Final Report

Solar PV Opportunities

Low-cost assessment & arrangement of solar PV opportunities

Project Code
2021-1047

Prepared by
Andrew Lister

Date Submitted
13 July 2023

Published by
AMPC

Date Published
13 July 2023

Final Report

Contents

1.0 Executive Summary

Solar PV remains one of the most effective technologies to help the sector achieve CN30 and support AMPCs 2025 Strategy to achieve 100% renewable electricity use by 2030. The purpose of the project is to drive the uptake of solar PV in the RMP sector in line with AMPCs 2030 goal. The project objectives of the project are to:

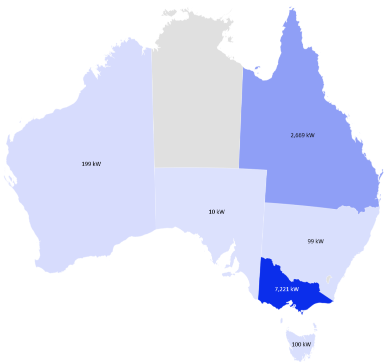
- Use software to quickly and accurately evaluate solar opportunities against site-specific conditions.
- Provide advice on the most effective procurement strategy to suit the RMP and drive a quality outcome at the best price and conditions
- Drive uptake of renewable energy in the RMP sector in line with AMPCs 2030 goal.
- For sites with existing solar PV systems, review the solar PV production data and validate if the solar PV system is performing as expected.

Our approach involved four major components:

1. A review of existing solar penetration in the red meat processing sector. This involved a desktop assessment of every RMP site in Australia to determine whether solar was installed, when it was installed and by who, and to determine the solar potential of the site based on available roof are.
2. Solar performance reviews were conducted for sites with existing solar to compare actual system performance against expected system performance.
3. Site specific solar assessments were conducted for AMPC members that elected to participate in the program from July 2021 to May 2023. This involved modelling the business case for more than 100 solar, battery and PFC scenarios for the site using site specific data, and helping the customer with decision making through online consultations.
4. For AMPC members that wanted to proceed to final investment decision, Beam Energy Labs provided assistance with procurement. This involved seeking pricing from Registered Suppliers on the Beam Solar platform via an Initial Offers project.

Review of existing solar penetration

We found that 26 red meat processing sites (19% of all sites) had solar installed as of the 31st of March 2021. There were 10.3 MW of solar PV installed, which is small relative to the potential, of which 6 MW is rooftop solar (6% of total rooftop solar potential) and 4.3 MW is ground mount solar (1% of potential). The bulk of solar was implemented in Victoria and to a lesser extent Queensland.



Solar Performance Review

We reviewed the performance of two existing solar systems in the RMP sector to determine whether output was in line with the business case and initial projections. The results of the two assessments showed that solar performed in line with or slightly above projections most of the time. Where underperformance did occur, this was due to an equipment fault that should be rectified under warranty. This highlights the importance of system monitoring so issues can be identified early and rectified quickly.

Solar Assessments

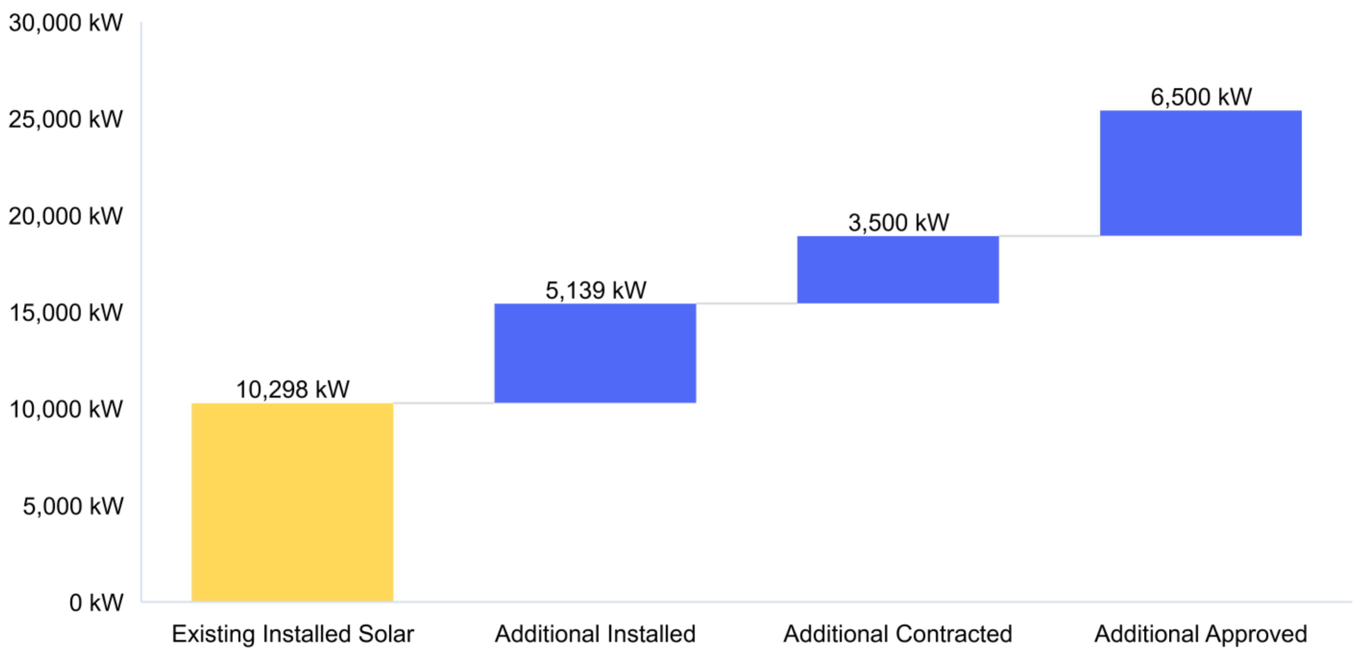
Over the period of 01 Jun 2021 to 31 May 2023, Beam Energy Labs completed site-specific solar assessments of 52 red meat processing sites in Australia. For many of these sites, multiple National Meter Identifier's (NMIs) were assessed, taking the number of individual solar and battery assessments completed to approximately 80. The number of sites assessed represented more than one third of red meat processing sites in Australia. Uptake of solar assessments was high in WA due to a coordinated engagement of RMPs early in the program.

Solar Procurement Strategy

Red Meat Processors that proceeded to the procurement phase, by requesting Initial Offers, were often close to making a final investment decision. This was evident with the 19 sites that utilised Beam Energy Lab's assistance with procurement, 11 of these sites have either installed, contracted or approved solar projects (58% of sites). These RMPs typically undertook a Solar Feasibility Assessment and a Final Offers round of procurement with shortlisted suppliers.

Driving uptake of renewable energy in the RMP sector

The *Low-cost assessment & arrangement of solar PV opportunities* project has been successful in driving uptake of renewable energy in the RMP sector. We estimate the project has led to an additional 15 MW of solar capacity installed, contracted or approved in the RMP sector. This equates to an increase in the installed base of solar in the red meat processing sector of 150%. The amount of solar installed in RMP sector has increased by 63% since the start of the project, whilst the amount of solar contracted or approved by RMPs amounts to an additional 34% and 50% respectively.



The Project appears to have facilitated an increase in solar deployment in the red meat processing sector relative to commercial solar in Australia as a whole. From 2014 to 2019 the solar capacity additions in the RMP sector broadly tacked capacity additions of medium scale solar throughout Australia, with the RMP sector representing 2-3% of Australian capacity additions. However, in 2020 there was a 60% drop in capacity additions in the RMP sector compared with a 10% drop throughout Australia, and in 2021 there was a 100% drop in the RMP sector vs. a 40% drop throughout Australia. Conversely, it can be seen that in 2022 the RMP sector added significant amounts of solar capacity (2.2 MW) despite a further reduction of 67% of capacity additions in the red meat processing sector.

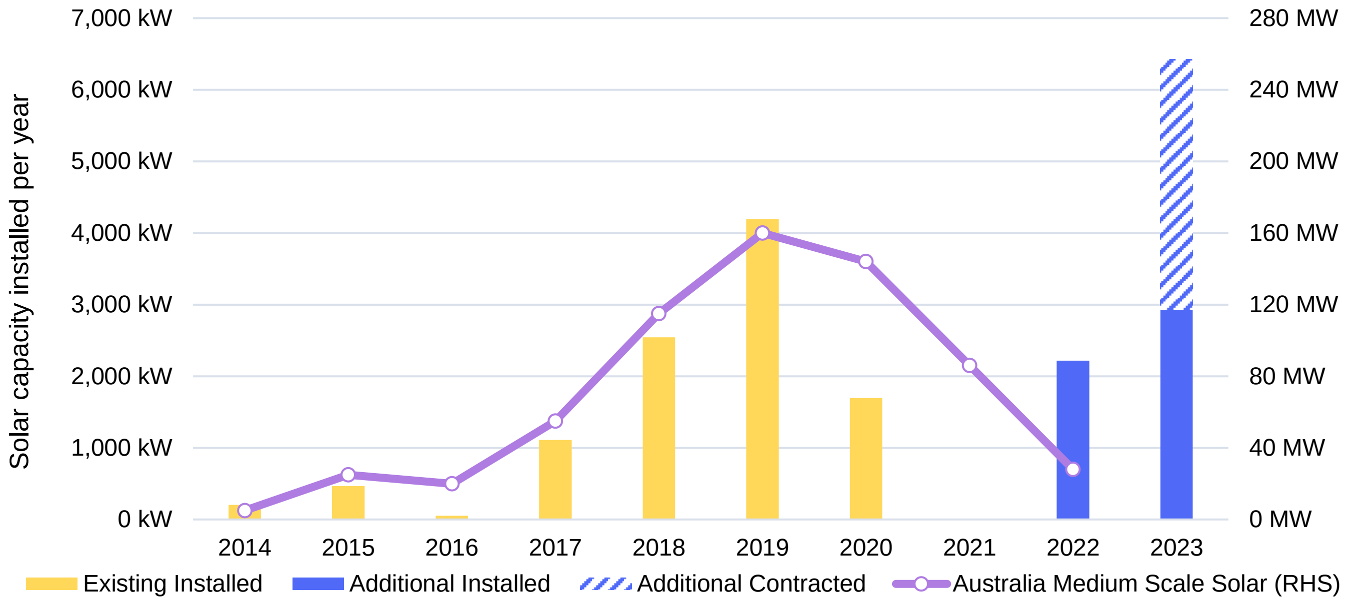


Figure 1: Comparison of solar capacity additions in the RMP sector vs. all of Australia

It is difficult to identify a cause for the drop in solar capacity additions in the RMP sector in 2020 and 2021, however the best guess is that it may be due to the impact COVID-19 had on company resources, particularly staff, available to deploy large engineering projects such as solar. A smaller drop in deployment was observed Australia-wide for medium scale solar installations. In addition to the Project, the rebound in capacity additions in the RMP sector in 2022 and 2023 may be attributable to the increase in electricity prices at the end of 2022 and the VEEC incentive in Victoria from 2021 onwards. However, a similar rebound was not observed in other sector.

Survey

The quarterly surveys of RMP members showed overwhelming support for solar throughout the period of the project and this view aligned with feedback from members during the assessments. Where solar wasn't supported, it was typically due to the assessment showing poor returns such as in Western Australia at the start of the project period.

Recommendations

Given the impact the Project had on the deployment of solar PV in the RMP sector, we recommend expanding the program to other renewable energy and electrification technologies. This should result in the continued deployment of solar PV and energy efficiency and kick-start the integrated deployment of technologies such as batteries and heat pumps in order to phase out natural gas. In discussion with AMPC members during the Project and in feedback provided in the final survey of AMPC members, battery energy storage and heat pumps are being considered by RMPs as they seek solutions to achieve emissions reduction targets.

100% renewable electricity can currently be achieved by purchasing renewable energy certificates, yet this comes with a large ongoing cost, impacting competitiveness of the RMP. Conversely, alternatives to grid gas and fossil fuels require large upfront investments and can present new risks to a RMPs operations. In order to achieve both objectives, and carbon neutrality by 2030 it is clear that RMPs will need to implement renewable energy and electrification technologies on a large scale. These are transformational projects that have the potential to drastically reduce operating costs, however they do require a large investment. However, similar to the issues AMPC members had with solar PV, there are issues with members making informed decisions about implementation and procuring at the best price and conditions.

2.0 Introduction

Solar PV remains one of the most effective technologies to help the sector achieve CN30 and support AMPCs 2025 Strategy to achieve 100% renewable electricity use by 2030. AMPC saw benefit in assisting members in fast tracking the deployment of Solar PV in the red meat processing (RMP) sector with a solution that allows for the low-cost evaluation of solar PV so that members can make informed decisions about implementation and procure at the best price and conditions.

Transparency in Solar PV quoting is another area that AMPC sought to address, with historic issues observed in the RMP sector for the correct sizing, quality equipment, acquisition, and appropriate contractual arrangements for solar PV systems. This project sought to bring additional transparency to these issues so that there would be greater uptake of solar PV within the RMP sector.

The purpose of the project is to drive the uptake of solar PV in the RMP sector in line with AMPCs 2030 goal.

3.0 Project Objectives

The project objectives as specified in the research agreement are provided below:

- Use software to quickly and accurately evaluate solar opportunities against site-specific conditions. Taking into account:
  - Topography
  - Roof and ground areas
  - Grid connection points
  - Existing energy contracts and tariffs rates
  - Current and future electricity consumption volumes and profiles
  - Existing or new on-site diesel/gas generation
  - Economic investment rates
  - Scalability
  - Preferred business model (on or off-balance sheet).
- Provide a clear and well-articulated pathway so that RMP members understand the whole of project milestones to implementing solar, energy storage and power factor correction
- Give RMP members clarity around the right level of Solar PV for their facility and if storage and power factor correction are viable additions.
- Provide transparency by showing all options for the site and how different factors such as solar and battery size, affect the business case.
- Investigate grid connection to ensure the selected solar PV system can be connected.
- Provide advice on the most effective procurement strategy to suit the RMP and drive a quality outcome at the best price and conditions
- Ensure members have the right level of instrumentation and metering so that they can validate the benefits during the life of the project against a set of contract KPIs.
- Ensure members have a mechanism for recourse if the project does not meet expectations including warranty periods and defect liability clauses.
- Drive uptake of renewable energy in the RMP sector in line with AMPCs 2030 goal.
- For sites with existing solar PV systems, the following objectives have been added:
  - Review the solar PV production data and validate if the solar PV system is performing as expected.
  - Where underperformance has occurred, attempt to identify the causes of this and recommend actions to improve performance and quantify the costs and benefits of these actions.
  - Determine actual cost savings and payback period for the solar PV project and compare this to predicted savings and returns when the project was approved

4.0 Methodology

4.1 Desktop review of existing penetration of solar at member sites

A list of 144 current and closed red meat processing sites and head offices was provided by AMPC as the scope of sites to review. The site list included the company name, site address, type and size of facility (Appendix A).

For each site we used the Beam Solar platform to determine the maximum rooftop solar potential (kW) of that site. The Beam Solar platform relies on an Application Programming Interface (API) with Geoscape Australia to return the building roof area of all buildings located at the address. The roof area is then converted to kW using Beam Solar's proprietary software algorithms. For each site we also checked whether existing solar was installed at the site using a combination of the Geoscape API, Nearmaps imagery, the Clean Energy Regulator database and web searches. After completing this first step, we were able to determine the following for each site:

- The maximum solar potential of the site (kW)
- Whether existing solar is present or not. If solar is present, then:
    - Existing solar system size
    - Whether the solar is roof or ground mounted
    - Approximate date installed
    - Installer company name (if found)

The Beam Solar platform was then used to simulate the hourly solar production for each site for the maximum solar size and 10-20 solar sizes as a portion of the maximum solar size. Solar production was simulated against an estimate of site electricity consumption and energy prices to produce a 'Quick Assessment' of solar at the site. A screenshot of an example Quick Assessment is shown in Figure 2. If a member elects to complete a detailed solar assessment under this project, the assessment will be further refined with site specific energy data and prices.

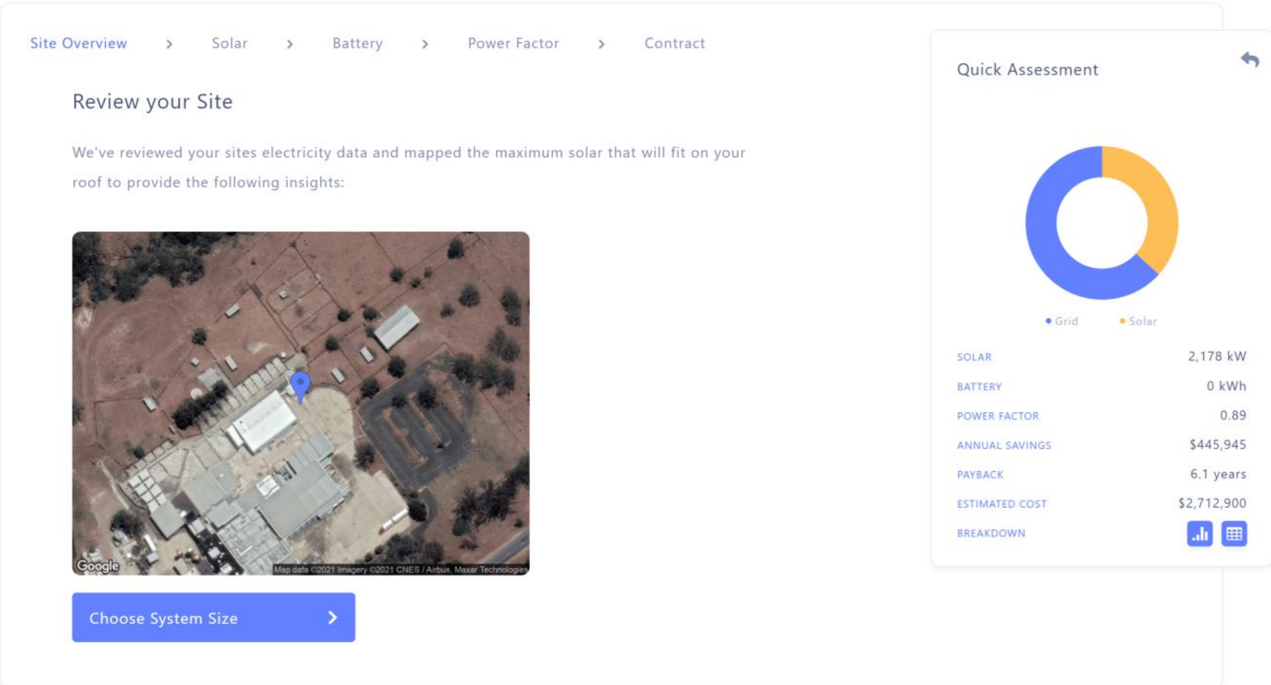


Figure 2: Example Quick Assessment on the Beam Solar platform

4.2 Solar Performance Review

Solar performance reviews were conducted for two sites with existing solar, a 1.3 MW ground mount system in Victoria and a 99 kW ground-mount system in WA. The objective of the solar performance review is to compare actual system performance against expected system performance. If actual performance is below expected, we can make recommendations that should boost performance for the site to consider.

The following general process was carried out to complete the performance review:

1. Visit the site to inspect the installation, discuss issues with staff and access system data.
1. Access solar production data for the existing solar PV system. This may include data from:
    a. Solar Analytics
    b. Other installed metering
    c. Inverter monitoring systems
    d. Data from the electricity retailer
2. Review the solar production data and validate if the solar PV system is performing as expected by comparing actual generation data against the predicted generation output
3. Provide monthly actual production vs expected generation numbers and charts.
4. Where underperformance has occurred, the project service will attempt to identify the causes of this i.e. equipment underperformance, equipment faults, system settings, network limitations, dirt/dust/bird dropping impacts.
5. Where underperformance has occurred, the project service will recommend actions to improve performance and quantify the costs and benefits of these actions.
6. Calculate the expected electricity charges for the site assuming no solar was installed by adding solar generation to grid consumption and applying this total to the electricity tariffs. This will be compared to actual charges to determine actual savings and payback period for the project. We will compare actual and predicted savings and returns.
7. Produce a summary report covering the above items including recommendations.

To compare the performance of existing solar systems with the expected generation values, nearby weather station data is used to create an expected generation dataset for the site. 5-minute Global Tilted Irradiance (GTI) data and ambient temperature data is used. The GTI values are then adjusted by a total system loss factor, multiplied by the DC system size, and then limited by the AC system size to convert the GTI values to expected PV generation for the system. The total loss factor applied to the irradiance values can be calculated using Equation 1.

$$L_{Total} = F_{man} * F_{temp} * F_{soil} * F_{shade} * L_{inv,eff} * L_{BOS}$$

$$\begin{aligned}
&Where: L_{Total} - Total\ system\ loss\ factor \\
&F_{man} - Manufacturers\ loss\ factor \\
&F_{temp} - Temperature\ loss\ factor \\
&F_{soil} - Soiling\ loss\ factor \\
&F_{shade} - Shading\ loss\ factor \\
&L_{inv,eff} - Inverter\ efficiency \\
&L_{BOS} - Balance\ of\ Systems\ efficiency\ (DC\ \&\ AC\ losses)
\end{aligned}$$

Equation 1: Total System Loss Factor

Equation 2 & Equation 3 show how F_{man} and F_{temp} are calculated, respectively.

$$\boldsymbol{F_{man} = 1 - \left(D_{1st\ yr} + D_{2nd-25th\ yr} * (Y_{current} - Y_{install})\right)}$$

$$Where: D_{1st\ yr} - 1st\ Year\ panel\ derating$$
$$D_{2nd-25th\ yr} - 2nd\ to\ 25th\ yr\ panel\ derating$$
$$Y_{current} - Current\ Year$$
$$Y_{install} - Install\ Year$$

Equation 2: Manufacturers Loss Factor

$$\boldsymbol{F_{temp} = 1 - \left(\gamma_{power} * (T_{amb} - T_{STC})\right)}$$

$$Where: \gamma_{power} - Panel\ power\ tolerance$$
$$T_{amb} - Ambient\ temperature$$
$$T_{stc} - Standard\ Test\ Condition\ Temperature\ (25C)$$

Equation 3: Temperature Loss Factor

4.3 Solar Assessments

Solar PV assessments were conducted for AMPC members that elected to participate in the 'Low-cost assessment & arrangement of solar PV opportunities' program from July 2021 to May 2023. Solar PV assessments started with a 30-60 minute consultation on site or over the phone to discuss the site's requirements, future plans and suitable locations for solar PV. Electricity interval meter data and a recent electricity invoice were provided to Beam directly by the member or by the site's electricity retailer via a Letter of Authority provided by Beam.

Following the initial consultation and upon receipt of the data, an initial solar PV system was completed following the methodology summarised below:

1. Solar PV arrays were designed for all suitable and available roof and land areas at a site using Helioscope to determine the maximum solar PV potential (kW) including tilt and azimuth of the solar arrays.
2. The solar PV array information, electricity interval data, electricity invoice information (electricity tariffs) and any assumptions about future energy prices and incentives were uploaded to the Beam Solar platform.
3. A Solar Assessment would be created by simulating hundreds of solar PV, battery, PFC and financing options for the site using the uploaded data plus solar production data from the National Renewable Energy Laboratory (NREL). The simulations were conducted on cloud computing infrastructure in less than one minute as follows:

    - Hourly solar production data for a 12-month period was downloaded for each solar PV array
    - For each solar PV system size, the solar production and battery charge/discharge is subtracted from the site's consumption each half-hour of a year
    - The cost of electricity before and after solar PV, battery and PFC is calculated for each half-hour of the year using the site's tariff structure, including consumption (kWh) and demand (kVA or kW) charges
    - The total annual cost savings for each system configuration (solar PV, battery and PFC size) is provided by summing the half-hourly simulation data
    - The cost to implement the system is calculated based on formulas derived from recent prices provided by solar retailers for similar sized systems in similar locations.
    - Financing options, in the form of power purchase agreements are simulated for each system configuration.

    Typically, more than one assessment was completed per site, focusing on different buildings or land areas or different energy price, incentives or change in energy demand assumptions.

4. The output of the simulations from the completed Solar Assessment(s) was then made available in the Beam Solar platform for review and sharing with the AMPC member. An example Solar Assessment can be found in the appendix section of this report.

An example Solar Assessment PDF report is provided in Appendix 1 - Example Beam Solar Assessment.

A second consultation was arranged, typically via video conference, to present the Solar Assessment(s), review the findings with the AMPC member, discuss feasibility and answer any questions with a goal of deciding to proceed with solar PV or not. Additional meetings were organised for most AMPC members to further refine the Solar Assessment(s) and to conduct further due diligence such as structural roof assessments.

4.4 Solar Procurement Strategy

For AMPC members that wanted to proceed to final investment decision, Beam Energy Labs provided assistance with procurement. This involved seeking pricing from Registered Suppliers on the Beam Solar platform via an Initial Offers project, with the following stems:

- A project brief was created to detail all the requirements and preferences of the solar PV system and site.
    - This includes standard Supplier Conditions ensures offers submitted by Register Suppliers comply with minimum requirements covering scope and specification.
    - An example project brief is shown in Appendix 2 – Example Initial Offers Project Brief.
- Registered Suppliers that qualify, based on their experience, capability and region serviced, were invited to submit Initial Offers through the Beam solar platform. A sample of Suppliers invited to submit Initial Offers for a project in Victoria in 2022 are provided in Appendix 3 – Sample of Suppliers Invited to Initial Offers.
- Initial Offers submitted by Suppliers were presented in an easy to compare format for supplier selection or shortlisting. A sample Initial Offers table is provided Appendix 4 – Sample of Initial Offers. The table included the following key project attributes:
    - Supplier Name
    - Solar Retailer Score
    - Solar Module and Score
    - Inverter and Score
    - Installation Warranty & Score
    - Proposal Document (if uploaded by the Supplier)
    - Additional Offer Details (if provided by the Supplier)
    - Offered Solar Size
    - Offered Inverter Size
    - Offered Price
    - Annual Savings (calculated from offered solar size)
    - Payback Period (calculated from offered solar size)
    - Project Cost ($/kW)
    - Price Score ($/kW)

Beam assisted AMPC members with reviewing Initial Offers and provided further assistance to AMPC members to move the solar PV projects to final investment decision, contract execution and implementation.

4.5 Member Surveys

AMPC members who undertook solar assessments were surveyed on a regular basis on their attitude towards on-site solar throughout the Low-cost assessment & arrangement of solar PV opportunities project. Survey questions related to the suitability of solar at their site(s) and solar configuration and financing preferences. The surveys were sent as a link via email to AMPC members where we had contact details and members completed the surveys online, anonymously or providing their contact details. Questions regularly asked in the survey include:

5. Do you think solar is a good option for your site?

6. Have recent energy price increases been a factor in your decision about solar?
7. If you haven't implemented solar at your site, what are the main barriers?
8. If you were to implement solar at your site, how would you likely fund the project?
9. If you were to implement solar, would it more likely be on the ground or roof?

5.0 Project Outcomes

5.1 Industry Baseline

We found that 26 red meat processing sites (19% of all sites) had solar installed as of the 31st of March 2021. There were 10.3 MW of solar PV installed, which is small relative to the potential, of which 6 MW is rooftop solar (6% of total rooftop solar potential) and 4.3 MW is ground mount solar (1% of potential). The estimated total installed capacity of solar in the red meat processing industry as of 31 Mar 2021, broken up by region, is provided in Figure 3.

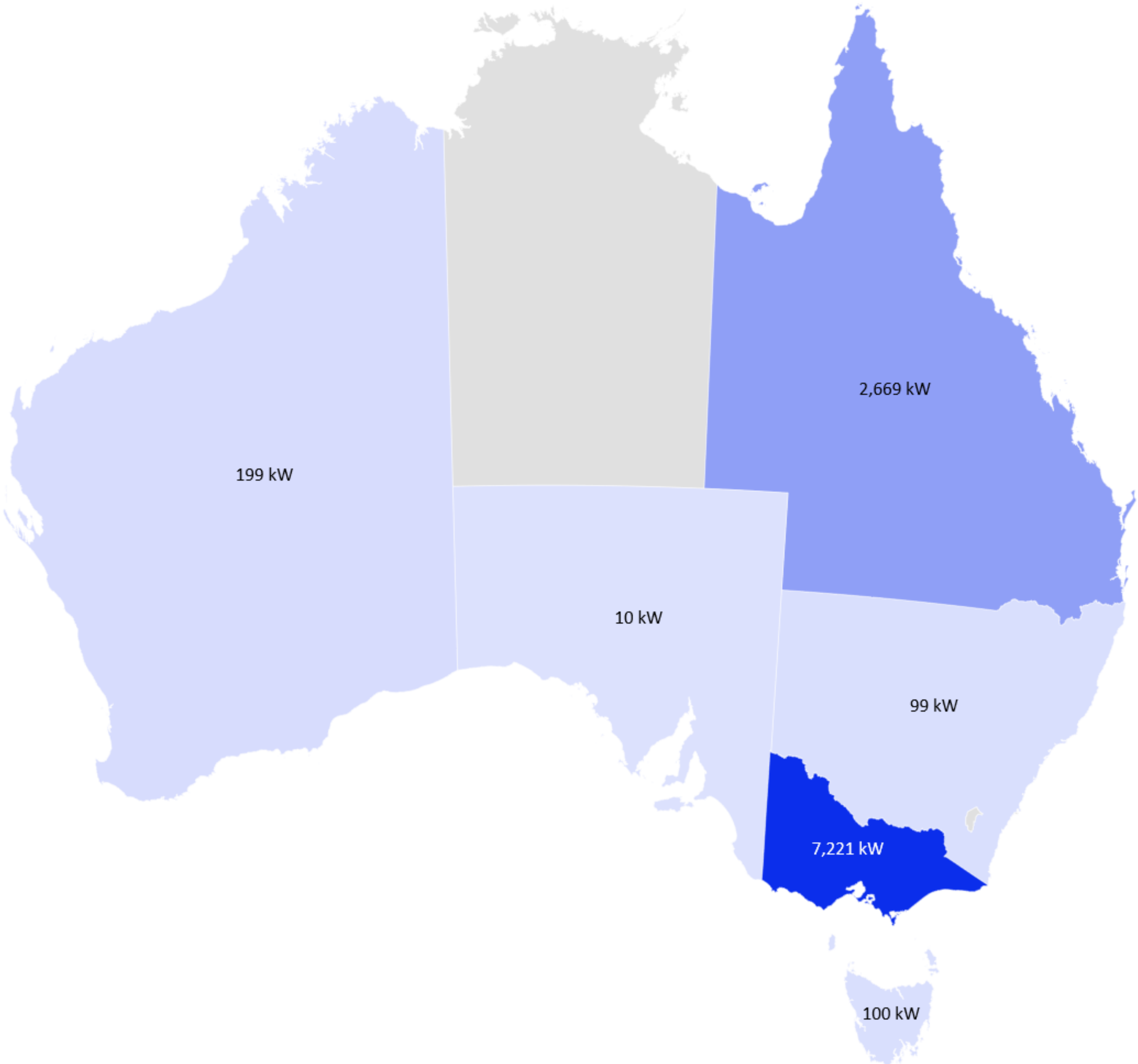


Figure 3: Installed Solar in the Red Meat Processing Industry as of 31 Mar 2021

5.2 Solar Performance Review

We reviewed the performance of two existing solar systems in the RMP sector to determine whether output was in line with the business case and initial projections. The results of the two assessments showed that solar performed in line with or slightly above projections most of the time. Where underperformance did occur, this was due to an equipment fault that should be rectified under warranty. This highlights the importance of system monitoring so issues can be identified early and rectified quickly.

5.3.1 Solar Performance Review 1: 1.3 MW Solar in Victoria

A 1.3 MW solar array was installed at a Victorian abattoir in late 2018 and was assessed in terms of its solar PV generation. Historic PV generation data was compared with expected generation based on irradiance and temperature data from a nearby weather station.

The results showed that the solar system has been performing well over the past couple of years and showed slightly higher than expected generation over the period July 2020 – June 2021 with an increase of 2.7% for the year. No excessive system losses or significant inverter clipping was identified based on the historic generation data. Figure 4 shows the monthly comparison between the actual and expected generation for this system.

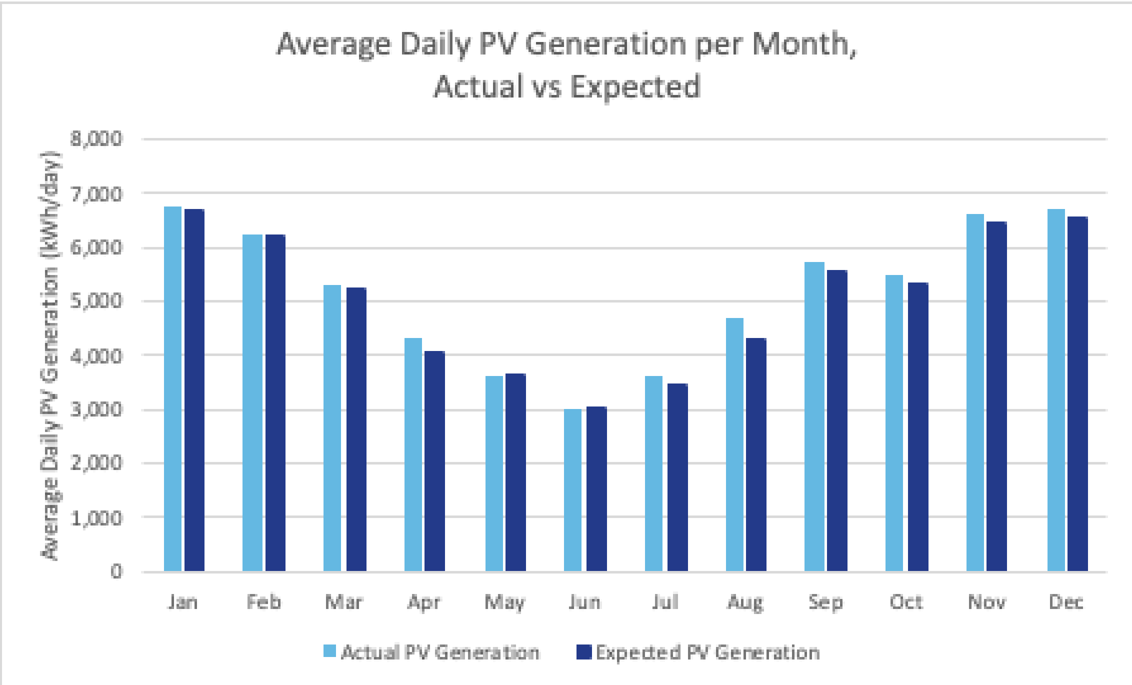


Figure 4: Actual and projected monthly solar production

A case study with additional detail is provided in Appendix 5 – Solar Performance Review Case Study 1

5.3.2 Solar Performance Review: 99 kW Solar in WA

A 99 kW array installed at a WA abattoir was assessed in terms of its solar PV generation. Historic PV generation data was compared with expected generation based on irradiance and temperature data from a nearby weather station.

The results showed that the solar system had been underperforming for several periods throughout the year, showing significant underperformance during August and some underperformance during January through to mid-April. From inspection of the system generation data during these periods it was identified that one of the three inverters was offline from 1st of Jan - 25th Mar, and the entire system was offline during the following periods:

- 19th - 23rd February,
- 17th - 18th April, and
- 30th July – 27th August.

The system showed slightly below expected generation for most other months assessed. No significant inverter clipping was identified based on the historic generation data. Figure 5 shows the monthly comparison between the actual and expected generation for this system.

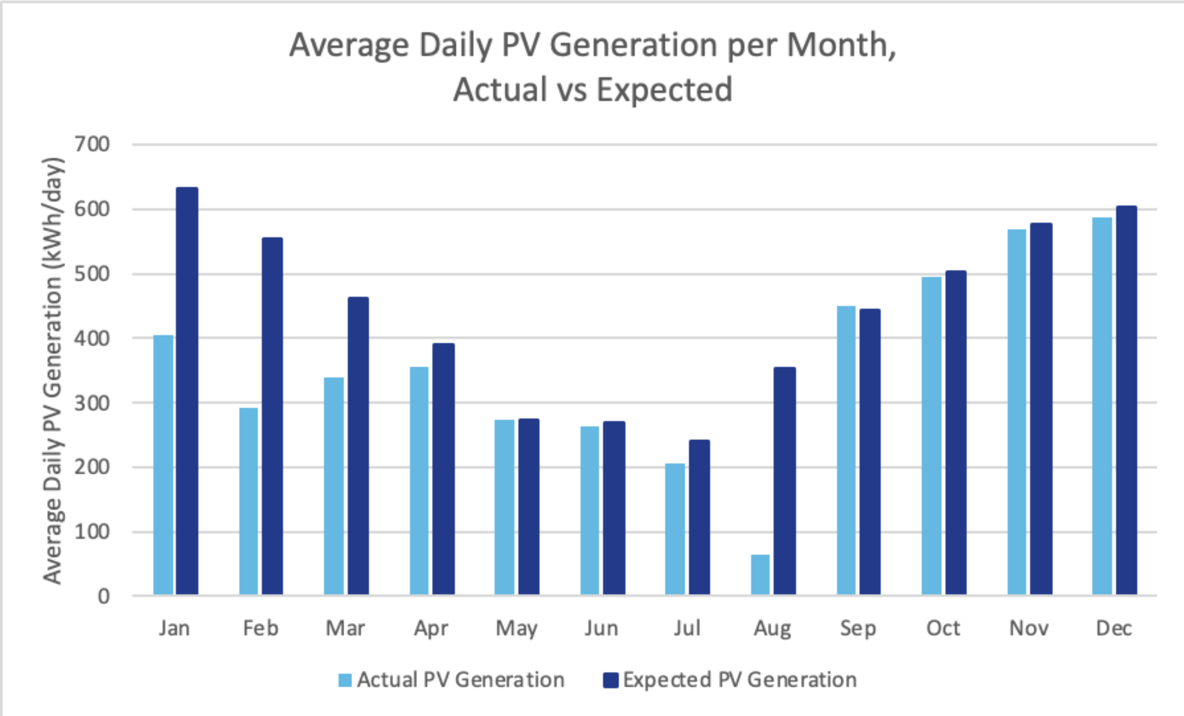


Figure 5: Actual and projected monthly solar production from Jan 2021 – Dec 2021

A case study with additional detail is provided in Appendix 6 – Solar Performance Review Case Study 2.

5.3 Solar Assessments

Over the period of 01 Jun 2021 to 31 May 2023, Beam Energy Labs completed site-specific solar assessments of 52 red meat processing sites in Australia. For many of these sites, multiple National Meter Identifier's (NMIs) were assessed, taking the number of individual solar and battery assessments completed to approximately 80. The number of sites assessed represented more than one third of red meat processing sites in Australia. Uptake of solar assessments was high in WA due to a coordinated engagement of RMPs early in the program, and high in Tas due to the small number of RMPs as summarised in Table 1.

Table 1: Red Meat Processor Site-Specific Solar & Battery Assessments by Region

Region	Total RMP Sites	Assessed RMP Sites	Percentage Assessed
NSW	29	12	41%
NT	1	0	0%
QLD	50	10	20%
SA	14	5	36%
TAS	6	4	67%
VIC	35	12	34%
WA	14	9	64%
Grand Total	**149**	**52**	**35%**

The assessments confirmed the feasibility of solar and batteries at the RMP site and were used by company representatives to make investment decisions relating to solar and battery projects at their sites.

The assessments included a review of the performance of existing solar assessments at three sites. For the largest of these, a 2 MW ground mount solar system in Victoria, the assessment concluded that the system was performing well. For the two smaller projects, 100 kW installations in WA and Tas, some performance issues were identified, and advice provided to rectify these issues.

For five of the sites where site-specific assessments were completed, the site engaged Beam Energy Labs to facilitate a Solar Feasibility Assessment. These assessments involved a site inspection and more detailed electrical, structural (or geotechnical) and financial assessment to determine the feasibility of the solar project. This additional study was required for the site to make a final investment decision on the project. Three of the sites progressed to implementation of solar following the solar feasibility assessment and the remaining two are pending completion.

5.4 Solar Procurement Strategy

Of the 52 sites that had site-specific assessments completed, 19 of these utilised Beam Energy Lab's assistance with procurement (37% of sites). Sites that did not utilise the procurement assistance were likely to fit into one of the following groups:

- Solar was not approved (or unlikely to go ahead) at the site
- Procurement was managed in-house without assistance
- Solar was already installed at the site

Procurement assistance involved requesting Initial Offers from accredited Solar Retailers on the beam.solar platform. For the sites that participated, Initial Offers were received from 3-9 accredited Solar Retailers as either an Outright Purchase (Capex) or Power Purchase Agreement (Opex) and these have been provided for the project in Figure 6 and Figure 7 respectively. Ground-mount projects and projects located in WA were consistently more expensive than rooftop projects and projects outside of WA.

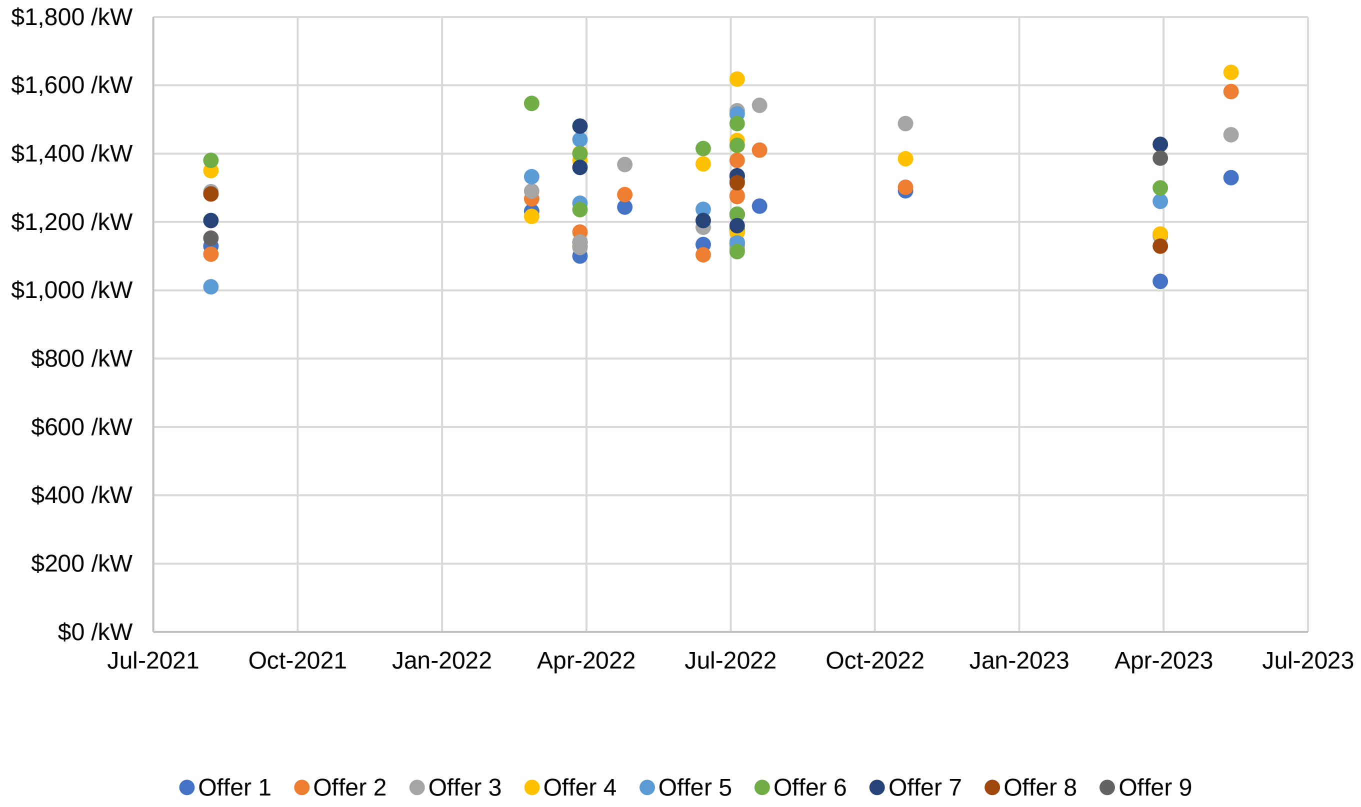


Figure 6: Initial & Final Offers for Rooftop & Ground Mount Solar as an Outright Purchase (Capex)

Procurement for PPA systems was less frequent despite being preferred equally with Outright Purchase in the surveys. A larger range of offered prices was also observed, reflecting variation in both implementation costs and financing costs for the solar retailer.

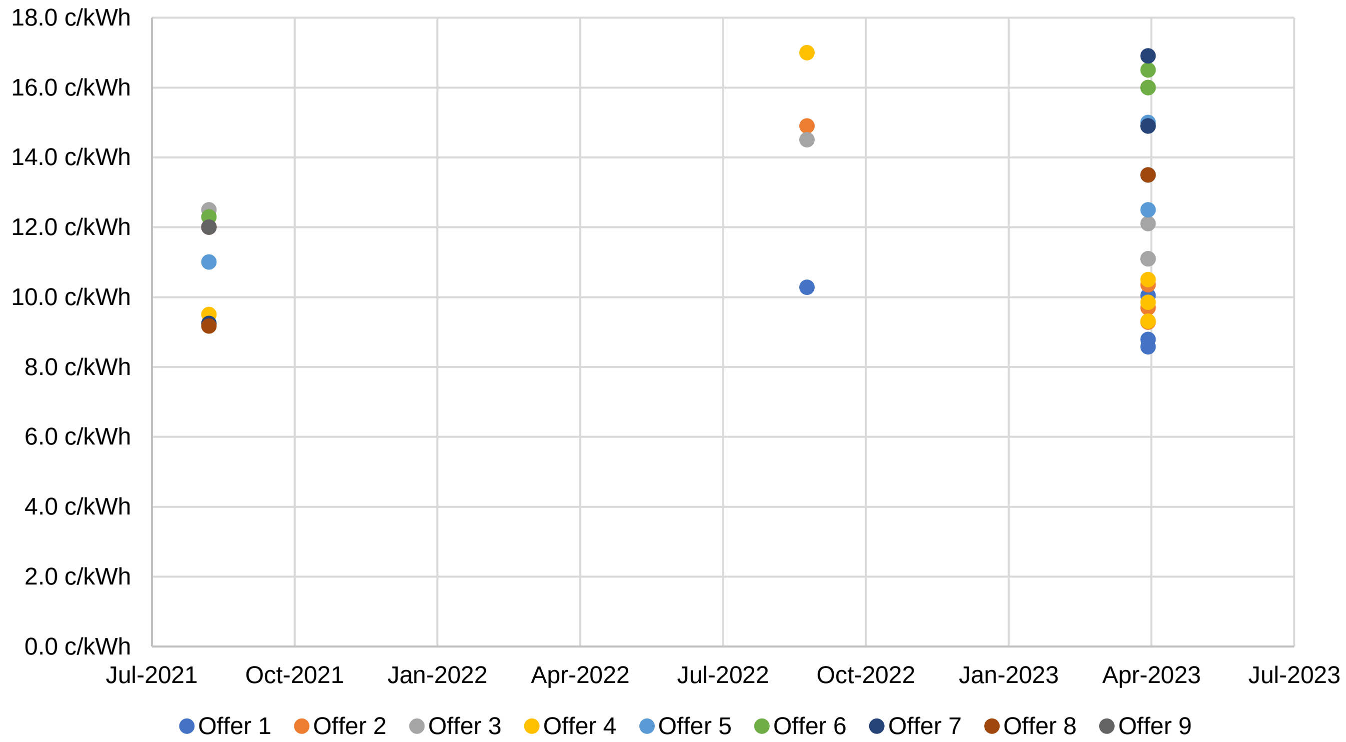


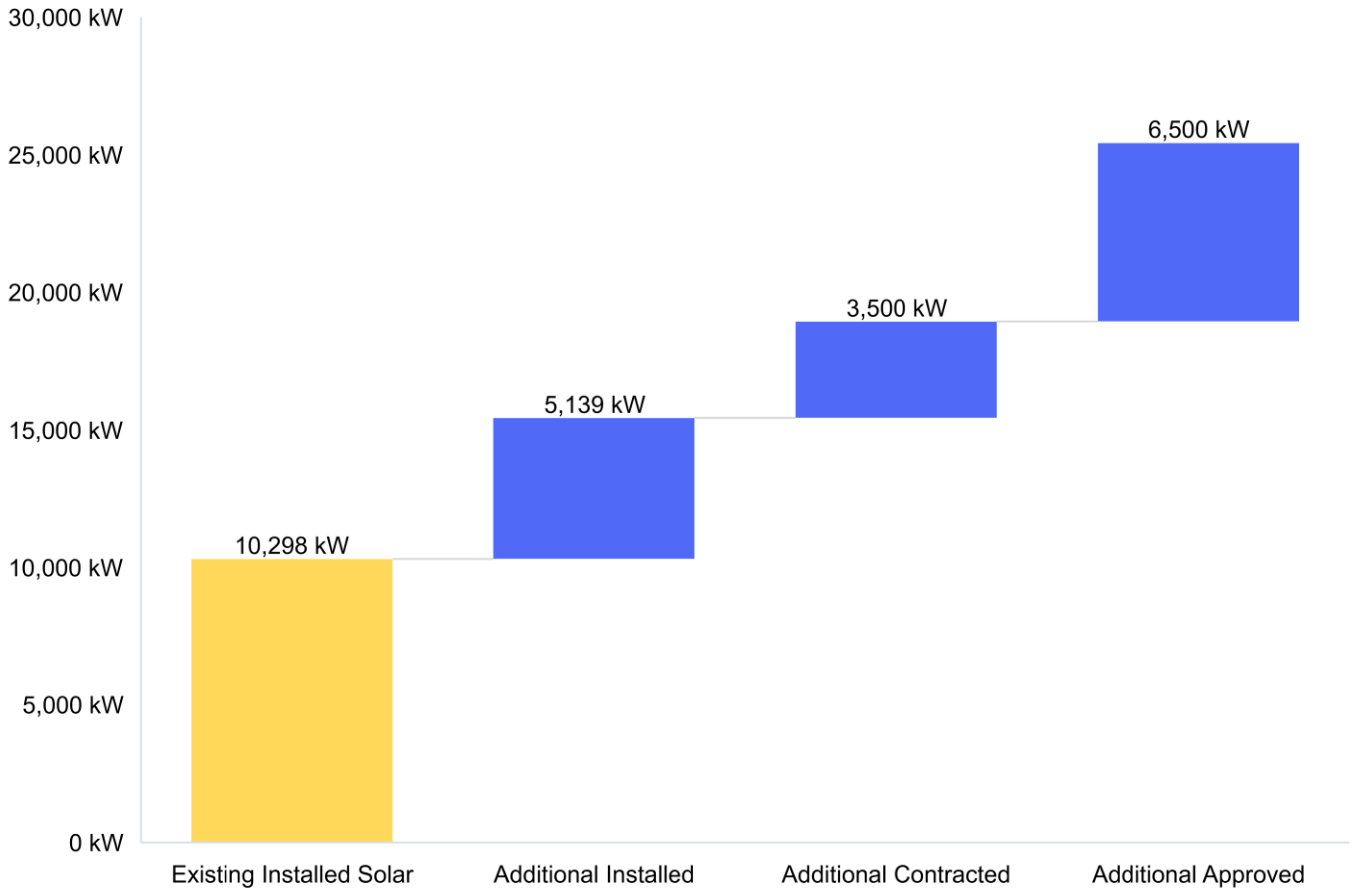
Figure 7: Initial & Final Offers for Rooftop & Ground Mount Solar as an Power Purchase Agreement (PPA - Opex)

Of the 19 sites that utilised Beam Energy Lab's assistance with procurement, 11 of these sites have either installed, contracted or approved solar projects (58% of sites). These RMPs typically undertook a Solar Feasibility Assessment and a Final Offers round of procurement with shortlisted suppliers.

5.5 Driving uptake of renewable energy in the RMP sector

The *Low-cost assessment & arrangement of solar PV opportunities* project has been successful in driving uptake of renewable energy in the RMP sector. We estimate the project has led to an additional 15 MW of solar capacity installed, contracted or approved in the RMP sector. This equates to an increase in the installed base of solar in the red meat processing sector of 150%. The amount of solar installed in RMP sector has increased by 63% since the start of the project, whilst the amount of solar contracted or approved by RMPs amounts to an additional 34% and 50% respectively. Table 2 shows the impact of the *Low-cost assessment & arrangement of solar PV opportunities project on the RMP sector as of 31 May 2023.*

Table 2: Impact project on installed, Contracted and Approved solar projects in the RMP Sector as of 31 May 2023.



Due to the long lead time of solar projects, including the time taken to complete assessments, internal decision making, the procurement process and the actual installation itself, the impact of the *Low-cost assessment & arrangement of solar PV opportunities* project is seen more in 2022 and 2023 rather than in 2021. Figure 8 shows the annual solar capacity installed in the RMP sector. The impact of the project can be seen in 2022 and 2023 with 2.2 MW and 2.9 MW of solar capacity installed respectively. This increases to 6.4 MW of solar capacity in 2023 when including a 3.5 MW project that is contracted and scheduled for completion in 2023. This follows disappointing years for solar implementation in 2020 and 2021, with 2023 projected to be a record year in the sector.

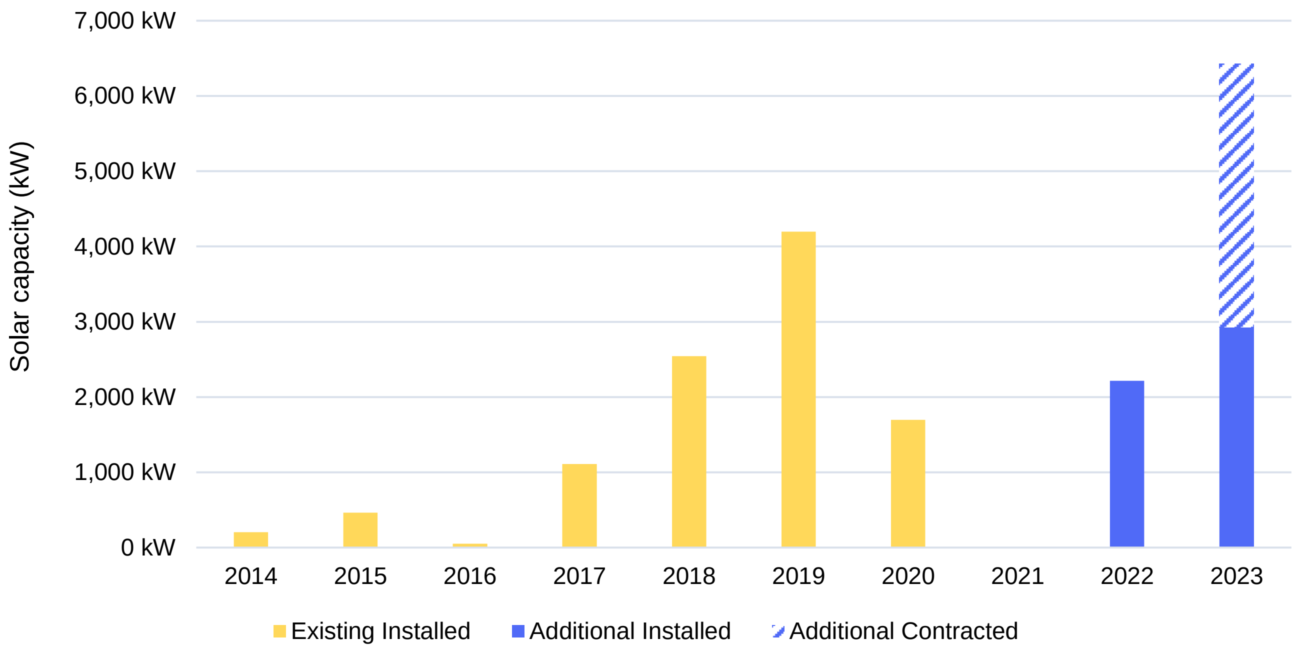


Figure 8: Annual Solar Capacity Installed in the RMP Sector

The average solar system size installed in the RMP sector has increased during the period of the *Low-cost assessment & arrangement of solar PV opportunities* project. Figure 9 shows the average solar system size in 2022 increased to 740 kW and is projected to be 2.14 MW in 2023.

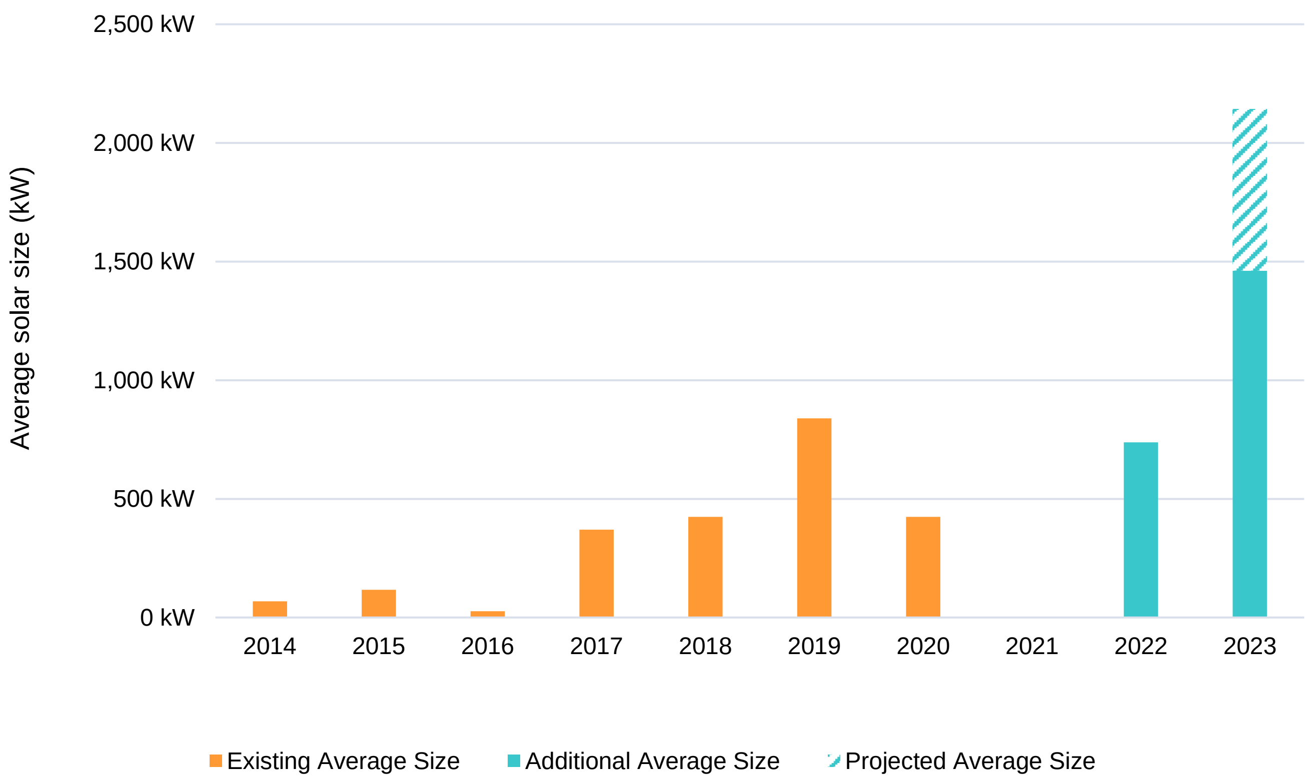


Figure 9: Average solar system size in the RMPC sector by year installed

NSW and Vic made up 100% of all additional installed and contracted solar capacity during the project. This increased the project installed solar in the RMP sector to 19 MW by the end of 2023. Figure 10 shows that solar penetration is dominated by RMP sites on the eastern seaboard, making up 99% of installed solar capacity in the sector.

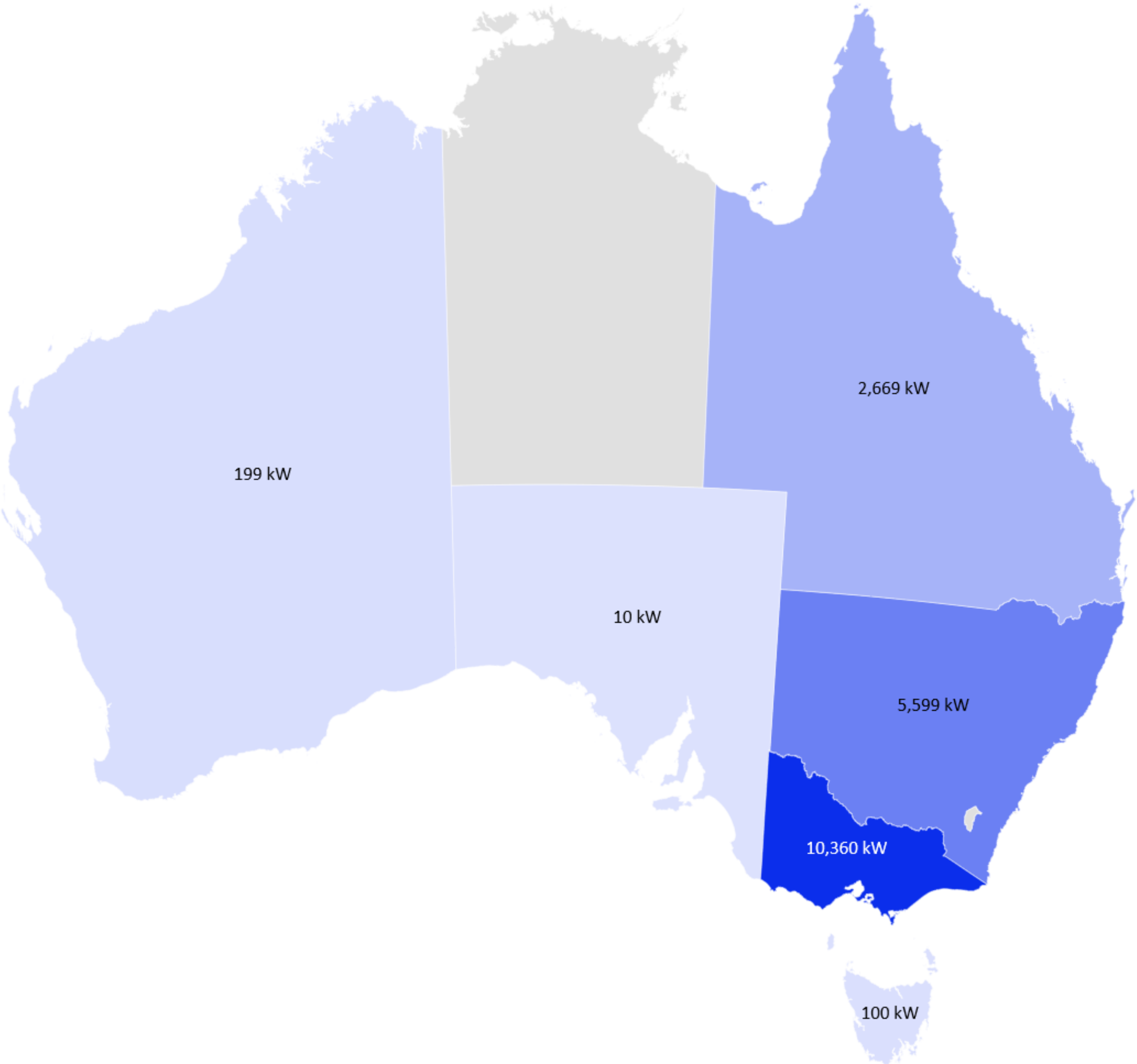


Figure 10: Projected installed Solar in the Red Meat Processing Industry for 2023

5.6 Survey Outcomes

Survey outcomes are summarised in Figure 11 to Figure 15 in the following pages for the period Oct 2021 to May 2023.

Responses for Figure 11 show that solar was recognised as a “good option” for RMP sites throughout the project period with almost all responses indicating a Yes or Yes (Solar installed already).

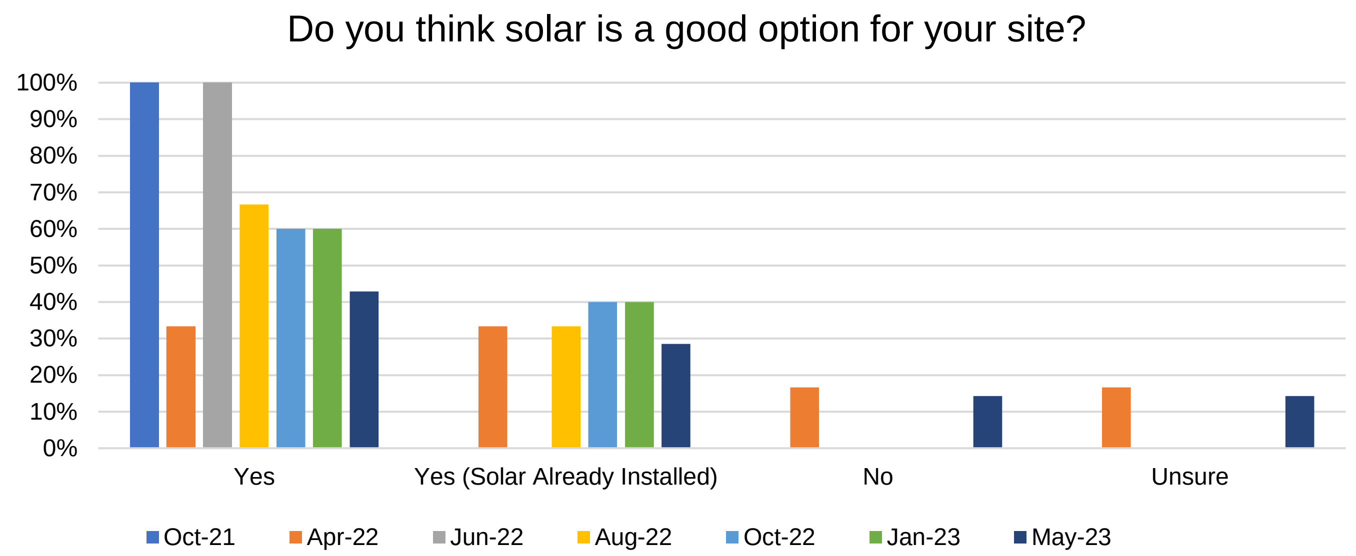


Figure 11: Survey Question 1 – Oct 2021 to May 2023

A new survey question was introduced in August 2022 relating to the large increase in electricity prices in the National Electricity Market. Responses shown in Figure 12 confirm that price increases were a factor or the main factor in decisions about implementing solar.

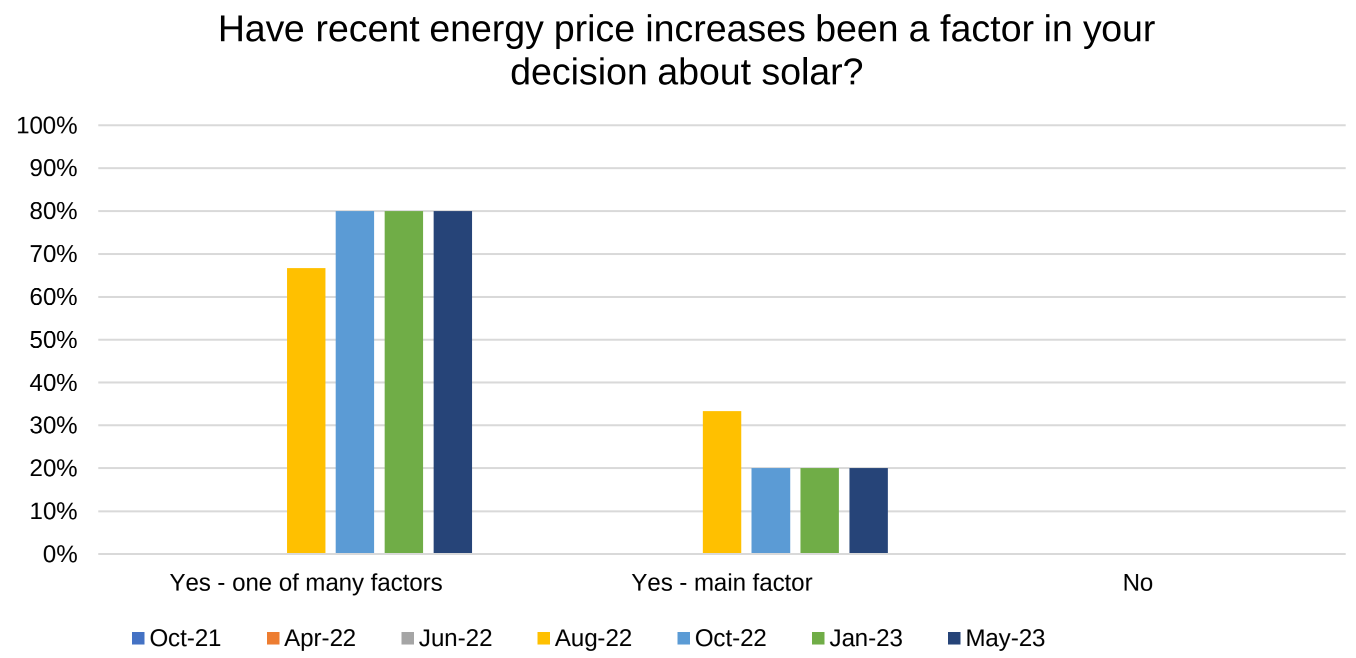


Figure 12: Survey Question 2 – Oct 2021 to May 2023

Figure 13 shows responses to questions about the barriers with implementing solar at sites. Major barriers indicated were “waiting for grant funding opportunities” and/or “competing projects” at the RMP site.

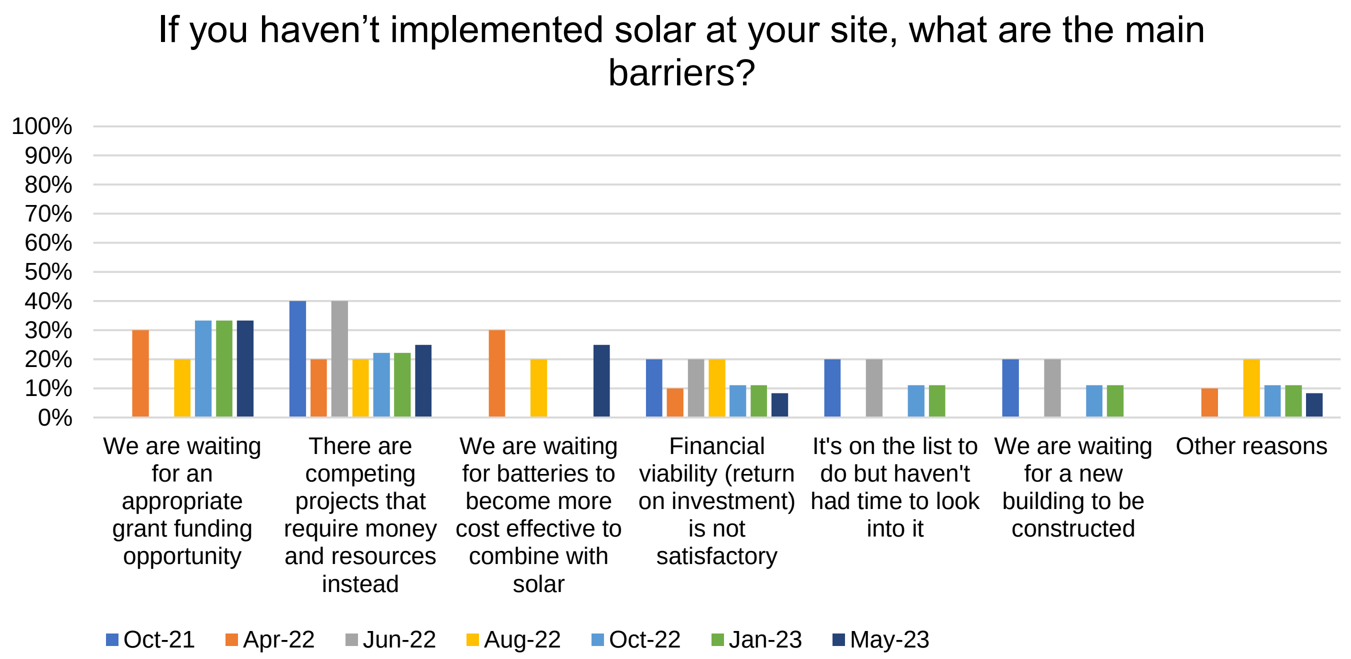


Figure 13: Survey Question 3 – Oct 2021 to May 2023

Funding of projects remained equally split between Outright Purchase (Capex) and Finance (Opex) throughout the project period, as shown in Figure 14.

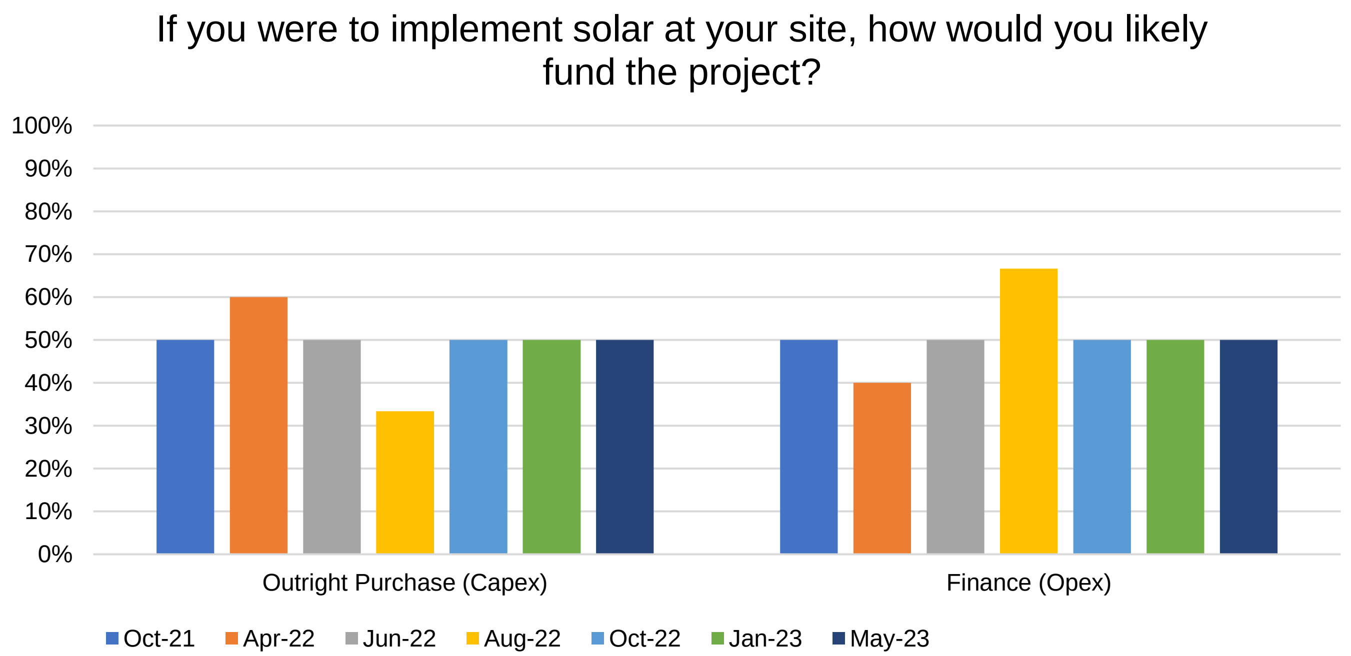


Figure 14: Survey Question 4 – Oct 2021 to May 2023

Ground mounted solar was the preferred array type in RMP surveys throughout the project period as shown in Figure 15.

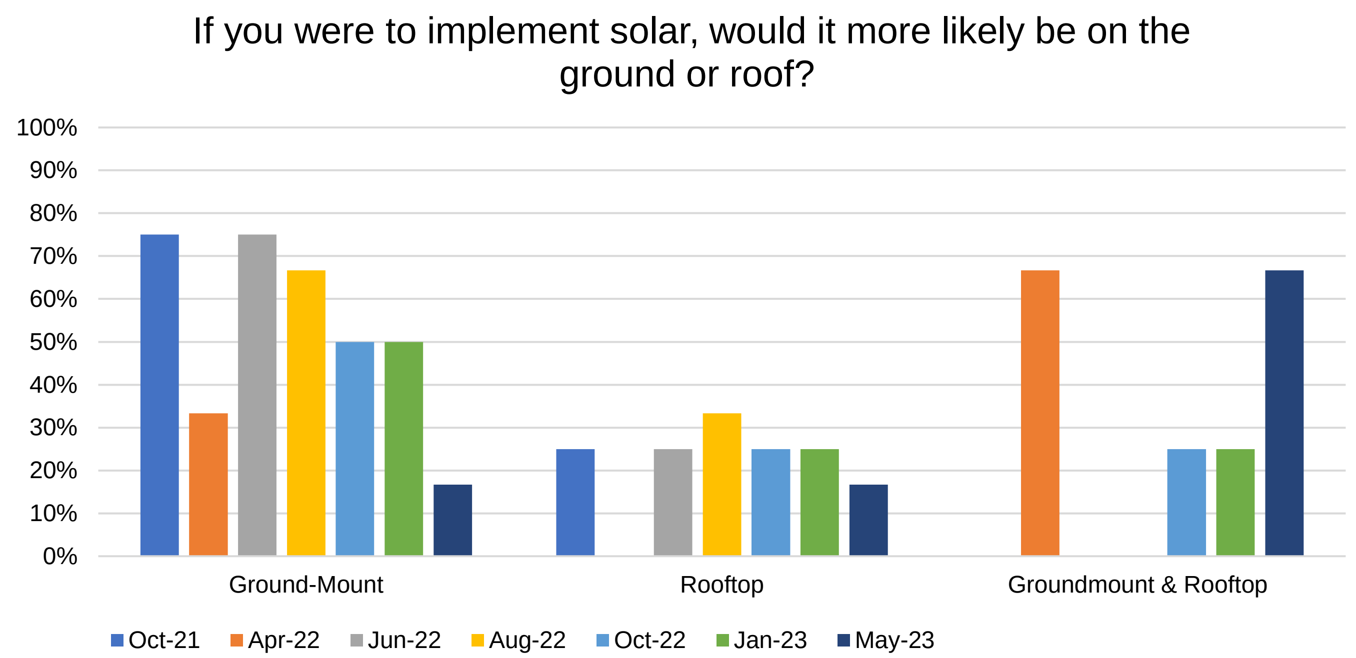


Figure 15: Survey Question 5 – Oct 2021 to May 2023

6.0 Discussion

6.1 Industry Baseline

6.1.1 Suitability of Solar to the Australian Red Meat Industry

The Australian red meat processing industry is active throughout Australia. Despite the variability in temperature and rainfall, the solar resource is excellent throughout Australia, from Tasmania to the Northern Territory. Figure 16 displays the amount of electricity (kWh) that would be produced each year from one kW of solar (0° Azimuth, 15° pitch) in each State/Territory capital city in Australia. It shows that all regions have a good solar resource, including Tasmania and Victoria which have a solar resource only 27% and 17% lower respectively than Perth and Darwin.

Figure 16: Solar production (kWh/kW) for Australian Capital Cities

The electricity demand profile of a red meat processing facility is typically well aligned with the electricity production profile of solar PV. Figure 17 shows electricity demand and solar production profiles for three red meat processing facilities in Australia – each profile represents a week Mon-Sun. Most solar that is produced is used, except in on non-operating days. A large solar system, as outlined in these charts, will reduce a site's energy consumption and emissions by 20-40%.

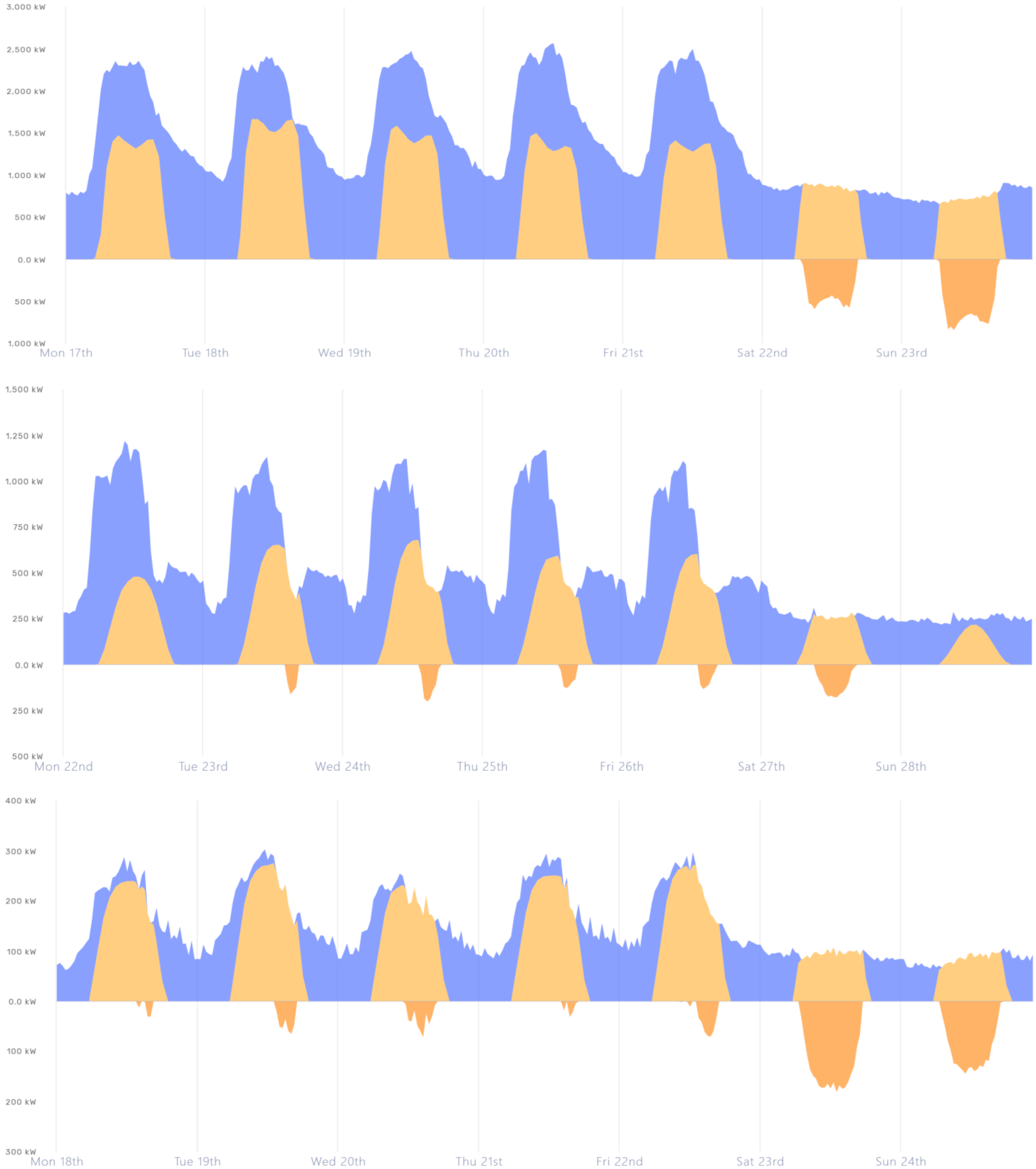


Figure 17: Electricity demand and solar production profiles (blue = grid electricity, yellow = solar electricity)

6.1.2 Potential for Solar in the Australian Meat Processing Industry

Rooftop solar is typically the cheapest form of solar installation at the sub 5 MW scale as the roof acts as the structure to support the panels compared with ground mount systems that require construction of piling and mounting systems. Most red meat processing facilities have roof space available to accommodate solar panels without augmentation. Typically, nearby land exists that could accommodate ground mount solar systems; however this land may have competing uses such as wastewater irrigation or animal grazing. Although ground mount solar systems can co-exist with irrigation and grazing it may add complexity and additional risk to the project. We have therefore focused on rooftop solar in our review and estimated that each site can accommodate on average three times as much ground mount solar as rooftop solar.

The potential for solar PV in the Australian red meat processing industry is large, with an estimated 105 MW of rooftop solar potential and more than 300 MW of ground mount solar potential available. Figure 18 shows the rooftop solar potential in the red meat processing industry. Queensland, Victoria and NSW show the greatest potential for rooftop solar in line with the concentration of red meat processing facilities in these three regions. South Australia, Western Australia and Tasmania have an order of magnitude less rooftop solar potential; however this is still large relative to the number of sites in these regions. The Northern Territory has one red meat processing facility, and this has limited roof area available for solar.

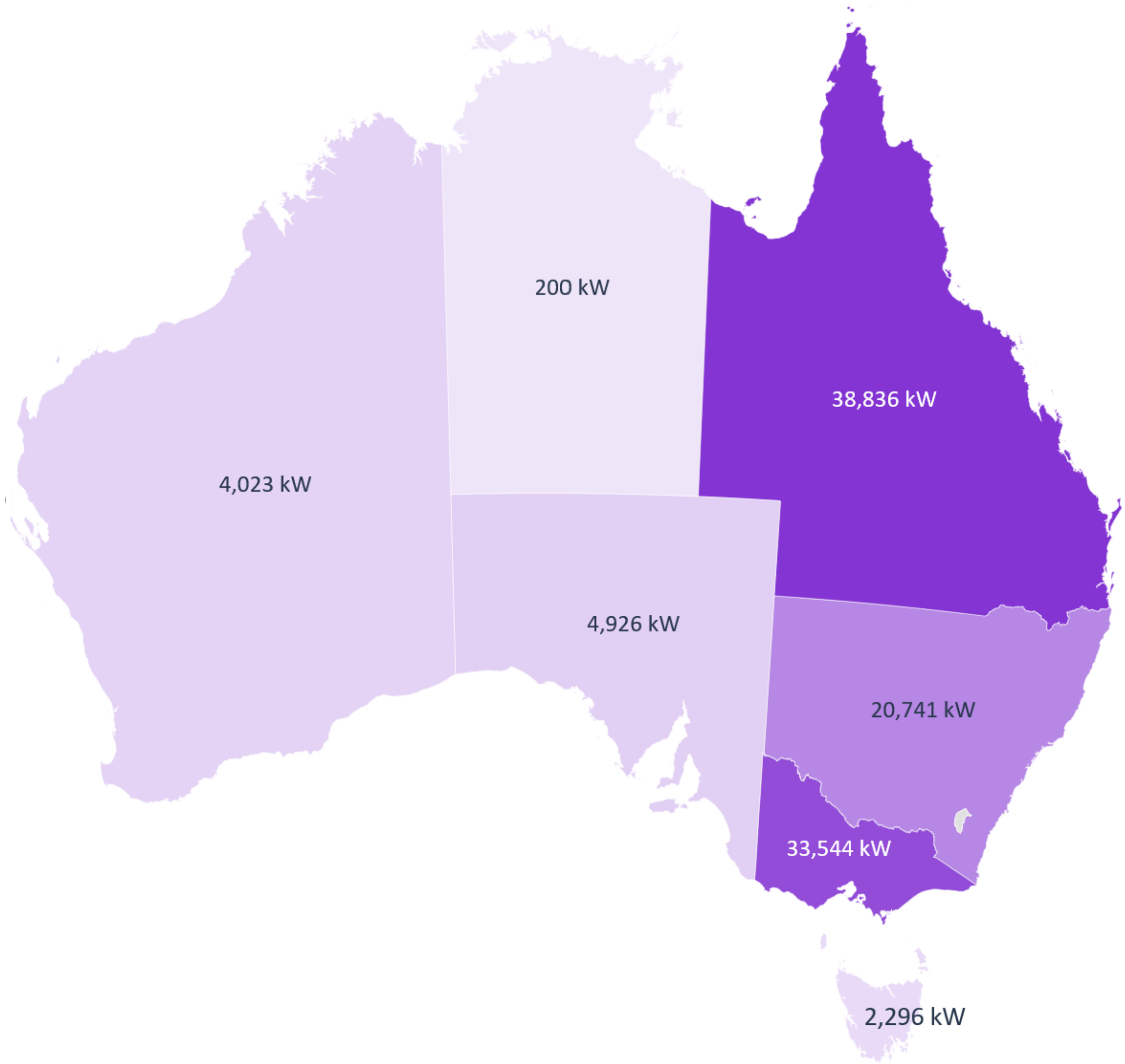


Figure 18: Rooftop solar potential in the red meat processing industry

It was found that solar potential varies significantly between red meat processing sites. Four sites were found to have the capacity to accommodate more than 5 MW of rooftop solar, including one site that can accommodate more than 8 MW of rooftop solar. Some sites were found to have capacity for only 5-10 kW of solar. From our experience completing detailed solar assessments for red meat processing sites, we have found that rooftop solar potential is mostly proportional to daytime electricity demand. Therefore, it is rare for the potential max rooftop solar production to exceed daytime electricity demand and export to the grid for red meat processing sites.

6.1.3 Solar penetration in the Australian Meat Processing industry

We found that 26 red meat processing sites (19% of all sites) have solar installed as of the 31st of March 2021. There is 10.3 MW of solar PV installed, which is relatively small relative to the potential, of which 6 MW is rooftop solar (6% of total rooftop solar potential) and 4 MW is ground mount solar (1% of potential). The estimated total installed capacity of solar in the red meat processing industry, broken up by region, is provided in Figure 3.

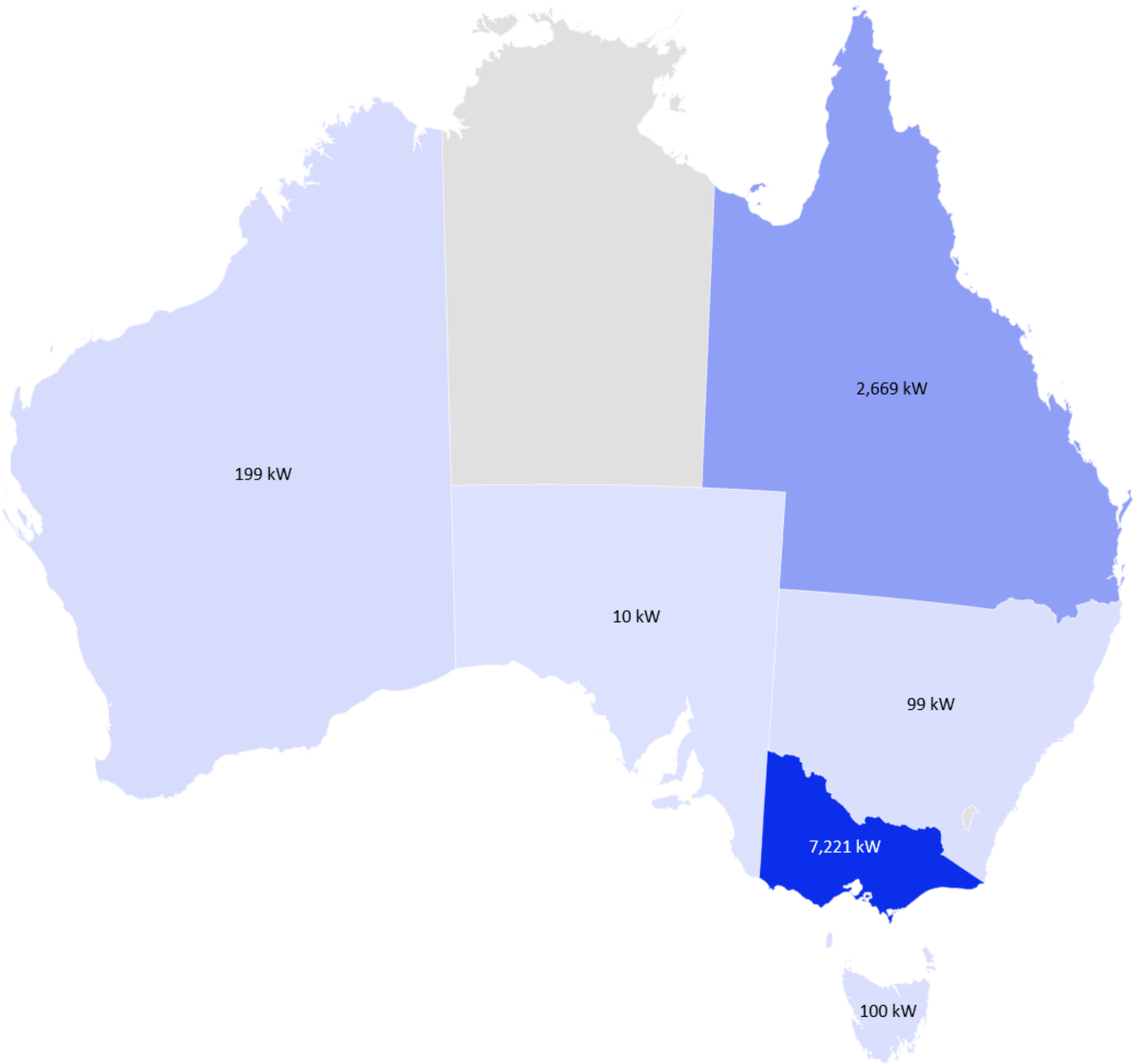


Figure 19: Installed Solar in the Red Meat Processing Industry as of 31 Mar 2021

Nearly all (97%) of the installed solar capacity is in Victoria and Queensland with 7.2 MW and 2.7 MW installed respectively. This total is dominated by a small number of large systems installed at sites, including five sites in Victoria with solar system sizes between 1.2 MW and 1.5 MW and one site in Queensland with 1.0 MW of solar. We could not determine why these two regions dispropotionally dominate existing solar penetration.

At the smaller end of the scale, there are 14 systems smaller than 100 kW including three that are less than 10 kW in size. We were unable to determine detailed information about these smaller systems such as installation date or solar supplier as these projects were not significant enough to generate press releases or marketing collateral from the customer or the supplier.

For sites with existing rooftop solar systems, the size of the system was on average 47% of the estimated potential capacity of the roof. We believe this is due to some areas of the roof being unsuitable for solar, smaller systems being chosen for economic reasons, and/or older solar systems having a smaller capacity per unit of roof area. The largest system as a percentage of available roof area is a 1.2 MW system at 93% of estimated roof capacity.

The amount of solar deployed in the red meat processing sector can be seen increasing in most years from 2014 to 2019, before dropping sharply in 2020, as shown in Figure 20. The increase in deployment aligns with the ongoing steep reduction in solar costs that occurred from 2010 and escalation in energy prices from 2016-2019. There was a 70% drop in solar installations in the red meat industry in 2020 relative to 2019. This may be due to the impacts of COVID-19, however, it was not reflective of solar installations in other industries throughout Australia which saw 117 MW of commercial scale solar installed in 2020, a drop of only 35% from 2019.

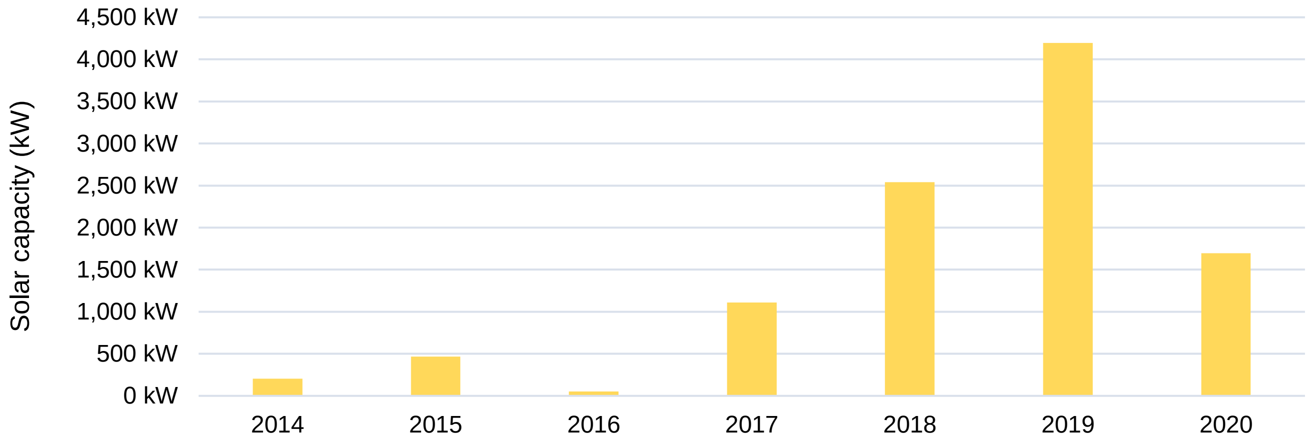


Figure 20: Solar capacity by year installed in the red meat processing industry

For most years the average solar system size has been increasing over time, in line with trends throughout Australia and internationally. Figure 21 shows the average solar system size installed each year – starting at 160 kW in 2014 to just over 1 MW in 2019 - a 6-fold increase in 4 years.

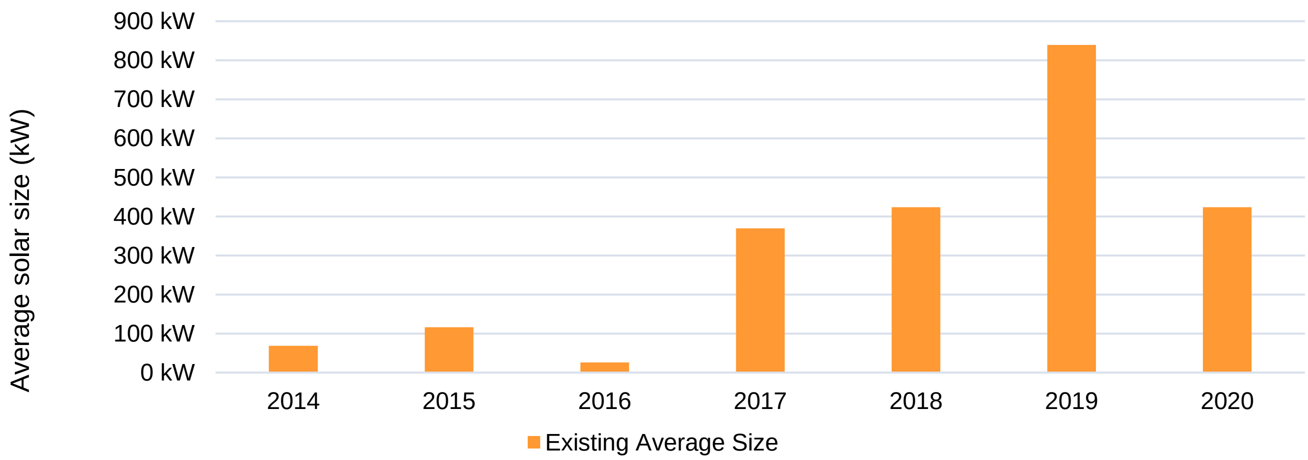


Figure 21: Average solar system size installed each year in the red meat processing industry

6.2 Solar Performance Review

6.2.1 Solar Performance Review 1: 1.3 MW Solar in Victoria

This member installed a 1.356 MW_{dc} solar PV system at their Vic plant at the end of 2018 to supply electricity to the site. The system is a ground-mounted, 30-degree fixed-tilt system with 4,110x 330W Jinko panels and 44x 27 kVA Fronius ECO inverters.

Expected PV Generation Data

Solcast Location Data

5-minute historic irradiance and temperature data was taken from Solcast for the period Jul 2020 – Jun 2021, using data from the closest weather station to the site location. This data was then used to generate the Global Tilt Irradiance (GTI) on the Plane of Array for this system (azimuth = 0, tilt = 30) for each timestamp. Figure 22 shows 5-min GTI data for the orientation specified as well as the ambient temperature data for an example week.

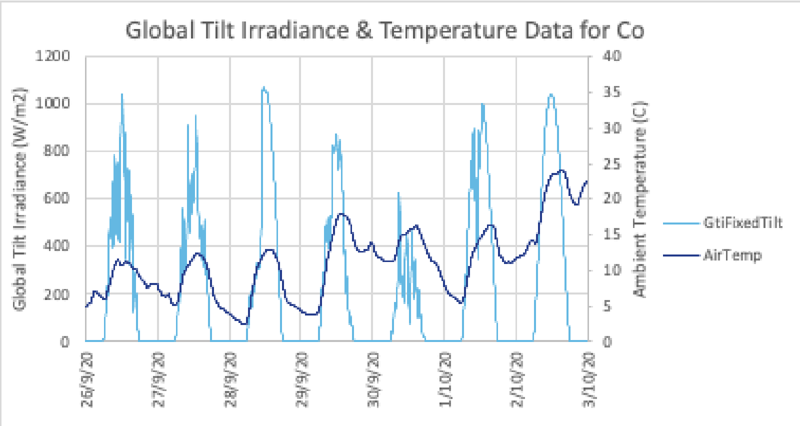


Figure 22: Global Tilt Irradiance and Ambient Temperature Data from a nearby Solcast weather station.

All parameters used in the calculation of expected PV generation for the system installed in Vic are provided in Table 3 below.

Table 3: Parameters used in calculating expected PV generation data

Parameter	Value	Comment
F_{soil}	0.98	2% derating due to soiling
F_{shade}	1	no derating from shading
$L_{inv,eff}$	0.98	From inverter datasheet
L_{BOS}	0.97	Assumed 3% combined BOS losses from AC & DC wiring.
$D_{1st\ yr}$	3%	From panel datasheet
$D_{2nd\text{-}25th\ yr}$	0.7%	From panel datasheet
$Y_{Install}$	2019	Assumed start of 2019 for install year
γ_{power}	-0.37%	From panel datasheet
DC System Size (kW)	1356.3	4110x 330W panels
AC System Size (kW)	1188	44x 27kW Inverters

The expected PV yield for the system over the period Jul 2020 – Jun 2021 using the Solcast irradiance and temperature data from nearby weather station, and the loss factors presented above comes out to be **1,355 kWh/kWp/yr** or approx. **3.7kWh/kWp/day**.

Daily and Monthly Generation

Monthly solar production between July 2020 and June 2021 for the solar system is compared with the expected solar generation data in Figure 23. Figure 24 shows the comparison between the real and expected average daily PV generation for the site, and Figure 25 shows a direct comparison between the 5-min data for a 3-day window in December 2020.

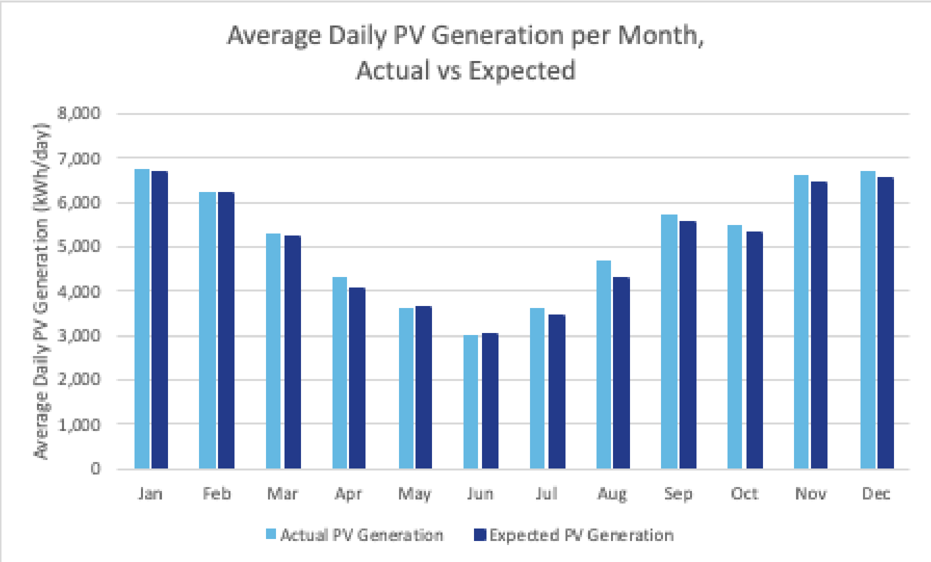


Figure 23: Actual and projected monthly solar production

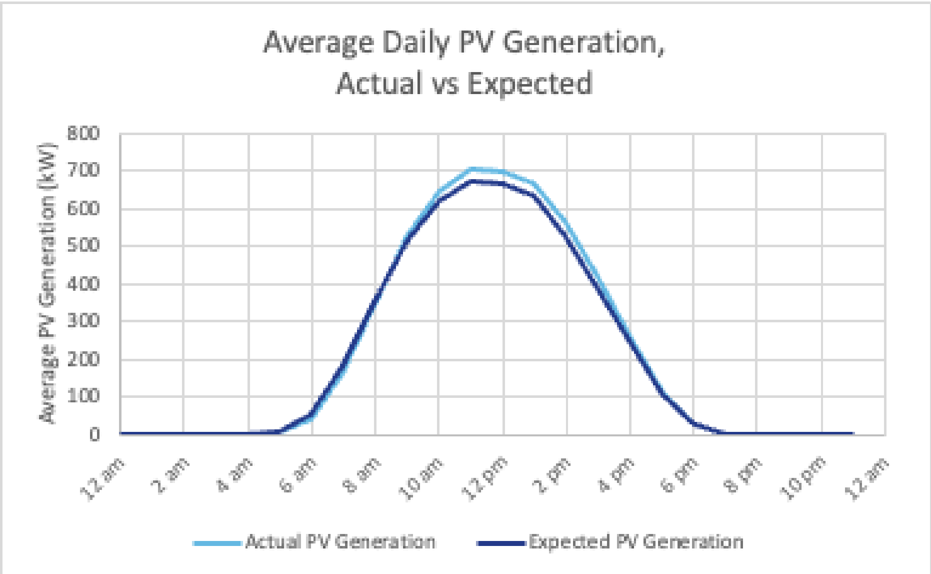


Figure 24: Actual and projected average daily solar production

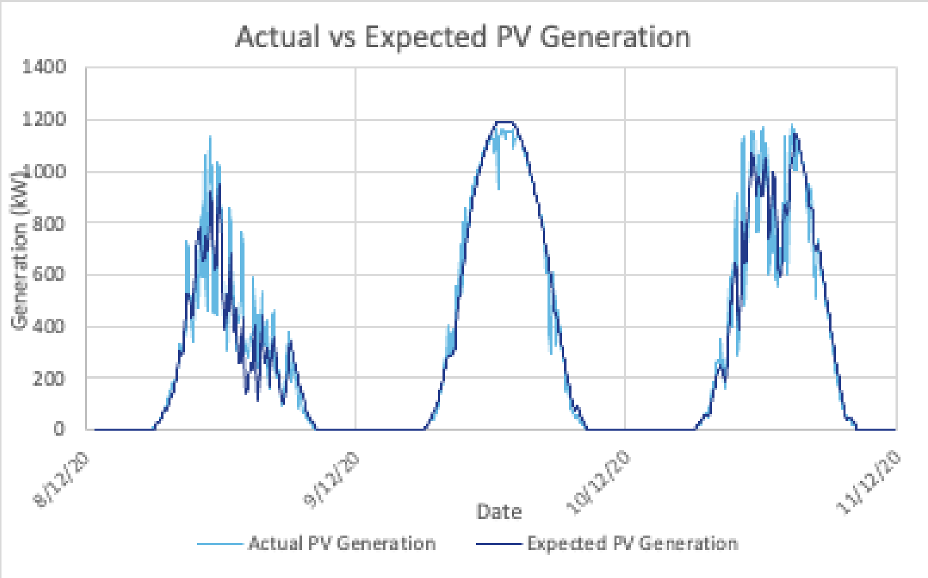


Figure 25: Actual and projected solar production for 8th – 10th December 2020

Solar production at this Vic site closely matches the output expected from this kind of system and shows a slight overperformance compared with the expected values for most months in the sample period analysed. Based on the loss values used in the calculation of the expected generation, it is unlikely that excess soiling, panel derating or other system inefficiencies are present with this system.

Annual Generation

The system appears to be performing well compared with the calculated expected generation data. Table 4 shows that the system outperformed the expected generation by approx. 2.6% over the period Jul 2020 – Jun 2021.

Table 4: Annual solar production comparison Jul 2020 – Jun 2021

	Total Generation (kWh)	Annual Yield (kWh/kWp/yr)	Daily Yield (kWh/kWp/day)
Actual	1,887,220	1,391	3.81
Expected	1,837,865	1,355	3.71
Comparison	+ 2.7%		

Inverter Size and Clipping

The site was concerned about inverter sizing and potential ‘clipping’ of solar output by the inverters. A review of solar production on the two largest generation days over the dataset, January 1st, 2020, and November 8th, 2020, did show some evidence of clipping. Figure 26 shows solar output for both days. Clipping is observed for a short period during the peak solar period and solar production reaches just below the 1,188 kW inverter limit.

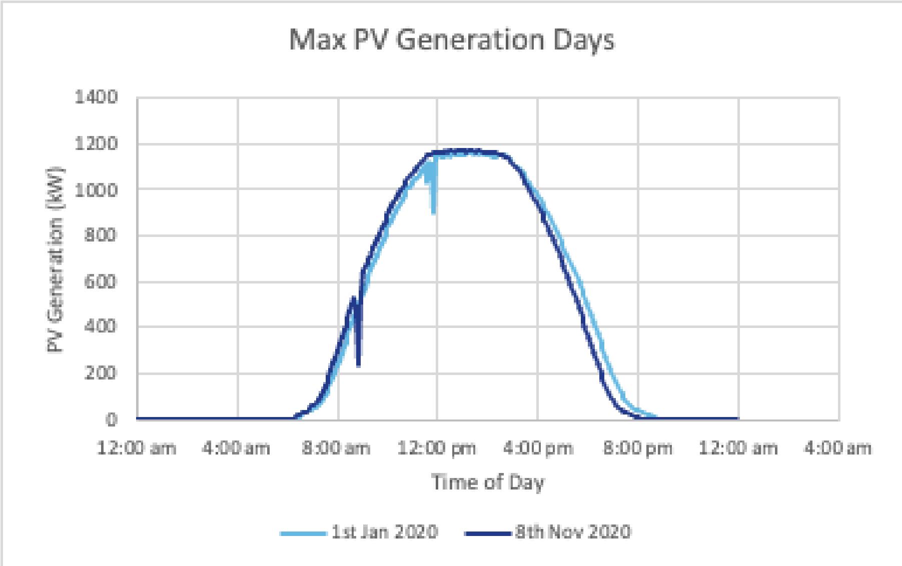


Figure 26: Solar production 1st January 2020, and 8th November 2020

Significant clipping would not be expected given the high inverter (AC) to solar (DC) ratio of 0.88 for this system (inverter capacity 88% of solar capacity). Excessive clipping is typically observed in systems with a much lower ratio such as 0.75 which is the minimum ratio mandated to generate Small Generation Certificates for small solar systems (<100 kW). Upon further review of the expected generation data, the impact of clipping on this system only attributed to a reduction in generation of ~0.1% per year.

Conclusion

From the review of available data, we can conclude the following:

- Solar production slightly outperformed expected values when compared over the period July 2020 – June 2021.
- Based on the loss factors used in generating the expected system generation data, there is no evidence that excessive soiling, shading, or component losses are causing any underperformance for this system.
- There is no evidence that significant clipping of solar production by the inverters is occurring.
- The total annual output throughout 2020, and 2021 is seen to be less than 2019 due to the combined impact of annual system degradation and the lower solar insolation for the latter two years.

Recommendations

To help identify any underperformance in the future, we recommend the following actions:

1. Install solar smart meter monitoring on the whole system.

- This will provide real-time monitoring and a comparison between actual and predicted performance of the system, making it easier to spot trends in performance. https://www.solaranalytics.com.au/
- AMPC have offered to fund solar smart meter monitoring hardware and appropriate subscriptions as part of the Core Project.
- This member is to confirm the CT size of 3,000 amps for the solar system and install the device upon receipt.

2. Trial solar panel cleaning on one or more sub-arrays.

- On one or more of the sub-arrays that are connected to a single inverter, member should clean all the solar panels and compare the solar output from that inverter vs. other inverters for a period.
- Cleaning can be completed in house, or a third party can be engaged to complete this.
- If the cleaned sub-array(s) shows a material difference in performance, the costs of cleaning can be compared against increase savings from the system to inform cleaning regime.

5.2.2 Solar Performance Review: 99 kW Solar in WA

The member installed a 99 kWdc solar PV system at their WA facility at the start of 2019 to supply electricity to the site. The system is a ground-mounted, 20-degree fixed-tilt system with 300x 330W Trina panels and 3x 27 kVA Fronius ECO inverters.

Expected PV Generation Data

Solcast Location Data

5-minute historic irradiance and temperature data was taken from Solcast for the period Jan 2021 – Dec 2021, using data from the closest weather station. This data was then used to generate the Global Tilt Irradiance (GTI) on the Plane of Array for this system (azimuth = 0, tilt = 20) for each timestamp. Figure 27 shows the GTI for the orientation specified as well as the ambient temperature data for an example week.

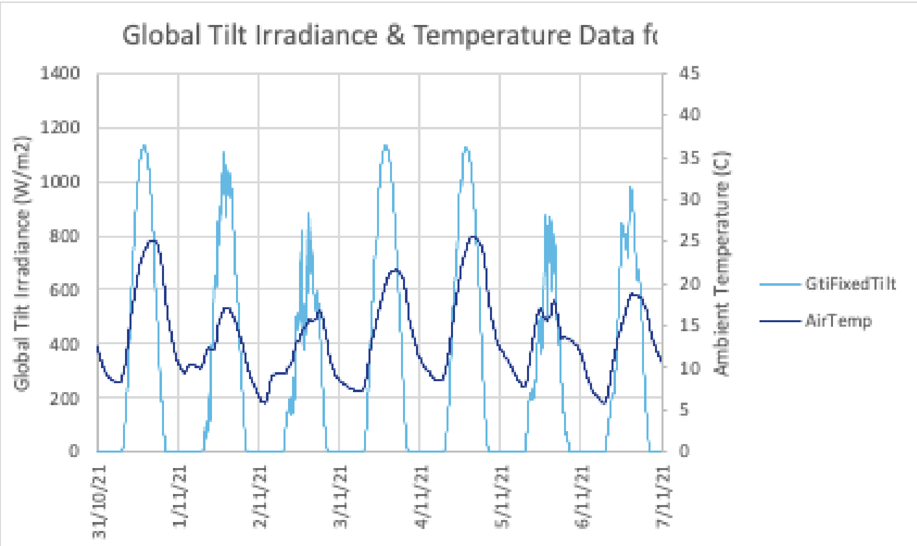


Figure 27: Global Tilt Irradiance and Ambient Temperature Data from a nearby Solcast weather station.

Parameters used in the calculation of expected PV generation for the system are provided in Table 5.

Table 5: Parameters used in calculating expected PV generation data

Parameter	Value	Comment
F_{soil}	0.98	2% derating due to soiling
F_{shade}	1	no derating from shading
$L_{inv,eff}$	0.98	From inverter datasheet
L_{BOS}	0.97	Assumed 3% combined BOS losses from AC & DC wiring.
$D_{1st\ yr}$	2.5%	From panel datasheet

$D_{2nd\text{-}25th\ yr}$	0.7%	From panel datasheet
$Y_{Install}$	2019	Assumed start of 2019 for install year
γ_{power}	-0.41%	From panel datasheet
DC System Size (kW)	99	300x 330W panels
AC System Size (kW)	81	3x 27kW Inverters

The expected PV yield for the system over the period Jan 2021 – Dec 2021 using the Solcast irradiance and temperature data from a nearby weather station, and the loss factors presented above comes out to be **1,627 kWh/kWp/yr** or approx. **4.5kWh/kWp/day**.

Solar Performance Review

Daily and Monthly Generation

Monthly solar production between Jan 2021 and Dec 2021 for the solar system is compared with the expected solar generation data in Figure 28. Figure 29 shows the comparison between the real and expected average daily PV generation for the site.

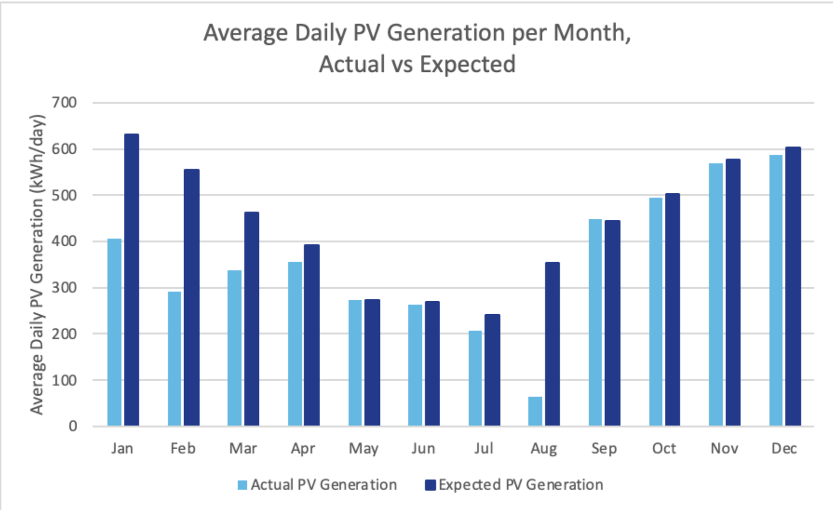


Figure 28: Actual and projected monthly solar production

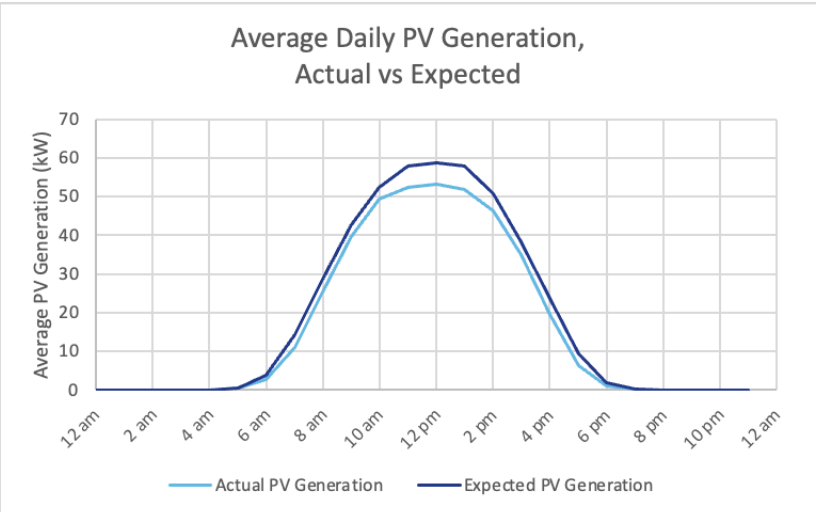


Figure 29: Actual and projected average daily solar production

Solar production at this site was found to be significantly below the expected generation for several months during 2021. Specifically, August showed the highest percentage of underperformance, followed by February, January, and March. Upon further investigation of the generation data, it was found that one of the three solar inverters was offline from 1st Jan – 25th Mar attributing to a 33% reduction in system output during this period. Figure 30 shows a comparison between the real and expected generation for a 3-day window in Jan 2021.

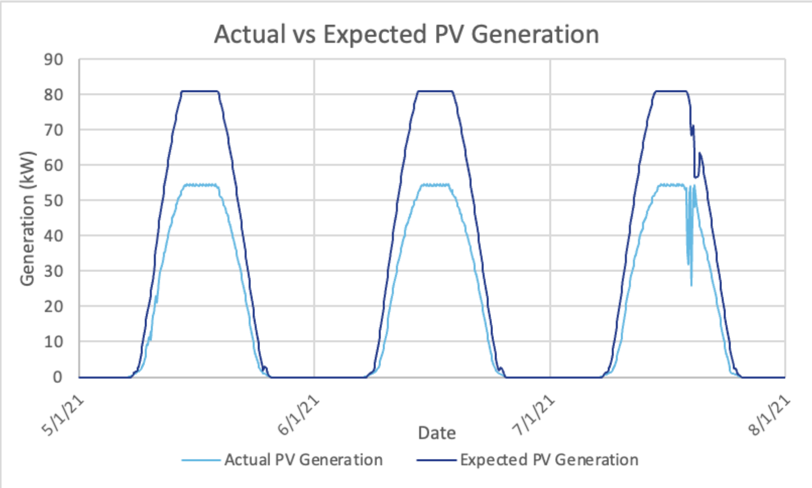


Figure 30: Actual and projected solar production for 5th – 7th January 2021

Furthermore, it was identified that the entire system was offline for several periods throughout February, April, July, and August. The exact outage windows are provided below:

- 19th to 23rd February 2021
- 17th to 18th April 2021
- 30th July to 27th August 2021

It is unclear whether these outages were a result of communications issues with the inverters or if the system was in fact not generating electricity during these times. Figure 31 shows a comparison between the real and expected generation for a 4-day window in August when the longest system outage was experienced. The system can be seen to come back online during the morning of the 27th.

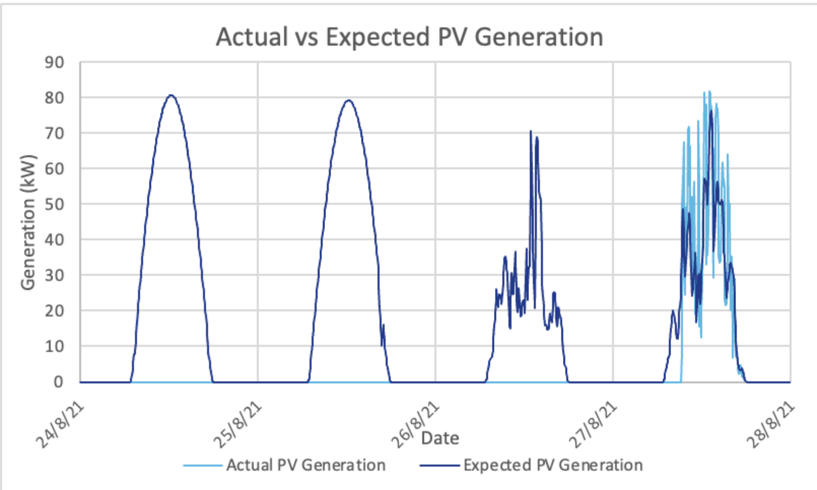


Figure 31: Actual and projected solar production for 24th – 27th August 2020

Outside of the periods of significant underperformance identified above, the system was only slightly below the expected generation values for the remainder of the year. This indicates that the system was operating as expected outside of any inverter or communications issues experienced. The slight underperformance could be attributed to higher-than-expected soiling losses or shading losses from nearby obstructions.

Annual Generation

Throughout 2021 the system showed substantial underperformance when looking at annual generation compared with the expected value. The impact of inverter and system downtime played into this underperformance, as identified above. Table 6 shows that the system underperformed by approx. 18.8% over the period Jan 2021 – Dec 2021 when compared to the expected generation.

Table 6: Annual solar production comparison Jan 2021 – Dec 2021

	Total Generation (kWh)	Annual Yield (kWh/kWp/yr)	Daily Yield (kWh/kWp/day)
Actual	130,797	1,321	3.62
Expected	161,110	1,627	4.46
Comparison	-18.8%		

When ignoring the time periods with inverter or system outages, the system can be assessed for its performance during normal operation. Table 7 shows the comparison between actual and predicted generation data after removing the impact of inverter and system downtime during the time periods identified in the previous section.

Table 7: Annual solar production comparison, normalised for system downtime Jan 2021 – Dec 2021

	Total Generation (kWh)	Annual Yield (kWh/kWp/yr)	Daily Yield (kWh/kWp/day)
Actual	153,966	1,555	4.26
Expected	161,110	1,627	4.46
Comparison	-4.4%		

After normalising for energy lost due to inverter or system downtime, the actual generation was only around 4.4% below the expected annual generation value. This slight underperformance could be attributed to higher soiling losses or shading losses from nearby obstructions.

Inverter Size and Clipping

The site was concerned about inverter sizing and potential ‘clipping’ of solar output by the inverters. A review of solar production on the two largest generation days over the dataset, 29th November 2021, and 5th December 2021, did show some evidence of clipping. Figure 32 shows solar output for both days. Clipping is observed for a short period during the peak solar period and solar production reaches the 81 kW inverter limit.

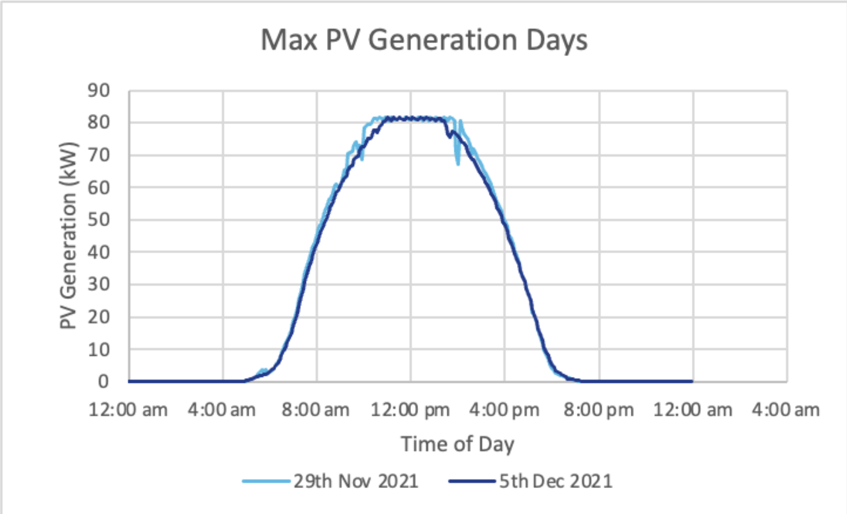


Figure 32: Solar production 29th November 2021, and 5th December 2021

Significant clipping would not be expected given the high inverter (AC) to solar (DC) ratio of 0.82 for this system (inverter capacity 82% of solar capacity). Excessive clipping is typically observed in systems with a lower ratio such as 0.75 which is the minimum ratio mandated to generate Small Generation Certificates for small solar systems (<100 kW). Upon further review of the expected generation data, the impact of clipping on this system attributed to a reduction in generation of ~1.1% per year.

Conclusion

From the review of available data, we can conclude the following:

- Solar production underperformed compared to expected values over the period Jan 2021 – Dec 2021 by 18.8%. The main factors contributing to the underperformance were:
    - an inverter outage from 1st January – 25th March
    - entire system outages during the periods:
        - 19th – 24th February
        - 18th – 19th April
        - 30th July – 27th August
- The system slightly underperformed by 4.4% compared to expected generation, after normalising for system downtime during the time periods listed above. This underperformance could be due to higher than modelled soiling losses or shading losses from nearby obstructions.
- Some clipping was identified during the peak generation days throughout the year, however, there is no evidence that significant clipping of solar production is occurring.

Recommendations

To help identify the cause of the underperformance from the system during 2021, and to identify any underperformance in the future, we recommend the following actions:

1. Install solar smart meter monitoring on the whole system.

- This will provide real-time monitoring and a comparison between actual and predicted performance of the system, making it easier to spot trends in performance. Solar Analytics is an example of an independent cellular smart metering hardware which provides real-time date for solar generation. https://www.solaranalytics.com.au

- AMPC have offered to fund the solar smart meter monitoring hardware and appropriate subscriptions as part of the Core Project.
- Member to confirm the CT size of 200 amps for the solar system and install the device upon receipt.

2. Trial solar panel cleaning on one or more sub-arrays.

- On one or more of the sub-arrays that are connected to a single inverter, member should clean all the solar panels and compare the solar output from that inverter vs. other inverters for a period. Figure 33 below shows an example of trial panel cleaning on all panels connected to inverter 1.
- Cleaning can be completed in house, or a third party can be engaged to complete this.
- If the cleaned sub-array(s) shows a material difference in performance, the costs of cleaning can be compared against increase savings from the system to inform cleaning regime.

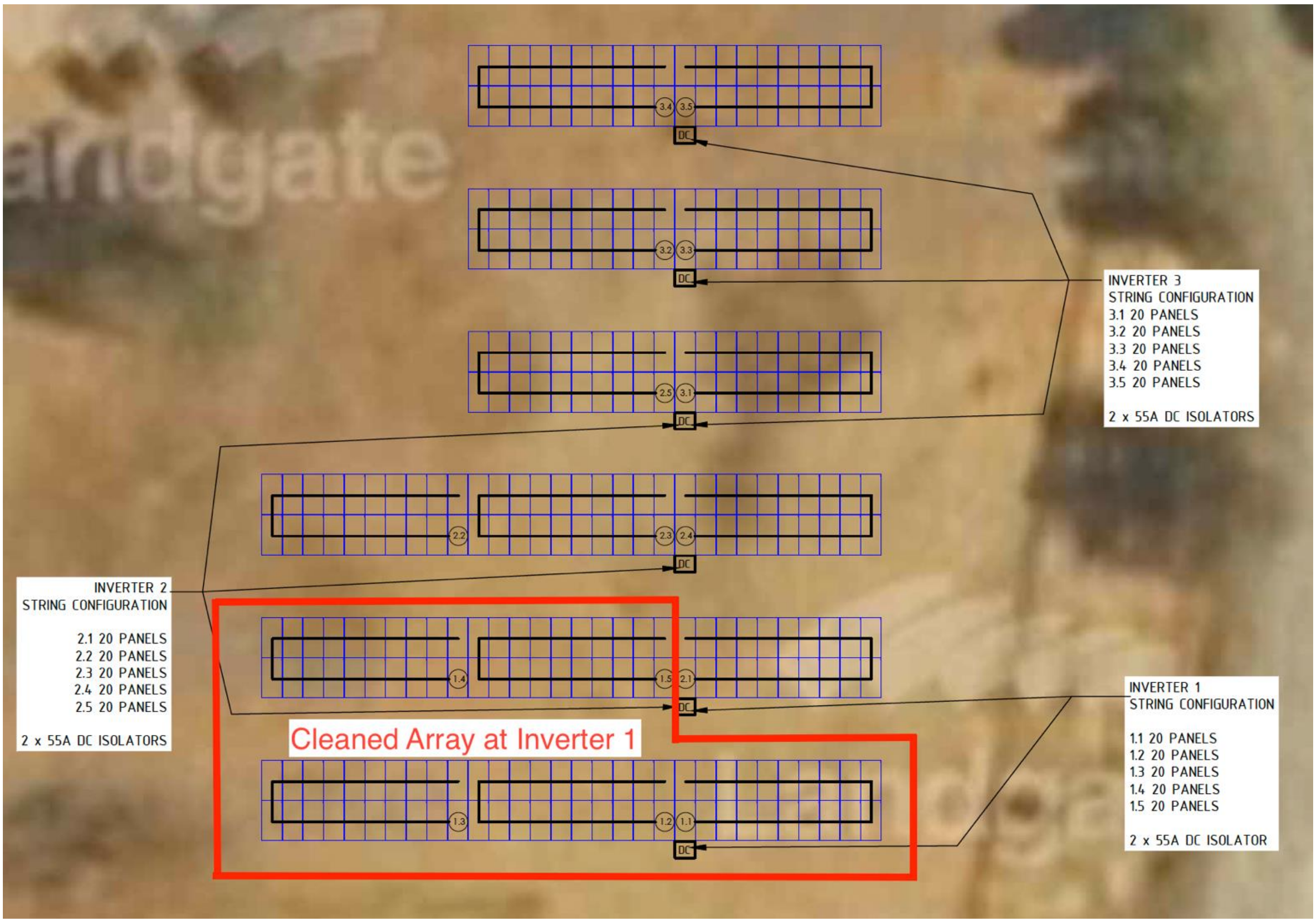


Figure 33: Example of proposed panel cleaning to test effect on system performance from inverter 1.

6.3 Solar Assessments

Representatives from red meat processors were engaged in the assessment process and actively used the assessments in their formal decision making process for solar and battery implementation. In most cases this was the only independent assessment and advice the member had received regarding solar and batteries. Previous assessments and advice were in the following forms which were sub-optimal for making a final investment decision (FID) for the following reasons:

- High level reports from consultants
  - Lacking detail on optimal size and accurate savings
  - Often based on outdated assumptions and pricing information
- In house assessment and analysis
  - Often based on outdated assumptions and pricing information
- Proposals from Solar Retailers
  - Not independent as the solar retailer would be a supplier to the RMP
  - Not accurate enough for FID as it is sales focused

In particular, outdated assumptions and pricing information were common reasons for solar not being considered by RMPs during the period of the project. Our observation in working outside of the RMP sector as this is common throughout Australia and may be due to the fast pace of technology and price change in solar and/or members drawing too close conclusions from their experience with home solar from many years ago. Common misconceptions that we encountered were:

- Solar panels are expensive and should be tilted and predominantly be on north facing roofs to maximise output per panel.
- Solar panel life is short, far less than the 20-30 year typical life of solar systems
- Large government rebates exist that will materially reduce the capital investment required.
- There is a material change in solar technology or efficiency just round the corner
- Batteries should be installed to minimise excess solar/exported solar at all costs

The Project was able to clear most misconceptions and provide an independent business case for solar at the RMP site that could be used to make a final investment decision by the RMP member, often leading to the implementation of solar at the site.

6.3.1 RMP Assessments - Queensland

Ten RMP site specific assessments were completed for RMP sites in Queensland throughout the project. In most cases these were large red meat processing facilities with large electrical demand peaking during the day due to refrigeration loads. Relatively low electricity prices in Queensland compared with other states (aside for a brief period of very high prices at the end of 2022) and lack of incentives beyond LGCs meant payback periods for solar were not as attractive as other states. The sites assessed were typically owned by companies with operations in other states and the Queensland sites may not have been prioritised for solar investment. Solar remains a good emissions reduction option for Queensland sites and there is a lot of potential with up to another 40 sites yet to be assessed. A sample output from a typical Queensland solar assessment is provided in Figure 34.

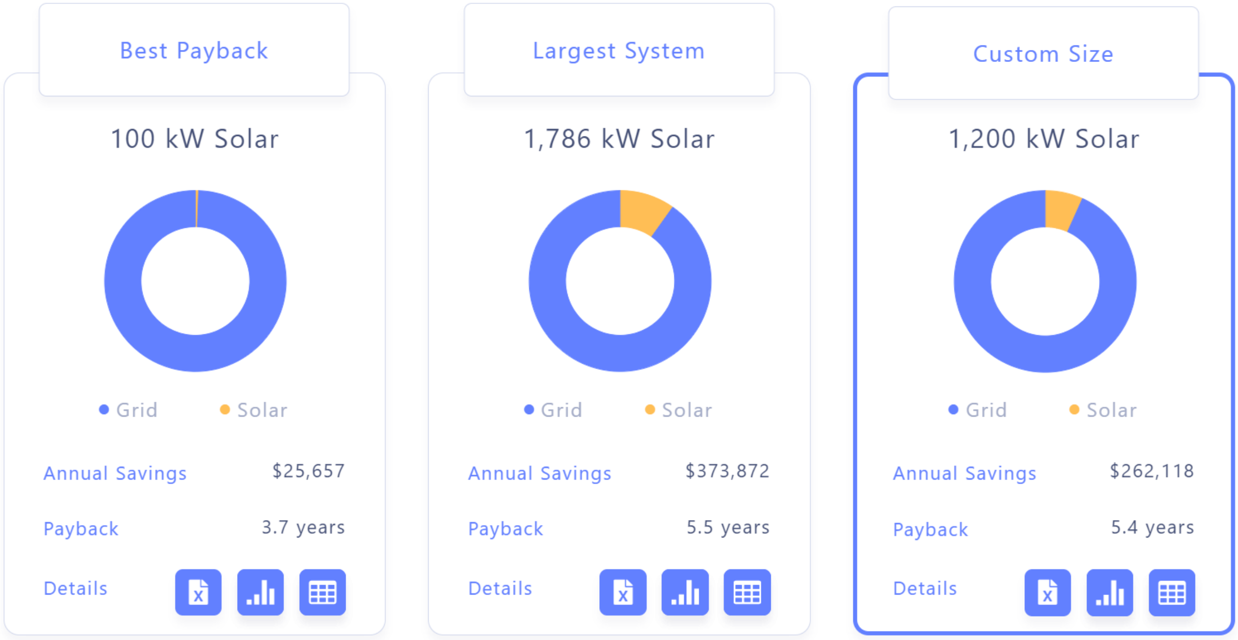


Figure 34: Sample output from a typical Queensland solar assessment

6.3.2 RMP Assessments – New South Wales

Twelve RMP site specific assessments were completed for RMP sites in NSW throughout the project. Relatively high electricity prices in NSW compared with other states meant solar was an attractive investment for a number of RMPs. In most cases large solar systems (1 MW and above) had a payback period of 4 years or less or were highly cashflow positive under a PPA. This likely contributed to the 5.5 MW of solar being installed or contracted during the project period. Solar remains a great emissions reduction option for NSW sites and there is a lot of potential with up to another 15 sites yet to be assessed and investment decisions pending for some assessed sites. A sample output from a typical NSW solar assessment is provided in Figure 35

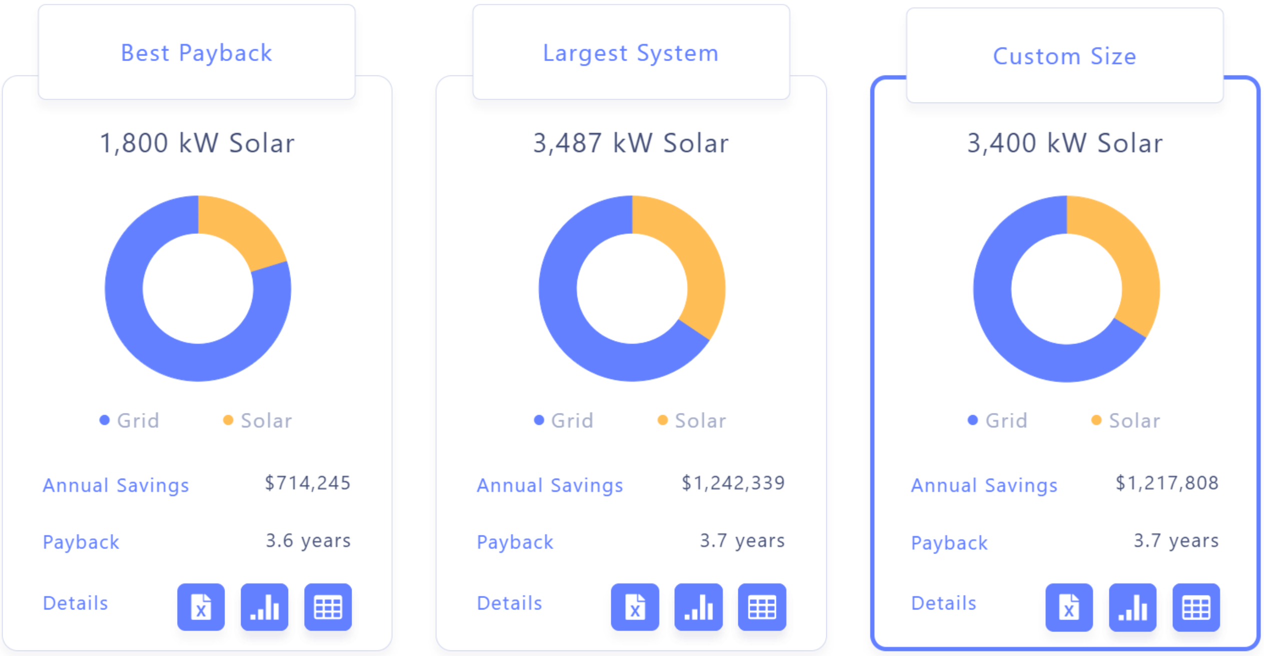


Figure 35: Sample output from a typical NSW solar assessment

6.3.3 RMP Assessments – Victoria

Twelve RMP site specific assessments were completed for RMP sites in Victoria. Although electricity prices were relatively low in the State, the VEEC incentive had a large impact on project economics, providing up to 40% of project costs. This meant solar was an attractive investment for a number of RMPs in Victoria. In most cases large solar systems (1 MW and above) had a payback period of 4-5 years or were cashflow positive under a PPA. This likely contributed to the 4.3 MW of solar being installed or contracted during the project period. Solar remains a great emissions reduction option for Victoria sites and there is a lot of potential with up to another 20 sites yet to be assessed. A sample output from a typical Victoria solar assessment is provided in Figure 35

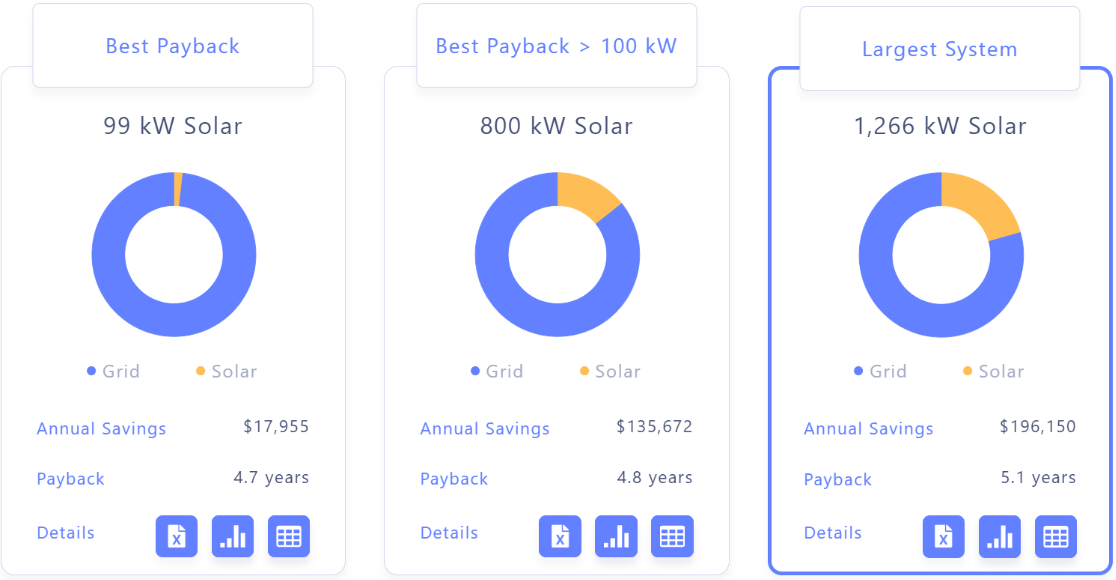


Figure 36: Sample output from a typical Victoria solar assessment

6.3.4 RMP Assessments – Tasmania

Four RMP site specific assessments were completed for RMP sites in Tasmania throughout the project. Due to the presence of existing solar, relatively low electricity prices and non-solar related factors, projects did not proceed past assessment. A sample output from a typical Victoria solar assessment is provided in Figure 35

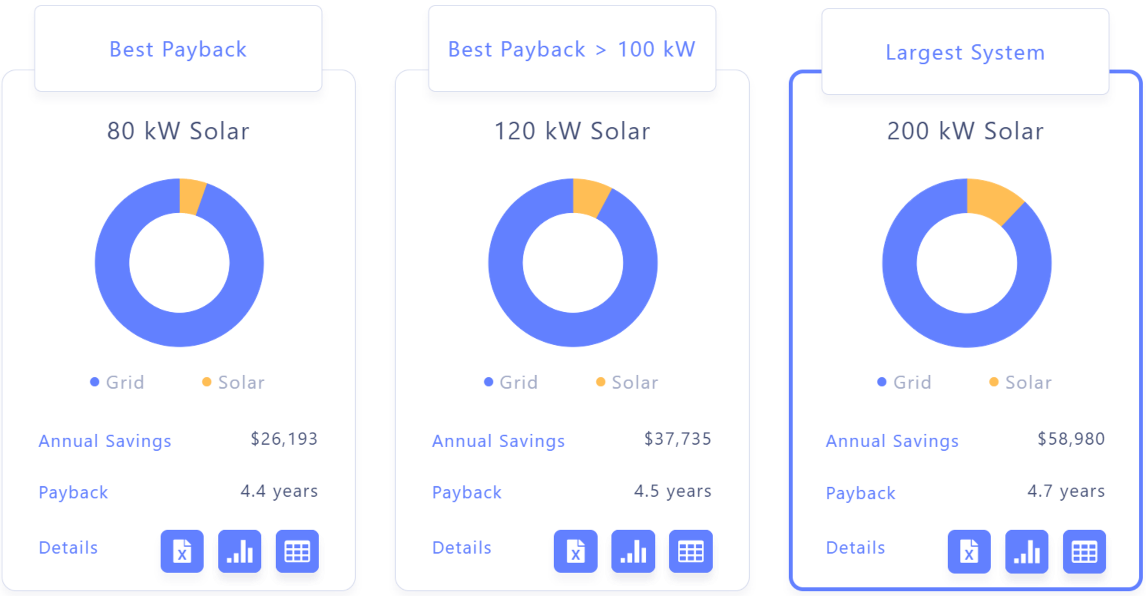


Figure 37: Sample output from a typical Victoria solar assessment

6.3.4 RMP Assessments – South Australia

Five RMP site specific assessments were completed for RMP sites in South Australia throughout the project. The sites assessed were typically owned by companies with operations in other states and the South Australia sites may not have been prioritised for solar investment. A sample output from a typical South Australia solar assessment is provided in Figure 35

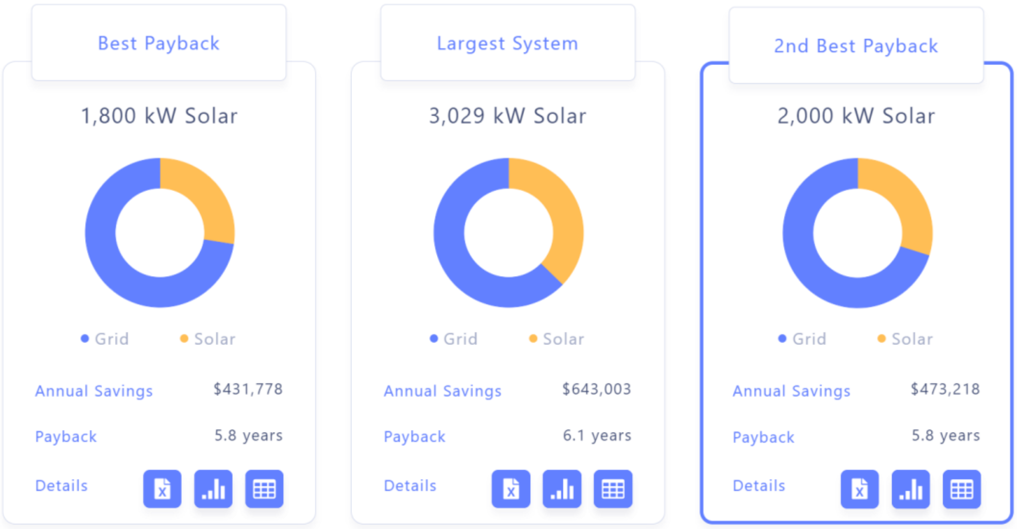


Figure 38: Sample output from a typical Victoria solar assessment

6.3.4 RMP Assessments – Western Australia

Twelve RMP site specific assessments were completed for RMP sites in Victoria throughout the project. Electricity prices were relatively low in Western Australia and the structure of the network and capacity charges are not conducive to solar projects. This meant solar was not an attractive investment for most RMPs in Western Australia. In most cases large solar systems (1 MW and above) had a payback period of 6-10 years or were not cashflow positive under a PPA. A sample output from a typical Western Australia solar assessment is provided in Figure 35

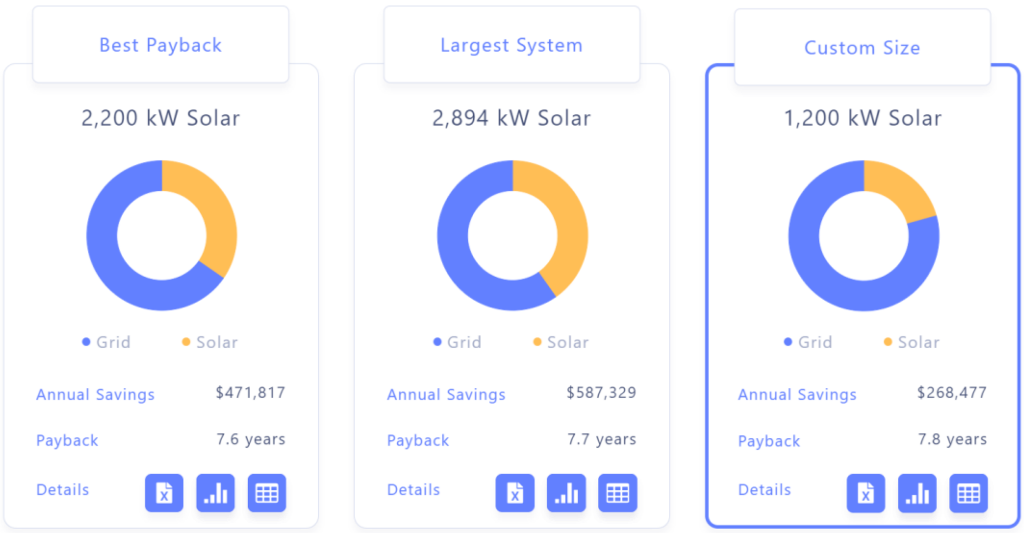


Figure 39: Sample output from a typical Victoria solar assessment

6.4 Solar Procurement Strategy

Red Meat Processors that proceeded to the procurement phase, by requesting Initial Offers, were often close to making a final investment decision. This was evident with the 19 sites that utilised Beam Energy Lab's assistance with procurement, 11 of these sites have either installed, contracted or approved solar projects (58% of sites). These RMPs typically undertook a Solar Feasibility Assessment and a Final Offers round of procurement with shortlisted suppliers.

A clear trend in price change over time is not observable, consistent with what is observed in the commercial solar market over the same period. Figure 40 shows the average cost for commercial solar in Australia over the last two and a half years[1]. Prices can be seen spiking in Q1 2021 before moderating the next quarter and remaining largely unchanged for the remaining period, consistent with offers received for RMPs in the Project.

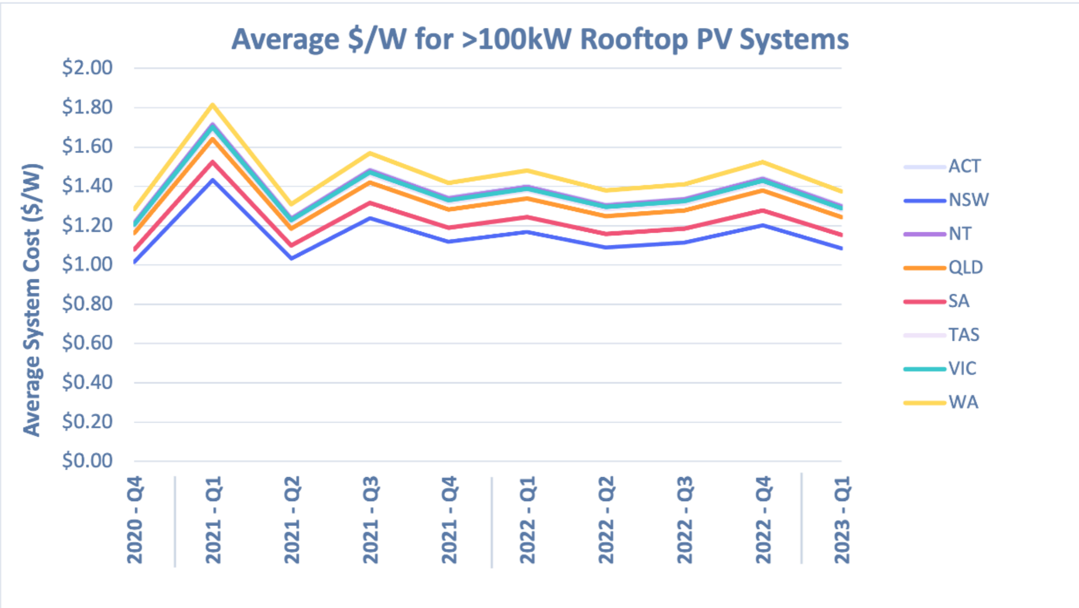


Figure 40: Average solar system costs Q4 2022 to Q1 2023 (systems > 100 kW)

The majority of procurement and contracting was done as an Outright Purchase (Capex) as opposed to a Power Purchase Agreement or other finance arrangement (Opex). This is somewhat contrary to the survey results which suggested an equal weighting of Capex and Opex. Based on discussions with RMPs, common reasons for selecting Outright Purchase (Capex) were:

- RMPs are used to using capital for large physical projects, whereas finance is not commonly used
- Additional tax and depreciation benefits were realised with a capital investment, that would not be realised through a Power Purchase Agreement
- RMP financial modelling indicated that an Outright Purchase was a better business case

[1] Beam Solar. "Solar Price Index." Beam Solar, 2023, https://www.beam.solar/solar-price-index

6.5 Drive uptake of renewable energy in the RMP sector

The Low-cost assessment & arrangement of solar PV opportunities Project (the Project) appears to have facilitated an increase in solar deployment in the red meat processing sector relative to commercial solar in Australia as a whole. A comparison to the overall volume of solar capacity installed in Australia in the 'Medium Scale' category (100 kW to 5 MW capacity)[2] is provided in Figure 41. The data shows that from 2014 to 2019 the solar capacity additions in the RMP sector broadly tacked capacity additions of medium scale solar throughout Australia, with the RMP sector representing 2-3% of Australian capacity additions.

However, in 2020 there was a 60% drop in capacity additions in the RMP sector compared with a 10% drop throughout Australia, and in 2021 there was a 100% drop in the RMP sector vs. a 40% drop throughout Australia. Conversely, it can be seen that in 2022 the RMP sector added significant amounts of solar capacity (2.2 MW) despite a further reduction of 67% of capacity additions in the red meat processing sector. In 2022 the red meat processing sector represented 8% of medium scale solar capacity additions in Australia, three times historic proportions. The cause of the changes in capacity additions over time are discussed in more detail in the following sub-sections.

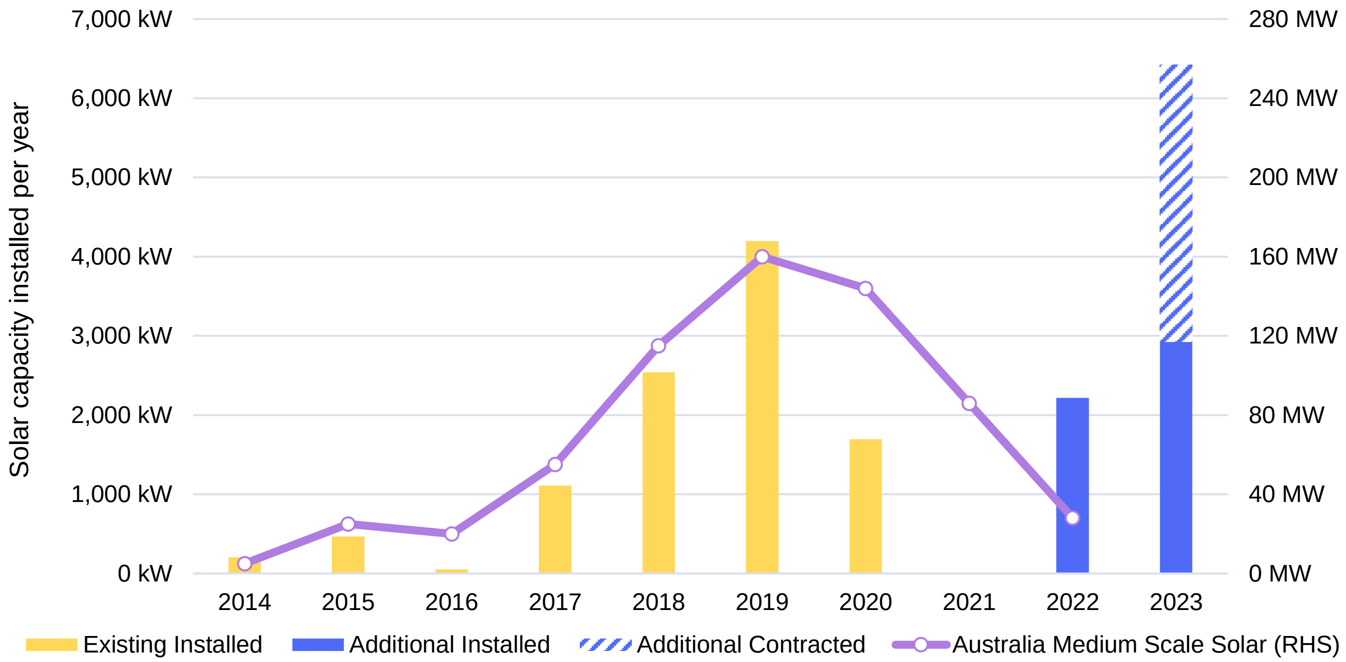


Figure 41: Comparison of solar capacity additions in the RMP sector vs. all of Australia

6.5.1 COVID-19 and impact on red meat processing industry

A potential reason for the sharp drop in solar capacity additions in the RMP sector in 2020 and 2021 is the impact that COVID-19 had on the RMP sector. Industry feedback suggested that COVID-19 caused a reduction in staff and skills available to focus on solar projects, with extra resources required for day to day operations. Although this may be a valid reason for the drop in capacity additions, it does not explain why this would impact the RMP sector any more than other sectors of the Australian economy. Figure 42 provides a comparison of solar capacity additions with beef and lamb production. A drop in beef production of 13% in 2020 and a further 10% in 2021[3] can be observed, however this is not proportional to the drop in solar capacity.

[2] Clean Energy Council: Clean Energy Australia Reports 2014-2023.
[3] Australian Bureau of Statistics: Red meat produced - beef: all series (tonnes), - lamb: all series (tonnes)

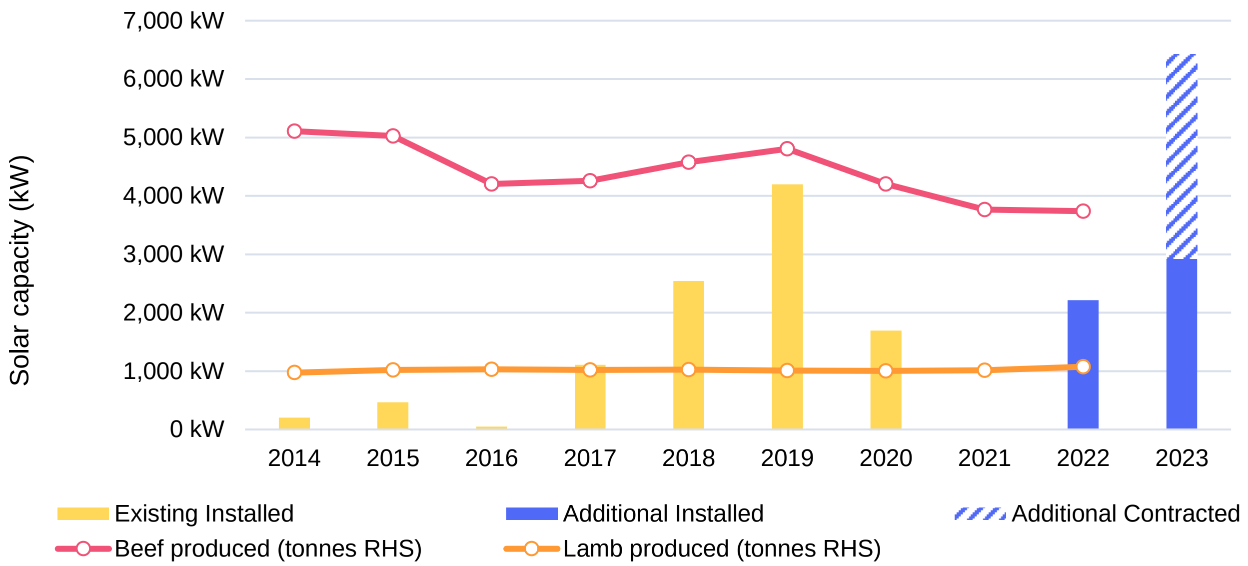


Figure 42: Comparison of solar capacity additions in the RMP sector with Beef and Lamb production

6.5.2 Impact of East Coast energy crisis on the business case

Electricity prices in the National Electricity Market (NEM), covering QLD, NSW, VIC, SA and Tas, dramatically increased towards the end of 2022 and this likely led to an increase in solar capacity installations in 2023 in the RMP sector and potentially in Australia Generally. This was the case in QLD and NSW in particular, where wholesale futures prices exceeded $250/MWh, a 300-400% increase in prices since the start of 2022. Since the government legislated caps on oil and gas prices, the electricity prices have begun to ease and drop down again for the start of 2023, but are still in an elevated state. Figure 43 shows January 2023 and the prior 12 month's wholesale futures prices for QLD, NSW, VIC and SA from ASX Energy[4].

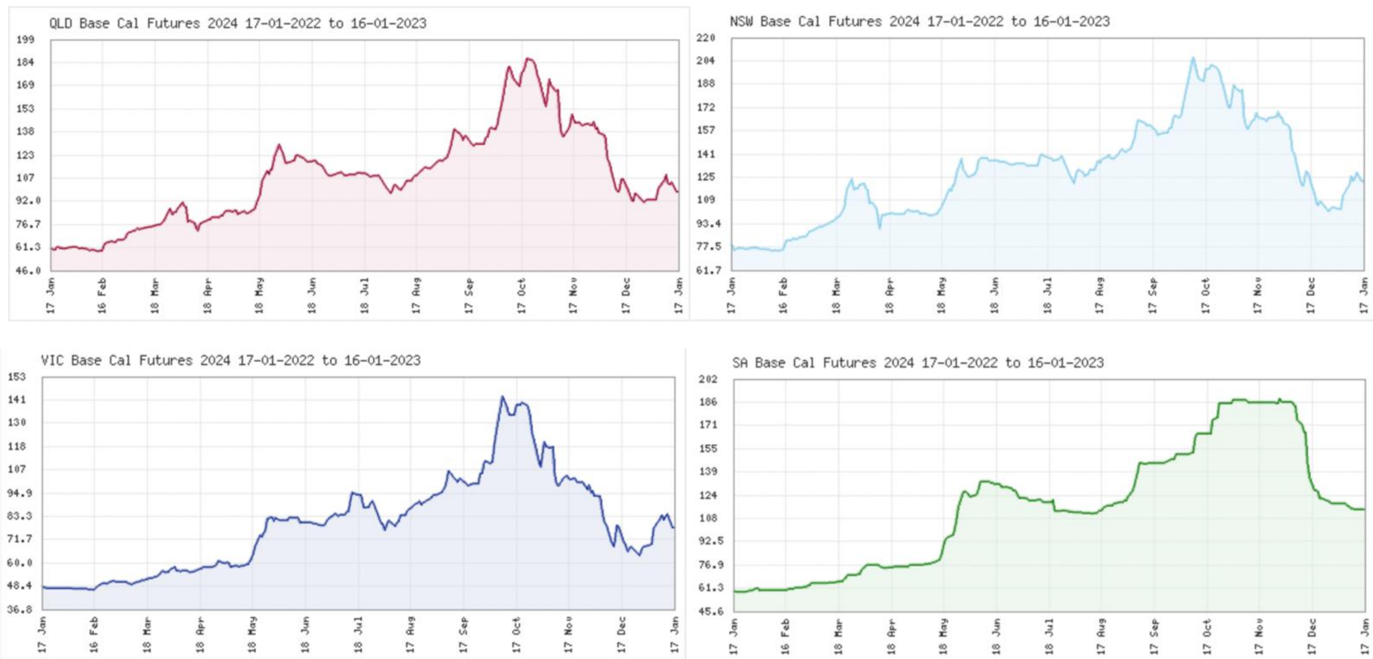


Figure 43: Calendar year 2024 electricity futures prices as at 16 Jan 2023

[4] https://www.asxenergy.com.au/

6.5.3 Impact of Incentives

Another driver of solar installations generally are incentives. For medium scale solar (100 kW to 5 MW) there are two incentives available: Large Generation Certificates (LGCs) and Victorian Energy Efficiency Certificates (VEECs). LGCs are renewable energy certificates that are created for each MWh of electricity generated from a renewable electricity generator in Australia. LGCs can be sold on a tradeable market to increase revenue from a solar project (increase savings). However, if the LGCs are sold, the renewable energy or emissions reduction benefits of the solar system cannot be claimed or promoted (as they are attached to the LGC). In Victoria, VEECs can be created for solar projects for any electricity reductions associated with solar, with up to 10 years of emissions reduction being claimed upon proof of energy savings. Both LGC and VEECs increased in price significantly from 2021 were a significant factor in the decision making of RMPS that implemented solar in 2022 and 2023, particularly for the VEEC incentive.

6.5.4 Impact of the program

It's likely that the 'Low-cost assessment & arrangement of solar PV opportunities' program led to an increase in the deployment of solar in the RMP sector. This can be seen in the large solar capacity additions in 2022 and 2023 (including 2023 projections) compared with the large drop in capacity additions in the RMP sector in 2020 and 2021 and a continued downtrend in solar capacity additions in Australia as a whole in 2022.

6.5 Survey

The quarterly surveys of RMP members showed overwhelming support for solar throughout the period of the project and this view aligned with feedback from members during the assessments. Where solar wasn't supported, it was typically due to the assessment showing poor returns such as in Western Australia at the start of the project period.

Survey respondents confirmed that large electricity price increases in the National Electricity Market (NEM), peaking in the last quarter of 2022, were the main factor or were a factor in their decision making for solar projects. This was consistent with our experience speaking with RMP members that were trying to mitigate pending large energy cost increasing due to electricity and gas price increases.

Survey results indicating the main barriers for implementing solar were insightful. Awaiting appropriate grant funding was identified as a barrier consistently by around 30% of members. In our view, there are unlikely to be material new incentives provided for rooftop solar in the future, aside from project specific support from AMPC or ARENA when combined with other technologies. In addition, solar assessments indicated that fairly good returns for solar would be achieved without grant funding or further incentives. Eliminating this barrier may result in increased deployment but its unclear how to do this other than providing grant funding for solar projects.

Competing projects that require money and resources instead was the most common barrier to implementing solar. This also aligned with our discussions with RMP members where resourcing in particular was identified as a barrier. It was common for RMPs to defer a solar project whilst they focused on maintaining production or other capital projects required to maintain production. In these cases the engineering/maintenance manager would be responsible for overseeing the solar project and they only had no spare time to take on an additional project.

Other barriers did not score consistently above 10% and given the small sample size, reading too much into the results should be avoided.

In hindsight, other questions should have been asked in the surveys. In particular, questions relating to the impact of COVID-19 and net zero emissions targets may have shed some light on why solar capacity additions dropped so much in 2020 and 2021 and what the main drivers might be going forward.

7 Conclusions / Recommendations

7.1 Industry Baseline

Prior to 2022 and the start of the Low-cost assessment & arrangement of solar PV opportunities Project, solar installations in the Red Meat Processing sector were small relative to potential and mostly isolated to Victora and to a lesser extent Queensland. Of the 10.3 MW of installed solar, 6 MW was rooftop solar (6% of total rooftop solar potential) and 4.3 MW was ground mount solar (1% of potential). The installed base of solar was small despite favourable conditions such as high solar irradiance throughout Australia, an electricity demand profile aligned with typical solar output profile and a large amount of roof space and ground area available for solar installations.

The amount of solar deployed in the red meat processing sector was increasing in most years from 2014 to 2019, before dropping by 70% in 2020. This may be due to the impacts of COVID-19; however, it was not reflective of solar installations in other industries throughout Australia which saw a smaller drop of only 35% from 2019 to 2020. This trend continued into 2021 reducing progress under industry targets such as CN30 and renewable energy.

7.2 Solar Performance Review

The findings from these reports identified that one system has been performing very well with generation figures slightly above expected values, while the other system has underperformed over the past year for a number of reasons.

Following the detailed assessment of historic generation data and expected generation data for both sites the following conclusions could be made:

For the large-scale VIC site:

- Solar production slightly outperformed expected values when compared over the period July 2020 – June 2021.
- Based on the loss factors used in generating the expected system generation data, there is no evidence that excessive soiling, shading, or component losses are causing any underperformance for this system.
- There is no evidence that significant clipping of solar production by the inverters is occurring.
- The system is performing well, and no immediate actions are required to improve system efficiency.

For the small-scale WA site:

- Solar production underperformed compared to expected values over the period Jan 2021 – Dec 2021 by 18.8%. The main factors contributing to the underperformance were:
    - an inverter outage from 1st January – 25th March
    - entire system outages during the periods:
        - 19th – 24th February
        - 18th – 19th April
        - 30th July – 27th August
- The system slightly underperformed by 4.4% compared to expected generation, after normalising for system downtime during the time periods listed above. This underperformance could be due to higher than modelled soiling losses or shading losses from nearby obstructions.

- Some clipping was identified during the peak generation days throughout the year, however, there is no evidence that significant clipping of solar production is occurring.
- We would recommend more stringent monitoring of this system to identify inverter or system outages more quickly.

We recommend arranging for ongoing monitoring of all existing systems through the installation of independent solar smart meters. AMPC is currently offering to fund solar smart metering hardware to members with existing solar systems on their sites.

Furthermore, we recommend arranging for regular performance reporting to be completed on existing systems on annual, quarterly, or monthly basis depending on the size of the system. These reports will provide insight into potential issues or inefficiencies with the existing systems and will aid in arranging for the appropriate service and maintenance works to bring generation back up to expected values.

Finally, for significantly large solar systems, we would recommend undertaking ongoing maintenance contracts for regular system inspections and repair works. These inspections may also include periodic array cleaning if the conditions on site deem it cost-effective. In general, if the array tilt is less than 10-degrees and/or the array is in a particularly dusty, damp, or salty region, then regular array cleaning may be beneficial.

7.1 Solar Assessments

Beam Energy Labs completed site-specific solar assessments of 52 red meat processing sites in Australia. For many of these sites, multiple National Meter Identifier's (NMIs) were assessed, taking the number of individual solar and battery assessments completed to approximately 80. The number of sites assessed represented more than one third of red meat processing sites in Australia. Uptake of solar assessments was high in WA due to a coordinated engagement of RMPs early in the program.

The assessments confirmed the feasibility of solar and batteries at the RMP site and were used by company representatives to make investment decisions relating to solar and battery projects at their sites. Representatives from red meat processors were engaged in the assessment process and actively used the assessments in their formal decision making process for solar and battery implementation. In most cases this was the only independent assessment and advice the member had received regarding solar and batteries. Previous assessments and advice were in the following forms which were sub-optimal for making a final investment decision.

Completing solar assessments as we did under this program likely led to the turnaround in solar capacity additions in the red meat processing sector in 2022 and 2023.

7.2 Solar Procurement Strategy

Red Meat Processors that proceeded to the procurement phase were often close to making a final investment decision. This was evident with the 19 sites that utilised Beam Energy Lab's assistance with procurement, 11 of these sites have either installed, contracted or approved solar projects (58% of sites). These RMPs typically undertook a Solar Feasibility Assessment and a Final Offers round of procurement with shortlisted suppliers to contract their solar project.

The majority of procurement and contracting was done as an Outright Purchase (Capex) as opposed to a Power Purchase Agreement or other finance arrangement (Opex). This is somewhat contrary to the survey results which suggested an equal weighting of Capex and Opex.

7.3 Drive uptake of renewable energy in the RMP sector

The Low-cost assessment & arrangement of solar PV opportunities Project (the Project) appears to have facilitated an increase in solar deployment in the red meat processing sector relative to commercial solar in Australia as a whole. We estimate the project has led to an additional 15 MW of solar capacity installed, contracted or approved in the RMP sector. This equates to an increase in the installed base of solar in the red meat processing sector of 150%. The amount of solar installed in RMP sector has increased by 63% since the start of the project, whilst the amount of solar contracted or approved by RMPs amounts to an additional 34% and 50% respectively.

From 2014 to 2019 the solar capacity additions in the RMP sector broadly tacked capacity additions of medium scale solar throughout Australia, however in 2020 and 2021 capacity additions dropped disproportionately compared to other sectors in Australia, reaching no new capacity additions in 2021. Following commencement of the project in July 2021, solar capacity additions in the RMP sector increased by 2.2 MW in 2022 and is projected to increase by at least 6.4 MW in 2023. This will be a record year of solar deployment in the red meat processing sector despite the trend of decreased deployment in other sectors of the Australian economy from 2020 to 2022.

It is difficult to identify a cause for the drop in solar capacity additions in the RMP sector in 2020 and 2021, however the best guess is that it may be due to the impact COVID-19 had on company resources, particularly staff, available to deploy large engineering projects such as solar. A smaller drop in deployment was observed Australia-wide for medium scale solar installations.

In addition to the Project, the rebound in capacity additions in the RMP sector in 2022 and 2023 may be attributable to the increase in electricity prices at the end of 2022 and the VEEC incentive in Victoria from 2021 onwards. However, a similar rebound was not observed in other sectors for medium scale solar deployments.

7.4 Survey

The quarterly surveys of RMP members showed overwhelming support for solar throughout the period of the project and this view aligned with feedback from members during the assessments. Where solar wasn't supported, it was typically due to the assessment showing poor returns such as in Western Australia at the start of the project period.

Survey respondents confirmed that large electricity price increases in the National Electricity Market (NEM), peaking in the last quarter of 2022, were the main factor or were a factor in their decision making for solar projects. This was consistent with our experience speaking with RMP members that were trying to mitigate pending large energy cost increasing due to electricity and gas price increases.

Survey results indicating the main barriers for implementing solar were:

1. Awaiting appropriate grant funding was identified as a barrier consistently by around 30% of members.
2. Competing projects that require money and resources instead was the most common barrier to implementing solar. This also aligned with our discussions with RMP members where resourcing in particular was identified as a barrier.

Other barriers did not score consistently above 10% and given the small sample size, reading too much into the results should be avoided.

In hindsight, other questions should have been asked in the surveys. In particular, questions relating to the impact of COVID-19 and net zero emissions targets may have shed some light on why solar capacity additions dropped so much in 2020 and 2021 and what the main drivers might be going forward.

7.1 Recommendations for further research/actions

Given the impact the Project had on the deployment of solar PV in the RMP sector, we recommend expanding the program to other renewable energy and electrification technologies. This should result in the continued deployment of solar PV and energy efficiency and kick-start the integrated deployment of technologies such as batteries and heat pumps in order to phase out natural gas. In discussion with AMPC members during the Project and in feedback provided in the final survey of AMPC members, battery energy storage and heat pumps are being considered by RMPs as they seek solutions to achieve emissions reduction targets.

Red Meat Processors (RMPs) appear supportive of these initiatives, however they are big and complex objectives, with material risks, that will require time and support to realise. 100% renewable electricity can currently be achieved by purchasing renewable energy certificates; however this comes with a large ongoing cost, impacting competitiveness of the RMP. Conversely, alternatives to grid gas and fossil fuels require large upfront investments and can present new risks to a RMPs operations.

In order to achieve both objectives, and carbon neutrality by 2030 it is clear that RMPs will need to implement renewable energy and electrification technologies on a large scale. These are transformational projects that have the potential to drastically reduce operating costs, however they do require a large investment. However, similar to the issues AMPC members had with solar PV, there are issues with members making informed decisions about implementation and procuring at the best price and conditions.

From our previous work on the Low-cost assessment & arrangement of Solar PV opportunities project (Solar Project) we understand that significant increases in adoption of renewable energy technologies can be driven by:

- A platform/tool that can rapidly and accurately assess the feasibility of many renewable energy options at an RMP site.
- Independent expert advice on the feasibility and procurement of renewable energy technologies and how they relate to an RMP site.
- Providing a path to competitively procuring renewable energy projects from qualified suppliers, supported by independent expertise.

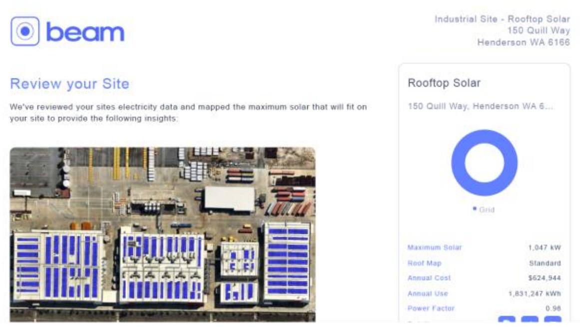
8 The quarterly surveys Bibliography

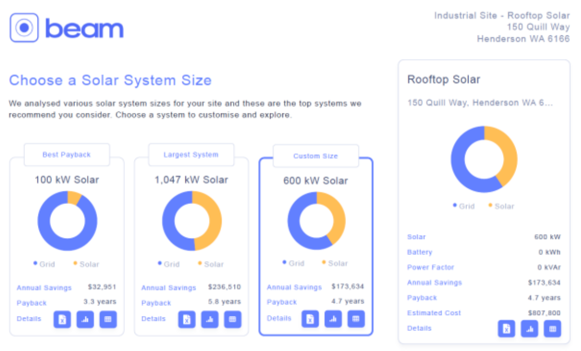
The author should include all references used in the report or referred to for background information. This must be done using the Harvard Referencing Style Guide.

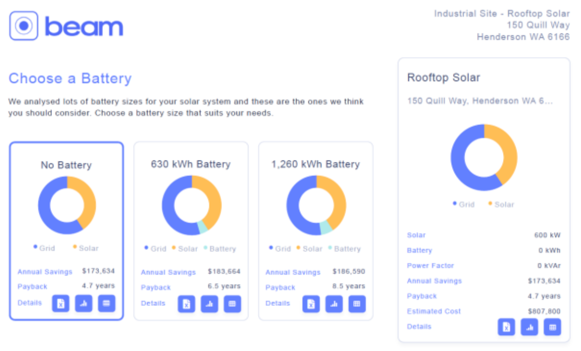
1. Beam Solar, 2023. Solar Price Index. [online] Available at: https://www.beam.solar/solar-price-index [Accessed 20 Jun 2023].
2. Clean Energy Council, n.d. Clean Energy Australia Reports 2014-2023. [online] Available at: https://www.cleanenergycouncil.org.au/resources/resources-hub/ [Accessed 20 Jun 2023].
3. Australian Bureau of Statistics, n.d. Red meat produced - beef: all series (tonnes), - lamb: all series (tonnes). [online] Available at: https://www.abs.gov.au/statistics/industry/agriculture/livestock-products-australia/latest-release [Accessed 20 Jun 2023].
4. ASX Energy, n.d. [online] Available at: https://www.asxenergy.com.au/ [Accessed 16 Jan 2023]

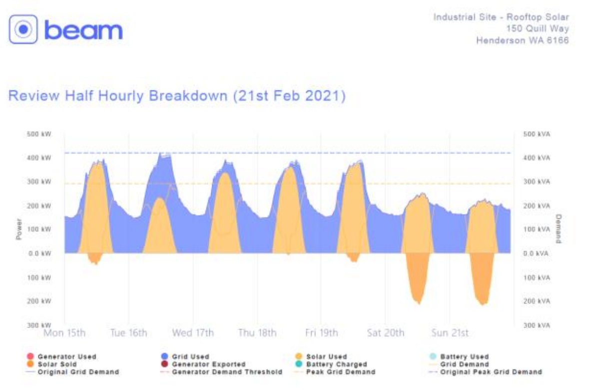
9 Appendices

9.1 Appendix 1 - Example Beam Solar Assessment

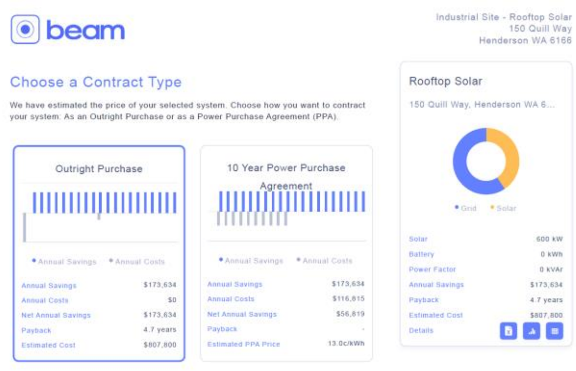






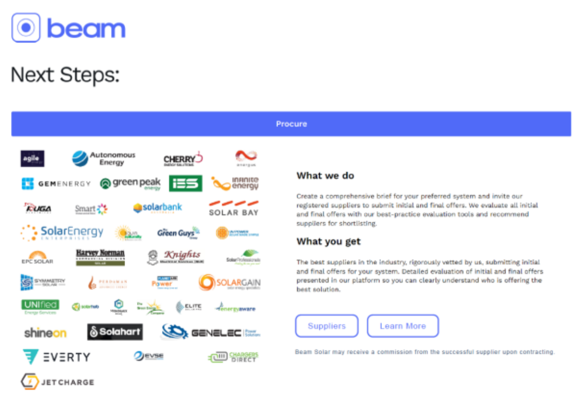


beam
Industrial Site - Rooftop Solar
150 Quill Way
Henderson WA 6166
Review Half Hourly Breakdown (21st Feb 2021)
Power
Demand
Mon 15th
Tue 16th
Wed 17th
Thu 18th
Fri 19th
Sat 20th
Sun 21st
Generator Used
Solar Sold
Original Grid Demand
Grid Used
Generator Exported
Generator Demand Threshold
Solar Used
Battery Charged
Peak Grid Demand
Battery Used
Grid Demand
Original Peak Grid Demand



beam
Industrial Site - Rooftop Solar
150 Quill Way
Henderson WA 6166
Choose a Contract Type
We have estimated the price of your selected system. Choose how you want to contract your system: As an Outright Purchase or as a Power Purchase Agreement (PPA).
Outright Purchase
Annual Savings
Annual Costs
Annual Savings $173,634
Annual Costs $0
Net Annual Savings $173,634
Payback 4.7 years
Estimated Cost $807,800
10 Year Power Purchase Agreement
Annual Savings
Annual Costs
Annual Savings $173,634
Annual Costs $116,815
Net Annual Savings $56,819
Payback -
Estimated PPA Price 13.0c/kWh
Rooftop Solar
150 Quill Way, Henderson WA 6...
Grid
Solar
Solar 600 kW
Battery 0 kWh
Power Factor 0 kVAr
Annual Savings $173,634
Payback 4.7 years
Estimated Cost $807,800
Details

beam
Industrial Site - Rooftop Solar
150 Quill Way
Henderson WA 6166
Tariff Charges
Loss Factors
TLF 1.0184
DLF 1.0312
Energy Charges
Peak 12.64 c/kWh
Off Peak 6.34 c/kWh
Solar Feed 4 c/kWh
Network Charges
Peak 5.21 c/kWh
Shoulder 4.31 c/kWh
Off Peak 2.1 c/kWh
Demand 13.086 $/kVA/Mth
Access 752.93 $/Day
Regulated Charges
Participant 0.045 c/kWh
Ancillary 0.045 c/kWh
Environmental Charges
LRET 0.519 c/kWh
SRES 1.094 c/kWh
Metering, Retail & Services Charges
Metering 3.21 $/Day
Service 0 $/Month
Other
LGC Sold 25 $/MWh



beam
Next Steps:
Procure
What we do
Create a comprehensive brief for your preferred system and invite our registered suppliers to submit initial and final offers. We evaluate all initial and final offers with our best-practice evaluation tools and recommend suppliers for shortlisting.
What you get
The best suppliers in the industry, rigorously vetted by us, submitting initial and final offers for your system. Detailed evaluation of initial and final offers presented in our platform so you can clearly understand who is offering the best solution.
Suppliers
Learn More
Beam Solar may receive a commission from the successful supplier upon contracting.

9.2 Appendix 2 – Example Initial Offers Project Brief

Introduction

(Customer) is seeking Initial Offers for 1.2 MW of rooftop solar for their site, split across two NMIs. The main drivers for the project are financial, environmental, reputational, and for energy security. The Customer has future plans to add onsite battery storage to the site.

The site has two existing cogeneration units with central protection and SCADA. The proposed solar systems will be integrated with the existing cogeneration system's controls during installation.

You have been invited to submit an Initial Offer for the supply and installation of the 1.2MW rooftop solar system.

Scope Summary

The scope of the solar project includes the sites, configurations and contract types detailed in the Supplier offer submission section below this event brief.

The site is fed by two separate electricity supplies. 573kW of solar is proposed on Supply A, and 652kW of solar on Supply B. This split is to best accommodate the loads on each supply and capacity in the switchboards identified for solar connection. Note that the aerial images provided in additional documents are out of date, and the western arrays shown in the PV layout are to be installed on the new shed buildings installed onsite (can be seen in the site photos folder).

Suppliers are to assume that there will be 4 inverter stations (2 for each supply). as indicated in the '1.2MW Rooftop' drawing in additional documents section. The inverter stations in the new cowshed building (north-most building) are to be in same location for both supplies, as shown in proposed inverter station layout drawing. Exact location of inverter stations and connection points in the new cowshed building are approximate only and have not yet been confirmed by the client. Suppliers should ensure inverter communication via master inverter or inverter manager is compatible with modbus TCP-IP for SCADA integration (to be done by others).

Suppliers should quote on 4 slave PVDBs (one for each inverter station) to be tripped by the existing protection relay and control setup. Contractor will provide PLC cabinets at each inverter station which will house the protection relay signal from the existing intellipros and will have these installed during solar installation. Suppliers should quote on supply and install of the cable runs mentioned below in their offers. These cable runs are shown in that attached 'Solar control' drawings.

- A 4 core 0.5mm2 (1 cable) from the existing cogen switchboards to the outdoor raypak heater area (approx. 70m) (likely already existing cable tray for this run)
- A 4 core 0.5mm2, a 3 core 1mm2, and a CAT5e (3 cables) (and tray if necessary) from the outdoor raypak heater area to the northern inverter area (approx. 70m)
- A 4 core 0.5mm2, a 3 core 1mm2, and a CAT5e (3 cables) (and tray if necessary) from the outdoor raypak heater area to the western inverter area (approx. 55m)
- A 4 core 0.5mm2, a 3 core 1mm2, and a CAT5e (3 cables) (and tray if necessary) from the outdoor raypak heater area to the southern inverter area (approx. 90m)

No structural assessments have been completed for the site as yet, and these should be included in pricing for all roof areas identified in the layout.

Site Information

All additional site details will be confirmed during the Final Offers round and made available to shortlisted Suppliers including the opportunity to conduct a site investigation

Site Documentation

Relevant site documentation can be downloaded from the Additional Documents section.

- Aerial Site maps showing:
- Photos of site switchboards, and proposed connection points
- Proposed inverter station layout for the inverter stations at the new cowshed building
- Zipped folder with site photos showing rooftops and switchboards
- Existing Cogeneration control SLD
- Switchboard connection SLD
- Structural drawings for new L-shaped building at NE site
- Structural drawings for new cowshed building at N site
- Intellipro modifications SLD
- Layout & Wiring
- Protection & Control SLD

Requirements

All requirements shall be in strict accordance with the Supplier Conditions for Participation unless specifically stated otherwise elsewhere in this event brief.

Project Commencement:

Due to ongoing construction works with the new cowshed building underway onsite, solar installation works are not likely to begin until mid-November 2022. Suppliers are to provide a detailed project plan during Final Offers round and confirm plans through discussions with the site regarding construction timelines.

Practical Completion:

In order to maximise the VEECs incentive for this project, practical completion is to be achieved before 31st January 2023. Suppliers are to submit offers in accordance with these dates.

Supplier Offer Submission

Document Uploads

Uploading a proposal document is optional.

Indicative solar panel layouts are available for each site below indicating the maximum solar that can be installed. Suppliers shall submit offers aligned to the target solar size and are asked to use the locations and layouts identified in the additional documents section for their submissions.

Scoring

Supplier offers submitted will be evaluated and scored based on the following:

- **Non-price:** 50 points
- **Price:** 50 points
- **Total:** 100 points

9.3 Appendix 3 – Sample of Suppliers Invited to Initial Offers

- Beon Energy Solutions
- Cherry Energy Solutions
- Clipsal Solar
- Elite Solar Pro
- Energy Aware
- EPC Solar
- Epho Pty Ltd
- Gem Energy Australia
- Harvey Norman Commercial Solar
- Infinite Energy
- Kuga Electrical
- Nextgen Electrical
- Origin Energy
- Planet Ark Power (GoZero Energy)
- Prana Energy
- Smart Commercial Solar
- Solar Energy Enterprises
- Solar Professionals
- Solargain
- Symmetry Solar
- The Green Guys Group Pty Ltd

9.4 Appendix 4 – Sample of Initial Offers

Assess | Procure | Manage

Details | Suppliers | Initial Offers Request | Initial Offers | Final Offers Request | Final Offers | Contract Preparation | Communication

Shortlist Selected Offers | Hide Unselected Offers | Hide Config Details | Deselect All Configs | Export Selection | Email Selected

Suppliers							
	Review Offer | View Feedback	Review Offer | View Feedback	Review Offer | View Feedback	Review Offer | View Feedback	Review Offer | View Feedback	Review Offer | View Feedback	Review Offer | View Feedback
Late?							
Solar Retailer Score	12/20	8/20	12/20	17/20	12/20	16/20	8/20
Solar Module	Hanwha Q CELLS - **8.9/10**	Hanwha Q CELLS - **8.9/10**	Trina Solar - **7.8/10**	Trina Solar - **7.8/10**	Jinko - **8.5/10**	Trina Solar - **7.8/10**	Jinko - **8.5/10**
Inverter	Sungrow - **9.4/10**	Sungrow - **9.4/10**	Sungrow - **9.4/10**	Sungrow - **9.4/10**	Sungrow - **9.4/10**	Sungrow - **9.4/10**	Fronius - **9.6/10**
Installation Warranty	5 Years - **7.5/10**	8 Years - **9.0/10**	10 Years - **10.0/10**	10 Years - **10.0/10**	10 Years - **10.0/10**	10 Years - **10.0/10**	10 Years - **10.0/10**
Proposal Document	Download	-	-	-	-	Download	-
Additional Offer Details	-	-	View	-	View	-	-
Tongala							
Supply A - Feb 2022 Assessment							
Solar Size	573.0 kW	573 kW	575 kW	573 kW	573 kW	396 kW	573 kW
Inverter Size	440 kVA	470 kVA	550 kVA	470 kVA	440 kVA	330 kVA	500 kVA
Outright Cost	$645,177	$630,000	$696,000	$785,010	$715,203	$554,892	$699,000
Annual Savings	$68,222	$68,217	$68,262	$68,217	$68,217	$47,943	$68,217
Payback	9.5 years	9.2 years	10.2 years	11.5 years	10.5 years	11.6 years	10.2 years
$/kW	$1,126	$1,099	$1,210	$1,370	$1,248	$1,401	$1,220
Price Score	49	50	45	40	44	39	45
Supply B - Feb 2022 Assessment							
Solar Size	653.1 kW	652 kW	602 kW	652 kW	652 kW	417.5 kW	652 kW
Inverter Size	550 kVA	500 kVA	550 kVA	490 kVA	550 kVA	440 kVA	520 kVA
Outright Cost	$740,700	$720,000	$713,000	$893,240	$806,505	$590,902	$785,000
Annual Savings	$75,446	$75,446	$70,234	$75,446	$75,446	$49,710	$75,446
Payback	9.8 years	9.5 years	10.2 years	11.8 years	10.7 years	11.9 years	10.4 years
$/kW	$1,134	$1,104	$1,184	$1,370	$1,237	$1,415	$1,204
Price Score	49	50	47	40	45	39	46
Total							
Non-price Score	38	35	39	44	40	43	36
Price Score	49	50	46	40	44	39	45
Overall Score	87	85	85	84	84	82	82
Solar Size	1,226 kW	1,225 kW	1,177 kW	1,225 kW	1,225 kW	814 kW	1,225 kW
Total Cost (Outright Purchase) *	$1,385,877	$1,350,000	$1,409,000	$1,678,250	$1,521,708	$1,145,794	$1,484,000
Annual Savings	$143,667	$143,663	$138,496	$143,663	$143,663	$97,653	$143,663

9.5 Appendix 5 – Solar Performance Review Case Study 1

Solar outperforms for Victorian Red Meat Processor

This Victorian abattoir had installed a 1.356 MWdc solar PV system at their plant at the end of 2018 to supply electricity to the site. The system is a ground-mounted, 30-degree fixed-tilt system with 4110x 330W Jinko panels and 44x 27 kVA Fronius ECO inverters.

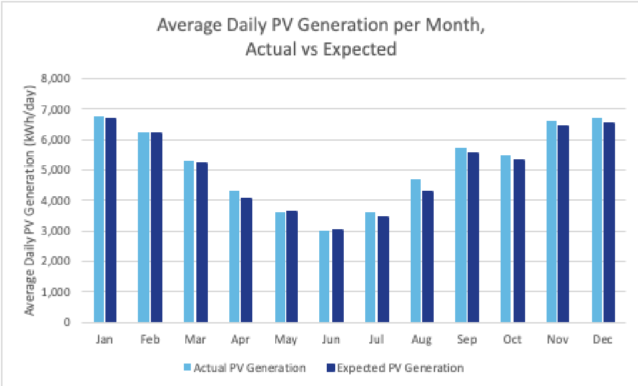
Beam Energy Labs were engaged to review the performance of the system and provide recommendations to improve performance if necessary. To review existing performance, actual solar generation data (MWh) was provided by the Vic plant for the period Jan 2019 to Jul 2021. This was compared to Solcast® solar irradiance data for this location from Jun 2020 to Jul 2021, converted to expected PV generation data using appropriate loss factors for each timestamp.

Performance

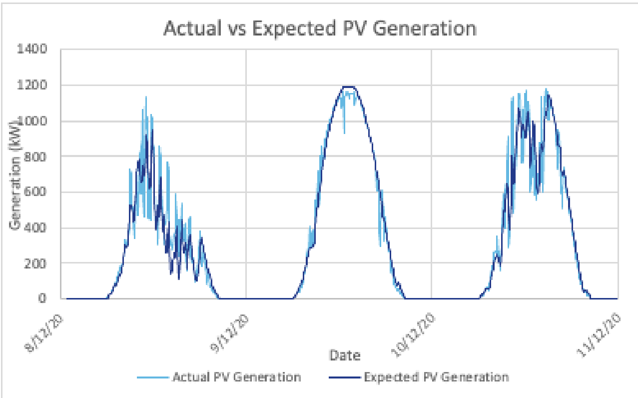
The system appears to be performing well compared with the calculated expected generation data. The table below shows that the system outperformed the expected generation by approximately 2.6% over the period Jul 2020 – Jun 2021.

	Total Generation (kWh)
Actual	1,887,220
Expected	1,837,865
Comparison	+ 2.7%

This is shown in the monthly solar production between July 2020 and June 2021 for the solar system compared with the expected solar generation data.



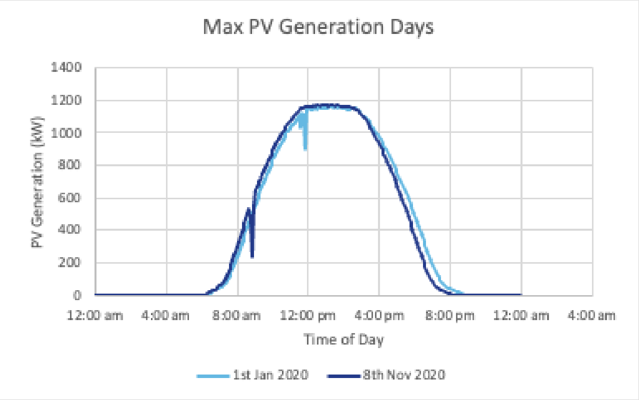
This is further illustrated by a comparison between the real and expected electricity generation for the site with 5-min data over a 3-day window in December 2020.



Solar production at this Vic plant closely matches the output expected from this kind of system and shows a slight overperformance compared with the expected values for most months in the sample period analysed. Based on the loss values used in the calculation of the expected generation, it is unlikely that excess soiling, panel derating or other system inefficiencies are present with this system.

Inverter size and clipping

The site was concerned about inverter sizing and potential 'clipping' of solar output by the inverters. A review of solar production on the two largest generation days over the dataset, January 1st, 2020, and November 8th, 2020, did show some evidence of clipping. The chart below shows solar output for both days. Clipping is observed for a short period during the peak solar period and solar production reaches just below the 1,188 kW inverter limit.



Significant clipping would not be expected given the high inverter (AC) to solar (DC) ratio of 0.88 for this system (inverter capacity 88% of solar capacity). Excessive clipping is typically observed in systems with a much lower ratio such as 0.75 which is the minimum ratio mandated to generate Small Generation Certificates for small solar systems (<100 kW). Upon further review of the expected generation data, the impact of clipping on this system only attributed to a reduction in generation of ~0.1% per year.

Conclusion

From the review of available data, we can conclude the following:

- Solar production slightly outperformed expected values when compared over the period July 2020 – June 2021.
- Based on the loss factors used in generating the expected system generation data, there is no evidence that excessive soiling, shading, or component losses are causing any underperformance for this system.
- There is no evidence that significant clipping of solar production by the inverters is occurring.
- The total annual output throughout 2020, and 2021 is seen to be less than 2019 due to the combined impact of annual system degradation and the lower solar insolation for the latter two years.

Recommendations

To help identify any underperformance in the future, we recommend the following actions:

1. Install solar smart meters to monitor solar

- This will provide real-time monitoring and a comparison between actual and predicted performance of the system, making it easier to spot trends in performance.
- AMPC offered to fund the solar smart meter monitoring hardware and appropriate subscriptions as part of the Core Project.
- The Vic plant needs to confirm the CT size of 3,000 amps for the solar system and install the device upon receipt.

2. Trial solar panel cleaning on one or more sub-arrays.

- On one or more of the sub-arrays that are connected to a single inverter, the Vic plant should clean all the solar panels and compare the solar output from that inverter vs. other inverters for a period.
- Cleaning can be completed in house, or a third party can be engaged to complete this.
- If the cleaned sub-array(s) shows a material difference in performance, the costs of cleaning can be compared against increase savings from the system to inform cleaning regime.

9.6 Appendix 6 – Solar Performance Review Case Study 2

System & Inverter Downtime Contribute to PV Underperformance

A WA abattoir installed a 99 kWdc solar PV system at their plant at the start of 2019 to supply electricity to the site. The system is a ground-mounted, 20-degree fixed-tilt system with 300x 330W Trina panels and 3x 27 kVA Fronius ECO inverters.

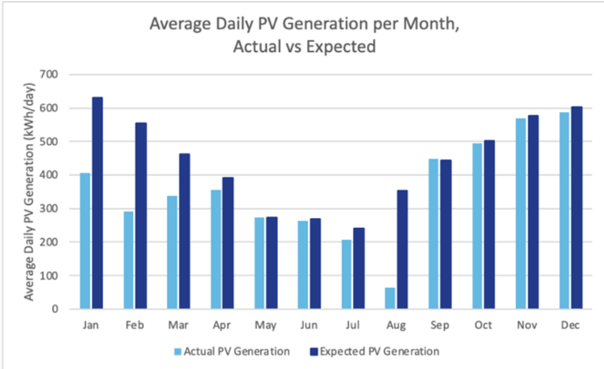
Beam Energy Labs were engaged to review the performance of the system and provide recommendations to improve performance if necessary. To review existing performance, actual solar generation data (kWh) was provided by the WA plant for the period Jan 2021 to Dec 2021. This was compared to Solcast® solar irradiance data for this location over the same timescale, converted to expected PV generation data using appropriate loss factors for each timestamp.

Performance

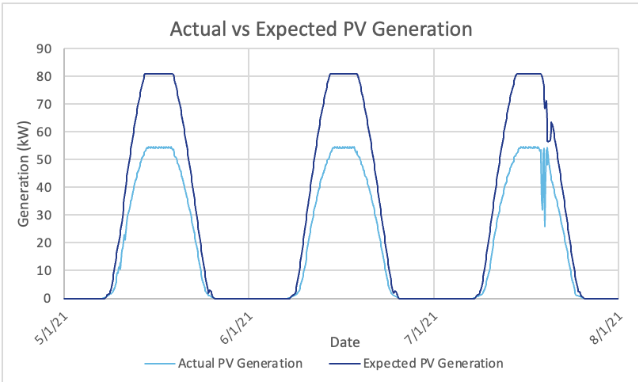
Throughout 2021 the system showed substantial underperformance when looking at annual generation compared with the expected value. The impact of inverter and system downtime played into this underperformance. The table below shows that the system underperformed by approx. 18.8% over the period Jan 2021 – Dec 2021 when compared to the expected generation.

	Total Generation (kWh)
Actual	130,797
Expected	161,110
Comparison	-18.8%

This is shown in the monthly solar production between January 2021 and December 2021 for the solar system compared with the expected solar generation data.



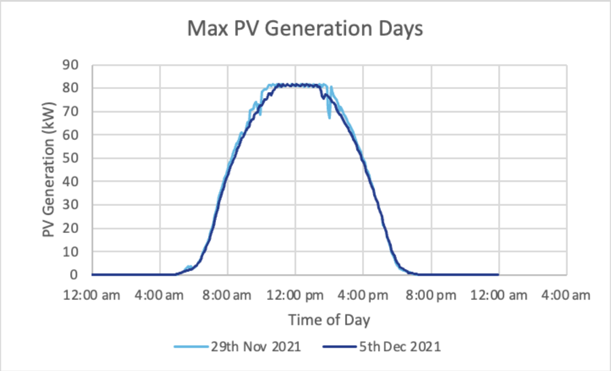
A single inverter outage from January through to early April contributed to the underperformance during the start of the year. This is outlined by a comparison between the real and expected electricity generation for the site over a 3-day window in January 2021.



Furthermore, several full system outages throughout the year also contributed to the underperformance. These outages occurred during the following days: 19th – 24th Feb, 18th – 19th Apr, 30th Jul – 27th Aug.

Inverter size and clipping

A review of solar production on the two largest generation days over the dataset, 29th November 2021, and 5th December 2021, did show some evidence of clipping. The chart below shows solar output for both days. Clipping is observed for a short period during the peak solar period and solar production reaches the 81 kW inverter limit.



Upon further review of the expected generation data, the impact of clipping on this system attributed to a reduction in generation of ~1.1% per year.

Conclusion

From the review of available data, we can conclude the following:

- Solar production underperformed compared to expected values over the period Jan 2021 – Dec 2021 by 18.8%. The main factors contributing to the underperformance were:
  - an inverter outage from 1st Jan – 25th Mar
  - entire system outages during the periods:
    - 19th – 24th Feb,
    - 18th – 19th Apr,
    - 30th Jul – 27th Aug
- The system slightly underperformed by 4.4% compared to expected generation, after normalising for system downtime during the time periods listed above. This underperformance could be due to higher than modelled soiling losses or shading losses from nearby obstructions.
- Some clipping was identified during the peak generation days, however, there is no evidence that significant clipping is occurring.

Recommendations

To help identify the cause of the underperformance from the system during 2021, and to identify any underperformance in the future, we recommend the following actions:

1. Install solar smart meter monitoring on the whole system.

- This will provide real-time monitoring and a comparison between actual and predicted performance of the system, making it easier to spot trends in performance.
- AMPC offered to fund the solar smart meter monitoring hardware and appropriate subscription as part of the Core Project.
- The WA plant needs to confirm the CT size of 200 amps for the solar system and install the device upon receipt.

2. Trial solar panel cleaning on one or more sub-arrays.

- On one or more of the sub-arrays that are connected to a single inverter, the WA plant should clean all the solar panels and compare the solar output from that inverter vs. other inverters for a period.
- Cleaning can be completed in house, or a third party can be engaged to complete this.
- If the cleaned sub-array(s) shows a material difference in performance, the costs of cleaning can be compared against increase savings from the system to inform cleaning regime.