100% renewables

NSW GOVERNMENT | Planning, Industry & Environment

BERRIGAN SHIRE

Berrigan Shire Council

ENERGY STRATEGY

Final report

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www.100percentrenewables.com.au

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Glossary of climate change & project abbreviations

Acronym	Definition
AC, DC	Alternating & direct current
ACCU	Australian Carbon Credit Unit
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AFOLU	Agriculture, Forestry and Other Land Use
APVI	Australian Photovoltaic Institute
B20, B50	Diesel blends with 20% and 50% biodiesel
BASIX	Building Sustainability Index
BAU	Business-as-usual
BCA	Building Code of Australia
BEEC	Building Energy Efficiency Certificate
BESS	Battery Energy Storage System
BMS	Building Management System
BEV	Battery electric vehicle
CDM	Clean Development Mechanism
C40	Network of the world's megacities committed to addressing climate change
CCF	Climate Change Fund
CER	Certified Emissions Reductions (offsets)
CFL	Compact fluorescent
COP	Coefficient of performance (refrigeration)
COP21	Conference of the Parties in Paris at which the Paris Agreement was reached
CO_2-e	Carbon Dioxide Equivalent
CPP	Cities Power Partnership
CPRS	Australia's Carbon Pollution Reduction Scheme
CSP	Community Strategic Plan
C4CE	Coalition for Community Energy
DOL	Direct On Line
DPIE	NSW Department of Planning, Industry and Environment
E3	Equipment Energy Efficiency program
EER	Energy efficiency ratio
EPA	Environmental Protection Authority
EPC	Energy Performance Contracting
EPC(M)	Engineer, Procure, Construct (Maintain)
ERF	Emissions Reduction Fund
ESB	Energy Security Board
ESC	Energy Saving Certificates
ESS	NSW Energy Savings Scheme
EUA	Environmental Upgrade Agreement
EV	Electric Vehicle
FiT	Feed-in-tariff
GFC	Global Financial Crisis

GHG	Greenhouse Gas
HVAC	Heating, ventilation, and air conditioning
ICE	Internal combustion engine
ICLEI	Local Governments for Sustainability
IPCC	Intergovernmental Panel on Climate Change
kWh, MWh, GWh	Units of energy – usually used for electricity
LED	Light Emitting Diode (lighting technology)
LGC	Large-scale Generation Certificate
MJ, GJ	Units of energy – usually used for gas
LGA	Local Government Areas
LPG	Liquefied Petroleum Gas
NABERS	National Australian Built Environment Rating System
NCC	National Construction Code
NDC	Nationally Determined Contributions by countries to meet Paris commitments
NEM	National Electricity Market
NCOS	National Carbon Offset Standard
NGA	National Greenhouse Accounts
O&M	Operation and maintenance
P2P	Peer to Peer trading of renewable energy
PHEV	Plug-in hybrid electric vehicle
PPA	Power Purchase Agreement
PV	Solar photovoltaic technology
REF	Revolving Energy Fund
RET	Australia's Renewable Energy Target
ROI	Return on Investment
S1	Scope 1 greenhouse gas emissions, from combustion of fuel at your facilities
S2	Scope 2 greenhouse gas emissions, caused by consuming electricity
S3	Scope 3 greenhouse gas emissions, indirect emissions upstream and downstream of your business
SDGs	Sustainable Development Goals
SRES	Small-scale Renewable Energy Scheme
SPS	Sewer Pumping Station
STC	Small-Scale Technology Certificates
STP	Sewerage Treatment Plant
VCS	Verified Carbon Standard
VFD, VSD	Variable Frequency Drive / Speed Drive
VGA	Virtual Generation Agreement
VPPs	Virtual Power Plants
W, kW, MW	Units of power – usually used for electricity
WTP	Water Treatment Plant

1 Executive Summary

100% Renewables was engaged by the NSW Department of Planning, Industry & Environment to develop an Energy Strategy with Berrigan Shire Council that will help it to cost-effectively increase the amount of renewable energy at its facilities, lower energy demand, and reduce costs.

This strategy focuses on stationary energy-related emissions associated with Council's operations, which can demonstrate to the community that emissions reduction is feasible and cost-effective, and position Council as a leader in the community's climate action. Council's broader climate response can extend beyond this to encompass transport for Council operations, landfill and other waste emissions resulting from community activities (that Council manages), climate resilience and adaptation, as well as emissions in the community from stationary energy use, transport, agriculture and other land use.

1.1 Recommended strategy and targets

1.1.1 Recommended strategy

This document outlines an approach for Council to progressively implement renewable energy and energy efficiency projects over the short, medium and long term. This energy plan is based on cost-effective and commercially available technologies and solutions that can position Berrigan Shire Council as a leader in sustainability through its emissions reduction actions. Specifically, Council's strategy for renewables in the short and medium term should be to:

- Focus on cost-effective solar PV and energy efficiency opportunities at Council-operated sites, as well as the planned streetlighting LED upgrade in the short term and medium term.
- Stay abreast of emerging opportunities for battery energy storage systems (BESS) as a way to increase the amount of solar PV that Council can install at its facilities, such as sewer pump stations, water treatment plants and at small and intermittently-used community facilities.
- Assess the scope for Berrigan Shire Council, alone or in partnership with other Councils – e.g. via RAMJO – to enter into a renewable energy power purchasing agreement (PPA) for the supply of electricity to Council's sites. As part of this assess the opportunity to be a customer of one or more of the solar farms planned for the area and assess the potential for a mid-scale solar farm on Council-owned land.
- Investigate new opportunities such as peer-to-peer solar energy trading opportunities between multiple Council-owned sites.

In addition, while this work has not included a focus on transport for Council's operations, it is recommended that Council take steps to be informed about and begin to source hybrid and electric fleet and install EV charging infrastructure. Recently, as part of the NSW Net Zero Plan, the government released an EV strategy to accelerate the growth of EVs' in NSW. The outlined support from the government could be an incentive for Berrigan Shire Council to start transitioning its fleet to sustainable transportation[1]

[1] A. (2021, June 20). NSW Electric Vehicle Strategy. NSW Environment, Energy and Science. https://www.environment.nsw.gov.au/topics/climate-change/net-zero-plan/electric-vehicle-strategy.

1.1.2 Suggested energy goals for Berrigan Shire Council

Our assessment of energy efficiency and renewable energy across Berrigan Shire Council indicates the following:

- The scope for grid energy savings from energy efficiency and behind-the-meter solar PV (with battery energy storage) at Council's facilities is up to **732 MWh per annum** or **34%** of current electricity consumption.
- Deterioration of solar performance over time and projects that progressively upgrade Council's sites and services can see some of this potential be reduced. Also, the above estimate excludes benefits for efficiency and renewables on new capital works and possible solar farm opportunities at Council.
- There is proven potential for local councils in NSW to source electricity from renewables at prices comparable to 'regular' prices, depending on wholesale electricity market trends, and this is likely to be feasible for Council's electricity supply in coming years.

Given the identified and assessed potential, the following targets can be considered for adoption by Berrigan Shire Council.

- By 2030 (or earlier) aim to source 100% of Council's grid-delivered electricity from renewables where cost-effective and incurring no added risk to Council. This will require that Berrigan Shire Council source electricity from renewables in its supply agreements.
- An interim (e.g. 2025) target of say 30-50% emissions reduction from electricity can be considered, focused on onsite solar, energy efficiency (particularly main road streetlighting) and potentially a renewable energy Power Purchase Agreement.

The setting of an overall target for emissions reduction for Council's operations would require additional consideration of transport emissions, and potentially emissions from other sources such as landfills.

1.2 Budget implications

A number of potential energy efficiency and behind-the-meter solar PV opportunities have been costed at a high level for this strategy. This estimates costs **of $1.43 million** for short, medium and long term actions, with annual cost savings based on current rates of around **$147,475**. Overall, this represents a payback of under **10 years**. This is underpinned by the potentially large cost of implementing several solar PV and battery storage systems with a combined capacity of **485kW** and **757kWh** respectively.

It is envisaged that Council would enter into a renewable energy power purchase agreement where there is no added cost or risk to Council compared with their normal electricity procurement process. This would be assessed at each procurement cycle, typically every two to three years, and it may be done via a group of Councils, through RAMJO for example.

To summarise our findings in this report, we have outlined a couple of key findings from our site visit to Berrigan Shire Council and analysing the supplied energy data.

- A number of identified projects include upgrading the existing solar PV infrastructure to integrate battery storage units to maximise the solar PV self-consumption.

- Sites such as the Barooga, Tocumwal and Finley water treatment plants have solar PV systems that are performing below the expected energy output. These are primarily due to the lack of solar PV maintenance and monitoring contracts to ensure Berrigan Shire Council's assets perform at optimum conditions.
- Furthermore, we have noticed that the solar PV systems at Tocumwal and Barooga water treatment plants are heavily shaded by surrounding structures. For e.g., during our site visits, the Barooga water treatment plant was performing at 25% of its capacity at noon.
- Berrigan Shire Council has multiple opportunities to develop large-scale solar PV project that could be developed as a community project or by RAMJO as a project for all RAMJO member councils (Finley saleyards and McCulloughs STP sites shown to illustrate this potential).

- We have noted that the voltage supplied to many of the sites in Berrigan is higher than the expected 230V supply. Our engagement with Council has suggested that this limits their capability to export surplus solar PV back to the grid. Hence, while developing these large-scale solar PV projects, it would be prudent to ensure the suggested battery systems are implemented along with the solar PV array to maximise the financial benefits to Council.
- There is savings potential for Council in shifting load, specifically at the water treatment plants from peak periods to off-peak periods. The savings are from reducing the peak network demand tariffs.

1.3 Council's 2019/20 energy use and carbon footprint

1.3.1 Council's carbon footprint for energy only

The focus of this energy strategy is Council's electricity use. Available data covers all of Council's electricity use; in addition bulk fuel (diesel, petrol and LPG) data were provided and are included in the carbon footprint. Fuel data for passenger vehicles or purchases made via fleet card were not available.

Council's energy and related carbon footprint for 2019/20 is tabulated below.

TABLE 1: COUNCIL'S ENERGY USE AND CARBON FOOTPRINT 2019/20

	Emission source	Activity data	Units	Scope 1 t CO2-e	Scope 2 t CO2-e	Scope 3 t CO2-e	Total	%
	Diesel	65.24	kL	177.3		9.1	186.4	7.1%
	Petrol (PULP)	23.01	kL	53.2		2.8	56.1	2.2%
	LPG	14.25	kL	22.8		1.3	24.1	0.9%
	Electricity used in council assets	1,657,213.14	kWh		1,342.3	149.1	1,491.5	57.2%
	Electricity used by streetlighting	496,256.00	kWh		402.0	446.6	848.6	32.6%
	TOTAL (Before reduction measures):			**253.3**	**1,744.3**	**609.0**	**2,606.6**	**100.0%**

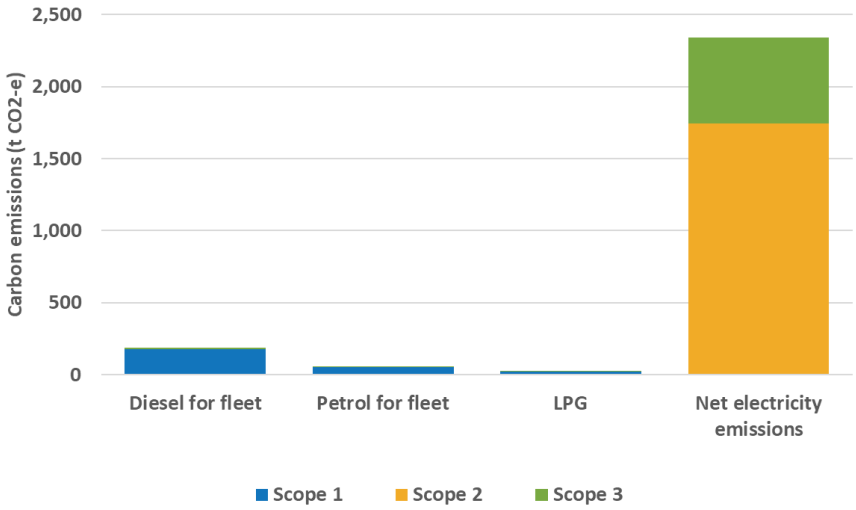

FIGURE 1: BERRIGAN SHIRE COUNCIL CARBON FOOTPRINT BY EMISSIONS SOURCE AND SCOPE, ENERGY ONLY

1.4 Efficiency, renewable energy & emissions reduction plans

A review of Berrigan Shire Council's current energy demand and carbon footprint, site visits and discussions with Berrigan Shire Council staff suggests that there are six main areas of action by Berrigan Shire Council that, implemented together in a planned way, can significantly reduce energy demand, increase onsite renewables, and reduce emissions. These six areas are:

1. Grid decarbonisation
2. Buying clean energy (e.g. via a renewable energy power purchase agreement or PPA)
3. Behind-the-meter solar (i.e. onsite solar and battery storage)
4. Energy efficiency
5. Sustainable transport (information included, opportunities assessment not in scope)
6. Sustainable procurement (information included, opportunities assessment not in scope)

A summary of the recommended action plans in the short, medium, and long term have been tabulated below.

1.4.1 Short and medium-term action plan

TABLE 2: BERRIGAN SHIRE COUNCIL TO MEDIUM TERM PLAN FOR COUNCIL OPERATED SITES

Category	Sub-category	Site	Energy-saving option	Indicative cost	Payback (years)	IRR
Behind the meter solar	Solar PV - Roof - STC	Barooga Water Treatment Plant - Solar (There are three NMI's under the same name, this NMI reflects the account with solar PV connection)	Upgrade the panels from 250W to 450W panels and remove all panels from the heavily shaded section, i.e., behind the water tank. This upgrade can increase the solar PV array size to 23.4kW from 14.5kW system.	$16,380	6.3	15%
Energy efficiency	VSD Control		Implement VSD control for clear water pumps at the water treatment plant.	$32,993	8.0	~13%
Energy efficiency	Load shifting		The Barooga water treatment plant only has a retailer (AGL) time-of-use, and the contract does not include any network demand tariffs. This plant *(4204150638)* only utilises 11% of its annual electricity during peak hours. By shifting this consumption to off-peak hours, there is a potential savings of up to ~**$881 per annum**.			
Energy efficiency	Streetlighting	Vermont St Streetlighting	Upgrade 10 twin light poles of the road median strip and private lights on the walkway to LED technology.	**Not assessed.** Requires details on the streetlighting inventory to estimate the savings potential from current streetlighting system.		
Behind the meter solar	Solar PV - Roof - STC	Berrigan Library	Install a 3.8kW roof-mounted solar PV system to meet most the daytime energy demand.	$3,800	4.5	22%
Energy efficiency	Lighting		Upgrade 27 x twin 28W T5 lights, 2 x 18W CFL and 4 x twin 26W CFLs in the foyer to LED.	$3,799	6.0	17%
Behind the meter solar	BESS	Berrigan Shire Offices	Based on the current consumption vs. export of the solar PV at the Council office, install a 60kWh battery storage unit to maximise the solar self-consumption. Or,	$54,000	22.7	1%
Behind the meter solar	Solar PV - Roof - STC		Expand the existing 50kW solar PV system with an additional 33.4kW solar PV system. The current solar array is exporting **~30%** *(based on SMA monitoring portal)* of energy generated back to the grid, which would be mainly during the weekends and summer months. This would ensure that the Council office is battery ready, when the price for BESS becomes competitive to install. Based on the solar PV generation, the existing solar PV system is yielding **-6%** of its expected energy. However, this could be due to minor shading and temperature losses.	$33,400	5.0	20%

Energy efficiency	Voltage Optimisation		The incoming voltage has been noted at ~250V, assess optimisation of this voltage supply to reduce to ~230V, which can reduce the total energy used by ~10%.	**Not assessed,** would require further investigation.		
Behind the meter solar	Solar PV - Ground - STC	Berrigan STP	Install a 7.7kW single pole ground mount system near to the switchboard of the STP.	$9,984	5.0	20%
Behind the meter solar	BESS	Berrigan Water Treatment Plant	The existing solar array is exporting ~40% of the energy generated back to the grid (these estimates were based on the latest electricity bills only), therefore install a 40kWh battery storage unit to maximise the solar self-consumption. ***Or,***	$36,000	18.5	4%
Behind the meter solar	Solar PV - Upgrade		Upgrade the current 275W solar panels to 380W panels to increase the total array size from ~20kW to 30.4kW. However, without a battery storage, the exports would be large due to the intermittent energy requirements of this site.	$21,280	3.2	32%
Behind the meter solar	BESS	Burkinshaw Street Barooga (Barooga Rec Reserve)	Assess the potential to couple a battery storage unit to the existing 5kW solar PV system at the Recreational reserve.	**Not assessed.** Requires consumption and generation data to estimate the potential for battery storage system.		
Behind the meter solar	Solar PV - Roof - STC	Chanter Depot	Install a 13.7kW roof-mounted solar PV system on the east and west section of the admin building at the Depot.	$13,700	3.2	31%
Behind the meter solar	Solar PV + BESS - Roof - STC		Alternatively, in the medium term, consider installing a larger 22.8kW roof-mounted solar PV system at the admin building with a 25kWh battery storage unit to meet most of the sites energy demand.	$45,300	4.9	19%
Energy efficiency	Lighting		Completely upgrade the remaining fluorescent lights to LEDs	$5,741	5.0	~20%
Behind the meter solar	Solar PV - Roof – STC	Berrigan Sportsground	Install an 8.36kW roof-mounted flush solar PV system on the grandstand.	$8,360	4.5	22%
Behind the meter solar	Solar PV - Roof - STC		Alternatively, install a larger 15.2kW roof-mounted flush solar PV system on the grandstand. This would ensure the Berrigan Sportsground is ready for battery storage system in the future.	$15,200	9.1	10%
Behind the meter solar	Solar PV - Roof - STC	Finley Library and Early Intervention	Install a 5.32kW roof-mounted solar PV system on the north section of the library building.	$5,320	4.6	22%
Behind the meter solar	Solar PV - Ground - STC	Finley STP	Install a 13.5kW ground-mounted solar PV system close to the main switchboard.	$17,550	10.3	8%

Energy efficiency	Lighting	Finley Water Treatment Plant	Upgrade indoor and outdoor lights to LED technologies	$3,215	9.0	~11%
Energy efficiency	VSD Control		Upgrade the raw water pumps from VLT soft starts to VSD controls	$20,685	10.0	~13%
Energy efficiency	VSD Control		Upgrade the clear water pumps from soft start to VSD control	$20,685	10.0	~13%
Behind the meter solar	Solar PV - Upgrade		Upgrade the existing solar PV system by replacing the 265W panels to 400W panels. This would increase the system to 27.2kW.	$19,040	3.7	27%
Behind the meter solar	Solar PV - Ground - STC		Install an 83.7kW ground-mounted solar PV system on the existing clarifier sections, which would be decommissioned after the new DAF plant is built.	$108,810	9.4	9%
Energy efficiency	Design		Integrate energy efficiency solutions to the new plant design incl VSDs, pump / pipework design, roofs and electric infrastructure designed for solar and future EV charging.			**Not assessed.**
Energy efficiency	Power factor correction		Install power factor correction device with a capacitor size of **50 kVAr.**	$5,000	2.52	~39%
Energy efficiency	Load shifting		Based on the interval data, we have estimated that, by shifting the loads completely from peak hours of operation to off-peak periods, Council can save ~**$6,972 per annum**. If Council opts to install a power factor correction device, the savings will reduce to **$6,042 per annum** due to the improved peak demand from the proposed 50 kVAR device. Furthermore, the site is currently supplied through a transitional tariff structure 'BLNDTRS' which is expected to change by July 2021 to 'BLND3AO'. With this change in tariff structure, the savings would be higher as the peak demand pricing is expected to increase by ~49%. Thereby the estimated annual savings with BLND3AO tariff is **~$9,830.**			
Behind the meter solar	Solar PV - Ground - STC	McCulloughs Rd STP	Install a 23.4kW ground-mounted solar PV system oriented towards the north-west, outside the plant fence.	$30,420	10.3	8%
Behind the meter solar	Solar PV + BESS - Roof - STC	Saleyards Road Truck wash	Install a 3kW roof-mounted solar PV system on the amenities block with a 5kWh BESS to match the site's grid electricity consumption.	$7,530	14.3	7%
Behind the meter solar	Solar PV - Ground - STC	Tocumwal Swimming Pool	Install a 9.18kW ground mount system, similar to 5B technology which has smaller footprint and limited civil work requirements on the south-east corner of the pool.	$11,934	8.1	11%

Energy efficiency	Lighting		Replace ~30 single T5 lights to LED battens	$3,420	6.0	~17%
Energy efficiency	Power factor correction	Water Treatment Pump - Tuppal St	Install power factor correction device with a capacitor size of 25 kVAr.	$2,500	2.4	~42%
Energy efficiency	Load shifting		Our analysis suggests that if the water treatment plant can shift all the electricity demand from peak periods to off-peak periods, Council could see a maximum savings of **$7,800 per annum,** with significant savings from reducing the peak demand charges. Additionally, if Council opts to implement a PFC device at this facility, the annual savings will reduce to **$6,947,** which is due to the improved power factor from this proposed 25 kVAR power factor device.			
Electricity	Renewable Energy Power Purchasing	Whole of Council	Develop a case to enter into a PPA to supply certain percentage of Council's site with renewable energy.	**Not assessed**. Assess this opportunity along with RAMJO Council members as part of bulk procurement to get competitive pricing in the current electricity market.		
Total				**$556,046**	**6.4**	**~18%**

1.4.2 Long term action plan

A suggested long-term action plan for Berrigan Shire Council is outlined below. Please note that the details in the table below for solar at Berrigan Library, Barooga Water Treatment Plant, Berrigan Water Treatment Plant, Barooga Rec Reserve, Berrigan Sportsground, and Finley Library the full costs and associated savings for these suggested systems. There are also short / medium term options suggested for these sites. If Council opts to install the short / medium term options, then Council will only incur the marginal cost for expanding the systems in the longer term, along with the marginal savings of the additional systems.

TABLE 3: BERRIGAN SHIRE COUNCIL LONG TERM PLAN FOR COUNCIL OPERATED SITES

Category	Sub-category	Site	Energy-saving option	Indicative cost	Payback (years)	IRR
Behind the meter solar	Solar PV + BESS - Ground - STC - Upgrade	Barooga Water Treatment Plant - Solar	Upgrade the existing solar PV system with additional solar on the main switchboard room to a 35.6kW ground-mounted solar PV system with a 70kWh battery storage system to maximise the solar self-consumption and reduce the site's grid dependency.	$87,920	8.9	8%

Behind the meter solar	Solar PV + BESS - Roof - STC	Berrigan Library	Install a larger 8.36kW solar PV system on the north and east section of the library building with a 10kWh battery storage system to meet the site's intermittent energy demand.	$17,360	5.8	15%
Behind the meter solar	BESS	Berrigan Shire Offices	Increase the total solar PV array size to 83.4kW at Council office and implement a 100kWh BESS to maximise the solar self-consumption from this site and match the site's grid electricity demand.	$123,400	22.0	1%
Behind the meter solar	Solar PV + BESS - Ground - STC - Upgrade	Berrigan Water Treatment Plant	Upgrade the existing 20kW ground-mounted solar PV system with a 30.4kW system and implement a 65kWh battery storage unit.	$79,780	6.8	12%
Energy Efficiency	VSD Control		Install VSD controls on the two clear water pumps.	$39,060	10.0	~10%
Behind the meter solar	Solar PV + BESS - Roof - STC	Burkinshaw Street Barooga (Barooga Rec Reserve)	Install a 15kW roof-mounted solar PV system to the existing 5kW solar PV system at the Recreational reserve with a 40kWh battery storage unit to meet the site's intermittent energy demand.	$51,000	16.5	5%
Behind the meter solar	Solar PV + BESS - Roof - STC	Berrigan Sportsground	Install a 15.2kW roof-mounted flush solar PV system with a 40kWh battery storage system to meet most of the site's electricity demand.	$51,200	8.9	7%
Behind the meter solar	BESS	Berrigan Swimming Pool	Based on the current solar PV generation, consumption and exports implement a battery storage system to reduce the exports back to the grid.	**Not assessed.** Require site's generation and consumption data to estimate the feasibility of solar PV at this site.		
Behind the meter solar	Solar PV + BESS - Roof - STC	Finley Library and Early Intervention	As the site is open only for three days in a week, most of the solar generated from this site would be exported back to the grid. Hence, install a 5.32kW solar PV system with a 10kWh battery storage unit to meet most of the site's electricity demand.	$14,320	7.8	9%
Behind the meter solar	Solar PV + BESS - Ground - STC	Finley STP	Install a 13.5kW ground-mounted solar PV system with a 45kWh battery storage unit to meet the site's intermittent electricity demand.	$58,050	8.9	7%

Behind the meter solar	Solar PV + BESS - Ground - STC	Finley Water Treatment Plant	Apart from the existing solar PV system, install an additional 83.7kW ground-mounted solar PV system on the existing clarifiers section (to be decommissioned after the new DAFT plant is built). Due to the intermittent nature of the electricity demand for water treatment plants, consider implementing a large-scale battery storage system of 140kWh to meet most of the sites electricity demand.	$234,810	19.1	3%
Behind the meter solar	Solar PV + BESS - Ground - STC	McCulloughs Rd STP	Install a larger ground-mounted solar PV system of 54.9kW coupled with 110kWh of battery storage to maximise the solar self-consumption.	$170,370	8.8	8%
Energy Efficiency	VSD Control	Sewer Pump - Barinya St Barooga	Install VSD controls on the pumps which are currently being upgraded.	$11,401	12.0	~8%
Energy Efficiency	Lighting	Tocumwal Aerodrome Runway Lighting	Upgrade all the runway lights to LED technology.	$2,314	15.0	~7%
Behind the meter solar	Solar PV + BESS - Roof - STC	Tocumwal Aerodrome	Install a 4.15kW roof-mounted solar PV system tilted towards the north orientation of the Aero club building. Additionally, implement a 6kWh battery storage unit to meet most of the site's electricity demand.	$9,550	6.2	13%
Behind the meter solar	Solar PV + BESS - Ground - STC	Water Treatment Pump - Tuppal St	Due to the limited land and roof area, consider implementing an additional 82.9kW ground-mounted solar PV system to the existing 17kW solar roof-mounted solar PV on the north-west section of the Recreational reserve with a 100kWh battery storage unit.	$197,640	22.9	1%
Total				**$1,148,175**	**9.8**	**~8%**

1.4.3 Continuous improvement

The following opportunities can be pursued over time as part of a continuous improvement approach to energy management by Berrigan Shire Council.

TABLE 4: BERRIGAN SHIRE COUNCIL'S CONTINUOUS IMPROVEMENT PLAN FOR COUNCIL OPERATED SITES

Category	Sub-category	Site	Energy-saving option	Cost or resources required
Behind the meter solar	Solar Operation and Maintenance	All sites with solar PV systems	Develop an operation and maintenance strategy for existing solar PV systems. This could be a contractual agreement with a local installer to provide quarterly/ biannual/annual standard maintenance on the existing system. Additionally, monitor the operation of the PV system to reduce any losses incurred due to prolonged system failures.	**Not assessed.**
Energy efficiency	HVAC	Berrigan Shire Offices	Develop a strategy to replace the existing HVAC systems to energy efficient multi-unit and single unit split systems. The current HVAC units are ~20 years old, utilising banned R22 refrigerant. These units could be replaced with any units with EER/COP greater than 4, preferably using R32 refrigerant gas.	**Not assessed.** Can be implemented through Council's procurement.
Energy efficiency	Demand reduction	Burkinshaw Street Barooga (Barooga Rec Reserve)	Switch-off equipment such as fryers and urn at the old pavilion/clubrooms.	**Not assessed**.
Energy efficiency	HVAC	Chanter St. Depot	Develop a strategy to replace existing HVAC units to more efficient ones.	**Not assessed.** Can be implemented through Council's procurement
Energy efficiency	Lighting	Finley School of Arts	Upgrade all indoor lights to LEDs.	**Not assessed.** As usage is low, consider these lighting upgrades on failure.
Energy efficiency	Energy efficiency	Hill Street Depot	Upgrade all indoor lights to LEDs.	**Not assessed.** As usage is low, consider these fluoro lighting upgrades on failure.
Energy efficiency	Demand reduction	Tocumwal Swimming Pool	Turn off all kiosk appliance at the end of swimming season	**Not assessed.**
Energy efficiency	Demand reduction		Consider shutting the filter pumps off at the end of swimming season (6 x 1.5kW).	**Not assessed.**

Energy efficiency	Lighting	Townbeach Rd (Rec Reserve)	Upgrade training lights to LED tower lights.	**Not assessed.** A project such as this is generally only feasible when field lights / poles are being replaced, or via grant funding.

1.4.4 Possible Community projects

A suggested list of mid-scale solar PV projects that could be implemented at Berrigan Shire Council is tabulated below. These projects have been sized to showcase the sites' capability to install a mid-scale solar farm/ community scale projects within Council.

TABLE 5: BERRIGAN SHIRE COUNCIL SOLAR FARM / COMMUNITY-SCALE PROJECTS

Category	Site	Energy-saving option	Assessed costs
Community-scale solar PV	Finley Saleyards	The Finley saleyards has a large roof space to install ~250kW solar PV system, that can generate up to 358MWh per annum. A project of this scale can be developed by the community.	~$378,000
Mid-scale solar farm	McCulloughs Rd STP	Council or the joint organisation can investigate an opportunity to install a ~2MW solar farm on the north-section outside the sewage treatment plant at Tocumwal. The land has an ideal terrain for implementing solar farm, and has distribution feeders running across the land, which could be utilised to connect into the Essential Energy grid network. However, based on the preliminary network enquiry, further assessment and size optimisation could be done to benefit Berrigan Shire Council and neighbouring Council members.	~$3,636,000

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Scope

Summary of the scope of work and approach

2 Approach and scope of work

100% Renewables was engaged by the NSW Department of Planning, Industry & Environment: Sustainable Councils and Communities Program to develop the Energy Plan for Berrigan Shire Council that will help it to cost-effectively increase the amount of renewable energy at its facilities and lower energy demand through efficiency measures. The scope of this project is outlined below and is focused on Council's operations, energy use and carbon emissions.

FIGURE 2: SEVEN-STEP PROCESS TO DEVELOP BERRIGAN SHIRE COUNCIL'S ENERGY PLAN

- **Stage 1 – Inception**
  - Meet Council's key stakeholders and discuss the project plan
- **Stage 2 – Energy & carbon footprint**
  - Collect energy data from Council's energy management platform or billing
  - Analyse interval data where available
  - Develop energy & carbon footprint for Council operations
- **Stage 3 – Engagement**
  - Set up meetings / presentations with key stakeholders across Council
  - Set up and conduct site visits across key sites at Council
- **Stage 4 – Draft opportunities**
  - Develop draft opportunities in Excel for discussion with stakeholders
  - Circulate these opportunities to Council staff for input, discussion and prioritisation
- **Stage 5 – Business case development**
  - Model solar PV business cases, assess efficiency opportunities
- **Stage 6 – Action plans**
  - Develop short, medium and long term action plans for Council
- **Stage 7 – Energy Plan**
  - Draft Energy Plan report
  - Finalise Energy Plan report

100% renewables

Background and context

Factors underpinning climate action at global and sectoral levels

3 Global context for climate action and targets

3.1 The need to reach 'net-zero' greenhouse gas emissions

Due to all historical and current carbon emissions global temperatures have increased by ~1°C from pre-industrial levels. The main driver of long-term warming is the total cumulative emissions of greenhouse gases over time. As shown by the Climate Action Tracker below, without additional efforts, human-caused carbon dioxide (equivalent) emissions may increase to over 100 billion tonnes annually by 2100, which is double current global emissions. The resulting increase in global temperatures would be up to 4.8°C (as per the IPCC Climate Change 2014 Synthesis Report).

With current policies around the world, global temperatures are projected to rise by about 3.1°C. To prevent dangerous climate change by limiting global warming, close to 200 of the world's governments signed the landmark Paris Agreement. This Agreement underpins science-based targets to limit global temperature increase to well below 2°C by 2050. With current pledges, and if all countries achieved their Paris Agreement targets, it would limit warming to 2.9°C. To limit warming to 1.5°C, carbon emissions must decline sharply in the short-term and reach net-zero by mid-century.

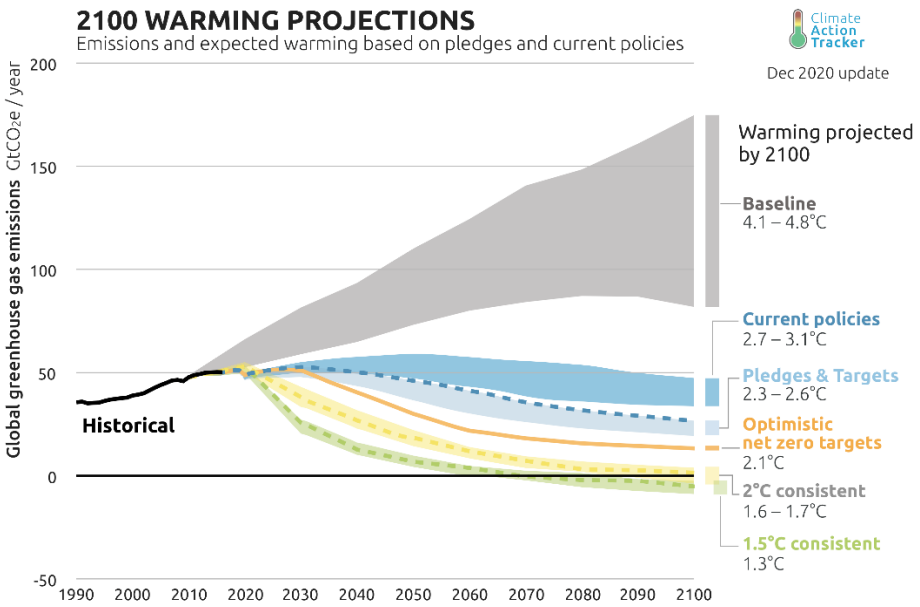

FIGURE 3: THE CLIMATE ACTION TRACKER'S WARMING PROJECTIONS FOR 2100, VARIOUS POLICY SCENARIOS

A net-zero target means that by the target date, there must be no greenhouse gas emissions on a net basis. For a local government's operations for example, this could mean:

1. GHG emissions from stationary fuel combustion such as LP gas use are minimised, and
2. GHG emissions from transport fuel combustion are minimised, and
3. GHG emissions from electricity consumption are minimised, and
4. GHG emissions from waste and in Council's supply chain are minimised, and
5. Remaining emissions offset or removed through sequestration measures

3.2 International drivers for climate action

Internationally, there are three primary drivers for urgent action on climate, additional to the second commitment period of the Kyoto Protocol from 2013 to 2020. These are:

1. **Sustainable Development Goals (SDGs)**

   In 2015, countries adopted the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals. Governments, businesses and civil society together with the United Nations are mobilising efforts to achieve the Sustainable Development Agenda by 2030[2]. The SDGs came into force on 1 January 2016 and call on action from all countries to end all poverty and promote prosperity while protecting the planet.

2. **Paris Agreement**

   To address climate change, countries adopted the Paris Agreement at the COP21 in Paris on 12 December 2015, referred to above. The Agreement entered into force less than a year later. In the agreement, signatory countries agreed to work to limit global temperature rise to well below 2°C, and given the grave risks, to strive for 1.5°C Celsius[3].

3. **Special IPCC report on 1.5°C warming (SR15)**

   In October 2018 in Korea, governments approved the wording of a special report on limiting global warming to 1.5°C. The report indicates that achieving this would require rapid, far-reaching and unprecedented changes in all aspects of society. With clear benefits to people and natural ecosystems, limiting global warming to 1.5°C compared to 2°C could go hand in hand with ensuring a more sustainable and equitable society[4].

FIGURE 4: GLOBAL CONTEXT FOR ACTION ON CLIMATE

[2] Sourced from https://www.un.org/sustainabledevelopment/development-agenda/
[3] Sourced from https://www.un.org/sustainabledevelopment/climatechange/
[4] Sourced from https://www.ipcc.ch/news_and_events/pr_181008_P48_spm.shtml

In addition, the World Economic Forum's Global Risks Report 2020[5] highlights adverse climate change-related outcomes as among the most likely to occur with the highest impacts to the global economy. The chart below from the WEF's report shows several key climate risks clustered in the top right corner; that is, these risks are assessed to be among the most likely to eventuate, with the greatest economic impact among all the global risks that were assessed.

FIGURE 5: GLOBAL RISKS REPORT – LIKELIHOOD & IMPACT OF CLIMATE, OTHER RISKS TO GLOBAL ECONOMY

[5] http://reports.weforum.org/global-risks-report-2020/

4 National and State Government action

4.1 National targets

At a national level, Australia's response to the Paris Agreement has been to set a goal for greenhouse gas (GHG) emissions of 5% below 2000 levels by 2020 and GHG emissions of 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 from renewable energy sources by 2020.

FIGURE 6: AUSTRALIA'S RENEWABLE ENERGY AND CARBON GOALS – NATIONAL LEVEL

According to the Clean Energy Regulator[6], the Renewable Energy target has been met and renewable energy generation will exceed the target by some 7,000 GWh.

The RET is the main successful policy underpinning Australia's climate mitigation efforts. Other key initiatives include the Climate Solutions Fund, formerly the Emissions Reduction Fund, which sources abatement from eligible activities in the economy via periodic auction processes. Despite these initiatives, Australia's GHG emissions have remained relatively steady over the period 2015 to 2020, with a dip in emissions expected to be confirmed for the final quarter of 2019/20 due to Covid-19.

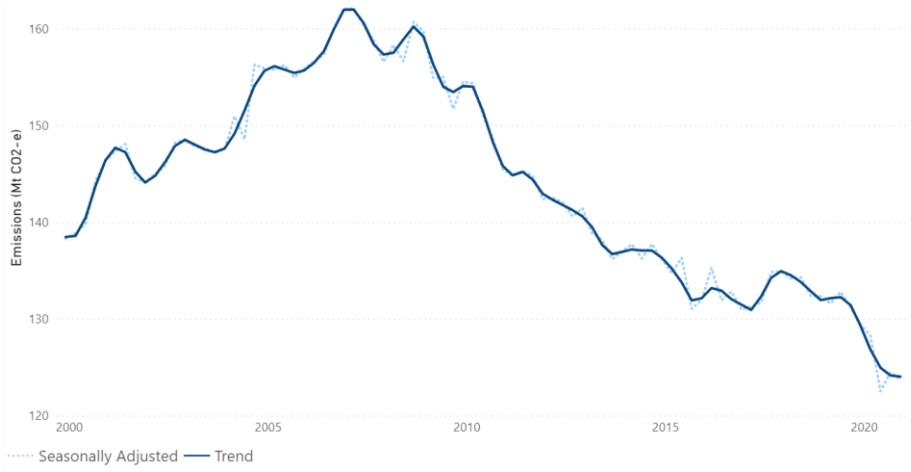

FIGURE 7: AUSTRALIA'S GHG EMISSIONS FROM ALL SOURCES

[6] March 2018, Australian Government – Clean Energy Regulator. 2018 Annual Statement to the Parliament on the progress towards the 2020 Large-scale Renewable Energy Target.

4.2 NSW State targets

At a sub-national level, most states and territories have established emissions targets as well as some legislated targets for renewable energy, as seen below.

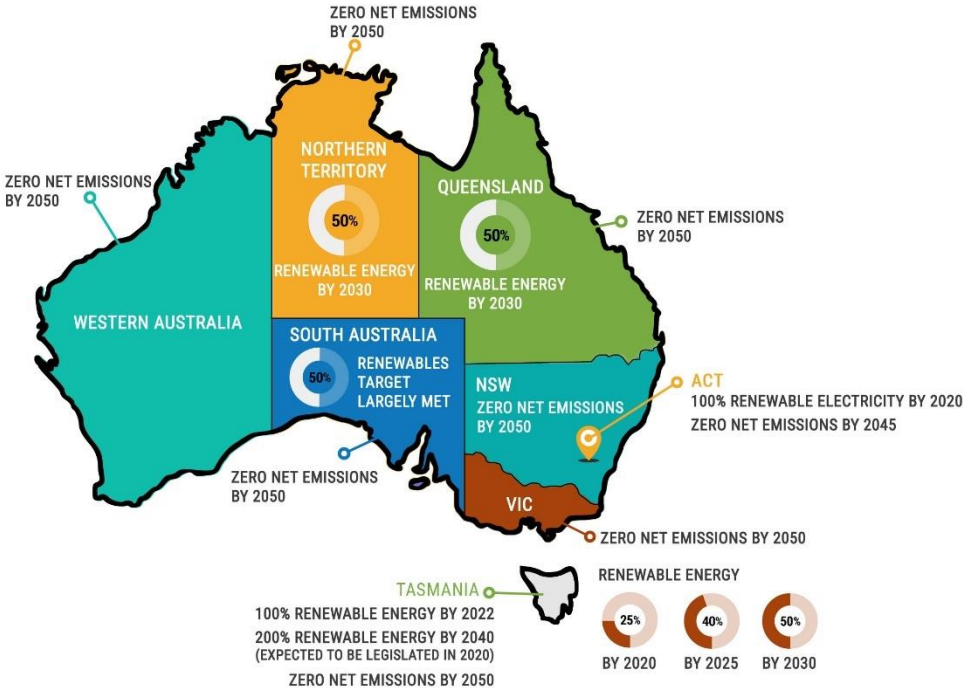

FIGURE 8: AUSTRALIA'S RENEWABLE ENERGY AND CARBON GOALS – STATE & TERRITORY LEVEL

Supporting the NSW Government's commitment to reach net zero emissions by 2050, NSW Government recently released its **Net Zero Plan Stage 1: 2020–2030**[7]. This sees the first of three 10-year plans released that will set a pathway to net zero emissions in NSW by 2050.

In addition the NSW Government has developed a **NSW Electricity Strategy**[8] which will help the State to deliver on its goal to attract renewable energy investment. On 27th November 2020 the NSW Government passed the *Electricity Infrastructure Investment Bill (2020)* which will help to drive the transition to renewables in the state in coming years by coordinating investment in new generation, storage and network infrastructure in New South Wales[9].

In the first instance a renewable energy zone (REZ) in Central West Orana will be developed, attracting significant private sector investment to developing new generation assets in this region. A larger renewable energy zone is to be developed in the New England region, with up to seven additional REZs' to be developed in future, including a recently-announced REZ for the Hunter Valley region.

The figures below show the approximate locations of the Central West Orana and South-West REZs'.

[7] © State of New South Wales 2020. Published March 2020
[8] https://energy.nsw.gov.au/renewables/renewable-energy-zones
[9] https://www.parliament.nsw.gov.au/bill/files/3818/XN%20Electricity%20Infrastructure%20Investment%20Bill.pdf

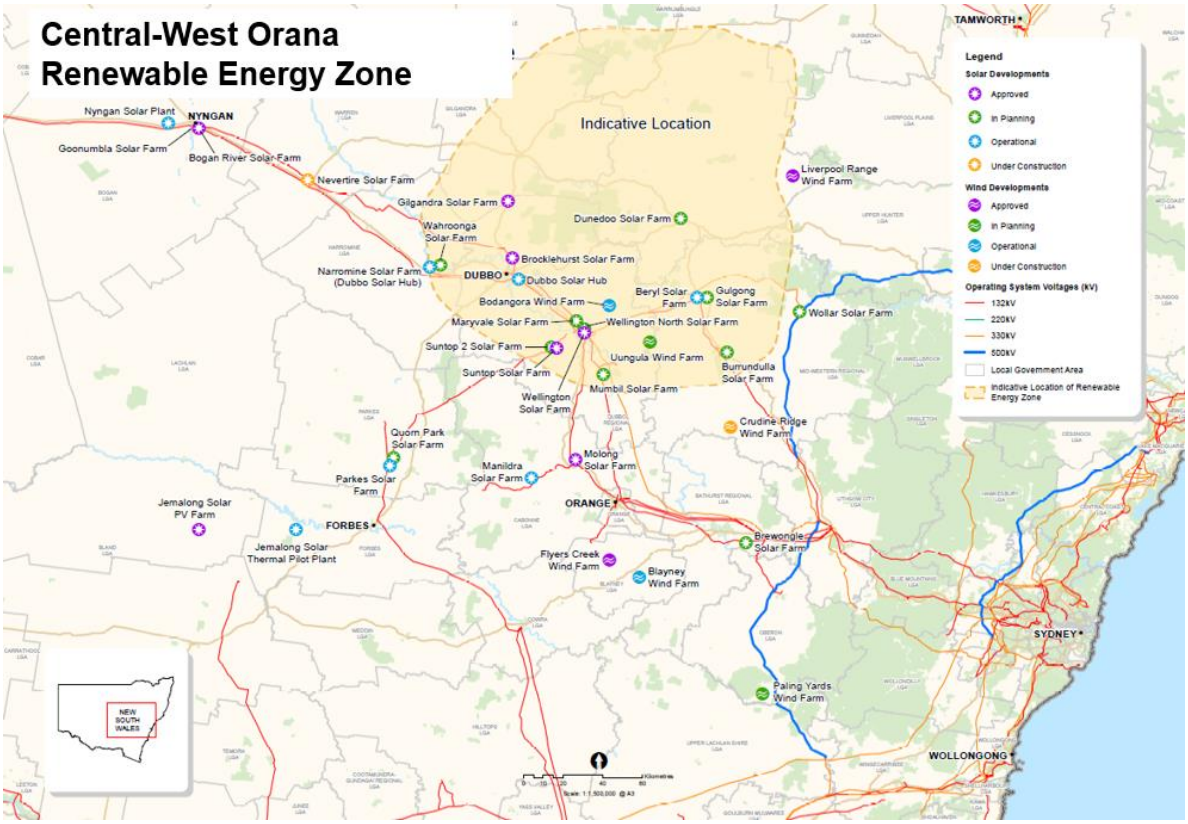

FIGURE 9: INDICATIVE CENTRAL-WEST ORANA NSW RENEWABLE ENERGY ZONE

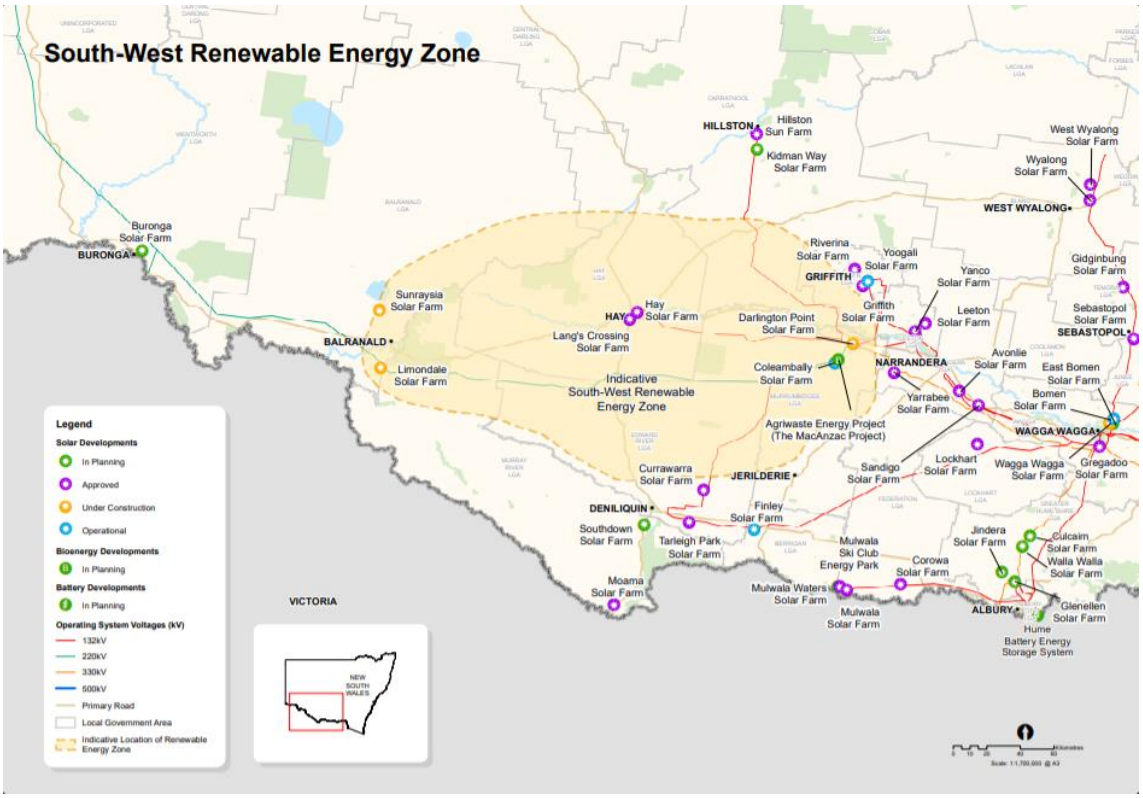

FIGURE 10: INDICATIVE SOUTH WEST RENEWABLE ENERGY ZONE

Some of the key highlights of the 2020-2030 Net Zero Plan include:

- A central focus of the plan is about jobs that will be created and about the lowering of energy costs for consumers. Many renewable energy jobs will be created in regional NSW.
- The Plan commits to breaking down barriers that remain to people and business investing in commercially available technologies, such as energy-efficient appliances and buildings, Roof-mounted solar, firmed grid-scale renewables, and electric vehicles.
- The Plan commits NSW to reducing State emissions by 35% by 2030 and to net-zero by 2050 and articulates this is a shared responsibility among business, individuals, and governments.
- There will be a broadening of the focus of abatement to encompass low-carbon products and services and providing consumers with more information to influence buying decisions.
- Clarity on some of the funding, targets and programs that will help drive this change, such as:
    - $450 million Emissions Intensity Reduction Program
    - $450 million commitment to New South Wales from the Climate Solutions Fund
    - $1.07 billion in added funding via NSW and Commonwealth across several measures
    - Development of three Renewable Energy Zones in the Central-West, New England and South-West of NSW to drive up to $23 billion in investment and create new jobs
    - Energy Security Safeguard to extend and expand the Energy Savings Scheme
    - Expanded Energy Efficiency Program
    - Expanded Electric and Hybrid Vehicle Plan with the Electric Vehicle Infrastructure and Model Availability Program to fast-track the EV market in NSW
    - Primary Industries Productivity and Abatement Program to support primary producers and landowners to commercialise low emissions technologies
    - Target of net-zero emissions from organic waste by 2030
    - Development of a Green Investment Strategy, with Sydney as a world-leading carbon services hub by 2030
    - Enhancement of the EnergySwitch service by allowing consumers to compare the emissions performance of energy retailers
    - Advocate to expand NABERS to more building types, and improve both the National Construction Code and BASIX
    - Establishment of a Clean Technology Program to develop and commercialise emissions-reducing technologies that have the potential to commercially out-compete existing emissions-intense goods, services and processes
    - Establishment of a Hydrogen Program that will help the scale-up of hydrogen as an energy source and feedstock, and target 10% hydrogen in the gas network by 2030
    - Aligning action by the government under GREP with the broader state targets through clear targets for Roof-mounted solar, EVs, electric buses, diesel-electric trains, NABERS for Government buildings, power purchasing and expansion of national parks

Several of these initiatives will be of interest and benefit to Berrigan Shire Council and its community.

4.3 NSW local governments response to climate change

Much of the leadership on renewable energy and climate in Australia comes from local government. Prominent examples of how local governments are demonstrating leadership are highlighted below.

1. Cities Power Partnership or CPP is an initiative of the Climate Council and it represents Australia's largest local government climate action network with >120 councils. While this doesn't involve setting specific targets per se, the commitment to key actions can either serve as a set of de facto targets or can provide a basis from which to set targets in future. Key aspects of the CPP include:
    a. Making five action pledges to tackle climate change.
    b. Connection and sharing between participants.
    c. Access to a comprehensive online Knowledge Hub and Power Analytics tool to help track emissions, energy and cost savings.
2. Adoption and publication of ambitious [10] targets for renewable energy and/or carbon emissions for Council operations. The chart below shows the status of target-setting by local councils in NSW (at October 2020).

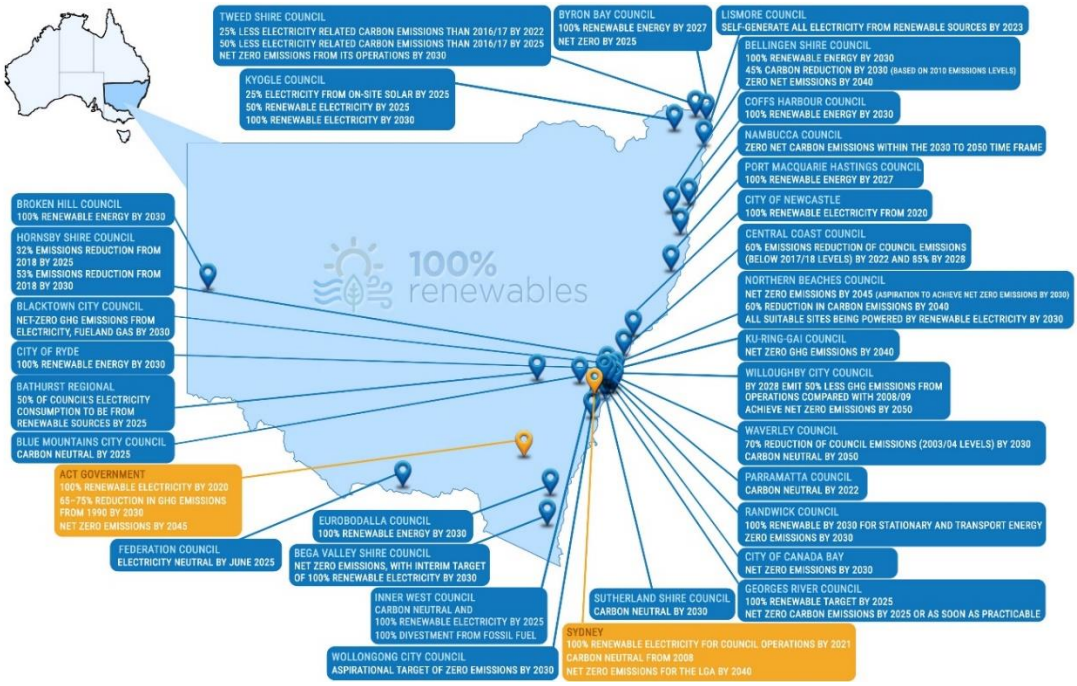

FIGURE 11: RENEWABLE ENERGY & CARBON TARGETS BY NSW COUNCILS & ACT

3. Many local councils across NSW have taken up opportunities as LED streetlighting has become available and approved for use, to upgrade their local and main road lights. Councils across NSW and across the three distribution networks have seen energy use and costs, as well as maintenance costs, fall dramatically as a result of these upgrades. Berrigan Shire Council is among those who will be upgrading their streetlights to LED in the near future.

[10] Most ambitious commitments by local councils include targets for renewable energy (electricity) and/or overall emissions that are aligned with or ahead of a science-based target timeframe for their included emissions sources

5 Local trends – what is occurring in Berrigan Shire?

Berrigan Shire Local Government Area is in the upper section of LGAs in terms of the uptake of solar hot water and solar PV systems. According to data sourced from the Australian Photovoltaic Institute (APVI), Berrigan Shire Council LGA has:

- 1,682 PV installations, a 34.4% penetration rate at May 2021, with over 186.21 MW of installed capacity. Refer to the APVI map with Berrigan Shire Council LGA details highlighted below.
- 198 installations over 10 kW and less than 100 kW, 1,483 installations of less than 10 kW, and 1 installation of over 100 kW *(Finley Solar Farm – 175 MW)*.

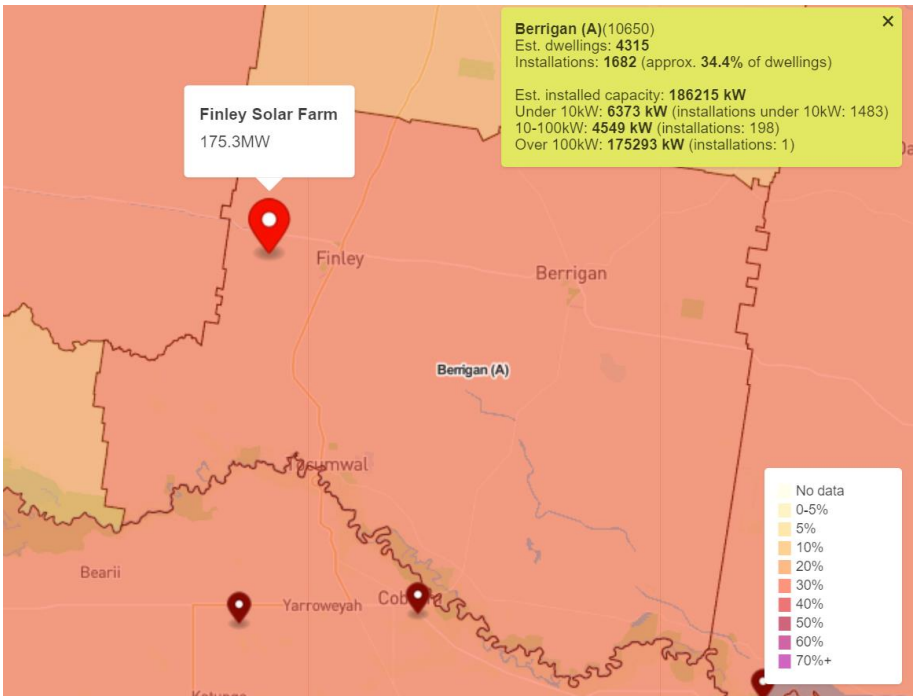

FIGURE 12: BERRIGAN SHIRE LGA SOLAR PV INSTALLATIONS, DECEMBER 2020

Berrigan Shire Council has implemented a number of initiatives to reduce energy demand and cost. Examples, supplied by Council and observed from site visits, include:

- 50 kW solar PV installation at Berrigan Shire Council Building.
- 17 kW solar PV installation at Tocumwal Water Treatment Plant *(Water Treatment Pump - Tuppal St).*
- 8 kW solar PV installation at Berrigan Swimming Pool.
- 45 kW solar PV installation at Barooga Water Treatment Plant.
- 20 kW solar PV installation at Berrigan Water Treatment Plant.
- 20 kW solar PV installation at Finely Water Treatment Plant.
- LED lighting across Berrigan Shire Council administration building.

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Baseline

Berrigan Shire Council's energy and carbon footprint

6 Council's 2020 energy use and carbon footprint

Council's energy use and carbon footprint were assessed based on available energy consumption only, and additional emissions from landfill gases, sewerage treatment emissions and other sources such as refrigerants were excluded. In 2019/20 Council's carbon footprint was dominated by electricity consumption and bulk diesel fuel consumption. Fuel consumption via fleet card purchases were not available and will be small relative to bulk diesel consumption.

TABLE 6: BERRIGAN SHIRE COUNCIL – CARBON FOOTPRINT 2020, ENERGY

	Emission source	Activity data	Units	Scope 1 t CO2-e	Scope 2 t CO2-e	Scope 3 t CO2-e	Total	%
	Diesel	65.24	kL	177.3		9.1	186.4	7.1%
	Petrol (PULP)	23.01	kL	53.2		2.8	56.1	2.2%
	LPG	14.25	kL	22.8		1.3	24.1	0.9%
	Electricity used in council assets	1,657,213.14	kWh		1,342.3	149.1	1,491.5	57.2%
	Electricity used by streetlighting	496,256.00	kWh		402.0	446.6	848.6	32.6%
	TOTAL (Before reduction measures):			**253.3**	**1,744.3**	**609.0**	**2,606.6**	**100.0%**

The above inventory summary is repeated graphically below.

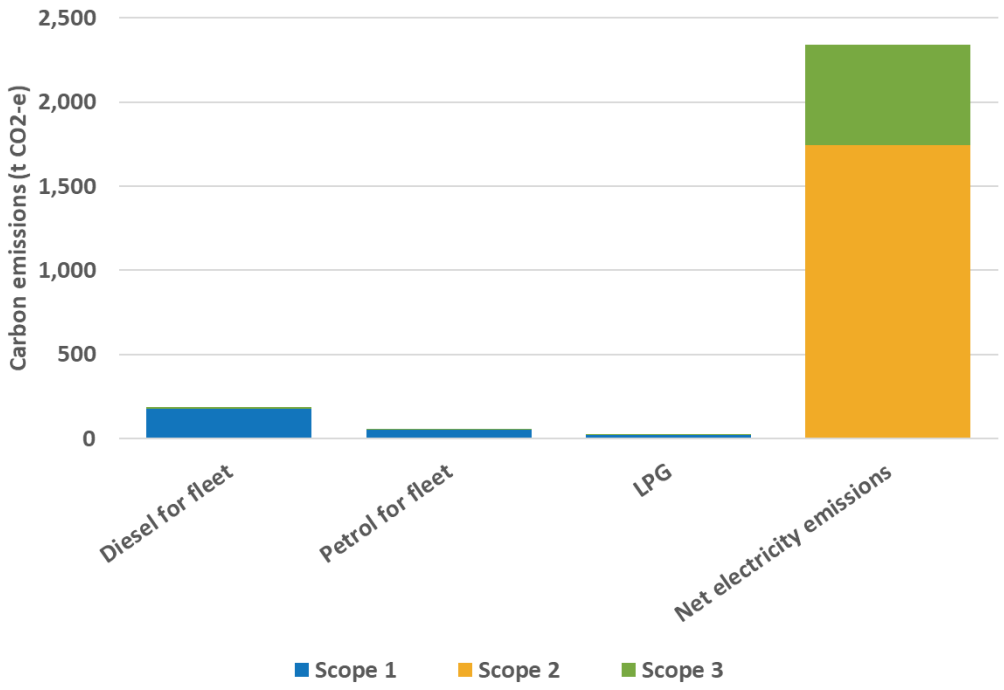

FIGURE 13: BERRIGAN SHIRE COUNCIL CARBON FOOTPRINT BY EMISSIONS SOURCE, ENERGY

6.1 Electricity consumption summary

As the main source of energy-related greenhouse gas emissions, electricity use was assessed further. The following two charts provide a summary of where and how electricity is used, including:

- Top 10 electricity using sites seen against the balance of consumption
- Assessed electricity end use by equipment type

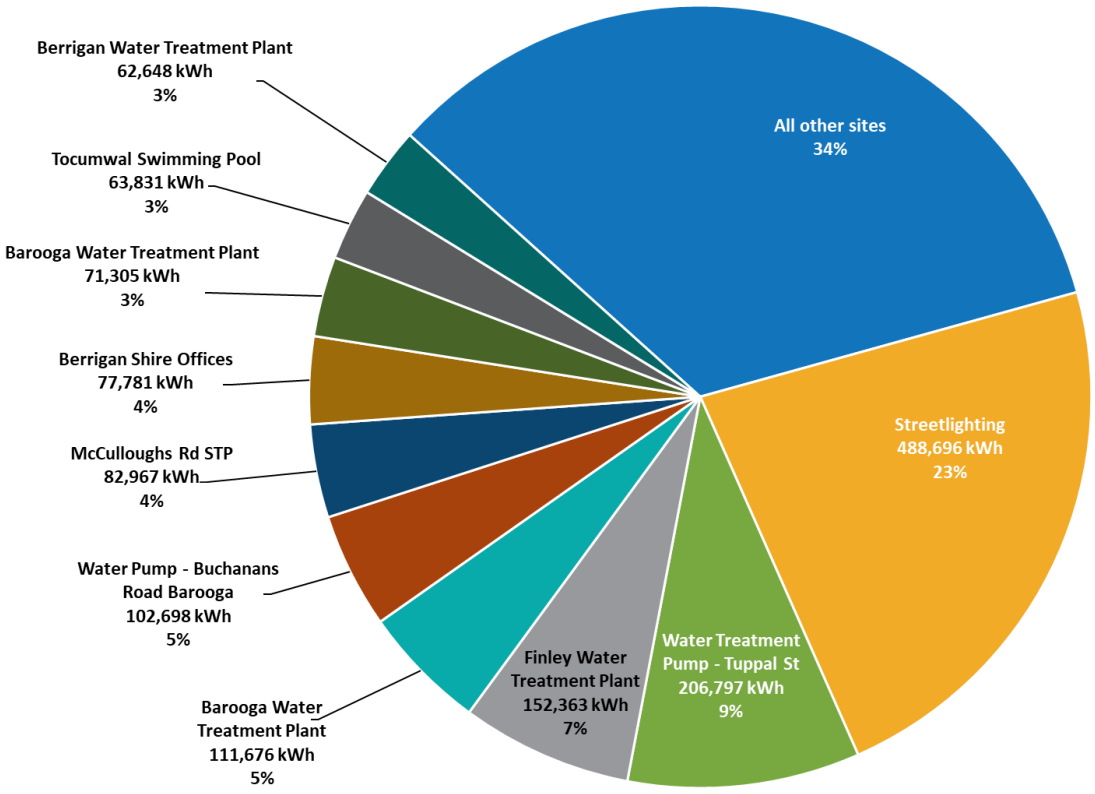

FIGURE 14: BERRIGAN SHIRE COUNCIL'S LARGE ELECTRICITY USING SITES

Electricity use is dominated by a small number of large sites (including the main streetlighting accounts) and several individually small electricity using sites. The 'top 10' sites' use 66% of all Council's electricity. As seen in the figure above, 23% of the electricity consumption is from streetlighting. The other major electricity consumers include pump stations and filtrations plants.

It is also possible to estimate the contribution by major equipment types to electricity use, based on experience with similar operations. The major equipment types include motor systems, lighting, air conditioning (HVAC) and power & appliances. The assessed contribution to Council's electricity consumption is illustrated below, highlighting motor systems and lighting as the major user, and likely the major focus areas for energy efficiency.

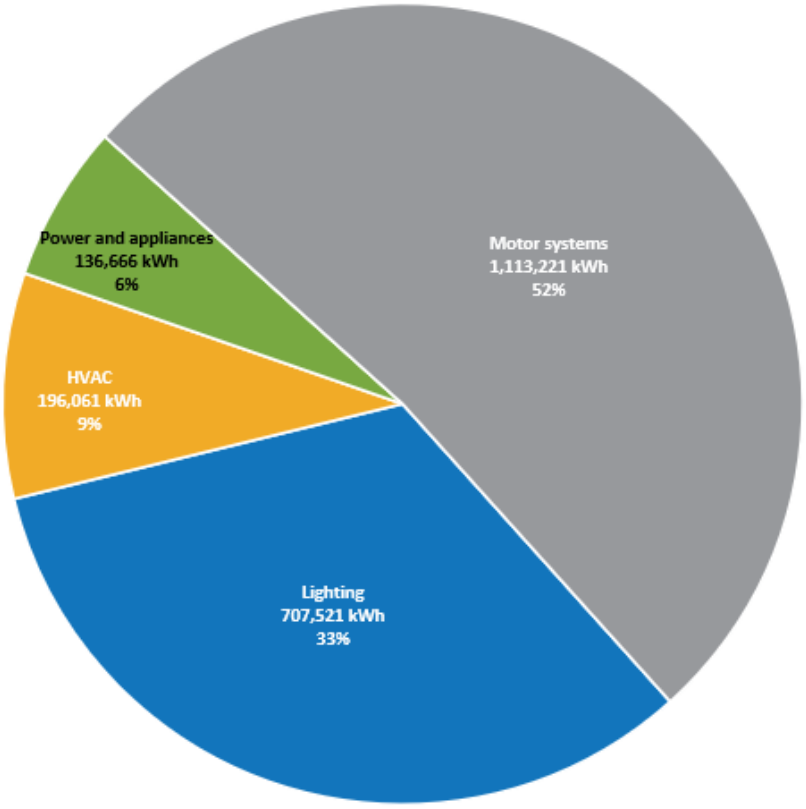

FIGURE 15: BERRIGAN SHIRE COUNCIL'S ELECTRICITY USE BY END USE EQUIPMENT

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Energy Strategy

Berrigan Shire Council's energy & emissions reduction opportunities

7 Berrigan Shire Council's emissions reduction options

7.1 Measures available to reduce Berrigan Shire Council's footprint

A review of Berrigan Shire Council's current operational energy demand and carbon footprint, site visits and discussions with Berrigan Shire Council staff, suggest that there are six main areas of action by Berrigan Shire Council that, implemented together in a planned way, can reduce energy demand, increase onsite renewables, and reduce emissions. These six areas are:

1. Grid decarbonisation
2. Buying clean energy (e.g. via a renewable energy power purchase agreement or PPA)
3. Behind-the-meter solar (i.e. onsite solar and battery storage)
4. Energy efficiency
5. Sustainable transport (information included, opportunities assessment not in scope)
6. Sustainable procurement (information included, opportunities assessment not in scope)

These six measures are illustrated in the graphic below. Following this, a summary of the scope, scale, cost-effectiveness and risks associated with in-scope measures is presented that can enable the success of Council's abatement efforts. This is then followed by the presentation of action plans that will enable Berrigan Shire Council to achieve its goals.

Action plans are based on analysis of information and data, visits to numerous Berrigan Shire Council facilities with experienced staff, and discussions with key stakeholders.

FIGURE 16: SIX CATEGORIES OF EMISSIONS REDUCTION FOR BERRIGAN SHIRE COUNCIL

7.2 Grid decarbonisation

Description

In NSW there are five coal-fired power stations with combined 10,240 MW capacity that supply most of the State's electricity and make up the majority of NSW electricity sector emissions (Liddell, Vales Point B, Eraring, Bayswater, Mt Piper).

The state is largely self-reliant for power, with this supplemented by interstate links as and when required. Since 2010 three coal-fired power stations with 1,744 MW of capacity have closed in NSW (Wallerawang C, Redbank and Munmorah).

In recent years several thousand MW of large-scale solar, wind energy and rooftop solar PV generation capacity has been built in NSW and much more is planned. In recent years rooftop solar installations have accelerated.

Recently, the first step towards implementing the 8 GW Renewable Energy Zone in New England region was taken by requesting expressions of interest from proponents of new solar, wind and energy storage capacity. Other REZs' are proposed to be located at Hunter-Central Coast, Illawarra and Central-West Orana and South-West regions with an assessed 12 GW of renewable energy.

As more coal-fired power stations approach the end of their life – announced closures are in 2022, 2028, 2034, 2035 and 2043 respectively for the five active coal-fired power stations noted above – they are most likely to be replaced with renewable energy. This is most likely to be from large-scale wind and solar PV, together with Distributed Energy Resources (DER) and demand-side measures.

Assuming this, the future carbon intensity of the NSW grid will decline, gradually until around 2035, then accelerating towards zero by the mid-2040s. The grid emissions intensity will be influenced by a range of factors, and AEMO's Integrated System Plan 2020[11] (ISP2020) models five scenarios with differing assumptions for key influencing factors including demand drivers, DER uptake, emissions, large-scale renewable build cost trajectories, investment and retirement considerations, gas market settings and coal price settings, together with assumptions regarding policy settings and transmission infrastructure development.

The resultant scenario outcomes for closure of large-scale generators in the NEM is illustrated below, highlighting the potential for a rapid transition to renewables.

[11] AEMO: https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2020-integrated-system-plan-isp

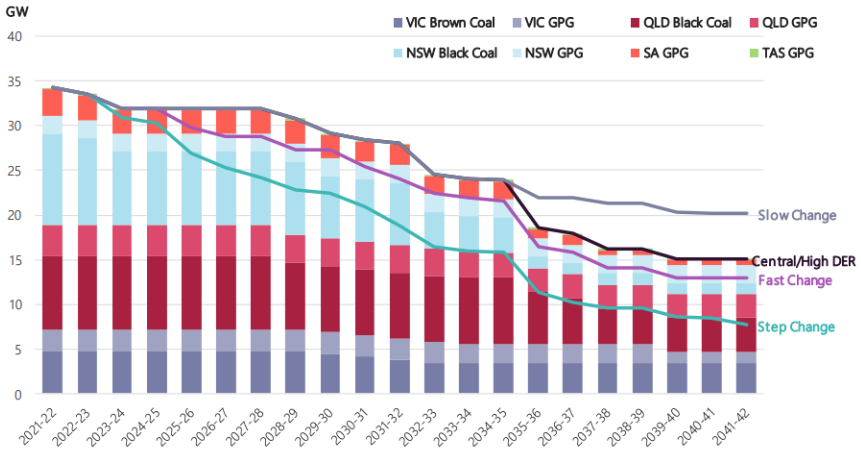

FIGURE 17: AEMO MODEL OF NEM COAL + GAS GENERATION CAPACITY & SCENARIOS[12]

The NSW Government's Electricity Infrastructure Investment Bill may facilitate an even more rapid transition to renewables in NSW than the AEMO Step Change scenario, and future ISP forecasts will reflect any new scenario modelling.

Scope for abatement

The above potential change to the NSW grid carbon intensity would have a significant impact on energy-related GHG emissions for Berrigan Shire Council, with the potential for nearly **2,340 t CO_2**-e of abatement if electricity supply is nearly all renewable and vehicles have transitioned to electric over time.

Under most of AEMO's scenarios (excepting Step Change) the majority of this impact would not be seen until the late-2030s and in to the 2040s', and under a Step Change scenario this would still not be seen until the 2030s. Hence, if Berrigan Shire Council wants to see its emissions decline at a faster rate, then significant abatement through energy efficiency, more onsite solar PV and battery storage, and switching to electric vehicles powered with renewables will be required.

Risks and mitigation

Berrigan Shire Council has little influence over the rate of change in the grid carbon intensity, and the main risk mitigation strategy is to try and build capacity across Berrigan Shire Council to respond with local solutions to reduce emissions.

Costs and benefits

There is no direct cost to Berrigan Shire Council associated with decarbonisation of the electricity grid, excepting impacts on energy pricing in future years. The development of regional renewable energy zones such as the South-West REZ may see economic opportunities for the Berrigan Shire area.

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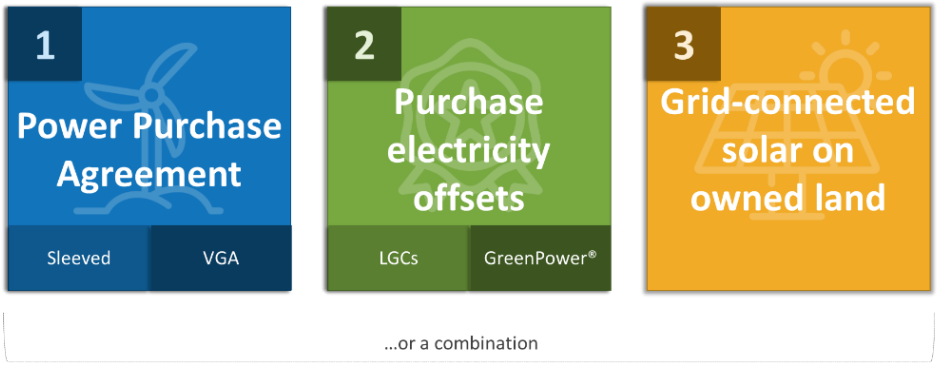
[12] AEMO: https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2020-integrated-system-plan-isp

7.3 Buying clean energy

7.3.1 Renewable energy power purchase agreement

Description

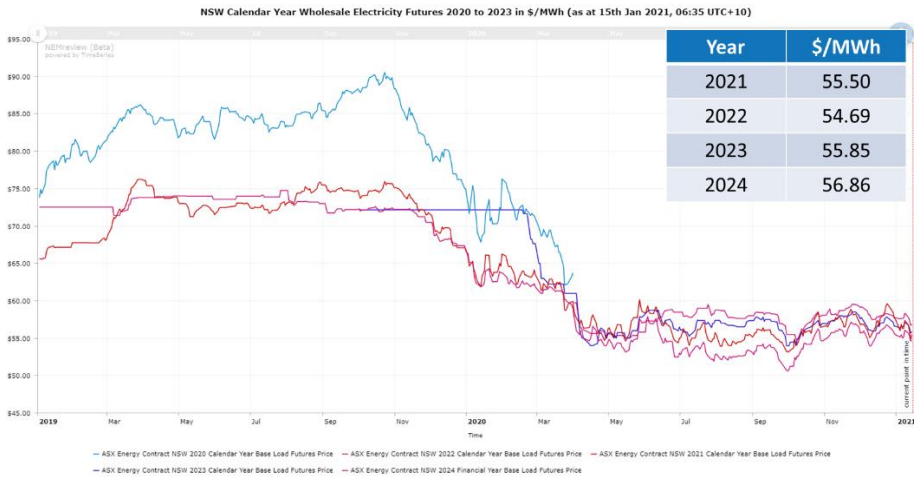
Electricity consumption accounts for 90% of Berrigan Shire Council's non-waste carbon footprint, and more than 66% of electricity is consumed by just 10 sites (including streetlighting). **The single biggest opportunity to reduce electricity emissions is to purchase renewable energy** and/or renewable energy offsets **via Council's electricity procurement process**. Unlike other abatement options, this does not require Berrigan Shire Council to physically implement change, only to stipulate that renewables be purchased to meet part or all of its electricity needs. This approach has been taken by several local governments in recent years and underpins most goals to reach carbon neutrality / net-zero emissions[13]. There are three main ways in which an organisation can source renewable energy, illustrated below.



The most favourable approach in the current market is to enter into a renewable energy power purchase agreement (PPA) with bundled electricity and Large-scale Generation Certificates (LGCs), and to consider the purchase of renewable energy offsets where a bundled PPA falls short of any targets Council may set in future. This can potentially be implemented for Berrigan Shire Council's next agreement.

The cost for a PPA (typically 7 up to 10 years unlike regular electricity agreements that are for 2-3 years) will be compared with forecast electricity retail rates (wholesale rates plus retailer margin) to estimate cost savings. One current 5-year forecast for NSW wholesale electricity is shown below[14], and a process to develop a renewable energy PPA in future would create an updated forecast to inform comparison with offers from renewable energy retailers, enabling Council to make the most informed purchasing decision.

[13] Examples of NSW Councils' purchasing renewables as part of their electricity supply include: Southern Sydney Regional Organisation of Councils, City of Sydney, City of Newcastle and Hawkesbury City Council.
[14] Sourced Energy: One view is provided of current and 4-year potential wholesale electricity pricing in NSW.



In the current market there are several types of PPA offers and going forward more will emerge. Challenges for the PPA market include:

- Development of simpler and more customer-focused offers that resemble more closely regular grid supply agreements
- Contracts for shorter terms with low management burden
- Cost-effective pricing, particularly in the current and forecast market
- De-risking PPAs for customers, with risk ideally managed by retailers rather than building in-house expertise

Scope for abatement

Based on Berrigan Shire Council's current energy mix, purchasing 100% renewables would lead to abatement of **2,340 t CO_2-e**, and 50% renewables would lead to abatement of **1,170 t CO_2-e** per year.

Risks and mitigation

Establishing a corporate PPA is complex, time-consuming and contains approaches and risks not previously considered by most consumers. These take time and resources to assess and manage, and this would be an integral part of Berrigan Shire Council's procurement process.

A renewable energy PPA:

- is typically for a longer time period than a regular agreement,
- is associated with new-build solar, wind, hydro and battery projects,
- may be with recent or new entrants to the energy market, and
- occurs in an uncertain policy environment for renewable energy and climate change response

The key risk areas are illustrated below and would be assessed as part of a process to determine the best procurement solution for Berrigan Shire Council.

Costs and benefits

The costs or benefits of a renewable energy PPA are assessable via comparison of PPA offer pricing with forecast regular power pricing, and so is inherently subject to the quality of knowledge and assumptions underpinning forecasting.

The market, pricing and contract models for renewable energy PPAs is still evolving, and the costs and benefits to Berrigan Shire Council should be assessed as part of Council's next procurement process.

7.3.1 Mid-scale renewable energy build by Berrigan Shire Council

Description

An option available to Berrigan Shire Council is to build its own mid-scale renewable energy plant on land it owns. Power generated would be exported to the grid, and Council could then potentially purchase this electricity (and LGCs) via a licensed retailer or could simply take the grid spot price as income and retire or sell LGCs depending on its income and/or abatement goals.

This arrangement is like projects developed in recent years by Sunshine Coast Council (15 MW solar farm at Valdora generates the same solar energy as Council consumes) and City of Newcastle (5MW Summerhill landfill solar farm meets ~30-40% of Council's electricity needs). A key aspect to note in these projects is that Council can't simply 'allocate' the renewable energy generated to its sites. If it wants to offset its regular power use with power from its own renewable energy plant, it would do so via a licensed retailer as an intermediary.

Like a PPA that is negotiated for supply from remote / non-Council projects, developing a mid-scale project is a complex undertaking, and requires assessment of a range of aspects, such as design, connection agreements, EPC and O&M contracts, ownership models, and the development of retail agreements to supply the power to Council. Community involvement in the ownership and/or purchasing of clean energy from the project could also be considered.

It is likely that this represents a medium to long term opportunity for Berrigan Shire Council, and this strategy does not assess the costs, benefits, options and risks associated with this approach. However, this project has highlighted two possible options that Council could examine in future, and these are highlighted below.

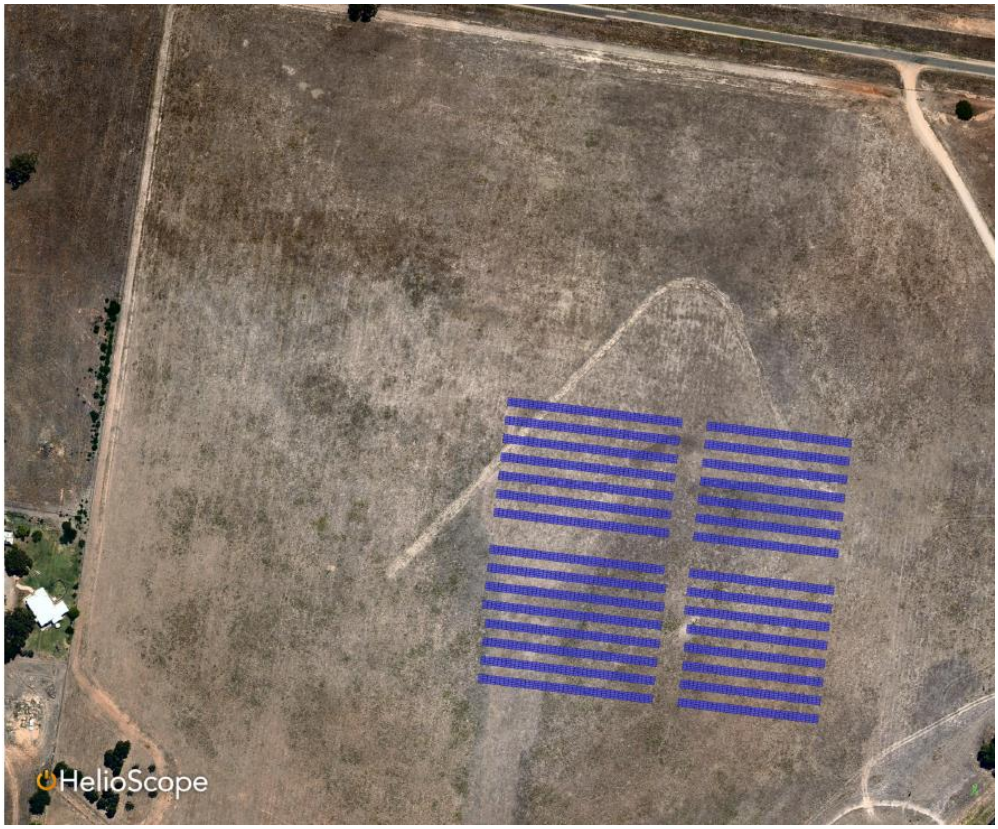
Option 1: Finley Saleyards

The Finley saleyards has a large north-east facing roof structure that could host a 250kW roof-mounted tilt and flush solar PV system. Berrigan Shire Council can implement this as a community project, where the community could share the benefits from this project among the local community interested in local renewable energy generation. The design is subject to structural integrity and may vary pending a structural assessment. Additionally, the site does not have the electrical infrastructure to host a 250kW roof-mounted solar PV system, and the total estimated capital cost mentioned in this report may vary pending a detailed site assessment. This 250kW flush and the tilted roof-mounted system can generate up to **358 MWh** of electricity per annum.

Option 2: McCulloughs Rd STP

Council owns ~20 ha land next to the Tocumwal sewage treatment plant with flat terrain and network distribution feeders and lines across this site. The image below only identifies the potential to implement a solar farm. Currently, we have designed a 2MW north-facing fixed tilted solar farm close to the site's distribution feeder. However, based on further investigation and engagement with the distribution network provider, Council could potentially implement a much larger system and could also consider implementing a system with racking that requires minimum civil works, such as the 5B east-west racking units. This could drive down the capital costs and be attractive for implementing a project of this scale. The project could also be developed along with RAMJO, which could benefit Berrigan Shire Council and the neighbouring Councils.

The above solar farm design near the McCulloughs Rd STP can generate more than **3 GWh** per annum.



Scope for abatement

The scope for abatement of Council's emissions would depend on the scale and type of project, treatment of LGCs generated from the project's operation, and Council's offtake fraction of energy generated, for example.

The case for Council to develop a project such as this may have multiple aspects, such as meeting its own targets for renewables and abatement, its desire to see more renewable energy projects built in Berrigan Shire, its desire to build projects that involve community ownership and/or establishment of a community energy retailer, and opportunities for grant funding that may make such a project economically viable compared with other options.

So, the scope for abatement of Council's emissions can range from a small fraction up to 100% of electricity emissions, and the scope for abatement in the wider community is potentially even larger.

Risks and mitigation

In addition to the renewable energy PPA risks highlighted above (which would also apply in the case of a mid-scale project), additional risks apply when looking at this opportunity. These include:

- Retailers may not want to be party to off-take, so the ability to sleeve the generation with Council's electricity agreement may be limited

- If the plant exceeds 5 MW in capacity, then registration with AEMO will be required, with associated registration and recurrent fees
- Greater skills and knowledge of wholesale markets would be required to manage revenue risk over time

These are examples and other risks may apply and would need to be identified, assessed and managed / mitigated as part of the project development.

Costs and benefits

In the current market – with declining wholesale prices, declining LGC prices, and lower offtake rates available for much larger renewable energy projects compared with mid-scale projects, the business case likely favours a PPA-only model to sourcing renewables for Council's facilities.

However continuing declines in costs for mid-scale solar projects, and grant support to community-based renewables may make a mid-scale project viable for Berrigan Shire Council in future.

7.4 Behind-the-meter solar

Description

Solar PV is a well-established technology, and more than 20% of Australian homes and an increasing number of businesses are installing solar panels to reduce their grid energy costs and greenhouse gas emissions. Uptake of battery energy storage (BESS) remains low but is expected to become more cost effective in future.

As noted above, Berrigan Shire Council has installed solar PV at the library, depot and Council chambers buildings. Visits to Council's operations as well as discussions about planned new facilities and upgrades has highlighted opportunities for solar at several sites. At several sites more than one option can be considered. At some sites implementation of solar and storage may be a staged approach.

The following is a summary of the solar PV and BESS opportunities that have been identified at Council operated sites:

Site name	Behind-the-meter solar potential
Anzac Ave Splash Park	The existing solar PV + BESS system seems to be underperforming as panels are heavily shaded. Consider trimming the trees or relocate the system to the stormwater pump station. This would require new housing for batteries and inverters.
Barooga Water Treatment Plant - 4204150638	There are multiple opportunities to implement solar PV system at this site. Council can upgrade the panels from 250W to 450W panels and remove all panels from the heavily shaded section, i.e., behind the water tank. This upgrade can increase the solar PV array size to 23.4kW from 14.5kW system. Or, consider upgrading the existing solar PV system with additional solar on the main switchboard room to a 35.6kW ground-mounted solar PV system with a 70kWh battery storage system to maximise the solar self-consumption and reduce the site's grid dependency. The other Barooga Water Treatment Plant NMI's don't have sufficient land or roof area to implement any solar PV opportunities.
Berrigan Library	Install a 3.8kW roof-mounted solar PV system to meet most the daytime energy demand. Or, consider installing a larger 8.36kW solar PV system on the north and east section of the library building with a 10kWh battery storage system to meet the site's intermittent energy demand.
Berrigan Shire Offices	Based on the current consumption vs. export of the solar PV at the Council office, install a 60kWh battery storage unit to maximise the solar self-consumption. Or, expand the existing 50kW solar PV system with an additional 33.4kW solar PV system. The current solar array is exporting ~30% of energy generated back to the grid,

	which would be mainly during the weekends and summer months. Else, as a staged approach after increasing the total solar PV array size to 83.4kW at Council office, implement a 100kWh BESS to maximise the solar self-consumption from this site and match the site's grid electricity demand
Berrigan STP	Install a 7.7kW single pole ground mount system near to the switchboard of the STP.
Berrigan Water Treatment Plant	The existing solar array is exporting ~40% of the energy generated back to the grid (these estimates were based on the latest electricity bills only), therefore install a 40kWh battery storage unit to maximise the solar self-consumption. Or, upgrade the current 275W solar panels to 380W panels to increase the total array size from ~20kW to 30.4kW. This system could also be coupled with a 65kWh battery storage unit to meet most of the site's energy demand.
Burkinshaw Street Barooga (Barooga Rec Reserve)	Assess the potential to couple a battery storage unit to the existing 5kW solar PV system at the Recreational reserve. However, to determine the savings potential from this opportunity, we require the solar PV generation and on-site grid electricity consumption. Else, Council can install a 15.2kW roof-mounted flush solar PV system with a 40kWh battery storage system to meet most of the site's electricity demand.
Chanter St Depot	Install a 13.7kW roof-mounted solar PV system on the east and west section of the admin building at the Depot. Alternatively, in the medium term, consider installing a larger 22.8kW roof-mounted solar PV system at the admin building with a 25kWh battery storage unit to meet most of the sites energy demand.
Berrigan Sportsground	Install an 8.36kW roof-mounted flush solar PV system on the grandstand. Alternatively, install a larger 15.2kW roof-mounted flush solar PV system on the grandstand. This would ensure the Berrigan Sportsground is ready for battery storage system in the future. Since most of the electricity load is during the evening and night-time, consider installing a 40kWh battery storage to meet most of the site's energy demand.
Berrigan Swimming Pool	Based on the current solar PV generation, consumption and exports implement a battery storage system to reduce the exports back to the grid. However, we require site's generation and consumption data to estimate the feasibility of solar PV at this site.

Berrigan War Memorial Hall	Install a ~2kW solar PV system coupled with a small battery unit on the newer section/ rear end of the building.
Finley Library and Early Intervention	Install a 5.32kW roof-mounted solar PV system on the north section of the library building. Additionally, since the site is open only for three days in a week, most of the solar generated from this site would be exported back to the grid. Hence, install a 5.32kW solar PV system with a 10kWh battery storage unit to meet most of the site's electricity demand.
Finley School of Arts	Install a ~2kW roof-mounted solar PV system with a battery storage unit to meet the complete demand of the site.
Finley STP	Install a 13.5kW ground-mounted solar PV system close to the main switchboard. Additionally, couple a 45kWh battery storage unit to meet the site's intermittent electricity demand.
Finley Water Treatment Plant	Upgrade the existing solar PV system by replacing the 265W panels to 400W panels. This would increase the system to 27.2kW. Additionally, Council can install an 83.7kW ground-mounted solar PV system on the existing clarifier sections, which would be decommissioned after the new DAFF plant is built. Furthermore, due to the intermittent nature of the electricity demand at water treatment plants, consider implementing a large-scale battery storage system of 140kWh to meet most of the sites electricity demand.
Hill Street Depot	Install a ~3kW roof-mounted solar PV on the admin building.
McCulloughs Rd STP	Install a 23.4kW ground-mounted solar PV system oriented towards the north-west, outside the plant fence. In the long term, consider installing a larger ground-mounted solar PV system of 54.9kW coupled with 110kWh of battery storage to maximise the solar self-consumption.
Saleyards Road truck wash	Install a 3kW roof-mounted solar PV system on the amenities block with a 5kWh BESS to match the site's grid electricity consumption. Council could also consider relocating the solar PV array and BESS system from the ANZAC splash park to the Truck wash as the system is under performing at the park.
Tocumwal Aerodrome	Install a 4.15kW roof-mounted solar PV system tilted towards the north orientation of the Aero club building. Additionally, implement a 6kWh battery storage unit to meet most of the site's electricity demand.

Tocumwal Library	Consider installing ~3kW solar PV system with a battery storage to meet the site's energy demand.
Tocumwal Swimming Pool	Install a 9.18kW ground mount system, similar to 5B racking technology that has a smaller footprint and limited civil work requirements on the south-east corner of the pool. Or, as an innovative project, Council could consider replacing the shade cloth over toddler's pool for a structure which is inclusive of battens and purlins to accommodate a 21.6kW solar PV system facing north. This solar PV system can be coupled with a 30kWh battery storage unit to meet the site's variable energy demand.
Townbeach Rd (Rec Reserve)	Install ~53kW solar PV system on the Rec reserve pavilion building. The roof space looks large with minimal shading, could have opportunities to trade generated energy to the WTP through peer-to-peer solar trading.
Water Treatment Pump - Tuppal St	Due to the limited land and roof area, consider implementing an additional 82.9kW ground-mounted solar PV system to the existing 17kW solar roof-mounted solar PV on the north-west section of the Recreational reserve with a 100kWh battery storage unit.

Scope for abatement

The above opportunities can be summarised as:

- Council-operated sites have scope for ~**309kW – 485kW** of solar PV, with some scope for BESS at sites with low or intermittent demand.
- This can generate from **~470MWh to 651MWh** of electricity per year with most of this consumed on Council sites and some export to grid. Abatement at current grid carbon intensity would be **250 to 465 t CO_2-e** per year based on self-consumed solar, with additional abatement associated with export of surplus solar energy to the grid.
- There are added longer term solar opportunities that are not quantified here.

Risks and mitigation

Risks associated with solar PV implementation are minimal provided systems are appropriately sized, designed, installed, connected and maintained on sound buildings and structures, as with any other asset.

The cost effectiveness of solar PV has long been demonstrated, and panel prices continue to fall. The commercial sector has embraced solar PV in recent years, and this has driven further acceleration in the implementation of rooftop solar.

Costs and benefits

The assessed costs and annual savings for each of the above systems is summarised in the tables below.

7.4.1 Onsite renewable energy

Site visits and data analysis were used to identify sites that are most likely to be suitable to install solar PV. A summary of the solar PV layouts at Berrigan Shire Council sites is provided in Appendix A. Note that opportunities for solar and storage in the long term represent full rather than marginal PV + storage opportunities, so Council has visibility of the overall opportunity and (current assessed) overall financial returns for each site. If Council elects to implement short / medium term opportunities for these sites, then only the marginal project scope and costs would warrant implementation in the longer term.

TABLE 7: ASSESSED COSTS AND SAVINGS FOR BEHIND-THE-METER SOLAR PV FOR COUNCIL-OPERATED SITES

Site	Modelled PV size	BESS (kWh)	Capital cost	Cost savings	Payback (years)	NPV	IRR	Solar yield (kWh)	% energy saving	% of solar export	Emissions reduction (t CO_2-e)[15]
Barooga Water Treatment Plant - 4204150638	*Medium term option:* **23.4kW** Solar PV - Upgrade		$16,380	$2,658	6.3	$20,985	15%	36,350	8%	~75%	8.18
	Long term option: **35.6kW** Solar PV + BESS - Ground - STC	70	$87,920	$10,044	8.9	$24,939	8%	52,820	31%	~35%	30.9
Berrigan Library	*Medium term option:* **3.8kW** Solar PV - Roof - STC		$3,800	$883	4.5	$7,762	22%	5,221	17%	~50%	2.35
	Long term option: **8.36kW**	10	$17,360	$3,126	5.8	$19,400	15%	11,380	60%	~20%	8.19

[15] Emissions reduction refers here only to reduced grid electricity use on site. Excess solar energy that is exported to the grid also reduces emissions that Council can claim for solar PV systems smaller than 100 kW.

Site	Modelled PV size	BESS (kWh)	Capital cost	Cost savings	Payback (years)	NPV	IRR	Solar yield (kWh)	% energy saving	% of solar export	Emissions reduction (t CO_2-e)[15]
	Solar PV + BESS - Roof - STC										
Berrigan Shire Offices	*Medium term option:* **60kWh** BESS **Or;**	60	$54,000	$3,871	22.7	-$20,964	1%	-	23%	-	16.43
	Medium term option: **33.4kW** Solar PV - Roof - STC		$33,400	$7,182	5.0	$57,187	20%	47,220	33%	~45%	23.37
	Long term option: **33.4kW**[16] Solar PV + BESS - Roof - STC	100	$123,400	$9,968	22.0	-$41,816	1%	47,220	63%	~66%	42.50
Berrigan STP	*Medium term option:* **7.68kW** Solar PV - Ground - STC		$9,984	$2,098	5.0	$17,560	20%	12,400	40%	~50%	5.58
Berrigan Water Treatment Plant	*Medium term option:* **40kWh** BESS **Or;**	40	$36,000	$3,245	18.5	-$3,659	4%	-	17%	-	9.86

[16] The battery has been sized to capture solar PV energy generated from the existing 50kW roof-mounted system and the proposed 33kW solar PV system. However, this business case only estimates the savings potential from the 33kW solar PV system and the 100kWh battery storage unit.

Site	Modelled PV size	BESS (kWh)	Capital cost	Cost savings	Payback (years)	NPV	IRR	Solar yield (kWh)	% energy saving	% of solar export	Emissions reduction (t CO_2-e)[15]
	Medium term option: **30.4kW** Solar PV - Ground - STC -Upgrade		$21,280	$7,035	3.2	$79,645	32%	47,480	38%	~50%	21.37
	Long term option: **30.4kW** Solar PV + BESS - Ground - STC - Upgrade	65	$79,780	$11,959	6.8	$63,775	12%	47,480	64%	~15%	36.32
Burkinshaw Street Barooga (Barooga Rec Reserve)	*Short term option:* **5kWh** BESS	**Not assessed**. Require solar PV generation and site consumption to accurately size the battery for this site and thereby estimate he savings potential.									
	Long term option: **15kW** Solar PV + BESS - Roof - STC	40	$51,000	$5,249	16.5	$73	5%	21,000	60%	~25%	14.18
Chanter St Depot	*Short term option:* **13.7kW** Solar PV - Roof - STC		$13,700	$4,450	3.2	$44,895	31%	18,790	34%	~30%	11.84
	Medium term option: **22.8kW** Solar PV + BESS - Roof - STC	25	$45,300	$9,781	4.9	$72,653	19%	30,430	74%	~5%	26.02

Site	Modelled PV size	BESS (kWh)	Capital cost	Cost savings	Payback (years)	NPV	IRR	Solar yield (kWh)	% energy saving	% of solar export	Emissions reduction (t CO_2-e)[15]
Berrigan Sportsground	*Short term option:* **8.36kW** Solar PV - Roof - STC		$8,360	$1,935	4.5	$16,972	22%	11,440	24%	~50%	5.15
	Medium term option: **15.2kW** Solar PV - Roof - STC		$15,200	$1,758	9.1	$7,332	10%	20,780	22%	~75%	4.68
	Long term option: **15.2kW** Solar PV + BESS - Roof - STC	40	$51,200	$6,065	8.9	$10,883	7%	20,780	75%	~15%	11.50
Berrigan Swimming Pool	*Short term option:* **BESS**	**Not assessed.** Require solar PV generation and site consumption to accurately size the battery for this site and thereby estimate he savings potential.									
Berrigan War Memorial Hall	*Low priority:* **2kW** Solar PV + BESS - Roof - STC	**Not assessed**. Electricity demand is too small and intermittent for solar PV system.									
Finley Library and Early Intervention	*Medium term option:* **5.32kW** Solar PV - Roof - STC		$5,320	$1,232	4.6	$10,679	22%	8,315	44%	~50%	3.74
	Long term option: **5.32kW**	10	$14,320	$1,948	7.8	$6,642	9%	8,315	71%	~20%	2.30

Site	Modelled PV size	BESS (kWh)	Capital cost	Cost savings	Payback (years)	NPV	IRR	Solar yield (kWh)	% energy saving	% of solar export	Emissions reduction (t CO_2-e)[15]
	Solar PV + BESS - Roof - STC										
Finley School of Arts	*Low priority:* **2kW** Solar PV + BESS - Roof - STC	**Not assessed**. Electricity demand is too small and intermittent for solar PV system.									
Finley STP	*Short term option:* **13.5kW** Solar PV - Ground - STC		$17,550	$1,792	10.3	$5,552	8%	21,190	21%	~75%	4.77
	Long term option: **13.5kW** Solar PV + BESS - Ground - STC	45	$58,050	$6,811	8.9	$11,779	7%	21,190	78%	~5%	18.12
Finley Water Treatment Plant	*Short term option:* **27.2kW** Solar PV - Upgrade		$19,040	$5,628	3.7	$57,217	27%	43,530	23%	~20%	31.34
	Medium term option: **83.70kW** Solar PV - Ground - STC		$108,810	$12,867	9.4	$47,684	9%	132,700	52%	~40%	71.66
	Long term option: **83.70kW** Solar PV + BESS - Ground - STC	140	$234,810	$20,372	19.1	-$47,186	3%	132,700	83%	~5%	113.46

Site	Modelled PV size	BESS (kWh)	Capital cost	Cost savings	Payback (years)	NPV	IRR	Solar yield (kWh)	% energy saving	% of solar export	Emissions reduction (t CO_2-e)[15]
Hill Street Depot	*Low priority:* **3kW** Solar PV - Roof - STC		$3,000	$854	3.7	$8,222	27%	4,207	69%	~40%	2.27
McCulloughs Rd STP	*Medium term option:* **23.4kW** Solar PV - Ground - STC		$30,420	$3,095	10.3	$9,455	8%	36,650	11%	~75%	8.25
	Long term option: **54.9kW** Solar PV + BESS - Ground - STC	110	$170,370	$20,424	8.8	$49,357	8%	86,390	73%	~30%	54.43
Saleyards Road Truck wash	*Medium term option:* **3.0kW** Solar PV + BESS - Roof - STC	5	$7,530	$853	14.3	$1,423	7%	3,603	42%	~30%	2.27
Tocumwal Aerodrome	*Long term option:* **4.1kW** Solar PV + BESS - Roof - STC	6	$9,550	$1,610	6.2	$8,988	13%	6,344	79%	~25%	4.28
Tocumwal Swimming Pool	*Medium term option:* **9.2kW** Solar PV - Ground - STC		$11,934	$1,562	8.1	$8,217	11%	12,990	8%	~60%	4.68

Site	Modelled PV size	BESS (kWh)	Capital cost	Cost savings	Payback (years)	NPV	IRR	Solar yield (kWh)	% energy saving	% of solar export	Emissions reduction (t CO_2-e)[15]
	Not feasible: **21.6kW** Solar PV + BESS - Structure - STC	30	$87,480	$4,996	23.9	-$36,047	0%	32,980	26%	~50%	14.84
Water Treatment Pump - Tuppal St	*Long term option:* **82.8kW** Solar PV + BESS - Ground - STC	100	$197,640	$14,125	22.9	-$74,574	1%	130,500	50%	~20%	93.96
Minimum Solar*	**309.24 kW**	**157**	**$467,208**	**$63,093**	**7.41**	**$281,478**	**16%**	**470,025**	**39%**	**43%**	**249.83**
Maximum Solar**	**485.16 kW**	**757**	**$1,254,264**	**$124,326**	**10.09**	**$85,513**	**9%**	**651,344**	**59%**	**26%**	**465.26**

* The minimum total of 309.2kW takes into account the minimum solar PV and battery opportunities for all the sites. These consider projects that Council has prioritised as short, medium and long term opportunities for each site. For example, if a site has only a small/ medium term target, the smaller system size is counted towards the minimum PV opportunities.

** The maximum total of 485kW takes into account the maximum solar PV and battery opportunities for all the sites. If a site has opportunities in both the long and short term, the long-term opportunity is counted in the maximum PV opportunities calculations. However, for sites that may only have a medium/ short term recommendation, the larger system size still gets calculated towards the maximum PV opportunities.

7.4.2 Assumptions used

The analysis of these opportunities was performed with the following inputs and parameters:

- Solar modelling software (Helioscope with Nearmap / Six maps) was used for all proposed installations.

- Council's energy billing data and site interval data (where available) was used to determine optimum solar array sizes and to estimate or calculate the level of self-consumption of solar and the amount likely to be exported in each case.
- Benchmark pricing for solar PV systems (flush roof-mount, tilted roof-mount and ground-mount systems) and inverters has been used. An additional of 20 cents is added in the pricing if the system was modelled with microinverters.
    - Flush and fixed roof-mount systems - $1/W STC scale and $1.5/W LGC scale
    - Upgrades to all solar PV systems - $0.7/W
    - Ground-mount systems - $1.3/W STC scale and $1.8/W LGC scale
    - Floating solar systems - $3/W STC scale and $3.5/W LGC scale
    - Carport solar systems - $2.8/W STC scale and $3.3/W LGC scale
- Annual expenses include cleaning / maintenance. Cleaning costs of $15/MWh of solar energy generation have been used. These are applied to each solar PV opportunity with annual escalation at 2.5%.
- For all exported energy a feed-in rate of $0.08/kWh was assumed to be available, which will require Council to seek this in electricity agreements.
- A single discount rate of 5% is applied for net present value (NPV) calculations.

7.5 Energy efficiency

Description

Energy efficiency remains the cheapest form of greenhouse gas abatement in many situations. This is reflected in Berrigan Shire Council's past and continuing efforts to manage energy efficiently as described above.

The following is a summary of the identified energy efficiency opportunities at Council sites:

- **Street Lighting:** Council has received a business case and proposed costs to upgrade its streetlights to LED technology from Essential Energy. This will apply to local as well as main roads (excluding lighting owned and managed by RMS). Additionally, Council can consider upgrading the twin light poles at Barooga town median strip.
- **VSD Controls:** Berrigan Shire Council can implement variable speed drives across their major water treatment plants at Berrigan, Barooga and Finley. However, the payback could be longer at the Berrigan water treatment plant due to lower run duties. And, with plans of upgrading the Finely water treatment plant, integrating VSD controls into the main pumps would be prudent as part of the plant design. Thereby, based on the timeline of the Finely water treatment plant upgrade, the agency can prioritise the implementation strategy of these VSD controls.
- **Lighting: office / indoor** many of Council's facilities have been upgraded to LED lighting. This will be the preferred lighting technology going forward and can be extended from higher use sites such as the Chanter Street depot, Berrigan library, Finley water treatment plant to lower use sites such as Hill Street depot, Apex Park and Tocumwal swimming pool.
- **Sports field lighting:** lighting of sporting fields with LED is widely available but tends to be best implemented when building new lighting infrastructure or when replacing lighting at the end of its life. When replacing lights on existing poles, a structural assessment may be necessary.
- **Design**: Integrate energy efficiency solutions to the new plant design, including VSDs, pump/pipework design, roofs and electric infrastructure designed for solar and future EV charging.
- **Power factor correction:** The water treatment plant at Tuppal Street and the Finley water treatment plant have poor power factors, and installation of PFC units will provide a quick-win for Council.
- **Voltage optimisation:** The incoming voltage at the Berrigan Shire office has been noted at ~250V, optimisation of this voltage supply to reduce to ~230V, which can reduce the total energy used by ~5-10%.
- **Load scheduling:** There are large savings potential at the water treatment plants at Tocumwal and Finley from shifting the electricity demand from peak to off-peak periods. Additionally, we have also identified saving potential for the smaller plants at Berrigan and Barooga.

Efficiency plans and budgeting will be informed by regular auditing of facilities and equipment and by Operational Budget planning and Delivery Program

planning that considers projects that will continuously reduce Council's energy footprint.

Scope for abatement

The scope for energy efficiency across Council's sites is assessed to be around **66.6 MWh per year**, equal to more than **3%** of current electricity demand. However, please note that this savings does not include savings from any streetlighting upgrade, as Council was unable to supply information to allow this to be assessed / included. We expect streetlighting energy demand to reduce by ~50% post the implementation of LED technology across Berrigan Shire Council.

While energy savings potential is significant, the design and construction of new facilities may see increases in energy demand as well, even where these new facilities are energy efficient. Hence the net savings potential could be lower than these estimates.

Risks and mitigation

The risks associated with energy efficiency upgrades are generally low provided business cases, specification and contractor management processes are robust. Some of the main risks and mitigants will include:

- Designing effective measurement and verification at an affordable cost that provides useful feedback about the success of projects
- Persistence of energy savings – it is not uncommon, particularly for education initiatives and control settings to lapse in their performance and be changed back to poor practices or inefficient settings, and providing resources to sustain energy savings is also important
- Regular review processes for energy management is important. For example, design guidelines and procurement guidelines should stay at the level of development of new technologies, practices and services

Costs and benefits

The assessed costs and annual savings for each of the above systems are summarised in the tables below.

7.5.1 Energy efficiency initiatives

Site visits and data analysis were used to identify energy efficiency opportunities at Berrigan Shire Council.

TABLE 8: INDICATIVE COSTS AND SAVINGS FOR ENERGY EFFICIENCY FOR COUNCIL-OPERATED SITES

Site	Description of potential energy efficiency opportunity	Indicative cost	Cost savings	Payback (years)	Resource savings (kWh)	Emissions reduction (t CO_2-e)	% energy savings	IRR
Apex Park Sprinklers	*Low priority option:* Upgrade all lights to LED technologies.	**Not assessed.** The energy usage is too small and intermittent, replace the lights on failure.						
Barooga Water Treatment Plant - 4204150638	*Short term option:* Implement VSD control for clear water pumps at the water treatment plant.	$32,993	$4,124	8.00	14,239	12.81	13%	~13%
	Long term option: Upgrade the soft-starters on raw water pump to VFD controls at the raw water pump station.	$28,869	$4,124	7.00	14,239	12.81	14%	~14%
	Short term option[17]*:* The Barooga water treatment plant only has a retailer (AGL) time-of-use, and the contract does not include any network demand tariffs'. To this, the current contract is cost-effective, with the 26% discount provided on the electricity charges.	The Barooga water treatment plant *(4204150638)* only utilises 11% of its annual electricity during peak hours. By shifting this consumption to off-peak hours, there is a potential savings of up to ~**$881 per annum**. The other NMI's at the Barooga water treatment plant have a similar AGL tariff structure, and shifting the load from peak hours to off-peak periods would attain similar savings potential (applicable based on annual energy consumption).						

[17] Based on interval data Jan 2020 – Dec 2020.

Site	Description of potential energy efficiency opportunity	Indicative cost	Cost savings	Payback (years)	Resource savings (kWh)	Emissions reduction (t CO_2-e)	% energy savings	IRR
Barroga town median strip private lighting (Vermont St Streetlighting)	*Short term option:* Upgrade 10 twin light poles of the road median strip and private lights on the walkway to LED technology.	**Not assessed.** Require further information on the street lighting inventory; however, Council can progress this upgrade along with other street lighting upgrades implemented at Berrigan Shire Council.						
Berrigan Library	*Short term option:* Upgrade 27 x twin 28W T5 lights, 2 x 18W CFL and 4 x twin 26W CFLs in the foyer to LED.	$3,799	$633	6.00	1,890	1.70	13%	~17%
Berrigan Shire Offices	*Short term option:* The incoming voltage has been noted at ~250V, assess optimisation of this voltage supply to reduce to ~230V, which can reduce the total energy used by ~5-10%.	**Not assessed,** would require further investigation.						
	Continuous Improvement: Develop a strategy to replace the existing HVAC systems to energy efficient multi-unit and single unit split systems. The current HVAC units are ~20 years old, utilising banned R22 refrigerant. These units could be replaced with any units with EER/COP greater than 4, preferably using R32 refrigerant gas.	**Not assessed.** Can be implemented through Council's procurement						

Site	Description of potential energy efficiency opportunity	Indicative cost	Cost savings	Payback (years)	Resource savings (kWh)	Emissions reduction (t CO_2-e)	% energy savings	IRR
Berrigan STP	*Medium term option:* With the installation of the proposed 7.68kW ground-mounted solar PV system, consider scheduling the pump to service the racecourse during daytime to increase solar self-consumption.	**Not assessed.** Interval data was not available to estimate the current pump operation hours and the savings potential from scheduling to maximise the solar PV self-consumption, if applicable.						
Berrigan Water Treatment Plant	*Long term option:* Install VSD controls on the two clear water pumps.	$39,060	$3,906	10.00	13,313	11.98	21%	~10%
	Short term option: The Berrigan water treatment plant only has a retailer (AGL) time-of-use, and the contract does not include any network demand tariffs'. To this, the current contract is cost-effective, with the 26% discount provided on the electricity charges.	Based on available interval data from February 2021 – June 2021, by shifting the electricity demand from peak to off-peak periods, there is a maximum savings potential of **$230.** Currently, only 13% of the electricity consumed at this site is during peak hours**.**						
Burkinshaw Street Barooga (Barooga Rec Reserve)	*Low priority option:* Upgrade 6 x HID lights at netball court to LED technology.	**Not assessed.** This project could be completed along with field lighting upgrades, or via grant funding.						
	Continuous Improvement: Develop a strategy to replace the existing Switch-off equipment such as fryers and urn at the old pavilion/clubrooms.	**Not assessed**.						

Site	Description of potential energy efficiency opportunity	Indicative cost	Cost savings	Payback (years)	Resource savings (kWh)	Emissions reduction (t CO_2-e)	% energy savings	IRR
Chanter St Depot	*Short term option:* Completely upgrade the remaining fluorescent lights to LEDs.	$5,741	$1,148	5.00	3,427	3.08	9%	~20%
	Continuous Improvement: Develop a strategy to replace existing HVAC units to more efficient ones.	**Not assessed.** Can be implemented through Council's procurement.						
Berrigan Sportsground	*Continuous Improvement:* Bar cool room temperature seems to be set at 1^0C, when it is supposed to be 4-5^0C.	**Not assessed.**						
Finley School of Arts	*Continuous Improvement:* Upgrade all indoor lights to LEDs.	**Not assessed.** As usage is low, consider these lighting upgrades on failure.						
Finley Water Treatment Plant	*Short term option:* Upgrade indoor and outdoor lights to LED technologies	$3,215	$357	9.00 years	2,666	2.40	2%	~11%
	Short term option: Upgrade the raw water pumps from VLT soft starts to VSD controls.	$20,685	$2,069	10.00	12,951	17.48	13%	~10%
	Short term option: Upgrade the clear water pumps from soft start to VSD control.	$20,685	$2,069	10.00	12,951	17.48	13%	~10%
	Short term option: Install power factor correction device with a capacitor size of **50 kVAr.**	$5,000	$1,988	2.52	-	-	-	~39%

Site	Description of potential energy efficiency opportunity	Indicative cost	Cost savings	Payback (years)	Resource savings (kWh)	Emissions reduction (t CO_2-e)	% energy savings	IRR
	Medium term option: Integrate energy efficiency solutions to the new plant design incl VSDs, pump / pipework design, roofs and electric infrastructure designed for solar and future EV charging.							**Not assessed.**
	Short term option: Consider shifting the load during peak hours of operation (5 PM- 8 PM) to off-peak periods to reduce the annual electricity charges.	Based on the interval data, we have estimated that, by shifting the loads completely from peak hours of operation to off-peak periods, Council can save ~**$6,972 per annum**. If Council opts to install a power factor correction device, the savings will reduce to **$6,042 per annum** due to the improved peak demand from the proposed 50 kVAR device. Furthermore, the site is currently supplied through a transitional tariff structure 'BLNDTRS' which is expected to change by July 2021 to 'BLND3AO'[18]. With this change in tariff structure, the savings would be higher as the peak demand pricing is expected to increase by ~49%. Thereby the estimated annual savings with BLND3AO tariff is **~$9,830.**							
Hill Street Depot	*Continuous Improvement:* Upgrade all indoor lights to LEDs.	**Not assessed.** As usage is low, consider these lighting upgrades on failure.						
Sewer Pump - Barinya St Barooga	*Long term option:* Install VSD controls on the pumps which are currently being upgraded.	$11,401	$950	12.00	2,836	3.57	25%	~8%
Tocumwal Aerodrome Runway Lighting	*Long term option:* Upgrade all the runway lights to LED technology.	**Not assessed.** A project such as this is generally only feasible when field lights / poles are being replaced, or via grant funding.						

[18] https://www.essentialenergy.com.au/our-network/network-pricing-and-regulatory-reporting/tariff-change

Site	Description of potential energy efficiency opportunity	Indicative cost	Cost savings	Payback (years)	Resource savings (kWh)	Emissions reduction (t CO_2-e)	% energy savings	IRR
Water Treatment Pump - Tuppal St	*Short term option*[19]*:* Consider shifting the load during peak hours of operation (5 PM- 8 PM) to off-peak periods to reduce the annual electricity charges.	Our analysis suggests that if the water treatment plant can shift all the electricity demand from peak periods to off-peak periods, Council could see a maximum savings of **$7,800 per annum,** with significant savings from reducing the peak demand charges. Additionally, if Council opts to implement a PFC device at this facility, the annual savings will reduce to **$6,947,** which is due to the improved power factor from this proposed 25 kVAR power factor device.						
	Short term option: Install power factor correction device with a capacitor size of **25 kVAr.**	$2,500	$1,058	2.4	-	-	-	~42%
Tocumwal Swimming Pool	*Medium term option:* Replace ~30 single T5 lights to LED battens.	$3,420	$570	6.00	1,915	1.72	3%	~17%
	Continuous Improvement: Turn off all kiosk appliance at the end of swimming season.							**Not assessed.**
	Continuous Improvement: Consider shutting the filter pumps off at the end of swimming season (6 x 1.5kW).							**Not assessed.**
Maximum total		**$179,682**	**$23,150**	**7.76 years**	**80,887**	**85**	**16%**	**~12%**

[19] Based on interval data from May 2019 – Apr 2020.

7.6 Sustainable transport

Description

The assessment of transport fleet and abatement options was not part of the scope of this work. Information provided below is aimed at helping Council to engage with this aspect of their energy demand and to begin planning for a transition to low / zero emissions fleet and to invest in EV charging infrastructure for its fleet.

NSW Government's Net Zero Plan 2020-2030 is developing a range of measures that will start to shape the future of transport in the State. Recently the government announced $490 million in funding, which includes:

- Waiving stamp duty on eligible EVs under $78,000
- $3,000 upfront rebates on 25,000 eligible EVs under $68,750
- $171 million for EV charging incl $131 million for ultra fast charging
- $33 million to help shift government fleets to electric
- 50% target for new vehicles to be EV by 2030, and
- No new road user tax until 30% of new vehicle sales are EV

Other measures underway also include electric buses and consumer information programs.

For communities such as Berrigan Shire, some of the key aspects that these measures will need to consider in order for EV strategies to be locally applicable will include:

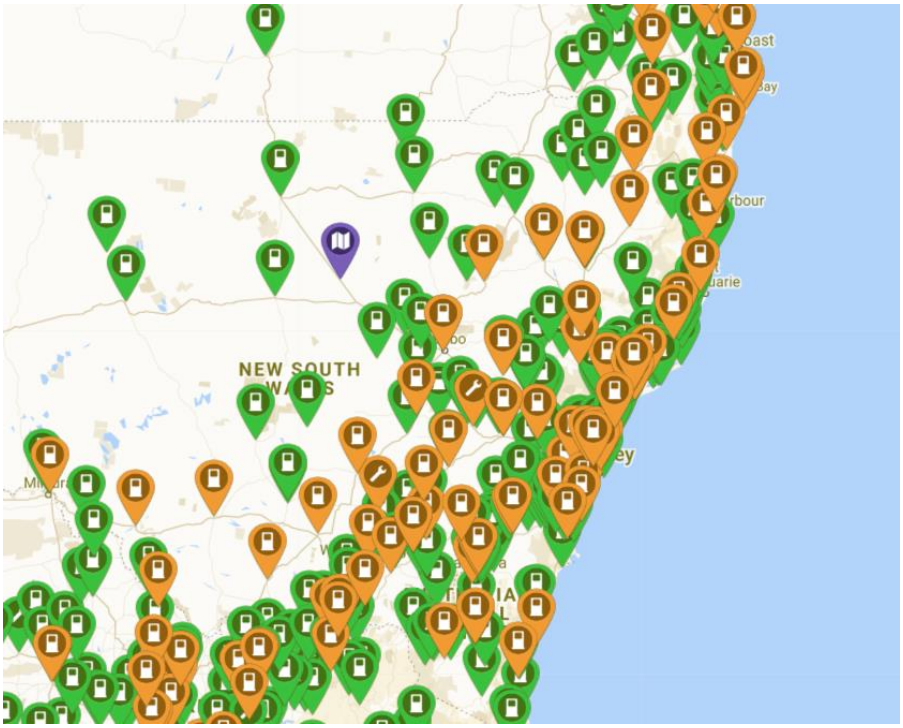
- Real data examining performance of hybrid and EVs in regional communities,
- Supply, warranty, and servicing issues at a local regional level, and
- Coordination on EV charging infrastructure development, between State Government, councils / groups of councils through RAMJO, and private + motoring association providers

This section provides an overview of the current status some of these key areas that will shape future transport, including current EV infrastructure, EV growth, and actions that Council can start to progress.

EV charging infrastructure

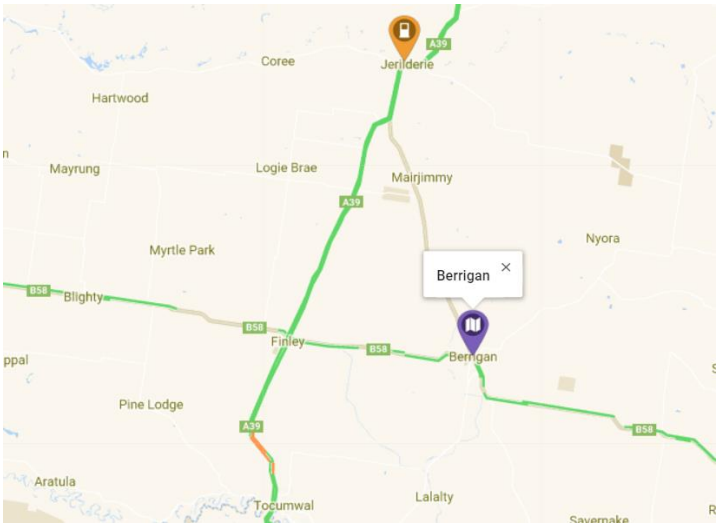
In August 2020 the Electric Vehicle Council reported that there were 2,307 DC and AC chargers in Australia [20]. Locations of DC and public chargers are readily accessible, see below[21], where green pins denote public chargers and orange pins denote fast, or rapid chargers. It has been noted that the EV infrastructure is rapidly growing, with a 40% jump in fast chargers in the past 12 months. Increasing numbers of private chargers are also being installed, retrofitted to homes and businesses as well as designed into new buildings.

[20] https://electricvehiclecouncil.com.au/wp-content/uploads/2019/09/State-of-EVs-in-Australia-2019.pdf, p19
[21] https://www.plugshare.com/



PLUGSHARE MAP OF PUBLIC (GREEN) AND FAST (ORANGE) EV CHARGERS IN NSW, AUG 2021

Currently, Berrigan Shire Council has no EV charging infrastructure, and the closest charging station is a 50kW NRMA charger at Jerilderie. However, with towns such as Finley and Tocumwal being ideally placed along the 'A39', Council should investigate opportunities to implement EV chargers at prominent locations across different towns at Berrigan Shire Council. Uptake of charging stations has also been seen among facilities such as hotels and motels, with local businesses seeking to provide charging for guests driving EVs.



EV CHARGING INFRASTRUCTURE NEAR BERRIGAN SHIRE, AUGUST 2021

Current and continued growth in EV charging infrastructure will facilitate uptake of EVs, and Council should continue to develop and/or enable the implementation of chargers in the region.

Types of EV Chargers

There are three types of EV chargers that have been implemented across Australia[22].

- Level 1: These are typically used at residential properties, and usually draw power from an existing power point (10-15 Amp, single phase). These are slow chargers and require long hours to fully charge a BEV. These chargers use five pin ports. Two pins are used as a communication portal between the EV and the station, and the other three pins are the AC lines for charging.
- Level 2: These are the typical commercial level chargers currently deployed in Australia. They are AC chargers, and have a seven-pin port which is to support the three-phase supply. The level 2 chargers can be found in apartment complexes, shopping centres, public and office spaces. A BEV can be charged overnight with this charger.
- Level 3: These are rapid DC EV chargers at power levels ranging from 25kW to 350kW. There is an uptake of these chargers across Australia, mainly at public locations, as they have the capability to charge certain EV's fully in less than 30 mins.

EV charging infrastructure providers in Australia

While there are multiple EV suppliers in the Australian market, we note some of the leading providers below.

- JET Charge: One of the largest suppliers of EV in Australia. They are the official charging partner to 14 different vehicle manufactures.
- Schneider Electric: They provide turn-key charging solutions for EV through their EVlink charging stations. They are compatible with most of the EV's manufactured for Australia. They also have different solutions for residential, commercial private and public parking areas.
- Tritium: They are specialised in designing and manufacturing the world's most advanced and reliable fast and high-powered DC chargers. Tritium has developed DC chargers with nameplates ranging from 50kW to 350kW.
- NHP: They are a well-established electrical and engineering company with over 50-years of experience in the Oceania region. They offer solutions ranging from low-cost home chargers to DC rapid chargers.

[22] https://electricvehiclecouncil.com.au/about-ev/charger-map/

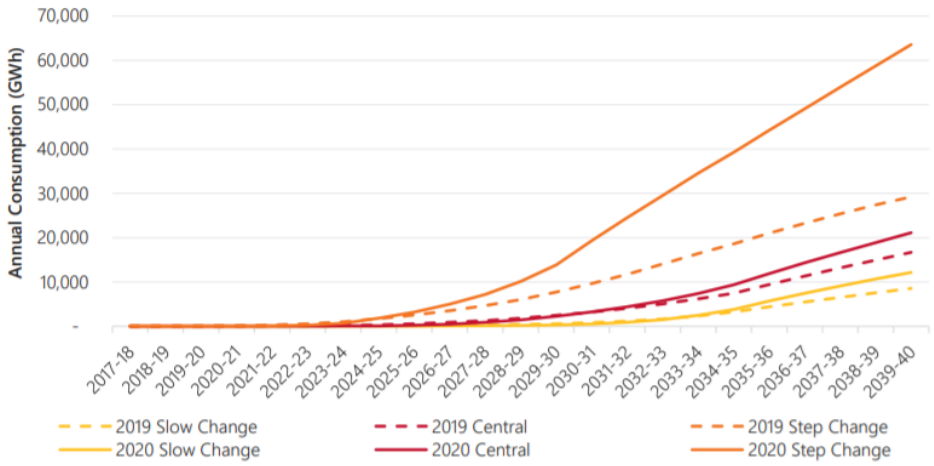
DC vs AC charging stations

Most electric cars are fitted with DC batteries. As the grid infrastructure carries AC power, Australia has pushed forward with AC charging infrastructure. Currently, there are 1,950 AC chargers, with 630 of them located in NSW. The AC current is converted onboard to DC, before the car is refuelled, hence the car takes longer to charge. On the other hand, DC chargers have AC-DC converters inside the charger, allowing for rapid charging. The DC chargers are more expensive units, and there are currently 350 charging stations across Australia with 153 of them located in NSW. The DC charging stations are beneficial for community areas, which could attract travellers and tourists.

Projected growth in electric vehicles

AEMO's 2020 Electricity Statement of Opportunities (SOO) forecasts energy demand for EV uptake through to 2040[23]. Except under a step-change forecast EV uptake forecasts remain low until the last 2020s' and into the 2030s.

Where fuelled with regular grid power in NSW EVs currently have higher operational emissions than hybrids, whereas where fuelled from renewables this is not the case. As the grid changes with planned retirements of coal fired power stations, this situation will change and emissions from EVs will become less than those from hybrids.



AEMO PROJECTIONS OF EV ELECTRICITY CONSUMPTION – SOO 2020

Based on these forecasts it is likely that emissions reduction from sustainable transport measures nationally will be modest in the period to 2030, but significantly increased by 2050 as the grid greens and EV uptake increases. Forecasts are updated periodically, and Council should monitor these from time to time. As indicated above the NSW Government's Net Zero Plan for the 2020-2030

[23] https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2020/2020-electricity-statement-of-opportunities.pdf?la=en

period includes significant work to incentivise and encourage uptake of EVs well ahead of the above forecasts, so this is an area that may accelerate quicker than current forecasts.

Availability of electric passenger vehicles in Australia

According to the Electric Vehicle Council[24], in 2020 there were 28 EV models available in Australia (both BEV and PHEV) from 11 manufacturers, and this was forecast to grow by a further 6 vehicles in 2021, with a continued shift towards battery electric vehicles (BEV).

In addition, the EV Council reports the commitments by most major car manufacturers to develop EVs in coming years. For example:

- Ford: By 2025, will invest $11 billion with the aim of having 24 hybrid and 16 fully electric vehicles in its global model portfolio by 2022.
- General Motors: 20 BEVs by 2023
- Hyundai: By 2024, $20 billion investment in EVs, AVs and batteries
- Nissan: 8 BEVs by 2022, $10 billion investment in EV
- Toyota: 10,000 units planned for 2020 and 30,000 for 2021, first new BEVs by 2021, 10 models are expected by 2025
- Subaru: By 2030, a minimum 40% of global sales will be electric vehicles (EVs) or hybrid electric vehicles (HEVs)

Corporate and government fleets make up more than 50% of new EV sales, and many Councils are now developing long term transport strategies that explicitly include a shift in their fleet to low and ultimately zero-emissions fleet. Most prominent at this time is the ACT Government, which is switching its passenger fleet to EVs for all new leases from 2020-21 and has trialled electric buses with a view to shifting these to all-electric by 2040 as part of the ACT's carbon neutral commitment.

Availability of low emissions Light Commercial Vehicles in Australia

Light Commercial Vehicles (LCVs), including utility vehicles are common among Council fleets and often account for a sizeable proportion of total diesel fuel use. Over the medium term, most of the major ute manufacturers have plans in place to provide electric and hybrid electric options in their ute range. A short summary of the current status for several vehicles is provided below.

- Mitsubishi Triton[25]: in September 2019 Mitsubishi advised that the next-generation Mitsubishi Triton ute – due two to three years from now (~2022/23) – will have the option of hybrid power, with decisions still to be made whether this will be a PHEV or a paired electric battery with fuel engine.

[24] https://electricvehiclecouncil.com.au/wp-content/uploads/2020/08/EVC-State-of-EVs-2020-report.pdf, p24
[25] https://www.caradvice.com.au/790317/mitsubishi-triton-to-get-hybrid-power-precede-nissan-navara-development/

- Toyota has committed to including electric options with all new vehicle models going forward, which will include utes[26]. Toyota is developing a hybrid version of its next-generation HiLux ute. It is expected this will be available from 2023. At this stage, Toyota has not committed to an all-electric model. A diesel-electric powertrain is one of the options under consideration.
- Nissan is also planning for an electric vehicle future, with a hybrid diesel-electric Nissan Navara ute potentially available by the mid-2020s[27]. Nissan also indicated that commercial vans were also candidates for electrification.
- Ford's next-generation Ranger and Everest models will include plug-in hybrid variants of both the dual-cab ute and off-road SUV, understood to be from 2022.

Most of the current activity and plans points to electric and hybrid electric utes being a medium to long-term proposition, and day-to-day performance while carrying load, and charging infrastructure are key factors that will evolve in the next couple of years.

For Berrigan Shire Council utility vehicles are widely used and hybrid models such as those noted above may provide an opportunity to trial one or more in Council's fleet in coming years.

Recommended actions – electrification of vehicles

Suggested actions for Council to pursue in coming years in relation to electrification of its vehicle fleet include:

- Assess the costs and benefits of hybrid passenger cars within council's petrol and diesel fleet for new purchases or leases.
- In the medium-term switch to hybrid passenger vehicles and LCVs when these become commercially available and viable, and potentially one or more electric passenger vehicles.
- Consider the development of EV charging infrastructure on Council land and by supporting local businesses.
- Consider trialling or implementing telematics on fleet to get more detailed data that can help to inform future vehicle selection decisions.
- In future reviews of Council's transport / vehicle procurement strategy, integrate planning to assess / evaluate and progress Council's fleet towards electric technologies where and when feasible.
- Stay abreast of developments in EV incentives, policy and other support, and incorporate these in Council's planning process for its transport fleet.
- Over the longer term, progressively migrate fleet to lower and zero emissions where it is technically and financially viable, including passenger vehicles, utes, commercial vans / buses and other operational plant.
- Continue transition from diesel to petrol vehicles where hybrids are not available (NOx, Euro 6).

[26] https://www.motoring.com.au/toyota-hilux-to-go-hybrid-121251/
[27] https://www.motoring.com.au/nissan-navara-e-power-hybrid-by-2025-119492

Scope for abatement

The scope for emissions reduction for Berrigan Shire Council overall from transport measures is **266.5 t CO_2-e** inclusive of both scope 1 and scope 3 emissions. The speed of emissions reduction will depend on the rate of adoption of EVs and hybrids, and on selection of renewable energy as the fuel source

Risks and mitigation

Berrigan Shire Council should assess the range of factors influencing the uptake of EVs for different types of vehicle user – owned or leased by Council, salary-sacrificed by staff, or driven by contractors. Factors will include:

- Whole of Life costing basis that consider purchase price, incentives, resale, and operating costs including electricity price
- Range and charging infrastructure
- Fitness for purpose
- Availability, serviceability, warranties
- The role of other technologies such as hydrogen, autonomous vehicles, etc in Council's long-term fleet strategy

Costs and benefits

The capital cost premium for EVs and hybrid models that are fit for purpose for Council requirements, as well as the future resale value will be assessed alongside fuel, registration, insurance and maintenance cost savings from time to time using a Whole of Life cost calculation. A cost-neutral approach would see low-emission vehicles have comparable total-cost-of-ownership to current fleet.

7.7 Sustainable procurement

Description

Sustainable procurement is an effective method of incrementally reducing Council's energy consumption and emissions and improving sustainability over time. There are three main components to a suggested sustainable procurement approach:

1. Regularly reviewing and updating existing procurement policy framework to incorporate or update sustainable procurement aspects
2. Providing engagement and training to Council staff to educate and drive the use of a sustainable procurement framework in all aspects of Council's operations
3. Review current equipment and services specifications, and identify opportunities to incorporate the sustainable procurement framework into the procurement and use of equipment

Sustainable procurement framework

A policy relating to sustainable procurement can set out Council's overall intent to procure products and services with consideration of Council's sustainability goals, such as emissions reduction, energy efficiency and water conservation (among others). Alongside a policy, Council should develop its internal sustainable procurement guidance, drawing on an appropriate framework. One is summarised here:

NSW Local Government Guide

*"Sustainable procurement takes into consideration responsibility for the **economic**, **environmental**, **social** and **governance** impacts of any purchase – products or services. These four factors are referred to as the quadruple bottom line and relate to a total purchase cost, and not just the upfront dollar expense.*
Sustainable procurement, applied to NSW councils' spending, represents a significant opportunity to drive social and environmental change throughout a wide range of not only direct suppliers, but also the associated supply chains[28]".

The 2017 Sustainable Procurement Guide for NSW local governments aims to help Councils develop and embed sustainable procurement practices in their organisation. The guide presents information on key concepts, certifications, standards and processes and is designed for all council staff involved in any purchasing. The Guide is applicable from major tenders through to one-off equipment purchases.

Council should examine the guide to identify key areas within its procurement processes where this can add value and lead to more informed and better procurement decisions.

Complementing a Guide such as this, Council has access to a wide range of information and data that can help it take decisions on equipment purchases. A prominent resource is the Equipment Energy Efficiency (E3) program.

[28] Sustainable Procurement Guide for Local Governments in NSW, 2017: https://www.lgnsw.org.au/files/imce-uploads/127/esstam-sustainable-procurement-guide-30.05.17.pdf

- The Equipment Energy Efficiency (E3) program[29], 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.

Engagement & Training

Even with a policy and sustainable procurement framework in place, decisions to source services and products that deliver best practice sustainability outcomes will happen when people who are buying these services and products take these decisions.

Underpinning this needs to be engagement, education and training of staff across Council who procure services and products. This could encompass:

- Capital works staff involved in the design of new projects such as new water and sewer treatment plants, or new / renovated buildings, where energy and water efficiency and onsite renewables and battery storage could be specified,
- Roads and pavement repair / maintenance teams who specify the types of materials to be used, where there may be opportunities to use more sustainable materials,
- Fleet procurement staff who assess plant and vehicle needs and specify new purchases and leases that will impact fuel use for a number of years,
- Operational staff who may repair or replace equipment as it fails, such as appliances, air conditioners, lights, where there are opportunities to ensure that replacements are fit for purpose and energy efficient

Equipment and Services Specifications

Policy, procurement frameworks and education / training should ultimately lead to the specifications that Council develops for services and works / products being modified to include requirements for efficiency and renewables where applicable. In addition, the evaluation criteria and weighting of responses to tenders and quotes should be designed to properly evaluate and weight performance against specified sustainability requirements, such as level of efficiency, emissions reduction and whole-of-life cost.

Products and services where Council could potentially amend its specifications include:

- **Building and road construction materials**: Council can include requirements and/or targets for low emissions materials, such as targets for use of recycled asphalt in road base for example, and later on progressing towards low emissions content in materials such as steel, cement and concrete.

[29] http://www.energyrating.gov.au/

- **Building lighting:** Council will see added savings over time as all lights are upgraded to LED, increasing if suitable controls are also specified as either additional components or built into LED lights.
- **HVAC:** The opportunities for Council to improve the energy efficiency of air conditioning include:
    - Review the design of planned new systems,
    - Select energy efficient AC units, that can be serviced locally,
    - Review energy efficient models in the current market (e.g. refer to www.energyrating.gov.au) and specify minimum efficiencies (COP / EER) in cooling and heating mode that align with good to best practice.
- **Power & appliances:** Power and appliances include servers that run 24/7, office equipment such as computers, copiers and printers, and appliances like fridges, boiling water units, microwaves, dishwashers and televisions. Efficient appliances and 'green IT' options are available and specifications can ensure equipment such as these are energy efficient when purchased.
- **Water and sewer pumps** are upgraded or rebuilt from time to time. Upgrades offer the opportunities to assess system design, evaluate VSD opportunities and improve control systems.
- **Public Park lighting:** LED lighting is emerging as the default technology here. As parks are upgraded this will emerge as the preferred technology, integrated with controls where feasible/practical.
- **Sporting oval lighting:** Ovals have relatively few operating hours, so the technology cost and warranties need to more closely match those for existing technologies to make a compelling case for change to LED.
- **Building design policies:** Energy efficiency performance requirements are set out in Section J of the BCA and these or an improvement to these could be stipulated by Council in designing new facilities.

Scope for abatement

The scope for abatement from sustainable procurement is sizeable, with incremental gains made via all purchased goods and services over the long term. Berrigan Shire Council also has the capacity to influence emissions reduction by its suppliers and contractors

Risks and mitigation

An assessment of risks and mitigation strategies would be part of any periodic review of procurement policies and processes for goods and services.

Costs and benefits

A robust sustainable procurement approach would see sustainable services and goods sourced on a whole-of-life cost basis, which will tend to favour efficiency and lower lifetime cost. Similarly, contractors and suppliers who are sustainable in their own operations are likely to have lower, not higher costs.

8 Berrigan Shire Council Action Plan

In order to achieve deep cuts in its energy use and associated GHG emissions, Berrigan Shire Council will need to commit time, resources and financial support to a multi-year program of work that will implement measures identified in this plan that reduce emissions. A key priority in this should be to invest in measures that also improve Council's bottom line.

These measures are identified below and tabulated into a short-medium term plan, and long-term and continuous improvement actions, based on priorities, costs and maturity of the technology recommended. The opportunities identified reflect the measures identified in the above section.

8.1 Short to medium term action plan

Based on the assessment of onsite measures, the current electricity market and sustainable transport opportunities, a suggested short to medium term action plan for Berrigan Shire Council is outlined below. Actions recommended could be implemented during the course of the current and next Delivery Plan cycle, for example.

TABLE 9: BERRIGAN SHIRE COUNCIL TO MEDIUM TERM PLAN FOR COUNCIL OPERATED SITES

Category	Sub-category	Site	Energy-saving option	Indicative cost	Payback (years)	IRR
Behind the meter solar	Solar PV - Roof - STC	Barooga Water Treatment Plant - Solar (There are three NMI's under the same name, this NMI reflects the account with solar PV connection)	Upgrade the panels from 250W to 450W panels and remove all panels from the heavily shaded section, i.e., behind the water tank. This upgrade can increase the solar PV array size to 23.4kW from 14.5kW system.	$16,380	6.3	15%
Energy efficiency	VSD Control		Implement VSD control for clear water pumps at the water treatment plant.	$32,993	8.0	~13%
Energy efficiency	Load shifting		The Barooga water treatment plant only has a retailer (AGL) time-of-use, and the contract does not include any network demand tariffs. This plant *(4204150638)* only utilises 11% of its annual electricity during peak hours. By shifting this consumption to off-peak hours, there is a potential savings of up to ~**$881 per annum**.			
Energy efficiency	Streetlighting	Vermont St Streetlighting	Upgrade 10 twin light poles of the road median strip and private lights on the walkway to LED technology.	**Not assessed.** Requires details on the streetlighting inventory to estimate the savings potential from current streetlighting system.		
Behind the meter solar	Solar PV - Roof - STC	Berrigan Library	Install a 3.8kW roof-mounted solar PV system to meet most the daytime energy demand.	$3,800	4.5	22%
Energy efficiency	Lighting		Upgrade 27 x twin 28W T5 lights, 2 x 18W CFL and 4 x twin 26W CFLs in the foyer to LED.	$3,799	6.0	17%
Behind the meter solar	BESS	Berrigan Shire Offices	Based on the current consumption vs. export of the solar PV at the Council office, install a 60kWh battery storage unit to maximise the solar self-consumption. Or,	$54,000	22.7	1%
Behind the meter solar	Solar PV - Roof - STC		Expand the existing 50kW solar PV system with an additional 33.4kW solar PV system. The current solar array is exporting **~30%** *(based on SMA monitoring portal)* of energy generated back to the grid, which would be mainly during the weekends	$33,400	5.0	20%

			and summer months. This would ensure that the Council office is battery ready, when the price for BESS becomes competitive to install. Based on the solar PV generation, the existing solar PV system is yielding **-6%** of its expected energy. However, this could be due to minor shading and temperature losses.			
Energy efficiency	Voltage Optimisation		The incoming voltage has been noted at ~250V, assess optimisation of this voltage supply to reduce to ~230V, which can reduce the total energy used by ~10%.	**Not assessed,** would require further investigation.		
Behind the meter solar	Solar PV - Ground - STC	Berrigan STP	Install a 7.7kW single pole ground mount system near to the switchboard of the STP.	$9,984	5.0	20%
Behind the meter solar	BESS	Berrigan Water Treatment Plant	The existing solar array is exporting ~40% of the energy generated back to the grid (these estimates were based on the latest electricity bills only), therefore install a 40kWh battery storage unit to maximise the solar self-consumption. ***Or,***	$36,000	18.5	4%
Behind the meter solar	Solar PV - Upgrade		Upgrade the current 275W solar panels to 380W panels to increase the total array size from ~20kW to 30.4kW. However, without a battery storage, the exports would be large due to the intermittent energy requirements of this site.	$21,280	3.2	32%
Behind the meter solar	BESS	Burkinshaw Street Barooga (Barooga Rec Reserve)	Assess the potential to couple a battery storage unit to the existing 5kW solar PV system at the Recreational reserve.	**Not assessed.** Requires consumption and generation data to estimate the potential for battery storage system.		
Behind the meter solar	Solar PV - Roof - STC	Chanter Depot	Install a 13.7kW roof-mounted solar PV system on the east and west section of the admin building at the Depot.	$13,700	3.2	31%
Behind the meter solar	Solar PV + BESS - Roof - STC		Alternatively, in the medium term, consider installing a larger 22.8kW roof-mounted solar PV system at the admin building with a 25kWh battery storage unit to meet most of the sites energy demand.	$45,300	4.9	19%
Energy efficiency	Lighting		Completely upgrade the remaining fluorescent lights to LEDs	$5,741	5.0	~20%
Behind the meter solar	Solar PV - Roof – STC	Berrigan Sportsground	Install an 8.36kW roof-mounted flush solar PV system on the grandstand.	$8,360	4.5	22%

Behind the meter solar	Solar PV - Roof - STC		Alternatively, install a larger 15.2kW roof-mounted flush solar PV system on the grandstand. This would ensure the Berrigan Sportsground is ready for battery storage system in the future.	$15,200	9.1	10%
Behind the meter solar	Solar PV - Roof - STC	Finley Library and Early Intervention	Install a 5.32kW roof-mounted solar PV system on the north section of the library building.	$5,320	4.6	22%
Behind the meter solar	Solar PV - Ground - STC	Finley STP	Install a 13.5kW ground-mounted solar PV system close to the main switchboard.	$17,550	10.3	8%
Energy efficiency	Lighting	Finley Water Treatment Plant	Upgrade indoor and outdoor lights to LED technologies	$3,215	9.0	~11%
Energy efficiency	VSD Control		Upgrade the raw water pumps from VLT soft starts to VSD controls	$20,685	10.0	~13%
Energy efficiency	VSD Control		Upgrade the clear water pumps from soft start to VSD control	$20,685	10.0	~13%
Behind the meter solar	Solar PV - Upgrade		Upgrade the existing solar PV system by replacing the 265W panels to 400W panels. This would increase the system to 27.2kW.	$19,040	3.7	27%
Behind the meter solar	Solar PV - Ground - STC		Install an 83.7kW ground-mounted solar PV system on the existing clarifier sections, which would be decommissioned after the new DAF plant is built.	$108,810	9.4	9%
Energy efficiency	Design		Integrate energy efficiency solutions to the new plant design incl VSDs, pump / pipework design, roofs and electric infrastructure designed for solar and future EV charging.	**Not assessed.**		
Energy efficiency	Power factor correction		Install power factor correction device with a capacitor size of **50 kVAr.**	$5,000	2.52	~39%
Energy efficiency	Load shifting		Based on the interval data, we have estimated that, by shifting the loads completely from peak hours of operation to off-peak periods, Council can save ~**$6,972 per annum**. If Council opts to install a power factor correction device, the savings will reduce to **$6,042 per annum** due to the improved peak demand from the proposed 50 kVAR device. Furthermore, the site is currently supplied through a transitional tariff structure 'BLNDTRS' which is expected to change by July 2021 to 'BLND3AO'. With this change in tariff structure, the savings would be higher as the peak demand pricing is expected to increase by ~49%. Thereby the estimated annual savings with BLND3AO tariff is **~$9,830.**			
Behind the meter solar	Solar PV - Ground - STC	McCulloughs Rd STP	Install a 23.4kW ground-mounted solar PV system oriented towards the north-west, outside the plant fence.	$30,420	10.3	8%

Behind the meter solar	Solar PV + BESS - Roof - STC	Saleyards Road Truck wash	Install a 3kW roof-mounted solar PV system on the amenities block with a 5kWh BESS to match the site's grid electricity consumption.	$7,530	14.3	7%
Behind the meter solar	Solar PV - Ground - STC	Tocumwal Swimming Pool	Install a 9.18kW ground mount system, similar to 5B technology which has smaller footprint and limited civil work requirements on the south-east corner of the pool.	$11,934	8.1	11%
Energy efficiency	Lighting		Replace ~30 single T5 lights to LED battens	$3,420	6.0	~17%
Energy efficiency	Power factor correction	Water Treatment Pump - Tuppal St	Install power factor correction device with a capacitor size of 25 kVAr.	$2,500	2.4	~42%
Energy efficiency	Load shifting		Our analysis suggests that if the water treatment plant can shift all the electricity demand from peak periods to off-peak periods, Council could see a maximum savings of **$7,800 per annum,** with significant savings from reducing the peak demand charges. Additionally, if Council opts to implement a PFC device at this facility, the annual savings will reduce to **$6,947,** which is due to the improved power factor from this proposed 25 kVAR power factor device.			
Electricity	Renewable Energy Power Purchasing	Whole of Council	Develop a case to enter into a PPA to supply certain percentage of Council's site with renewable energy.	**Not assessed**. Assess this opportunity along with RAMJO Council members as part of bulk procurement to get competitive pricing in the current electricity market.		
Total				**$556,046**	**6.4**	**~18%**

8.1.1 Long term action plan

A suggested long-term action plan for Berrigan Shire Council is outlined below. Please note that the details in the table below for solar at Berrigan Library, Barooga Water Treatment Plant, Berrigan Water Treatment Plant, Barooga Rec Reserve, Berrigan Sportsground, and Finley Library the full costs and associated savings for these suggested systems. There are also short / medium term options suggested for these sites. If Council opts to install the short / medium term options, then Council will only incur the marginal cost for expanding the systems in the longer term, along with the marginal savings of the additional systems.

TABLE 10: BERRIGAN SHIRE COUNCIL LONG TERM PLAN FOR COUNCIL OPERATED SITES

Category	Sub-category	Site	Energy-saving option	Indicative cost	Payback (years)	IRR
Behind the meter solar	Solar PV + BESS - Ground - STC - Upgrade	Barooga Water Treatment Plant - Solar	Upgrade the existing solar PV system with additional solar on the main switchboard room to a 35.6kW ground-mounted solar PV system with a 70kWh battery storage system to maximise the solar self-consumption and reduce the site's grid dependency.	$87,920	8.9	8%
Behind the meter solar	Solar PV + BESS - Roof - STC	Berrigan Library	Install a larger 8.36kW solar PV system on the north and east section of the library building with a 10kWh battery storage system to meet the site's intermittent energy demand.	$17,360	5.8	15%
Behind the meter solar	BESS	Berrigan Shire Offices	Increase the total solar PV array size to 83.4kW at Council office and implement a 100kWh BESS to maximise the solar self-consumption from this site and match the site's grid electricity demand.	$123,400	22.0	1%
Behind the meter solar	Solar PV + BESS - Ground - STC - Upgrade	Berrigan Water Treatment Plant	Upgrade the existing 20kW ground-mounted solar PV system with a 30.4kW system and implement a 65kWh battery storage unit.	$79,780	6.8	12%
Energy Efficiency	VSD Control		Install VSD controls on the two clear water pumps.	$39,060	10.0	~10%
Behind the meter solar	Solar PV + BESS - Roof - STC	Burkinshaw Street Barooga (Barooga Rec Reserve)	Install a 15kW roof-mounted solar PV system to the existing 5kW solar PV system at the Recreational reserve with a 40kWh battery storage unit to meet the site's intermittent energy demand.	$51,000	16.5	5%
Behind the meter solar	Solar PV + BESS - Roof - STC	Berrigan Sportsground	Install a 15.2kW roof-mounted flush solar PV system with a 40kWh battery storage system to meet most of the site's electricity demand.	$51,200	8.9	7%
Behind the meter solar	BESS	Berrigan Swimming Pool	Based on the current solar PV generation, consumption and exports implement a battery storage system to reduce the exports back to the grid.	**Not assessed.** Require site's generation and consumption data to estimate the feasibility of solar PV at this site.		

Behind the meter solar	Solar PV + BESS - Roof - STC	Finley Library and Early Intervention	As the site is open only for three days in a week, most of the solar generated from this site would be exported back to the grid. Hence, install a 5.32kW solar PV system with a 10kWh battery storage unit to meet most of the site's electricity demand.	$14,320	7.8	9%
Behind the meter solar	Solar PV + BESS - Ground - STC	Finley STP	Install a 13.5kW ground-mounted solar PV system with a 45kWh battery storage unit to meet the site's intermittent electricity demand.	$58,050	8.9	7%
Behind the meter solar	Solar PV + BESS - Ground - STC	Finley Water Treatment Plant	Apart from the existing solar PV system, install an additional 83.7kW ground-mounted solar PV system on the existing clarifiers section (to be decommissioned after the new DAFT plant is built). Due to the intermittent nature of the electricity demand for water treatment plants, consider implementing a large-scale battery storage system of 140kWh to meet most of the sites electricity demand.	$234,810	19.1	3%
Behind the meter solar	Solar PV + BESS - Ground - STC	McCulloughs Rd STP	Install a larger ground-mounted solar PV system of 54.9kW coupled with 110kWh of battery storage to maximise the solar self-consumption.	$170,370	8.8	8%
Energy Efficiency	VSD Control	Sewer Pump - Barinya St Barooga	Install VSD controls on the pumps which are currently being upgraded.	$11,401	12.0	~8%
Energy Efficiency	Lighting	Tocumwal Aerodrome Runway Lighting	Upgrade all the runway lights to LED technology.	$2,314	15.0	~7%
Behind the meter solar	Solar PV + BESS - Roof - STC	Tocumwal Aerodrome	Install a 4.15kW roof-mounted solar PV system tilted towards the north orientation of the Aero club building. Additionally, implement a 6kWh battery storage unit to meet most of the site's electricity demand.	$9,550	6.2	13%
Behind the meter solar	Solar PV + BESS - Ground - STC	Water Treatment Pump - Tuppal St	Due to the limited land and roof area, consider implementing an additional 82.9kW ground-mounted solar PV system to the existing 17kW solar roof-mounted solar PV on the north-west section of the Recreational reserve with a 100kWh battery storage unit.	$197,640	22.9	1%
Total				**$1,148,175**	**9.8**	**~8%**

8.1.2 Continuous improvement

The following opportunities can be pursued over time as part of a continuous improvement approach to energy management by Berrigan Shire Council.

TABLE 11: BERRIGAN SHIRE COUNCIL'S CONTINUOUS IMPROVEMENT PLAN FOR COUNCIL OPERATED SITES

Category	Sub-category	Site	Energy-saving option	Cost or resources required
Behind the meter solar	Solar Operation and Maintenance	All sites with solar PV systems	Develop an operation and maintenance strategy for existing solar PV systems. This could be a contractual agreement with a local installer to provide quarterly/ biannual/annual standard maintenance on the existing system. Additionally, monitor the operation of the PV system to reduce any losses incurred due to prolonged system failures.	**Not assessed.**
Energy efficiency	HVAC	Berrigan Shire Offices	Develop a strategy to replace the existing HVAC systems to energy efficient multi-unit and single unit split systems. The current HVAC units are ~20 years old, utilising banned R22 refrigerant. These units could be replaced with any units with EER/COP greater than 4, preferably using R32 refrigerant gas.	**Not assessed.** Can be implemented through Council's procurement.
Energy efficiency	Demand reduction	Burkinshaw Street Barooga (Barooga Rec Reserve)	Switch-off equipment such as fryers and urn at the old pavilion/clubrooms.	**Not assessed**.
Energy efficiency	HVAC	Chanter St. Depot	Develop a strategy to replace existing HVAC units to more efficient ones.	**Not assessed.** Can be implemented through Council's procurement
Energy efficiency	Lighting	Finley School of Arts	Upgrade all indoor lights to LEDs.	**Not assessed.** As usage is low, consider these lighting upgrades on failure.
Energy efficiency	Energy efficiency	Hill Street Depot	Upgrade all indoor lights to LEDs.	**Not assessed.** As usage is low, consider these fluoro lighting upgrades on failure.
Energy efficiency	Demand reduction	Tocumwal Swimming Pool	Turn off all kiosk appliance at the end of swimming season	**Not assessed.**
Energy efficiency	Demand reduction		Consider shutting the filter pumps off at the end of swimming season (6 x 1.5kW).	**Not assessed.**

Energy efficiency	Lighting	Townbeach Rd (Rec Reserve)	Upgrade training lights to LED tower lights.	**Not assessed.** A project such as this is generally only feasible when field lights / poles are being replaced, or via grant funding.

8.1.3 Possible Community projects

A suggested list of mid-scale solar PV projects that could be implemented at Berrigan Shire Council is tabulated below. These projects have been sized to showcase the sites' capability to install a mid-scale solar farm/ community scale projects within Council.

TABLE 12: BERRIGAN SHIRE COUNCIL SOLAR FARM / COMMUNITY-SCALE PROJECTS

Category	Site	Energy-saving option	Assessed costs
Community-scale solar PV	Finley Saleyards	The Finley saleyards has a large roof space to install ~250kW solar PV system, that can generate up to 358MWh per annum. A project of this scale can be developed by the community.	~$378,000
Mid-scale solar farm	McCulloughs Rd STP	Council or the joint organisation can investigate an opportunity to install a ~2MW solar farm on the north-section outside the sewage treatment plant at Tocumwal. The land has an ideal terrain for implementing solar farm, and has distribution feeders running across the land, which could be utilised to connect into the Essential Energy grid network. However, based on the preliminary network enquiry, further assessment and size optimisation could be done to benefit Berrigan Shire Council and neighbouring Council members.	~$3,636,000

8.1.4 Low priority

For completeness, we have summarised a list of opportunities that are currently not feasible or of low priority for Council.

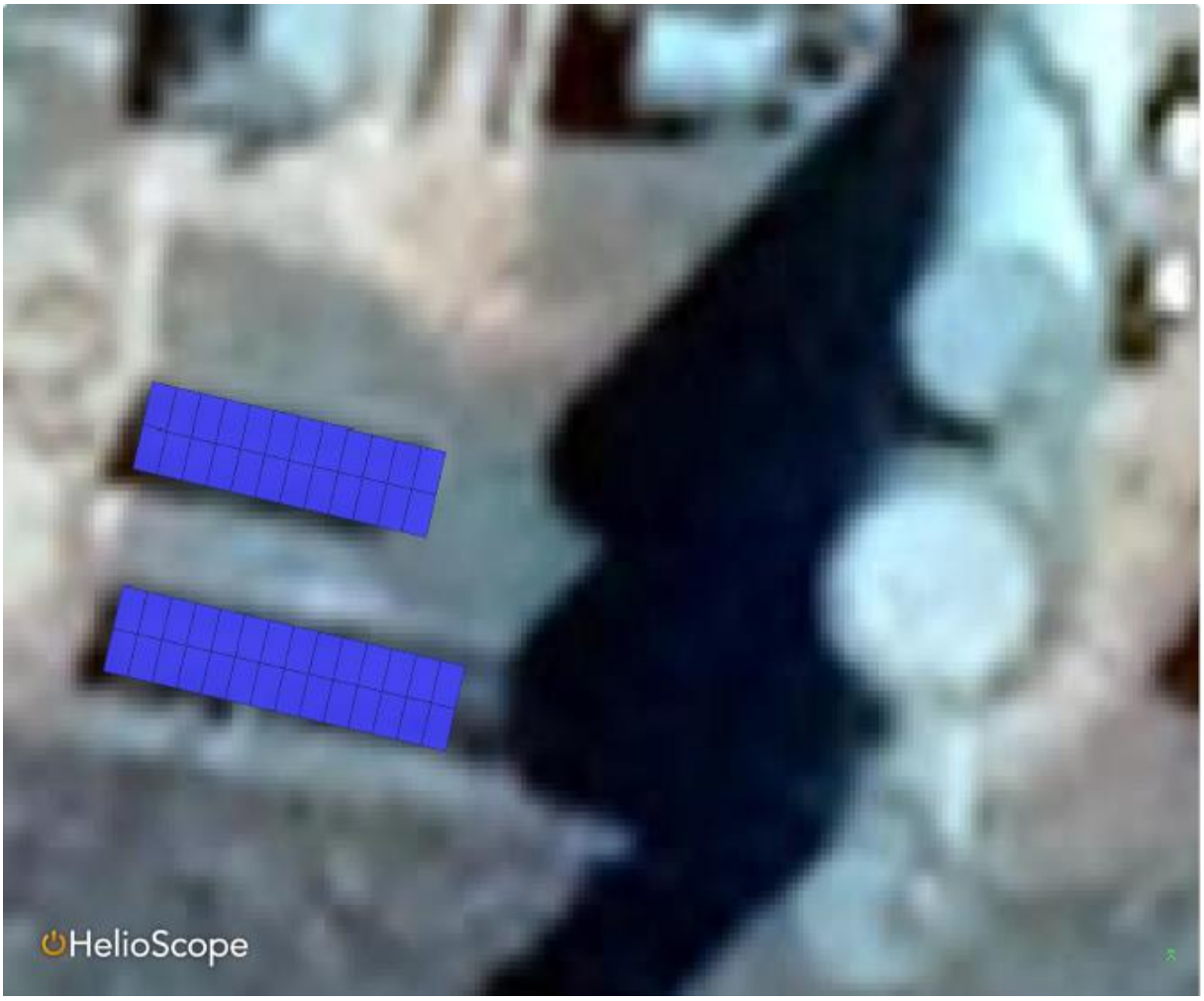
TABLE 13: LOW PRIORITY OPPORTUNITIES AT BERRIGAN SHIRE COUNCIL

Category	Sub-category	Site	Energy-saving option	Cost or resources required
Energy efficiency	Energy efficiency	Apex Park Sprinklers	Upgrade all lights to LED technologies.	**Not assessed.** The energy usage is too small and intermittent, replace the lights on failure.
Energy efficiency	Lighting	Burkinshaw Street Barooga (Barooga Rec Reserve)	Upgrade 6 x HID lights at netball court to LED technology.	**Not assessed.** This project could be completed along with field lighting upgrades, or via grant funding.
Energy efficiency	Demand reduction	Berrigan Sportsground	Bar cool room temperature seems to be set at 1^0C, when it is supposed to be 4-5^0C.	**Not assessed.**
Behind the meter solar	Solar PV + BESS - Roof - STC	Berrigan War Memorial Hall	Install a ~2kW solar PV system coupled with a small battery unit on the newer section/ rear end of the building.	**Not assessed.** The energy consumption is too small and intermittent for a solar PV array and BESS.
Behind the meter solar	Solar PV + BESS - Roof - STC	Finley School of Arts	Install a ~2kW roof-mounted solar PV system with a battery storage unit to meet the complete demand of the site.	**Not assessed.** The energy consumption is too small and intermittent for a solar PV array and BESS.
Energy efficiency	Demand reduction	Hill Street Depot	Install a ~3kW roof mounted solar PV on the admin building.	**Not assessed.** The electrical infrastructure at this site is too old, and the electrical boards may require an upgrade. Furthermore, the annual energy consumption is too small for solar PV.
Behind the meter solar	Solar PV + BESS - Roof - STC	Saleyards Road Truckwash	Consider relocating the solar array and BESS from the splash park.	**Not assessed.** This opportunity has been noted as the system at splash park seems to be heavily shaded and currently under performing.
Behind the meter solar	Solar PV + BESS - Roof - STC	Tocumwal Library	Consider installing ~3kW solar PV system with a battery storage to meet the site's energy demand.	**Not assessed.** This site was not listed as a priority during our site inspection. However, we have noted the site has a

				potential roof space for solar PV installation in the future.
Behind the meter solar	Solar PV + BESS - Carport - STC	Tocumwal Swimming Pool	Replace the shade cloth over toddler's pool for a structure which is inclusive of battens and purlins to accommodate a 21.6kW solar PV system facing north. This solar PV system can be coupled with a 30kWh battery storage unit to meet the site's variable energy demand.	~**$87,480**
Behind the meter solar	Solar PV - Roof - STC	Townbeach Rd (Rec Reserve)	Install ~53kW solar PV system on the Rec reserve pavilion building. The roof space looks large with minimal shading, could have opportunities to trade generated energy to the WTP through peer-to-peer solar trading.	**Not assessed.** This opportunity requires further assessment to accurately estimate the energy savings for Council.
Behind the meter solar	Solar PV	Water Treatment Pump - Tuppal St	Replace the existing 250W panels with 400-450W panels to increase the total system capacity.	**Not feasible.** The solar PV system is heavily shaded and would not be beneficial to upgrade this solar PV system.
Behind the meter solar	BESS		Install a battery storage system to store the excess solar energy generated from the existing solar PV system.	**Not feasible.** Most of the energy generated from the existing solar PV system is self-consumed at the water treatment plant.

Appendix A: Solar PV potential locations

Barooga Water Treatment Plant – 23.4kW – Solar PV upgrade



Barooga Water Treatment Plant –35.6kW – Solar PV upgrade + BESS

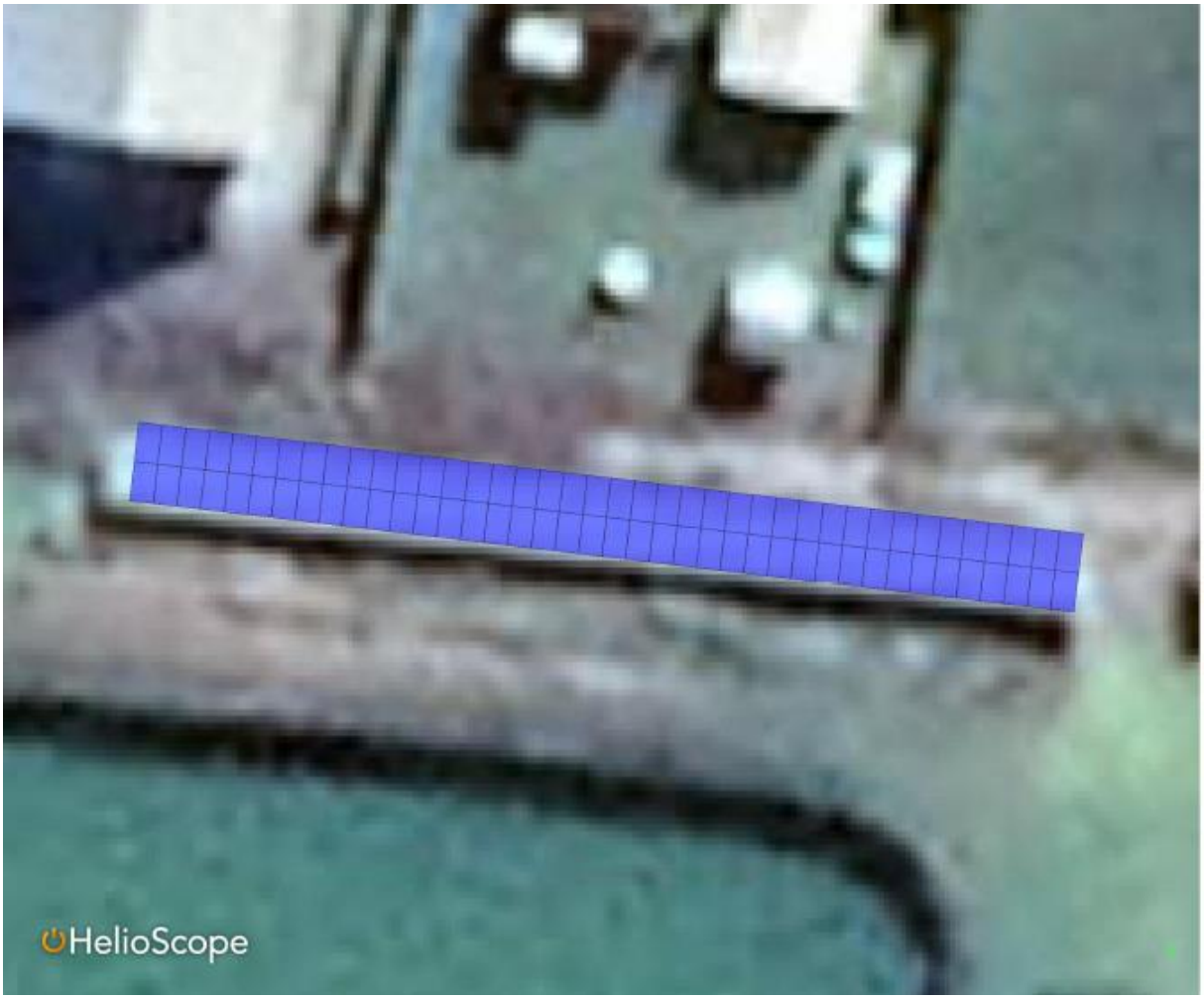
Berrigan Library – 3.8kW – Solar PV - Roof - STC

Berrigan Library – 8.36kW – Solar PV + BESS - Roof - STC

Berrigan Shire Offices – 33.4kW – Solar PV + BESS - Roof - STC

Berrigan STP – 7.7kW – Solar PV - Ground - STC

Berrigan Water Treatment Plant – 30.4kW –Solar PV + BESS - Ground - STC -Upgrade



Burkinshaw Street Barooga (Barooga Rec Reserve)– 15kW Solar PV + BESS - Roof - STC

Chanter St Depot – 13.7kW – Solar PV - Roof - STC

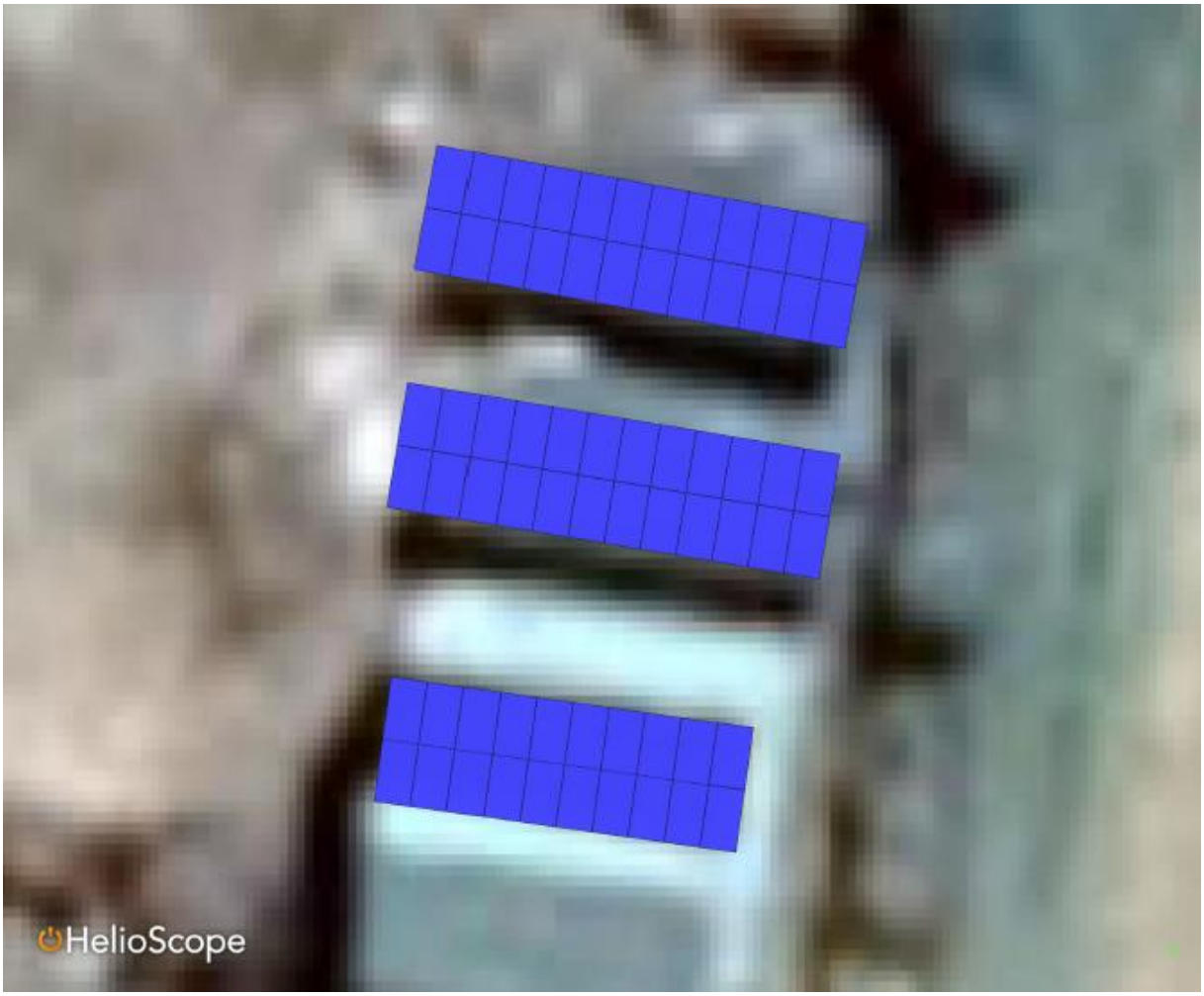
Chanter St Depot – 23kW –Solar PV + BESS - Roof - STC

Committee - Berrigan Sportsground– 15.2kW – Solar PV + BESS- Roof - STC

Finley Library and Early Intervention – 5.32kW – Solar PV + BESS - Roof - STC

Finley STP – 13.5kW – Solar PV + BESS - Ground - STC

Finley Water Treatment Plant – 27.2kW – Solar PV - Upgrade



Finley Water Treatment Plant – 83.7kW– Solar PV + BESS - Ground - STC

Hill Street Depot – 3kW– Solar PV - Roof - STC

McCulloughs Rd STP- 23.4kW – Solar PV - Ground - STC

McCulloughs Rd STP- 55kW – Solar PV + BESS - Ground - STC

Saleyards Road Truck wash – 3.03kW – Solar PV + BESS - Roof - STC

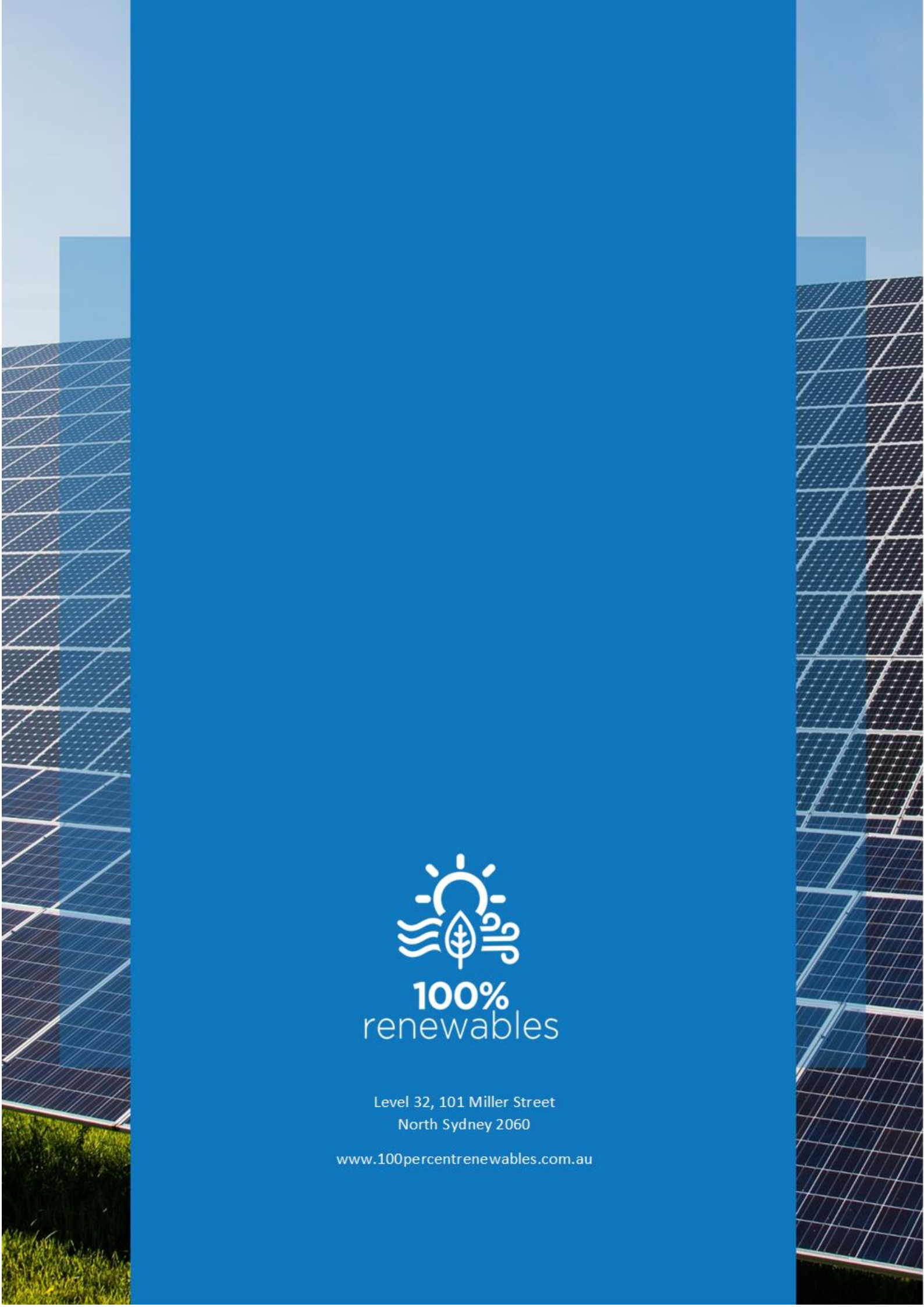
Tocumwal Aerodrome– 4.15kW– Solar PV + BESS - Roof - STC

Tocumwal Swimming Pool– 9.18kW– Solar PV - Ground - STC

Tocumwal Swimming Pool– 21.6kW– Solar PV Structure + BESS

Townbeach Rd (Rec Reserve) – 56.3kW– Solar PV - Roof - STC

Water Treatment Pump - Tuppal St – 82.8kW– Solar PV + BESS - Ground - STC



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