Broken Hill City Council
Renewable Energy Action Plan

Completed by Constructive Energy Pty Ltd

OCTOBER 2020

Endorsed by Broken Hill City Council for public exhibition – 25 November 2020 – Minute No. 46395
Adopted by Broken Hill City Council – 24 February 2021 – Minute No. 46439

Contents

Disclaimer

This report documents the results of preliminary observations and analysis of material provided to Constructive Energy Pty Ltd. In preparing the report, we have relied upon information provided by Broken Hill City Council, retailers and Azility Energy Management through referral to form our conclusions. Whilst we have reviewed this information to assess its reasonableness and internal consistency, we are not able to consider specific and/or abnormal circumstances that may impact your energy use.

The findings, conclusions and recommendations and all written material contained in the report represents our best professional judgement based on estimated and generic data and visual inspection where appropriate. Recommendations have assumed average conditions and historical usage.

Executive Summary

Constructive Energy have completed a process involving staff interviews, meetings and workshops, literature review, site visits, data collation and interrogation, modelling, market research and high-level business plan/feasibility development. As a result, we have identified a range of projects and initiatives designed to meet the unique objectives, constraints and opportunities of Broken Hill City Council (BHCC).

BHCC shares many concerns common among local governments in relation to energy, such as cost control and uncertainty about how to engage with renewable energy technologies and business models. Admirably however, Council have an overarching objective to drive operations from 100% renewable energy by 2023. This goal necessitates examining building energy consumption (both electricity and gas) and vehicles, plant and equipment.

While a full range of renewable energy technologies are explored, CE finds the most obvious opportunity in solar PV, following essentially one of two pathways; Behind the Meter (BtM) distributed energy or Distributed Energy installations across a number of Council and possibly partner assets. These options are discussed in detail throughout the Plan.

Energy Storage should be considered as part of the evaluation for every project for its ability to provide flexibility and adaptability in energy management in the future. This is particularly true if Council elects to follow the distributed energy route.

The accessibility of energy consumption data is poor across Council assets with very little real time monitoring available. Smart metering upgrades are an immediate priority even in the absence of any other activity as this represents a 'no regrets' strategy in both providing data for decision making and future proofing the Council for smarter energy trading and management.

The retailing sector is changing dramatically and BHCC is well positioned to take advantage of emerging models in valuing and sharing renewable energy. Capacity now exists for BHCC to effectively operate as a 'generator-retailer' and to use excess energy to underpin services or affordable energy to local business and industry.

Efficiency should not be forgotten as this both reduces the CAPEX required to achieve 100% renewable and, if the right generator-retail deal is brokered, will result in additional value for Council.

Vehicles, plant and equipment represent a challenge which can be managed basically through offsetting or substitution depending on financial factors, the appetite of Council for innovation/leadership and the practicality of developing alternative fuels in Broken Hill.

Constructive Energy are of the opinion that becoming 100% renewable is not only achievable, but that it makes economic sense to do so and will improve the fitness of council for the future on multiple levels. We recommend that Broken Hill City Council adopt this Renewable Energy Action Plan, use it to gain or leverage government and private investment, and start soon in order to meet the 2023 target.

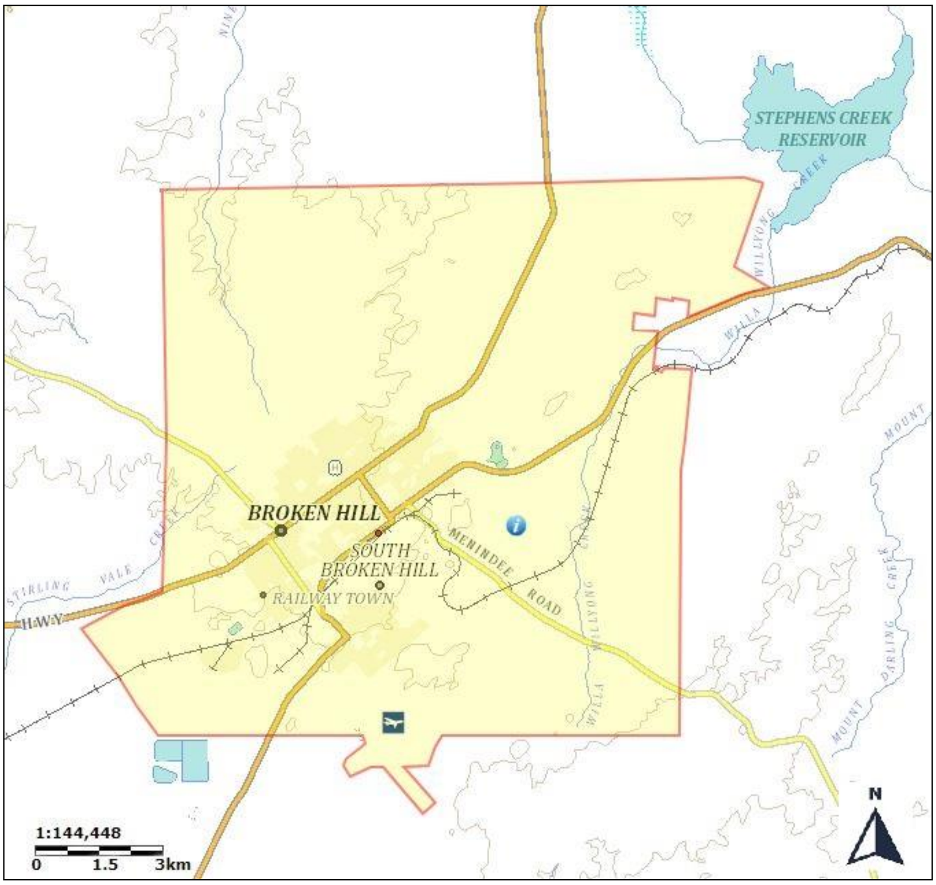
Constructive Energy is passionate and dedicated to the integration of renewable energy in Regional Australia for the advantage of local communities. As such, we are available as a 'critical friend' to Council on an ongoing basis at no charge. Constructive Energy can assist in grant submission, business case development and project delivery that BHCC may require. Recognising that energy is important but not necessarily core business for Councils, we also have the capacity to fully-fund, install and operate infrastructure to the benefit of Council and regional communities.

1.0 Introduction

1.1 Broken Hill City Council (BHCC)

Broken Hill City Council (BHCC) is a Council located in the far West of NSW. The Broken Hill region has a population of 17,814 recorded during the (Australian Bureau of Statistics, 2016 Census).

The City Council covers approximately 170.29 km2 and is located within the Essential Energy distribution network.



Map 1. Broken Hill City Council boundary – (source: https://maps.six.nsw.gov.au/ - Apr 2020)

1.2 Purpose Statement

The Renewable Energy Action Plan reflects Broken Hill City Council's desire to engage with renewable energy and identify options for projects that benefit Council and the Broken Hill community.

Broken Hill City Council (BHCC) supports innovation in energy use and delivery for the purpose of improved cost control, demonstrating leadership within the community and preparing for any future carbon price.

- "Broken Hill City Council is committed to developing a sustainable and liveable city" (source, BHCC, sustainability strategy 2018-2023)
- Broken Hill City Council leads and supports the community through education, demonstration, partnership, and projects.
- Broken Hill is a Power Partner of the Cities Power Partnership focussing on Renewable Energy, Energy Efficiency, Sustainable Transport and Collaboration.

BHCC has identified their ambition to contribute to meeting the United Nations Sustainable Development Goals (2015-2030).

Sustainable Development Goal (SDG) 7 is particularly relevant to this Renewable Energy Action Plan:-

> "Ensure access to affordable, reliable, sustainable and modern energy for all." (source, BHCC, sustainability strategy 2018-2023)

In context of the above, the purpose of this Plan is to provide strategic direction into the specific opportunities and pathways for Council to become 100% Renewable by 2023 and to support the entire city reaching the same status by 2030.

1.3 Broken Hill City Council Objectives

Broken Hill City Council has developed this Renewable Energy Action Plan with the following objectives:

- To reduce the cost and uncertainty of future energy supply to Council infrastructure and transport.
- "Increase use and innovation of renewable resources and decrease the use of nonrenewable resources" (source, BHCC, sustainability strategy 2018-2023)
- To attract and retain people and businesses to Broken Hill City Council.
- To support residents and local businesses suffering financial stress or discomfort due to energy affordability.
- To play its part in mitigation for, and adaptation to, climate change.

1.4 Decision Making Framework

The following framework was developed in consultation with Broken Hill City Council staff and Councillors to assist in evaluating the relative importance of projects identified through the Renewable Energy Action Plan:

- Benefit/Cost – does the project have positive financial impact?
- Community benefit – how does the wider community benefit from this project?
- Logic – is the project practical, defensible, sound, ethical, enduring?
- Leadership – will the project stimulate positive change in others?

1.5 Desktop Analysis

Given that Council intends to power the entire organisation operations using 100% renewable forms of energy, we start by quantifying where energy is consumed, how much and in what form.

Electricity

The first task in developing this action plan was to complete a desktop analysis of all metered sites to create a general profile of how BHCC uses electricity. Then further, to understand how contracts and energy supply arrangements are structured with various energy retailers and the network provider.

Broken Hill City Council engages Azility Energy Billing Services to provide a bill validation service and this portal was used to collect and verify site data.

The analysis period for all sites was the 2019 calendar year. Both negotiated 'Contract' sites and general 'Tariff' sites were analysed. In NSW consumers are entitled to negotiate or 'contest' a cheaper electricity retail charge if they consume more than 100,000 kWh per year.

Only limited data has been available for Council's contract and tariff sites. Azility and the Energy retailers were contacted to obtain interval data. Raw data tables and analysis are not included in this report.

	No. of Sites	kWh	MWh	% usage	Cost $	% cost	c/kWh	GHG (tonnes)
Contract	8	4,255,012	4,255	91%	$ 888,822.30	87%	21%	3447
Tariff	44	408,209	408	9%	$ 135,938.18	13%	33%	331
Total	52	4,663,222	4,663		$ 1,024,760.49			3777

Table 1. Contract site VS Tariff site summary

In 2019, the 8 Contract sites consumed 4,225 MWh of electricity compared to 408 MWh consumed by the 44 tariff sites as is shown in the Table 1.

While the major 'contract' sites represent 91% of energy usage, they represent 87% of the overall energy costs. This initial analysis indicates that the electricity c/kWh rates are within the anticipated range of what we would expect based on BHCC consumption.

For comparison, most Councils we have worked with have slightly lower tariff rates ($0.29 / $0.30 c/kWh) but usually pay more for contract sites ($0.24 to $0.37).

Scope 2 greenhouse gas emissions have been calculated referencing the National Greenhouse Accounts 2019, and show that Council emitted approximately 3777 tonnes via indirect emissions from consumption of purchased electricity.

Vehicles, plant and equipment

BHCC own and operate a significant register of machines required to execute the various operations of Council. Ignoring workshop and landscaping tools, there are approximately 50 pieces of small plant/special equipment, a further ~45 specific task machines from garbage compactors to road making plant to lawnmowers, and just under 60 vehicles.

The vast bulk of fuel consumed is diesel and petrol (some gas). It has been difficult to establish an average year for calculating consumption estimates but BHCC appears to consume around 60,000 L of liquid fuel each year. Based on the split of diesel and petrol this equates to approximately 600,000 kWh of energy and associated emissions in the order of 150 tonnes per annum.

These figures become the working numbers for planning how to reach 100% renewable for vehicles, plant and equipment.

Gas

BHCC requires LPG at 6 sites which is delivered via exchangeable 15kg or 45kg bottles for 2 sites and bulk transfer to on-site storage for the remaining 4 sites. Consumption at these sites appears highly variable however averaged over 3 years from 2016 to 2019 the annual consumption is in the order of 22.7 tonnes as per the table below.

		2016	2017	2018	Ave	kWh	Cost		
Living Desert Office	litres		882	1764	1323		15	ea	
Winter usage?	tonnes		0.45	0.9	0.68	9,180	per 45kg	$ 120	$ 1,800
Street Sweeper	litres		1000	441	720.5	mix of 45 kg and 15 kg bottles			
Annual usage	tonnes		0.51	0.225	0.37	4,998	per 15kg	$ 40	$ 980
Warnock St Depot - Hea	litres		5280	1694	3487		CPL	75.63	$ 2,637
Winter usage	tonnes		2.69	0.86	1.78	24,194	Ann rental	748	
Admin office	litres	40806	22371	14748	25975		CPL	83.33	$ 21,645
Nearly all winter usage	tonnes	20.81	11.41	7.52	13.25	180,155	Ann rental	570	
Civic Centre	litres	216	5169	6920	4102		CPL	75.63	$ 3,102
All winter usage	tonnes	0.11	2.64	3.53	2	28,469	Ann rental	748	
South Site	litres	10663	6542	9579	8928		CPL	75.63	$ 6,752
Mostly winter - 5-10% su	tonnes	5.44	3.34	4.88	4.55	61,925	Ann rental	561	
					22.71	308,922			$ 36,917

Table 2. BHCC gas consumption

Two important conclusions can be drawn from these figures:-

1. The carbon emissions associated with consuming this gas equate to around 74 tonnes which is not insignificant and;

2. 308,922 kWh is a substantial amount of energy to replace. Note however that there are complexities converting electrical kWh to heat kWh so this is not a one-to-one relationship.

Energy Approaches

Constructive Energy has examined the entirety of Council's assets and operations with the view to becoming 100% renewable. We have considered 4 broad approaches.

1. **Seek 100% renewable power.**

   Simply seek renewable electricity suppliers and move to electrify vehicles and as much equipment as possible.

2. **Find alternate fuels.**

   Seek suppliers of biogas and biodiesel to operate existing plant and equipment.

3. **Make your own.**

   Establish Council as a Generator-Retailer of electricity and small-scale producer of transport fuels from waste.

4. **Replace versus offset.**

   Substitute non-renewable for renewable energy where practicable and support off-set activities/projects for remaining energy-related emissions.

It should be noted that during the writing of this report, AGL announced plans to develop storage infrastructure that effectively renders the entire city of Broken Hill 100% renewable. Even without this eventuating, the Australian Energy Market Operator and many industry commentators expect the national grid to be 50% renewably powered by 2025 and 90% renewable around 2030. It is currently about 20% on a national scale but much higher in South Australia.

In effect, if carbon neutrality is the key driver, this results in Council having a legitimate 'do nothing' approach - except for the objective of being 100% renewable by 2023 and for the non-renewable energy associated with gas for HVAC and liquid fuels for vehicles, plant and equipment.

This strategy however renders BHCC as a 'price taker' only.

This report examines opportunities for Council to become investors and long-term financial beneficiaries of energy infrastructure in the process of becoming 100% renewable.

Useful work has been completed by the NSW DPIE in relation to identifying the capacity of BHCC properties to support solar installations. Constructive Energy did not seek to replicate this work, rather to aggregate and examine the overall energy consumption story for contract and tariff sites.

2.0 Contract Site Analysis

All contract sites were analysed in detail and summary findings are included in Appendix 1 of this report.

2.1 Contract Site Overview

The following table lists all contract sites with their usage and annual cost. We have also included the resultant cents per kilowatt hour (c/kWh) to help identify which sites might be the most important to focus on. This figure reflects the ratio of fixed costs (i.e. metering and supply) to consumption and will change between bills and years, however it does help identify expensive sites and sub-optimal contract terms.

On the face of this information one might focus on sites with the highest c/kWh rate or those with the highest consumption however, more detailed analysis can often move the priority elsewhere.

Site Name	Retailer	Usage kWh	GHG tonnes	Cost $	c/kWh
Charles Rasp Library	ERM Power	209,746.47	170	$ 55,126.55	$0.2628
Engineers Depot	ERM Power	210,078.58	170	$ 51,048.25	$0.2430
Tourist Information Centre	ERM Power	221,055.92	179	$ 57,766.65	$0.2613
Civic Centre	ERM Power	262,820.71	213	$ 73,306.32	$0.2789
Sully's Art Gallery	ERM Power	266,021.78	215	$ 63,910.54	$0.2402
Administration Building	ERM Power	382,614.27	310	$102,278.80	$0.2673
Aquatic Centre	Origin Energy	1,345,286.27	1,090	$227,476.57	$0.1691
Un-Metered Street Lighting	Origin Energy	1,357,388.36	1,099	$257,908.62	$0.1900
					$0.2589

Table 3. Broken Hill City Council usage and costs for Contract sites

The following chart relates to the same data but provides a clear visual indication of which sites consume the most electricity.

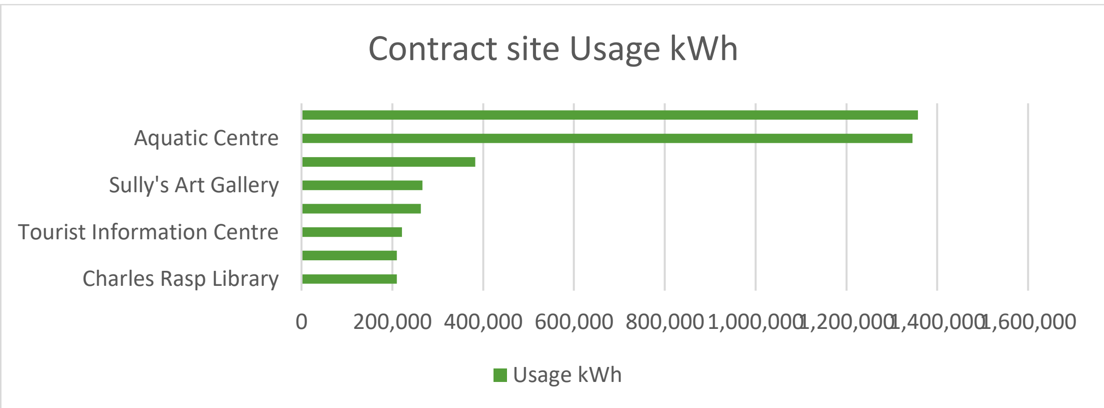


Chart 1. Contract site usage

The two largest consumers of energy, by a significant margin, were the Unmetered Streetlighting and the Aquatic Centre. The Chart 1 reveals that the annual consumption of Aquatic Centre has almost the combined total usage of the six other contract sites.

2.2 Billing Structure

The billing structure becomes important when considering the potential of on-site renewable energy to reduce costs and drive operational changes. The following image is an excerpt of a bill for the Civic Centre and provides a detailed breakdown of the charges for electricity supply to this site.

Pricing Details — Account: BHCC02_004

Charges	Usage	Unit Price	Loss Factor	Total Price (excl GST)
Retail Charges				
NSW Peak	3,914.880 kWh	13.7609 c/kWh	0.91280	$491.75
NSW Off Peak	5,558.520 kWh	7.8430 c/kWh	0.91280	$397.94
NSW Shoulder	10,223.520 kWh	11.7814 c/kWh	0.91280	$1,099.44
Environmental Schemes				
NESC	19,696.920 kWh	0.2001 c/kWh	1.06910	$42.14
LRECs	19,696.920 kWh	1.1193 c/kWh	1.06910	$235.70
SRECs	19,696.920 kWh	0.8203 c/kWh	1.06910	$172.74
Network Charges				
BLNT1AO - Peak	1,303.440 kWh	14.1636 c/kWh		$184.61
BLNT1AO - Shoulder	12,834.960 kWh	12.7531 c/kWh		$1,636.86
BLNT1AO - Off Peak	5,558.520 kWh	6.3854 c/kWh		$354.93
BLNT1AO - Supply Charge	31 Days	5.6482 $/Day		$175.09
Market Operator Charges				
AEMO Ancillary Fee	19,696.920 kWh	0.0533 c/kWh	1.06910	$11.22
AEMO Market Fee	19,696.920 kWh	0.0368 c/kWh	1.06910	$7.75
AEMO Market Fee	31 Days	0.3633 c/day	1.00000	$0.11
Metering Charges				
Meter Charge		1,175.00 $/mtr/pa		$99.79
GST				$491.00
Total (excl GST)				$4,910.07
TOTAL for NMI 4508000046				**$5,401.07**

Example Invoice for Contract Site (Civic Centre)

For ease of analysis the charges can be grouped and represented visually as per the chart below.

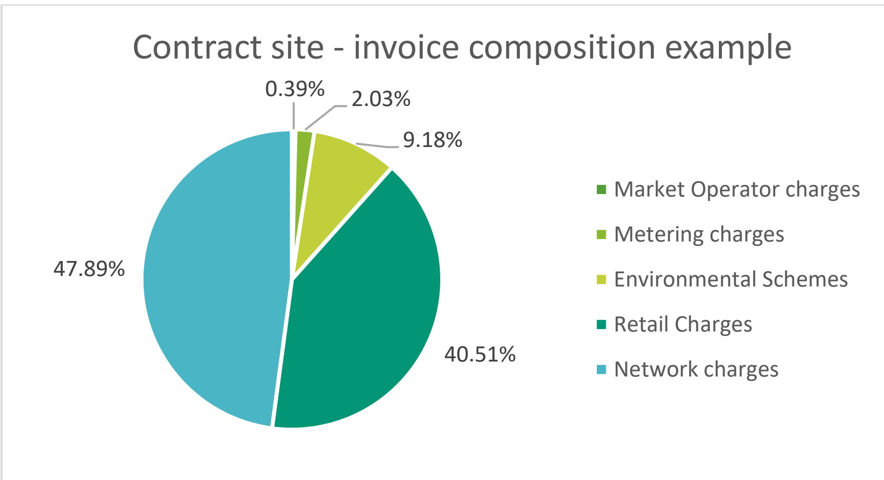


Chart 2. Contracted sites bill comparison (Dec 2019)

There are important insights to be made from this information.

- Consumers have no bargaining power over the Network, Market, Metering or Environmental charges. The only way to avoid these is to not buy electricity.
- 40% of the bill is open to negotiation (retail charges). If, for example, one could halve the retail charge rate, the overall bill saving would be 20%, or, in the above example $3,916 vs $4,910.

- The reason that 'behind the meter' (BTM) projects are attractive is because they reduce all elements of the bill though reducing the full purchase of electricity.
- Short of purchasing the network 'poles and wires' from Essential Energy, embedded networks and micro-grids can also avoid network charges.

Understanding the composition of electricity fees and charges can lead to the ideal of going "off grid", however, other than for new installations, this will generally push out the pay-back period due to the inability to sell excess energy, unless this revenue is less than the monthly connection fee.

Being aware of the charge structure can also lead to simple 'wins' through load shifting. The below chart shows the current retail charge structure for Broken Hill City Council's large usage sites.

The most cost-effective time of day to consume electricity is in the Off-peak period from 8pm to 7am. Shoulder times (9am-5pm) and Peak times (7-9am and 5-8pm) are charged at higher rates.

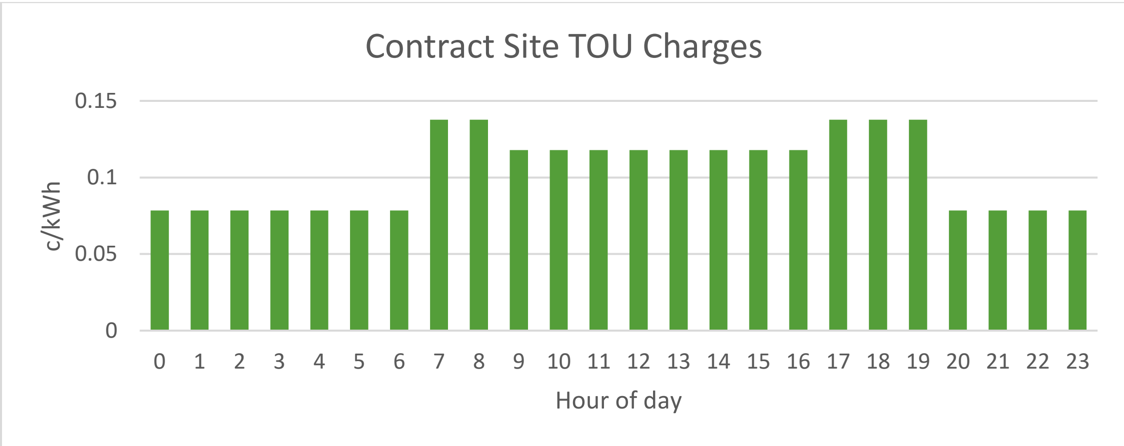


Chart 3. Contract Sites - Time of Use retail charges

Finally, the differential between peak and off-peak charges can also provide the economic rationale for battery storage and/or behind the meter load shifting.

Most obviously, can energy be purchased at the least expensive off-peak times, stored and then consumed Behind-the-meter in the most expensive periods?

2.3 100% Renewable

It would be impossible to achieve full renewable capacity at each of these sites with solar only, not least because of limited site capacity and grid connection limitations. An on-site battery can be sized to accommodate the full demand however to effectively 'off grid' the facilities requires significant investment.

A third approach would be to integrate a co-generation or hybrid energy plant. Biodiesel cogeneration plants are readily available commercially. Hybrid energy systems with on-site solar and wind generation plus battery and back-up generator are increasingly common for off-grid homes and larger industrial applications. The calculations for taking this approach are relatively straight forward and market testing could be used to establish a provider at an equivalent c/kWh to the current rate paid. Commercial options range from Council owned and operated through to full 'energy as a service' providers. The key question is; is managing these sites in isolation better than a collective approach to the full suite of council assets?

Considerations include Council capacity/desire to own/operate additional infrastructure with commensurate increase in O&M, insurance, etc.

Recommendation: Improve energy transparency and control at all sites. Also consider closely the relative merits of creating a situation where a council owned, mid-scale renewable energy generator can be established to provide energy for contract sites for near zero cost, versus reducing overall consumption with oversized BtM systems and an energy sharing platform.

3.0 Tariff Site Analysis

3.1 Tariff Site Overview

Broken Hill City Council manages 44 facilities which relate to a unique National Meter Identifier (NMI). For this analysis we have grouped these sites into areas of common function as per the Table 4 below. As per contract sites, the simple derivative of annual cost divided by consumption gives an indicative c/kWh and provides metric to prioritise sites that will benefit from a BtM renewable energy installation.

Site group	Annual kWh	GHG tonnes	Annual cost	c/kWh
Airport	138,281	112	$ 43,585.78	31.52
Amenities	18,246	15	$ 6,564.80	35.98
Hall or community centre	107,124	87	$ 31,674.27	29.57
Other	45,419	37	$ 16,788.74	36.96
Parks or sports fields	90,873	74	$ 32,634.98	35.91
Water treatment and pumping	8,267	7	$ 4,689.61	56.73
	408,209	331	$ 135,938.18	37.78

*Indirect emissions from consumption of purchased electricity

Table 4. Tariff sites cost and usage breakdown

The categorisation used for Table 4.

Site group	Description
Airport	All energy usage NMIs at the BHCC airport
Amenities	toilet blocks, lookouts and town square.
Hall or community centre	Halls, community centres and libraries.
Parks or sports fields	Sports facilities, parks and gardens.
Water treatment or pumping	Sewer, septic and water pumps.
Other	Any other site that did not fit into the above categories.

Chart 4 below represents the same information in a manner that allows us to see the groupings that draw the most energy. The major tariff sites being the Airport and Halls and community centres.

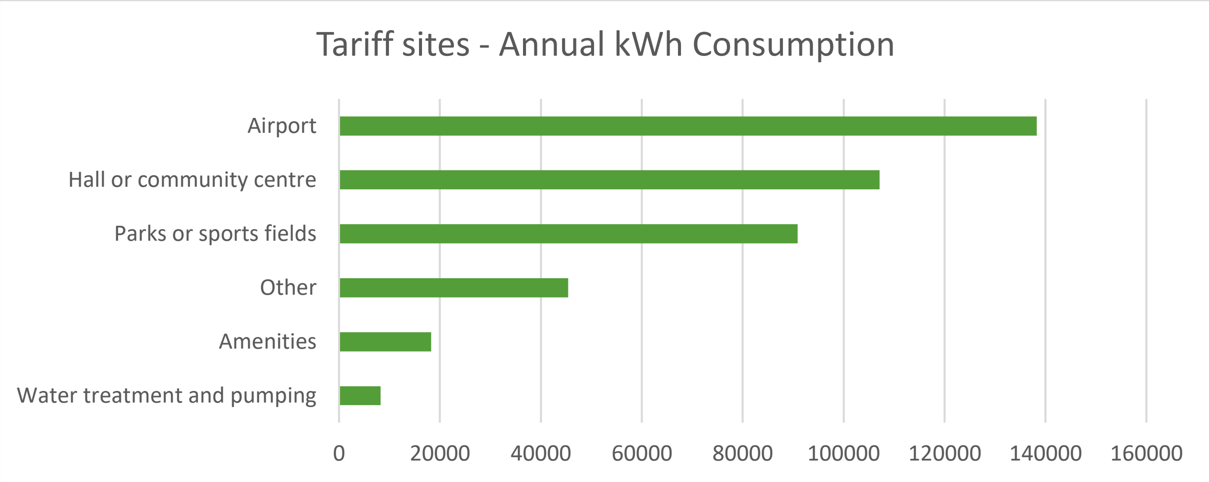


Chart 4. Grouped tariff sites annual kWh usage chart

Further insight is gathered by looking into the individual sites that consume the most energy. Table 5, below, displays any sites that consume over 20,000 kWh pear year.

Site Name	**Annual kWh**	**GHG tonnes**	**Annual cost**		**c/kWh**
Air Conditioning Airport	69,296	56	$	19,364.55	27.94
South Community Centre	59,146	48	$	16,879.93	28.54
Sturt Park	32,212	26	$	9,316.87	28.92
Airport Terminal Building - Kiosk	30,651	25	$	8,907.33	29.06
Geo Centre	22,753	18	$	6,773.17	29.77
	214,057	**173**	**$**	**61,241.86**	**28.85**

*Indirect emissions from consumption of purchased electricity

Table 5. Tariff sites cost and usage breakdown

Continual tariff review is also likely to remain of value for this group of facilities, and all others on contestable tariffs.

Key questions

- Which of these sites is best suited to BtM solar?
- Which sites can change their energy use through either behaviour change or technology?
- How can we get interval/operational data for these sites?

3.2 Tariff Site Strategy

The c/kWh column in Table 5 above is a relatively blunt but useful metric. Sites with high rates (greater than 30c/kWh) usually occur when the proportion of energy consumed is small compared to the daily supply charges. The highest of these figures point to potential disconnection of certain sites from the grid and replacement with standalone solar-battery systems. As an example, this approach could be cost-effective for amenity blocks. Certainly, this approach should be considered for all new facilities where connection costs can be redirected into off-grid CAPEX with little on-going outlay.

Of the larger tariff sites, beyond energy efficiency measures there are three strategies for reducing costs; behind the meter solar installations, self-consumption of export from other Council sites at a reduced fee (see more on this below), and load shifting to optimise tariff structures. While we know there are some sites that are 'no-brainers' for small roof-top solar, it would be better to make decisions based on data and again, we are limited by the lack of energy consumption interval data at the tariff sites.

Behind the meter renewables

Constructive Energy supports findings of the Solar Suitability Assessment and Business Case developed by the NSW Dept. Planning, Industry and Environment in 2019. While pricing will have changed slightly the analysis and rationale for assessment is sound.

However, this approach will at best account for around one third of energy consumed in aggregate (8.8 – 47% range per site over 13 sites). While this results in a significant financial saving of itself (est. $191,000 per year) it will not result in 100% renewable status. It is possible to take the approach of maximising production per site through 'oversizing' each solar array however this suffers the combined limitations of roof space and network capacity for export. It also diminishes the ROI for each site although this compensate for by internal peer-to-peer trading of the excess from each site. Is short, our analysis indicates that reaching 100% renewable with a distributed array on council facilities is not practical. At the very least it becomes expensive per Watt installed.

There may be an argument for behind the meter battery installation at some sites, particularly if paired with solar or small-scale wind, as this will result in the ability to avoid peak tariff charges and participate in emerging demand response opportunities.

Internal energy sharing

Over recent years the capacity has emerged to pool several solar sites, managing them as a Virtual Power Plant (VPP), and/or to specify pathways of energy sharing between customers/sites – Peer-to-Peer trading. Examples already exist in Australia and conceptually this could be a useful model for BHCC. There is a financial advantage in paying ones-self for energy or, in time, supplying excess from site A to site B for free (although network charges still apply).

The establishment of internal energy trading will necessitate both upgraded metering devices and identifying a hierarchy applied to sites. The hierarchy will be based on factors such as consumption profile, overall load/cost and social benefit. This hierarchy enables Council to optimise the excess summer export from a Council owned and operated 'Virtual Power Plant'.

Later in this report we take this approach to an extreme and investigate the opportunity to consume energy at every BHCC site with electricity which has been generated at a single large site. This enables the pay-off of an array to be made with funds already budgeted for to operate multiple sites. As for the distributed generation approach, once the single large array is 'paid back' Council can choose to supply to itself effectively for free.

Load shifting

There are advantages in having the ability to control when and how energy is consumed. Most obviously the ability to avoid peak charge periods and optimise lower fee windows however there are also emerging markets for Demand Response. This is where network operators (retailers or network providers) make payments to consumers for decreasing load or providing/choking supply in response to issues managing the entire network. An example is asking Council to turn off non-essential loads in heatwaves to avoid overloading the network and causing blackouts.

This capacity is contingent on equipment installed at the switchboard and a software interface with embedded control logic. There are several suppliers in the market and more emerging with devices ranging from "Super smart meters" which report to retailers and also have load control capacity embedded, through to multiple sub-circuit controllers.

Recommendation: Regardless of the direction chosen in regard to strategies for tariff sites, we recommend that all installations of solar and/or electrical upgrades now be accompanied with a smart meter installation, preferably with embedded load control functionality.

In time, and as the level of available site data improves, it will be possible to implement and accurately measure energy saving initiatives such as retrofits and behaviour change programs and to take advantage of emerging load response initiatives.

4.0 Priority Renewable Energy Options

As with most things in life, it may be that there is no silver bullet solution and in-fact we are looking for 'silver buck-shot' with multiple strategies. As always, it is important to be clear on core objectives and the decision-making framework in evaluating alternative options.

In this section of the report Constructive Energy have highlighted the projects we feel stand out given our understanding of BHCC objectives.

4.1 Energy Efficiency Measures

Before investigating alternative sources of energy, maximising energy efficiency should be a primary objective. To reinforce this the following measures are recommended (and to some extent already evident at BHCC):

- **Monitor consumption**: Engineering and/or Finance are responsible for reviewing energy usage at all sites and of key equipment/assets.
- **Reporting and performance**: Energy use for sites/assets is reported in regular section meetings and efficiency forms a component of staff Position Descriptions.
- **Procurement policy**: Energy consumption rates are considered in the procurement of any new equipment or servicing and maintenance of existing items. This includes new buildings and vehicles.
- **Retrofit strategy:** Building modifications will be carried out at least in part for the purpose of reducing energy consumption.
- **Education**: Broken Hill City Council makes it easy for staff and constituents to reduce energy consumption through promotion of strategies and materials that facilitate energy efficiency.
- **Planning**: Broken Hill City Council promotes energy efficiency in design through the planning phase where applicants are encouraged to adopt Guidelines for factors including – insulation, glazing, orientation, primary equipment, water use, etc.
- **Product broker**: Broken Hill City Council applies knowledge and purchasing power to support residents and businesses with products that reduce their energy consumption.
- **Street lighting**: Broken Hill City Council continues to work with other councils/programs to replace existing lights with efficient alternatives.

Recommendation: That BHCC integrate the above strategies into ordinary operations.

4.2 Smart metering and load control

Australia is in transition from a centralised, 'dumb' monopolistic grid with fixed generation and regional distribution, to a dynamic, integrated and distributed network of coordinated generation and load at varying scales. With the privatisation and corporatisation of generation and transmission assets, and the opening of retail markets in NSW to competition, the sector is experiencing unprecedented growth in the number and type of generation assets and innovation in technology and retail mechanisms. The days of simply looking for the best kWh price from a limited pool of options, and then forgetting about it, are over.

In this context, data is increasingly important along with the old adage, "*what we inspect we improve, what we measure we manage*".

Retailers are now reluctant to send people into the field to read meters when the automated alternative, digital meters, is less costly and more accurate. So called "Smart Meters" are able to measure consumption in intervals, usually of 30 or 5 minutes, and these can be used to create a usage profile, as has been completed for this report, but also to enable billing on a cost-reflective basis. Beyond this functionality, a new range of 'super smart' meters are also able to control a number of devices by sending signals to relays on the basis of pre-defined logic.

These load monitoring and controlling devices may or may not also be equipped with appropriate approvals to act as the network meter. In other words, there is a choice to either seek a meter that does everything, or to separate the network meter for billing, and the monitor and control device that provides operational intelligence and control. Both devices usually exist at the switchboard. It is critical that the metering platform can be used to provide close to real-time data through an accessible dashboard which may also eliminate the need for bill-validation platforms.

Recommendation: BHCC invest in the roll-out of meters with monitoring and control capacity across all assets with both significant consumption and, ideally, the potential to move or modify loads without adversely effecting operations. It may even be possible to leverage retailer relationships so that the cost is borne, or at least shared, as part of the energy supply contract. We suggest that there are about ~40 sites which should be equipped with smart meters.

4.3 Solar

Solar Photo-Voltaic (PV) cells are a proven technology capable of delivering on-site electricity for immediate consumption and/or export. While panel efficiency has improved in recent years, the major factor driving an increase in solar installations has been dramatic reductions in panel costs, combined with government subsidies. The subsidies for systems less than 100kW (Small Technology Certificates or STCs) are reducing year on year until being completely phased out by 2030. Subsidies for systems larger than 100kW exist in a market mechanism (Large Generation Certificates or LGCs) that has been volatile and oversubscribed to date resulting in uncertain and low values.

- Currently the greatest economic impact from solar is to consume locally and avoid purchasing from the grid – known as Behind the Meter (BtM). This works particularly well when the demand pattern of solar use
  closely matches the intensity of the sun.

These circumstances lead to 2 principal approaches; several sub-100kW systems distributed over multiple sites and larger mid-scale single site systems in the order of 500kW to 5 MW. These two approaches are detailed below.

4.3.1 Medium Scale Solar Arrays

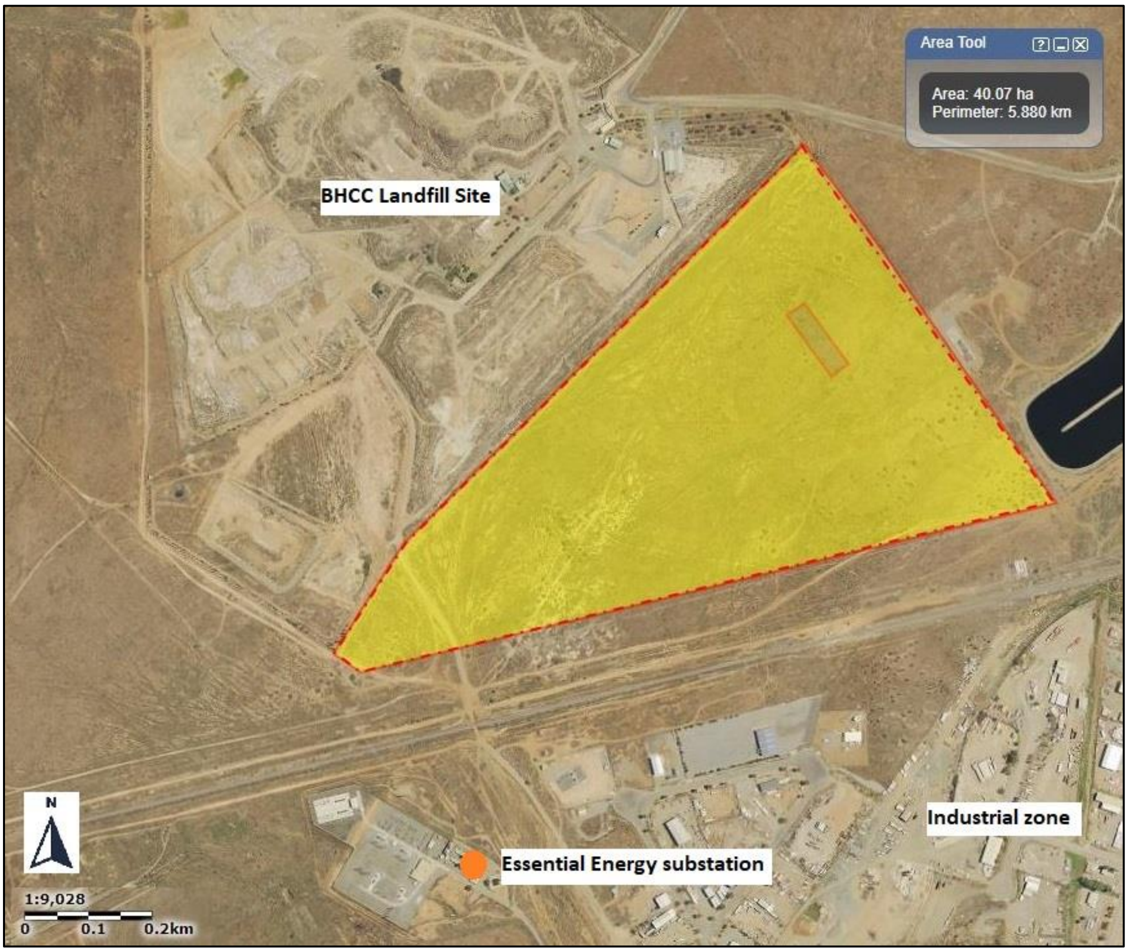
When identifying a potential location for standalone medium scale renewable energy installations, it is important to consider proximity to suitable power lines, transformers and electricity substations; close range of a substation or appropriate 'feeder' can lead to more cost-effective grid connection for larger arrays.

Larger solar installations require more research and modelling than those installations below 5 MW because they can have a disruptive and damaging impact on the network. Facilities under 5MW require an intermediary licenced market participant to sell into the National Energy Market but currently avoid extensive Australian Energy Market Operator (AEMO) reporting requirements. Once the 5MW threshold is broken, these additional costs, along with increased implementation costs such as network fault protection works, typically result in systems of around 8MW or more to stack up financially. It is likely that the 5MW threshold will change in time as the Market Operator recognises the value in increased mid-scale generation across the network.

There is another threshold within the Essential Energy distribution network at 1MW, below which the potential network impact, and hence approval process, is usually significantly easier and less costly. Solar installations below 1MW are not regarded as High Voltage customers whereas arrays over 1MW require Connection Investigation Services Agreements that will incur costs in the order of $25,000 to $250,000, including detailed engineering and High Voltage design.

In the Broken Hill City Council LGA there is an obvious opportunity for mid-scale solar around the Essential Energy sub-station on the South-Western edge of the city near the Council Landfill site. Council has recently purchased a 40ha land parcel adjacent to the Landfill. This site is a prime candidate for a mid-scale solar opportunity as it is close to energy infrastructure and industrial loads – important for network stability.

There will be many more suitable sites available within the distribution network within the city limits which may support smaller arrays than those over the 1MW threshold which, depending on strategy, would be required for Broken Hill City Council to become 100% renewably powered and to offset carbon emissions. Ideally Council would own land or assets for solar and battery installations, however this is not critical as, for example, site lease costs can be integrated into the business plan.



Map 2. Essential Energy Substation location (SixMaps, July 2020)

The commercial development appetite for medium to large solar arrays has reduced from a peak in 2018 of around 20 GW, as uncertainty relating to the daytime market price has increased. There are now periods where solar supply exceeds market demand, and this is pushing the pool price down resulting in the so-called 'duck curve' already evident in some parts of the NEM (National Energy Market) particularly during spring and autumn months. In the past, the market price average was reliably above the cost of production making solar projects profitable but now there is an increased risk of a revenue shortfall. This issue has been exacerbated by network constraints resulting in Market Operator curtailment of export from large solar farms. This reinforces the case for more, smaller, solar arrays within the Distribution network – provided that there is a customer 'locked in' at an appropriate rate.

Developers usually seek to secure revenue by locking in customers with a fixed price Power Purchase Agreement, however for Councils the opportunity exists to create an internal arrangement linked to the wholesale electricity market. With supply matched to demand and a floating market price, the Council is less concerned with what the energy price is at any point in time and more concerned about the transactional cost. That is; if the NEM price is high then increased costs of consumption are offset by increased revenue for the array. Equally, low prices reduce revenue to the array but save on expenditure at Council sites. To avoid excess export at low value it is important to match the solar array size to demand, noting that the opportunity exists to increase the pool of customers by signing up local Commercial and Industrial facilities. Of course, once the array is paid off, Council has access to electricity at negligible cost (refer to the section "Council as energy retailer" below).

Understanding this model is critical to the decision for Council to invest in a mid-scale array as without it, CE would not currently advise Council to proceed with a mid-scale solar project. See more about this in section 4.4 Council as Energy Generator/Retailer.

Modelling was completed to examine what the options might be for BHCC to progress a mid-scale array. Local climate data was used to project solar generation and aggregated to monthly figures. These were mapped against actual usage for the 2019 calendar year. The following chart represents annual consumption in aggregate and the percentage of usage likely to currently occur in daylight (solar production) hours. It also includes the equivalent electrical demand for substitution of gas and transport fuels.

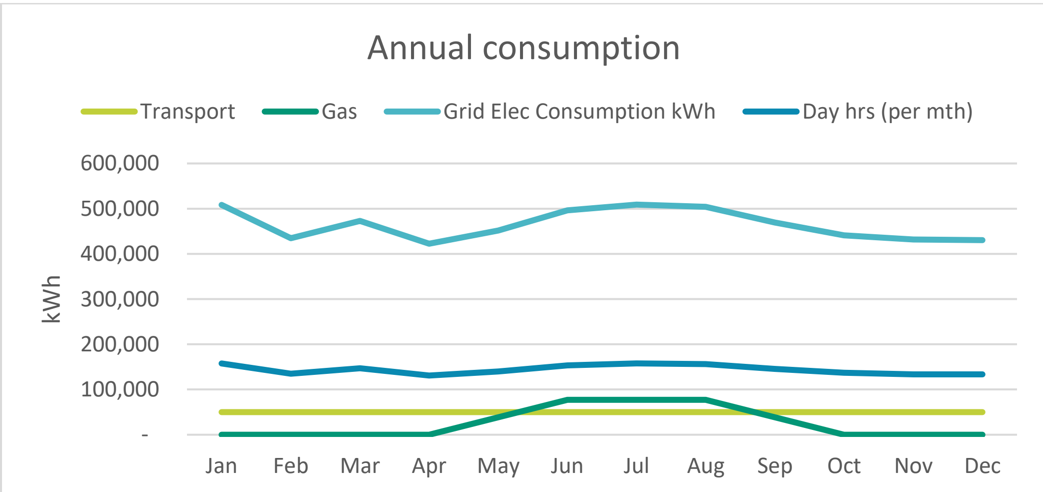
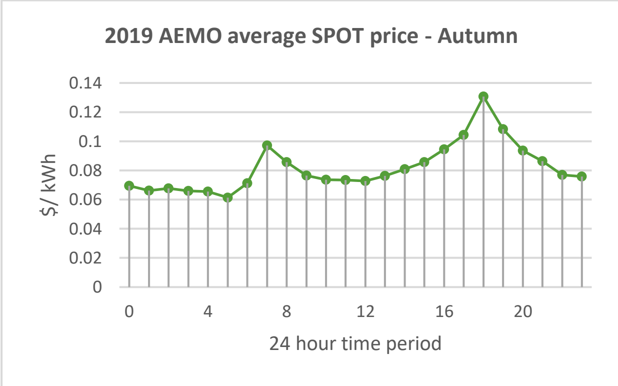
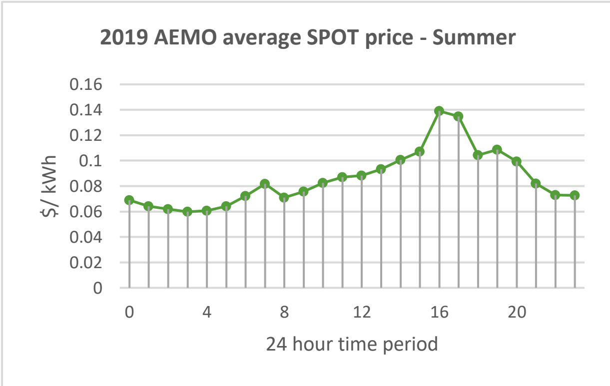


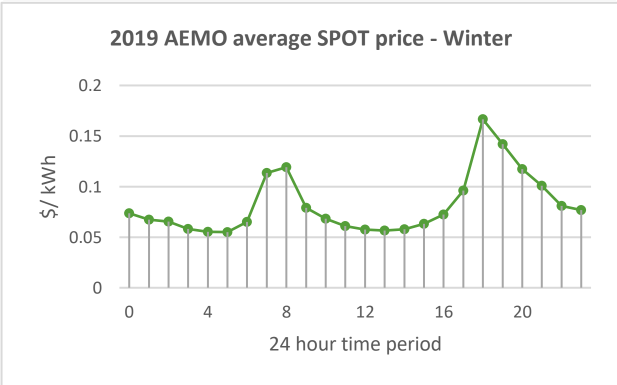
Chart 5. Broken Hill City Council Annual electricity consumption

The profile is interesting as it visually represents two important factors relevant to solar generation; peak consumption occurs in the summer and winter months and consumption during daylight hours is around 1/3 of total consumption.

We now need to understand how this profile interacts with the wholesale or spot price on the National Energy Market. The charts below indicate that, on average, summer is a good time to be selling solar energy into the spot market as the price is relatively high compared to other seasons– particularly in the peak heat of mid-afternoon. In shoulder seasons daytime export is of lesser value than it is in winter but in all three seasons there is a distinct peak at the start and end of each day.







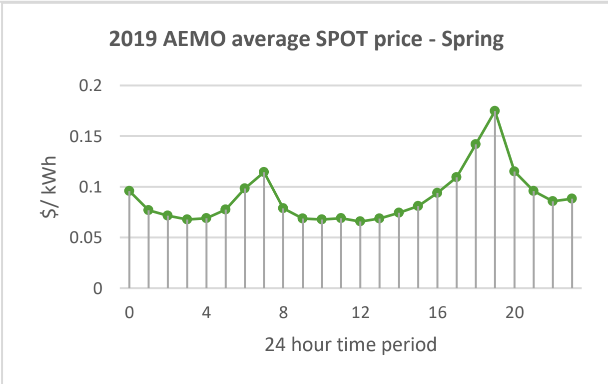


Chart 6. Seasonal average AEMO (Australian Energy Market Operator) spot market electricity price charts

We now examine a scenario for the purpose of informing decision making around the objectives and scale of a stand-alone BHCC solar array to enable BHCC to be a 100% NET renewable energy consumer. For the sake of illustration, the scenario assumes that BHCC is happy to pay itself 8c/kWh for solar energy which represents a saving of approximately 6c off small site retail and that export is also purchased by a third party for 8c. We have also modelled the array install cost at $1.45 per watt which is inclusive of all project costs.

Our analysis indicates the improved financial case for Council self-consuming the energy vs finding a consumer willing to enter into a Power Purchase Agreement (PPA) for 8c (more likely around 6c at present) or relying solely on the spot market. Not surprisingly, the key variables for financial return are the install cost and sale/purchase price per kWh.

100% offset	------------->	Array Size	3300	kWp		**CAPEX**	$ 1.45	per watt	**TOTAL CAPEX**	$4,785,000			
Daytime offset	------------->	Array Size	2500	kWp		**CAPEX**	$ 1.45	per watt	**TOTAL CAPEX**	$3,625,000			
	Solar Production B.O.M.		Revenue	Council consumption							$ 0.08	$ 0.06	$ 0.08
month	kWh/m2	kWh/m	$	Large	Tariff	Gas	Transport	Combined	Day hrs (per mth)	Export	Int'l rev.	retail saving	Exp. rev.
Jan	7.93	776,757	$ 62,141	420,593.43	37,441.73	-	50,000.00	508,035.16	157,491	619,266	$ 12,599	$ 9,449	$ 49,541
Feb	7.02	648,770	$ 51,902	351,296.32	33,424.35	-	50,000.00	434,720.67	134,763	514,007	$ 10,781	$ 8,086	$ 41,121
Mar	6.12	523,411	$ 41,873	388,545.13	34,575.14	-	50,000.00	473,120.27	146,667	376,743	$ 11,733	$ 8,800	$ 30,139
Apr	4.59	348,629	$ 27,890	339,490.28	32,978.49		50,000.00	422,468.77	130,965	217,664	$ 10,477	$ 7,858	$ 17,413
May	3.36	242,526	$ 19,402	330,615.47	32,611.25	38,615.25	50,000.00	451,841.97	140,071	102,455	$ 11,206	$ 8,404	$ 8,196
Jun	2.80	190,170	$ 15,214	333,830.52	34,894.81	77,230.50	50,000.00	495,955.83	153,746	36,423	$ 12,300	$ 9,225	$ 2,914
Jul	3.04	213,072	$ 17,046	345,866.70	35,865.58	77,230.50	50,000.00	508,962.78	157,778	55,293	$ 12,622	$ 9,467	$ 4,423
Aug	4.07	293,979	$ 23,518	343,343.87	33,816.80	77,230.50	50,000.00	504,391.17	156,361	137,618	$ 12,509	$ 9,382	$ 11,009
Sep	5.27	403,843	$ 32,307	351,425.98	29,465.44	38,615.25	50,000.00	469,506.67	145,547	258,296	$ 11,644	$ 8,733	$ 20,664
Oct	6.49	554,863	$ 44,389	360,982.43	30,280.07	-	50,000.00	441,262.50	136,791	418,072	$ 10,943	$ 8,207	$ 33,446
Nov	7.30	652,527	$ 52,202	346,260.00	35,583.01	-	50,000.00	431,843.01	133,871	518,655	$ 10,710	$ 8,032	$ 41,492
Dec	7.95	778,504	$ 62,280	342,762.22	37,272.77	-	50,000.00	430,034.99	133,311	645,193	$ 10,665	$ 7,999	$ 51,615
	5.5	5,627,050	$ 450,164	4,255,012	408,209	308,922	600,000	5,572,144	1,727,365	3,899,685	$ 138,189	$ 103,642	$ 311,975
		Payback	$ 10.6										

Table 6. Summary table of generation and revenue

Scenario – 100% Renewable Energy generation matched to BHCC's stationery and transport consumption.

In this scenario, we have matched a 3330kWp array to meet energy consumption on the basis of creating a revenue stream to offset unavoidable usage and to reach 100% renewable status in terms of carbon abatement. The size of an array to achieve this is approximately 3300 kWp.

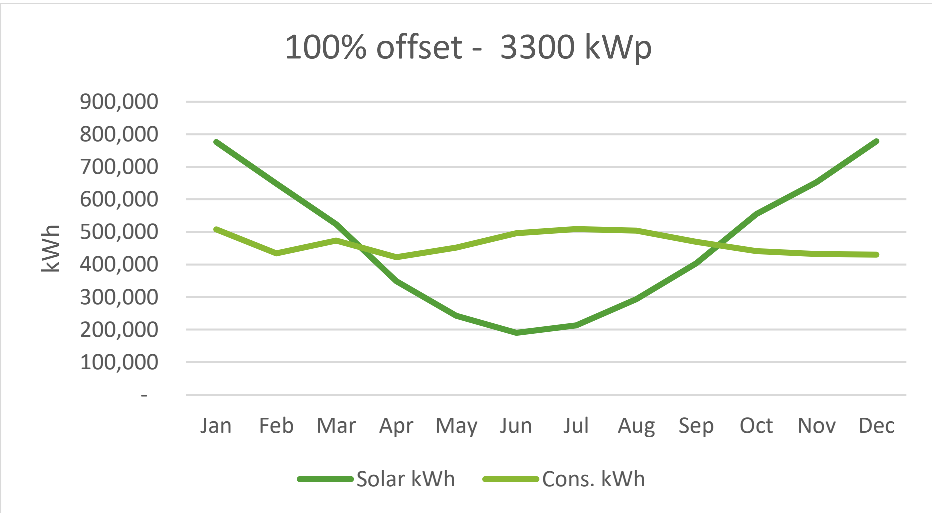


Chart 7. Solar generation matched to daytime consumption – 3300 kWp array

Chart 7 indicates that the bulk of all energy consumed, 24 hours per day, both exceeds and is less than the amount generated depending on the season. In terms of annual volume however the curves are equivalent. The corresponding revenue charts are displayed below.

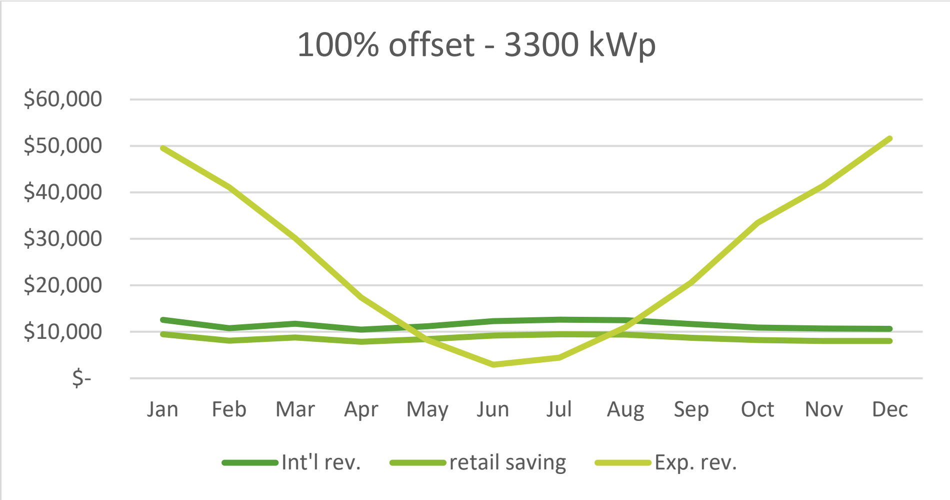


Chart 8. Intersection of monthly revenue/value curves for a 3330kWp array

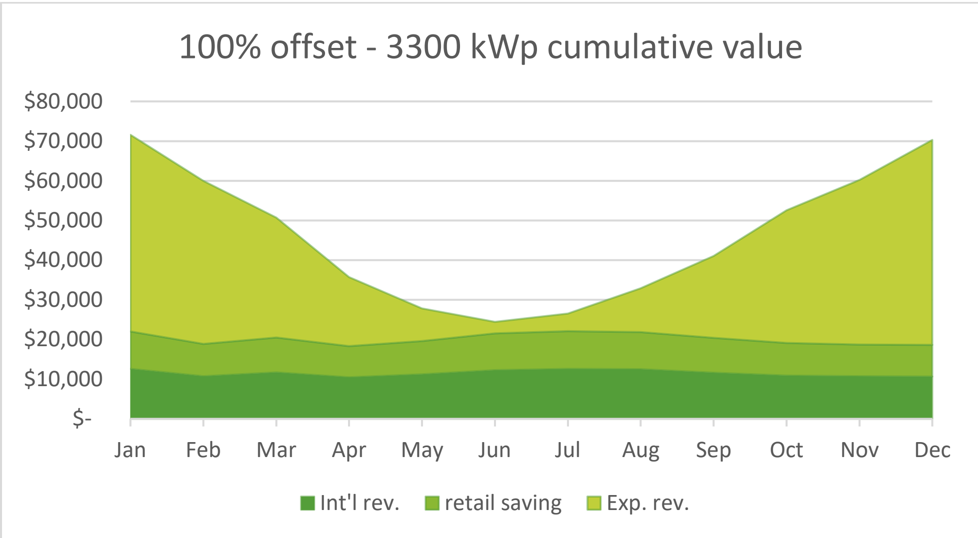


Chart 9. Cumulative value created by a 3,300kW array.

The above scenario illustrates to BHCC the need to be clear on objectives in constructing and operating a mid-scale array. The analysis has been undertaken to illustrate concepts, highlight risks and demonstrate the impact of alternative approaches to becoming active in the renewable energy generation space. We have been careful to be realistic and conservative in our analysis however detailed modelling, costing and analysis will be required before investing in a project.

That said, our analysis reveals that it is possible for an investment in a single site array of just under $5 million to create annual value of just over $500,000, with Council paying off a their own solar farm in around 10 years instead of paying a retailer. After this point, council can decide what to do with 1.7GWh of free energy.

Clearly there is also value in being able to vary consumption to be within solar producing hours or in least-cost market hours as referenced in 4.2 above.

Given that the minimum effective life of a solar array is the warranty period, i.e. 25 years, and infact usually more like 40 years, Council have the capacity to structure finance over a longer term to deliver increased cash flow now, or as-short-a term as possible to pay off quickly and create an effectively free energy supply. Aside from whatever advances in technology are available at that time in the future, including electric vehicles, there are a wide range of social impacts that could be supported with this low-cost energy.

Constructive Energy has completed detailed modelling for another Council who have elected to proceed with this approach based on favourable economic and social returns. The project will reduce current outgoings for energy in the medium term, pay off a 5MW array in just under 10 years, engage local business with lower cost local renewable energy and deliver a financial dividend of ~$13 million over 25 years.

If Broken Hill City Council elects to further investigate this concept CE can facilitate the necessary system design and Network Enquiries and work with Council to develop the detailed business plan.

A final point of note is to consider that there may be city-based local governments that would welcome the opportunity to partner with a 'country cousin' that can generate renewable energy for them, to offset their usage. This could be another way of locking in price certainty and revenue to de-risk the business plan.

4.3.2 Distributed Solar Installation (+ Virtual Net Metering)

In November 2019 BHCC engaged DPIE (Dept Planning Industry and Industry) to undertake a feasibility of BtM 'Behind the Meter' (BtM) installations at 13 Council facilities.

The purpose of the feasibility study was to explore the ability for BHCC to:

- reduce electricity costs
- minimise the environmental impact of BHCC's operations (reducing carbon emissions)
- Contribute to the Government's Resource Efficiency Policy (GREP) solar target

As recommended in the DPIE Solar suitability assessment and business case, the most conventional renewable energy option for reducing costs is to install 'Behind the Meter' (BtM) solar arrays at strategic locations.

BtM solar arrays in both residential and commercial settings self-consume electricity generated during daylight hours, thus avoiding power costs charged on a per kWh basis. Excess energy generation is sold into the network at a negotiated feed-in tariff or shared with other consumers. An ideal site for this type of installation (where a faster return on capital investment can be achieved) should present the following characteristics; -

- High, regular electricity consumption, with most of the usage occurring during the daylight hours.
- Large suitable roof structure, preferably north facing and not shaded, or suitable nearby space for ground/frame mounted solar.

Important Considerations

- Identify project drivers as cost, energy-sharing and carbon offsetting will all lead to different answers
- Size and design individual systems correctly to meet the identified objectives
- The Small-scale Renewable Energy Scheme currently offers significant discounts on solar systems smaller than 100kW. The scheme reduces in value on 31st December each year until it ends in 2030.
- Systems larger than 30kW require additional costs associated with network connection studies and permission from the network provider to connect to the grid.

There are currently new technologies and market-place arrangements being developed that allow peer-to-peer solar energy trading between properties, known as Virtual Net Metering (VNM) and the ability to collectively manage multiple installations, known as a Virtual Power Plant. At a small scale, a household can trade their excess solar generation to a property of their choosing at a negotiated price. This system usually requires both parties in the transaction to be with the same retailer and arrangements can be put in place for one-off transactions or longer-term periods.

Using this concept, it is possible for Broken Hill City Council to develop a Rooftop Solar Virtual Power Plant large enough to power a major portion of Council sites and other businesses and residences in the LGA. Under this model, Council could also subsidise or facilitate the installation of solar and battery systems at selected sites and facilitate customers with the enabling retailer and load control metering devices.

Important Considerations

- All properties/customers operating within the network would probably need to sign up with the same retailer. The retailer would also need to be involved in setting up and operating the system.
- A specific meter/device is required to monitor and acquit energy usage.
- The project may require a significant effort to recruit customers (which could include customers outside of the LGA if desired).

To illustrate this opportunity CE considered the impact of existing/augmented solar systems and new BtM installations as part of a holistic program (sourced from the DPIE feasibility study 2019).

NMI	Site Name	Annual Site cons kWh	BtM System Size kWp	On site gen /yr	Self cons kWh	Avoided GHG tonnes
4508000032	Administration Building	382,614	31	47,450	46,700	38
45080000909	Air Conditioning Airport	69,296	32.6	51,200	38,100	31
4001208908	Aquatic Centre	1,345,286	332	528,075	514,000	416
4508000046	Civic Centre	262,821	75	100,200	85,500	69
4508000110	Engineers Depot	210,079	156	197,300	150,000	122
45080003199	Geo Centre	22,753	10	15,400	9,700	8
45080009550	Chloride Street Public Toilets	16,990	4.6	6,900	5,300	4
45080001996	South Community Centre	59,146	20	31,500	22,700	18
45080126783	Sturt Park	32,212	4	5,600	3,400	3
4508009467	Sully's Art Gallery	266,022	72	107,135	103,500	84
4508000071	Tourist Information Centre	221,056	40	61,000	47,500	38
Totals		**2,888,274.35**	**777**	**1,151,760**	**1,026,400.00**	**831**

Table 7. Example distributed solar BtM installations

CE integrated the capacity for a virtual network and imagined that Broken Hill City Council charged themselves 8c/kWh for energy consumed at the retail tariff sites (which would be on the high side but result in a shorter payback period). The table 7 below is a summary of the collective financial impact if these projects were to proceed.

Council consumption	BtM solar generation		CapEx	Revenue	GHG	Payback and Yield	
Total combined consumption kWh (across all sites)	Daytime consumption	Export kWh	Inst cost	Tot revenue p.a. (including VNM)	Avoided GHG tonnes	Payback (simple)	Yield
4,589,488.22	**1,026,400.00**	**125,360.00**	**$ 1,105,042.90**	**$ 261,379.20**	**831**	**4.23**	**23.7%**

Table 8. Example distributed solar BtM collective financial impact

While these figures are very general, it is evident that there is an improvement in the economic case for roof-top solar when viewed holistically under a virtual network. It may also be desirable for Council to facilitate the involvement of other organisations and individuals in a Council-wide virtual network, however this can become complex and should be modelled in more detail. It would also be advisable to plan this with the engagement of service/community groups and the business groups.

It should be noted that the resultant payback and yield on paper achieve an exceptionally good financial return on the investment. However, this approach does not account for the complexity of the multiple solar installation at separate locations. Detailed project and financial planning will be required to firm up actual figures for investment readiness.

Each site location would require, detailed network applications, structural and electrical assessments, and may be subject to export limitations or unforeseen wiring upgrades, which would financially impact the project. Furthermore, connection limitations make it very difficult to realise the full Council self-sufficiency figure of 3,300kWp.

Prior to progressing the case for BtM solar installations, it is important for Council to acknowledge that the broadscale implementation of BtM roof-top solar systems potentially cannibalises the case for a mid-sized solar array. Installing multiple BtM solar installations reduces the amount of solar energy that Council can sell to itself in order to secure revenue for the larger project (which may be likely to provide a more significant pay-off in the longer term).

That said, BtM solar is readily achievable and delivers an immediate financial return and it may be that a hybrid of the two approaches is acceptable.

There are essentially three options for progressing BtM installations;

1. Broken Hill City Council Capital investment – savings invested to immediately reduce operating costs
2. Project finance – taking advantage of low interest rates in a cash-positive structure
3. 'Rent to buy' – Third-party installs and operates until nominated hand-over

Constructive Energy can provide oversight or facilitation of each of these options if desired.

Recommendation: There is a strategic choice to be made between implementing distributed BtM solar and a mid-scale solar project. If the key project driver is return on investment then distributed solar wins out, however it is more challenging to deliver 100% renewable status itself by 2023 so BHCC may also require a retail agreement to purchase renewable energy from an existing generator to fill the balance of demand.

Distributed batteries

Battery storage in association with BtM solar can create value through back-up capacity, improved power quality, optimised consumption and export in relation to tariff charges, enhanced demand control capacity and improved monitoring/reporting.

At present many commentators contend that the payback for batteries is too long, however when viewed holistically there are many cases where the yield of a combined solar + storage installation is above 10%. Given the high potential IRR for distributed solar it would be remiss not to consider the opportunity to incorporate energy storage where advantageous.

Site Name	Qty Batteries	Battery Capacity /yr kWh	Tot revenue p.a. (including batteries)	Solar + battery Payback (simple)	Solar + battery Yield	Avoided GHG tonnes
Administration Building	1	4,928	$ 11,596.88	4.81	20.8%	38
Air Conditioning Airport	2	9,855	$ 11,898.60	5.72	17.5%	39
Aquatic Centre	8	39,420	$ 128,005.25	4.75	21.0%	428
Civic Centre	4	19,710	$ 24,298.50	5.91	16.9%	81
Engineers Depot	2	9,855	$ 42,858.60	5.47	18.3%	129
Geo Centre	1	4,928	$ 3,603.30	7.16	14.0%	12
Chloride Street Public Toilets	-	-	$ 1,464.00	4.10	24.4%	4
South Community Centre	2	9,855	$ 7,612.75	6.75	14.8%	26
Sturt Park	-	-	$ 1,080.00	4.72	21.2%	3
Sully's Art Gallery	1	4,928	$ 25,777.03	5.02	19.9%	87
Tourist Information Centre	3	14,783	$ 14,704.13	6.06	16.5%	49
Totals	24	118,260	$ 272,899.03	5.19	19.3%	896

Table 9. Example distributed solar + battery collective financial impact

Our analysis of solar only BtM installations reveals a collective yield on investment in excess of 23%. The table above indicates that the functionality of 24 batteries can be added to the project with the minimal impact of lowering the yield below 20% but still achieving system pay-back well within the 10 yr/3000 cycle warranty of most batteries.

If managed collectively, a number of distributed batteries can not only assist with individual sites, but also enable participation in market and network 'events' for which network operators will pay in order to reduce difficulties in managing the grid.

Recommendation: BHCC should consider the case for battery storage in association with any BtM solar installation and especially for sites with energy quality or security requirements

4.4 Council as Energy Generator / Retailer

Broken Hill City Council has the land access, load and grid capacity to install and operate a medium scale solar power plant in the order of 3MW. The inevitable question regarding this option is how to consume the generated energy in local assets and how to maximise financial benefit from selling the excess. As a Council owned and controlled asset, a solar PV facility has the potential to generate both energy for self-consumption and a revenue stream to off-set unavoidable consumption costs such as street lighting.

Clearly, if it were not possible to consume renewable energy 'behind the meter' then the next best thing would be to supply the excess energy to other Council sites and other larger consumers such as local industry. As described in 4.1 above, Power Purchase Agreements (PPAs) are the most common mechanism for this to occur to date. However, if this is done, it is still necessary to pay for the "poles and wires" either by paying the network owner-operator a fee or through owning the network. It is unclear at this point if discrete rural energy networks will ever be 'for sale', however, an embedded network constructed and owned by Council, such as for a new greenfield development or an industrial estate, already has precedent.

Power Purchase Agreements have been established and tested in the Australian context and are a feasible option for BHCC to consume energy from their own solar generation, or any other arrays for that matter, however they do require integration with a 'friendly' retailer and monthly reconciliation of estimated versus actual generated/consumed electricity. For simplicity, it may be possible to find a local large consumer that agrees to purchase all energy generated from a Broken Hill City Council array.

Recommendation: A third option as indicated above would be for Council to effectively operate as a generator-retailer, choosing to purchase energy from its own solar array at an agreed price, but also to purchase energy from the National Energy Market and then choose the level of price mark-up on-selling to themselves (see Chart 25 below). While there are benefits in removing the retailer's margin through purchasing wholesale, the risk of this approach is that the pool price may, or will at times, be higher than the relevant standard tariff. Our modelling has shown for previous years that wholesale consumers tend to be better off overall, but this is not guaranteed. To mitigate against this risk, the ability to control loads automatically would limit exposure to any price spikes. In other words, if the price is high outside of solar production periods, then we switch things off! The other key mitigating factor would be integration of battery storage which could be used as an economic tool to play the market or to load shift (see below).

It would be possible for Council to apply for its own licences so as to be formally recognised as a retailer however this carries cost in establishment and on-going compliance overheads that are, in our view, prohibitive. While the Local Government Act carries the capacity for Councils to supply energy (as per County Councils of last century) in the current competitive and innovative environment it may be smarter to partner with an existing retailer willing to provide the mechanism.

There are several retail organisations currently delivering cost-reflective pricing and facilitating sale of energy into the NEM. Linked to a solar array of course Council would be exposed to purchasing energy from the market for the times outside of solar production hours. (Wind power and energy storage would change this.) The degree to which Council is exposed to the volatility of pricing in these periods versus having the retail partner set a fixed price to 'hedge' the risk depends on the ability to negotiate a deal.

To further illustrate the concept, we have prepared the charts below comparing the amount BHCC actually paid to power the Admin Building, a high yet consistent usage tariff site, versus what would have been paid at the market spot price.

Chart 10 displays each 1 hour interval averaged over a month (Jan) and extrapolated over a 24 hour period. We have then overlayed the corresponding Electricity SPOT prices from the NEM for the same period.

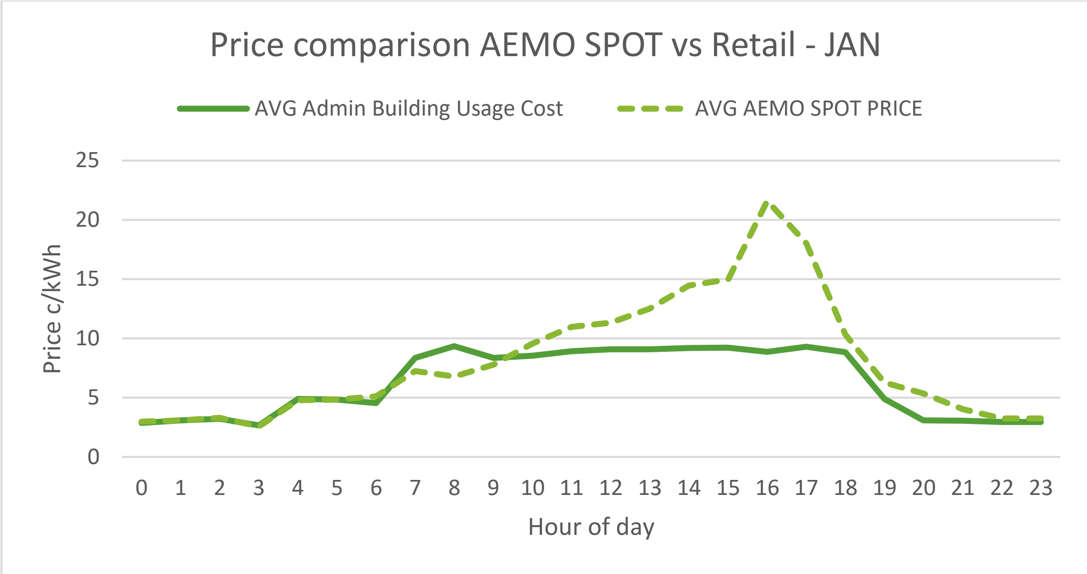


Chart 10. Comparison of Council Admin Building cost by hour versus equivalent spot market cost Jan-19

Based on this analysis it can be seen that if BHCC paid wholesale price for energy during January, this would have been more expensive that paying the pre-agreed retail tariff. In other words, the retailer took a hit in supplying BHCC!

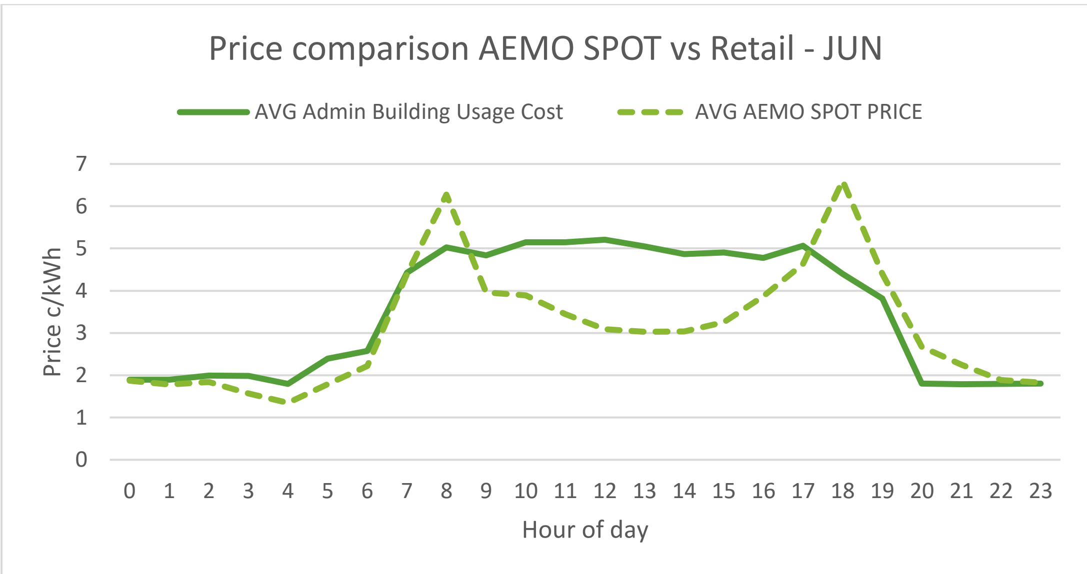


Chart 11. Comparison of Council Admin Building cost by hour versus equivalent spot market cost June - 19

Chart 11 above indicates a period when BHCC would have made a saving purchasing energy at wholesale prices, even considering peaks at the beginning and end of the day. This chart also indicates the obvious opportunity in load control and energy storage – maximising energy consumed from 09:00 to 17:00, avoiding consumption in morning and evening peak periods and aiming to sell stored energy into the market at its highest price.

The primary purpose of bringing this to the attention of Broken Hill City Council is to be aware of both the opportunity and consequence of 'stepping into' the generator - retailer space. While there are costs in establishing Councils as generator-retailers the savings and potential revenues are significant. However, even with automation, there will be a requirement for human oversight and this would need to be in the form of internal staff responsibility or outsourced services. Essentially BHCC needs someone 'in their corner' to ensure that the generator is performing as expected, the retail structure is delivering value, and that the load controlling logic is optimising self-consumption and minimising external energy purchase.

Part of the role of Constructive Energy is to guide and support Council decision making, in regard to establishing projects, negotiating deals and managing renewable energy assets to optimise benefit. Should BHCC wish to follow this pathway, after securing the opportunity to deploy or own energy generation assets, the next step would be to test the retail market to identify suppliers willing to engage in this manner. We have previously received positive responses from Enosi/Energy Locals, Simply Energy, Energy Australia, Origin Energy and Flow Power.

It is important to note that, as identified in 4.1.1 above, sizing a solar array to 100% meet Council demand inevitably leads to an export 'problem'. This requires BHCC to find a market outside itself that values this export. Such a market could be a small number of high-demand industrial users, commercial and retail businesses with daytime usage, and/or local residences. This 'solar power station' model is illustrated below.

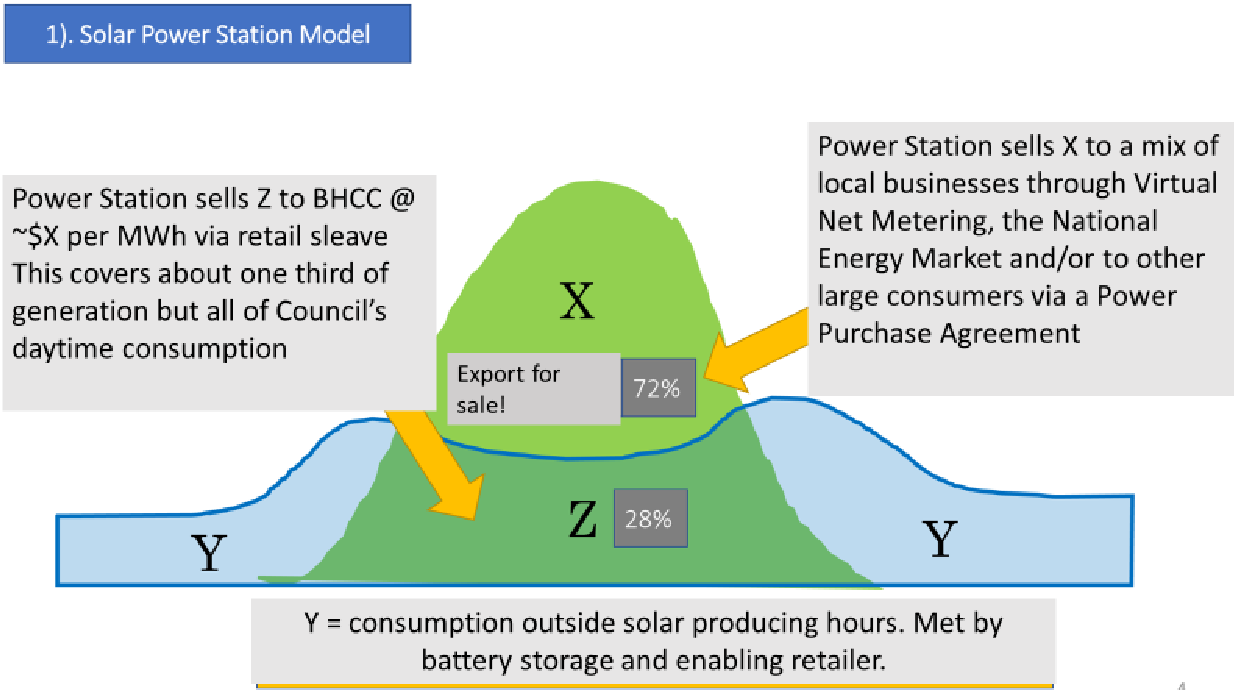


Figure 1. What to do with solar excess

In reality it is difficult to establish the exact quantum of 'X' in the figure above and to that extent there is a risk in raising the expectations of the last few customers who may never consume much energy from the array. In other words, after 'Z' is fully allocated we can guarantee supply for the first customer but not the last! Figure 2 below illustrates the likely management of this issue which is to have a certain percentage sold commercially with the remainder exposed to the wholesale market price.

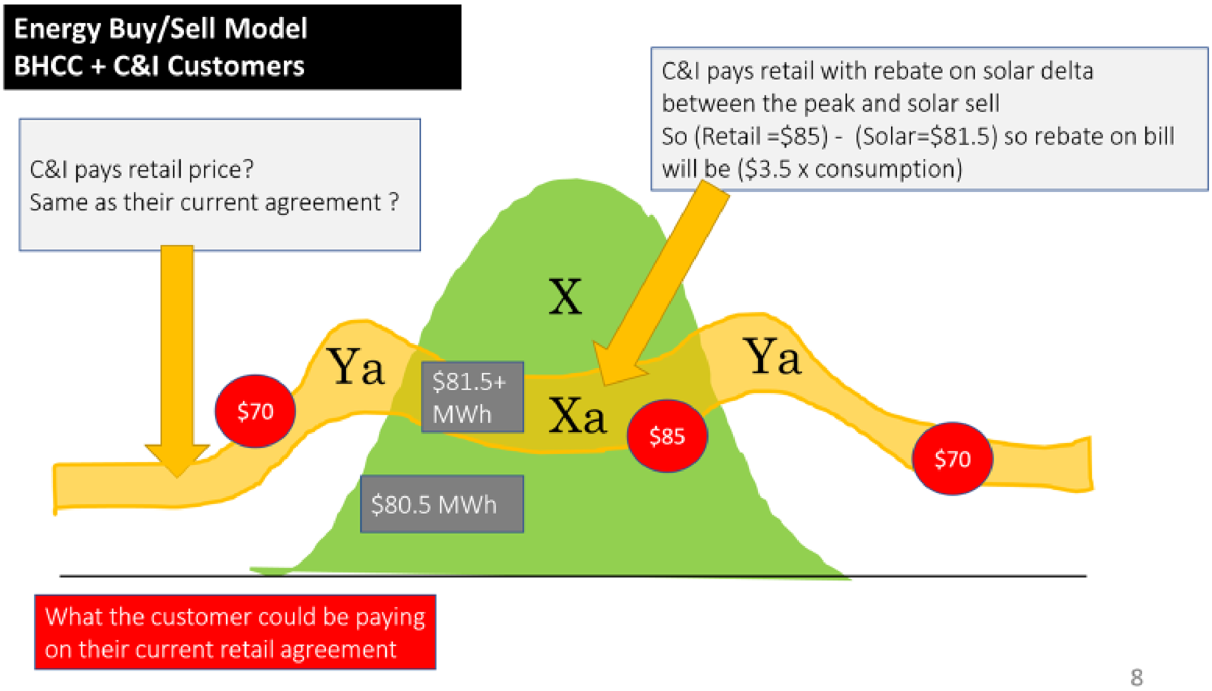


Figure 2 C&I customer engagement concept

An ideal agreement would incorporate both elements, so Council is able to negotiate 'certainty' and savings with electricity production and consumption, ultimately benefiting the BHCC community, and to underpin affordable local energy to the local community. The retailer would provide customer support and billing facilities and in return the Council could assist the retailer with their brand promotion and customer acquisition in their Local Government Area.

Recommendation: If BHCC decide to progress the mid-scale 100% offset option, this should be done in concert with identifying and negotiating with a retail partner. BHCC will need to come to a position on which local customers to engage, how and why. Eg. Main street shops to assist in providing affordable, local energy.

Interestingly, an example of where Council has successfully operated as a retailer, exists in the telecommunications industry. The Southern Phone company was formed in 2002 and is a successful collaboration of 35 regional Councils providing mobile, fixed-line and data services to the benefit of regional Australians. Their website states that … "since 2008 we've delivered more than $15.8 million in dividends and grants for the benefit of regional communities".

Southern Phone has acquired and services over 100,000 customers with the vast majority located within regional Australia. In December 2019, Southern phone was acquired by AGL Energy Ltd, providing each of their shareholders $785,000 return from their initial investment of $2 (source Southern Phone Jan20).

4.5 Energy Storage

In addition to exploring the various large-scale solar installation options available, it is important to consider integration of energy storage options to bring additional value and benefit to a project. Batteries are an increasingly critical part of optimising the economic and environmental benefits of renewable energy generation and are now affordable to the extent that pay-back periods are usually less than 10 years and can be less than 5 with the right price and market settings.

The battery market is currently in price decline as various providers and technologies vie for market share. In addition, the impact of batteries on the grid is in the early stages of implementation in practice so case studies will have important flow-on impact. Energy storage integration presents the following key benefits to a project-

- Load smoothing: battery storage can buffer solar generation peaks and intermittent or variable demand profiles.
- Load sharing: particularly where micro-grids are implemented, battery storage can provide a power sharing and grid stabilising faculty.
- Load shifting: supporting the economic case for avoiding purchase of high-cost electricity.
- Load export: smart-meter technology can identify when a system should export onto the grid (when demand and price is high) and when to divert to storage. Under a generator/retailer model, integration of battery technology adds an additional advantage to 'playing' the energy markets.

The enduring problem with intermittent renewable energy generation is reliability of supply, a factor which has been improved dramatically at the time of writing by the improving economics around battery storage. The emergence of technologies that can offer utility scale storage at a price point with a 10 year pay-back is significant. It is now technically feasible to operate 'off grid' at scale, however, taking all BHCC's sites off the grid is not desirable for a range of reasons and at present would increase the cost of supply. However respected industry energy analysts suggest that price parity for this scenario could occur in the next 5 years and it will be worthwhile for Broken Hill City Council to consider this scenario with their high use sites in the next 5-10 years.

There are other reasons to integrate batteries, including energy security, control and monitoring. For example, if every BtM solar installation included a Tesla Powerwall, this would automatically provide data and control measures plus a degree of redundancy/security in the case of blackouts. A trial of 1200 households in Adelaide equipped with a Tesla Powerwall and rooftop solar, operating a virtual network, is proving successful in providing cheaper energy to householders partly because the system as a whole can be controlled and derive revenue from demand management to support network stability.

Recommendation: BHCC should model energy storage as part of the business plan in both medium scale and/or distributed solar project options. This modelling should compare a single, mid-scale, grid connected storage device (ideally with the solar array) and multiple smaller behind-the-meter devices.

4.6 Retail arrangements

Broken Hill City Council has a variety of sites that have large and consistent consumption and this has provided leverage for negotiations in the past which, through well run tendering processes, resulted in sharper competition between each of the energy retailers and hence better pricing.

As discussed above, as Broken Hill City Council implements the recommendations of this REAP it is possible to become a net generator of electricity which is then sold back to other BHCC sites, the community and local industry. This changes the relationship with retailers who are already being disrupted by the 'prosumer' revolution affordable solar has created. However, we appreciate that BHCC may not wish develop renewable energy projects themselves and if so, negotiating suitable retail contracts remains important.

Proposed changes to network operating rules will see smaller operators such as Councils able to participate in high value demand responses, such as being paid to reduce demand or produce electricity at times where the network is stressed. Any supply agreements should account for this into the future.

Because the sector is rapidly changing it is difficult to provide definitive guidance in respect to retailer contracts. That said, there is also opportunity emerging in this period of significant innovation so it is important for Council

Recommendation: Going forward Council should be increasingly wary of simple bulk purchasing contracts for electricity as these approaches can limit the capacity for Council to save or off-set usage (usually a 20% reduction cap before fees apply) and to gain from participating in the new distributed energy economy. We recommend that Council be careful in engaging with any retailer over a long term and ensure the ability to reduce consumption along with fair exit conditions. Ideally any new retail agreement needs to enable Council to sell excess energy production to the retailer at a market or negotiated price, whilst purchasing electricity consumption at a fixed low price during peak times. The contract should also enable peer-to-peer trading and the operation of a Virtual Power Plant.

to be clear on wants and needs as, chances are, at least one of the retailers will be eager to attract and retain council business.

4.7 Transport, plant etc,

4.7.1 Electric Vehicles

Australia lags many other developed nations where electrification of transport is progressing rapidly. With Tesla most prominently spearheading the 'mainstreaming' of fully electric cars, as opposed to hybrid drive trains, all major brands are now developing Electric Vehicles (EVs). Many countries internationally have incentives and targets for EV uptake and China leads the world with development and sales, particularly in the heavy vehicle sector.

"For a GVW of less than 16 tonnes, an increasingly wide selection of all-electric trucks is reaching the market. In fact, major postal and package delivery companies, including DHL, UPS and FedEx, are expanding their fleets, and the Swiss and Austrian postal services have pledged to transition to all-electric fleets by 2030 or earlier." (source, International Energy Agency 2019)

For regional councils, the immediate challenges of model availability, range anxiety and relatively high prices are likely to abate by about 2025 (unless government incentives are established before then) as competition increases.

The relevance of EVs to this plan is particularly apparent when considering export of surplus generation and the fact that in around a decade, Council will be producing energy for essentially no cost. Even at modest c/kWh prices, the operational savings are clear as illustrated in the table below comparing a basic hatch-back sedan.

Internal Combustion Engine (ICE)				Battery Electric Vehicle (BEV)			
Fuel efficiency		7	L/100km	Power efficiency		16	kWh/100km
Fuel cost	$	1.40	per L	Electricity cost	$	0.10	kWh
Annual running cost	$	1,470		Annual running cost	$	240	
Annual km		15,000		Savings with EV	$	1,230	per annum

However, because the fuel costs are marginal in the context of greater CAPEX, even considering reduced servicing costs, at present the financial case for EVs is not compelling. That said, the BHCC 100% renewable target may add to other factors, such as research, leadership, etc and these may outweigh the reduced financial case. CE conceives that the 'tipping point' for wide scale adoption will occur when the price gap for equivalent ICE cars reduces to around 15%.

Aside from fleet cars, there is perhaps a more compelling case to look at electrification of heavy vehicles. The City of Casey in Victoria has commenced garbage collection services with an all-electric truck and many factories already use electric forklifts. Again, the case for these will be made more compelling in years to come if Council has the ability to set its own pricing for the electric 'fuel'.

The most obvious conflict with solar energy and electric powered vehicles is in the time of use – that being the overlap of solar generation and daylight working hours. This can really only be managed through the use of batteries and/or by analysing which vehicles/plant can be charged during the day.

An additional issue with EVs arises in relation to charging capacity; not just where to place them but the engineering behind delivering large amounts of energy quickly. So-called 'superchargers' require large amperage, not always available through the existing grid, and therefore can incur significant costs to establish. This leads to longer charge times and the necessity of charging overnight.

Recommendation: That BHCC invest in a small number of electric vehicles to test how they can be best integrated into operational activities. (Thought bubble – as the home of Mad Max – BH could become the centre of electric hotrod (and sedan) retrofits!

4.7.2 Hydrogen powered drive trains

It is important to understand the 4 distinct elements involved in production and utilisation of hydrogen as a fuel.

1. Energy Source. This needs to provide regulated, good quality electricity and be matched to full chain production capacity.
2. Hydrogen Production. Classified as 'green' = produced with renewable energy or 'blue' = produced with fossil fuels. Basically, using energy to either split water or hydrocarbons.
3. Gas storage. From short term (buffering in production) to long term and both stationary (as energy storage) or transportable (like LPG).
4. Energy Conversion. Oxidation of the hydrogen to release water and energy in the form of electricity and heat. Most commonly in fuel cells or turbines.

Based on CE research it is possible to purchase existing small-scale electrolysers and produce hydrogen at around \$5 - \$6 per kg. This could be done at the site of a solar array to produce a transportable form of renewable energy.

The following table indicates the relative value of the hydrogen fuel in application.

Toyota Mirai		
100	km/kg	
5	kg tank capacity	
33	kWh per kg	
165	kWh per tank	
3	kWh per km	
495	km for	\$ 25.00
99	km/kg	
7	L/100km	petrol car
34.65	L equiv.	\$ 45.05
Truck FB	Scania/Volvo EV	
200	km range	
80	kWh battery	
2.5	km per kWh	
412.5	km for 5kg	\$ 25.00
82.5	km/kg	diesel truck
20	L diesel	\$ 28.00
Water pump		
100	kW capacity	
3.03	kg H per hr	\$ 15.15
25	L diesel per hr	\$ 35.00

Table XX vehicle and pump performance and cost comparison

It is important to remember that hydrogen vehicles are actually electric vehicles with a hydrogen fuel cell replacing chemical batteries. The advantage of this approach is in energy density and recharge times. A hydrogen powered vehicle can be recharged in a few minutes, just like a standard gas vehicle, and as can be seen in the table above, just 1 kg can move a vehicle 100km.

There is much conjecture about whether EVs or HVs will win the Australian market for renewably powered vehicles however it is the view of CE that each system has strengths and weaknesses. The range and speed of refuelling through existing infrastructure point to an advantage for HVs in regional and remote Australia. Certainly, one Australian company is banking on a solid market - H2X currently plans to produce 20,000 HVs each year by 2025 out of the Illawarra region in NSW.

BHCC own and operate a range of plant and equipment for which there are currently no battery-electric or hydrogen-electric powered models available. Caterpillar, Hitachi, New Holland and many more start-up firms are researching and developing renewable powered alternatives to the full range of heavy plant and equipment. Mining companies at the forefront in much of this development.

The Australian Government is invested in the CSIRO National Hydrogen Roadmap released in 2019 and has leveraged $ billions in private investment to stimulate a hydrogen economy for both internal and export markets. The stated aim in much of this investment is to lower production costs to meet a $2 per kg threshold. Some commentators expect the price to fall from the current $5-6 and reach $3 by 2023.

Recommendation: That BHCC position itself as a centre for R&D in the emerging hydrogen economy. Also that Council conduct feasibility into a pilot plant and vehicle(s).

4.7.3 Electric devices

Cordless power tools and light plant such as lawnmowers are also the focus of many manufacturers. For example, Makita have allegedly ceased all R&D into petrol powered tools. While these tools and plant use a small amount of energy in comparison to cars for example, there are operational advantages in not having to deal with mixing fuel and small engine maintenance.

Commercial grade brush-cutters and chainsaws are quieter, simpler and deliver instant power with back-back battery systems that can deliver several hours of continuous operation. They are significantly more expensive to purchase however these prices are falling with increased market share. In time we can expect to see a greater range of electric small plant and equipment as the energy density and affordability of batteries improve.

If BHCC seeks to electrify small plant and equipment we suggest that a decision is made to, as much as possible, stick with one ‘family’ so that battery packs and chargers can be shared. Thought must also be given into the creation of battery e-waste and the non-sense in discarding perfectly functional equipment which may only have occasional use, simply to remove a small amount of hydrocarbon fuel consumption.

Recommendation: That BHCC adjust procurement policy to preference electric plant and equipment for replacement and new purchases.

5.0 Other Renewable Energy Options

5.1 Pumped Hydro

The Broken Hill City Council region contains hills and disused mining facilities that may be appropriate for pumped hydro schemes Any new Council water security initiatives should also consider energy production as part of their remit.

Pumped Hydro is emerging as a preferred dispatchable energy source, particularly over longer timeframes, due to its flexibility and low carbon emissions. Using combined pump/turbine plants, water is pumped from lower reservoirs to higher ones at times of plentiful or cheap energy and then released at times of peak demand when the price for electricity is high. Medium scale Pumped Hydro is likely to become an important ‘product’ in future markets as a buffer or insurance against high power prices and to time-shift large solar production from the middle of the day until night-time.

If Broken Hill City Council elects to proceed with a mid-scale array then an equivalent scale pumped hydro scheme should be investigated in comparison to other chemical forms of storage.

Regardless of progressing Broken Hill City Council’s own solar, it may be that a council-owned pumped hydro facility in association with a decommissioned mine would be economic on the basis of services to other renewable energy projects in the area. In the medium term dispatchable energy is becoming increasingly valuable to the National Energy Market, often attracting pricing around twice the value of daytime generation. It will be interesting to see how AGL fares with their compressed air energy storage project. It may be the case that feasible, mid-scale water-based systems are not applicable in Broken Hill due to practical considerations.

Recommendation: Limited action in relation to pumped hydro in decommissioned mines at this point in time. It may be something to have ‘on the radar’ in discussion with Transgrid/AGL and various mining companies.

5.2 Wind

Broken Hill City and surrounds have a fantastic wind energy resource, as evidenced by the establishment of Silverton wind farm to the North West.
Technologies that harness the wind resource present a significant opportunity for BHCC to reduce operational costs and meet carbon emissions reduction ambitions.

Cases for wind energy include powering:

- Lighting for footpaths and roadways.
- Public amenities - roadside rest areas, toilet blocks, barbeques and shelters.
- Pumping stations.
- Telecommunications towers.
- Telemetry systems such as for water monitoring devices and security systems.

Street lighting typically contributes from between 30% to 60% of a council’s carbon emissions (https://www.energyrating.gov.au/products/street-and-public-lighting). From the energy consumption data, street lighting produces around 30% of the Council’s emissions and a renewable energy-based street lighting system therefore represents a strong pathway to meeting a significant proportion of the Council’s emissions reduction goals.

5.2.1 Small Wind Turbines

Small wind turbines are emerging as a cost-effective renewable energy technology. These systems can be beneficial where there is a desire to provide amenities to the public in locations where grid-connections are cost prohibitive. In many cases, the cost to buy and install these amenities can be significantly less than the grid-connection, with the additional benefits that the operational cost to power the sites is effectively zero, using zero emission technology.

BHCC has already made inroads in this regard, implementing some small wind turbines in Sturt Park. There are several Australian owned companies providing barbecues, shelters and other public amenities furniture with integrated solar, small wind and battery systems.

One Australian start-up Diffuse Energy (https://www.diffuse-energy.com/) has designed and commercialised small wind turbines. Their Hyland 920 turbine has been designed to work side by side with solar and batteries to reliably power telecommunications infrastructure at remote locations. The operating costs for this technology are extremely low, compared to diesel power generation.

To demonstrate how this technology may be applied for BHCC, we have produced a conceptual model of a new off-grid public amenity (using Duke of Cornwall Park consumption figures). This highlights how cost effective the renewable energy technology is whilst providing 24/7 reliable energy with zero emissions.

New amenity	Load		kWh/yr*	kWh/d*
1	New amenity		3880	10.6
	Annual cost		$1,436.00	
	Cost per day		$3.93	
Grid connection				
1	Grid installation CapEx		$30,000.00	
	reduced to daily rate at		10	year Payback
		=	$8.47	per day to finance
	Total cost		**$12.40**	per day

*Usage figures modelled off Duke of Cornwall Park

smallWind	System size		220	W
1	Daily output		2.1	kWh
	Annual cost		$2,433.33	
	Cost per unit per day (installed)		$6.67	
Solar	System size		2.5	kWh
1	Per W installed		$1.35	
	CapEx		$3,375.00	
		=	$0.95	per day (10 years)
Battery	System size		13.5	kWh
1	Installation cost		$11,700	
	reduced to daily rate at		10	year Payback
		=	$3.21	per day to finance
	Total cost		**$10.82**	per day
	Carbon Offset		3.1428	tonnes p.a.

*Emission factor August 2019 (NSW)

Table 10. Broken Hill City Council Offgrid public amenity concept

5.2.2 Community Large Wind

There is also the potential for Council to use larger wind energy installations to offset significant amounts of energy usage. Larger installations necessitate more planning requirements with longer implementation timeframes but can provide significant benefits.

A BHCC backed community project, in a form similar to the Hepburn community wind energy project (https://www.hepburnwind.com.au/) could play a very substantial role in reducing the Council's emissions footprint. That project delivers around 10 GWh per year - more than double BHCC's energy consumption. An innovative business model, where BHCC has a power purchase agreement (PPA) with the community project could provide the necessary incentives to get the project running and attract external investment, while also allowing BHCC to meet its goals of becoming net carbon neutral. The approvals process for large scale wind turbines can be slow however and may not be realistic by 2023.

Although turbines are available from 100kW to 1,000kW, the economics of wind energy tend to leave out the middle ground, leading to the massive turbines and multiple tower wind farms we see developing. That said, Broken Hill is somewhat unique in having reasonable levels of strong evening wind which would be very useful in generating energy at the time that streetlights are consuming it for example. It may be worth testing the market for a mid-scale turbine in the vicinity of the possible solar farm on high ground, in proximity to usable network infrastructure, and away from residences.

Recommendation: Small-scale wind generators should be considered for any new or existing remote infrastructure. Mid-scale wind generators could be considered as part of a hybrid mid-scale project (which we have not modelled). Local wind farms should be approached to provide renewable energy to Council to fill the shortfall if Council elects to proceed with BtM solar only as the offset strategy.

5.3 Virtual Power Plants

As referenced previously in this report, there are currently new technologies and market-place arrangements being developed that allow peer-to-peer solar energy trading between residential properties, known as Virtual Power Plants (VPP). At a small scale, a household can trade their excess solar generation to a property of their choosing at a negotiated price. This system requires both parties in the transaction to be with the same retailer and arrangements can be put in place for one-off transactions or longer-term periods. The integration of battery technology and smart grid software can significantly improve these systems by being able to meet demand during non-solar generating periods. There are pilot schemes in Australia where entire residential housing developments are connected into an embedded network; - residents effectively generate and share power for the net benefit of everyone involved.

Using this concept, it is possible for Broken Hill City Council to develop a Rooftop Solar Virtual Power Plant large enough to offset Council consumption and other businesses and residences in the LGA. Under this model, Council would subsidise the installation of solar and battery systems at selected sites and facilitate customers with the enabling retailer and load control metering devices.

As can be imagined, this approach would require Council to recruit and facilitate a group of 'partners' with the capacity to install solar that, after whatever self-consumption occurs, resulted in the equivalent of 4 MW capacity. Subtracting the 2.89 MW identified in section 4.1.2 above, this equates to a further 1.11 MW. This could potentially be met through oversized systems on about 100 to 200 premises.

CE have previously modelled this for another council and found the $ per kW installation cost significantly more expensive than the mid-scale array option. This may be mitigated to a large extent if an attractive deal can be constructed for participants to part fund the installation themselves. This approach clearly places Council in the realm of community solar projects and as such, council need to be sure they have the appetite internally and confidence in the community to become engaged in such an approach. The approach would require detailed modelling, careful structuring and a recruitment campaign.

Recommendation: BHCC decide on the degree to which their 100% renewable target should be pursued with discrete projects they can readily control, versus a community engaged approach with incentives and a VPP structure for Council to claim the entire generation pool.

5.4 Bioenergy

Bioenergy requires organic feedstocks which are digested or gasified in vessels, resulting in a range of simple hydrocarbon gasses (eg methane) or liquids (eg ethanol). While bioenergy can be applied as a dispatchable energy source, the immediately apparent value to BHCC is potentially to become renewable fuel sources that replace gas and diesel, rather than electrifying the HVAC systems and diesel plant and equipment.

Given the arid nature of the Broken Hill region there are limited feedstocks of organic materials or wastes. Residential and commercial waste transported to the waste treatment centre may provide enough feedstock to match council demand but this has not been quantified for this report. For example, in simple terms, would there be around 30,000 L per year of waste cooking oil to be converted into biodiesel for running Councils heavy plant and equipment? (Not-withstanding production quality and warranty issues). Could the landfill site generate enough methane which, when scrubbed, would be meet the demand for ~23 tonnes of LPG?

The Australian Energy Market Operator has identified bioenergy as part of the 'future mix' of energy for Regional Australia and Broken Hill City Council presents as an excellent candidate for the integration of this technology in a diversified and distributed low-carbon energy future. A specific high-level audit of organic waste streams would be the starting point for investigating bioenergy.

Recommendation: BHCC make a strategic decision on how to approach renewable energy for building HVAC gas and diesel plant/vehicles. BHCC may seek interest or funding from suitable agencies to conduct a study into this element of the REAP as it has wide-spread application.

5.5 Microgrids

The term microgrid traditionally applies to a single point of connection into 'the grid' behind which sit multiple metered loads. Examples are shopping centres and some industrial subdivisions. Transgrid recently promoted Broken Hill's potential to become "one of the world's biggest renewable microgrids" although this is in some way an oxymoron!

Microgrids are going to play a large role in future new greenfield developments in regional Australia. The costs of installing and firming renewables are now competitive and, in some circumstances, much cheaper than installing and maintaining the poles and wires to new remote locations. There are also examples where a number of meters can be consolidated into a single market facing meter and with basic wiring and administrative changes, result in reduced billing due to standing charges.

An article in ABC News recently reported significant interest in micro-grids and energy sharing in a variety of applications from small townships to university campuses to remote communities (See ABC News 4th December 2019).

Recommendation: For Broken Hill City Council, microgrids should be considered for any development likely to have a few or more meters connected to the network. If Council is the enabler, then it is likely to result in reduced operating costs for sub-metered customers and an on-going revenue stream to Council.

Constructive Energy has the role of Technical Director in a federal government funded study into the application of microgrids in agriculture with Queensland Farmers Federation and others.

5.6 Off-grid facilities and critical infrastructure

Many remote communities and mining operations are currently installing independent generation facilities. A good example of this has occurred in remote farming communities around Esperance WA. In 2015 a large bushfire caused loss of life and property, including large swathes of the local electricity distribution infrastructure. In agreement with the local community the electricity provider (Horizon Energy) has installed a virtual microgrid with each customer having their own solar production and firming capacity (battery). Locals have confirmed that the outcome for them has been stable and reliable power at equivalent cost (source: ABC news Oct 2019)

We recommend that serious consideration is given to installation of solar, battery and backup generation capacity for any new developments planned by Broken Hill City Council where access to the network may be problematic or expensive. Further, this approach can provide energy security for critical infrastructure in the event of natural disasters or other supply interruptions. The emerging hydrogen economy can also offer

Recommendation: That Broken Hill City Council consider the relative importance of energy security at key sites and factor this into considerations for BtM installations as this may be the factor that weights the business case towards proceeding.

solutions in the context.

5.7 Ground Source Heating and Cooling

Where major retrofits are being undertaken or new buildings constructed, the possibility of using ground source air conditioning should be considered. Opportunities such as open trenches for other plumbing work could be used to improve the cost-effectiveness of installing buried pipe loops as part of a ground source heat pump solution.

There are examples globally of roads being underpinned with a network of pipes to capture solar-thermal energy which then dramatically reduces heating costs for nearby buildings in winter.

While seemingly left-of-field, using the temperature of the earth to heat and cool can be low-cost, low maintenance renewable energy source, particularly in a setting like Broken Hill which receives high variance between daytime and night-time temperatures.

Recommendation: Include ground source as a technical solution to investigate in specifying upgrades to building Heating Ventilation Air Conditioning systems.

5.8 Demand Side Participation (DSP)

Demand Side Participation has been referenced elsewhere in the Plan however it does stand on its own as an opportunity for Council to participate and financially benefit from the scheme. The Australian Energy Market Operator (AEMO) has forecast elevated risk to electricity supply over the next 10 years, and in particular, interruptions to electricity supply during peak summer periods.

A contractual arrangement can be entered into by Council (the participant) with AEMO, in which they agree to the curtailment of non-scheduled energy consumption or provision of non-scheduled generation in response to the demand of electricity.

- Examples include industrial facilities that are exposed to the wholesale price and elect to reduce electric load at times of high prices, consumers that agree to let their battery be controlled by a third party or are incentivised to switch off air-conditioners, and small non-scheduled generators that have the ability to produce electricity at these times, offsetting local consumption (source: March 2020 - Demand side participation forecast and methodology).

The mechanisms and regulation for DSP are currently evolving however we can be sure that this will become an increasingly prevalent component of energy retailing and network operation.

Recommendation: Council explore opportunities to have excess solar and battery production enabled during these peak periods, for financial reward.

6.0 CAPEX Funding and Ownership Models

The strong economic return in renewable energy infrastructure is resulting in a range of potential investment options and there is currently significant investor interest which can be leveraged. The following enabling mechanisms all have relevance and precedent within the local government sphere.

Broken Hill City Council owned and operated on BHCC facilities

Delivers BHCC the shortest pay-back and maximum return (cash flow) but BHCC carries all the risk (after warranty). BHCC may choose to invest existing reserves (including grant funding) or take advantage of low borrowing rates to structure projects as cash-positive from day 1.

Corporate owned

Corporate owned on Broken Hill City Council facilities**:** It is common practice for solar companies to offer installation at no cost and to enter into a Power Purchase Agreement (or equivalent lease-type arrangement) that will slightly reduce and lock in a cost for energy over typically a 7 - 10-year timeframe. In this instance the provider carries the risk and maintenance burden but is able to generate a cash flow and profit after the pay-back period. The asset is often gifted to the host at contractual exit e.g. after a 12-year period

Community Owned on Broken Hill City Council facilities

There is a strong movement for community ownership of commercial and larger scale solar plants and many models and organisations exist to facilitate this. The arrangements are similar to corporate investment however the financial returns are distributed to community investors, typically at around 6 – 10%. Community owned solar is seen as a way to engage community and to share economic benefits locally and in many parts of the world a set percentage of community ownership is stipulated as a condition of consent – particularly in wind projects.

Broken Hill City Council as provider on/to third parties

Subject to the right agreements and on the strength of business modelling, Broken Hill City Council may choose to invest in solar panels on or near industrial sites in BHCC and to benefit from a Power Purchase Agreement while supporting local business through reduced operating costs and energy certainty.

Hybrid funding

For certain larger installations it is possible that a range of funders invest in the project. For example, the host/energy user, the community, Council and a third-party commercial operator may all invest in a set percentage share of a project.

7.0 BHCC Renewable Energy Roadmap

In August 2020, Constructive Energy met with the BHCC Key Directions Working Group. The working group were seeking a detailed 'Roadmap' with next steps for Council to achieve net zero emissions on Council assets by 2023.

In response to reviewing the draft REAP, the working group identified essentially 3 main pathways to achieve this; mid-scale array, distributed energy + community program, or wait for a 3rd party to de-carbonise the local grid.

After deliberation, it was agreed to further pursue the mid-scale array option in concert with improved energy monitoring and control. In the next section of this Renewable Energy Action Plan (REAP), we have documented a potential Roadmap for Council to adopt, enabling BHCC to achieve their Carbon Neutral ambitions, with a positive business case, via this pathway.

It must be noted that some of the steps outlined in each of the projects have already been completed by BHCC as part of developing this REAP. For the purpose of completeness, the entire process has been outlined.

Constructive Energy has also been engaged by other Local Government clients to undertake similar projects. If BHCC decide to engage Constructive Energy to proceed with the any or all of these projects, this will allow BHCC to leverage the work already performed by these other Councils. This will mean several of the steps outlined in this Roadmap can be expedited and the results from previous analysis shared directly with BHCC (Subject to direct relevance and consent of other Council(s) that have recently facilitated this work).

For instance, Constructive Energy has recently performed an Expression of Interest (EOI) for a Central West rural Council for them to build and operate their own 1.7MW solar array and battery.

This EOI has discovered multiple market offerings that would be beneficial to the BHCC mid-scale solar business case. In this instance it would be highly beneficial to BHCC to approach these suppliers and the EOI step to be skipped by BHCC, reducing the costs and time incurred.

7.1 Mid-scale solar project

MIDSCALE SOLAR STAGES

1 Establish size & Shortlist Locations

- Project steering committee appointed
- Metering upgrade and consumption analysis
- Site confirmation
- Preliminary network enquiry / CISA ($25k)
- Develop Business Case
- Present to Council and seek endorsement to proceed to next stage
- Develop RFT for design & construct and market participation
- Select preferred tenderer(s)

$30- $50k Indicative pricing

2 Detailed Concept Modelling

- Develop detailed construction and financial model(s)
- Secure Council endorsement to proceed with full project
- Secure project finance
- Community engagement strategy development and delivery

$30 - $50k Indicative pricing

3 Full Detailed Project Planning

- Contract establishment and supplier engagement
- Complete engineering and design and network connection approval
- Final site studies (including geotechnical) and submission of the development application (DA)
- Customer engagement strategy

$250k – 500k Indicative pricing

4 Project Delivery

- Site preparation and construction
- Network connection completion and testing
- Energisation & Commissioning and Defect Liability Period (DLP) commences
- Post commissioning network submission

CONSTRUCTIVE ENERGY

7.1.1 Establish Size & Shortlist Locations

Project Steering Committee appointed

A project steering committee will be formed to work closely with Constructive Energy, guiding and ensuring that Council and the Community's interests are aligned with project outcomes.

Metering upgrade and consumption analysis

This task is an important first step required to establish a baseline of Council's consumption, critical to optimising any mid-scale or behind-the-meter solar and battery installation and managing load profiles.

Please refer to section "Energy monitoring and control".

Site confirmation

Constructive Energy to confirm potential locations for the installation of a mid-scale solar array. This analysis will involve due diligence with land tenure, claim overlays and site suitability including landform, soils and vegetation impacts.

Final location selection will be dependent on Network Connections approval. Our previous experience has shown that a site may seem ideal on paper but when the Preliminary Network Enquiry is submitted, there are unforeseen network constraints with the location, e.g. feeder upgrades or substation transformer upgrades.

Preliminary network enquiry / CISA ($25k)

For a mid-scale solar and battery installation to proceed with grid connection, the first step is to perform a Preliminary Network Enquiry (PNE) with the local Distribution Network Service Provider (DNSP). This process is designed to propose to the DNSP where the installation is to be located and the generation/load size, profile, etc. The PNE is to establish at a high level if the existing infrastructure has capacity to handle the proposed project. This process usually takes up to a month once the submission is lodged to receive the results.

For a midscale solar and battery to be connected to the National Energy Market (NEM), a Connection Investigation Services Agreement (CISA) needs to be lodged with the DNSP. This is required for all midscale solar installations above >1MWp. There is a ~ $25,000 lodgement fee and potential further costs incurred as the CISA process is undertaken.

Develop Business Case

Complete feasibility studies to develop realistic budgets for CAPEX, O&M and Revenue/Value for Council to integrate with existing financial modelling approaches. CE can also assist with content for many of the standard inclusions in council business papers.

Present to Council and seek endorsement to proceed to next stage

Based on network feedback, Constructive Energy and the project steering committee will present to Council the proposed project and high-level performance/financial modelling. The steering committee we will then seek Council endorsement and budget allocation to proceed with the next stage of the project.

Develop RFT for design & construct and market participation

Constructive Energy will prepare a Request for Tender (RFT) for the purpose finding the project partners, to assist with the market participation (sharing energy across Council sites and selling excess energy) and the detailed engineering and design of the system.

Constructive Energy can conduct this step as a 'Select RFT' based on knowledge of which providers currently have capacity to deliver. CE can introduce experienced project partners and suppliers to the BHCC RFT that will bring market leading offerings to Council. CE has recently undertaken this market testing process with other local government clients and can leverage the existing supplier relationships.

Select preferred tenderer(s)

Evaluate the competitive tenders to identify best match. Engage the supplier in an iterative 'gateway' contract arrangement to minimise risk, maximise local contractor involvement and comply with Local Government procurement guidelines.

7.1.2 Detailed Concept Modelling

Develop detailed construction and financial model(s)

Working with the preferred suppliers and steering committee on a fully costed business case. This will include details about how best to monetise the inevitable excess summer or shoulder season generation plus the construction costs and associated network design to be completed.

Secure Council endorsement to proceed with full project

Present market tested cost estimates and revenue/value projections to Council. Also, present findings in relation to key potential ‘showstoppers’ such as excessive network augmentation costs, DA barriers, unforeseen site issues, etc.

Secure project finance

The Council will be in position to seek project finance for the next two stages. The full project planning and project delivery stages. The fully costed business case will be used to secure finance from Council’s preferred financial institution.

Constructive Energy can assist with any government grant or private funding applications that Council may seek to assist with the project, e.g. government battery subsidies, or build own operate transfer (BOOT) proposals.

Community engagement strategy development and delivery

The steering committee will develop a community engagement strategy to ensure that the local community and stakeholders are brought along and with the project and their sentiment is heard. This phase may also involve recruitment of community customers.

7.1.3 Full detailed project planning

Contract establishment and supplier engagement

Council Executive and project steering committee will negotiate terms and timelines with delivery partner(s). The final agreement will be presented to Council for endorsement and signoff.

Complete engineering and design and network connection approval

The next stage of the project commences with the detailed engineering and design being developed by an accredited Level 3 network engineering firm and the solar and\or battery installation partner. This step will also require engagement with the DNSP and may go through multiple iterations to arrive at the final design and approval.

Final site studies (including geotechnical) and submission of the Development Application

Note – the DA process will have commenced during the previous stage. Outcomes of site studies in response to DA initial feedback can then be integrated into the final submission ensuring that the development is compliant with local and state planning rules.

Customer engagement strategy

If the business case for the solar array requires Council and their retail partner to trade the excess energy from the array and batteries, then a customer engagement campaign will need to be conducted with local business and possibly households. This is a very important step to aggregate local demand for the future energy output from the array once the BHCC array comes online.

Constructive Energy experience has demonstrated that there is extraordinarily strong community sentiment for supporting a Council owned solar and battery array. The retail partner engaged for the project will be required to provide the supporting services including customer acquisition, invoicing, and energy firming capacity.

7.1.4 Project delivery

Site preparation and construction

The project at this point will be 'shovel-ready' and earthworks and solar array can be constructed. Where possible, the local workforce will be used reflecting one of the key drivers for Council.

Construction will include supply and install of all LV and HV transformers, switchboards, grid protection boards, trenching, cabling, inverters, solar panels and batteries. Oversight will be provided by the Managing Contractor to ensure that all safety standards are met and industry best practice is adopted.

Network connection completion and testing

When the construction phase has been completed and prior to grid connection, there is a requirement to test the capability of the generation asset to meet agreed performance standards. Results are shared with the Australian Energy Market Operator (AEMO) and the local DNSP. Formal connection approval will follow.

Energisation & Commissioning and Defect Liability Period commences

Once approvals have been received and the project has received regulatory signoff an official go-live date can be scheduled. This may include a 'ribbon-cutting' event involving the Mayor and local Member of Parliament!

Post commissioning network submission

Network connection requires that AEMO and the DNSP are provided with updated performance information within 3 months of commissioning. This must be accompanied with a compliance monitoring program implemented no later than 6 months from the energisation of the solar array.

7.2 Energy Monitoring and Control

One of the recommendations of this REAP is for CE to assist BHCC upgrading Council managed assets with a 'complete energy management solution'. The objective is to provide visibility on BHCC consumption patterns and to ultimately provide Council with energy usage and cost savings.

Constructive Energy recommends that BHCC invest in a BtM metering and control system that enables real-time energy visibility through an intuitive portal plus the capacity to switch non-critical loads on and off and modulate flexible loads like Air Conditioning.

The modest Capital Expenditure for the devices is offset by immediate savings realised by Council when staff behaviour changes and energy use within existing tariff structures is optimised.

Local electricians are preferred for installation due to familiarity with site usage and wiring at Council sites.

There are three stages suggested with an Energy monitoring and control project: -

7.2.1 Energy monitoring and control pilot

Council may wish to undertake an energy monitoring and control pilot to understand the capability of devices and the ability for them to work in BHCCs operating environment, including: -

- Ease of installation of the devices at the pilot site.
- Ability to capture real-time (or near) energy consumption and generation data (if applicable).
- Ease of using the metering dashboard for reporting.
- Ability to extract and manipulate energy consumption and generation data.
- Ability to identify and realise potential cost and energy savings reductions at the pilot site.

Constructive Energy is currently running pilot programs for two Councils and the QLD Farmers Federation. Results of these can be shared with BHCC. BHCC can then decide whether a pilot study is warranted.

Once the pilot has been conducted and results reported back to Council and the BHCC key directions working group, then the project can progress to the next stage.

7.2.2 Staged rollout of selected devices to Council priority sites

The next step is to categorise Council sites into three categories: -

- Energy monitoring only.
- Energy monitoring and control.
- No devices required.

Constructive Energy will work with Council to recommend a hierarchy to rollout the selected devices.

7.2.3 Ongoing management and reporting

Constructive Energy would assist with ongoing support of these devices and provide Council with insight at both strategic and operational levels leading to cost control, transparency in energy use, better reporting, and real-data validation of future energy-related project proposals.

Capability Statement

Constructive Energy

Constructive Energy (CE) was founded in 2018 in the regional city of Bathurst (NSW). We are a renewable energy strategy and energy management firm.

Constructive Energy has a combined experience of over 25 years' worth of renewable energy and energy efficiency expertise.

Our key focus is to assist regional local government organisations with their transition towards a renewable energy future.

Since forming, Constructive Energy has:

- Developed Renewable Energy Action Plans for 5 local governments.
- Developed the detailed business case and commenced project delivery of a $7.6 million, 5 MW solar array.
- Completed several major funding applications for renewable energy projects with multi-State and national consortia including microgrid feasibility with the Murray Darling Association, Queensland Farmers Federation and Cotton Australia (result pending).
- Delivered energy efficiency training to builders in Australia and the US.
- Presented on renewable energy at several conferences and forums.

Our service offering includes:

- Renewable energy and energy efficiency strategy
- Small and medium scale renewable energy installation and project management
- Energy contract management and renewable energy procurement
- Outsourced energy management and energy consumption reporting

Our stated goal by 2030 is to:

- Assist Local Government to install and own over $60m in renewable energy infrastructure.
- Facilitate the micro-grid, VPP and behind-the-meter transition across regional Australia
- Deliver 20m tonnes in Carbon abatement.

Appendix

Specific Site Analysis

We will now explore a series of charts related to each of the facilities listed. Understanding when energy is consumed across time creates an 'energy profile' for each site which becomes important in making decisions about the business case for renewable power, load shifting, energy storage and efficiency.

Streetlights are omitted from this detailed analysis due to the timing and consistency of the load however an offset option will be discussed later in the report.

Please note that

Broken Hill City Council Administration Building

Site details

Street Address	Sulphide Street Broken Hill NSW 2880
NMI	4508000032
Current Retailer	ERM Energy
Roof space	Yes
Map URL	https://nationalmap.gov.au/renewables/#share=s-gFEFXMYPhmBj82vC
Description	The site does not appear to have any solar installed on the roof. However there appears adequate for a modest mid-size rooftop solar installation.

Assessment

This Administration building's annual consumption for FY1819 was 382 MWh. This site has an interval meter installed, collecting meter reads at 15-minute intervals. The interval data has been analysed and shows that it has typical administration centre profile with a relatively small 'resting' load overnight, ramping up at 4am likely when HVAC systems start, then moving to into higher use during office hours.

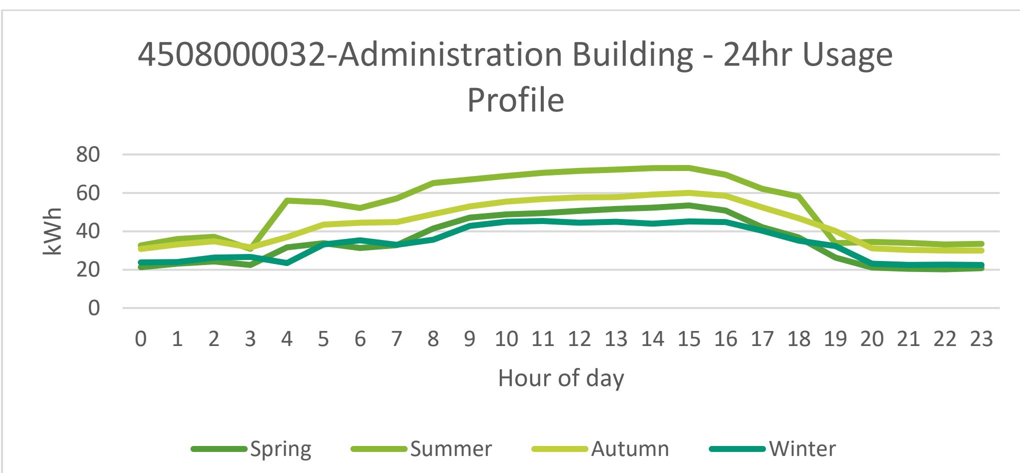


Chart 12. Example office facility energy profile

Clearly there is a strong overlap between the administration consumption profile and the generation profile of photo-voltaic (PV) solar panels. This overlap, combined with the ability to generate 'behind the meter' and thus to avoid purchasing energy, makes a compelling business case for commercial solar.

The other factor to consider, which we can obtain from the monthly billing data, is the annual energy profile. For example, Does the Administration Centre use more energy for cooling in summer or heating in winter? The figure below (Chart 13) shows that energy use peaks in summer months, due to the HVAC systems at the site.

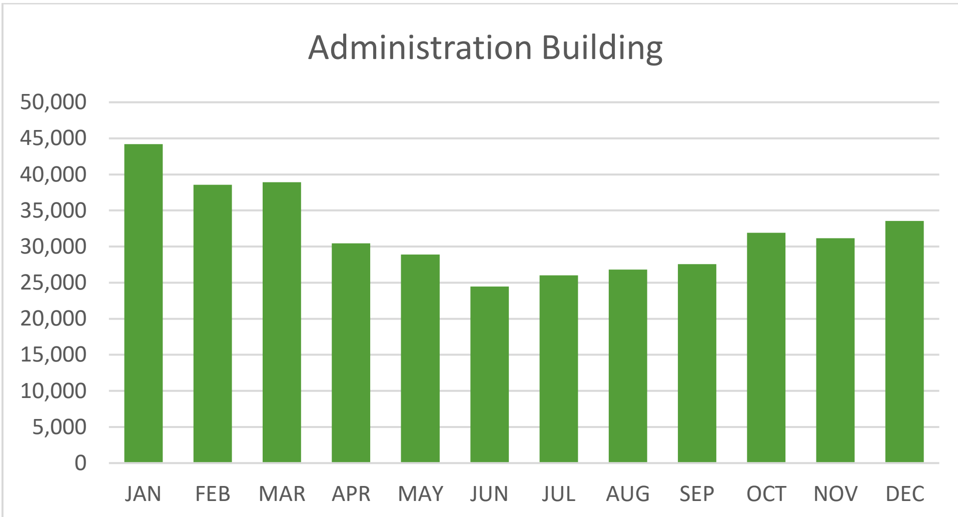


Chart 13. Administration building annual usage profile

Gas consumption

While there is no 'town gas' in Broken Hill, the administration building consumes gas for heating via gas delivered to an external storage tank. The amount consumed varies considerably over the years and appears to be declining. The average from 2016-2018 was 13.25 tonnes which equates to 180,155 kWh.

While it used to be the case that gas heating was more cost-effective than electrical this is no longer the case. That said, the changeover costs for fully electric HVAC can be substantial and would require detailed costings. Another alternative would be to support the development of gas in Broken Hill from organic waste streams or even hydrogen. This would need to be tied into a broader program to be viable of course.

CE is also aware of a comprehensive review into site HVAC which noted a range of legacy issues and failure expected without significant works anticipated in the next 2 – 5 years.

Given the site usage profile, there is no obvious case for a battery installation alongside the rooftop solar however, as battery installation costs are falling this option should be kept on-the-horizon. Battery installations provide the ability for a site to 'time-shift' solar production hours to night-time hours when other Council sites and plant are operating e.g. pumping and\or street lighting.

We also recommend implementing energy efficiency measures at the Council Administration building as an easy and cost-effective opportunity to reduce energy consumption at this site. These measures include, lighting upgrades, increased insulation and window/wall shading that would reduce energy demand – particularly in summer. A third-party provider with audit capacity would be advantageous in developing a detailed and fully costed energy efficiency plan. These usually 'pay back' within a few years and possibly less if approved under the NSW government Energy Saving Certificates Scheme.

Site recommendation

With or without a BtM solar installation, the Administration Centre's energy usage profile closely matches the solar production hours which is useful. We suggest that when HVAC upgrades are scheduled Council takes the opportunity to transition to an all-electric solution.

Aquatic Centre

Site details

Street Address	336 McCulloch Street Broken Hill NSW 2880
NMI	4001208908
Current Retailer	Origin Energy
Roof space	Yes
Map URL	https://nationalmap.gov.au/renewables/#share=s-eWbjxS2ZtYAcWcl3
Description	Located in the Northern edge of the City.

Assessment

This site is Council's largest consumption site (excluding streetlighting). The annual consumption for 2019 was 1.345 GWh. Consumption data was analysed and shows a consistent usage profile across a 24 hour period regardless of season. There is some seasonal variance as would be expected at this type facility.

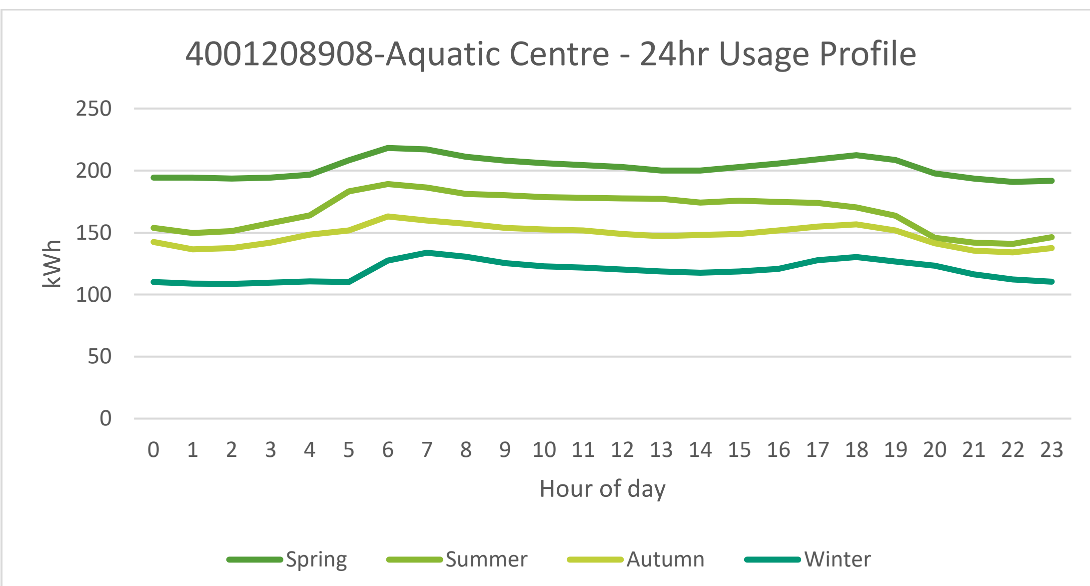


Chart 14. Aquatic Centre 24-hour usage profile

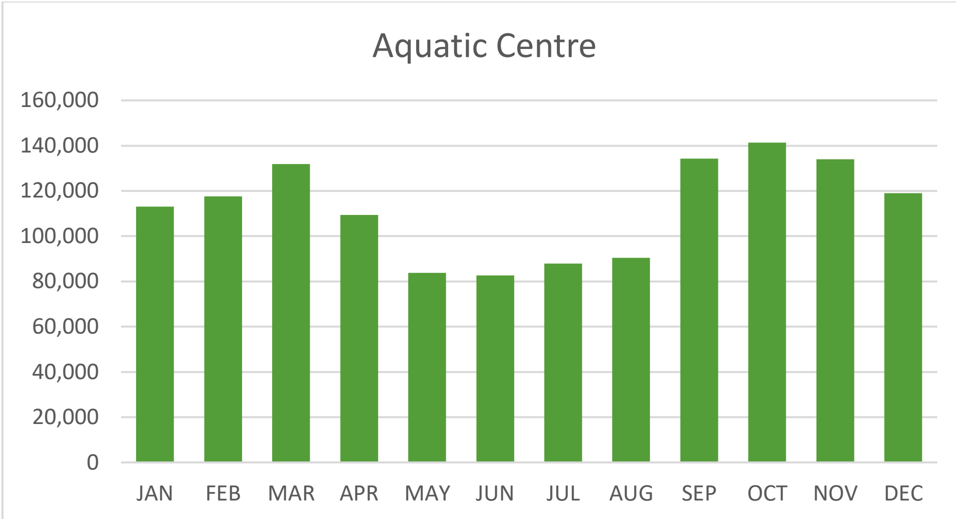


Chart 15. Aquatic Centre annual usage profile

Chart 15 demonstrates the monthly variance in consumption at this site showing peak usage across shoulder seasons. The profile is relatively well matched to an annual solar production profile apart from the summer peak when a solar system sized to meet winter demand would produce excess energy.

Site recommendation

BtM rooftop solar installation was previously marked for installation for this site, however due to a severe hailstorm, prior to this system being commissioned, this project was abandoned. The storm caused damage to the solar panels and roof structure.

CE is aware that a structural assessment is being undertaken on the roof structure. Based on this, our immediate recommendation is to investigate the possibility for this site to purchase energy from a Council owned and operated Medium Scale Solar Array via a Virtual Net Metering arrangement (refer to section 4.1.1)

An audit specifically for this site would be advantageous as the consumption appears especially high for equivalent facilities and from our site visit it was not immediately obvious as to why.

Broken Hill Regional Art Gallery (Sully's Art Gallery)

Site details

Street Address	408 Argent Street, Broken Hill, NSW, 2880
NMI	4508009467
Current Retailer	ERM Power
Roof space	Limited
Map URL	https://nationalmap.gov.au/renewables/#share=s-yKe3zj0e4H1jvhVP
Description	Located near the railway near the Geographic centre of the city.

Assessment

Sully's gallery is the third highest consumption site and has substantial energy consumption of 266 MWh per annum.

Chart 16 below shows the 24hr usage profile at Sully's gallery across the 4 seasons. The profile for this site is not as we would expect it. The site energy consumption doesn't drop off as much as would anticipate it to overnight. There is a modest increase in usage through daytime and opening hours, as we would anticipate. However, the most striking anomaly is the concave daytime consumption curve during winter.

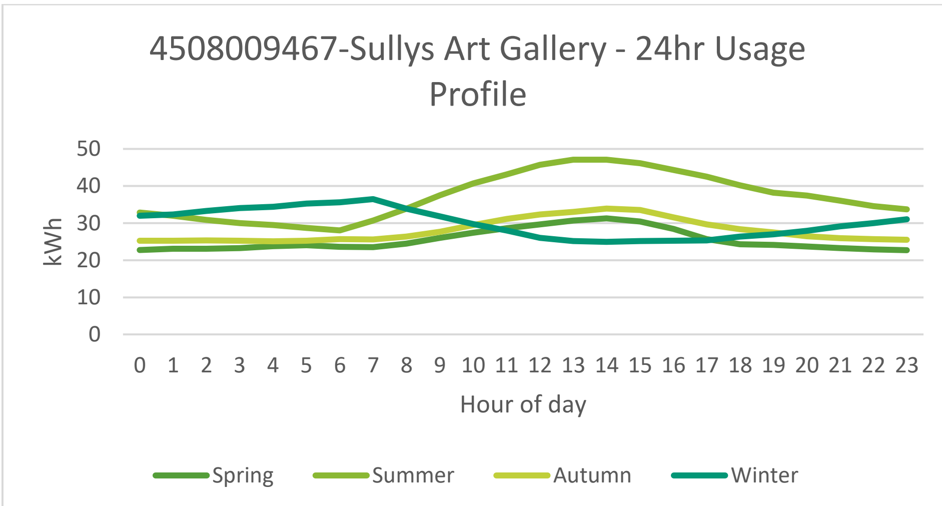


Chart 16. Sully's Art Gallery 24-hour usage profile

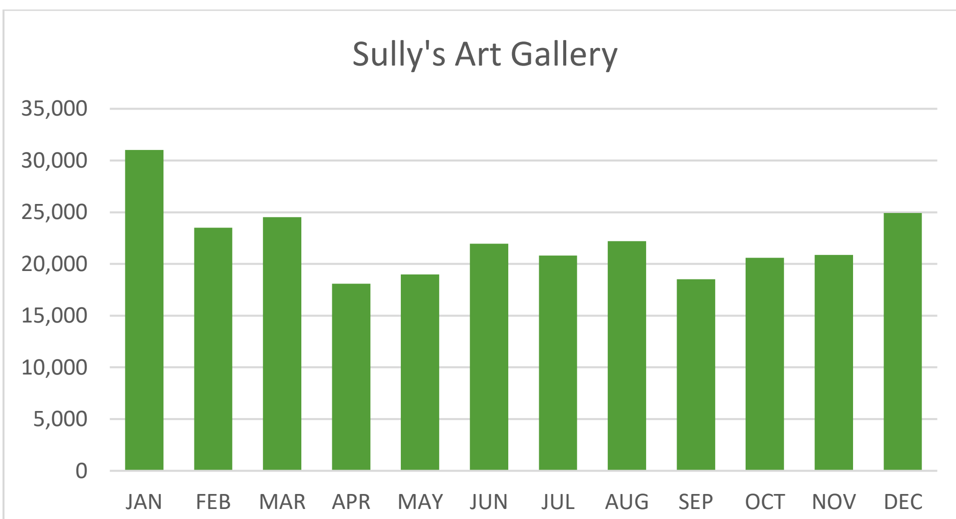


Chart 17. Sully's Art Gallery annual usage profile

Chart 17 demonstrates that there is seasonal variance in the electricity usage at the site, peaking in January. The likely cause of this increase in usage is due to HVAC systems in summer.

Site recommendation

Our immediate recommendation is to investigate why the overnight usage at this site is so high.

- Is the overnight HVAC system required to run 24x7 keep the temperate and humidity constant in the building and for the artwork preservation?
- If so, can the building be retrofitted with energy efficient measures to reduce, the night-time usage when the building is not being used?

Our recommendation is that the energy consumption, at Sully's gallery could be offset by Council owned and operated mid-scale solar array and virtual net metering arrangement.

BHCC Civic Centre

Site details

Street Address	31 Chloride Street, Broken Hill, NSW, 2880
NMI	4508000046
Current Retailer	ERM Power
Roof space	Yes
Map URL	https://nationalmap.gov.au/renewables/#share=s-dRwdquKjLwiv1FFj
Description	The Civic Centre located in the centre of town and close to the other Council facilities.

Assessment

The Civic Centre, as shown in Chart 18 demonstrates the perfect 'bell-shaped' electricity usage profile. There is little overnight usage, however from 5am through to 6pm is the vast majority of usage.

This energy profile is 'text-book' for a BtM Solar array business case. Currently the majority of the site's usage is consumed during Peak and Shoulder Tariff times and daylight hours.

BtM solar consumption at this site, would enable Council to self-consume and offset both the network and consumption charges, dramatically shortening the payback period and return on investment.

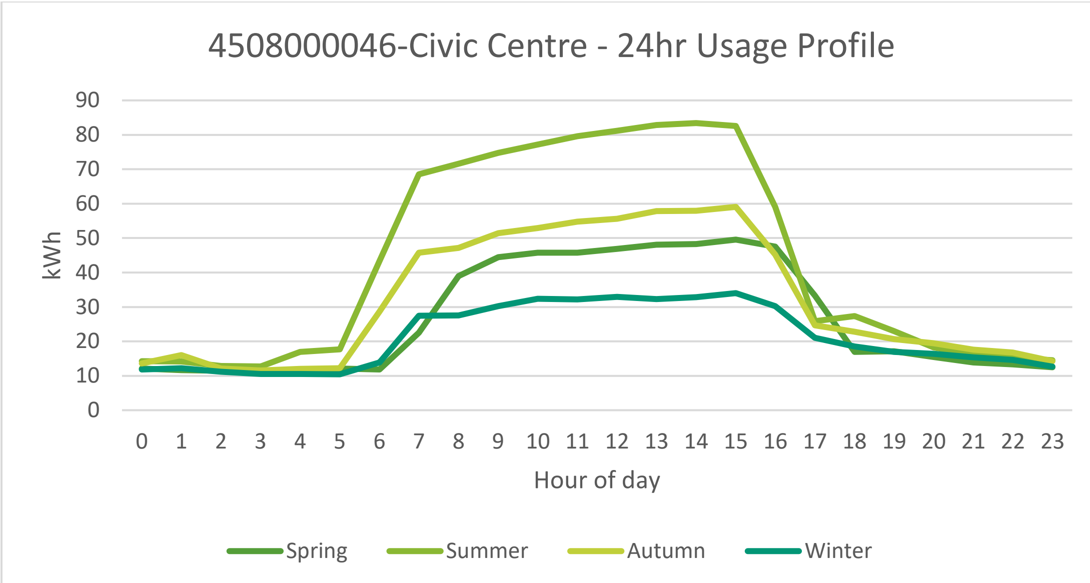


Chart 18. BHCC Civic Centre 24-hour usage profile

Chart 19 below, demonstrates the there is some seasonal variance and as we anticipated the summer months have the most amount of consumption.

Many BtM solar installations are constrained by the problem of what to do with their excess summer production? Fortunately, at the Civic Centre, the increase in summer consumption, aligns beautifully with the increase in solar output from a PV array, adding weight to the case for a BtM solar installation at this site.

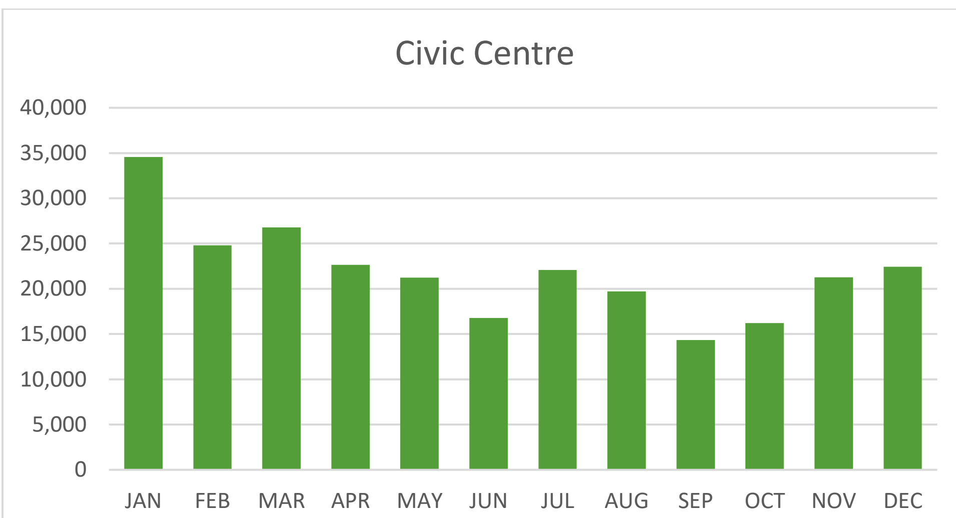


Chart 19. Civic Centre annual usage profile

Site recommendation

With almost ~1000m2 Roof space, and the bell-shaped consumption and seasonal profiles, we highly recommend a detailed business case for BtM solar PV installation at this site be prepared.

Any solar installation under 100 kWp, qualifies for small-scale technology certificates (STC's) reducing the capital expenditure required. An array of this magnitude would also likely bring this site under the 160MWh p.a threshold and would remove the additional network demand charges, improving the business case further.

Tourist Information Centre

Site details

Street Address	23 Bromide Street, Broken Hill, NSW, 2880
NMI	4508000071
Current Retailer	ERM Energy
Roof space	Yes
Map URL	https://nationalmap.gov.au/renewables/#share=s-n8qYeSqlc400YVso

Assessment

Interval data was not able to be obtained for the Tourist Information Centre. However, billing data was able to give us an overall picture of the annual usage for the site. Refer to Chart 20 below.

Like the other sites the consumption through the summer months was high. For the rest of the year the consumption fell within a consistent band of 12,000 kWh and 20,000 kWh consumed.

Although we don't have interval meter reading data for this site, we can assume that most of its consumption would be during the normal operating hours (8:30am – 5pm).

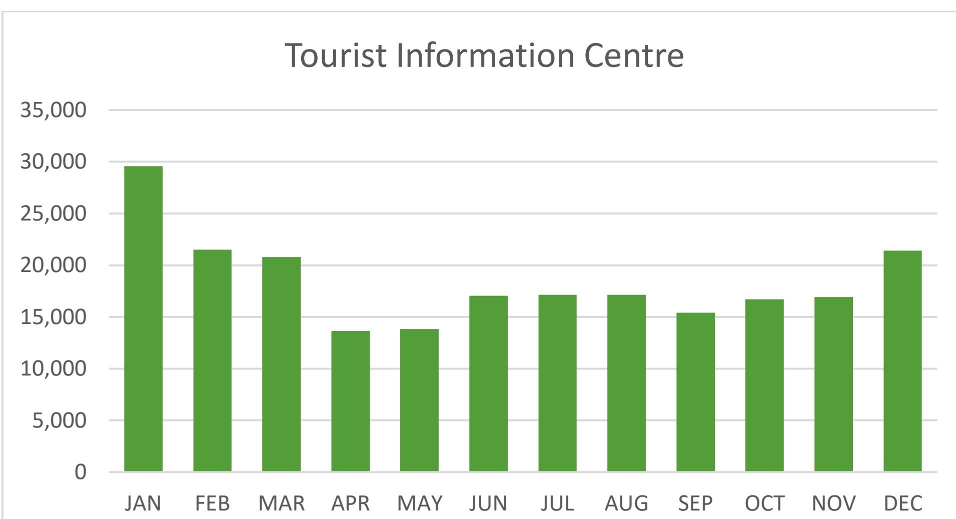


Chart 20. Tourist Information Centre annual usage profile

Site recommendation

This site consumes ~220MWh per annum. This is again close to threshold applied to site a for network demand charges applied by the network operator Essential Energy (large consumption tariff >160 MWh p.a.). Therefore, these costs could be easily eliminated by installation of rooftop solar PV and battery.

Aerial photography of the site reveals that there is available roof space, without shade, suitable for a rooftop solar installation. We recommend a meter upgrade at this site, so that interval data can be obtained, and a detailed business case prepared for a BtM solar installation.

Engineers Depot

Site details

Street Address	Warnock Street Broken Hill, NSW, 2880
NMI	4508000110
Current Retailer	ERM Power
Roof space	N\A
Map URL	https://nationalmap.gov.au/renewables/#share=s-mqq0cJXFYepxRWkW

Assessment

Similar to the BHCC Tourist Information Centre, interval data was unavailable for the Engineers Depot. The usage was consistent across the year, except for January, where there was a huge spike in electricity consumption.

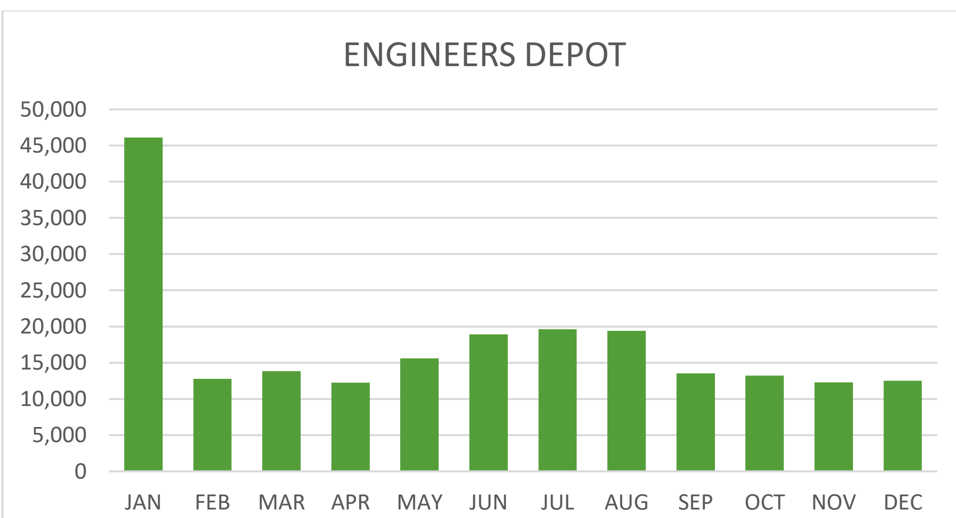


Chart 21. Engineer's Depot annual usage profile

Site recommendation

Our recommendation for this site, is to install a smart interval meter at this site. We also recommend further investigation on the reason for the spike in energy usage in January to determine whether this was a once-off or a more regular event.

Similar sites investigated for other Council's has revealed that Council depots usually consume all their energy during daylight hours, making them very good candidates for BtM solar and battery installations. We recommend that a more detailed investigation of the costs of electrification of the plant and equipment paired with solar and batteries to enable cost and carbon reductions at this site.

Charles Rasp Memorial Library

Site details

Street Address	249 Blende Street, Broken Hill, 2880
NMI	4508000044
Current Retailer	ERM Energy
Roof space	Limited
Map URL	https://nationalmap.gov.au/renewables/#share=s-fQYgmr85XPND6lei
Description	Also known as the Broken Hill City Library

Assessment

This site has the least amount of consumption of all of the Contract sites, at 209MWh for 2019. The season profile is similar to that of Sully's Art gallery.

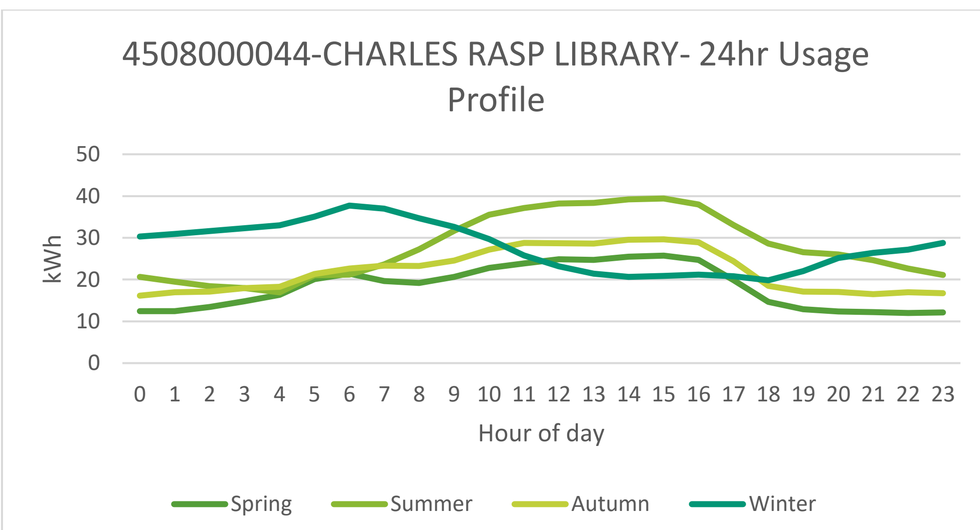


Chart 22. Charles Rasp Library 24-hour usage profile

This site has a more pronounced bell curve profile peaking during business hours, as we would anticipate. The only anomaly is during winter where energy usage increases and peaks overnight.

Chart 22 reveals peaks during summer and winter months and troughs during shoulder seasons. This is a typical profile where HVAC are required most.

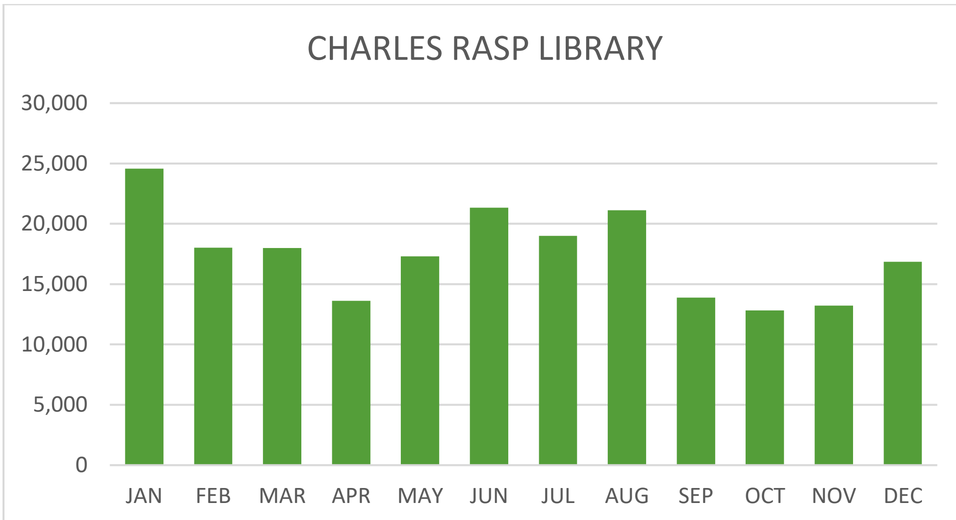


Chart 23. Charles Rasp Library annual usage profile

Site recommendation

This site has adequate roof space without shading and would be another candidate for BtM rooftop solar or mid-scale solar option as discussed in detail further in this report.

OUTCOME SUMMARY TABLE

Activity/Outcome	Summary	Ranking	Responsible
ENERGY EFFICIENCY			
Monitor consumption:	Engineering are responsible for reviewing energy usage at all sites and of key equipment/assets.		
Reporting and performance	Energy use for sites/assets is reported in regular section meetings and efficiency forms a component of staff Position Descriptions		
Procurement policy	Energy consumption rates are considered in the procurement of any new equipment or servicing and maintenance of existing items. This includes new buildings and vehicles.		
Retrofit strategy	Building modifications will be carried out at least in part for the purpose of reducing energy consumption.		
Planning	Broken Hill City Council promotes energy efficiency in design through the planning phase where applicants are encouraged to adopt Guidelines for factors including – insulation, glazing, orientation, primary equipment, water use, etc		
Product broker	Broken Hill City Council applies knowledge and purchasing power to support residents and businesses with products that reduce their energy consumption		
Street lighting	Broken Hill City Council works with Essential Energy, etc to replace existing streetlights with efficient alternatives.		
SOLAR ENERGY			
On-site Solar for Council assets	Broken Hill City Council installs solar panels on (or nearby) Council owned sites 'behind the meter' sized to minimise purchase		
Education and Leadership	Broken Hill City Council makes it easy and safe for residents and businesses to install solar.		
Micro-grids	Broken Hill City Council develops new industrial and residential estates with the capacity for Council owned micro-grids and reduced energy costs to constituents from Council supplied electricity		
Generator /retailer models	Broken Hill City Council engages actively in leading the advent of energy sharing/virtual power plant metering where Council and constituents can be the		

	beneficiaries of local renewable generation 'in front of the meter.		
Industry support	Local industries are encouraged and supported to offset energy demand with commercial solar installations and/or to purchase Council generated energy at a competitive rate.		
HYDRO ELECTRICITY			
Hydroelectric generation	Broken Hill City Council remain on the lookout for opportunities and encourage mine decommissioning plans to investigate this.		
BIOENERGY			
Bioenergy	Broken Hill City Council is home to many carbon-rich agricultural and primary production feedstocks capable of generating bioenergy. As a dispatchable energy source, this may be an important part of the local energy mix in the coming years. BHCC should foster and collaborate with local businesses developing bioenergy.		
TRANSPORT			
Plant and Transport	Keep a watching brief on development of battery powered tools, electric and hydrogen powered plant and electric vehicles noting a likely exponential rise in adoption from 2025.		
ENERGY STORAGE			
Critical Infrastructure	Battery storage will be investigated to both maximise the value of solar generation and to provide back-up energy security for key services.		
Batteries for load sharing	Where Council creates/controls micro-grids, battery storage will be investigated to provide power sharing and grid stabilising faculty		
Medium scale array	Storage must be integrated into any proposal for developing a solar array to enable load shifting and to mitigate market risks if/when BHCC becomes a generator-retailer		
Virtual Power Plant	Distributed batteries are supported as part of developing a community wide VPP.		
Energy Resilience	Batteries storage to be integrated with all 'Greenfield' installations to provide energy resilience against extreme weather events, e.g. bushfire, storms.		