARBON EMISSIONS 2030 INCL LANDFILL & STP

These charts show that:

- Focusing on Council's operational energy use only, implemented initiatives plus changes to grid carbon intensity could mean that emissions in 2030 are reduced by some 53% compared with 2016/17,
- However, if we include landfill emissions then total abatement is just 5% of 2016/17 levels,
- This highlights both the significance of landfill GHG emissions and that its projected growth trend erodes much of the abatement gains made elsewhere

A summary of Council's energy and carbon footprint, and a summary of the major initiatives that underpin the above abatement and recommended targets, is provided below.

1.3 CVC’s energy and carbon footprint

CVC’s energy and greenhouse gas emissions for 2016-17 are tabulated below.

TABLE 1: CLARENCE VALLEY COUNCIL ENERGY USE & GHG EMISSIONS 2016-17

Emissions Source	FY 16-17	
Electricity (Council-owned assets)	8,508,483 kWh	8,276 t CO_2-e
Electricity (streetlighting owned by Essential Energy)	1,462,118 kWh	
Diesel fuel consumption (transport)	827,823 Litres	2,251 t CO_2-e
Premium unleaded petrol consumption (transport)	21,621 Litres	473 t CO_2-e
Unleaded petrol consumption (transport)	134,133 Litres	
Unleaded with 10% Ethanol consumption (transport)	56,067 Litres	
Sewerage treatment plants direct emissions (t CO_2-e)	650 tonnes	650 t CO_2-e
Landfill Gas emissions (t CO_2-e)	12,934 tonnes	12,934 t CO_2-e
CVC GHG emissions, including landfill		**24,584 t CO_2-e**
CVC GHG emissions, excluding landfill & STP		**11,000 t CO_2-e**

Landfill gas emissions account for over half of all CVC’s GHG emissions if this source is included. Excluding this, electricity is the dominant source of emissions. This is illustrated below.

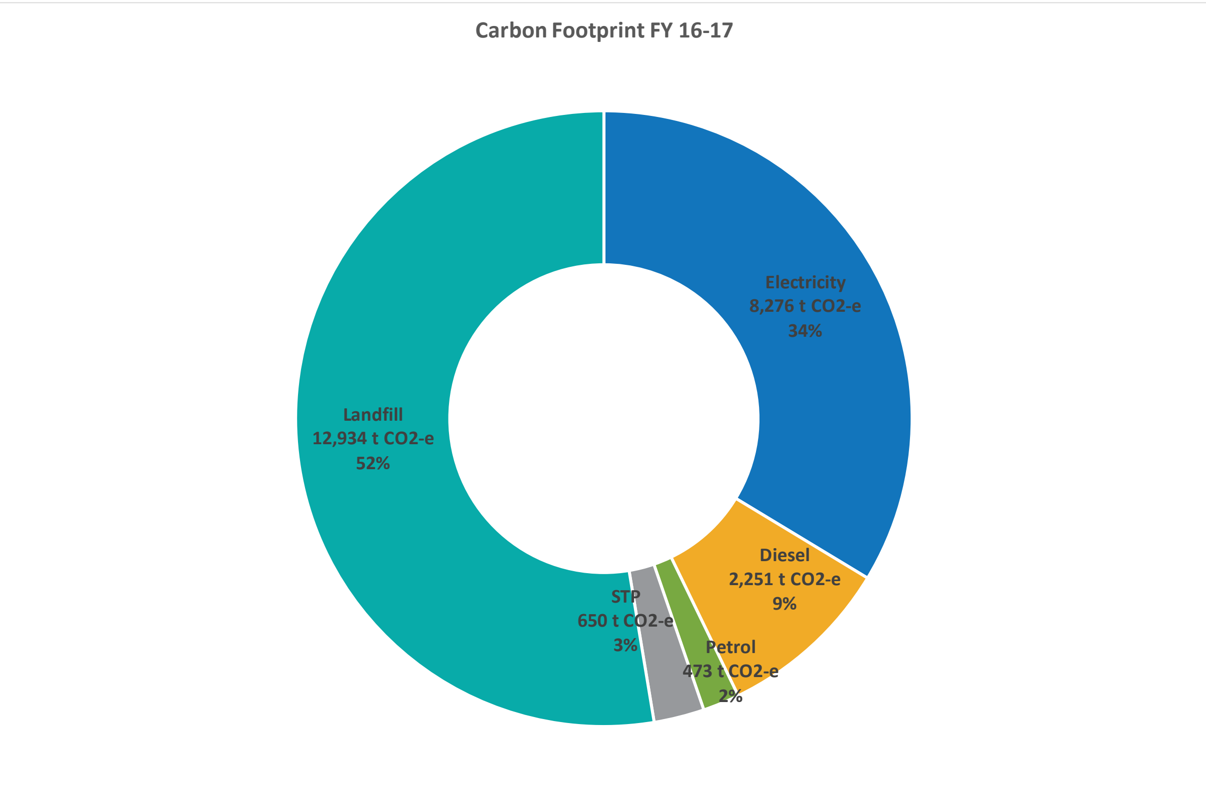

FIGURE 4: CLARENCE VALLEY COUNCIL’S GHG EMISSIONS 2016-17, ALL SOURCES

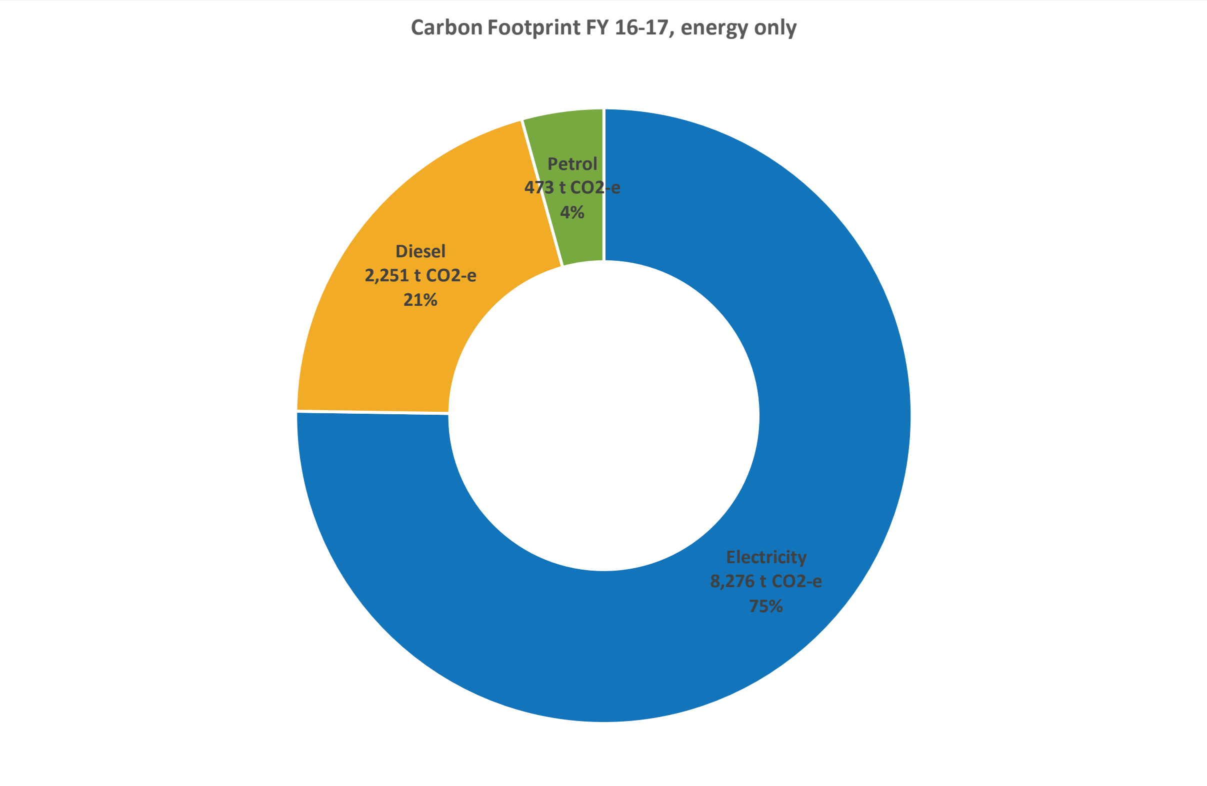

FIGURE 5: CLARENCE VALLEY COUNCIL'S GHG EMISSIONS 2016-17, ENERGY-ONLY

1.4 Projected energy use and GHG emissions to 2030

Projections are made of electricity demand and greenhouse gas emissions to 2030 taking into account asset changes, underlying population trends and landfill gas emissions modelling.

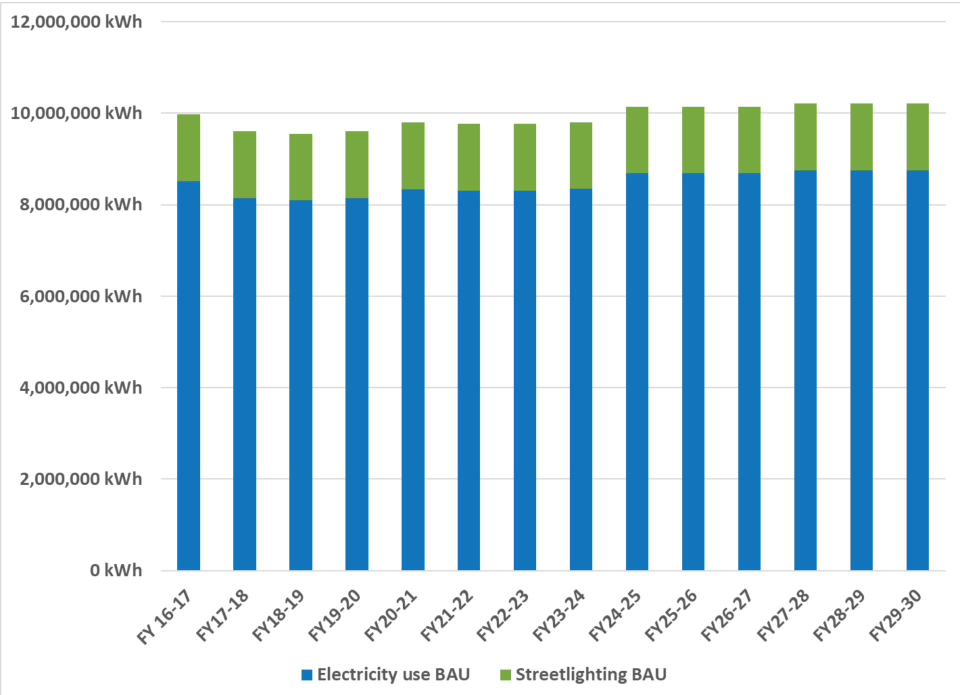

FIGURE 6: CLARENCE VALLEY COUNCIL ELECTRICITY USE PROJECTIONS TO 2030

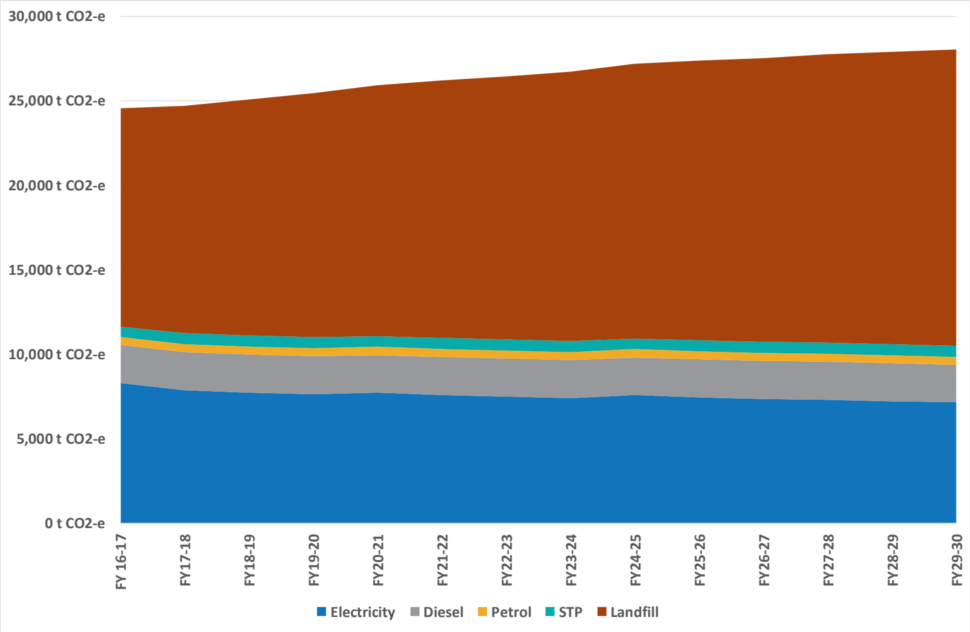

FIGURE 7: CLARENCE VALLEY COUNCIL GHG PROJECTIONS TO 2030 – ALL SOURCES

Repeating this projection but omitting landfill gas and STP emissions yields the following forecast.

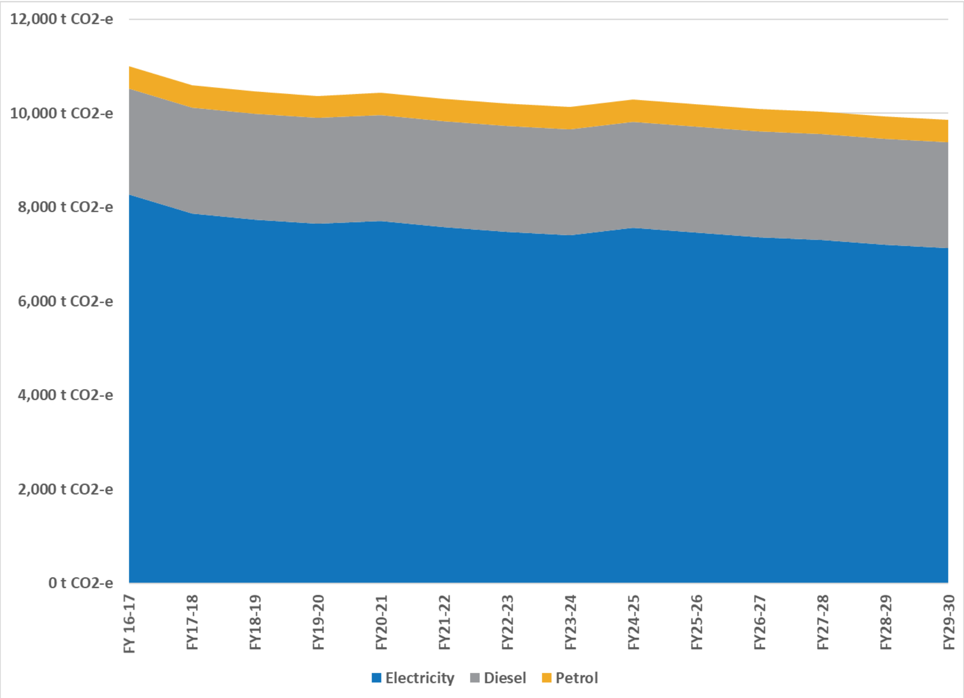

FIGURE 8: CLARENCE VALLEY COUNCIL GHG PROJECTIONS TO 2030 – EXCLUDING LANDFILL

1.5 Energy efficiency and onsite solar PV opportunities

A total of 47 initiatives were assessed for energy efficiency and onsite solar PV at CVC sites, including maintenance costs. The simple payback for most measures ranges from 4 to 8 years, equivalent to an internal rate of return of 12% to 25%. Suggested measures are staged over several years, with an aggregate estimated capital investment of $5,764,796. The timing of these investments (which are indicative) and principal activities in each year are summarised below.

TABLE 2: SUMMARY OF POTENTIAL CAPITAL COSTS TO CLARENCE VALLEY COUNCIL

Financial Year	Capital cost	Primary activities
FY18-19	-$100,000	Street lighting stage 1 – local roads (commences June-19)
FY19-20	-$1,369,020	Solar PV, Street lighting stage 1 – local roads, building lighting
FY20-21	-$674,316	Solar PV & building lighting, park/oval lighting
FY21-22	-$500,420	Solar PV and small battery storage systems
FY22-23	-$1,241,980	Street lighting stage 2 – main roads, Solar PV & building lighting, park/oval lighting
FY23-24	-$256,521	Solar PV and battery storage
FY24-25	-$561,153	Solar PV and battery storage, park/oval lighting
FY25-26	-$391,447	Solar PV and battery storage
FY26-27	-$640,555	Solar PV and battery storage, park/oval lighting
FY27-28	$0	NA
FY28-29	-$29,384	Park / oval lighting
TOTAL	**$-5,764,796**	**All solar, battery storage and lighting opportunities**

Based on this indicative financial expenditure timing, two scenarios were developed by Council that highlights possible sources of funding under the above as well as an accelerated scenario. These are tabulated below.

1.5.1 Scenario A: Expenditure as per Table 2, by project type

TABLE 3: SUMMARY OF POTENTIAL CAPITAL COSTS TO CLARENCE VALLEY COUNCIL BY TYPE AND YEAR – SCENARIO A

Year	Solar/Bat	Street Lighting	Park Lighting	Building Efficiency	Total
18/19		$100,000			$100,000
19/20	$383,107	$821,329		$164,584	$1,369,020
20/21	$480,348		$29,384	$164,584	$674,316
21/22	$500,421				$500,421
22/23	$159,797	$888,214	$29,384	$164,584	$1,241,979
23/24	$256,520				$256,520
24/25	$531,768		$29,384		$561,152
25/26	$391,447				$391,447
26/27	$611,171		$29,384		$640,555
27/28					$0
28/29			$29,384		$29,384
29/30					$0
Total	**$3,314,579**	**$1,809,543**	**$146,920**	**$493,752**	**$5,764,794**

TABLE 4: SUMMARY OF POTENTIAL CAPITAL COSTS TO CLARENCE VALLEY COUNCIL BY PROPOSED FUNDING SOURCE

Year	Grant	Sust Reserve	Street Lighting Reserve	Water Fund	Sewer Fund	Waste Reserve	CCT	General Fund	Total
18/19		$100,000							$100,000
19/20		$500,000	$130,000	$59,104	$147,465		$62,621	$469,830	$1,369,020
20/21		$200,000						$474,316	$674,316
21/22		$238,740			$261,681			$0	$500,421
22/23		$200,000			$43,667			$998,312	$1,241,979
23/24		$229,785					$26,735	$0	$256,520
24/25		$29,384		$326,437	$144,104	$61,227		$0	$561,152
25/26		$52,813			$338,634			$0	$391,447
26/27		$75,339			$565,216			$0	$640,555
27/28									$0
28/29		$29,384						$0	$29,384
29/30									$0
									$0
	$0	$1,655,445	$130,000	$385,541	$1,500,767	$61,227	$89,356	$1,942,458	$5,764,794

The resultant annual net cashflow and cumulative net cashflow from this investment approach to 2030 is illustrated below, which takes into account recurrent energy savings as well as recurrent maintenance savings and costs. Beyond 2030 cumulative net cashflow continues to increase as savings from all measures increase and capital inputs stop.

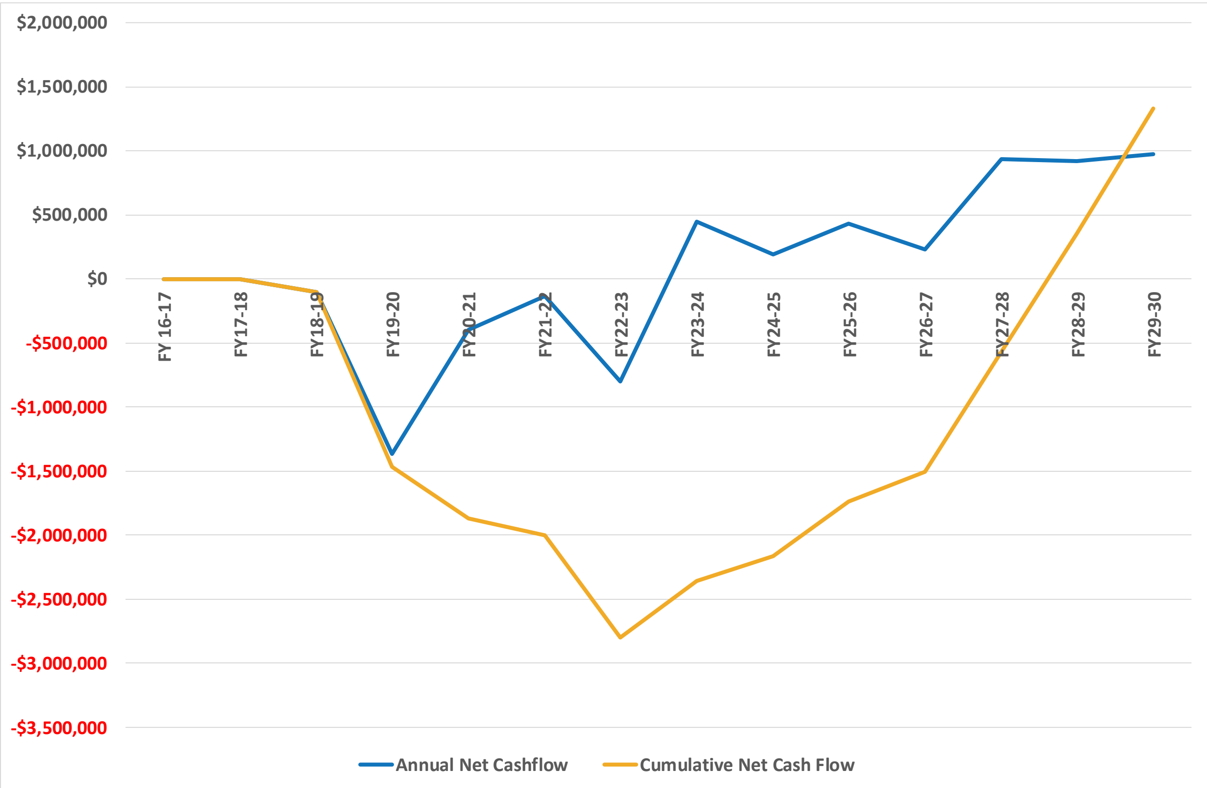

FIGURE 9: CVC ANNUAL AND CUMULATIVE NET CASHFLOW FROM EFFICIENCY AND ONSITE SOLAR TO 2030

The data underpinning this chart is shown below; in particular annual savings from implementation of savings are seen to approach $1m per year towards the end of the period to 2030.

TABLE 5: CVC ANNUAL AND CUMULATIVE NET CASHFLOW FROM EFFICIENCY AND ONSITE SOLAR TO 2030

Financial Year	Costs for Opportunities	Savings from Opportunities	Annual Net Cashflow	Cumulative Net Cash Flow
FY18-19	-$100,000	$0	-$100,000	-$100,000
FY19-20	-$1,369,020	$0	-$1,369,020	-$1,469,020
FY20-21	-$677,100	$277,926	-$399,174	-$1,868,194
FY21-22	-$505,653	$372,806	-$132,847	-$2,001,042
FY22-23	-$1,250,262	$450,439	-$799,823	-$2,800,865
FY23-24	-$266,142	$710,818	$444,676	-$2,356,189
FY24-25	-$572,656	$760,813	$188,156	-$2,168,033
FY25-26	-$405,824	$837,146	$431,323	-$1,736,710
FY26-27	-$657,000	$889,864	$232,865	-$1,503,845
FY27-28	-$19,182	$956,298	$937,116	-$566,729
FY28-29	-$49,046	$971,267	$922,221	$355,492
FY29-30	-$20,153	$991,635	$971,482	$1,326,973

1.5.2 Scenario B: Accelerated Expenditure

Council could elect to bring forward investment to a shorter timeframe in order to lock in the benefits earlier. This is tabulated below for each project type, and Council would then also adjust the annual amounts from each identified funding source to meet each year's requirement.

TABLE 6: SUMMARY OF POTENTIAL CAPITAL COSTS TO CLARENCE VALLEY COUNCIL BY TYPE AND YEAR – SCENARIO B

Year	Solar/Bat	Street Lighting	Park Lighting	Building Efficiency	Total
18/19		$100,000			$100,000
19/20	$863,455	$821,329	$29,384	$329,168	$2,043,336
20/21	$660,218		$29,384	$164,584	$854,186
21/22	$788,288		$29,384		$817,672
22/23	$1,002,618	$888,214	$58,768		$1,949,600
Total	**$3,314,579**	**$1,809,543**	**$146,920**	**$493,752**	**$5,764,794**

In addition to the costs and benefits associated with energy efficiency and solar PV projects there are additional opportunities that merit further investigation, in particular:

- Micro-hydro power generation at the Rushforth Road water treatment site. A 65 kW MH system is indicated by the current inflows to the site together with advised head pressure. The energy generated from this system would be two to four times the site's demand and would therefore be exported to the grid. The value for this power would be quite low, and if implemented today the business case would be weak. However a more detailed feasibility assessment would look at a range of factors, such as a smaller system that could be scaled up, future energy demand for the site that could increase the value of hydro-electricity. Future potential changes to network and market rules could also see energy sharing or local generation tariffs apply, which would further enhance the business case.

1.6 Renewable energy power purchase agreement

Efficiency and onsite solar initiatives will have an impact on Council's grid energy demand and GHG emissions. However sourcing the bulk of Council's electricity from offsite renewables will be necessary if Council elects to pursue an ambitious target of say more than 50% renewables.

Both build and purchase options are evaluated in this report. Under a build option Council could become both a generator and buyer of renewable energy from a project developed on Council-owned land, or on land owned by a regional partner – say another council or group of councils. Options that can be explored in this context include the restoration of the Nymboida hydro plant, local solar farm or a regional solar and/or wind farm. Under a purchase option Council would seek to buy a proportion of its electricity from renewable energy sources, and may not necessarily have or express a preference as to the location of renewable energy generators meeting their demand.

The premise of either option should be that there is a financial return to Council. In the case of a build option this entails earning income from offtake agreements and potentially LGCs, plus electricity cost savings to pay for an investment in say a solar farm. In the case of a PPA the cost of delivered renewables need only be the same or lower than would be purchased through a regular grid contract, and several recent cases evidence that this is feasible.

Based on the characteristics of the options and the current policy and market situation, a power purchase agreement (PPA) is likely to be a preferred solution. For the purpose of this report a 20% renewable energy PPA is assumed to be entered into in 2021, rising to 50% in 2025.

1.7 Carbon offsets

Purchasing carbon offsets differs from other abatement options outlined in that this represents a direct cost to Council, whereas other measures are premised on Council seeing a return on its investment. The cost to purchase offsets ranges from under $2.50 per tonne of CO_2-e when sourced from overseas, to over $9.50 per tonne if sourced locally. In charts above, the emissions that remain after all efficiency and renewable measures are implemented represents the scale of any carbon offset task for Council.

A proposal has been received to replant a 100 Ha area of the Shannon Creek Dam catchment, and this could possibly create 10,000 carbon offsets annually. Under the present proposal Council would incur no costs for the area to be replanted but would also not own the offsets, hence this provides no benefit from a council abatement perspective. However Council could seek to buy offsets from this project (likely at similar costs to Australian offsets), and/or could seek to co-invest in the development and management of the plantation in return for offsets.

It is recommended in the first instance that Council consider if the purchase of carbon offsets as part of its abatement strategy is a good fit given this comes at a cost premium (e.g. funded in future years by savings from other abatement actions). It is also recommended that as the Shannon Creek Dam opportunity is being analysed, Council's abatement objectives are considered.

2 Context for action on climate

Council's context for acting on climate change and increasing renewable energy exists at many levels, including global, national and local, and applies across all energy and emissions sources.

2.1 Global context

To address climate change, countries adopted the Paris Agreement at the COP21 in Paris on 12 December 2015. The Agreement entered into force less than a year later. In the agreement, all countries agreed to work to limit global temperature rise to well below 2 degrees Celsius, and given the grave risks, to strive for 1.5 degrees Celsius[1].

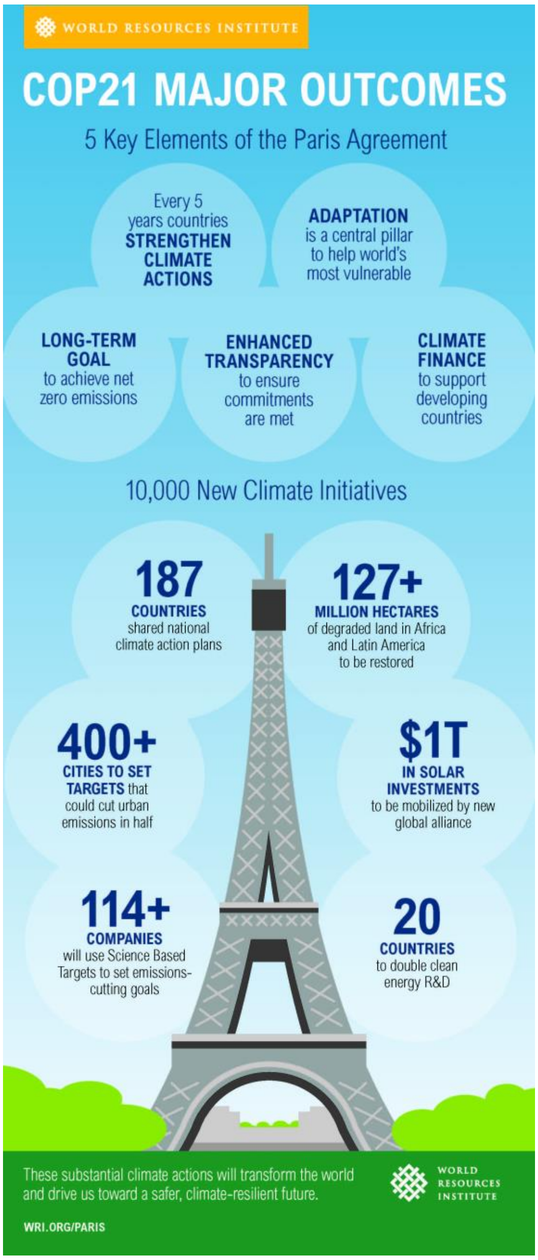

FIGURE 10: KEY ASPECTS OF THE PARIS CLIMATE AGREEMENT[2]

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[1] Sourced from https://www.un.org/sustainabledevelopment/climatechange/

[2] Sourced from https://www.connect4climate.org/infographics/paris-agreement-turning-point-climate-solution

2.2 National context for climate action and renewable energy

At a national level, Australia's response to the Paris Agreement has been to set a goal of GHG emissions of 5% below 2000 levels by 2020 and GHG emissions that are 26% to 28% below 2005 levels by 2030. A major policy that currently underpins this is the Renewable Energy Target (RET). This commits Australia to source 20% of its electricity (33,000 GWh pa, estimated to equate to a real 23% of electricity) from eligible renewable energy sources by 2020. The scheme runs to 2030. These two key targets are illustrated below.

Figure 11: Australia's renewable energy and carbon goals

An added scheme underpinning Australia's national targets is the Emissions Reduction Fund (ERF). This fund provides incentives to businesses, farmers, landfill operators, landholders and others to reduce GHG emissions. Projects are funded on an auction basis with proponents bidding for the lowest cost (incentives) required to abate GHG emissions. To date, six auctions have been held with the most recent being in December 2017.

A new initiative, the National Energy Guarantee (NEG) is currently being formulated and aims to put in place two measures to improve affordability, reliability and emissions, including:

- A reliability guarantee will be set to deliver the right level of dispatchable energy—from ready-to-use sources such as coal, gas, pumped hydro and batteries—needed in each state. It will be set by the AEMC and AEMO.
- An emissions guarantee will be set to contribute to Australia's international commitments. The level of the guarantee will be determined by the Commonwealth and enforced by the AER[3].

At this time the details of the NEG are not finalised. Initial modelling by others suggests that the scheme may not offer a pathway towards deep emissions cuts over and above Australia's commitment to the Paris Agreement, and may not deliver cuts to emissions from the electricity sector beyond the RET.

2.2.1 Energy management (commonwealth level)

As well as the RET the Commonwealth works to improve energy efficiency in collaboration with the States and Territories via the Council of Australian Governments (COAG). Major initiatives that are

[3] Sourced from https://www.energy.gov.au/government-priorities/better-energy-future-australia

led by the Commonwealth and which can have impacts on energy use by Clarence Valley Council include:

- The Equipment Energy Efficiency (E3) program, through which Australian jurisdictions (and New Zealand) collaborate to deliver nationally consistent mandated energy efficiency standards and energy labelling for equipment and appliances. Procurement policies and practices that routinely ensure that high star-rated appliances (motors, air conditioning units, kitchen appliances) are selected when replacing or buying new equipment will help Council's energy footprint decline over time.
- Periodic review and update of the National Construction Code as it relates tro efficiency (Section J). This section is currently undergoing a review, with proposed changes likely to come into effect in mid-2019. Both residential and commercial building changes will be targeted. The commercial building changes are aiming via increased stringency requirements to target savings in buildings of 23-53%. Among other measures the changes will target improvement via improved consideration of on-site renewable energy such as solar PV[4]. Any building upgrades or new facilities may need to comply with these requirements after mid-2019.
- Support to voluntary / market-based schemes such as Green Star and NABERS, and the implementation of the mandatory Commercial Building Disclosure (CBD) program. The Commercial Building Disclosure (CBD) Program is a regulatory program that requires energy efficiency information to be provided in most cases when commercial office space of 1000 square metres or more is offered for sale or lease. The CBD Program requires most sellers and lessors of office space of 1000 square metres or more to have an up-to-date Building Energy Efficiency Certificate (BEEC).

At a national level, the Commonwealth is also a periodic provider of programs, funds and incentives aimed at helping governments, homes and businesses become more energy efficient. Examples of past programs that may have been applicable to the Clarence Valley Council include:

- Community Energy Efficiency Program
- Energy Efficiency Information Grants Program
- Local Government Energy Efficiency Program
- Renewable Energy Bonus Scheme - Solar Hot Water Rebate

2.2.2 Sustainable Transport (commonwealth level)

Nationally sustainable transport initiatives are supported by a few Departments.

- Information resources are provided, such as the Green Vehicle Guide and the Truck Buyers Guide
- The Department of Infrastructure and Regional Development manages policy and standards development on vehicle emissions, vehicle noise and fuel consumption labelling. Fuel consumption labelling applies to all light vehicles sold in Australia, indicating fuel consumption and GHG emissions data
- The Clean Energy Finance Corporation provides financing to drive uptake of low emissions vehicles
- The Department of the Environment and Energy is responsible for fuel quality standards

[4] http://www.abcb.gov.au/Connect/Articles/2017/03/09/Section-J-Overhaul-big-changes-are-coming-your-way

As reported by ClimateWorks Australia in 2017[5], there are relatively few incentives or policies in place at a Commonwealth level relating to electric vehicles, and most of the effort to promote, incentivise and support the uptake of EVs is occurring in the private sector and by mortoring associations, and to an extent at State and Territory levels.

2.3 NSW context for climate action and renewable energy

The NSW Climate Change Policy Framework[6] outlines the State's target of reaching net-zero emissions by 2050. This is an aspirational objective and helps to set expectations about future GHG emissions pathways to help others to plan and act. The current policy framework will be reviewed in 2020.

In 2016 the NSW Government announced a $500 million funding package and consulted on two draft plans to help implement the Policy (Climate Change Fund Draft Strategic Plan and A Draft Plan to Save NSW Energy and Money). At this time these initiatives have not been finalised.

Through the Office of Environment and Heritage, the NSW Government provides support to local governments to assess climate change risks.

The NSW Renewable Energy Action plan has helped to drive the growth of renewables in the State through its three key goals:

- Goal 1 – Attract renewable energy investment
- Goal 2 – Build community support, including the establishment of the Renewable Energy Advocate
- Goal 3 – Attract and grow renewable energy expertise

2.3.1 Energy management (state level)

The NSW Government runs a number of initiatives aimed at promoting and increasing the uptake of energy efficiency and sustainable practices. In the main these initiatives are spearheaded by the NSW Department of Planning and Environment, and by the Office of Environment and Heritage within this Department. Just some of the initiatives that help local governments, residents and businesses are:

- Sustainability Advantage program, which helps local governments and businesses commit to, plan, implement and be recognised for sustainability practices in their operations and supply chains
- Energy Savings Scheme – information and resources that help organisations get access to financial incentives by implementing verifiable energy savings initiatives, such as building retrofits, plant upgrades and lighting upgrades to LED
- In 2018 the government completed a panel of renewable energy Power Purchase Agreement (PPA) providers, which local governments can access to provide solar PV solutions at no upfront cost and ongoing cost savings compared with current electricity costs
- Community renewable energy guides and resources

[5] https://climateworksaustralia.org/sites/default/files/documents/publications/state_of_evs_final.pdf
[6] http://www.environment.nsw.gov.au/topics/climate-change/policy-framework

- A wide range of tools, guides, case studies, training courses and other materials is available to businesses through OEH, covering a wide range of sectors, technology types and energy forms
- Environmental Upgrade Agreements (EUA), which can help organisations and participating Councils overcome some traditional barriers to implementing and benefitting from environmental upgrades
- Clean Energy for Business – a program that ran in 2017 and helped businesses and local governments plan for a net-zero / 100% renewable energy future. Case studies from this program will help other organisations plan similar clean energy pathways
- The government's Power to Save initiative aims to help eligible homes and businesses save on their power bills with targeted assistance. This includes discounted energy efficient lighting (e.g. LED), appliance replacement incentives for eligible people (e.g. pensioner concession, VA Gold Card), and appliance and lighting upgrade incentives / discounts for small businesses

2.3.2 Sustainable Transport (state level)

There are few initiatives or incentives available to NSW motorists to switch to electric vehicles at this time. A report by ClimateWorks Australia in 2017[7] indicates that a stamp duty and registration discount of <$250 is available for a $60,000 electric vehicle. There are efforts to promote uptake of EVs in government fleet, though not to the extent of the ACT Government[8], which recently announced plans for all government fleet to be EV by 2021 via the *Transition to Zero Emissions Vehicles Action Plan 2018-2021*.

Much of the work being done in NSW to prepare for future EV growth is by private sector (e.g. charging stations at Westfield Chatswood), motoring bodies (NRMA[9]: $10m plan to roll out over 40 EV charging stations in NSW and the ACT) and peak bodies such as the Electric Vehicle Council.

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[7] https://climateworks.com.au/sites/default/files/documents/publications/state_of_evs_final.pdf

[8] https://www.cmtedd.act.gov.au/open_government/inform/act_government_media_releases/rattenbury/2018/new-action-plan-to-drive-growth-in-electric-vehicles

[9] https://www.mynrma.com.au/community/news-and-media-centre/nrma-to-build-ev-fast-charging-network

2.4 Local context for action on climate and renewable energy

2.4.1 Local uptake of solar PV

Solar PV installations in the Clarence Valley LGA numbered 5,832 in mid-2018, or 25.3% of dwellings, ranking in the top 22% of LGAs in NSW. Total installed capacity is 21,634 kWp, with an increasing number of mid-sized commercial-scale systems from 10-100 kWp, driven by declining solar costs and greater uptake by commercial businesses.

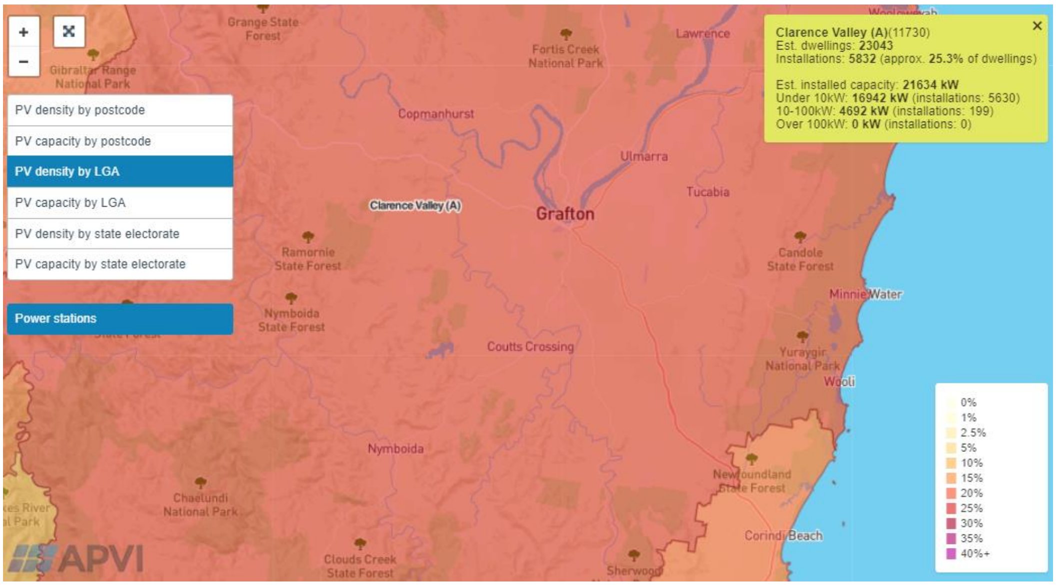

Figure 12: Current uptake of solar PV in the Clarence Valley LGA[10]

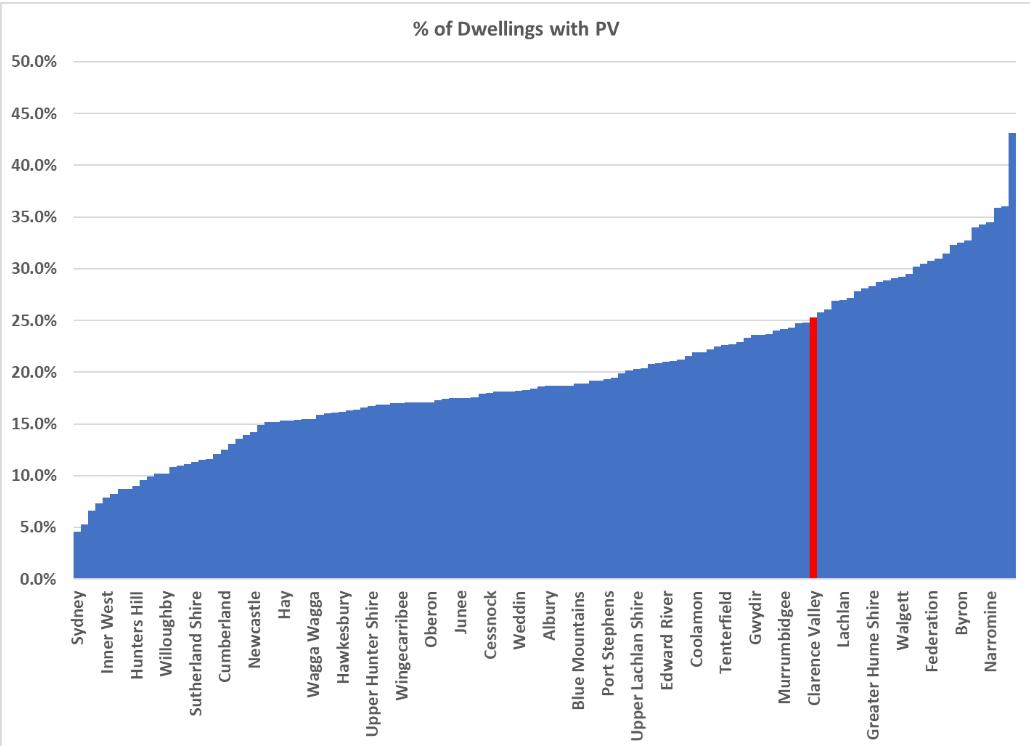

Figure 13: Uptake of solar PV in the Clarence Valley LGA compared with other NSW LGAs

[10] Sourced from http://pv-map.apvi.org.au/historical#12/-33.8277/151.1684

2.4.2 Clarence Valley Council's climate change policy

Council adopted its climate change policy in August 2016 (due for review in August 2018). In this Council sets out the following objectives and policy statements:

Council is committed to:

(a) leading the response to climate change challenges in the Clarence Valley,
(b) introducing strategies that mitigate and reduce Council's contribution to climate change,
(c) introducing strategies that mitigate and reduce the community's contribution to climate change,
(d) introducing strategies to adapt Council activities and responsibilities to unavoidable impacts of climate change,
(e) developing resilience to the effects of climate change within both Council and the community,
(f) assisting the Clarence Valley community to adapt to the effects and impacts of climate change, and
(g) planning for sustainability in response to climate change.

In meeting the challenges of climate change, Council will:

- *develop a Climate Change Action Plan for Council's activities which includes climate change mitigation and adaptation strategies for Council that:*
    - *i. integrate climate change adaptation and mitigation measures into Council's operations,*
    - *ii. ensure that Council's actions, decisions and policy response to climate change remains current and reflects Council's operational capacity, community expectations and changes in climate change benchmarks, and*
    - *iii. are inclusive of the effects of climate change on the natural environment and wildlife of the Clarence Valley,*
- ***develop greenhouse gas emission reduction and renewable energy targets by August 2018 and the matter be reported back to Council,***
- *ensure decisions are consistent with any applicable benchmarks, whether from the IPCC (Intergovernmental Panel on Climate Change) or otherwise, as adopted by Council or State or Federal Governments from time to time,*
- *encourage all sectors of the Clarence Valley community to adapt to the unavoidable impacts of climate change, to reduce greenhouse gas emissions and to develop local solutions to climate change,*
- *develop appropriate sustainable development controls on land predicted to be adversely affected by climate change,*
- *regularly review its climate change plans, strategies and benchmarks to ensure they remain current as the science of climate change develops,*
- *where appropriate, take into account the effects of climate change when assessing development applications, and*
- *resource climate change initiatives and seek external assistance where available.*

This analysis of Council's energy use and greenhouse gas emissions, and the development of recommended targets for future actions by Council, is carried out within this context.

3 CVC achievements

3.1 Summary of Council's achievements

In line with its policy position on climate change, and in step with residents and businesses in Clarence Valley, Council has pursued significant carbon emissions reduction and renewable energy initiatives over the past several years. A summary of measures implemented by CVC is tabulated below.

TABLE 7: CLARENCE VALLEY COUNCIL: IMPLEMENTED SOLAR PV SYSTEMS

Sites where solar PV is installed (June 2018)	System Size - kW	Potential electricity generation (1,400 kWh/kW per year)
South Grafton Works Depot, Tyson Street	100	140,000 kWh
Grafton Regional Library, Pound St	51	71,400 kWh
Grafton Regional Library additional system	49	68,600 kWh
Grafton Community Centre, Duke Street	42	58,800 kWh
Yamba Sports Centre	42	58,800 kWh
Woodford Island STP	38	53,200 kWh
CVC Prince St Office	31	43,400 kWh
Yamba Pool	31	43,400 kWh
Shannon Creek Dam	30	42,000 kWh
Yamba STP	30	42,000 kWh
Iluka STP	30	42,000 kWh
Clarenza STP	30	42,000 kWh
Organics Recovery Facility	25	35,000 kWh
Grafton Meals on Wheels, Bacon Street	20	28,000 kWh
Townsend Works Depot	20	28,000 kWh
Yamba Community Centre, Treelands Drive	13.5	18,900 kWh
Grafton Regional	10	14,000 kWh
Grafton Regional Landfill	10	14,000 kWh
CVC Maclean Office, River Street	10	14,000 kWh
Yamba Surf Club	7.3	10,220 kWh
Yamba Surf Club (second system)	7.3	10,220 kWh
Yamba Meals on Wheels	6.2	8,680 kWh
Grafton Waste Transfer Station, Kirchner Street	5	7,000 kWh
South Grafton Indoor Pool & Gym, Armidale Road	5	7,000 kWh
Grafton Landfill Weighbridge	5	7,000 kWh
Clarence Lawn Cemetery - solar + battery, 703 Armidale Road	5	7,000 kWh
Glenreagh Hall	3	4,200 kWh
Total	**656.3 kW**	**920,220 kWh pa**

TABLE 8: CLARENCE VALLEY COUNCIL: ADDITIONAL ENERGY EFFICIENCY AND CARBON ABATEMENT INITIATIVES

Efficiency / abatement initiative	Estimated abatement in tonnes of CO_2-e
Solar Hot Water systems at 15 sporting amenities (15 systems)	>5
Landfill gas capture & destruction	12,473
Mixed recycling collection (diversion from landfill)	3,900
Food & Organics collection service (diversion from landfill)	1,900
Street light low energy (compact fluoro) replacement	800
CVC Prince St Office Air Conditioning Replacement	130
Grafton Regional Landfill Airport Lighting Replacement	35
CVC Victoria St Office Air Conditioning Replacement	31
CVC Maclean Office Energy Management System	2
CVC Prince St Office Energy Management System	4
CVC Prince St Office Low Energy Globe Replacement	2
CVC Victoria St Office Energy Management System	2
Total	**>19,284 t CO_2-e pa**

3.1.1 Contribution to energy demand, savings compared with business-as-usual

These achievements are significant, though they are largely under-reported.

- For solar PV projects the generation potential is estimated to be around 920 MWh per year, which would represent 8.4% of Council's electricity demand. Data on energy consumed v energy exported is not maintained, so this is only an approximation, and the true contribution may be lower than this. Nonetheless this level of solar energy generation compares favourably with other councils' efforts.
- Implemented and reported energy efficiency efforts are typical of many councils, with many local street lights upgraded to CFL since 2000, and energy efficient lighting, air conditioning and building management systems becoming the norm. In addition, it is business-as-usual practice to implement efficient energy technologies and techniques for new and upgrade works; for example variable speed drives are commonplace within the water and wastewater treatment network.
- Like many landfills, CVC's operation has benefitted from Commonwealth's incentives and flaring of gas has seen greenhouse gas emissions decline by 40-50% compared with business-as-usual forecasts.

The net result of these efforts is that Clarence Valley Council's greenhouse gas emissions are substantially lower – potentially by more than 40% - than where they would be without abatement efforts. This story should be communicated effectively and provides a platform from which continued abatement efforts towards more ambitious targets can be launched.

4 Council's energy demand and GHG emissions

Clarence Valley Council's emissions boundary for the purpose of this work[11] includes Council's operational energy use. These represent the energy and emissions sources over which Council has the greatest ability to influence. Landfill gas and STP emissions are also estimated and can inform Council's approach to target setting for carbon abatement. GHG emissions are estimated based on both the National Greenhouse Account Factors workbook updated at July 2017[12], and advice from Council's advisor on landfill gas emissions, MRA and Council's Manager Water Cycle (STP emissions).

4.1 2016/17 energy use and emissions

CVC's energy and greenhouse gas emissions for 2016-17 are tabulated below.

TABLE 9: CLARENCE VALLEY COUNCIL ENERGY USE & GHG EMISSIONS 2016-17

Emissions Source	FY 16-17	
Electricity (Council-owned assets)	8,508,483 kWh	8,276 t CO_2-e
Electricity (streetlighting owned by Essential Energy)	1,462,118 kWh	
Diesel fuel consumption (transport)	827,823 Litres	2,251 t CO_2-e
Premium unleaded petrol consumption (transport)	21,621 Litres	473 t CO_2-e
Unleaded petrol consumption (transport)	134,133 Litres	
Unleaded with 10% Ethanol consumption (transport)	56,067 Litres	
Sewerage treatment plants direct emissions (t CO_2-e)	650 tonnes	650 t CO_2-e
Landfill Gas emissions (t CO_2-e)	12,934 tonnes	12,934 t CO_2-e
CVC GHG emissions, including landfill		**24,584 t CO_2-e**
CVC GHG emissions, excluding landfill		**11,000 t CO_2-e**

Landfill gas emissions account for over half of all CVC's GHG emissions if this source is included. Excluding this source electricity is the dominant source of emissions. Electricity use is recorded for more than 370 sites in total. The vast majority of these are owned and operated by Council, while a small number of sites are managed by third parties on behalf of Council, such as pools and sports centres. Electricity can be broken up by asset category per the table below.

TABLE 10: CLARENCE VALLEY COUNCIL ELECTRICITY USE 2016-17 BY ASSET CATEGORY (ADJUSTED BY 100%RE)

Asset category	2016-17 Electricity use kWh	% of CVC electricity
Water and wastewater	4,407,485 kWh	44%
Council-owned facilities	3,378,564 kWh	37%
Open spaces & facilities (incl sports facilities)	425,119 kWh	4%
Street lighting	1,480,568 kWh	15%

The majority of diesel is consumed by Council's road maintenance and waste fleet. During 2016-17 there were 172 passenger and light commercial vehicles in Council's fleet.

[11] Scope 1 + Scope 2 emissions are counted, with street lighting taken to be a Scope 2 source. A carbon footprint aligned with National Carbon Offset Standard (NCOS) would include Scope 3 upstream emissions from energy, and indirect emissions such as air travel, employee commute, consumables, etc. If Council wants to pursue a carbon neutral target, then these Scope 3 emissions would be included in the carbon footprint.

[12] http://www.environment.gov.au/climate-change/climate-science-data/greenhouse-gas-measurement/publications/national-greenhouse-accounts-factors-july-2017

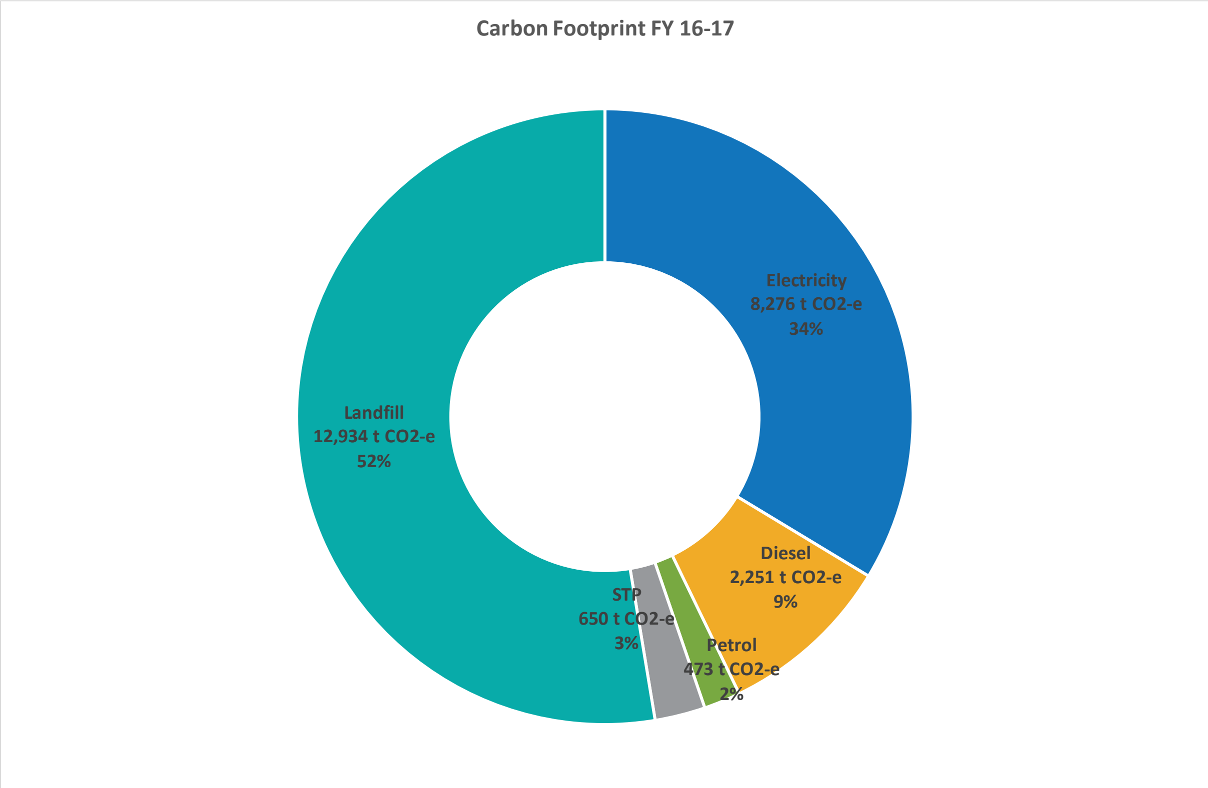

FIGURE 14: CLARENCE VALLEY COUNCIL'S GHG EMISSIONS 2016-17, ALL SOURCES

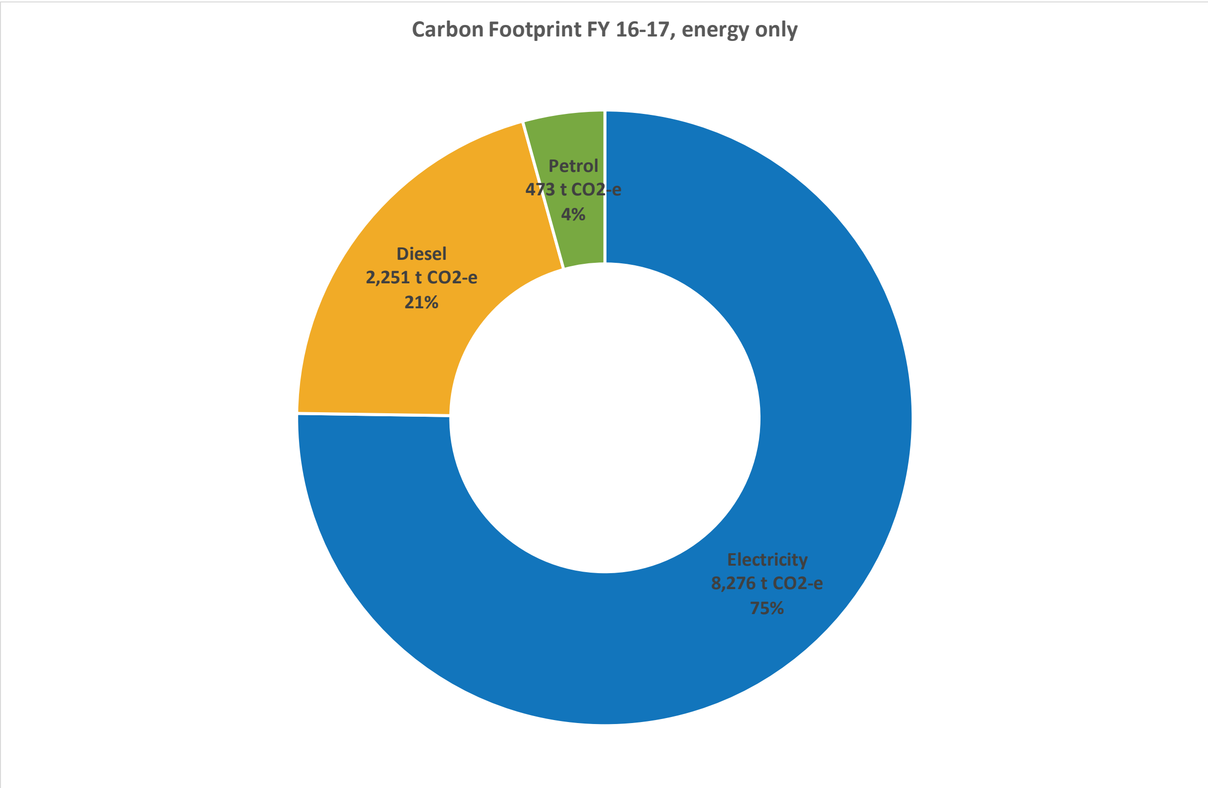

FIGURE 15: CLARENCE VALLEY COUNCIL'S GHG EMISSIONS 2016-17, ENERGY ONLY

4.2 Planned changes to CVC assets

During 2016-17 and over the next several years a number of sites will be sold / divested, or upgraded / redeveloped, resulting in changes to Council's electricity demand. These changes are accounted for in forecast energy demand, and the main changes are summarised below.

TABLE 11: CLARENCE VALLEY COUNCIL ASSET CHANGES COMPLETED AND PLANNED

Project	Date	Impact on energy demand
New Grafton Works Depot, Tyson St	Feb-18	New energy demand for CVC
Closure Bruce St Depot	Mar-18	No energy use in future by CVC
Closure Swinghammer St Works Depot	Feb-18	No energy use in future by CVC
Part closure 42 Victoria St Office	Mar-18	Reduced energy use in future by CVC
Closure 42 Victoria St Office	Est 2021	No energy use in future by CVC
Redevelop 2 Prince St Office	Ongoing	Minor reduction in energy use by CVC
Closure of McNaughton Place Office	2017	No energy use in future
Grafton Community Centre, Duke St, lease to Headspace	Fom Nov-17	No energy use in future by CVC
Grafton STP upgrade	Est 2028	Increased energy demand for CVC
Rushforth Rd Reservoir UV treatment[13]	Est 2018	Increased energy demand for CVC
Floodplain Depot sale	2016	No energy use in future by CVC
Weeds Office sale	TBC	No energy use in future by CVC
70 Pound St Office sale	2016	No energy use in future by CVC
South Grafton Visitors Centre sale		No energy use in future by CVC
Brooms Head caravan park re-dev	2018-2020	Increased energy demand for CVC
Calypso caravan park re-development	2018-2020	Increased energy demand for CVC
Grafton Regional Gallery expansion	TBC	Increased energy demand for CVC
Council offices 48 River St refurbishment	2019	Increased energy demand for CVC
Maclean library move to 48 River St	2019	No energy use in future by CVC
Grafton Olympic Pool redevelopment	TBC	Increased energy demand for CVC
Sports centre Powell St transfer to PCYC	2018	No energy use in future by CVC
Treelands Drive comm centre redev	2018-19	Increased energy demand for CVC
Wooli Street community hall divestment	TBC	No energy use in future by CVC
Other caravan parks upgrades over time	TBC	Increased energy demand for CVC

The net impact of all of these changes may be in the order of 600 MWh in increased annual electricity demand by 2030, or just 6% of Council's current electricity consumption. That is just 0.5% increase per year, which is small. This is referred to as business-as-usual or BAU growth.

Business-as-usual changes in energy demand by some of Council's largest energy users – such as Shannon Creek Dam, Yamba WWTP and Kremnos Pumping Station – can be much larger than this from year to year.

[13] There is a possibility that Council may have to develop a water filtration system at Rushforth Road in future, though this is not committed or included in any forward plans at this time. Future energy forecasts do however make an allowance that this may occur in order to present a conservative forecast of future electricity use and emissions so that future efforts to meet renewable energy or carbon targets are not under-estimated.

4.3 Underlying growth in energy demand

Aside from the changes noted above, there may be additional underlying growth in energy demand due to population changes forecast in the Clarence Valley LGA or from increases in tourism.

Estimates by the NSW Department of Planning suggested a population of 56,250 by 2031[14]. Compared with profile.id statistics (51,298 people in 2017), this is an annual increase of 0.75%. However according to census data there has been no growth in population over the last six years, as shown below[15].

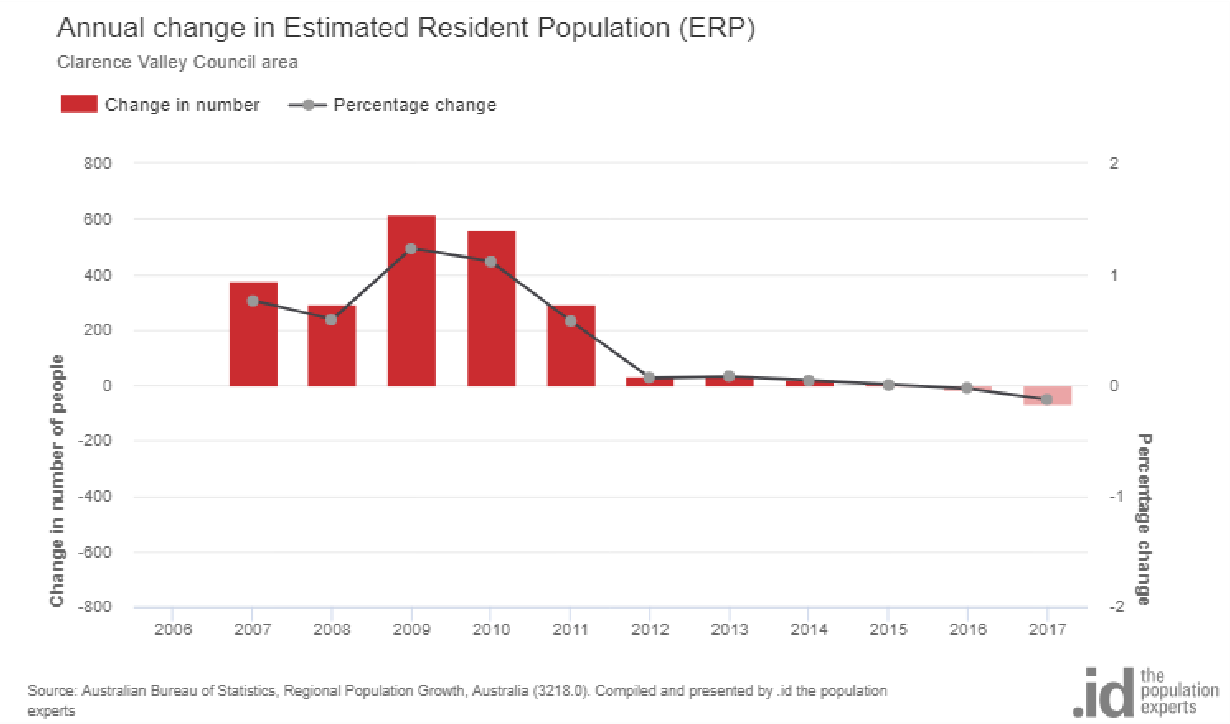

FIGURE 16: CLARENCE VALLEY LGA RECENT POPULATION TRENDS

A growing population may lead to more energy demand for Council services, such as street lights, sewer and water supply. However, the rate of energy consumption increase would likely be lower than population growth as some services' increased energy demand would be marginal, such as wastewater treatment, community facilities, Council administration and sporting fields & aquatic centres.

For energy forecasting purposes planned Council changes and the most recent population data are used in this case. As such growth is based only on the BAU changes identified above.

Forecasts of landfill emissions are based on assumed similar levels of waste going to landfill as occurs at present. Estimates of associated GHG emissions take into account new waste, legacy waste and Council's flaring of landfill gas. The forecast of landfill emissions to 2030 was developed by MRA.

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[14] http://www.planning.nsw.gov.au/~/media/Files/DPE/Reports/north-coast-employment-land-review--section-9-lga-analysis-clarence-valley-0315.ashx
[15] https://profile.id.com.au/clarence-valley/population-estimate

4.4 Projected energy use and GHG emissions to 2030

Projections are made of grid demand and emissions to 2030 with the above summary of asset changes, underlying population trends, STP emissions estimates and landfill gas emissions modelling.

4.4.1 Electricity projection to 2030

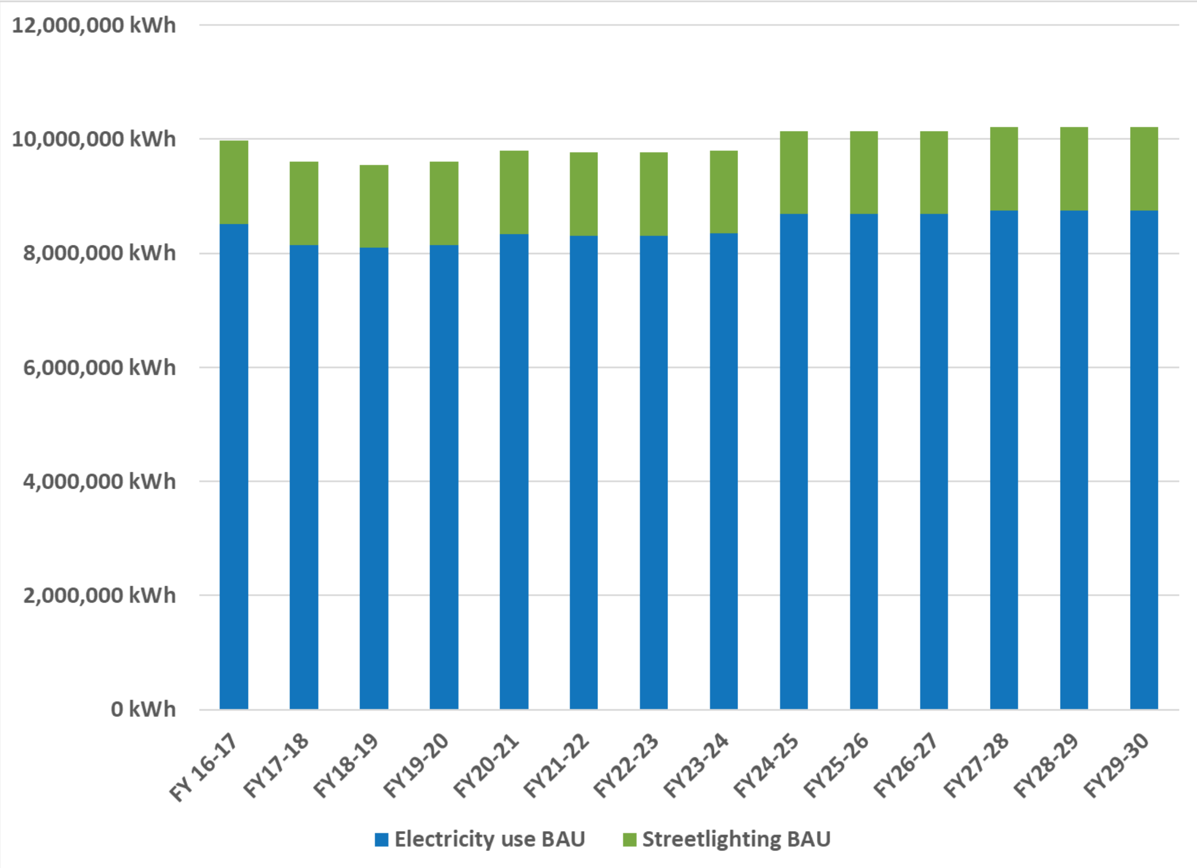

FIGURE 17: CLARENCE VALLEY COUNCIL ELECTRICITY USE PROJECTIONS TO 2030

This forecast suggests that without underlying population changes the overall change in electricity use by 2030 will be small, made up of net increases identified above potentially offset by BAU changes to large water supply assets (noting energy demand by water supply assets can be quite variable year-to-year). This projection provides the main base against which renewable energy initiatives will be compared in order to derive recommended targets for renewable energy in future.

4.4.2 Emissions projection to 2030

GHG emissions are derived from the energy projections by applying NGA Factors (July 2017) to fuel, Commonwealth Government projections of electricity sector emissions by 2030[16], added to landfill GHG estimates provided by MRA and STP emission estimates provided by Council. Projections based on BAU changes are shown below.

[16] Electricity sector GHG emissions will not remain at current levels, with changes to the supply mix (towards more renewables) and underlying demand growth leading to a decline in grid GHG-intensity over time. A simple estimate of grid GHG-intensity is derived from Commonwealth Government projections of electricity sector emissions. https://www.environment.gov.au/system/files/resources/eb62f30f-3e0f-4bfa-bb7a-c87818160fcf/files/australia-emissions-projections-2017.pdf

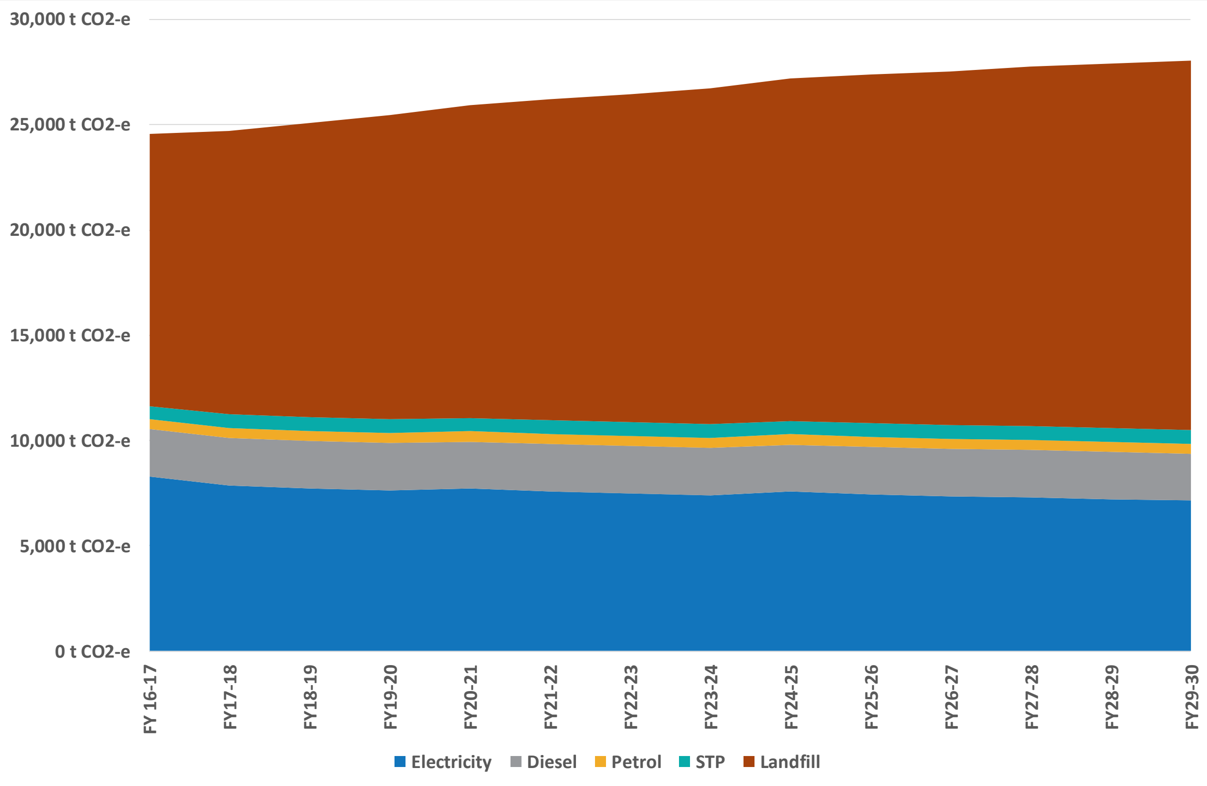

Figure 18: Clarence Valley Council GHG projections to 2030 – BAU

Repeating this projection but including energy-only emissions yields the following forecasts.

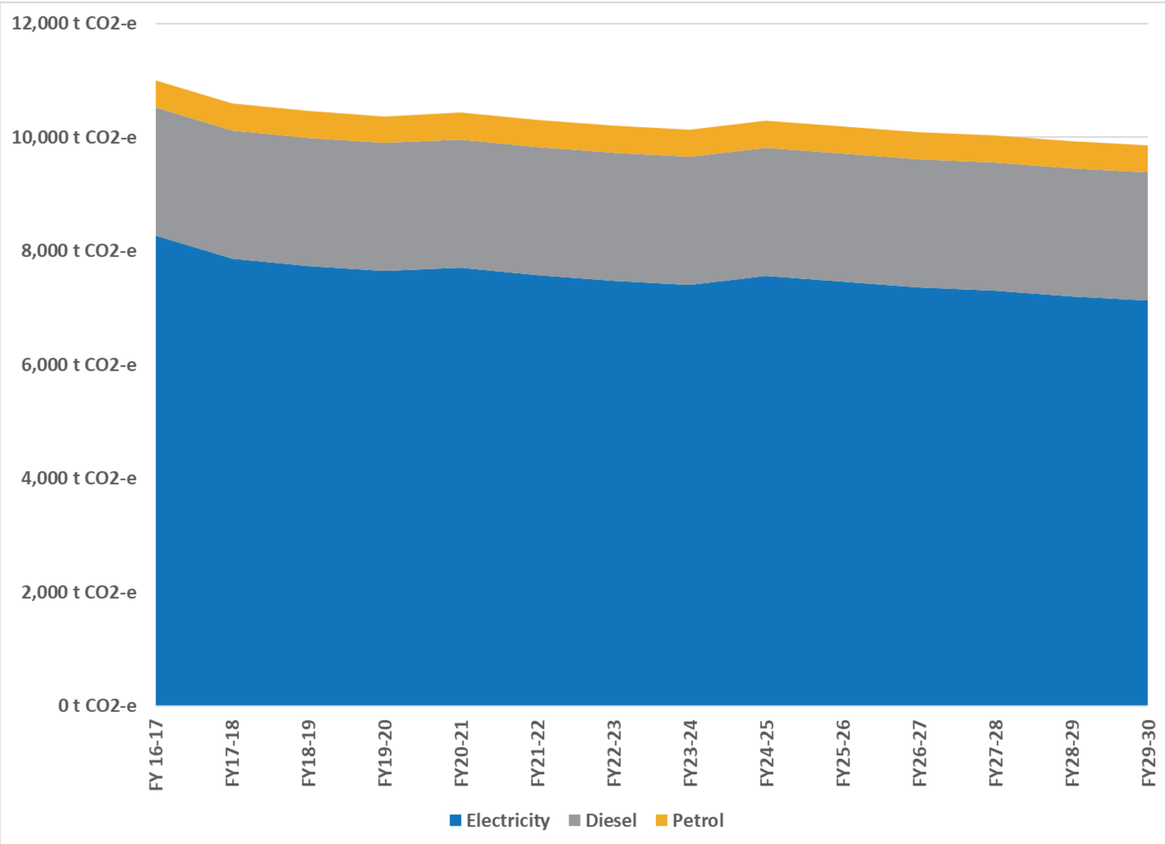

Figure 19: Clarence Valley Council GHG projections to 2030 – BAU, energy-only

5 Opportunities to reduce carbon emissions and increase renewable energy

Clarence Valley Council wishes to establish targets for renewable energy and carbon abatement from its operations. As described above more than 8% of electricity is now sourced from onsite renewable energy (solar PV) systems, several energy efficiency measures have been implemented, and emissions from landfill operations have been reduced significantly by gas flaring.

Despite the significant gains made, much more can be achieved, and this project has assessed further opportunities for renewables and abatement. These opportunities are outlined below, followed by a summary of the costs and savings for different measures. Opportunities are organised into four categories:

- Energy efficiency and onsite renewable energy
- Transport fuel consumption
- Renewable energy offsite (generation or purchasing)
- Landfill operations

5.1 Energy efficiency and onsite renewable energy

5.1.1 Water and wastewater treatment

Water and wastewater treatment systems are CVC's largest consumer of electricity, with more than 4,400 MWh (44% of CVC total) consumed in 2016/17. The vast majority of this demand is from electric motor systems, mainly pumps. Only small amounts of energy are consumed by non-motor systems such as lighting, air conditioning and general power.

A total of 158 kWp of solar PV systems are installed across five water and wastewater treatment sites, including Shannon Creek Dam, Yamba STP, Woodford Island STP, Iluka STP and Clarenza STP.

5.1.1.1 Energy efficiency opportunities

The main opportunities for improved energy efficiency in water and wastewater systems are in operational practices and new build or plant upgrade works. Relatively few opportunities were identified for retrofits to existing plant. Summarising the main potential improvements observed from site visits:

- Operating practices for large sites such as Shannon Creek Dam favour offpeak operation to minimise costs, which is good practice.
- Most wastewater treatment plants use energy efficient technology such as widespread use of VSDs and fine bubble diffusion. Optimisation of aeration processes is an ongoing part of day-to-day operations. At Yamba STP an older surface aeration system has been used from time to time as other plant has been unavailable; a goal for the site is to minimise operation of this older equipment.
- Significant pump station (water and sewer) upgrades will typically assess the potential for efficiency in pump selection, VSD control, level sensing and control strategies, etc. The Tyson Street SPS is a good example of an upgrade incorporating VSD control of the two pumps.
- Upgrading to LED lights at all water and wastewater treatment sites will have a modest impact on energy demand, and should be pursued as part of routine maintenance as lights fail and as a retrofit option where there are high-use fittings (e.g. office spaces, night lighting that operates dusk to dawn).

- Only minor retrofit opportunities were identified, such as the potential to replace / retrofit the water pump station on Rushforth Road with VSD control in place of the existing bypass operating mode.

5.1.1.2 Onsite renewable energy opportunities

There is scope to implement more solar PV as well as battery energy storage at several of Council's water and wastewater treatment sites. At Rushforth Road there may also be the potential for a small micro-hydro system on the incoming water from Nymboida weir and Shannon Creek Dam. The following opportunities were modelled and reviewed together with CVC staff. Note that export estimates (surplus generation) may be subject to approval by Essential Energy.

- Clarenza STP
  - An additional 40 kWp (68 MWh generation) ground-mount system would be 70% self-consumed with 30% exported. The ground area to the north of the site was used for modelling, however the site is large enough for the preferred location to be changed.
  - An expansion by a further 160 kWp (270 MWh generation) with 500 kWh of battery energy storage would enable the site to be largely self-reliant for energy (for cost-benefit modelling a conservative 80% self-consumption is assumed). The ground area to the north of the site was also used for modelling this larger system. It is assumed that this larger system would be installed after 2025 when batteries are expected to be more affordable than they are today.
- Iluka STP
  - An additional 30 kWp (51 MWh generation) ground-mount system would be 90% self-consumed with 10% exported. The ground area in front of the office / lab building was used for modelling, as this appears to be the only substantial land available – most roof space is taken up with the existing solar PV system.
  - An expansion by a further 91 kWp (154 MWh generation) with 300 kWh of battery energy storage would enable the site to be largely self-reliant for energy (for cost-benefit modelling 90% self-consumption is assumed). The ground area in front of the office / lab building was also used for modelling this larger system. It is assumed that this larger system would be installed after 2025 when batteries are expected to be more affordable than they are today.
- North Grafton STP
  - A new wastewater treatment plant is to be built close to 2030. It is assumed that a 100 kWp solar PV system will be built with the new plant, though there may be adequate roof, water and land space to build a more substantial plant and battery storage to meet a large proportion of the site's expected energy demand.
- Woodford Island STP
  - 84 kWp of ground mounted solar PV is modelled (159 MWh pa generation), located either side of the main gate to the plant. A further location in front of the office / lab is flat and could accommodate a sizeable solar PV system, but is understood to be earmarked for future expansion of the plant. Around 70% of the output is estimated to be consumed on site with 30% exported. While battery storage is not modelled this could potentially be considered at a later time, possibly in conjunction with additional solar PV.
- Yamba STP
  - An additional 69 kWp of roof and ground mount solar PV was modelled for a building and land at the south-east corner of the site. Load data suggests that around 90%

would be consumed on site with 10% exported. There is limited additional space on the site that is not operational land, though the south facing roof of the office building could potentially host additional PV with tilted arrays.

- Rushforth Road reservoir / WTP
  - There are few buildings but significant amounts of land at the reservoir site that could potentially be used for solar PV. A 40 kWp array is modelled on land just east of the main building (70 MWh pa generation) and is assumed to be 90% consumed on site, particularly given plans to implement UV treatment systems.
  - An expansion by a further 80 kWp (137 MWh generation) with 300 kWh of battery energy storage would generate more energy than the site consumes at present, however with planned expansion this will not be the case. A conservative 80 % of generation is assumed to be consumed on site with 20% exported. The same ground space is used for modelling of this system.
  - An alternative to the solar expansion project may be a micro-hydro generation system located where raw water enters the site near the north-west corner of the raw water reservoir. At this stage, advised flow, head pressure and time-of-use suggest that a 65 kW generator could be developed to meet the site's energy requirements. Based on current demand, around 75% of the energy generated would have to be exported to the grid, with low value based on IPART guidance on feed-in tariffs for 2018/19 and forecast moderation of wholesale electricity prices in coming years. As such this would yield a low return compared with other options at this time. However the size of the potential generation is around 5% of Council's total demand, and as such a feasibility study of the opportunity is warranted to inform future energy generation decisions at this site.
- Tyson Street SPS
  - The SPS has ground area around the pump station and is secured. Based on 2016-17 consumption a 39 kW solar PV system with 50 kWh battery is modelled (67 MWh pa generation). 70% is estimated to be consumed on site with 30% exported. It is noted that this system may be oversized as the supply to the Tyson Street depot development came through this meter. Data for 2018-19 should be reviewed to determine if the size of the ideal system at this location should be changed.

A summary of solar PV and battery storage opportunities in water and wastewater operations is tabulated below. Note that multiple entries for a single site denotes an opportunity in the short term to install and / or increase the size of solar PV, with a further opportunity to expand this system in future with additional solar PV plus battery energy storage. Modelling for all solar PV systems is supplied as an addendum to this report.

Table 12: Summary of water and wastewater solar PV opportunities

Site	Opportunity	Solar kW	Battery kWh	Generation (MWh)	Self-Consumed Energy (MWh)	Exported Energy (MWh)
Clarenza WWTP	Ground Mount PV	40 kW	0 kWh	68 MWh	47 MWh	20 MWh
Clarenza WWTP	Ground Mount PV + Storage	160 kW	500 kWh	270 MWh	216 MWh	54 MWh
Iluka WWTP	Ground Mount PV	30 kW	0 kWh	51 MWh	46 MWh	5 MWh

Iluka WWTP	Ground Mount PV + Storage	91 kW	300 kWh	154 MWh	139 MWh	15 MWh
North Grafton WWTP	Ground Mount PV	100 kW	0 kWh	170 MWh	153 MWh	17 MWh
Rushford Road Reservoir	Ground Mount PV	40 kW	0 kWh	70 MWh	63 MWh	7 MWh
Rushford Road Reservoir	PV + Storage	80 kW	300 kWh	137 MWh	109 MWh	27 MWh
Tyson St SPS	Ground Mount PV + Storage	39 kW	50 kWh	67 MWh	47 MWh	20 MWh
Woodford Island WWTP	Ground Mount PV	84 kW	0 kWh	159 MWh	111 MWh	48 MWh
Yamba WWTP	Roof + Ground Mount PV	69 kW	0 kWh	109 MWh	98 MWh	11 MWh
All W & WW		**733 kW**	**1,150 kWh**	**1,255 MWh**	**1,029 MWh**	**224 MWh**

5.1.2 Holiday parks

While energy demand at holiday parks is high, most electricity use is within the control of permanent and concession residents and plug-in camper vans. The main energy demand that is under the direct control of Council includes office / reception / shop buildings, amenities, swimming / paddle pools, camp kitchens, laundry, roadway lighting and any short-stay cabins that are owned by Council.

At the time of the development of this project CVC is in the process of planning for the re-development of two holiday parks at Brooms Head and Calypso (Yamba), and other sites may be re-developed over time. Given this, energy management, energy efficiency and renewable energy opportunities are described for existing as well as re-development sites. For the Brooms Head and Calypso sites reference was made to master planning documents provided by Council.

5.1.2.1 Energy management opportunities

Two main energy management opportunities should be considered, that could significantly reduce Council's reported carbon footprint and lead to an overall energy demand reduction by users.

- Permanent residents and Concessions are generally supplied via Council's main meter. In many cases meters at each house / cabin are read and charges are paid by the occupant, however the main meter data remains accounted for as part of Council's carbon footprint. It is not uncommon for permanent and concession occupants to have their own electricity account, and this should be investigated by Council with Essential Energy.
- Plug-in camp sites are not separately metered at any of CVC's holiday parks, and the cost to install meters and charge energy use on top of camp fees should be investigated. Energy used on these sites would remain part of Council's carbon footprint, however a user-pays approach may lead to greater efforts by users to conserve energy rather then see it is a free resource.

5.1.2.2 Energy efficiency opportunities

With low energy use as a fraction of the total bill, energy efficiency opportunities for CVC at existing sites is modest. Based on site visits to Iluka, Minnie Water and Wooli some of the main opportunities with a 4-6 year payback include:

- Upgrade amenities and common area lighting to LED technology (already part-completed at Minnie Water).
- Rationalise shop / office fridges and appliances, and select energy efficient appliances when replacing appliances.
- Implement solar hot water to preheat water in conjunction with LPG or electric heating when replacing amenity block hot water systems.
- Around 20 cabins on these three sites are Council-owned; LED lighting and efficient appliances should be selected on replacement (though noting that if upgrades are planned that will replace or upgrade cabins then investment in higher cost replacement appliances may not be justified).

For the two sites to be redeveloped at Brooms Head and Calypso, incorporating efficient energy solutions can pay for themselves within a couple of years. Based on master plans for the two sites the following are suggested for inclusion in design specifications (where applicable):

- Road network / pathways lighting to use LED technology, with dimming controls to lower night time demand.
- Managers residences to go beyond minimum requirements including passive design, insulation, LED lights, heat pump or solar hot water and energy efficient appliances.
- Workshop facilities to include LED lights with controls, and efficient appliances.
- Amenities blocks to include LED lights with controls, heat pump and/or solar hot water, efficient laundry appliances.
- Camp kitchens to include LED lights with controls and efficient appliances.
- Cabin renovations to consider adding to existing levels of insulation, improving glazing performance, installing LED lights, energy efficient appliances, and efficient split system air conditioning units (e.g. minimum EER / COP of 4 for heating and cooling).
- New cabins to require passive design features, LED lights, efficient appliances, heat pump if own hot water, and efficient split system air conditioning units (e.g. minimum EER / COP of 4 for heating and cooling).
- Solar PV to be assessed for all new builds including new cabins, amenities blocks, managers' residences and recreation facilities, and installed wherever feasible (i.e. not excessively shaded, not south-facing). Where energy demand will be intermittent, solar and battery storage should be considered, and provision made for future installation if not economically viable at this time. Solar PV should also be considered as an alternative to solar hot water or heat pumps for water heating.

5.1.2.3 Onsite renewable energy opportunities

The three sites that will not be redeveloped in the near future all have opportunities for solar PV on amenities blocks and managers residences. The following systems were modelled:

- Iluka Holiday Park
    - 21 kWp of solar PV was modelled across 3 roofs (amenities and office, 31 MWh pa generation), 100% assumed to be consumed on site based on the site's load data.
- Minnie Water Holiday Park

    - 30.5 kWp of solar PV was modelled across 3 roofs (amenities, laundry and office, 44 MWh pa generation), 90% assumed to be consumed on site based on load data.
- Wooli holiday Park
    - 18 kWp of solar PV was modelled on the roof of the amenities block (26 MWh pa generation) and is assumed to be 80% consumed on site with 20% exported. Both the east and west roofs were included in the modelling.

A summary of solar PV and battery storage opportunities in holiday park operations is tabulated below. With limited roof space and significant tree cover at all sites it is unlikely that significant added PV will be feasible, and battery energy storage is unlikely to be warranted. Modelling for all solar PV systems is supplied as an addendum to this report.

Table 13: Summary of holiday park solar PV opportunities

Site	Opportunity	Solar kW	Battery kWh	Generation (MWh)	Self-Consumed Energy (MWh)	Exported Energy (MWh)
Iluka HP	Roof Mount PV	21 kW	0 kWh	31 MWh	31 MWh	0 MWh
Minnie Water HP	Roof Mount PV	31 kW	0 kWh	44 MWh	39.4 MWh	4.4 MWh
Wooli HP	Roof Mount PV	18 kW	0 kWh	26 MWh	20.5 MWh	5.1 MWh
All HP		**70 kW**	**0 kWh**	**101 MWh**	**91 MWh**	**10 MWh**

5.1.3 Parks and ovals, carparks, amenities

Council owns a number of parks, ovals, carparks and amenities blocks across the LGA, which together consume more than 425 MWh of electricity each year[17]. The majority of this energy demand is for lighting, including metal halide floodlighting of sporting fields and pathway lights and fluorescent technologies used in change rooms, club facilities, toilet blocks and carparks for example. Some energy demand will be for barbeque facilities, appliances and field irrigation.

5.1.3.1 Energy efficiency opportunities

Upgrading to LED lighting with controls represents the major energy efficiency opportunity for parks and ovals. LED lighting to replace fluorescent lights in carparks, toilets and buildings is well established and can be implemented with Council's routine maintenance and upgrade program, or retrofitted to high-use facilities.

LED floodlight and pathway technologies are available and many sporting field lighting suppliers now prominently feature their LED solutions alongside more traditional lighting solutions. Apart from technology, the cost of LED lighting has been a barrier and this may remain the case, particularly for low-use fields, and for pathways where whole luminaires are required if replacing older lights. Hence while LED lighting is very likely the technology of choice in future for sporting fields and public pathways, a program to implement this across CVC parks may take many years.

[17] The Open spaces and Open spaces & Facilities asset categories in CVC's energy database includes numerous facilities such as holiday parks, sports centres and aquatic centres. These are addressed within the properties / facilities section below.

It is recommended that Council engage with field and pathway lighting suppliers to understand the current business case and cost trends for LED lighting technology[18]. The costs and benefits of LED solutions should be sought in future field and park lighting upgrade tenders for comparison with other solutions. Lighting controls should also be assessed as part of these processes – for example dimming controls can be very effective with pathway LED lighting as lights can ramp up to full brightness almost instantly, and can dim down to lower but safe levels when there is no movement.

5.1.3.2 Onsite renewable energy opportunities

A number of parks have electricity accounts that appear to relate to club houses or other building located in the parks themselves. Three buildings were selected for modelling of the capacity for solar PV and storage, for Council to consider and/or use to encourage clubs to invest in solar technology to reduce their costs where these are passed through by Council. The following systems were modelled:

- Fisher Park Grafton
  - The building between Ellem Oval and Fisher Park next to the hockey fields is partially shaded, but offers good potential for solar PV on north-east and no facing roofs. A 40 kWp solar PV system (65 MWh pa generation) was modelled, and without load profile data was assumed to be 60% self-consumed with 40% exported.
- Netball Courts Maclean
  - There are two buildings next to the netball courts that could host solar PV. A small 4 kWp system with a 15 kWh battery was modelled (this would allow nearly all of the electricity generated daily to be discharged outside of solar hours). 75% of energy generated is assumed to be consumed on site with 25% exported.
- Yamba Sports Oval
  - The clubhouse building next to the main oval could host solar PV. A small 8 kWp system with a 25 kWh battery was modelled. 75% of energy generated is assumed to be consumed on site with 25% exported.

A summary of solar PV and battery storage opportunities in parks / ovals is tabulated below. Modelling for all solar PV systems is supplied as an addendum to this report.

Table 14: Summary of parks and ovals solar PV opportunities

Site	Opportunity	Solar kW	Battery kWh	Generation (MWh)	Self-Consumed Energy (MWh)	Exported Energy (MWh)
Fisher Park	Roof Mount PV	40 kW	0 kWh	65 MWh	39 MWh	26 MWh
Netball Courts Maclean	Roof Mount PV + Storage	4 kW	15 kWh	7 MWh	5 MWh	2 MWh
Yamba Sport Oval	Roof Mount PV + Storage	8 kW	25 kWh	12 MWh	8 MWh	4 MWh
Parks / Ovals		**52 kW**	**40 kWh**	**84 MWh**	**52 MWh**	**32 MWh**

[18] http://jasstech.com.au/, http://www.lighting.philips.com.au/systems/packaged-offerings/public-spaces/perfect-play/outdoor-sports, http://www.iwegroup.com.au/sports-fields (upgraded Oxley Oval in Port Macquarie, Strathfield Council's new synthetic pitch to LED lighting), http://www.musco.com/au/, https://gerardlighting.com.au/products/floodlights/sports are just some examples of field lighting suppliers with LED product offerings.

5.1.4 Properties / facilities

The largest group of assets that were assessed as part of the project are the properties and facilities used by Council staff and the community – office accommodation, depots, community buildings, sports and aquatic centres. Within this large group of facilities, planned changes such as redevelopments and divestments are noted above. In addition several facilities such as sports and aquatic centres are operated by third parties, and as such suggested energy efficiency and solar PV opportunities will require investment by these operators. Council can potentially influence these outcomes through the provision of information (such as solar modelling performed for this project), or through conditions placed on future contracts for management of these operations.

5.1.4.1 Energy efficiency opportunities

Site visits to numerous CVC facilities highlighted the many energy efficiency improvements that have already been made, as well as opportunities for further improvement.

- Offices and Prince St Grafton and the new library in Grafton use high efficiency air-cooled air conditioning systems (Daikin IV with heat recovery) and energy efficient lighting (LED nearly completed at Prince St, T5 included in design for the library). Both facilities also have solar PV systems installed.
- The new South Grafton depot has a 100 kWp solar PV system, energy efficiency air conditioning systems and T5 fluorescent lighting.
- Recent HVAC system upgrades at the Art Gallery and BMS controls are energy efficient, though many older systems remain in place.
- Pools have implemented a range of energy / carbon saving measures, including unglazed solar heating (South Grafton Pool), pool covers, solar PV (Yamba pool), gas heating (South Grafton) and heat pumps.
- Upgrade / redevelopment works at the Treelands Community Centre, Grafton Olympic Pool, Maclean Civic Centre and the Art Gallery expansion would be expected to continue Council's current practices and install efficient technology as well as maximise passive design opportunities and design for the inclusion of solar PV and potentially future battery energy storage.
- There remain significant LED lighting opportunities that should be developed – potentially into a Council-wide lighting upgrade program. These include:
  - All sports centres – Maclean, Yamba and Powell Street Grafton, where lighting (highbay and fluorescent technologies) is a significant part of the energy demand of these sites.
  - Grafton Regional Gallery, where high-energy stage lighting is used widely and could be upgraded to low energy LED lighting that would also reduce HVAC energy use.
  - Office building at River Street Maclean has a small amount of LED lighting installed and has a large opportunity to reduce energy demand by expanding this to the whole building.
  - The T5 fluorescent lighting systems installed in the new depot and the Grafton library can be earmarked for upgrade to LED in the medium to long term.
  - LED lighting can replace high bay and fluorescent lighting at Council's other depots in Yamba and Maclean.
- Air conditioning upgrades are long term projects that are not generally justified on energy saving grounds alone. As noted several sites' systems have been upgraded, and systems at facilities like Maclean offices, Grafton Regional Art Gallery have effective building

management systems to improve energy efficiency. These systems can be upgraded with best practice technology when they are at end of life.

5.1.4.2 Onsite renewable energy opportunities

A number of Council facilities already have solar PV as noted above. Several of these sites could have additional solar PV and potentially battery energy storage, while there are also several sites where solar could be installed for the first time. In several cases, solar PV would need to be installed by a third party operator. Sites that were modelled include:

- Yamba depot
  - A 10 kWp solar PV system was modelled on the main roof of the facility. Low daytime demand may mean high export % initially, and it is assumed that a battery would be retrofitted at a later date to increase self-consumption and minimise export.
- Grafton airport
  - Grafton airport has a solar PV system, and the terminal building could potentially host a further 26 kWp, with 75% assumed to be self-consumed. Future use of this facility would be central to any decision to expand the solar PV system at this site.
- Grafton regional landfill
  - This site already has solar PV systems as well as a battery storage system for the weighbridge. The PV system can be expanded to cover the roof of the sustainability centre, though a battery may be required to avoid excessive export given the systems already installed. A 24 kWp solar system with 65 kWh battery were modelled.
- Grafton Olympic Pool
  - Two systems, 10 kWp and an additional 30 kWp are modelled on the front roofs of the facility. A 10 kWp system would be largely used on site even during the off season. With planned upgrades to the site and proposed year-round operation, the additional 30 kWp would also be consumed on site. Depending on the new buildings to be established on the site there may be scope for further solar PV or an alternate location internal to the facility if this is desired compared with a system facing into the park.
- Grafton Regional Gallery
  - Two systems were modelled, a 19 kWp system on existing west-facing roofs, and an additional 31 kWp (to 50 kWp in total) with the planned expansion of the gallery. With the initial suggested system a slightly smaller capacity may be selected if the roof closest to the front of the building cannot be used for heritage reasons.
- Grafton South Pool Gym
  - The operator of the gym would need to decide whether or not to install solar PV, and as the building is fairly old a structural assessment would be prudent. However the roof size and orientation are large enough to accommodate a 100 kWp system, with 94 kWp in two arrays modelled on top of the existing small solar PV system. The generation is assumed to be largely consumed on site, with less than 20% assumed to be exported to the grid.
- Grafton Waste Transfer
  - This site is also third-party operated and already has a small solar PV system. It is understood that this site will be unaffected by the redevelopment of the adjacent sewerage treatment plant. Energy use data and roof space suggest that a 27 kWp solar PV system and 50 kWh battery could meet most of the site's energy demand.
- Maclean Depot

  - The Maclean depot already has a solar PV system, and the suggested 12 kWp solar PV system plus 25 kWh battery would meet most of the site's energy demand in future.
- Maclean Offices and Civic Centre
  - The roof of the Maclean office building would require a structural assessment and consideration of the likely future replacement of the roof to inform a decision about expansion of the existing PV system to cover most of the roof. Similarly, implementation of solar PV on the roof of the Civic Centre should be considered in light of the planned redevelopment works at the site in the next couple of years. Three systems were modelled, with 88 kWp on the main office building, 12 kWp on the community services building also at 50 River Street, and a 17 kWp array on the roof of the Civic Centre (potentially using microinverters owing to the large telecommunications tower). A 50 kWh battery is included in the cost benefit analysis for the Civic Centre, but should be reviewed based on new energy demand following upgrade works.
- Maclean Sports Stadium
  - A 13 kWp solar PV system and 30 kWh battery was modelled owing to the high night time use of the facility and low daytime use. As a third-party operated facility the decision to implement would not lie with Council.
- Prince St CVC Offices
  - It is understood that an additional solar PV system is planned for this site once the remainder of the roof has been replaced. A 20 kWp system was modelled with no battery storage.
- Raymond Laurie SC
  - A 57 kWp solar PV system and 150 kWh battery was modelled owing to the high night time use of the facility and low daytime use. As a third-party operated facility the decision to implement would not lie with Council. It is noted that the roof of this facility could potentially host a much larger solar array, which could be of interest in future – e.g. to develop a community energy / solar garden.
- South Grafton Depot
  - The depot has a 100 kWp solar PV system, with no data yet to show how this is performing or what proportion of daytime load is served by the system. There is adequate roof space to expand this system in future, and 97 kWp of new solar plus a 200 kWh battery are included in cost benefit analysis based on preliminary estimates of future grid demand. This should be evaluated in 2-3 years time and the optimum size system re-assessed at that time.
- Yamba CC Treelands
  - This facility is being redeveloped and a 15 kWp solar system plus 50 kWh battery is assumed to be feasible in addition to the replacement of the solar PV system on the existing/ old community centre.
- Yamba Historical Hall Museum
  - This facility has low run hours so a small solar PV system (located on the rear roof tilted to the north) and 10 kWh battery was modelled, which would be able to meet most of the site's energy demand.

A summary of solar PV and battery storage opportunities in properties / facilities is tabulated below. Modelling for all solar PV systems is supplied as an addendum to this report.

Table 15: Summary of propoerties / facilities solar PV opportunities

Site	Opportunity	Solar kW	Battery kWh	Generation (MWh)	Self-Consumed Energy (MWh)	Exported Energy (MWh)
Council Depot Yamba	Roof Mount PV	10 kW	0 kWh	18 MWh	7 MWh	11 MWh
	Storage	0 kW	25 kWh	0 MWh	16 MWh	2 MWh
Grafton Airport	Roof Mount PV	26 kW	0 kWh	40 MWh	30 MWh	10 MWh
Grafton Landfill	Roof Mount PV + Storage	24 kW	65 kWh	39 MWh	31 MWh	8 MWh
Grafton Olympic Pool	Roof Mount PV	10 kW	0 kWh	15 MWh	12 MWh	3 MWh
Grafton Olympic Pool	Roof Mount PV	30 kW	0 kWh	47 MWh	43 MWh	5 MWh
Grafton Regional Gallery	Roof Mount PV	19 kW	0 kWh	29 MWh	29 MWh	0 MWh
Grafton Regional Gallery	Roof Mount PV	31 kW	0 kWh	46 MWh	46 MWh	0 MWh
Grafton South Pool / Gym	Roof Mount PV	51 kW	0 kWh	74 MWh	66 MWh	7 MWh
		43 kW	0 kWh	59 MWh	41 MWh	18 MWh
Grafton Waste	Roof Mount PV + Storage	27 kW	50 kWh	47 MWh	33 MWh	14 MWh
Maclean Depot	Roof Mount PV + Storage	12 kW	25 kWh	21 MWh	19 MWh	2 MWh
Maclean Offices and Civic Centre	Roof Mount PV	88 kW	0 kWh	140 MWh	112 MWh	28 MWh
		12 kW	0 kWh	19 MWh	19 MWh	0 MWh
	Roof Mount PV + Storage	17 kW	50 kWh	27 MWh	21 MWh	5 MWh
Maclean Sports Stadium	Roof Mount PV + Storage	13 kW	30 kWh	20 MWh	15 MWh	5 MWh
Prince St CVC Offices	Roof Mount PV	20 kW	0 kWh	28 MWh	20 MWh	8 MWh
Raymond Laurie SC	Roof Mount PV	57 kW	150 kWh	83 MWh	58 MWh	25 MWh
South Grafton Depot	Roof Mount PV + Storage	97 kW	200 kWh	142 MWh	113 MWh	28 MWh
Yamba CC Treelands	Roof Mount PV + Storage	15 kW	50 kWh	23 MWh	18 MWh	5 MWh
Yamba Historical Hall Museum	Tilt Frame PV + Storage	4 kW	10 kWh	7 MWh	5 MWh	1 MWh
All properties		**606 kW**	**655 kWh**	**924 MWh**	**754 MWh**	**185 MWh**

5.1.5 Street lighting

Clarence Valley Council pays energy and maintenance costs for street lights across the LGA. Essential Energy owns the street lighting network and performs maintenance and lamp replacement via spot and bulk upgrade programs.

Local road lights can now be upgraded to LED technology, and Essential Energy has been working with many councils in its network to make this change in recent months. A proposal for four options has been received by CVC, which outlines the cost for four LED options.

Essential Energy proposes to replace 80% of Council's streetlights (3,108) on local roads, with LED technology. These lights account for 45% of electricity used by all streetlights (3,849), with the remaining 55% of electricity use by higher energy lamps on main roads.

The proposal indicates that Council can save 360 MWh per year by upgrading local road lighting – this is an average across options, with savings potential as high as 420 MWh per year (Option 4).

The local road lighting upgrade is scheduled for June 2019 subject to Council approval. The cost-benefit analysis is summarised in the next section; this indicates a payback well within the life of the new lighting and it is recommended that Council proceed with the upgrade.

In the short to medium term main road LED lighting will also be approved, and there will be an opportunity for Council to achieve even larger savings, with initial estimates of savings at a little over 500 MWh per year in addition to the savings for local road lighting.

Hence the overall opportunity for CVC is an energy saving of 920 MWh per year, which is 9.2% of Council's electricity consumption in 2016/17.

5.2 Transport fuel consumption

Greenhouse gas emissions from fleet are a relatively small part of Council's footprint, at 11% inclusive of landfill, and 25% if landfill is excluded.

Diesel fuel use is most significant at 828 kL in 2016/17. Petrol consumption was around a quarter of this at 212 kL.

Current policies / practices and areas for potential future improvement include:

- Emissions intensity of fleet
  - Clarence Valley Council will work with the NRMA to install a rapid charge electric vehicle (EV) charge station at the Grafton library, as part of the NRMA's rapid charge EV rollout program aimed at facilitating greater uptake of EVs across NSW.
  - This presents an opportunity for Council to take a leading position and source one or more EVs in its fleet of operational vehicles, and cost-benefit assessment should be carried out to evaluate this opportunity.
  - 26% of Council's petroleum consumption is an E10 blend, and the potential to increase this via awareness / education for eligible vehicles should be reviewed periodically.
  - At present there are no biodiesel (e.g. B20) sources in the region that provide a consistent quality and reliable supply that could meet some of Council's heavy fleet requirements; this situation should be reviewed periodically to assess new opportunities.
- High Efficiency Vehicles
  - Council's processes relating to the procurement / lease of heavy vehicles seeks to upgrade to latest emissions technology for plant and vehicles as older plant is renewed, with Euro v standards sought where available. A number of heavy vehicles are due to be upgraded / replaced in the next two financial years.
  - Council's leaseback policy for passenger vehicles can be reviewed periodically and look to further incentivise low emissions and/or smaller vehicles.

5.3 Renewable energy offsite generation or purchasing

Energy efficiency, onsite renewable energy and transport efficiency measures can reduce Council's carbon footprint and energy demand significantly, however if Council's ambition for renewables and abatement is greater than say 50% or up to 100% over the next decade then sourcing renewable energy and/or offsets, and generating renewable energy at scale are options that should be considered.

Several councils have implemented or are building renewable energy generation plants – Sunshine Coast, City of Newcastle, City of Fremantle for example – while others have entered into renewable energy purchasing agreements for a part of their load – South Sydney Region of Councils (SSROC) for example. Many other organisations such as Monash University, UNSW, Telstra, Sun Metals, City of Melbourne consortium, Mars, Coca-Cola Amatil are also developing corporate renewable energy agreements to supply part or all of their electricity demand from renewables.

As part of this project the following potential opportunities for sourcing offsite renewables are identified:

- Small hydro[19]
  - Council has resolved to undertake a study into the viability of getting the Nymboida Power Station operational again. This former power station is not a Council asset and the site remains owned and maintained by Essential Energy. Some of the key considerations / barriers to be included as part of this study are the eligibility and treatment of Large-scale Generation Certificates (LGCs, Nymboida was not eligible to create these under the RET as a pre-existing power station), and the EPA's requirements regarding water flows, specifically the taking of water from one river and discharging to another as occurred when the power station was operational.
- Landfill gas
  - Landfill gas is currently flared from the Grafton Regional Landfill. Given the volume of gas flared the business case for installing a generation system is currently weak. Council will continue to monitor trends in technology for LFG generation as well as grant opportunities that could potentially make this a viable opportunity.
- Solar PV
  - Council owns land throughout the LGA that could potentially be suitable to host a solar farm to meet Council's electricity requirements, or a larger site that could meet other business and community energy demand. The proportion of total power demand that can be met depends on several factors, including retailer participation and the type of structure / model employed, among other factors.
    - Mid-scale projects will be best suited to land that:
    - Is north facing with little or no shading impact
    - Is not subject to a restraint such as a tree protection order or environmental management plan
    - Does not have a higher value use and is not for community use
    - Is near the electricity network at a suitable voltage and a connection can be achieved
    - Is not subject to flooding and is geotechnically sound

[19] Small hydro generally refers to projects in the 1 MW to 20 MW range, with mini and micro hydro terminology referring to projects smaller than this, and large or utility-scale hydro referring to projects greater than 20 MW in capacity

- As part of the preliminary investigations here the following sites were identified and should be further evaluated in future should Council consider this option. Energy generation potential figures are indicative and are based on the total area of land – where part of this land is operational or protected / heavily vegetated the final generation capacity may be lower than the amounts indicated.

TABLE 16: SUMMARY OF LAND THAT COULD POTENTIALLY HOST MID-SCALE SOLAR PV

Site name	Size in hectares (Ha)	Potential generation capacity (MWp / MWh)	Proportion of CVC electricity demand (2016/17 grid)
Old Maclean garbage depot and dog pound	10 Ha	3.33 MWp / 4,662 MWh pa	47%
Eatonsville rubbish depot	13 Ha	4.3 MWp / 6,015 MWh	60%
Clarenza treatment works	16.3 Ha	5.4MWp / 7,607 MWh pa	76%
Rushforth Road reservoir	60 Ha	20 MWp / 28,000 MWh pa	281%
Grafton regional landfill	183 Ha	61 MWp / 85,675 MWh pa	859%

- A number of quarry / gravel sites and the Grafton Regional Airport are also on large areas of land. Future development or sale plans for many of these sites are being considered and they are not highlighted for possible solar farm development at this stage. These sites could be re-visited at a future date once the outcomes of Council's planning if firmed.

➤ Renewable energy purchasing

- Council can consider the option to stipulate a proportion of electricity to come from renewable energy sources in its next or subsequent tenders via a Power Purchase Agreement (PPA). It can do this alone or in conjunction with one or more partners, for example a group of regional councils. An underpinning purpose of a renewable energy procurement process would be to source renewables (including LGCs) at the same or lower cost that 'regular' grid power. This has been achieved by corporate entities and groups as well as by groups of councils. Some of the key factors to consider include:
- Sourcing LGCs above Council's obligation amount under the Renewable Energy Target (RET) so that additional renewables are being purchased,
- Decisions on whether to withhold or sell surplus LGCs and the implication for claims relating to renewable energy purchasing,
- Price for power and renewables over a long term, typically 10-years, and the ability to evaluate whether savings have been achieved,
- Impacts – as yet unknown – of the proposed National Energy Guarantee (NEG)

The next section looks at the costs and benefits, as well as the applicability to Councils of several models for offsite renewable energy purchasing.

5.4 Landfill operations

Emissions from the Council-owned regional landfill in Grafton relate to waste disposed by the community, both residential and business. As such these emissions are not the direct result of Council's operations but are under Council's operational control. In addition to landfilling the site also hosts recycling and composting operations (for green waste / organics) which are operated by third parties.

In 2013 Council implemented a gas flare which has resulted in a substantial reduction in GHG emissions and helped the landfill to stay below the threshold for mandatory reporting under the National Greenhouse and Energy Reporting (NGER) Act. A forecast has also been made of potential future emissions based on current levels of waste being sent to landfill.

The chart below illustrates past and projected GHG emissions for the regional landfill.

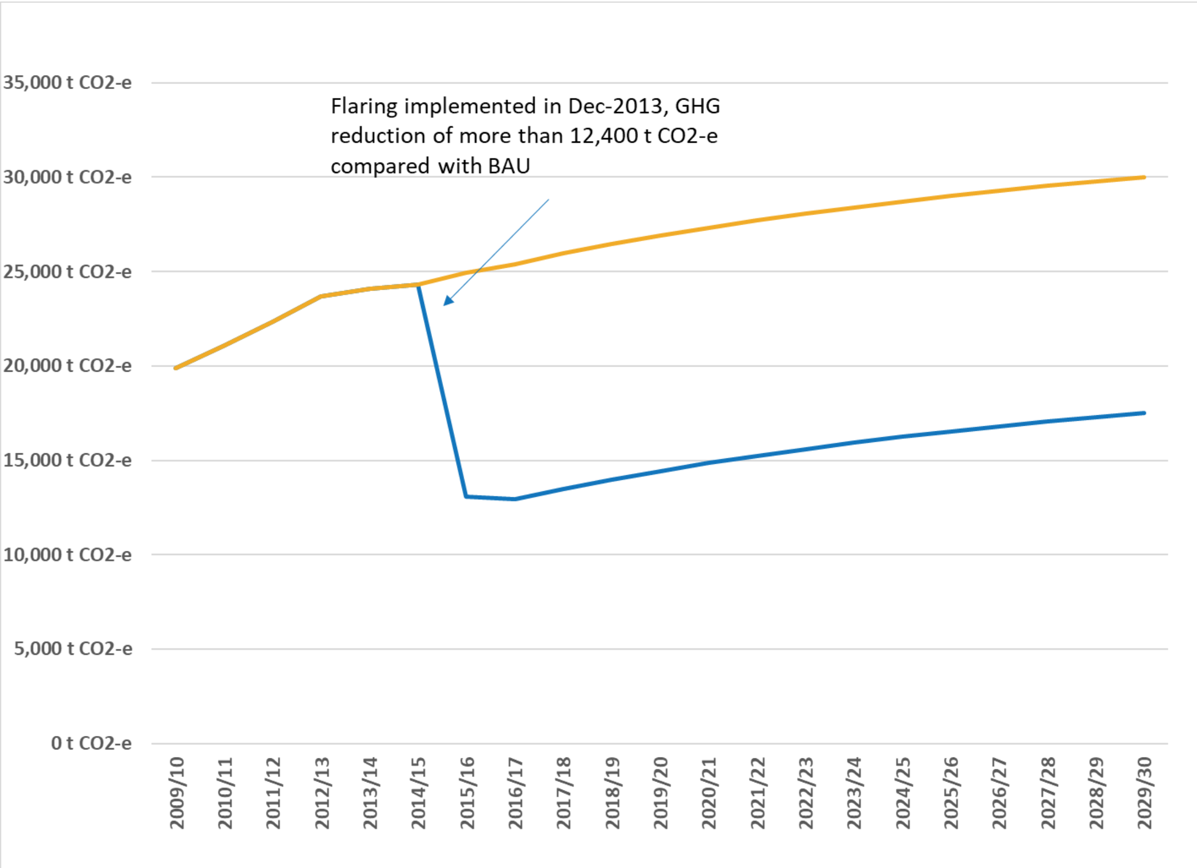

FIGURE 20: GRAFTON REGIONAL LANDFILL GHG PROJECTIONS TO 2030

Future opportunities for GHG reduction may include generation as noted above, though gas volumes are too small for this to be financially viable at this time. Additional GHG reduction opportunities are limited, with Council's target of 60% waste diversion from landfill having been exceeded (under the current 10-year waste contract (to 2022) a 65% diversion from landfill has been achieved.

Emissions from landfill will continue to be monitored and reported, and generation and/or further flaring opportunities will be evaluated on an ongoing basis.

6 Evaluation of opportunities

6.1 Summary of evaluated and omitted opportunities

A total of 49 opportunities to increase renewable energy and reduce Council's GHG emissions were evaluated as part of this work. These include:

- Street lighting upgrade to LED with local roads implemented in 2019/20 and main roads assumed to be implemented in 2022/23. The costs are as advised by Essential Energy (less estimated ESC credit) and savings are calculated with reference to the current asset base and advised wattage of LED replacement options.
- Properties and facilities lighting upgrade to LED, building on prior LED upgrades. It is assumed that lighting can be upgraded over a three-year program for evaluation purposes. Lighting is assumed to account for 25% of facility electricity use and 50% savings are possible (LED typically saves 60%+, a lower savings estimate reflects upgrades already completed).
- Park / pathway lighting upgrade to LED is likely to be a multi-year program, and it is assumed that 50% of lighting can be upgraded to LED by 2030.
- Onsite solar PV and battery storage projects as described in the prior section are 'implemented' over a multi-year period to stage investments, with solar-only projects implemented initially and battery storage projects implemented later.
- Power purchase agreements are included at 2021 and 2025 for 20% rising to 50% renewable energy.

The timing of investment for all opportunities is indicative, and Council will take its own decisions each year about what sites to invest in and the exact scope and size of lighting, solar and storage solutions, as well as whether or not to pursue offsite renewable energy solutions such as a PPA.

A range of other opportunities are not included in the cost-benefit analysis but will also contribute towards Council's efforts to reduce energy consumption if and when taken up. These include:

- Efficiency and renewable energy as part of Holiday Park redevelopments,
- Air conditioning upgrades as plant reaches the end of its useful life,
- Transport efficiency and landfill abatement opportunities,
- Offsite renewable energy projects such as landfill gas generation, small-hydro (e.g. Nymboida) or mid-scale solar PV,
- Onsite renewable energy opportunities that were assessed but have at this stage been deemed unviable – e.g. on land that is currently operational or is earmarked for operational use, or because of economic factors. This includes an estimated 620 kWp of solar PV plus over 900 kWh of battery energy storage capacity, as well as micro-hydro at Rushforth Road.

6.2 Assumptions used in evaluation of opportunities

The estimation of costs and benefits for opportunities used the following assumptions:

- Street lighting upgrade to LED: electricity rates are assumed to be $0.135/kWh and the net value of energy saving certificates (ESCs) are assumed to be $15/ESC to Council after fees are paid to an Accredited Certificate Provider (ACP).
- Properties and facilities lighting upgrade to LED: a 6-year simple payback is assumed to be possible and savings are calculated based on an average energy cost of 18¢/kWh.

- Park / pathway lighting upgrade to LED: a 6-year simple payback (on the marginal cost to install LEDs instead of say metal halide technology) is assumed to be possible and savings are calculated based on an average energy cost of 18¢/kWh.
- Onsite solar PV and battery storage projects: current energy costs for each site were used in modelling, with the value of savings discounted to omit fixed costs, and export energy valued at an assumed feed-in rate of 6¢/kWh.
- Power purchase agreements: it is assumed that no net costs or cost savings are realised, with recent PPAs achieving modest savings compared with 'regular' grid pricing.
- The capital cost for various renewable energy solutions was based on:
  - Ground mount / tilt frame solar PV under 100 kWp @ $1.50 per Watt
  - Ground mount / tilt frame solar PV over 100 kWp @ $2.10 per Watt
  - Roof mount / no tilt frame solar PV under 100 kWp @ $1.30 per Watt
  - Roof mount / no tilt frame solar PV over 100 kWp @ $1.90 per Watt
  - Battery energy storage total cost of $865 / kWh (AUD)
  - Learning rate / cost decline for solar PV of 0.5% per year
  - Learning rate / cost decline for battery energy storage of 5.5% per year
- Cost of solar PV maintenance of $10/kWp per year
- Increase in maintenance costs for solar PV and for street lighting savings of 2.5% per year
- Increase in the cost of electricity and thus the value of electricity savings of 2.5% per year
- Degradation rate for solar PV savings of 0.5% per year

6.3 Summary of evaluation – energy efficiency and onsite solar PV

Based on these assumptions and the assessed opportunities, the following pages show the projected costs and benefits, and energy / grid savings associated with implementation of all opportunities.

Table 17: Summary of potential capital costs to Clarence Valley Council

Financial Year	Capital Expense on efficiency and solar[20]	Primary activities
FY18-19	-$100,000	Street lighting stage 1 – local roads (commences June-19)
FY19-20	-$1,369,020	Solar PV, Street lighting stage 1 – local roads, building lighting
FY20-21	-$674,316	Solar PV & building lighting, park/oval lighting
FY21-22	-$500,420	Solar PV and small battery storage systems
FY22-23	-$1,241,980	Street lighting stage 2 – main roads, Solar PV & building lighting, park/oval lighting
FY23-24	-$256,521	Solar PV and battery storage
FY24-25	-$561,153	Solar PV and battery storage, park/oval lighting
FY25-26	-$391,447	Solar PV and battery storage
FY26-27	-$640,555	Solar PV and battery storage, park/oval lighting
FY27-28	$0	NA
FY28-29	-$29,384	Park / oval lighting
TOTAL	**$-5,764,796**	**All solar, battery storage and lighting opportunities**

[20] Council has $100,000 in FY19 in the Sustainability Reserve and is shown here but is not included in the subsequent total expense on EE/RE projects, which are shown to commence from 2019/20

Table 18: Summary of evaluated solar PV, battery energy storage, energy efficiency and renewable energy purchasing opportunities

Project	Site	Opportunity	Solar (kW)	Battery (kWh)	Starting Year
		Solar PV and Battery Storage opportunities			
1	Clarenza STP	Ground Mount PV	40 kW	0 kWh	19/20
2	Clarenza STP	Ground Mount PV + Storage	160 kW	500 kWh	26/27
3	Council Depot Yamba	Roof Mount PV	10 kW	0 kWh	19/20
4	Council Depot Yamba	Roof Mount PV + Storage	0 kW	25 kWh	22/23
5	Fisher Park	Roof Mount PV	40 kW	0 kWh	22/23
6	Grafton Airport	Roof Mount PV	26 kW	0 kWh	23/24
7	Grafton Landfill	Roof Mount PV + Storage	24 kW	65 kWh	21/22
8	Grafton Olympic Pool	Roof Mount PV	10 kW	0 kWh	19/20
9	Grafton Olympic Pool	Roof Mount PV	30 kW	0 kWh	20/21
10	Grafton Regional Gallery	Roof Mount PV	19 kW	0 kWh	19/20
11	Grafton Regional Gallery	Roof Mount PV	31 kW	0 kWh	23/24
12	Grafton South Pool Gym	Roof Mount PV	51 kW	0 kWh	20/21
13	Grafton South Pool Gym	Roof Mount PV	43 kW	0 kWh	25/26
14	Grafton Waste	Roof Mount PV + Storage	27 kW	50 kWh	24/25
15	Iluka Holiday Park	Roof Mount PV	21 kW	0 kWh	23/24
16	Iluka STP	Ground Mount PV	30 kW	0 kWh	22/23
17	Iluka STP	Ground Mount PV + Storage	91 kW	300 kWh	25/26
18	Maclean Depot	Roof Mount PV + Storage	12 kW	25 kWh	20/21
19	Maclean Offices and Civic Centre	Roof Mount PV	88 kW	0 kWh	21/22
20	Maclean Offices and Civic Centre	Roof Mount PV	12 kW	0 kWh	22/23
21	Maclean Offices and Civic Centre	Roof Mount PV + Storage	17 kW	50 kWh	26/27
22	Maclean Sports Stadium	Roof Mount PV + Storage	13 kW	30 kWh	22/23
23	Minnie Water Holiday Park	Roof Mount PV	31 kW	0 kWh	19/20
24	Netball Courts Maclean	Roof Mount PV + Storage	4 kW	15 kWh	21/22
25	North Grafton STP	Ground Mount PV	100 kW	0 kWh	24/25
26	Prince St CVC Offices	Roof Mount PV	20 kW	0 kWh	20/21

Project	Site	Opportunity	Solar (kW)	Battery (kWh)	Starting Year
27	Raymond Laurie Sports Centre	Roof Mount PV	57 kW	150 kWh	23/24
28	Rushford Road Reservoir	Ground Mount PV	40 kW	0 kWh	19/20
29	Rushford Road Reservoir	PV + Storage	80 kW	300 kWh	24/25
30	South Grafton Depot	Roof Mount PV + Storage	97 kW	200 kWh	20/21
31	Tyson St SPS	Ground Mount PV + Storage	39 kW	50 kWh	21/22
32	Woodford Island STP	Ground Mount PV	84 kW	0 kWh	21/22
33	Wooli Holiday Park	Roof Mount PV	18 kW	0 kWh	19/20
34	Yamba CC Treelands Drive	Roof Mount PV + Storage	15 kW	50 kWh	19/20
35	Yamba Historical Hall Museum	Tilt Frame PV + Storage	4 kW	10 kWh	21/22
36	Yamba Sport Oval	Roof Mount PV + Storage	8 kW	25 kWh	21/22
37	Yamba STP	Roof + Ground Mount PV	69 kW	0 kWh	19/20
Energy Efficiency Opportunities					
38	Street Lighting Option 4	Option 4 of the options offered by Essential Energy for local roads			18/19/20
39	Street Lighting Main Roads	Main roads LED lighting upgrade			22/23
40	Facilities Lighting	Phase 1 of 3 (Reduce lighting energy use by 50% over three years)			19/20
41	Facilities	Phase 2 of 3			20/21
42	Facilities	Phase 3 of 3			22/23
43	Parks and Ovals	Phase 1 of 5 (Reduce lighting energy use by 60% over 20 years)			20/21
44	Parks and Ovals	Phase 2 of 5			22/23
45	Parks and Ovals	Phase 3 of 5			24/25
46	Parks and Ovals	Phase 4 of 5			26/27
47	Parks and Ovals	Phase 5 of 5			28/29
Renewable Energy Purchasing via Power Purchase Agreement					
48	PPA 1	20% renewable energy purchase			20/21
49	PPA 2	50% renewable energy purchase			24/25

Table 19: Summary of net electricity (grid) savings to Clarence Valley Council

Project	Site	FY19-20	FY20-21	FY21-22	FY22-23	FY23-24	FY24-25	FY25-26	FY26-27	FY27-28	FY28-29	FY29-30
Solar PV and Battery Storage opportunities												
1	Clarenza STP		47 MWh	47 MWh	47 MWh	47 MWh	47 MWh	46 MWh	46 MWh	46 MWh	46 MWh	45 MWh
2	Clarenza STP									216 MWh	215 MWh	214 MWh
3	Council Depot Yamba		7 MWh	7 MWh	7 MWh	7 MWh	7 MWh	7 MWh	7 MWh	7 MWh	7 MWh	7 MWh
4	Council Depot Yamba					9 MWh	9 MWh	9 MWh	9 MWh	9 MWh	9 MWh	9 MWh
5	Fisher Park					39 MWh	39 MWh	38 MWh	38 MWh	38 MWh	38 MWh	38 MWh
6	Grafton Airport						30 MWh	30 MWh	30 MWh	30 MWh	30 MWh	29 MWh
7	Grafton Landfill				31 MWh	31 MWh	31 MWh	31 MWh	31 MWh	31 MWh	30 MWh	30 MWh
8	Grafton Olympic Pool		12 MWh	12 MWh	12 MWh	12 MWh	12 MWh	12 MWh	12 MWh	12 MWh	12 MWh	12 MWh
9	Grafton Olympic Pool			43 MWh	42 MWh	42 MWh	42 MWh	42 MWh	42 MWh	41 MWh	41 MWh	41 MWh
10	Grafton Regional Gallery		29 MWh	29 MWh	29 MWh	29 MWh	29 MWh	28 MWh	28 MWh	28 MWh	28 MWh	28 MWh
11	Grafton Regional Gallery						46 MWh	46 MWh	46 MWh	45 MWh	45 MWh	45 MWh
12	Grafton South Pool Gym			66 MWh	66 MWh	66 MWh	65 MWh	65 MWh	65 MWh	65 MWh	64 MWh	64 MWh
13	Grafton South Pool Gym								41 MWh	41 MWh	41 MWh	40 MWh
14	Grafton Waste							33 MWh	32 MWh	32 MWh	32 MWh	32 MWh
15	Iluka Holiday Park						31 MWh	31 MWh	31 MWh	31 MWh	31 MWh	30 MWh
16	Iluka STP					46 MWh	46 MWh	45 MWh	45 MWh	45 MWh	45 MWh	44 MWh
17	Iluka STP								139 MWh	138 MWh	137 MWh	137 MWh
18	Maclean Depot			19 MWh	19 MWh	19 MWh	19 MWh	19 MWh	18 MWh	18 MWh	18 MWh	18 MWh
19	Maclean Offices and Civic Centre				112 MWh	112 MWh	111 MWh	111 MWh	110 MWh	109 MWh	109 MWh	108 MWh
20	Maclean Offices and Civic Centre					19 MWh	19 MWh	18 MWh	18 MWh	18 MWh	18 MWh	18 MWh
21	Maclean Offices and Civic Centre									21 MWh	21 MWh	21 MWh
22	Maclean Sports Stadium					15 MWh	15 MWh	15 MWh	15 MWh	15 MWh	15 MWh	15 MWh
23	Minnie Water Holiday Park		39 MWh	39 MWh	39 MWh	39 MWh	39 MWh	38 MWh	38 MWh	38 MWh	38 MWh	38 MWh
24	Netball Courts Maclean				5 MWh	5 MWh	5 MWh	5 MWh	5 MWh	5 MWh	5 MWh	4 MWh
25	North Grafton STP							153 MWh	152 MWh	151 MWh	151 MWh	150 MWh
26	Prince St CVC Offices			20 MWh	20 MWh	19 MWh	19 MWh	19 MWh	19 MWh	19 MWh	19 MWh	19 MWh

Project	Site	FY19-20	FY20-21	FY21-22	FY22-23	FY23-24	FY24-25	FY25-26	FY26-27	FY27-28	FY28-29	FY29-30
27	Raymond Laurie Sports Centre						58 MWh	58 MWh	57 MWh	57 MWh	57 MWh	57 MWh
28	Rushford Road Reservoir		63 MWh	62 MWh	62 MWh	62 MWh	61 MWh	61 MWh	61 MWh	60 MWh	60 MWh	60 MWh
29	Rushford Road Reservoir							109 MWh	109 MWh	108 MWh	108 MWh	107 MWh
30	South Grafton Depot			113 MWh	113 MWh	112 MWh	112 MWh	111 MWh	111 MWh	110 MWh	110 MWh	109 MWh
31	Tyson St SPS				47 MWh	46 MWh	46 MWh	46 MWh	46 MWh	45 MWh	45 MWh	45 MWh
32	Woodford Island STP				111 MWh	111 MWh	110 MWh	110 MWh	109 MWh	109 MWh	108 MWh	107 MWh
33	Wooli Holiday Park		20 MWh	20 MWh	20 MWh	20 MWh	20 MWh	20 MWh	20 MWh	20 MWh	20 MWh	20 MWh
34	Yamba CC Treelands Drive		18 MWh	18 MWh	18 MWh	18 MWh	18 MWh	18 MWh	18 MWh	18 MWh	18 MWh	17 MWh
35	Yamba Historical Hall Museum				5 MWh	5 MWh	5 MWh	5 MWh	5 MWh	5 MWh	5 MWh	5 MWh
36	Yamba Sport Oval				8 MWh	8 MWh	8 MWh	8 MWh	8 MWh	8 MWh	8 MWh	8 MWh
37	Yamba STP		98 MWh	97 MWh	97 MWh	96 MWh	96 MWh	95 MWh	95 MWh	94 MWh	94 MWh	93 MWh
Energy Efficiency Opportunities												
38	Street Lighting Option 4		420 MWh	420 MWh	420 MWh	420 MWh	420 MWh	420 MWh	420 MWh	420 MWh	420 MWh	420 MWh
39	Street Lighting Main Road					502 MWh	502 MWh	502 MWh	502 MWh	502 MWh	502 MWh	502 MWh
40	Facilities		152 MWh	152 MWh	152 MWh	152 MWh	152 MWh	152 MWh	152 MWh	152 MWh	152 MWh	152 MWh
41	Facilities			152 MWh	152 MWh	152 MWh	152 MWh	152 MWh	152 MWh	152 MWh	152 MWh	152 MWh
42	Facilities					152 MWh	152 MWh	152 MWh	152 MWh	152 MWh	152 MWh	152 MWh
43	Parks and Ovals			20 MWh	20 MWh	20 MWh	20 MWh	20 MWh	20 MWh	20 MWh	20 MWh	20 MWh
44	Parks and Ovals					20 MWh	20 MWh	20 MWh	20 MWh	20 MWh	20 MWh	20 MWh
45	Parks and Ovals							20 MWh	20 MWh	20 MWh	20 MWh	20 MWh
46	Parks and Ovals									20 MWh	20 MWh	20 MWh
47	Parks and Ovals											20 MWh
Renewable Energy Purchasing via Power Purchase Agreement												
48	PPA 1			1,687 MWh	1,623 MWh	1,471 MWh	1,507 MWh					
49	PPA 2							3,612 MWh	3,526 MWh	3,436 MWh	3,441 MWh	3,435 MWh
Grid energy savings from efficiency and onsite renewables			**907 MWh**	**1,339 MWh**	**1,656 MWh**	**2,453 MWh**	**2,613 MWh**	**2,923 MWh**	**3,095 MWh**	**3,345 MWh**	**3,335 MWh**	**3,346 MWh**
Fossil-fuel energy savings from Power Purchase Agreements				**1,687 MWh**	**1,623 MWh**	**1,471 MWh**	**1,507 MWh**	**3,612 MWh**	**3,526 MWh**	**3,436 MWh**	**3,441 MWh**	**3,435 MWh**

Table 20: Summary of capital costs and net cost savings (energy savings less maintenance costs) to Clarence Valley Council

Project	Site	FY18-19	FY19-20	FY20-21	FY21-22	FY22-23	FY23-24	FY24-25	FY25-26	FY26-27	FY27-28	FY28-29	FY29-30
						Solar PV and Battery Storage opportunities							
1	Clarenza STP		-$59,104	$7,907	$8,032	$8,159	$8,289	$8,421	$8,556	$8,694	$8,835	$8,978	$9,125
2	Clarenza STP									-$565,216	$39,711	$40,409	$41,121
3	Council Depot Yamba		-$20,687	$2,378	$2,409	$2,441	$2,473	$2,506	$2,540	$2,575	$2,610	$2,646	$2,683
4	Council Depot Yamba					-$15,401	$1,975	$2,027	$2,080	$2,135	$2,190	$2,246	$2,304
5	Fisher Park					-$50,459	$8,817	$8,951	$9,088	$9,228	$9,371	$9,516	$9,665
6	Grafton Airport						-$32,258	$9,106	$9,271	$9,438	$9,609	$9,784	$9,962
7	Grafton Landfill				-$72,801	$8,937	$9,101	$9,269	$9,440	$9,615	$9,793	$9,974	$10,160
8	Grafton Olympic Pool		-$12,806	$2,949	$3,002	$3,057	$3,113	$3,170	$3,228	$3,287	$3,347	$3,408	$3,471
9	Grafton Olympic Pool			-$38,226	$10,348	$10,545	$10,745	$10,950	$11,159	$11,372	$11,589	$11,811	$12,036
10	Grafton Regional Gallery		-$24,844	$5,451	$5,558	$5,667	$5,779	$5,893	$6,008	$6,127	$6,247	$6,370	$6,495
11	Grafton Regional Gallery						-$38,408	$9,489	$9,676	$9,866	$10,060	$10,258	$10,460
12	Grafton South Pool Gym			-$64,984	$13,709	$13,967	$14,231	$14,499	$14,774	$15,053	$15,338	$15,629	$15,925
13	Grafton South Pool Gym								-$52,813	$10,176	$10,349	$10,526	$10,706
14	Grafton Waste							-$61,227	$6,691	$6,801	$6,914	$7,029	$7,146
15	Iluka Holiday Park						-$26,735	$5,209	$5,311	$5,416	$5,522	$5,630	$5,741
16	Iluka STP					-$43,667	$8,654	$8,817	$8,983	$9,152	$9,324	$9,500	$9,679
17	Iluka STP								-$338,634	$28,192	$28,723	$29,265	$29,818
18	Maclean Depot			-$33,046	$4,790	$4,881	$4,974	$5,069	$5,166	$5,265	$5,366	$5,468	$5,573
19	Maclean Offices and Civic Centre				-$111,949	$21,486	$21,866	$22,253	$22,649	$23,052	$23,463	$23,883	$24,311
20	Maclean Offices and Civic Centre					-$15,390	$3,396	$3,463	$3,531	$3,601	$3,671	$3,743	$3,817
21	Maclean Offices and Civic Centre									-$45,955	$5,902	$6,010	$6,121
22	Maclean Sports Stadium					-$34,880	$4,176	$4,251	$4,327	$4,405	$4,484	$4,565	$4,647
23	Minnie Water Holiday Park		-$39,058	$8,635	$8,798	$8,965	$9,135	$9,308	$9,484	$9,665	$9,848	$10,036	$10,227
24	Netball Courts Maclean				-$15,053	$1,492	$1,518	$1,545	$1,572	$1,600	$1,629	$1,658	$1,688
25	North Grafton STP							-$144,104	$28,815	$29,356	$29,907	$30,470	$31,044
26	Prince St CVC Offices			-$25,484	$3,826	$3,888	$3,952	$4,017	$4,083	$4,150	$4,219	$4,290	$4,362

Project	Site	FY18-19	FY19-20	FY20-21	FY21-22	FY22-23	FY23-24	FY24-25	FY25-26	FY26-27	FY27-28	FY28-29	FY29-30
27	Raymond Laurie Sports Centre						-$159,119	$14,369	$14,613	$14,863	$15,118	$15,378	$15,644
28	Rushford Road Reservoir		-$59,104	$11,031	$11,237	$11,448	$11,663	$11,882	$12,105	$12,333	$12,566	$12,803	$13,045
29	Rushford Road Reservoir							-$326,437	$22,502	$22,903	$23,313	$23,730	$24,156
30	South Grafton Depot			-$318,608	$21,140	$21,512	$21,892	$22,279	$22,674	$23,077	$23,488	$23,907	$24,335
31	Tyson St SPS				-$89,647	$11,714	$11,915	$12,120	$12,329	$12,542	$12,759	$12,981	$13,208
32	Woodford Island STP				-$172,034	$21,507	$21,858	$22,217	$22,583	$22,956	$23,337	$23,726	$24,122
33	Wooli Holiday Park		-$23,563	$4,808	$4,895	$4,984	$5,074	$5,166	$5,260	$5,356	$5,454	$5,554	$5,656
34	Yamba CC Treelands Drive		-$55,580	$4,456	$4,537	$4,619	$4,704	$4,789	$4,877	$4,966	$5,058	$5,150	$5,245
35	Yamba Historical Hall Museum				-$12,370	$1,796	$1,829	$1,863	$1,898	$1,934	$1,970	$2,007	$2,045
36	Yamba Sport Oval				-$26,567	$2,284	$2,324	$2,364	$2,405	$2,447	$2,490	$2,534	$2,579
37	Yamba STP		-$88,361	$13,699	$13,952	$14,209	$14,471	$14,738	$15,011	$15,289	$15,573	$15,862	$16,157
	Energy Efficiency Opportunities												
38	Street Lighting Option 4	-$100,000	-$821,329	$183,549	$185,114	$186,718	$188,361	$190,046	$191,773	$193,544	$195,358	$197,218	$199,124
39	Street Lighting Main Road					-$888,214	$188,361	$190,046	$191,773	$193,544	$195,358	$197,218	$199,124
40	Facilities		-$164,584	$30,278	$31,035	$31,811	$32,607	$33,422	$34,257	$35,114	$35,991	$36,891	$37,814
41	Facilities			-$164,584	$31,035	$31,811	$32,607	$33,422	$34,257	$35,114	$35,991	$36,891	$37,814
42	Facilities					-$164,584	$32,607	$33,422	$34,257	$35,114	$35,991	$36,891	$37,814
43	Parks and Ovals			-$29,384	$4,156	$4,260	$4,366	$4,475	$4,587	$4,702	$4,819	$4,940	$5,063
44	Parks and Ovals					-$29,384	$4,366	$4,475	$4,587	$4,702	$4,819	$4,940	$5,063
45	Parks and Ovals							-$29,384	$4,587	$4,702	$4,819	$4,940	$5,063
46	Parks and Ovals									-$29,384	$4,819	$4,940	$5,063
47	Parks and Ovals											-$29,384	$5,063
	Annual net cashflow	**-$100,000**	**-$1,369,020**	**-$399,174**	**-$132,847**	**-$799,823**	**$444,676**	**$188,156**	**$431,323**	**$232,865**	**$937,116**	**$922,221**	**$971,482**

6.4 Evaluation of offsite renewable energy options and offsets

The evaluation summary above shows that considerable carbon, energy and financial benefits can be achieved through a focus on onsite measures such as solar PV, battery energy storage, and energy efficiency.

However, the analysis also shows that for an organisation with aspirations or targets for much greater levels of carbon abatement, or much higher utilisation of renewable energy to power its operations, a focus on changing the sources of energy supply is necessary.

Previously, organisations would pay a premium to purchase a fraction of their electricity from renewables, such as through the GreenPower® program. A sizeable premium is paid for this, which has limited the willingness of organisations to take this option. For example, many State and local government organisations purchase a level of 6% GreenPower®, but few buy much more than this.

Similarly, organisations can 'offset' their carbon emissions by purchasing the abatement achieved by efficiency, renewable energy or carbon sequestration projects implemented elsewhere, typically in jurisdictions and/or from projects where the cost of abatement is significantly lower than the cost of abatement in an organisation's own facilities. This can be cheaper than buying GreenPower®, but a premium is still paid, and organisations may be concerned with the quality of carbon offsets and may be concerned that this is inferior from a reputational perspective.

In recent months and years, as more and more large-scale renewable energy projects are built in Australia to meet the legislated requirements of the Renewable Energy Target (RET), new models for the procurement of electricity have emerged. Whereas in the 'traditional' electricity market only large energy retailers and a small handful of very large energy users bought power directly from generators, in the emerging renewable energy market corporates and groups of businesses are seeking to engage directly with projects to secure the type and quantity of renewable energy supply that they require at prices comparable to the traditional energy market. In addition, new business models by innovative energy retailers are emerging to facilitate these transactions, with more traditional energy retailers also now beginning to engage with these business-led models.

It is in this context that a number of leading councils in the Sydney region (SSROC), are seeking to source 20% of their electricity from renewable energy (solar PV) for the next ten years.

This section looks at the emerging energy market and at options that may be available to Council to source more of its electricity from renewables in future energy retail agreements (typically every two to three years). Topics covered include:

- Introduction to the electricity market,
- Terminology and participants in the NEM and in emerging renewable energy purchasing,
- Policy and electricity market factors affecting the case for large-scale renewables,
- Options for meeting Council's residual load using offsite renewable energy, and
- Options for meeting Council's residual load using offsets and/or LGC purchases

6.4.1 Introduction to the electricity market

It is useful in the first instance to outline how businesses and homes receive electricity to carry on their activities. To do that it is necessary to understand the basics of the National Electricity Market, or the NEM. The summary provided here is sourced from the Australian Energy Market Operator's website (AEMO)[21,22]. As its name suggests, AEMO is the operator of the NEM and is responsible for monitoring electricity consumption and the flow of energy across the power system, among other functions.

The NEM covers Australia's eastern and south-eastern mainland states (including the ACT), and Tasmania, covering a distance of 5,000 km, and carrying electricity from electricity generators to large industrial energy users and local electricity distributors across these states, who deliver it to homes and businesses. A simple overview of the journey electricity makes from generator to customer is shown below.

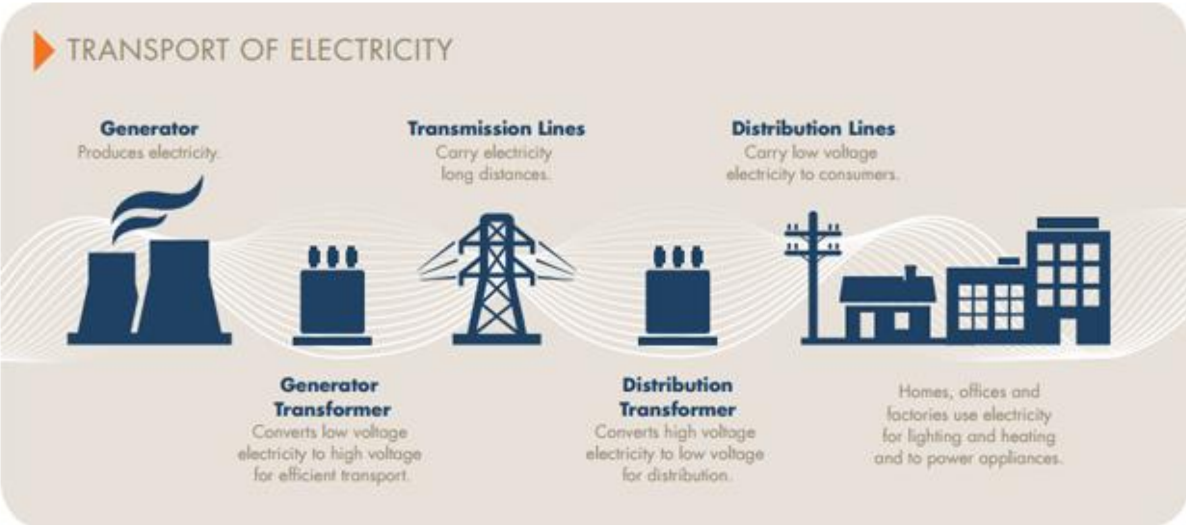

FIGURE 21: TRANSPORT OF ELECTRICITY IN THE NEM

The transport of electricity from generators to consumers is facilitated through a 'pool', or spot market, where the output from all generators is aggregated and scheduled at five-minute intervals to meet demand, with supply matched to demand for electricity by consumers.

The spot price of electricity in each half-hour period can vary from as much as $14,200 per MWh (cap) to as low as -$1,000 per MWh (floor). Electricity is bought in this market by energy retailers, who pay AEMO the spot price and re-price and on-sell the electricity to their customers, homes and businesses, under commercial agreements. To manage price volatility, retailers and generators often enter into hedging contracts to fix the price for future electricity sales.

Retailers also pass through regulated charges for the use of the electricity transmission and distribution network, as well as market fees, metering charges and environmental charges.

The majority of customers – generally with the exception of the largest industrial energy users – do not participate directly in the NEM, and simply purchase their electricity through a licensed electricity retailer.

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21 https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM
22 https://www.aemo.com.au/-/media/Files/Electricity/NEM/National-Electricity-Market-Fact-Sheet.pdf

6.4.2 Terminology and participants in the NEM and in emerging renewable energy purchasing

As renewable energy generation ramps up in response to the Renewable Energy Target, and the price of renewables continues to fall, businesses and emerging energy retailers are increasingly looking to disrupt the traditional way of doing business in the NEM and make renewable energy purchasing more available and cost-competitive compared with traditional electricity procurement.

In this emerging market a range of pre-existing and 'new' terms in the context of electricity purchasing are being used more widely. Some of these terms are explained below.

TABLE 21: COMMON TERMS RELATING TO 'TRADITIONAL' ELECTRICITY AND RENEWABLE ENERGY PURCHASING

Term	Meaning / description in the context of renewable energy projects
MWh, kWh	Megawatt hour, kilowatt-hour – units of energy
MW, kW, W	Megawatts, Kilowatts, Watts – units of power
Renewable Energy Target (RET)	The RET is a Commonwealth legislated target to ensure that 20% (expressed as a quantity equal to 33,000 GWh) of electricity supply in Australia comes from eligible renewable energy sources by 2020. This target is the driver of large-scale solar and wind projects that have been developing rapidly in Australia in recent years, and also the rise in small and commercial scale rooftop solar PV systems.
National Energy Guarantee (NEG)[23]	The proposed national energy guarantee is/was a policy to support the provision of reliable, secure and affordable electricity with a focus on ensuring: • the reliability of the system is maintained • electricity sector emissions reductions needed to meet Australia's international commitments are achieved • the above objectives are met at the lowest overall costs Following recent political uncertainty it appears that this policy may be scrapped or changed, and a focus on emissions has certainly been taken out of the narrative.
Australian Energy Market Operator (AEMO)	AEMO plays multiple roles in the NEM including: • Monitoring electricity consumption and the flow of energy across the power system, and making adjustments or intervening to resolve system limitations or risks to supply. • Monitoring of electricity voltage and frequency to make sure the system stays secure, including monitoring the impact of planned power outages to make sure the system can accommodate any subsequent loss of generation or transmission capacity. • Protection of the power system via instructions to network service providers to cut off supply to some customers if required as a last resort when supply in a NEM region cannot meet demand. • Operation of the retail electricity markets across the NEM.
Distribution Network Service Provider (DNSP)	Electricity and natural gas distributors own and maintain the distribution networks, including substations, transformers, electricity powerlines and power poles ('poles and wires'), and natural gas pipelines that carry electricity and natural gas to houses and businesses. For Clarence Valley Council the local DNSP for electricity is Essential Energy.

[23] http://www.coagenergycouncil.gov.au/publications/energy-security-board-update. As noted above there is considerable uncertainty about the future of this policy, particularly with regard to emissions reduction.

	DNSPs build and maintain poles and wires to ensure reliable and safe delivery of power to homes and businesses. Their charges for pass-through of electricity are regulated by the Australian Energy Regulator (AER), and are passed through on electricity bills by an organisation's electricity retailer. Regulated charges are published annually in tariff pricing plans, with the tariff applicable to a particular business or home dependent on their level of electricity consumption.
Contract for Difference	A financial derivative contract in that its value is derived from another market. In the case of renewable energy, this means the wholesale electricity market. Typically, a contract is between a renewable energy project developer and another party. Both parties agree on a price level that is usually set at a cost per MWh that the renewable energy project requires to finance its development and achieve a return on investment. When the renewable project generates electricity into the market, it receives the wholesale market price. If the wholesale price it receives is above the agreed price, then the other party will be paid the difference by the project. If the wholesale price is below the agreed price, then the other party will pay the project the difference. This ensures that the project is guaranteed revenue for generated electricity at the agreed price. CFDs are commonly used as the basis of a "virtual PPA" where no actual electricity is delivered to the customer, instead only a financial transaction occurs, completely separate to any agreement for electricity supply. A Ministerial order prohibits Councils in NSW from entering into such an agreement (for a derivative product), hence NSW councils are seeking alternate power purchasing solutions.
Feed-in-Tariff	A rate in $/MWh offered by a retailer for renewable energy exported to the grid, typical in many retail energy supply agreements.
Large-scale Generation Certificate (LGC)	An LGC represents one MWh of electricity generated from an eligible renewable energy plant under the Renewable Energy Target. Liable parties such as electricity retailers must purchase and surrender LGCs in proportion to their market share.
Power Purchase Agreement	An agreement between an electricity retailer and an energy user to purchase renewable energy.
Grid Connection Agreement	Application must be made, and agreement reached with the distributor to connect a renewable energy generator to the grid.
Offtake Agreement	An agreement between a renewable energy generator and an electricity retailer to buy the power generated by a renewable energy project.
Hedging	A risk management technique involving investing to reduce adverse price movements in a commodity or asset.
Counterparty	The other party in any financial transaction or agreement. Typically, there will be a buying counterparty or entity that is paired with a selling counterparty or entity. Both parties will have obligations for delivery outlined in an agreement or contractual transaction.
Counterparty risk	The risk that a counterparty cannot meet its obligations for delivery in a financial transaction or agreement. Often based on creditworthiness of a party. Government entities such as state governments, government agencies, departments and councils, will typically present a low counterparty risk compared to commercial organisations.
Engineer Procure and Construct	Typical agreement underpinning the implementation of a renewable energy project.
Firming	Firming is the mechanism by which an intermittent or fluctuating electricity load can be made firm in terms of volume. Typically, this volume will be specific to

	consumption of the energy user (which may also fluctuate) but can also be a fixed MWh amount. Renewable projects can use financial or physical firming products to guarantee delivery of a set amount of MWh of electricity even in times of low or no generation. A financial product may be a derivative or simply enable a substitute energy purchase from the wholesale market or another renewable project. A physical product could be pumped hydro generation or gas fired generation that could be deployed at short notice to physically deliver against a shortfall in renewable generation. Retailers can offer a firming service by directly purchasing the balance of grid power from the wholesale market if a customer wishes to integrate renewable energy into their energy mix. Retailers will charge a premium for this service as they will not know how much electricity to buy in advance, for example on a day that is windy versus a day of no wind where a customer has wind generation incorporated into their electricity purchases.
Merchant Projects	Projects that sell their output either totally or in part into the wholesale market without having an offtake agreement with an end user customer.
Spot Market	A spot market trades commodities like energy for immediate delivery i.e. they trade on the spot immediately. The National Electricity Market (NEM) facilitates the exchange of electricity between generators and retailers. All electricity supplied to the market is sold at the 'spot' price. Generators are paid for the electricity they produce, and retailers pay for the electricity their customers consume. Power supply and demand is matched instantaneously. Where intra-day electricity consumption increases above the expected 'baseload', more generators are brought on selling at higher and higher prices to instantly satisfy demand.
Wholesale prices	Prices without retailer margins. In Australia in the National Electricity Market there is a wholesale market for each state and territory. Wholesale pricing is available for registered market participants to purchase on the Spot Market or on the Futures or Forward Market.

6.4.3 Policy and electricity market factors affecting the case for large-scale renewables

Any business case for renewable energy (whether via a PPA or with Council as a developer and owner of a renewable energy generating asset, for example in partnership with other regional councils) needs to be assessed within the context of available pricing of non-renewable or standard grid power rates. Notwithstanding the environmental and other benefits gained, for a business case to be viable it should make financial sense for decision makers.

The below analysis provides context for assessing the possible financial benefits to council where renewable energy costs less than what council would likely pay for grid power. This includes discussion of the electricity market and the Large-scale Renewable Energy Target, as well as the planned National Energy Guarantee.

6.4.3.1 The electricity market

The electricity market in 2017 saw significant volatility and unprecedented high pricing, and many of the price drivers at play will continue to influence power costs in future years. Comparing renewable energy pricing to this inflated market has prompted increased interest from consumers.

However, large-scale projects that often take over 18 months to begin generating and have lives of 30 years or more require an assessment beyond the contemporary market. These projects require assessment against long-term forecasts. Owing to recent volatility, even energy industry experts are finding it difficult to develop a reliable case.

What is clear is that over time the cost of renewable energy technology is declining and that for the first time in the NSW market, there appears to be a consistent price differential favouring renewable energy over standard grid power.

Using the Australian Energy Market Operator's (AEMO's) forecast influences on demand in the electricity market, the following price trajectory for wholesale power is a possible outcome.

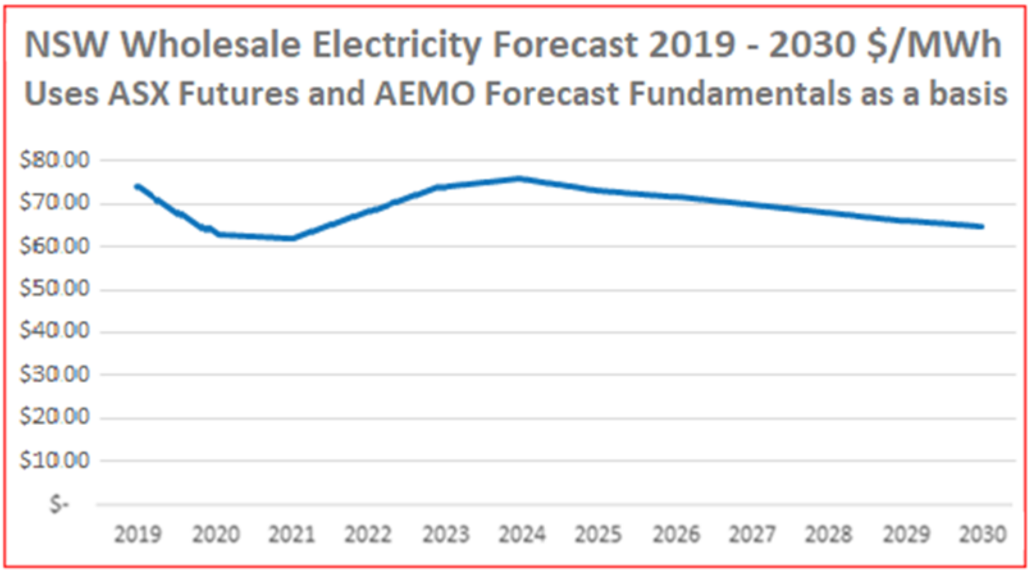

FIGURE 22: FORECAST AEMO-BASED PRICE TRAJECTORY FOR WHOLESALE POWER

Underlying this price path are the following drivers:

- Retirement of Liddell coal-fired power station in 2022 exerting upward pressure on pricing before exit.
- Declining gas pricing as a result of new entrant supply available from 2019.
- Incorporation of Snowy Hydro 2 and potentially more generation from Tasmania providing additional supply in the order of 3,500 to 4,500 MW from 2024.
- Increased proliferation of renewable generation with reducing technology costs and greater output.

If there is a relatively consistent and overall decline in standard grid power pricing, then it is likely that renewable energy will be more cost-effective in the initial years and then less so in the later years of a contract for its supply. However, if at the conclusion of the contract the renewable energy asset becomes the property of Council, then it may only require ongoing maintenance costs to continue generating at very low cost into the future.

Discussion of a generating asset in the current market must also consider the likelihood of achieving a network connection, in the case where Council is a developer / owner. In the case of rooftop and small-scale generation, most networks in NSW agree to connect through standard metering arrangements, and it would be unusual not to achieve a connection in a relatively short timeframe.

In the case of mid and large-scale generation, networks are currently being swamped by applications to connect. This can result in the connection process being drawn out for many months or in some cases, for example in some regions of the Essential Energy Network, a refusal to connect where the network is at capacity. With the increase in large scale and behind the meter PV there is a future risk (within the 30-year life of a solar project) that the grid may become saturated with PV during peak production times and there will be constraints placed on generators or negative pricing. This could particularly be the case if the asset is a semi scheduled generator as these can be requested to curtail by the market operator.

If considering a renewable energy project in regional NSW, connection limitations are important to address with the network operator. University of New South Wales (UNSW) has recently faced this issue where they had their own available land for a renewable energy development in the Riverina, however Essential Energy was unable to accept connection. The end result was that UNSW had to source a project built on someone else's land.

Given the current market conditions and available pricing in the NSW wholesale futures market, it is possible that Council's next retail electricity contract will be priced at a premium to the existing contract across all times of use.

The below chart shows the trend in Calendar Year electricity futures in NSW.

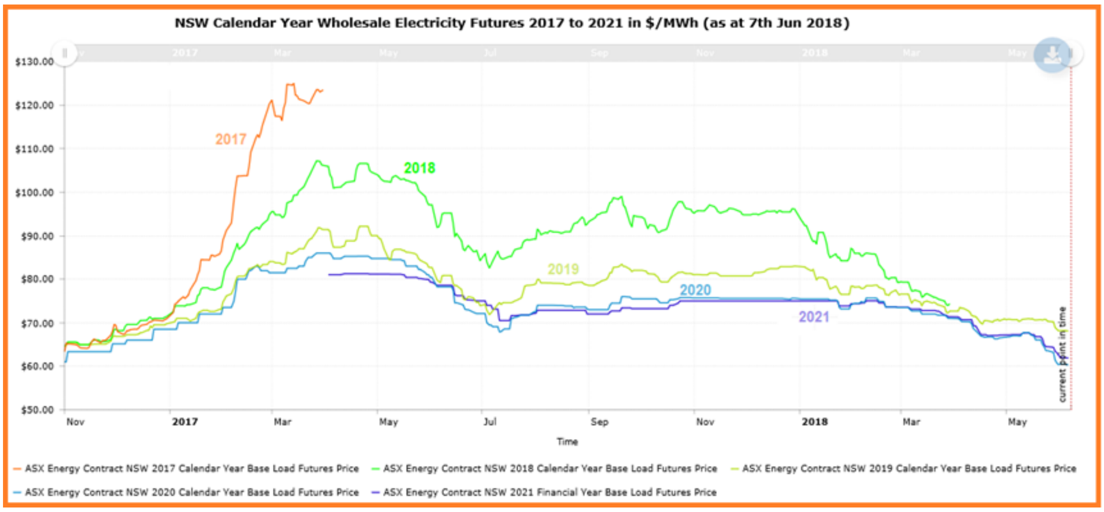

FIGURE 23: TREND IN CALENDAR YEAR ELECTRICITY FUTURES IN NSW

Clearly a downtrend has been in operation since the market highs in 2017. Rates following 2020 may see a slight upswing, as noted above, with the planned exit of Liddell power station in NSW in 2022.

6.4.3.2 The LRET and its influence on the business case

In the current market, many renewable energy project developers are competing to apply for network connections and construct generation assets in short order to take advantage of higher electricity market pricing, combined with high prices for Large-scale Generation Certificates (LGCs). These certificates are created when a large-scale project generates 1-megawatt hour of renewable energy that would otherwise have been majority coal-fired or non-renewably generated grid energy.

LGCs also make up around 8 to 10 percent of costs to energy consumers as retailers are obligated under the Renewable Energy Act to ensure that a percentage of their electricity sold to clients is sourced from renewable energy generation. This means that the retailer must surrender certificates to a government set percentage value annually, with the percentage increasing each year to in excess of 20% of their load under management by 2020.

The cost to retailers purchasing these certificates is passed on to consumers via their electricity bills. Alternatively, where large customers have access to their own LGCs, either by purchasing them on a secondary market or where a large-scale renewable energy project is willing to sell to them directly, the retailer may allow self-surrender by customers of an amount of LGCs equivalent to their load obligation.

As LGCs do trade on a secondary market after being created and have an associated penalty per megawatt hour for retailers if the required volume is not surrendered, they effectively have a notional market cap. The penalty translates to an after-tax market cap of around $90 per megawatt hour as the retailer could elect to pay the penalty rather than purchase certificates if they were priced above this value.

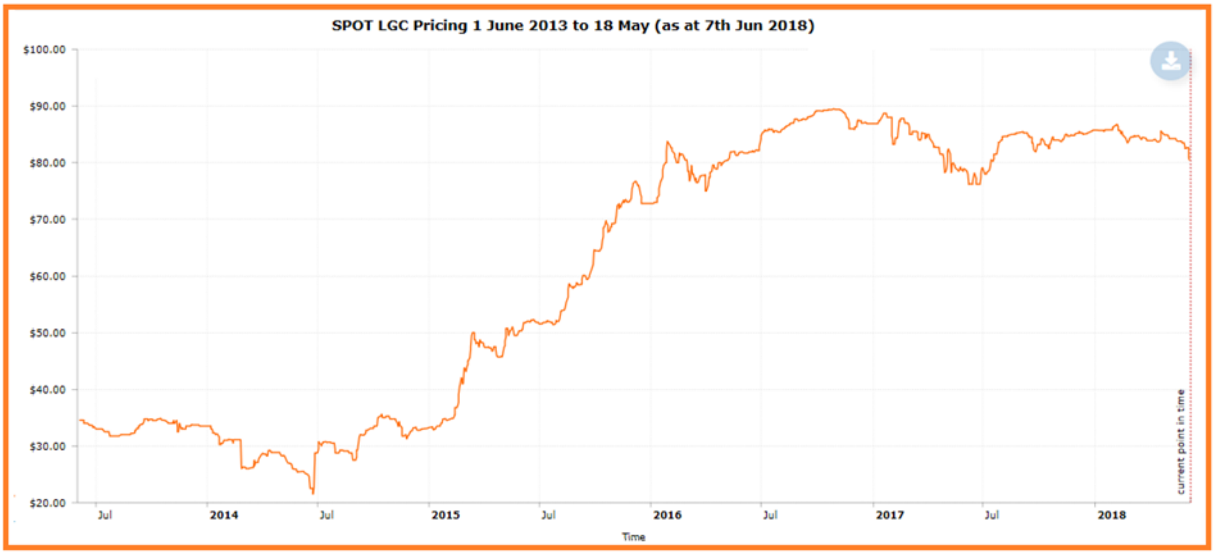

FIGURE 24: LGC 'SPOT' MARKET PRICING (DATA SOURCE: GREEN ENERGY MARKETS)

Over recent years where long-term energy policy (including the Renewable Energy Target that drives the amount of LGCs required to be purchased by retailers) has been far from certain, the appetite for investment in large-scale renewable energy has been low, with developers and financiers concerned about the uncertainty of returns.

The outcome of lower investment in renewable generation resulted in a short supply and has seen LGC pricing increase to around penalty levels over the last two years. This not only provides an incentive for renewable energy project developers but provides a driver for Council and energy consumers to investigate ways of reducing LGC costs.

Many organisations have considered purchasing LGCs directly from project developers who have been motivated vendors, the aim being to self-surrender or resell LGCs in the secondary market to achieve a discount overall against what their retailers would otherwise charge them as a result of their Renewable Energy Target obligations.

In the context of purchasing electricity from a large-scale project, developers have recently been bundling the sale of LGCs and renewable electricity in a single rate per megawatt hour. For Council, this has cost-saving implications both if electing to purchase supply from an off-site renewable energy project or if generating its own electricity and LGCs from a large-scale on-site project.

Importantly, continued uncertainty regarding energy policy is impacting LGC pricing especially with respect to the life of the Renewable Energy Target scheme and whether the Federal Government's proposed National Energy Guarantee will be enacted.

The possibility of the NEG becoming a reality, combined with the increased number of large-scale renewable energy projects planned that would all be creating LGCs, has led some consultants to suggest that the price of LGCs will decline rapidly towards zero by the mid-2020s. This concept of lower value LGCs in coming years is another consideration when assessing the business case for a long-term renewable energy project.

6.4.4 Options for meeting Council's residual load using offsite renewable energy

So, what renewable energy options will be available to Council to source over the coming years? Unlike many businesses local councils' load when seen in aggregate tends to be biased towards night time demand owing to street lighting, water pumping and the 24/7 operation of large energy users such as heated swimming pools. Hence, solar PPAs or developments can serve to meet most of Council's daytime demand (on a load-matching basis, with CFDs unable to be entered into). This may suggest that a combined solar and wind energy PPA is better suited to achieving a high proportion of renewable energy supply, and some PPA offers are emerging that combine wind and solar to reflect 24-hour operations.

However, the continuing decline in battery costs may mean that future power purchase agreements can be sculpted using any renewable energy technologies to meet the energy requirements of end users with 24/7 operations, such as councils. As such, going forward Council should keep an open mind regarding their preferred technologies to help them achieve their targets.

According to Bloomberg New Energy Outlook 2018, battery prices are continuing to decline, and batteries combined with cheaper solar and wind energy technologies will become increasingly cost competitive.

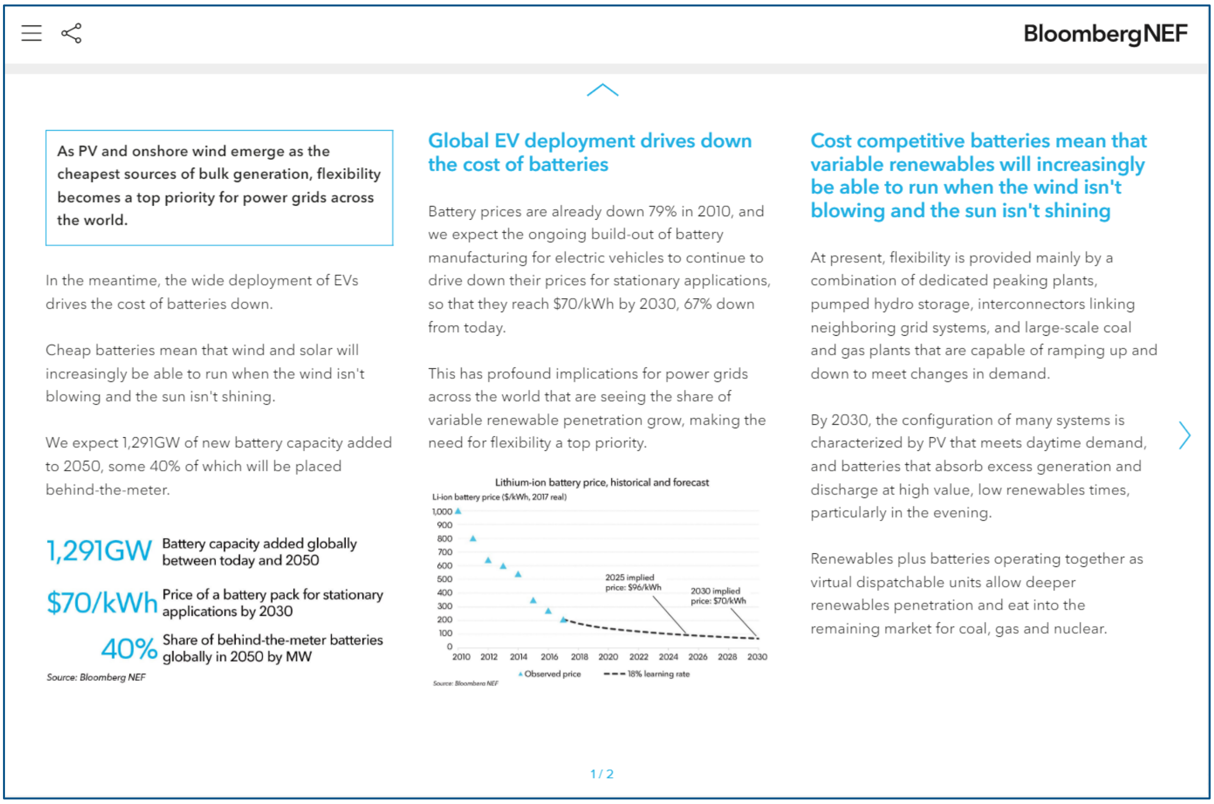

FIGURE 25: SUMMARY OF GLOBAL BATTERY TRENDS, BLOOMBERG NEW ENERGY OUTLOOK 2018 (PUBLIC VERSION)[24]

[24] https://about.bnef.com/new-energy-outlook/#toc-download

To build and purchase, or to purchase-only?

The main decision that faces Council is whether to enter into a PPA to source additional renewable energy, or to build its own renewable energy generation project (for e.g. on one of the sites identified as having potential for mid-scale solar, or with another regional partner such as a council or group of councils).

In either case the need for Council to use a licensed energy retailer to facilitate the purchase of renewable energy for its operations remains the same as is the case now. Even if Council builds its own generator, output must be sent to the grid and a retailer must be engaged to buy and then re-sell the electricity back to Council (except where the output simply receives the spot price from AEMO and is not purchased by Council).

Whether a renewable energy generation project is solar, wind or either of these with battery storage, the requirements for the build case and the agreements for the build and PPA cases won't be much different. Below are set out the main characteristics and models of two approaches, including:

1. Building, owning and operating a renewable energy project, potentially in partnership with other councils, with CVC as an offtaker
2. Contracting renewable energy directly via a Power Purchase Agreement, looking at several models currently in use or emerging

The models examined reflect the range of renewable energy generation and procurement options for mid-sized corporates that we have observed in the last 6-12 months, and numerous other options may be feasible.

The options are set out from the perspective that they could be implemented 'now' – thereby considering LGCs as a potential source of revenue in build cases.

Building, owning, operating a renewable energy project - EPC model

Building and owning a renewable energy project may be an **Engineer, Procure, Construct (EPC) model** where Clarence Valley Council (CVC) invests capital and directly or indirectly project manages the construction of the renewable energy asset. An EPCM model adds maintenance of the asset to the project characterisation; for the purpose of this report, EPC is used.

Under an EPC model, there is greater interest in the technical aspects as ownership is transferred to Council upon commissioning or after an agreed period of operation. Council subsequently takes on the management and risk of ongoing performance.

While there are many styles of EPC contracting, here we outline two that cover the majority of currently used approaches.

EPC AND SELL FIXED PRICED OFF-TAKE INCLUDING LGCs

Model Name	EPC - and sell fixed priced off-take including LGCs
Basic Description	Construction agreement is EPC. Generation from the plant is exported to market to supply a third party offtaker. The generation is sold through a separate agreement at an agreed fixed price per megawatt hour as council cannot offer as a contract for difference (CFD). A retailer needs to pass through or sleeve this separate agreement. Typically, the offtake price will be at a discount to market. LGCs would be optional to sell/purchase. If not sold CVC can use the LGCs to offset obligations or retire them to claim the carbon reduction and renewable energy generation. Depending on the size of the project (e.g. if >5 MW AC), the project may need to be registered as a generator with AEMO.
Agreements	• Land lease Agreement • EPC Agreement • Off-Take Agreement • Registration as generator (potentially)
Agreements and counterparties	**EPC Agreement:** EPC Company and Council. **Off-Take agreement:** Council as generator. Off-taker could be a corporate, a retailer or an aggregator (another council and/or CVC itself could be offtakers but only through a retailer otherwise model would involve a CFD). **Registration as generator:** Council and AEMO, if required
Duration	EPC open until construction and defects/initial maintenance complete. The off-take agreement will be aligned with financing where possible i.e. if the underlying financing is 15 years then ideally the off-take agreement will be for 15 years. Registration as a generator with AEMO is an annual renewal if required. The project life will be 30 years or more and will require inverter upgrades at periodic intervals (say 14 and 28 years).
Costs	• Capital cost • Inverter replacement cost • O&M cost • AEMO registration (if applicable) • Retailer pass through margin $/MWh • Loan finance (if applicable) • Leasing costs
Benefits	• Sale of RE output to offtaker • Reduction in electricity prices compared with standard retail agreement • Reduced LGC obligation • Surplus LGCs if LGCs created exceed the obligation amount
Risks	1. Retailers may not want to be party to off-take. 2. AEMO increases fees for generators. 3. Wholesale market prices increase significantly and agreed off-take price is at a significant discount to market thereby Council foregoes revenue 4. Off-take term is shorter than financing if applicable 5. Regular retail price or competing off-take price falls below off-take price – no one takes up off-take or off-take needs to operate at a

	loss
Mitigants (that respond to the identified risks)	1. As market matures more retailers will want to participate. Legislation may drive obligations for retailers. Alternative is to take spot market revenue until off-take can be achieved. 2. Calculation of breakeven point will inform when this makes project unprofitable. Incorporate change in law clause. 3. Build in sufficient buffer when offering fixed for floating prices. 4. Negotiate longest duration possible and offer discounts for longer terms. Negotiate multiple offtake deals. 5. Get robust market pricing advice, and don't proceed if this is a likely outcome. Sell project if already constructed.
Case example	Majority of PPAs in market. Announced Project off-take agreements. Newcastle Council, City of Fremantle
Suitable for councils	Yes
Cost benefit	Recent analysis of mid-scale projects forecast fairly low returns of 4-6% IRR for mid-scale solar projects, with moderated wholesale market forecasts, declining LGC revenue and project capital costs still in the order of $1.50-$1.60/W (a 5 MW solar plant would likely cost around $8 million to develop). Consideration of whether a social cost of carbon (SCoC) warrants inclusion – this would significantly improve the business case.

EPC AND RECEIVE SPOT MARKET REVENUE

Model Name	**EPC and receive spot market revenue**
Basic Description	This model requires that Council registers as a generator, e.g. a semi-scheduled market generator (less than 30 MW generation) market participant. Generation will be sent to market via an export meter. Spot market revenue will be received from AEMO.
Agreements	• EPC Agreement • Registration as semi-scheduled market generator
Agreements and counterparties	**EPC Agreement:** EPC Company and Council. **Registration as semi-scheduled market generator:** Council and AEMO
Duration	EPC open until construction and defects/initial maintenance complete. Registration as semi-scheduled market generator is an annual renewal. The project life will be 30 years or more and will require inverter upgrades at periodic intervals (say 14 and 28 years).
Costs	• Capital cost • Inverter replacement cost • O&M cost • AEMO registration as a semi-scheduled market generator (currently $20,000 pa) • Loan finance (if applicable) • Lease costs
Benefits	• Spot price revenue • LGC revenue
Risks	1. AEMO increases registration fees for semi-scheduled market generators. 2. Market price is low and provides lower than expected revenue for daytime generation. 3. Project finance may be difficult if there are no off-takers.
Mitigants (that respond to the identified risks)	1. Review viability of other models and cost to change. If viable make change. 2. Review viability of other models with long-term fixed pricing.
Case example	All merchant sellers of renewable energy
Suitable for councils	Yes
Cost benefit	Very similar to the EPC + offtake model with comparable prices offered for offtake v spot market at this time.

Bundled and LGC-only offsite Power Purchase Agreements

Below are outlined PPA models that are prevalent in this evolving marketplace, but this is not an exhaustive list. Most models endeavour to give price surety and tenure to developers to satisfy their financing needs and most also ensure delivery of as firm a load as possible for customers.

SLEEVED PPA

Model Name	**Sleeved PPA**
Basic Description	A sleeved PPA is similar to a regular grid power agreement, but instead of regular generation from coal-fired and other sources, the underlying electricity generation is from a specific renewable energy project. The customer has an agreement with the retailer for both renewable and standard grid power. Underlying this agreement, the retailer has a renewable energy supply agreement with a project developer either at a fixed rate or using a contract for difference. The retailer then sells the electricity including a margin to the customer and manages the risk of fluctuations in generation of the project. The customer typically pays either a risk included rate for all power or separate rates for renewably generated electricity and regular grid power.
Agreements	Retail Electricity Agreement inclusive of a sleeved PPA
Agreements and counterparties	**Sleeved PPA Agreement**: Retailer and Council (Typically combined with retail agreement). There is also an underlying agreement **between project developer and retailer, typically a CFD**, to which the Council would not be a party.
Duration	Term will likely be 10 or 15 years for the renewable component of the sleeved PPA. If the retail agreement is a separate agreement, the term for the retail component may not necessarily be ten years. The retailer may agree to a shorter term for the retail component. This then requires entering subsequent retail agreements until the end of the PPA term.
Costs	No upfront costs but each retail agreement will be subject to market pricing, so cost will not be known for the retail component unless there is a fixed price for ten years.
Benefits	Lower cost for power than traditional retail agreement.
Risks	Retailers may not be interested in taking on a sleeved PPA after the initial retail term.
Mitigants (that respond to the identified risks)	Lock in a longer-term retail agreement potentially with a transparent market matching clause
Case example	City of Melbourne
Suitable for councils	Yes

DIRECT (OR 'SELL SIDE') PPA

Model Name	Direct (or 'sell side') PPA
Basic Description	A direct PPA involves a customer buying electricity directly from a renewable energy project developer (typically at a fixed price) over a term of 7, 10 or 15 years. This kind of PPA requires a retailer to pass through the terms of the agreement between the developer and customer and then also risk-manage any fluctuations in generation against a required amount of megawatt hours of electricity. Typically, the agreement will incorporate a performance guarantee or 'firming' clause that reduces the risk management required by the retailer. Retailers have in the past agreed to this type of PPA where the volume of renewable energy is only a small part of the customer's overall electricity load. This is because, in effect, they are receiving no margin on the small amount of renewable energy and are still making a margin on most of the overall load supplied by regular grid power. The retailer also must reconcile and bill for the renewably generated electricity.
Agreements	Direct PPA Agreement (assumes a retail agreement will be in place to supply balance of load and to cover retail invoicing of renewable power))
Agreements and counterparties	**Direct PPA Agreement**: Project developer and customer **Retail electricity agreement**: (incorporates PPA price) Retailer and Council.
Duration	PPA agreement: 7-15 years, typically ten years. Retail electricity agreement: 1-10 years
Costs	No upfront costs but each retail agreement will be subject to market pricing, so cost will not be known for the retail component unless there is a fixed price for ten years.
Benefits	Lower cost for power than traditional retail agreement.
Risks	Retailers may not be interested in taking on a Direct PPA.
Mitigants (that respond to the identified risks)	Request that projects provide PPA offers that incorporate a retailer offer and that they are willing to work with any retailer.
Case example	Sun Metals, Nectar Farms, Westpork
Suitable for councils	Yes

VIRTUAL PPA

Model Name	**Virtual PPA**
Basic Description	A virtual PPA decouples the link between a grid power supply agreement and renewable energy generation in that a virtual PPA does not require the physical delivery of electricity. A virtual PPA is a stand-alone financial derivative agreement that guarantees a fixed price return for the project developer. The customer and the developer agree on a 'strike price' and agree to settle the difference between that strike price and the spot electricity market. If the spot market price rises above the strike price, then the customer receives a payment from the project developer (who would have sold the generated power into the spot market and received revenue for it). If the spot market price falls below the strike price, then the customer would be required to pay the difference. This payment would guarantee that the project developer would not receive anything less than the strike price for each megawatt hour generated and would offer income opportunities for the customer of up to the market cap of $14,200 per megawatt hour, less the strike price value. This form of contract is also known as a contract for difference and may require Australian Financial Services Licence to deal in this derivative product. There is a Ministerial Order for preventing councils from directly investing in derivatives and so Council would need to take a position on whether this form of PPA or a variation of it would be acceptable for investment. If a virtual PPA was to be used to meet 100% renewable energy target, an additional PPA for LGCs would have to be undertaken (separate agreement, but could be bundled).
Agreements	PPA Agreement (financial-only, no retail agreement)
Agreements and counterparties	**PPA Agreement** (financial-only): Project developer and customer
Duration	PPA agreement: 7-15 years, typically ten years.
Costs	Difference between strike price and market price (when strike price is above market price) multiplied by consumption
Benefits	No Retailer is required Income available when market price is above strike price
Risks	1. Exposure to low-value spot market pricing 2. Reputational and financial penalty of breaching ministerial order if a council
Mitigants (that respond to the identified risks)	1. May be possible to purchase a further hedging derivative that increases in value as price drops below strike. 2. Councils should not use this model unless they receive legal advice that suggests it is possible to enter this form of contract.
Case example	UNSW, UTS
Suitable for councils	No, and also not suitable for meeting 100% renewable energy

LGC-only Purchase Agreement

Model Name	LGC-only Purchase Agreement
Basic Description	An LGC-only PPA is relatively simple because Council would only purchase the green attributes of renewable energy generation and would not be concerned with balancing energy demand with the output from a renewable energy generator. There is little risk in matching the number of LGCs purchased to the electricity consumed in any given year. It also means that there will be little or no change to the retail electricity agreement. However, Council may be able to achieve a better price through a bundled PPA and striking a deal with a renewable energy generator for LGCs-only may not be sufficient for a new renewable energy project to get off the ground.
Agreements	LGC Purchase Agreement
Agreements and counterparties	**LGC Purchase Agreement:** Council and LGC Owner (Likely a renewable energy project or aggregator)
Duration	Single transaction or ongoing quarterly or annual purchase
Costs	Negotiable, typically referenced to forward market pricing
Benefits	Easy to operate, can be GreenPower®-accredited, achieve renewable energy targets at low cost with straightforward investment
Risks	1. Market volatility and likely rapid price decline 2. Fine print clauses in retail agreements and retail appetite for small amounts of LGCs surrendered. (if retiring LGCs this is not applicable)
Mitigants (that respond to the identified risks)	1. After 2020, it is likely to be a buyer's market and CVC would be able to aggressively negotiate on price. Assumption can be made that costs will be very low, and this should be verified by professional advice and market pricing when agreeing price levels. 2. Ensure review of existing and upcoming retail contracts prior to any transaction. If tendering/negotiating for electricity, ensure LGC surrender is a supply requirement
Case example	Two models exist in terms of surrendering LGCs: 1. retire them and achieve gains towards renewable energy goals 2. offset retailer RET cost obligations as a result of energy consumption
Suitable for councils	Yes

Virtual Generation Agreement

Model Name	Virtual Generation Agreement
Basic Description	Refers to offers of electricity pricing from "Virtual Generation Agreements" (VGAs) with renewable energy projects combined with hedges against wholesale price volatility for the supply of electricity when the projects are not generating. For example, a combined wind and solar PPA may be offered for a defined portion of CVC's total load. Outside of solar or wind generation hours, the retailer procures the remaining energy needs from the wholesale market on CVC's behalf and charge CVC the wholesale rate. Any excess generation not consumed can be sold back to the wholesale market or sold to the retailer at a fixed rate. If the generation asset is operating, i.e. the wind is blowing and the sun is shining, then it should be possible to cover a high % of the required load. However, if there is a lack of wind and light, e.g., a cloudy day with no wind, then more electricity will need to be bought on the wholesale market. If this happens to be a highly priced peak demand day, then this could prove to be very expensive. To balance this risk somewhat, the generated renewable energy will at other times be surplus to the customer's consumption and the excess would be sold into the market. To further manage exposure to spot market risk, a hedging product could be used to place a cap on spot pricing paid by the customer but would come at a price in $/MWh which may impact the business case. As CVC would essentially be operating as a wholesale market participant, the retailer would also have to charge a security deposit based on their deposit requirements from AEMO. This is currently estimated at over $125,000 and would need to be paid up front (typically in the form of a Bank Guarantee).
Agreements	Power Purchase Agreement (with VGA and underlying hedges)
Agreements and counterparties	**Power Purchase Agreement:** CVC and retailer
Duration	Typically 10 years
Costs	• VGA Rates (may incl LGC costs) • Variable Wholesale electricity costs • Hedging Costs • Security Deposit • Legal/advice costs
Benefits	• Large percentage of renewable energy • De-escalating renewable energy costs • Potential electricity cost savings over standard grid power
Risks	• Retail market declining below VGA pricing within 10-year term • Exposure to wholesale market pricing • Intermittent generation
Mitigants (that respond to the identified risks)	• Negotiate best possible terms and pricing • More accurately model peak and offpeak load matching • Use a different form of PPA
Case example	
Suitable for councils	Yes

The Evolving PPA market in Australia

The PPA market is evolving rapidly in Australia partly due to increased appetite of consumers for renewable energy and partly due to the cost differential between regular grid power and long-term PPA prices.

At the same time, project developers are highly motivated to achieve off-take agreements to satisfy financing needs and also take advantage of current market pricing for electricity and LGCs. These market conditions and the fact that there are more projects in planning than there is load in NSW suggests that there is competitive pressure driving agreement negotiations. Innovative models that are beneficial to both project developers and energy users are emerging.

Retailers, many of whom have taken out long-term off-take agreements with very large renewable energy projects at low prices, are also now actively seeking longer-term supply agreements with their customers. These deals benefit from having pre-existing generation assets and reduced counterparty risk. They also potentially offer good blended pricing of retail and renewable energy.

We have recently seen the emergence of intermediaries such as the Renewable Energy Hub by TFS Green (LGC broker), which is seeking to match customers loads with renewable energy projects that provide a best fit, and also offer a project 'firming' capability which reduces risk for the retailer in pricing and may offer cheaper outcomes for customers.

With the alternative of a regular grid contract also at lower pricing than in recent years customers are more demanding of project developers to reduce delivery and price risk, and where possible make their PPA more like a regular electricity supply agreement. This has seen the development of innovations that assist in reducing exposure to declines in market pricing through market matching or indexing clauses in agreements, caps and floors around price levels and ability to renegotiate retail portions of load during a PPA term.

These rapid developments are most likely pointing towards simplified future renewable energy purchasing that is little or no different from current 'standard' electricity retail procurement.

6.4.5 Options for meeting Council's residual load using offsets

Actions implemented by Council, and treatment of Large-scale Generation Certificates associated with renewable energy projects, allied to established abatement targets, will determine future greenhouse gas emissions and confirm the size of the abatement task that may need to be met via the purchase of carbon offsets. Offsetting is likely to be part of Council's abatement efforts if zero net emissions / carbon neutrality is an established goal.

If pursuing a net zero strategy Council's emissions baseline may seek to comply with the requirements of the National Carbon Offset Standard (NCOS)[25] which includes Scope 3 GHG emissions. Under NCOS, only high-quality carbon offsets are allowed for reaching carbon neutrality. Accepted offsets are:

- Australian Carbon Credit Units (**ACCUs**) issued by the Clean Energy Regulator in accordance with the framework established by the Carbon Credits (Carbon Farming Initiative) Act 2011.
- Certified Emissions Reductions (CERs) issued as per the rules of the Kyoto Protocol from Clean Development Mechanism (**CDM**) projects, with some exceptions.
- Removal Units (**RMUs**) issued by a Kyoto Protocol country on the basis of land use, land-use change and forestry activities under article 3.3 or 3.4 of the Kyoto Protocol.
- Voluntary Emissions Reductions (VERs) issued by the **Gold Standard**.
- Verified Carbon Units (VCUs) issued by the **Verified Carbon Standard** (VCS).

The table below shows estimated costs for carbon offsets based on the need to offset 10,000 t CO_2-e, 15,000 t CO_2-e or 20,000 t CO_2-e, which reflects the range of Council's potential 2030 GHG emissions depending on actions implemented and on whether landfill gas emissions form part of Council's targets. This draws on the range of costs seen for local projects (more expensive and low supply, for example VCS credits for Tasmanian native forest protection can be bought from $9.50), and international projects (for example, VCS carbon offsets from wind farm projects in China or India from $1.50 per tonne[26]. Carbon offset projects with social benefits, e.g. REDD projects (reducing emissions from deforestation and forest degradation in developing countries), start at $4.50).

Table 22: Potential range of costs for offsets for different GHG emissions and offset source scenarios

Type of offsets sourced	Australian offset		International low cost		International social benefit	
Scenario	Low cost	High cost	Low cost	High cost	Low cost	High cost
Offset price per tonne	$9.50	$20	$1.50	$5	$4.50	$15
10,000 t CO_2-e	$95,000	$200,000	$15,000	$50,000	$45,000	$150,000
OR 15,000 t CO_2-e	$142,500	$300,000	$22,500	$75,000	$67,500	$225,000
OR 20,000 t CO_2-e	$190,000	$400,000	$30,000	$100,000	$90,000	$300,000

Additional to these costs would be inventory development (unless carried out internally), third party verification fees every two years, and NCOS license fees, currently at $18,000 per year. Total additional costs could be from $20,000 to $50,000 per year. A non-NCOS approach would limit costs to the purchase price for offsets as tabulated above.

[25] http://www.environment.gov.au/climate-change/government/carbon-neutral/ncos
[26] A recent project (Dec-17) sourced VCS offsets from a wind project in India at $3/offset – i.e. mid-range of international low cost offset prices noted above.

Carbon offsets creation on Council-owned land at Rockview / Shannon Creek Dam

One local alternative to purchasing offsets per above was noted by Council to be the revegetation of a 100 Ha cleared area at Rockview, part of the Shannon Creek Dam catchment.

A proposed plantation of this area by Greenfleet was advised to include no upfront cost to Council, but that Greenfleet would own the rights to carbon offsets for 100 years. Under this scenario the offsets would not be available to Council except via purchase from Greenfleet. The cost to purchase these offsets is not included in information supplied, but could be similar to the cost of Australian offsets as tabulated above. Council's Executive Report (18/44) notes a range of additional benefits to the local natural environment.

The council report does not include an estimate of the amount of offsets that could be created, and this may be subject to further analysis if/as the proposal proceeds. A 'rule-of-thumb' assessment could see say 1,000 stems planted per hectare, with say 10 trees sequestering one tonne of CO_2-e per year[27]. This would create abatement of 10,000 tonnes CO_2-e per year, which is potentially substantial in the context of Council's emissions and abatement aspirations, particularly given the challenges associated with reducing emissions from landfill.

A review of this proposal and the costs and benefits of alternate options was not included in the brief for this project, so this remains an action for Council to pursue. If Council has an objective or target to source say 10,000 tonnes of CO_2-e from offset measures, options to consider include:

- The offer as outlined by Greenfleet would have no cost to Council and offsets would be created and traded by Greenfleet (or other party if a competitive process were undertaken). If Council elected to not purchase the offsets then the net impact for Council from this project would be the local natural environment benefits. Council would need to source offsets from elsewhere, at potential costs as outlined above, e.g. $15-50,000 per year for international offsets.
- As above but Council purchases 10,000 t CO_2-e of offsets from the project annually. Costs for offsets may be in the range noted for Australian offsets, i.e. >$95,000 per year. The natural environment co-benefits are supplemented by the benefits of locally-created plantations offsetting locally-generated emissions from landfill.
- Council may seek to co-invest in the capital and management costs of the plantation in exchange for a proportion of the offsets created from the project. Greenfleet (or other party) would remain responsible for all obligations associated with their role of creating, verifying and selling offsets. If this approach is workable then Council could offset part of its emissions through local action, and could source the balance of its targets from elsewhere.

[27] https://carbonneutral.com.au/faqs/

Appendix A: Site inspection summary

39 sites accounting for 81% of Council's electricity use (excluding street lights) were visited as part of the project to identify opportunities for renewable energy and carbon abatement.

Site Name	Annual MWh	Date of site visit
Rushforth Road Reservoir	114 MWh	Monday, 12 March 2018
Water Pump Station Rushforth Rd	60 MWh	Monday, 12 March 2018
Sewage pump station Tyson St South Grafton	63 MWh	Monday, 12 March 2018
STP North Grafton	95 MWh	Monday, 12 March 2018
STP Clarenza	301 MWh	Monday, 12 March 2018
STP Coutts Crossing	61 MWh	Monday, 12 March 2018
STP Yamba	798 MWh	Tuesday, 13 March 2018
STP Iluka	209 MWh	Tuesday, 13 March 2018
STP Woodford Island	447 MWh	Tuesday, 13 March 2018
Shannon Creek Dam	1,060 MWh	Tuesday, 13 March 2018
Kremnos Pumping Station	242 MWh	Tuesday, 13 March 2018
Wooli Recreation Park	87 MWh	Wednesday, 21 February 2018
Minnie Water Caravan Park	163 MWh	Wednesday, 21 February 2018
Iluka Caravan Park & Camping Reserve	328 MWh	Wednesday, 21 February 2018
Brooms Head Caravan Park	277 MWh	Wednesday, 21 February 2018
Calypso Caravan Park Yamba	328 MWh	Wednesday, 21 February 2018
Yamba Sports Oval (2 accounts)	14 MWh	Thursday, 22 February 2018
Yamba Historical Hall (external)	6 MWh	Thursday, 22 February 2018
Yamba Community Centre Treelands Drive	19 MWh	Thursday, 22 February 2018
Yamba Depot	14 MWh	Thursday, 22 February 2018
Yamba Raymond Laurie Sports Centre	94 MWh	Thursday, 22 February 2018
Yamba heated pool	81 MWh	Thursday, 22 February 2018
Yamba Community Hall Wooli St (incl library)	39 MWh	Thursday, 22 February 2018
Maclean pool	65 MWh	Thursday, 22 February 2018
Barry Watts Oval (Maclean sports hall)	20 MWh	Thursday, 22 February 2018
Netball courts Rannoch Ave Maclean	6 MWh	Thursday, 22 February 2018
Wherrett Park Maclean	5 MWh	Thursday, 22 February 2018
Maclean library Stanley St	10 MWh	Thursday, 22 February 2018
Maclean offices 50 River St	259 MWh	Thursday, 22 February 2018
Maclean Civic Centre 48 River St	32 MWh	Thursday, 22 February 2018
Grafton Regional Gallery	116 MWh	Thursday, 22 February 2018
Sports Centre Powell St Grafton	59 MWh	Thursday, 22 February 2018
Grafton Olympic pool	84 MWh	Thursday, 22 February 2018
Ellem Oval & Fisher Park (5 accounts)	92 MWh	Friday, 23 February 2018
Grafton regional landfill (3 accounts)	76 MWh	Friday, 23 February 2018
South Grafton pool and gym	270 MWh	Friday, 23 February 2018
Grafton Civic Centre 2 Prince St	210 MWh	Friday, 23 February 2018
Grafton Library	279 MWh	Friday, 23 February 2018
Grafton airport / aerodrome	40 MWh	Friday, 23 February 2018

Appendix B: LED Streetlighting supporting information

Four options were provided by Essential Energy, of which Option 4 represents the most cost-effective option that delivers the greatest carbon emissions savings. Spreadsheet analysis of Essential Energy data is supplied with this report. Three elements of the analysis are supplied here:

1. Analysis of energy use and cost savings, and the value of Energy Saving Certificates

Current Tariff	Number of Luminaires Upgraded	Watts Baseline	Watts LED	kWh Saved	Elec cost saved	ESCs value	Base Elec use kWh
FLU0350-ST-1620-003-B	165	46.40	18.00	20,525 kWh	$ 2,771	$ 3,916	33,533 kWh
FLU0350-ST-1620-004-B	1862	46.40	18.00	231,618 kWh	$ 31,268	$ 44,193	378,418 kWh
FLU0350-ST-1620-005-B	9	46.40	18.00	1,120 kWh	$ 151	$ 214	1,829 kWh
FLU0350-ST-1630-004-B	10	46.40	18.00	1,244 kWh	$ 168	$ 237	2,032 kWh
FLU0350-ST-1660-003-B	19	46.40	18.00	2,363 kWh	$ 319	$ 451	3,861 kWh
FLU0350-ST-1660-004-B	197	46.40	18.00	24,505 kWh	$ 3,308	$ 4,676	40,037 kWh
FLU0350-ST-1700-003-B	5	46.40	18.00	622 kWh	$ 84	$ 119	1,016 kWh
FLU0350-ST-1700-004-B	671	46.40	18.00	83,467 kWh	$ 11,268	$ 15,926	136,369 kWh
FLU0350-ST-1700-005-B	6	46.40	18.00	746 kWh	$ 101	$ 142	1,219 kWh
HPS0020-ST-0040-001-B	9	86.00	35.00	2,010 kWh	$ 271	$ 384	3,390 kWh
HPS0020-ST-0040-003-B	1	86.00	35.00	223 kWh	$ 30	$ 43	377 kWh
HPS0020-ST-0350-001-B	1	86.00	35.00	223 kWh	$ 30	$ 43	377 kWh
HPS0020-ST-0350-003-B	1	86.00	35.00	223 kWh	$ 30	$ 43	377 kWh
HPS0020-ST-0360-004-B	3	86.00	35.00	670 kWh	$ 90	$ 128	1,130 kWh
MVA0020-ST-0010-001-B	3	95.80	18.00	1,022 kWh	$ 138	$ 195	1,259 kWh
MVA0020-ST-0010-002-B	2	95.80	18.00	682 kWh	$ 92	$ 130	839 kWh
MVA0020-ST-0010-004-B	3	95.80	18.00	1,022 kWh	$ 138	$ 195	1,259 kWh
MVA0020-ST-0810-003-B	1	95.80	18.00	341 kWh	$ 46	$ 65	420 kWh
MVA0020-ST-0990-001-B	5	95.80	18.00	1,704 kWh	$ 230	$ 325	2,098 kWh
MVA0020-ST-0990-002-B	119	95.80	18.00	40,551 kWh	$ 5,474	$ 7,737	49,933 kWh
MVA0020-ST-0990-003-B	1	95.80	18.00	341 kWh	$ 46	$ 65	420 kWh
MVA0020-ST-0990-004-B	14	95.80	18.00	4,771 kWh	$ 644	$ 910	5,874 kWh
	3107			**419,994 kWh**	**$ 56,699**	**$ 80,135**	**1,338,182 kWh**

2. Summary of costs and benefits (original analysis)

Option	Number of Upgraded Luminaires	Cost of Upgrade	Discount for Tariff 2 Luminaires	Discount for Bulk Lamp	Residual Value	Total Cost for Council	Essential Energy's Contribution
1	3107	$1,145,879.31	$(25,327.89)	$(171,197.45)	$14,955.11	$964,309.08	$196,525.34
2	3107	$952,304.03	$(25,327.92)	$(171,197.45)	$14,955.11	$770,733.77	$196,525.37
3	3107	$953,728.03	$(25,327.93)	$(171,197.45)	$14,955.11	$772,157.76	$196,525.38
4	**3107**	**$1,147,303.31**	**$(25,327.90)**	**$(171,197.45)**	**$14,955.11**	**$965,733.07**	**$196,525.35**

	P4/P5 Luminaire Power Consumption (Watts)	P3 Luminaire Power Consumption (Watts)	LED Annual SLUOS (Current Proposed Negotiated)	SLUOS Savings	Energy Cost Savings	ESC Discount	Simple Payback to CVC
Option 1	17	42	$95,388.33	$121,134.44	$56,690.30	$80,122	4.97 years
Option 2	25	42	$112,085.09	$104,437.68	$43,892.20	$62,034	4.78 years
Option 3	25	35	$112,255.36	$104,267.42	$43,901.07	$62,047	4.79 years
Option 4	**17**	**35**	**$95,558.60**	**$120,964.18**	**$56,699.17**	**$80,135**	**4.98 years**

3. Revised costing from Essential Energy

In June 2018 a revised pricing proposal was received from Essential Energy, with these costs replacing those provided earlier. All other parts of the analysis were left as originally assessed.

Projected Luminaire Volume	Council Contribution			
	Option 1 17W + 42W Gerard	Option 2 25W GE + 42W Gerard	Option 3 25W GE + 35W Pecan	Option 4 17W Gerard + 35W Pecan
3108	$1,021,468	$827,830	$829,254	$1,022,892

Appendix C: Solar PV modelling

Solar PV modelling reports are provided as separate attachments to Council.

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