Mid-scale solar outlook
Systems above 100kW to 5MW

Report to the Clean Energy Regulator

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1. Executive Summary

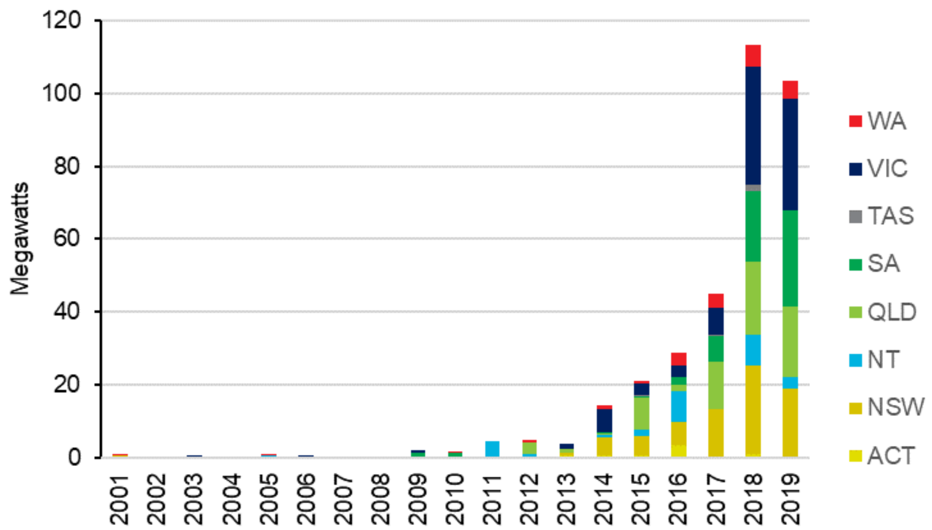
Green Energy Markets has been commissioned by the Clean Energy Regulator to provide a projection of levels of mid-scale solar capacity installed by year for the period of 2019 to 2023. Mid-Scale capacity is defined as solar systems above 100 kilowatts and up to 5 megawatts of generating capacity. The projection covers:

- Systems installed on electricity consumers' premises in a behind the meter configuration (where the generation can be self-consumed to offset the need to purchase power from the grid at the retail-delivered price of electricity)
- Systems installed as power plants in front of the meter which are dependent on revenue tied to the value of the wholesale electricity market; and
- Systems installed in remote or off-grid power systems where their primary benefit is to reduce gas and diesel fuel use to supply power.

Projecting uptake within this narrow sub-sector of the solar market is subject to considerable uncertainty because the market is highly immature and still undergoing rapid development and change.

The market has only really emerged at any noticeable level in the last three years as a result of significant reductions in system costs, and a dramatic increase in the wholesale price of electricity in the east-coast National Electricity Market.

Figure 1-1 Capacity of mid-scale solar systems by year of accreditation (2019 numbers only up to August)



Complicating matters in projecting uptake is that the underlying supply-demand balance for electricity is changing rapidly due to a large influx of solar and wind capacity within a short period of time. It appears likely that the wholesale market value of electricity during sunny periods will decline rapidly over the next 2 years, which will noticeably reduce the revenue gain (or avoided electricity cost) solar systems provide.

This report's projections of solar uptake are based on a combination of:

- interviews with a range of solar industry participants that have experience in the mid-scale segment of the solar market;
- bottom-up research identifying near-term, significant solar roll-out plans by large organisations such as supermarkets, shopping centre operators, airports, water companies, and government entities.
- Financial modelling of the payback periods for investing in solar systems for a range of customer/building site types in different states. Uptake in 2021 to 2023

is calibrated against uptake and payback periods for two reference years – 2019 and 2015. Given expected large falls in the wholesale market value of electricity, it is expected paybacks will deteriorate (become longer) relative to 2019 electricity prices. Therefore, the amount of capacity installed is expected to decline. The extent of the decline is guided against how much paybacks deteriorate relative to what they were in 2015, which provides a type of bottom-end guidepost.

Projections have been undertaken using two scenarios or sensitivities for the potential path of wholesale electricity prices.

A moderate scenario involves wholesale power prices during daytime periods across the NEM falling by 2021 to levels that are set half the time by the short-run operating cost of the marginal NSW black coal generators – Mt Piper, Eraring and Vales Point, and half the time by that of the lower cost combined cycle gas generators – Pelican Point, Tallawarra and Darling Downs. Based on AEMO's assumption workbook for the 2019 Integrated System Plan this leads to a cost of around $55/MWh. This wholesale power price is used under what is termed the 'Moderate Scenario'. In the case of the WA SWIS under this scenario it is assumed the wholesale energy price during solar output periods averages $50/MWh.

In addition, a 'Lower Bound Scenario' is also considered where wholesale energy prices available for solar generation fall to similar levels in real terms as prevailed overnight in NSW between 2010 to 2011 of $28/MWh (in today's dollars). For the WA SWIS $35/MWh is assumed.

Table 1-1 provides the resulting nation-wide estimates of capacity accredited over the outlook period (or in the case of Victoria the capacity registered under their Energy Saver Initiative) under the Moderate scenario.

Table 1-1 Projected total megawatts accredited/installed – Moderate scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	27.3	47.9	27.3	21.0	21.0
NT	0.4	8.4	2.8	1.2	1.2
QLD	24.3	23.5	20.7	20.7	23.1
SA	34.8	72.9	61.1	21.5	21.5
TAS	0.0	0.9	0.8	0.8	0.8
VIC	46.2	64.2	53.0	44.8	45.8
WA	7.2	12.6	7.3	7.3	7.3
Off Grid - all states	6.0	8.0	12.0	16.0	20.0
TOTAL	**146.2**	**238.4**	**184.9**	**133.2**	**140.6**

Table 1-2 below provides the results with the lower wholesale electricity market prices assumed under the Lower Bound scenario.

Table 1-2 Projected total megawatts accredited/installed – Lower Bound scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	27.3	47.9	16.0	7.3	8.4
NT	0.4	8.4	2.8	0.9	0.9
QLD	24.3	23.5	6.0	7.2	8.0
SA	34.8	72.9	53.1	11.0	12.0
TAS	0.0	0.9	0.8	0.8	0.8
VIC	46.2	64.2	29.9	23.7	30.2
WA	7.2	12.6	6.1	6.8	6.8
Off Grid - all states	6.0	8.0	12.0	16.0	20.0
TOTAL	**146.2**	**238.4**	**126.7**	**73.7**	**87.1**

The average amount of annual LGC production each year's installed capacity would achieve is detailed in Table 1-3 for the Moderate scenario and

Table 1-4 for the Lower Bound scenario. Please note that Victorian projects are not expected to create any LGCs because they are better off instead registering to create Victorian Energy Efficiency Certificates under the Victorian Energy Upgrades Scheme.

Table 1-3 Expected annual ongoing LGC creation by year of plants' accreditation – Moderate scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	39,988	80,448	47,284	28,695	28,695
NT	578	13,248	4,398	1,813	1,813
QLD	35,883	34,585	30,501	30,501	34,089
SA	59,415	129,695	103,364	31,771	31,771
TAS	-	1,114	991	991	991
VIC	58,716	90,715	-	-	-
WA	11,267	22,719	11,363	11,410	11,410
Off Grid - all states	13,246	17,520	26,280	35,040	43,800
TOTAL	**219,093**	**390,043**	**224,181**	**140,221**	**152,569**

Table 1-4 Expected annual ongoing LGC creation by year of plants' accreditation – Lower Bound scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	39,988	80,448	31,898	9,933	11,529
NT	578	13,248	4,398	1,394	1,394
QLD	35,883	34,585	8,858	10,572	11,816
SA	59,415	129,695	91,435	16,337	17,713
TAS	-	1,114	991	991	991
VIC	58,716	90,715	-	-	-
WA	11,267	22,719	9,577	10,703	10,703
Off Grid - all states	13,246	17,520	26,280	35,040	43,800
TOTAL	**219,093**	**390,043**	**173,437**	**84,971**	**97,945**

2. Overview of the Market

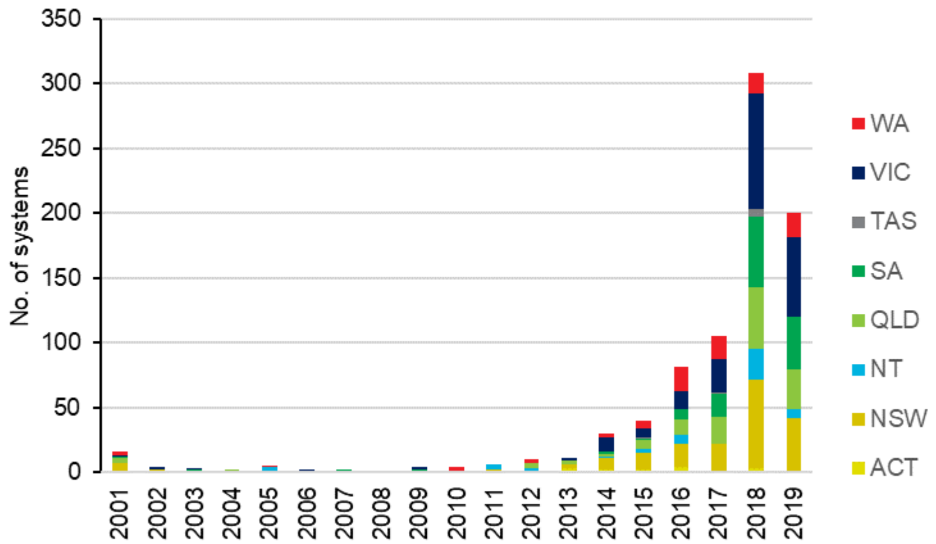
The mid-scale solar market has undergone considerable flux and is subject to significant uncertainty

Assessing the likely trajectory of installations for mid-scale solar systems (defined as those 100 kilowatts and up to 5 megawatts in capacity) is subject to considerable uncertainty.

Factors making it difficult to predict future installations include the fact that the market is in reality highly immature and still undergoing rapid development and change. Prior to 2016 solar systems larger than 100kW were not really a commercial proposition to electricity customers where a large proportion of network charges are recovered via demand-based tariffs[1]. In addition, while solar was a more viable financial option for use in remote applications for displacing diesel fuel, it's widespread use was limited due to other factors such as unfamiliarity with the technology and concerns around maintaining power system reliability

As shown in **Figure 2-1** the number of systems installed in Australia prior to 2016 was small, with just 40 systems accredited in 2015, 30 in 2014 and an average of just 5 per annum from 2001 to 2013. The most installed in any single state was just 13 prior to 2016. This very small sample set over a short period of time makes it difficult to draw confident inferences about how the market responds to different factors likely to influence uptake.

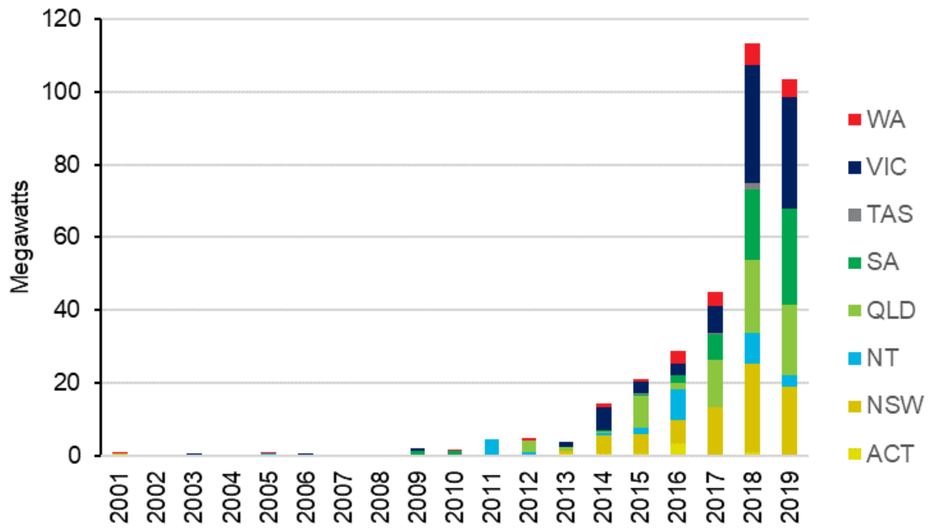
Figure 2-1 Number of mid-scale solar systems by year of accreditation (2019 numbers only up to August)



Megawatts of generating capacity have followed a similar trajectory to the number of systems, although capacity per system accredited in 2019 is tracking at noticeably higher levels so far than 2018 accredited systems.

[1] This is where a customer is charged by the power network provider on the basis of their maximum kilovolt-amp or kVA demand drawn from the network across any individual 30 minute interval over the measured period, rather than their overall consumption of kilowatt-hours on the network.

Figure 2-2 Capacity of mid-scale solar systems by year of accreditation (2019 numbers only up to August)



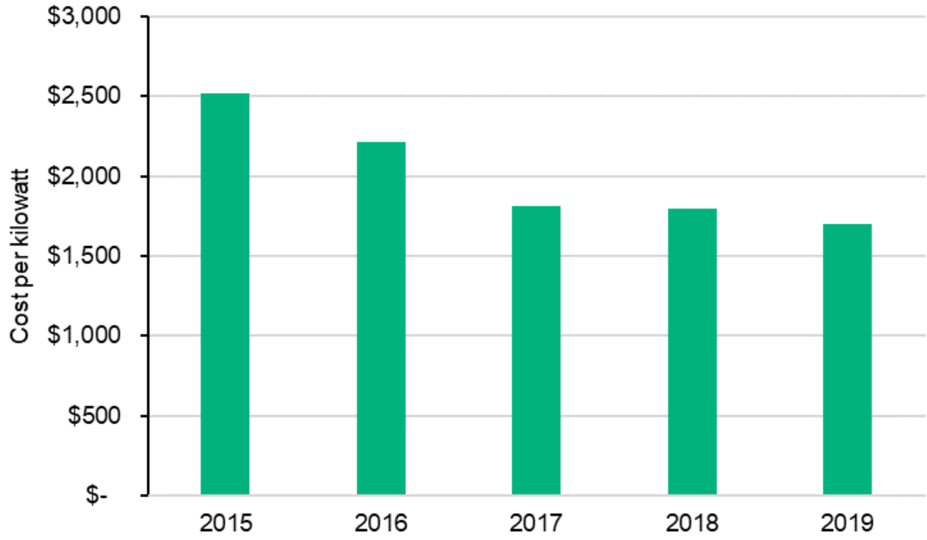
The small numbers of installations until just recently means there is a scarcity of historical data with which to assess statistical relationships between uptake and possible causes of increased uptake that might facilitate precise quantitative analysis.

Rapid growth in mid-scale has been spurred by a dramatic improvement in solar system financial attractiveness

Even though the limited sample set constrains the ability to develop a precise and confident relationship between uptake and plausible variables that influence uptake, what is clear is that the market's rapid growth since 2016 was predominately a function of improving financial attractiveness of solar systems relative to end consumers buying power from the grid.

Based on the sample set provided by the Clean Energy Regulator, system cost per kilowatt declined by 29 percent between 2015 and 2018.

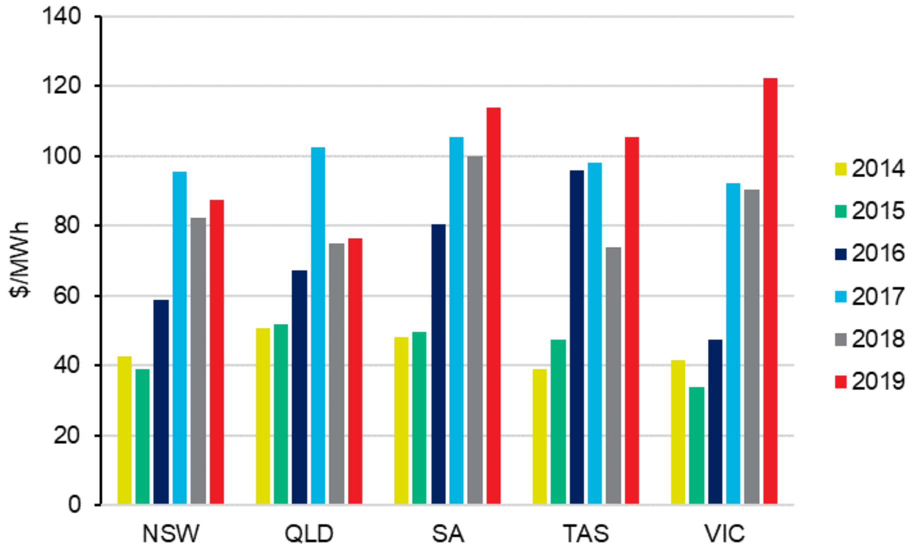
Figure 2-3 Cited installed cost of mid-scale systems per kilowatt by year (excluding off-grid/remote grid systems)



Note: Off-grid or remote grid systems have been excluded because these usually involve substantial additional costs not faced by mains grid-connected systems which then act to skew the cost data upwards in years in which off-grid systems were accredited.

Meanwhile, over the same period we saw a dramatic rise in wholesale electricity prices in the East-Coast National Electricity Market. The jump in prices began in 2016 but was greatest in 2017 for NSW, QLD and Victoria.

Figure 2-4 Average time-weighted wholesale electricity spot price by state

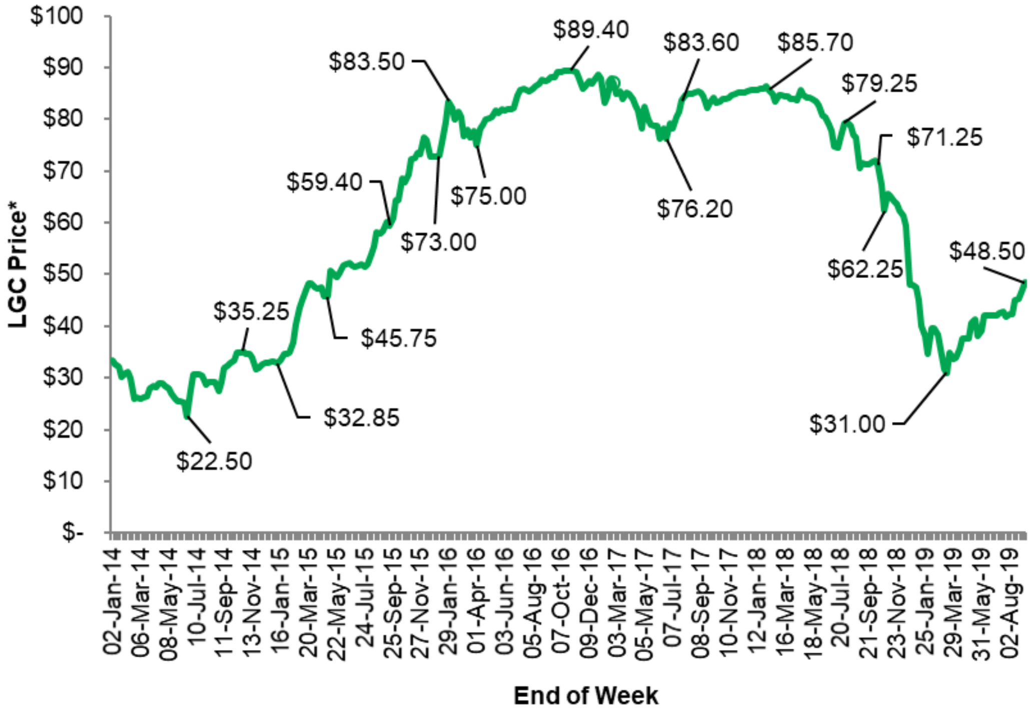


Note: 2019 prices are for the period January to August. This is likely to excessively inflate prices for Victoria which experienced extremely high pricing peaks for a few days in Summer. Victoria tends to experience lower prices over the remaining months of the year which will act to lower the time-weighted average.

For customer sites potentially suitable for behind the meter systems larger than 100kW, changes in wholesale market energy prices have a far greater impact on kilowatt-hour charges than for smaller customers such as the residential market (whose network charges are recovered based on consumption of kilowatt-hours). And of course, these prices are the predominant driver of revenue for in-front of the meter power station installations.

The final factor that helped drive a dramatic improvement in the financial attractiveness of 100kW+ solar systems around 2016 was a significant rise in the LGC spot price – shown in **Figure 2-5**. LGC prices subsequently collapsed in the last quarter of 2018 but were elevated at close to $80 throughout 2016 and 2017 and much of 2018.

Figure 2-5 LGC spot prices (end of week)



Combining the decline in system costs with the increase in revenue from higher wholesale prices and higher LGCs prices, we estimate the payback period on solar systems roughly halved for a range of customer sites likely to be suitable for 100kW+ behind the meter systems.

Suppliers also became more capable in marketing and installing 100kW+ solar systems

It is important to recognise that Australia's solar industry has traditionally been dominated by selling and installing small, generic solar systems to residential households. Selling and installing such residential systems is usually much simpler than what's required for large commercial systems. Commercial clients have more varied tariff types, need a more tailored approach to system design, take a more involved and sophisticated approach in evaluating whether to purchase solar, are more prone to landlord-tenant split incentives, and the technical requirements of such systems are more difficult, in particular the grid connection process. Another factor that has been more important in the commercial sector than residential has been the provision of financing that avoids the need for clients to commit their own upfront capital to purchasing the system.

As the financial attractiveness of large commercial solar systems has improved and the levels of interest in installing solar has grown, the solar industry has gained much greater experience in the sale and installation of these larger systems. This has allowed them to become better at presenting and explaining the investment proposition for solar to clients involving multiple decision makers and detailed evaluation processes. In addition, they have become more adept at dealing with the needs and concerns of electricity networks, and likewise electricity networks have gained greater comfort and understanding in having 100kW+ solar systems operating within their network. Also financing products have been developed with more attractive terms such as lower interest rates, longer repayment periods, and repayments tied to consumption of electricity from the solar system otherwise known as power purchase agreements. These have helped to at least somewhat mitigate tenant-landlord split incentives, and the often-myopic approach businesses take to allocating capital to non-core elements of their business (a problem of bounded rationality which is a well understood factor behind sub-optimal levels of investment in energy efficiency).

Feedback from industry interviews indicates that more technically sophisticated and experienced commercial sector solar firms have found themselves facing increasing levels of competition and difficulty maintaining margins as they find more firms capable of selling and installing systems above 100kW in scale. One interviewee colourfully reflected, “systems bigger than 100kW used to be confined to technically savvy outfits. But now any old monkey can install up to a 300kW system, with 600kW where they get out of their depth.”

The improved capability and greater spread of capability in installing 100kW+ solar systems has meant customers see not just a lower purchase price for solar systems, but also find the purchase decision making process easier and more compelling. In many cases the decision to purchase solar is not an over-riding priority for a business. Given this, the ability of the solar supplier to develop customer confidence about solar can make a decisive difference.

The role of lags and customer foresight

An important feature to keep in mind in assessing how changes in system cost and electricity prices flow through to solar uptake is that there can be significant lags involved in customers responding to changes in the economics of mid-scale solar PV by installing and then accrediting these systems.

Firstly, large electricity customers tend to procure electricity via 2 to 3 year contracts. This means that it can take several years before customers experience the impact of changes in wholesale market costs. Secondly the purchasing evaluation and supplier selection process for solar, particularly in large organisations that are often the target market for mid-scale solar, can take many months. Lastly the actual scheduling and then ultimate installation can take several months plus there can be further lags until the system is ultimately accredited with the Clean Energy Regulator. There are several examples of accredited mid-scale projects where this whole process took over 12 months, even though installation may have only taken a month or two.

These lags mean that even though power prices surged over 2016 and 2017 while system costs declined, and both have since largely stabilised, the impact in terms of increased solar system accreditations only came through in earnest in 2018. Furthermore, our interviews suggest that systems coming through accreditation now are likely to still be a function of customer responses to the 2017 surge in electricity costs.

These lags mean that solar uptake in each year will tend to reflect the economic conditions of a solar system for 12 to 24 months previously. Interestingly interviews suggested that customers evaluating whether to purchase solar in the last few months, are for the most part basing this on current and recent historical electricity prices, rather than seeking to anticipate likely future supply and demand conditions affecting electricity prices. This is especially important given that it is highly likely both the National Electricity Market and the Western Australian South-West Interconnected System (SWIS) will experience a growing and very substantial surplus of available generating capacity during daytime periods when solar power is generating at significant levels. Unless there are further major coal generator retirements, wholesale electricity prices are likely to decline significantly over periods when solar system output is high. This myopic approach to evaluating whether to purchase solar, along with lags in customer response, mean that when we evaluate likely customer uptake, it is informed by a customer perception of paybacks based on an assumption that electricity prices from the prior year were going to remain static in real terms over the life of the solar system.

Taking into account customer diversity

In seeking to evaluate the likely uptake of mid-scale solar systems that are behind the meter it is important to recognise that customers' sites tend to be subject to a wide degree of variation in characteristics that affect the viability of mid-scale solar systems.

Our analysis of the likely uptake of solar takes into account several generic customer segments which attempt to account for these differences, albeit imperfectly.

Factors that need to be taken into account in evaluating the prospects for 100KW+ systems for each customer type and therefore the size of the market for such large systems include:

- **Suitable space.** Is there enough suitable space for installation of such a system?
- **Premium on wholesale price.** What is the value of electricity that the solar system's generation can displace?
- **Site occupation structure.** Does the host organisation own its premises or must it negotiate with a landlord to agree to installation of the solar system and contribution towards the system's cost? Also, how long into the future does the host organisation feel confident it will continue to operate at its existing premises?
- **Investment time horizon.** What is the organisation's time horizon for its investments and does it value environmental benefits? Some organisations require very high rates of return or short payback periods for potential capital investments and apply the same criteria to solar systems. Other organisations can be willing to accept longer payback periods for investments more generally or solar systems in particular.
- **Alignment of site energy consumption with solar generation profile to maximise self-consumption.** To what degree will the site's electricity consumption be sufficiently high to consume most or all of a large solar system's generation? As a rough rule of thumb a solar system's economics look most attractive when its generation meets but does not exceed a customer's need for electricity on site. This is because customers will usually pay noticeably more for electricity they wish to import from the grid than what a retailer will pay for electricity that the customer may export.

Table 2-1 below provides a traffic light assessment of how the factors driving the propensity to adopt solar apply in the market segments we have identified. Green coloured squares indicate that this factor is favourable to adoption of solar, at least in comparison to how this factor applies to other sectors, while red is unfavourable and amber is in between.

Table 2-1 Traffic light assessment of factors driving propensity to invest in solar by sector

Sector	Suitable space	Premium on wholesale price	Extent of self-consumption	Site occupation structure	Investment time horizon
School					
Food processing/Coldstore/Baking					
Supermarket					
Shopping centres					
Heavy Manufacturing					
Light manufacturing					
University/TAFE					
Aged Care					
Government-Public Bldgs					
Office					
Hospitals					
Hotels-Accommodation-Entertainment					

3. Market conditions

Solar system costs anticipated to continue decline steadily

We assume a solar system cost for mid-scale behind the meter, grid connected solar systems of $1,600 per kilowatt prevailed in 2019. This is based on a combination of feedback from interviews with solar industry participants and data provided from the Clean Energy Regulator's extract of registry data.

For future costs we assume the installed cost of a rooftop system will reach $900 per kilowatt (2019 dollars) in 2030 with a linear annual decline in costs from 2019 to 2030. The $900 cost per kilowatt is similar to, but slightly lower than CSIRO's projection prepared for the Australian Energy Market Operator's Integrated System Plan[2].

Ongoing cost reductions in the mid-scale sector are expected to be driven by ongoing declines in module prices, but mainly savings in labour and balance of system equipment costs per watt installed through gains in solar module conversion efficiency. This gain in module conversion efficiency allows for more watts to be installed for a given number of modules, with the number of modules installed being a key driver of labour and balance of system costs. The potential to exploit productivity gains remains significant in the mid-scale solar segment where installations can take several days to be completed and sometimes roof space can be a constraining factor.

The residential sector has exploited this opportunity for productivity gains through steadily moving towards larger capacity systems per household. However, because the residential market is now hitting the limits of capacity that are allowed under network and CEC installation guidelines (5kW inverter and 33% oversizing of panel capacity to inverter capacity – 6.6kW) the potential to exploit productivity gains in the residential sector from improved panel efficiency is greatly diminished.

Wholesale electricity market prices expected to drop significantly during sunlight hours

A very significant amount of solar generating capacity will be added to both the National Electricity Market and Western Australia's SWIS over 2017 to 2021. This is likely to substantially depress wholesale power prices during daylight periods relative to what was experienced over the 2017 and 2018 period.

In the NEM Green Energy Markets' power project database has almost 6,000MW of LGC-registered solar systems being added to the grid from 2017 to 2021 based on projects already accredited, under construction or with offtake contracts in place. On top of this, STC registered solar systems in the NEM are being added at a rate exceeding a gigawatt per annum on average since 2017. When one adds the large amount of extra wind output likely to coincide with solar generation (6,000MW of wind will also be added between 2017-2021), the residual demand left over for fossil fuel generators over daytime periods should result in substantial oversupply of low operating cost coal capacity. This would appear to replicate oversupply conditions not unlike those that prevailed late at night during 2010 to 2011 when wholesale power prices averaged below $30 per megawatt-hour.

Wholesale power prices in recent years have been highly elevated because the price of gas increased considerably, and the closure of Northern and Hazelwood power Stations provided greater scope for the remaining coal generators to price their output relative to the cost of gas generation. Given the substantial additional supply from solar and wind generators coming on stream, during sunny periods it is likely coal generators will increasingly need to price their output relative to the operating cost of other coal generators, rather than gas plant, in order to be dispatched. For that reason we have evaluated economic attractiveness of solar on the basis that wholesale power prices fall by 2021 to levels that are set half the time by the short-run operating cost of the

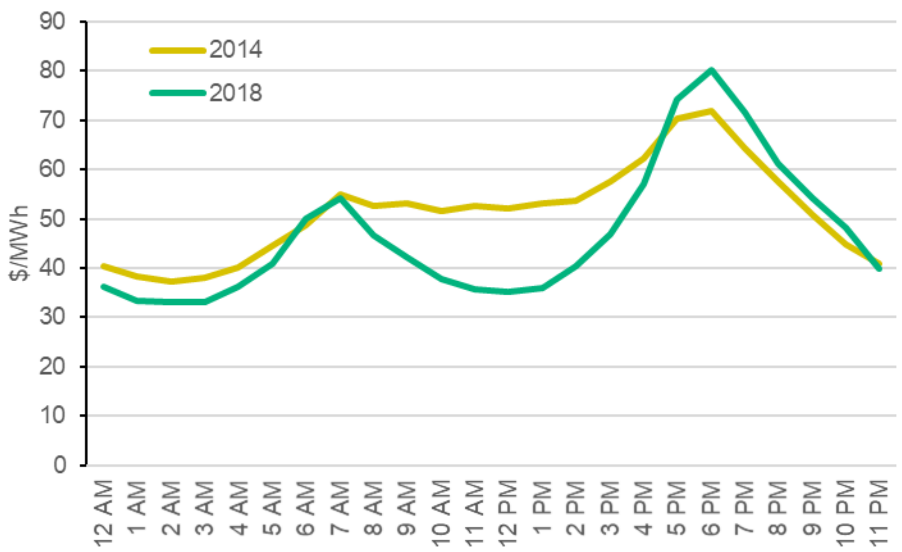
[2] CSIRO (2018) GenCost 2018 – Updated projections of electricity generation technology cost

marginal NSW black coal generators – Mt Piper, Eraring and Vales Point, and half the time by that of the lower cost combined cycle gas generators – Pelican Point, Tallawarra and Darling Downs. Based on AEMO's assumption workbook for the 2019 Integrated System Plan this leads to a cost of around $55/MWh. This wholesale power price is used under what is termed the 'Moderate Scenario'. In addition, a 'Lower Bound Scenario' is also considered where wholesale prices fall to similar levels in real terms as prevailed overnight in NSW between 2010 to 2011 of $28/MWh (in today's dollars).

For the WA SWIS the amount of extra LGC-registered solar is much less significant, but additions of STC-registered solar are considerable. Since 2017, monthly capacity additions have been running at close to 17MW per month or slightly above 200MW per annum. Cumulative installed STC solar capacity now stands above 1000MW. Given average operational demand in the SWIS is just 2,000MW and 2018-19 demand peaked at 3,256MW, the amount of solar capacity in the system is very significant.

So far this this year (as at 11 September) the SWIS short-term balancing market has recorded negative prices between 10am and 2pm for slightly more than 1 in every 7 days (44 days out of 254). Average prices by hour already display a noticeable hollowing out in the middle of the day when you compare 2018 average prices by hour to that of several years ago when solar PV capacity was much lower.

Figure 3-1 Average SWIS STEM prices by hour - 2014 vs 2018



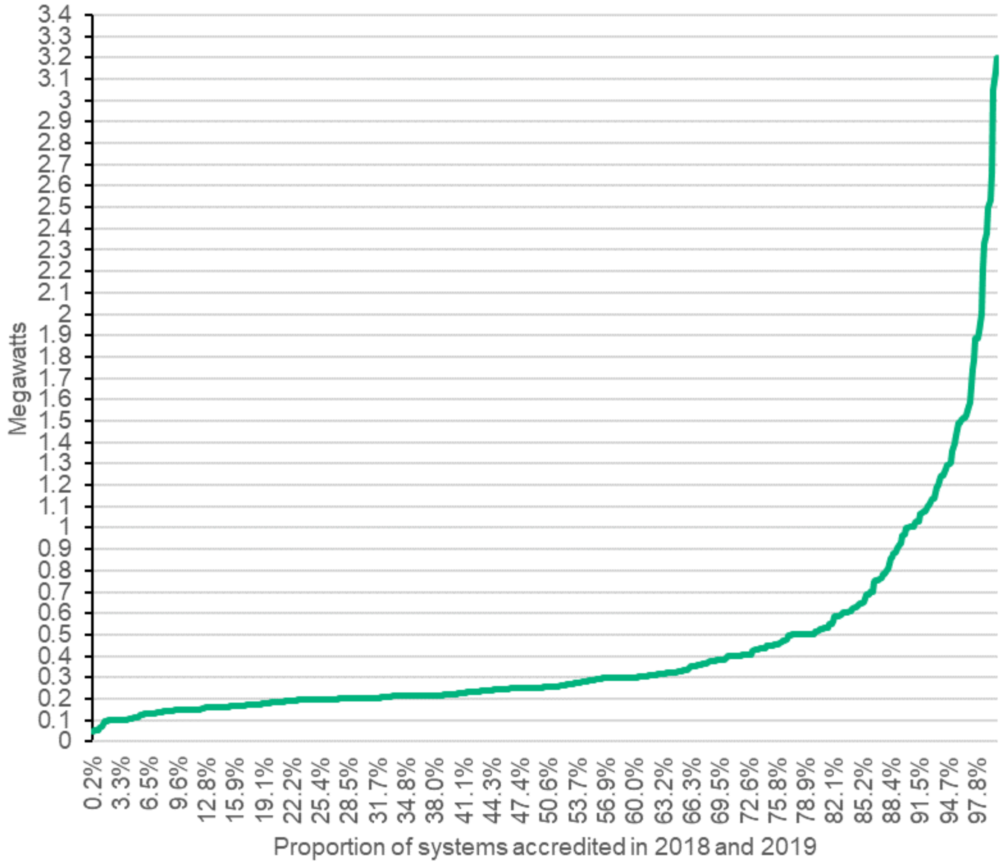
LGC prices

LGC prices used for our assessment of paybacks are based on forward prices exchanged via reported broker trades in early September 2019 for the period 2019 to 2022. These were $49 for 2019, $29 for 2020, $14 for 2021 and $10 for 2022. For the years 2023 until 2030, where there are no forward trades from which to draw a value, a price of $5 per LGC was assumed.

The large fall anticipated in LGCs, while the STC value remains linked to $40 (at least over the longer term), should improve the financial returns of a sub-100kW systems relative to those above that size. Consequently, one would expect this would encourage customers to opt for a system below 100kW in order to be eligible for STCs at least as a first stage.

However, a review of the capacity of LGC solar systems reveals most are well above 100kW in capacity. **Figure 3-2** shows that more than 70% of systems which were accredited in either 2018 or 2019 are at least double the 100kW STC threshold. And this is in circumstances where the market anticipated LGC prices would plummet in value over the coming three to four years.

Figure 3-2 Distribution of systems by capacity accredited 2018-2019



If these 70% of customers instead chose to install just 100kW they would be sacrificing some very large energy bill savings provided by the 200kW+ system (presumably at an attractive rate of return) relative to a 100kW system. This would substantially outweigh the gains from opting for STCs rather than LGCs.

Now it is also possible that customers could elect to divide the installation into 2 stages – the first up to 100kW and then a second above 100kW. But this too imposes costs in terms of having to pay for site mobilisation twice, and also forgone energy bill savings by delaying the roll-out of the ideal-sized system.

Victorian Energy Efficiency Certificate price assumptions

It is conceivable that solar systems installed in Victoria could be eligible to create Victorian Energy Efficiency Certificates under the Victorian Energy Upgrades Scheme. These would be awarded the avoided greenhouse gas emissions associated with displaced electricity that would otherwise have been imported from the grid. The Victorian Energy Upgrades Scheme, a bit like the Renewable Energy Target, imposes a legal obligation on electricity retailers to achieve emission abatement targets which are satisfied through surrendering Victorian Energy Efficiency Certificates. To date no solar system has elected to create VEECs because LGCs have been more financially attractive. However, with the price of LGCs expected to decline significantly over the next few years, creating VEECs from solar may become more financially attractive than LGCs.

The Victorian Government is still yet to define the key parameters for the Victorian Energy Upgrades scheme for the period after 2020, in particular the level of the target.

Consequently, there is insufficient information from which to evaluate supply-demand dynamics and the likely future value for Victorian Energy Efficiency Certificates. For the purposes of this analysis we have taken a value that lies half way between the average market price for VEECs over the year to date, and $39 - which was the upper bound value the Victorian Government used to inform what level of target is should set during the last target setting process in 2015. This price for VEECs is held constant throughout the outlook period at this level.

Interviews with solar industry participants suggest behind the meter solar system installations and accreditations will remain buoyant in 2020, in spite of expected downturn in wholesale power prices and LGCs

While it appears likely that wholesale power prices during sunny periods will decline substantially relative to recent times, interviews with a range of solar industry participants suggested that customer interest and orders for mid-scale solar systems remained at high levels relative to historical standards.

These interviews suggested that they expected installations in 2020 to be similar to, or exceed those of 2019. When challenged about this optimistic outlook given the prospects for significant falls in wholesale power prices, industry participants explained that the following factors acted to moderate the impact of such falls on customers' willingness to install solar:

- A substantial proportion of the kWh price paid by many prospective mid-scale customers was associated with the network charge which is not expected to fall.
- Financing terms for power purchase agreements had improved considerably and this would allow suppliers to offer prices for power from solar under PPAs that would remain attractive to many customers even with large falls in wholesale energy costs.
- A range of large corporate entities had advanced their plans to roll-out solar at megawatt-scale to a point where they were unlikely or unable to halt or substantially scale back their roll-out.
- A number of potential customers would be on electricity contracts that would not benefit from price declines for another two to three years;
- Electricity retailers may encounter difficulty restructuring their pricing offers to deliver discounted prices for consumption during daylight periods, which were significantly more attractive to customers than sticking with more conventional and familiar price offerings that smeared wholesale energy costs across solar and non-solar output periods.
- A number of large corporate clients looking to purchase solar systems were doing it as part of prominent public commitments to reducing their carbon emissions or achieving 100% renewable energy targets. Interviewees noted that even if wholesale electricity costs fell considerably, any financial gain from abandoning a planned solar system would be small in the scheme of these corporate clients' broader operations. Therefore, they would maintain their solar roll-out plans rather than put at risk the credibility of their environmental commitments and brand image.

Viability of batteries remains elusive but interest is high

At present uptake of batteries in the mid-scale market is inconsequential. However, a number of participants are very attentive to the potential for batteries to address the three major issues which hinder solar's economics:

- the inability to provide a guarantee the solar system will reduce network demand charges;
- that solar system's economics rapidly deteriorate once they reach a size where they exceed on-site demand due to the lower value available for exported generation or even the inability to export at all (due to network connection controls).

- that solar generation is now increasingly likely to co-incide with periods of low wholesale market prices, yet much higher prices will prevail within just a few hours of solar generation subsiding.

Several market participants were of the opinion that the cross-over point for batteries becoming an attractive proposition for customers was within sight. However, pin pointing when this might occur remains subject to great uncertainty, and it is not clear it will occur within the short-time period that is the subject of this projection exercise. At present we do not envisage that over the outlook period batteries will reach a price where they might noticeably mitigate the deterioration in solar payback periods likely to unfold as a result expected drops in wholesale power prices during daytime.

Yet given the considerable uncertainty surrounding battery economics and the considerable focus being dedicated to them, we would concede this creates a risk of that solar uptake may be underestimated.

4. Payback periods and solar uptake propensity

As noted earlier, the lack of a suitably large and representative sample set of solar system installations, stretching back over several years, prevents the development of a robust quantitative evaluation of how solar system uptake is likely to change in response to changes in the financial attractiveness of solar systems. Nonetheless changes in payback periods provide a useful benchmark or guidepost to inform how future mid-scale solar uptake might unfold.

As noted in section 2 of this report payback periods for solar systems can vary depending on customer sites' load profiles and the type of tariffs they face. In estimating solar system paybacks we have developed several generic usage and tariff group profiles to try to capture a degree of this diversity. We have attempted to evaluate how uptake is likely to change by assessing payback periods on solar systems in 2021 to 2023 relative to a baseline of the 2019 year. Given the noticeable lags affecting the mid-scale solar market we believe 2019 installation levels are a reasonable reflection of the likely sustained customer solar uptake in response to the large electricity price and system cost changes that unfolded over 2016 to 2018.

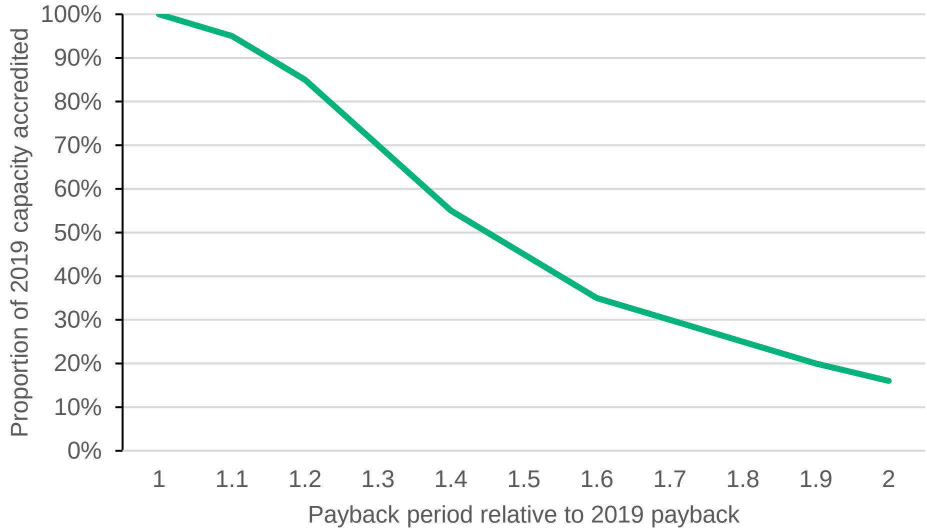
Based on the data provided by the Clean Energy Regulator the mid-scale capacity accredited up to August this year stood at 103 megawatts. In front of the meter power plants and remote power systems will be considered via their own distinct analysis and so we need to deduct their 17.7MW. With these plants excluded, the average monthly level of accreditations to August was 10.7MW. If this was maintained from September until December then we could expect close to 129MW of capacity to be accredited by the end of the year. These levels become our reference or benchmark for evaluating how changes in payback relative to 2019 but with each state considered separately given they each have distinctive characteristics influencing mid-scale solar uptake (tariffs, industrial structure etc.).

We expect that paybacks will deteriorate over the outlook period to 2023 for mid-scale solar systems. To provide a lower bound guidepost as to how much capacity accredited could fall as paybacks deteriorate, we've used 2016 installation levels as a benchmark which we assume were a product of payback periods based on 2015 market prices. While it varies between states and customer-types, payback periods based on 2015 market conditions were roughly twice as long as what they were in 2019 (in Victoria and NSW it was about 2.5 times as long, in Queensland and WA it was closer to 1.5 times longer than 2019 levels). Mid-scale solar capacity accredited in 2016, excluding remote or off-grid power, was 20.5MW or 16% of the capacity we expect to be accredited in 2019.

With these two reference points we have constructed an uptake curve shown in **Figure 4-1**, which illustrates the degree to which the amount of mid-scale solar is assumed to change as paybacks lengthen. Both uptake and paybacks are referenced relative to 2019 levels. So, if the payback period in a future year was the same as 2019 levels (a value of 1) then the capacity accredited would be the same, or 100%, of what it was in 2019. If the payback period is twice as long as what it was in 2019 then uptake is assumed to drop down to the same levels as in 2016 which were 16% of 2019 levels.

Interviews with industry participants suggested that uptake would remain at similar levels to recent times even with a noticeable fall in wholesale prices. For that reason uptake falls slowly as paybacks initially lengthen to 1.2 times the period of 2019 levels. After that point uptake starts to fall quite steeply until it reaches 1.6 times 2019 levels, at which point uptake remains less sensitive to lengthening payback. This is based on feedback from industry participants and observations of the market that suggest there is an underlying level of demand for solar installations that is heavily driven by non-financial motivations. This source of demand is much less sensitive to payback periods.

Figure 4-1 Uptake of solar in response to changes in payback periods – relative to 2019 levels



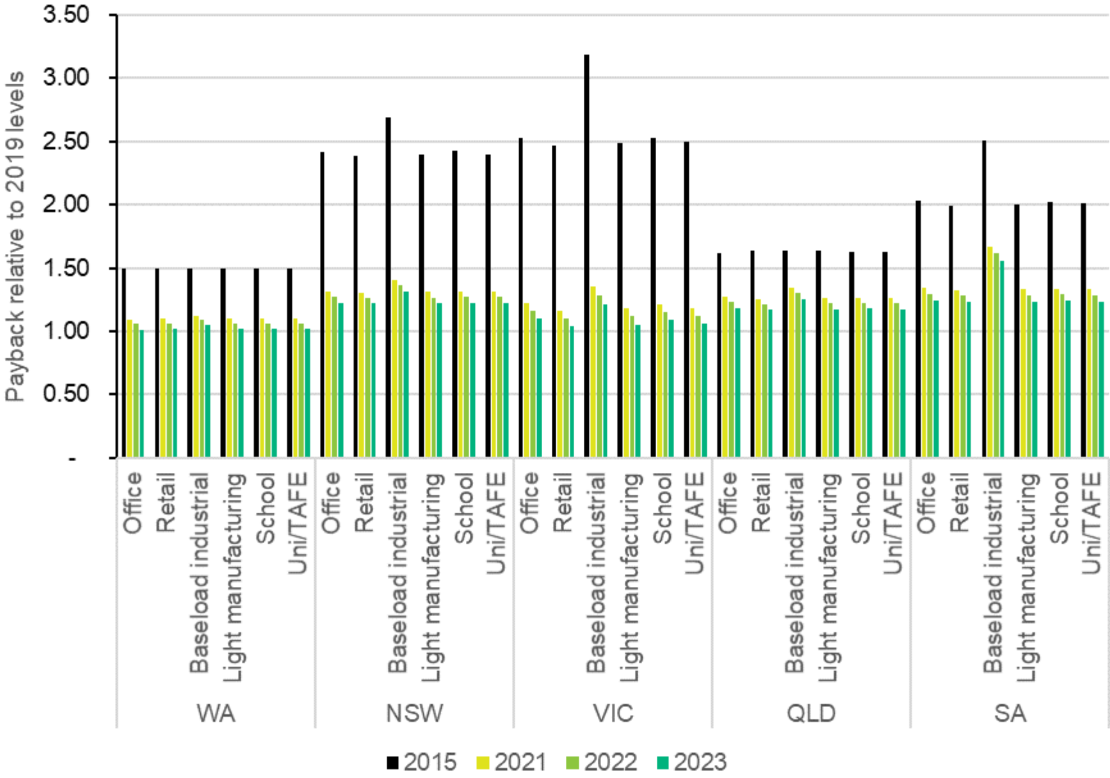
Payback period under Moderate Scenario

Payback periods become longer relative to 2019 but tend to remain significantly better than in 2015

Figure 4-2 details how estimated payback periods in 2021 to 2023 compare relative to what they were in 2019 under a scenario where wholesale power prices drop in line with a situation where the operating costs of a mixture of gas and coal baseload generators set prices. This is entitled the 'moderate scenario'. Note that the scale is not the payback period in years but rather the length of the payback relative to or divided by what it was in 2019. So if the value is exactly 1 it means the payback period has remained the same as it was in 2019 in that state and that customer usage/tariff profile. If the value is 2 then it means the payback period is twice as long as what it was in 2019. As explained earlier to provide a reference point of possible lower-bound uptake we've also analysed likely paybacks under 2015 market conditions relative to 2019 which are also illustrated in **Figure 4-2**.

Figure 4-2 Changes in payback period by state and site type relative to 2019 level – moderate scenario

2019 payback period assigned value of 1



Payback periods are less attractive (longer) than 2019 levels across every year from 2021 to 2023 across every segment and every state. This is a result of an assumed fall in wholesale power prices that reduces revenues which exceed the expected reduction in system costs. The deterioration is least noticeable in WA and most significant in SA. The deterioration in paybacks is greatest for the baseload industrial usage-tariff customer profile because this profile has the lowest network, retailer and environmental charges per kWh consumed and so has the greatest sensitivity to changes in wholesale energy costs.

In a number of usage-tariff profiles and states the deterioration in paybacks relative to 2019 levels are considerable. In NSW payback periods increase by around 30% in 2021 declining to around 20% longer by 2023. Queensland experiences similar changes. In Victoria in 2021 they are around 25% to 30% longer than 2019 levels and at the extreme of the baseload-industrial profile they are 45% longer. South Australia experiences slightly greater lengthening of payback periods than Victoria. By contrast WA's payback periods increase by only about 10% in 2021 relative to 2019 levels and by 2023 and only slightly longer than 2019 levels. WA's changes are less significant because they have not experienced the same extreme increases in wholesale prices that have occurred in the NEM since 2015 and so have less room to fall. Although WA prices have also been structured around Synergy's business retail tariffs rather than the bottom-up construction applied to the NEM states. This assumed a straight pass-through of network tariffs and wholesale energy costs with a small retailer margin.

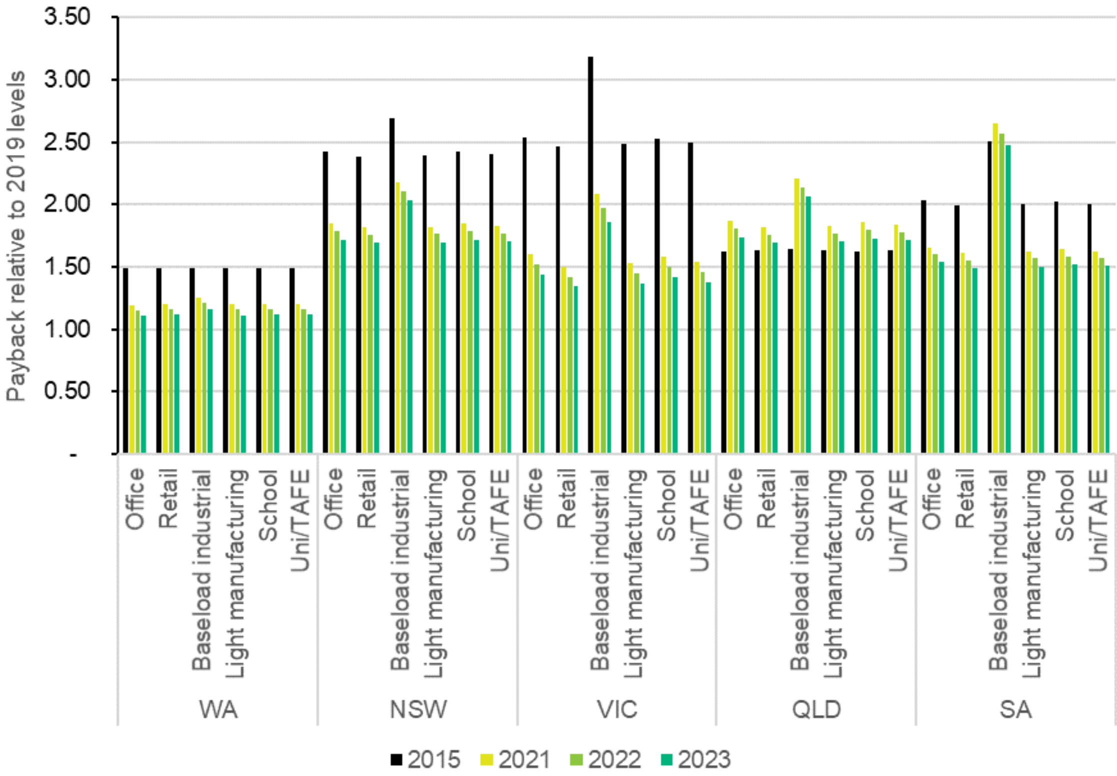
While we expect capacity installed should fall in 2021 to 2023 below levels achieved in 2019 we would note that paybacks are still vastly superior to those estimated for 2015 market conditions. This indicates that uptake should still be substantially higher than in 2016.

Paybacks under Lower Bound Scenario

Payback periods become much longer relative to 2019 although still better than 2015 levels, except in QLD

In addition to the moderate scenario, we have also examined a lower bound scenario where wholesale power prices between 2021 and 2013 during daytime periods in the NEM drop to levels in line with what was experienced late at night over 2010 and 2011 - $28/MWh (2019 dollars). For the WA SWIS they are assumed to fall to $35 per megawatt-hour. **Figure 4-3** illustrates how payback periods in 2021 to 2023 compare relative to 2019 levels under this scenario.

Figure 4-3 Changes in payback period by state and site type relative to 2019 level – lower bound scenario
(2019 payback period assigned value of 1)



Payback periods lengthen very considerably across all the NEM states and all usage-tariff profiles in this scenario. In Queensland payback periods even become longer than they were in 2015 across all usage-tariff profiles. In NSW paybacks in 2021 become over 80% longer than they were in 2019 and more than double for the Baseload Industrial profile. By 2023 system cost reductions bring this down to about a 70% longer payback period. For Victoria the payback period also doubles for the baseload industrial profile while increasing by around 60% to 70% for other profiles in 2021. This declines to around 50% by 2023. South Australia sees similar outcomes as Victoria although the Baseload-Industrial profile is more severely affected by the fall in wholesale power prices.

In spite of the substantial lengthening in payback periods relative to 2019 payback periods remain noticeably better than they were in 2015 across all usage-tariff profiles, with the exception of Queensland and SA' baseload-industrial customers. Consequently, installation levels could be expected to remain above those in 2015 and 2016, but noticeably lower than 2019.

5. Uptake projections

Uptake in megawatts of capacity have been developed according to several customer groupings detailed in the headings below. Changes in payback periods relative to 2019 and 2015 levels are the predominant factor informing megawatt uptake from 2021 to 2023 with some minor adjustments in 2021 to account for significant solar roll-out initiatives that have been publicly disclosed (e.g. SA Water). Estimates for 2020 are largely informed by a combination of industry interviews and bottom-up research of organisations' plans and objectives for the roll-out of solar systems and decarbonisation of their energy supplies.

Healthcare, accommodation, aged care, hospitality, and entertainment

This sector incorporates a number of sites which often have notable refrigeration or space conditioning electrical loads associated with accommodating people over daytime periods and keeping fresh food. In the case of hospitals and large entertainment facilities they will face relatively low energy charges but for smaller sites they will often be on low voltage network tariffs with significant kWh charges.

A number of organisations involved in aged care have undertaken nationwide roll-outs of solar across many of their facilities indicating solar represents a cost-competitive option.

In terms of hospitals the Northern Territory, Victorian and NSW Governments have all indicated an interest or firm intention on rolling out solar across their facilities. These are expected to elevate installation levels in these states in 2020 and also 2021 for Victoria and the NT.

At present we have not come across public information on significant solar rooftop roll-out programs amongst hotels and entertainment venues. But there are numerous examples of solar adoption in the sector in the past and substantial unexploited roof-space that would suggest it will continue to provide a source of demand.

Under the Moderate Scenario, after an uptick in installations in 2020 driven by already announced hospital roll-outs, they then drop down below 2019 levels to 12.9MW in 2021, 12.4MW in 2022 and then recover slightly in 2023 to 12.7MW.

Table 5-1 Projected megawatts accredited – Moderate scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	4.1	4.5	2.9	3.5	3.5
NT	0.4	2.0	2.0	0.4	0.4
QLD	2.8	1.5	2.4	2.4	2.7
SA	1.0	1.5	0.7	0.8	0.8
TAS	0.0	0.0	0.0	0.0	0.0
VIC	3.2	5.0	3.1	3.2	3.2
WA	2.2	0.5	2.2	2.2	2.2
TOTAL	**13.7**	**15.0**	**13.2**	**12.5**	**12.8**

In the Lower Bound Scenario capacity accredited drops precipitously in 2021 and then remains below 7MW in 2022 and 2023.

Table 5-2 Projected megawatts accredited – Lower Bound scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	4.1	4.5	1.0	1.2	1.4
NT	0.4	2.0	2.0	0.1	0.1
QLD	2.8	1.5	0.7	0.8	1.0
SA	1.0	1.5	0.3	0.4	0.5
TAS	0.0	0.0	0.0	0.0	0.0
VIC	3.2	5.0	1.5	1.8	2.3
WA	2.2	0.5	1.9	2.1	2.1
TOTAL	**13.7**	**15.0**	**7.4**	**6.5**	**7.4**

Agriculture, food processing & distribution centres

Food processing and distribution sector is characterised by a significant daylight load driven by the need for refrigeration to keep food fresh and avoid spoiling. Within agriculture solar supportable loads are often a function of either irrigation pumping requirements, or indoor temperature control for animals housed indoors such poultry, pigs and cattle in feedlots.

Because a number of these facilities are connected at low voltage and within regional areas they will also often face high electricity tariffs.

Under the moderate scenario uptake remains reasonably stable and in fact in 2022 and 2023 uptake is greater than what we anticipate for 2020 although lower than 2019 levels. Uptake remains stable in spite of falling wholesale costs because these facilities are assumed to face significant kWh network charges. Queensland’s installation numbers in 2020 are boosted by the 3.3MW Cubbie Station plant we expect will be accredited that year and then fall noticeably below other NEM states because QLD network charges for both low and high voltage customers are heavily skewed to peak kVA with only a small proportion of costs charged on the basis of kWhs consumed.

Table 5-3 Projected megawatts accredited – Moderate scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	9.2	7.0	6.5	7.8	7.8
NT	0.0	0.2	0.2	0.2	0.2
QLD	3.4	6.8	2.9	2.9	3.2
SA	10.7	6.5	7.5	9.1	9.1
TAS	0.0	0.5	0.2	0.2	0.2
VIC	14.6	16.0	13.9	13.9	14.6
WA	0.7	0.5	0.7	0.7	0.7
TOTAL	**38.6**	**37.5**	**31.8**	**34.8**	**35.9**

Under the Lower Bound Scenario uptake more than halves relative to 2019 and 2020 levels.

Table 5-4 Projected megawatts accredited – Lower Bound scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	9.2	7.0	2.3	2.8	3.2
NT	0.0	0.2	0.2	0.2	0.2
QLD	3.4	6.8	0.9	1.0	1.0
SA	10.7	6.5	3.7	4.8	4.8
TAS	0.0	0.5	0.2	0.2	0.2
VIC	14.6	16.0	6.6	8.0	10.2
WA	0.7	0.5	0.6	0.6	0.6
TOTAL	**38.6**	**37.5**	**14.5**	**17.7**	**20.3**

Retail and airports

Retail outlets such as shopping centres and supermarkets as well as airports have the advantage of being 7-day-a-week operations that are rarely closed throughout the year. This provides a reasonably stable daytime load across the year so that solar output will rarely exceed on-side demand.

We expect installation levels in 2020 will exceed those in 2019 boosted by solar roll-out programs across the major supermarket outlets and also major shopping centre operators. The NT's 2020 installations are also lifted up abnormally by a planned 3.3MW installation at the RAAF air base in Darwin and another 2MW at Tennant Creek Airport.

Table 5-5 Projected megawatts accredited – Moderate scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	7.1	10.4	4.9	6.0	6.0
NT	0.0	5.7	0.2	0.2	0.2
QLD	12.7	10.0	10.8	10.8	12.1
SA	6.8	6.0	4.7	5.8	5.8
TAS	0.0	0.2	0.2	0.2	0.2
VIC	14.8	15.0	14.0	14.8	14.8
WA	2.1	3.0	2.1	2.1	2.1
TOTAL	**43.4**	**50.3**	**37.0**	**39.8**	**41.1**

Under the lower bound scenario installations in 2021 are expected to drop to 14.7MW nationally, followed by 18MW in 2022 and 21.2MW in 2023.

Table 5-6 Projected megawatts accredited – Lower Bound scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	7.1	10.4	1.8	2.1	2.5
NT	0.0	5.7	0.2	0.2	0.2
QLD	12.7	10.0	3.2	3.8	4.4
SA	6.8	6.0	2.4	3.0	3.7
TAS	0.0	0.2	0.2	0.2	0.2
VIC	14.8	15.0	6.6	8.1	10.3
WA	2.1	3.0	1.8	2.0	2.0
TOTAL	**43.4**	**50.3**	**16.1**	**19.5**	**23.4**

Manufacturing and water treatment

Manufacturing has very wide variance in terms of the suitability of their loads to soak up solar output and the extent of network costs that are charged via kWh consumption versus peak kVA. The opportunity for behind the meter solar is largely with smaller manufacturers that have reasonably stable daytime loads but who are small enough that a significant proportion of network costs are recovered on the basis of kWh consumption and also face significant retailer charges. While very large industrial manufacturers have the virtue of very large and constant loads that could readily soak up the amount of power generated by a solar system that might fit on site, the disadvantage is that network and retailer charges per kWh are minimal and the solar systems' economics don't look all that much different to an in-front of the meter solar farm. Consequently, uptake of behind the meter solar at energy-intensive manufacturing sites is very low and they are often better served looking at a power purchase agreement with a large solar farm located off-site.

Water treatment businesses are not dis-similar to a large industrial manufacturer in terms of kWh charges that are largely a function of wholesale energy costs with a low network and retailer cost component. However, unlike many large industrial manufacturers who often face fierce international competition, water treatment businesses can be confident about their long term viability and can afford to make long-term investments. In addition, they usually have access to very low interest rate finance. Lastly, water supply businesses tend to be very conscious of the serious impacts of climate change and the need to mitigate emissions. Almost all the major water supply authorities around the country have carbon emission reduction and/or renewable energy procurement targets. Consequently a number of the water authorities have instigated solar roll-out programs across their facilities.

Our projections over 2020 and 2021 are heavily inflated by SA Water's Project Zero initiative to roll-out 154MW across 93 of it's sites. Based on their tender documents we have identified about 60MW of site deployments which are above 100kW but below 5MW. We have assumed these will be installed and accredited in equal amounts over 2020 and 2021. Victoria's 2020 numbers are also boosted upwards by our expectation that Victorian North-East Water will accredit its Wodonga 3MW solar plant in that year.

Table 5-7 Projected megawatts accredited – moderate scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	2.9	6.1	2.0	2.4	2.4
NT	0.0	0.2	0.2	0.2	0.2
QLD	1.5	1.5	1.3	1.3	1.5
SA	2.7	31.5	30.0	1.9	1.9
TAS	0.0	0.0	0.2	0.2	0.2
VIC	8.5	13.5	7.2	8.1	8.1
WA	0.6	1.5	0.6	0.6	0.6
TOTAL	**16.2**	**54.3**	**41.5**	**14.7**	**14.9**

Under the Lower Bound scenario 2021 installations remain relatively high as a result of SA Water's solar roll-out but then drop away to just 5.3MW in 2022 and 6MW in 2023.

Table 5-8 Projected megawatts accredited – Lower Bound scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	2.9	6.1	0.6	0.7	0.9
NT	0.0	0.2	0.2	0.2	0.2
QLD	1.5	1.5	0.3	0.4	0.4
SA	2.7	31.5	30.0	0.7	0.8
TAS	0.0	0.0	0.2	0.2	0.2
VIC	8.5	13.5	3.0	3.0	3.8
WA	0.6	1.5	0.5	0.6	0.6
TOTAL	**16.2**	**54.3**	**34.8**	**5.7**	**6.9**

Educational and research facilities

Educational and research facilities, especially universities, have demonstrated widespread uptake of solar. This is even though they suffer from extended lower load holiday periods as well as weekends. This is a particular problem for schools, that leads to either spilled output where grid export constraints exist or far lower revenue because the output can at best only capture the wholesale market value of electricity. While Universities also have extended holiday periods and weekends, because many of the campuses are very large their underlying base level of load is still capable of absorbing the output of a quite large solar system. But universities have the disadvantage of often paying high voltage network tariffs which mean their solar avoidable network and retail charges per kWh are often relatively low.

Yet in spite of these disadvantages educational facilities have been enthusiastic adopters of solar. Industry interviews indicate this is due to a combination of security that they will maintaining operations at their current site for a very long time to come, low costs of capital, and often very strong senior management commitments to lowering their carbon emissions and taking a technology-leadership position.

We expect slightly higher levels of installations next year before they fall in 2021 to around 12MW under the Moderate Scenario, and then recover some of the lost ground over 2022 and 2023.

Table 5-9 Projected megawatts accredited – Moderate scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	0.9	4.2	0.6	0.7	0.7
NT	0.0	0.3	0.2	0.2	0.2
QLD	2.6	3.0	2.2	2.2	2.5
SA	4.6	2.0	3.2	3.9	3.9
TAS	0.0	0.2	0.2	0.2	0.2
VIC	4.6	4.0	4.4	4.4	4.6
WA	1.6	2.0	1.6	1.6	1.6
TOTAL	**14.3**	**15.7**	**12.4**	**13.2**	**13.7**

Under the Lower-Bound Scenario capacity accredited in 2021 falls to 5.9MW but then rises to 7.1MW in 2022 and 7.6MW in 2023.

Table 5-10 Projected megawatts accredited – Lower Bound scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	0.9	4.2	0.2	0.3	0.3
NT	0.0	0.3	0.2	0.2	0.2
QLD	2.6	3.0	0.7	0.8	0.8
SA	4.6	2.0	1.6	2.1	2.1
TAS	0.0	0.2	0.2	0.2	0.2
VIC	4.6	4.0	2.1	2.5	3.2
WA	1.6	2.0	1.4	1.5	1.5
TOTAL	**14.3**	**15.7**	**6.3**	**7.6**	**8.3**

Offices and public buildings

While offices occupy some of the largest amounts of commercial floor area in the country and are larger consumers of electricity than educational facilities or healthcare, while being comparable to retail, they have several characteristics that inhibit the uptake of solar:

- A large proportion of office space is located in CBDs involving high rise buildings where roof space is heavily constrained relative to overall floor space;
- They are usually rented tenancies and so suffer from a landlord-tenant split incentive problem;
- Electricity loads drop off considerably over weekends when the buildings' temperatures are not conditioned such that solar output may exceed load.

Consequently, office buildings have so far not been a significant source of demand for mid-scale solar systems. Public buildings, such as town halls, while being less problematic in terms of high rise or landlord-tenant split, also often suffer from periods of regular non-operational periods with low loads that are insufficient to soak up a large solar-system's output.

We expect this sector will continue to represent a relatively small source of demand for mid-scale solar under either the Moderate or Lower Bound Scenarios.

Table 5-11 Projected megawatts accredited – Moderate scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	0.6	0.7	0.4	0.5	0.5
NT	0.0	0.0	0.0	0.0	0.0
QLD	1.2	0.7	1.0	1.0	1.1
SA	0.0	0.4	0.0	0.0	0.0
TAS	0.0	0.0	0.0	0.0	0.0
VIC	0.5	0.7	0.4	0.5	0.5
WA	0.0	0.2	0.1	0.1	0.1
TOTAL	**2.2**	**2.7**	**1.9**	**2.1**	**2.2**

Table 5-12 Projected megawatts accredited – Lower Bound scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	0.6	0.7	0.1	0.2	0.2
NT	0.0	0.0	0.0	0.0	0.0
QLD	1.2	0.7	0.3	0.3	0.4
SA	0.0	0.4	0.0	0.0	0.0
TAS	0.0	0.0	0.0	0.0	0.0
VIC	0.5	0.7	0.2	0.2	0.3
WA	0.0	0.2	0.0	0.0	0.0
TOTAL	**2.2**	**2.7**	**0.6**	**0.7**	**0.8**

Power plants

In front of the meter power plants are solely dependent on the wholesale market for electricity market revenue and tend to be much larger in scale while smaller in aggregate number. Consequently, we have used a bottom-up approach to estimating their future uptake, solely dependent on feedback from industry participants.

Since solar became an economically competitive option for deployment in front of the meter, developers have favoured quite large plants, typically 50MW or larger in scale. This has been partly a function of lower construction costs, but the major reasons were financier preferences for larger transaction sizes to minimise due diligence effort, and maximising returns for developer effort. Power stations smaller than 5MW have been uncommon and most have been developed by a single company – Yates Electrical Services. However due to the increasing difficulty and cost involved in obtaining grid connection for solar power plants 30MW in scale or greater, several developers are switching their attention towards smaller-scale plant, including those 5MW or smaller in size.

Our evaluation of the economics of these plants - based on an expectation of large falls in wholesale power prices during daylight hours - suggests they are not financially viable. Therefore, one should logically expect a drop away in installation levels from past levels. However, a number of developers and their investors do not share the same pessimistic outlook. Or they are willing to accept very modest returns in the short-term on the expectation that either: a major coal fired power station will close; or new emission reduction policies will be introduced at either a State or Federal Government level that will significantly lift revenue.

Table 5-13 details the amount of megawatts that feedback from developers and solar equipment suppliers suggests is reasonably likely in the 5 megawatt or smaller scale. These are provided on an alternating current rated capacity of inverter output rather than direct current panel capacity. It is important to note that there is large room for error in these estimates. This is because projects can come in sizable lots of 5 MW per project, so it doesn't take much of a change in the number of projects proceeding for there to be a large change in the megawatts of capacity accredited. Also, there may be developers that are well progressed with projects that we are unaware of because projects of this scale do not need to pass through state government level approval processes, and can escape media attention. On the downside, there are plenty of hurdles that might stall or halt projects that industry participants fail to anticipate and mean ultimate accreditations fall short of the estimates below.

Table 5-13 Projected megawatts (AC basis) accredited

State/Territory	2019 (YTD)	2020	2021	2022	2023
ACT&NSW	2.6	15.0	10.0	0.0	0.0
NT	0.0	0.0	0.0	0.0	0.0
QLD	0.0	0.0	0.0	0.0	0.0
SA	9.0	25.0	15.0	0.0	0.0
TAS	0.0	0.0	0.0	0.0	0.0
VIC	0.0	10.0	10.0	0.0	0.0
WA	0.0	4.9	0.0	0.0	0.0
TOTAL	**11.7**	**54.9**	**35.0**	**0.0**	**0.0**

Remote power systems

While the economics of solar displacing diesel in remote power applications have appeared to be attractive for many years, to date the capacity of mid-scale solar systems accredited for LGCs in remote power applications has been modest. 15.8MW has been accredited since 2016 of which 64% was the product of NT Power and Water's SETuP initiative which was very heavily subsidised via ARENA funding. Other significant remote power solar plants installed in recent times have also involved significant ARENA grant subsidies such EDL's Cooper Pedy hybrid wind-solar project, Rio Tinto's Weipa solar farm, and Sandfire Resources' DeGrussa Solar-Battery hybrid project.

However, some recently announced projects for powering remote mine sites without grant funding suggest solar has reached a critical inflection point where its economics and demonstrated technical performance suggest installations will rise substantially without the need for ARENA funding. These include the Cannington, Granny Smith, Nova Nickel, and Agnew mine sites (ARENA funding was provided to support the wind but not the solar component of this project). Further reinforcing the viability of solar for remote power is that in these sites solar has been deemed attractive for displacing gas, which is noticeably cheaper than diesel. Public statements from Energy Developments Limited – one of Australia's largest operators of remote power systems – indicate that solar is economically viable now for displacement of gas up to 10% penetration and within 5 years they expect 50% displacement to be viable. Western Australia's remote power utility – Horizon Power – has also indicated publicly that they see solar as now being economically viable across many of their sites.

However, it is critical to note that viability is conditional on the customer for the power being able to make a 10 year commitment to purchase the power in order to justify the significant upfront investment involved in deploying solar. For many mine sites a ten-year commitment is difficult because of either volatile prices for their mined product, or because the economically recoverable resource may be exhausted within that timeframe. Also, some sites may have contracts in place with several years until expiry that potentially limit the flexibility or incentive for solar to be deployed. This means that even though solar looks economically attractive now, its speed of adoption is constrained.

Feedback from industry participants suggested 8MW is realistic for 2020 although this was subject to considerable uncertainty and was not constructed based on a comprehensive site by site evaluation. We'd then expect this to grow strongly to reach 20 MW of annual accreditations by 2023 but with considerable uncertainty surrounding this estimate given this sector has only just recently reached an economic viability threshold. Given the uncertainties afflicting this sector it was not possible to break-this down to state level estimates, although we'd expect the bulk of capacity to be installed in WA, followed by NT and QLD. Note that these projections are in terms of alternating current rated capacity of inverter output rather than direct current panel capacity.

Table 5-14 Projected megawatts (AC basis) accredited nationally

2020	2021	2022	2023
8	12	16	20

6. LGC Creation

The tables below provide estimates of projected annual LGC creation for the plant accredited in each year of the projection by each market category. These are not projections of LGC creation in the year indicated but rather the ongoing annual LGCs the capacity accredited in each year indicated can be expected to produce over a full year of operation.

Please note that Victorian projects installed from 2021 onwards are not anticipated to create any LGCs because analysis indicates that system owners would be better off creating Victorian Energy Efficiency Certificates instead.

Healthcare, accommodation, aged care, hospitality, and entertainment

Table 6-1 Expected annual ongoing LGC creation by year of plants' accreditation – Moderate scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	5,694	6,260	3,986	4,840	4,840
NT	578	3,163	3,163	578	578
QLD	4,234	2,247	3,599	3,599	4,022
SA	1,502	2,269	1,052	1,277	1,277
TAS	-	-	-	-	-
VIC	4,193	6,469	-	-	-
WA	3,493	791	3,493	3,493	3,493
TOTAL	**19,694**	**21,200**	**15,292**	**13,786**	**14,209**

Note this is intended as an approximate average of annual LGC creation, panel degradation means in reality output and therefore LGCs will decline slowly over time as systems age.

Table 6-2 Expected annual ongoing LGC creation by year of plants' accreditation – Lower Bound scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	5,694	6,260	1,423	1,708	1,993
NT	578	3,163	3,163	158	158
QLD	4,234	2,247	1,059	1,270	1,482
SA	1,502	2,269	526	676	826
TAS	-	-	-	-	-
VIC	4,193	6,469	-	-	-
WA	3,493	791	2,969	3,318	3,318
TOTAL	**19,694**	**21,200**	**9,139**	**7,131**	**7,777**

Note this is intended as an approximate average of annual LGC creation, panel degradation means in reality output and therefore LGCs will decline slowly over time as systems age.

Agriculture, food processing & distribution centres

Table 6-3 Expected annual ongoing LGC creation by year of plants' accreditation – Moderate scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	12,493	9,481	8,745	10,619	10,619
NT	-	308	308	308	308
QLD	4,956	9,910	4,213	4,213	4,708
SA	15,686	9,540	10,980	13,333	13,333
TAS	-	617	247	247	247
VIC	18,423	20,142	-	-	-
WA	1,041	772	1,041	1,041	1,041
TOTAL	**52,599**	**50,768**	**25,533**	**29,760**	**30,256**

Note this is intended as an approximate average of annual LGC creation, panel degradation means in reality output and therefore LGCs will decline slowly over time as systems age.

Table 6-4 Expected annual ongoing LGC creation by year of plants' accreditation – Lower Bound scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	12,493	9,481	3,123	3,748	4,373
NT	-	308	308	308	308
QLD	4,956	9,910	1,239	1,487	1,487
SA	15,686	9,540	5,490	7,059	7,059
TAS	-	617	247	247	247
VIC	18,423	20,142	-	-	-
WA	1,041	772	885	989	989
TOTAL	**52,599**	**50,768**	**11,292**	**13,837**	**14,461**

Note this is intended as an approximate average of annual LGC creation, panel degradation means in reality output and therefore LGCs will decline slowly over time as systems age.

Retail and airports

Table 6-5 Expected annual ongoing LGC creation by year of plants' accreditation – Moderate scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	9,834	14,469	6,884	8,359	8,359
NT	-	9,014	316	316	316
QLD	19,043	14,982	16,187	16,187	18,091
SA	10,248	9,077	7,174	8,711	8,711
TAS	-	253	253	253	253
VIC	19,092	19,407	-	-	-
WA	3,317	4,746	3,317	3,317	3,317
TOTAL	**61,535**	**71,948**	**34,132**	**37,144**	**39,049**

Note this is intended as an approximate average of annual LGC creation, panel degradation means in reality output and therefore LGCs will decline slowly over time as systems age.

Table 6-6 Expected annual ongoing LGC creation by year of plants' accreditation – Lower Bound scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	9,834	14,469	2,459	2,950	3,442
NT	-	9,014	316	316	316
QLD	19,043	14,982	4,761	5,713	6,665
SA	10,248	9,077	3,587	4,612	5,637
TAS	-	253	253	253	253
VIC	19,092	19,407	-	-	-
WA	3,317	4,746	2,820	3,151	3,151
TOTAL	**61,535**	**71,948**	**14,196**	**16,996**	**19,465**

Note this is intended as an approximate average of annual LGC creation, panel degradation means in reality output and therefore LGCs will decline slowly over time as systems age.

Manufacturing and water treatment

Table 6-7 Expected annual ongoing LGC creation by year of plants' accreditation – moderate scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	3,886	8,262	2,720	3,303	3,303
NT	-	308	308	308	308
QLD	2,258	2,186	1,919	1,919	2,145
SA	4,001	46,230	44,029	2,801	2,801
TAS	-	-	247	247	247
VIC	10,698	16,994	-	-	-
WA	925	2,316	878	925	925
TOTAL	**21,768**	**76,296**	**50,101**	**9,502**	**9,728**

Note this is intended as an approximate average of annual LGC creation, panel degradation means in reality output and therefore LGCs will decline slowly over time as systems age.

Table 6-8 Expected annual ongoing LGC creation by year of plants' accreditation – Lower Bound scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	3,886	8,262	777	972	1,166
NT	-	308	308	308	308
QLD	2,258	2,186	452	564	564
SA	4,001	46,230	44,029	1,000	1,200
TAS	-	-	247	247	247
VIC	10,698	16,994	-	-	-
WA	925	2,316	786	878	878
TOTAL	**21,768**	**76,296**	**46,597**	**3,969**	**4,363**

Note this is intended as an approximate average of annual LGC creation, panel degradation means in reality output and therefore LGCs will decline slowly over time as systems age.

Educational and research facilities

Table 6-9 Expected annual ongoing LGC creation by year of plants' accreditation – Moderate scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	1,143	5,624	800	972	972
NT	-	456	304	304	304
QLD	3,795	4,319	3,226	3,226	3,606
SA	6,646	2,907	4,652	5,649	5,649
TAS	-	244	244	244	244
VIC	5,744	4,988	-	-	-
WA	2,491	3,077	2,491	2,491	2,491
TOTAL	**19,820**	**21,615**	**11,718**	**12,886**	**13,266**

Note this is intended as an approximate average of annual LGC creation, panel degradation means in reality output and therefore LGCs will decline slowly over time as systems age.

Table 6-10 Expected annual ongoing LGC creation by year of plants' accreditation – Lower Bound scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	1,143	5,624	286	343	343
NT	-	456	304	304	304
QLD	3,795	4,319	949	1,139	1,139
SA	6,646	2,907	2,326	2,991	2,991
TAS	-	244	244	244	244
VIC	5,744	4,988	-	-	-
WA	2,491	3,077	2,118	2,367	2,367
TOTAL	**19,820**	**21,615**	**6,226**	**7,387**	**7,387**

Note this is intended as an approximate average of annual LGC creation, panel degradation means in reality output and therefore LGCs will decline slowly over time as systems age.

Offices and public buildings

Table 6-11 Expected annual ongoing LGC creation by year of plants' accreditation – Moderate scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	708	874	496	602	602
NT	-	-	-	-	-
QLD	1,597	941	1,357	1,357	1,517
SA	-	542	-	-	-
TAS	-	-	-	-	-
VIC	566	815	-	-	-
WA	-	286	143	143	143
TOTAL	**2,870**	**3,457**	**1,996**	**2,102**	**2,262**

Note this is intended as an approximate average of annual LGC creation, panel degradation means in reality output and therefore LGCs will decline slowly over time as systems age.

Table 6-12 Expected annual ongoing LGC creation by year of plants' accreditation – Lower Bound scenario

State/Territory	2019	2020	2021	2022	2023
ACT&NSW	708	874	177	212	212
NT	-	-	-	-	-
QLD	1,597	941	399	399	479
SA	-	542	-	-	-
TAS	-	-	-	-	-
VIC	566	815	-	-	-
WA	-	286	-	-	-
TOTAL	**2,870**	**3,457**	**576**	**612**	**691**

Note this is intended as an approximate average of annual LGC creation, panel degradation means in reality output and therefore LGCs will decline slowly over time as systems age.

Power plants

Table 6-13 Expected annual ongoing LGC creation by year of plants' accreditation

State/Territory	2019 (YTD)	2020	2021	2022	2023
ACT&NSW	6,229	35,478	23,652	-	-
NT	-	-	-	-	-
QLD	-	-	-	-	-
SA	21,332	59,130	35,478	-	-
TAS	-	-	-	-	-
VIC	-	21,900	-	-	-
WA	-	10,731	-	-	-
TOTAL	**27,560**	**127,239**	**59,130**	**-**	**-**

Note this is intended as an approximate average of annual LGC creation, panel degradation means in reality output and therefore LGCs will decline slowly over time as systems age.

Remote power systems

Table 6-14 Expected annual ongoing LGC creation by year of plants' accreditation

2020	2021	2022	2023
17,520	26,280	35,040	43,800

Note this is intended as an approximate average of annual LGC creation, panel degradation means in reality output and therefore LGCs will decline slowly over time as systems age.