Updated STC Forecast 2021 - 2025

Report to the Clean Energy Regulator

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Executive Summary

The Clean Energy Regulator (CER) has engaged Green Energy Markets Pty Ltd (GEM) to provide updated forecasts of the Small-scale technology certificates (STCs) likely to be created during the 2021 calendar year, and for the years 2022 to 2025.

In developing our projections for small generation units (SGUs), solar water heaters (SWH) and air-source heat pumps (ASHP) we have updated and expanded our models and databases used in developing our STC forecasts previously undertaken for the CER in 2020. We have also made extensive use of the registry data provided by the CER and interviewed a range of solar industry participants.

We have segmented the solar market into the following sub-markets to more accurately forecast the level of installations:

- SGU PV – New Residential market
- SGU PV – Upgrade Residential market
- SGU PV – New Non-residential (commercial market)
- SGU PV – Upgrade Non-residential market
- SWH – New building market
- SWH - Replacement or existing dwelling market
- ASHP – New building market
- ASHP - Replacement or existing dwelling market

In making projections for installations of solar PV and SWH we have aimed to isolate the key factors that have influenced the historical uptake of systems. In the case of solar PV the predominant factor influencing uptake is financial attractiveness. We have developed a state-based payback model as a proxy for financial attractiveness for the residential and commercial sectors and then incorporated the expected impact of market saturation in each state. To incorporate non-financial factors we also account for changes in customer awareness and solar industry competitiveness and marketing which are informed by industry interviews.

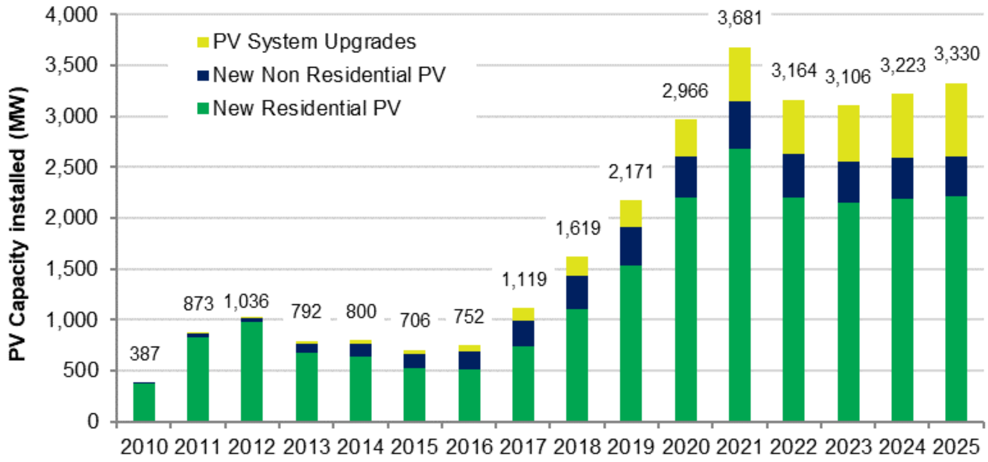
The following factors have been influential in the development of our estimates of the level of future solar installations:

- Daytime wholesale power prices are expected to continue to decline which will flow through to lower feed-in tariffs. We continue to assume that retailers will offer tariffs exceeding the daytime wholesale price as part of customer retention and acquisition strategy;
- The Victorian Solar Homes Program is expected to underpin installations in Victoria over the forecast period with parameters of the program assumed to be adjusted to deliver on the policy commitment of 650,000 PV systems over 10 years;
- The average system size for residential installations is expected to continue to increase though at more modest levels than recent years;
- We expect to see battery costs continue to decline so that paybacks of residential solar plus battery systems becomes more attractive than solar only systems by the end of the forecast period in South Australia and NSW where support polices are in place;
- We expect that technical and market challenges will increase with the significant levels of roof-top PV being installed. These include low levels of minimum demand creating grid management issues, increasing levels of curtailment, moving to time of use tariffs as well as potential charges for PV exports. We have adjusted estimates of financial attractiveness in our model to account for these changes;
- The level of non-residential (commercial) PV system installations is expected to reduce over the forecast period, though not as dramatic as new residential systems. Paybacks for these systems are not expected to deteriorate as much as residential systems as they are not as dependent on exporting electricity;

- The Upgrade market is more extensive than we previously expected. New system information collected by the CER from late 2020 indicates that the level of upgrades was more than 70% higher as it now includes both the upgrade of existing system as well as the replacement of older systems. Upgrades are expected to increase modestly over the forecast period; and
- The number of SWH systems installed in new homes is expected to increase over the forecast period in line with expected increases in new home commencements. The replacement market is expected to increase significantly as increasing numbers of SWH systems installed in 2009 and 2010, where the market surged due to expanded government grants, start to be replaced. In addition there are a number of new entrants installing air-sourced heat pumps that are also securing energy savings certificates where they replace electric storage systems.

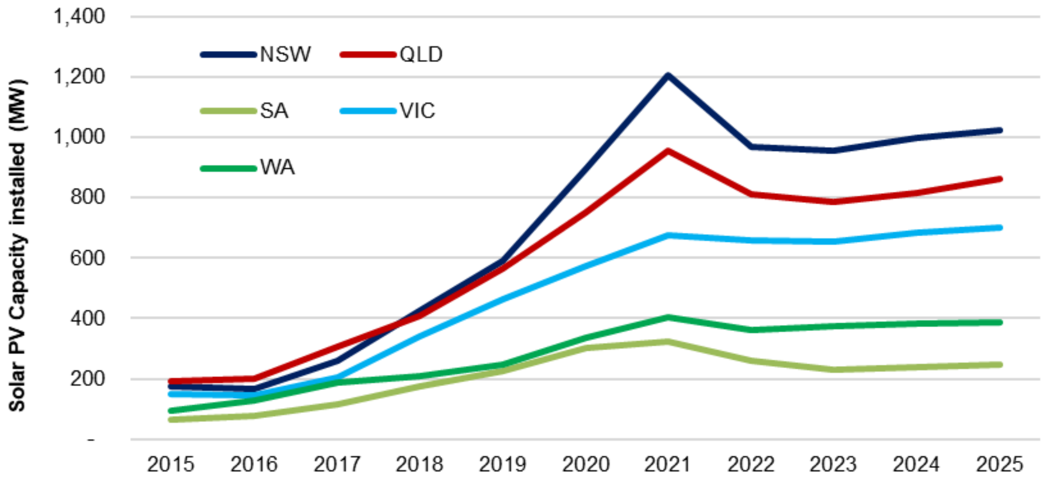
We estimate that 3,681 MW of solar PV will be installed in 2021 which is a 24% increase on 2020 levels. We expect that the capacity installed in 2022 will fall by 14% to 3,164 MW and then rise slightly to reach 3,330 MW by 2025.

PV Capacity installed by sector



The Victorian market underpinned by the government's solar program is expected to remain buoyant over the forecast period as other states generally decline. Victoria's share of capacity in 2025 is expected to be 21.1%, significantly higher than its 18.4% share in 2021.

PV Capacity installed by state



We estimate that 89,300 SHW and ASHP systems will be installed 2021 which is an 18% increase on 2020 levels. We expect that the number of systems installed to grow to more than 112,000 by 2025. This growth is predominantly from ASHP installed in the replacement market, supported by attractive state based programs.

Year of installation	Actual 2018	Actual 2019	Estimate 2020	Estimate 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025
New Buildings								
SWH	28,798	27,887	25,628	23,613	27,018	29,073	30,992	32,163
ASHP	8,532	8,758	9,170	12,568	12,016	12,929	14,233	15,051
	37,330	**36,645**	**34,799**	**36,181**	**39,034**	**42,001**	**45,225**	**47,214**
Replacement								
SWH	16,822	16,385	16,877	15,407	16,422	17,305	18,238	19,222
ASHP	12,824	12,327	23,803	37,711	39,455	41,475	43,601	45,837
	29,646	**28,712**	**40,680**	**53,118**	**55,876**	**58,781**	**61,839**	**65,058**
Total								
SWH	45,620	44,272	42,505	39,020	43,440	46,378	49,230	51,384
ASHP	21,356	21,085	32,974	50,279	51,470	54,404	57,834	60,888
	66,976	**65,357**	**75,479**	**89,299**	**94,910**	**100,782**	**107,064**	**112,272**

We expect that 51.5 million STCs will be submitted for registration in 2021 and 41.9 million in 2022. Summary of results are as follows:

'000 STCs Actual	Actual 2018	Estimate 2019	Estimate 2020	Forecast 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025
STCs for installations in year								
Solar PV	27,652	34,191	42,648	49,441	38,149	33,275	30,218	26,763
SWH	1,380	1,333	1,286	1,185	1,177	1,117	1,038	929
ASHP	623	617	1,012	1,573	1,450	1,362	1,266	1,142
Total	**29,655**	**36,142**	**44,946**	**52,200**	**40,777**	**35,754**	**32,522**	**28,834**
Less								
STCs submitted following year (lag)	3,357	3,690	4,579	5,318	4,154	3,643	3,313	2,938
Add								
Previous year installs created this year	2,580	3,357	3,690	4,579	5,318	4,579	5,318	4,154
STCs submitted for creation	**28,878**	**35,809**	**44,057**	**51,461**	**41,940**	**36,690**	**34,527**	**30,051**

There are a number of uncertainties in developing our projections and as a result we have developed a High Distributed Energy Resources (High DER) scenario where we allow for:

- More accelerated cost reductions for solar PV only systems and battery systems leading to improved paybacks for both residential and commercial installation;
- Increased level of consumer awareness and acceptance of solar and distributed energy technologies more broadly; and
- Greater level of installations for the balance of 2021.

The level of PV installations in 2021 under the High DER scenario is expected to be 467,254 systems increasing to 487,644 by 2025. The number of systems by state under both the Base Case and High DER scenarios are summarised in the following table.

Summary of PV systems installed by state

Base Case

	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Total
2021	7,089	140,210	1,782	109,740	35,744	4,392	84,917	56,324	440,196
2022	5,355	108,867	2,604	89,347	27,384	3,181	80,592	48,444	365,775
2023	5,034	104,936	2,626	83,987	23,765	3,001	78,104	48,736	350,190
2024	5,062	106,567	2,665	85,311	24,017	3,038	79,281	48,504	354,445
2025	5,109	107,202	2,673	88,498	24,343	3,104	79,597	47,827	358,354

High DER

	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Total
2021	7,663	157,286	1,782	111,623	38,032	4,696	86,341	59,829	467,254
2022	6,545	134,042	3,203	106,594	32,290	3,490	93,493	56,445	436,102
2023	6,235	131,372	3,565	102,219	28,168	3,294	92,483	58,062	425,399
2024	7,415	158,975	3,215	106,908	30,985	3,377	96,319	59,385	466,578
2025	8,028	172,232	3,242	111,093	33,956	3,466	96,449	59,181	487,644

The total capacity of PV installations in 2021 under the High DER scenario is expected to be 3,890 MW increasing to 4,510 MW by 2025. The number capacity by state under both the Base Case and High DER scenarios are summarised in the following table.

Summary of PV capacity systems installed by state (GW)

Base Case

	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Total
2021	0.06	1.20	0.02	0.96	0.32	0.03	0.68	0.40	3.68
2022	0.05	0.97	0.03	0.81	0.26	0.03	0.66	0.36	3.16
2023	0.05	0.96	0.03	0.79	0.23	0.03	0.66	0.37	3.11
2024	0.05	1.00	0.03	0.82	0.24	0.03	0.68	0.38	3.22
2025	0.05	1.02	0.03	0.86	0.25	0.03	0.70	0.39	3.33

High DER

	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Total
2021	0.07	1.34	0.02	0.97	0.34	0.04	0.69	0.43	3.89
2022	0.06	1.19	0.03	0.97	0.31	0.03	0.76	0.42	3.77
2023	0.06	1.19	0.04	0.96	0.28	0.03	0.77	0.44	3.77
2024	0.07	1.47	0.03	1.03	0.31	0.03	0.83	0.46	4.23
2025	0.08	1.62	0.03	1.09	0.34	0.03	0.85	0.48	4.51

1. Introduction

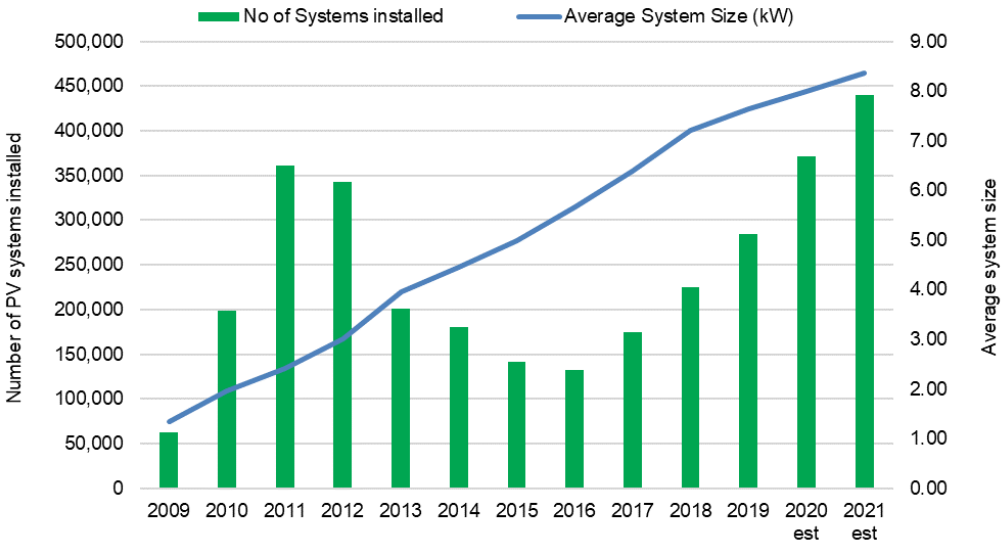
The Clean Energy Regulator (CER) has engaged Green Energy Markets Pty Ltd (GEM) to provide an updated estimate of the Small-scale technology certificates (STCs) likely to be created during the 2021 calendar year, and for the years 2022 to 2025.

The Small-scale Renewable Energy Scheme (SRES) creates financial incentives for investment in eligible small-scale renewable energy systems. Small-scale renewable energy systems are defined as solar PV systems with a capacity no more than 100kW and solar hot water and air-source heat pump installations. Solar PV dominates the creation of STCs accounting for more than 95% of STC creation.

The growth in the number of solar PV installations has been primarily due to the surge in the demand from households and businesses as power prices have increased and solar PV has become a more financially attractive proposition. The average system size has continued to increase which has resulted in a significant expansion in the capacity installed and subsequent STC creation (Figure 1.1).

We include a Variance Analysis comparing results to our January 2021 projections as Attachment 10 and also include projections by capacity bands as Attachment 11.

Figure 1.1 Number of solar PV systems installed and average system size (kW)



As part of its report GEM is required to:

- model expected small-scale technology installations for 2021-2025. This will include forecasts of the number of STCs and installed capacity;
- identify key factors affecting the type, number and size of small-scale systems installed and the trends in STC creation by various categories including residential and commercial uptake across states and territories in Australia; and
- update prior years' modelling and estimates. This will include reviewing the current STC dataset and remodelling prior estimates for STC creations in light of any identified changes to circumstances. Variance between the prior and revised estimates is to be analysed and clearly specified.

This report is set out in 4 sections

Section 2. Methodology and approach – summarises the approach that GEM has taken in developing its STCs estimates for each solar market sub-sector.

Section 3. Assumptions – summarises the key assumptions that have been made in the models used to develop the estimates

Section 4. Updated STC forecasts for Solar PV – summarises the number of PV systems expected to be installed together with the expected capacity and resultant STCs created.

Section 5. Updated STC forecasts for SWH – summarises the number of SWH systems expected to be installed together with the resultant STCs created.

2. Methodology and Approach

We have segmented the solar market into the following sub-markets, which tend to have different characteristics and consumer drivers:

- SGU PV – New Residential market
- SGU PV – Upgrade Residential market
- SGU PV – New Non-residential (commercial market)
- SGU PV – Upgrade Non-residential market
- SWH – New building market
- SWH - Replacement or existing dwelling market
- ASHP – New building market
- ASHP - Replacement or existing dwelling market

Residential and commercial installations have been segmented based on the “property installation type” classification in the registry data provided by the CER. We have used the CER’s delineation from 2015 when a full year’s data was available. For systems installed prior to 2015 we have assumed that systems greater than 10 kW were commercial and those less than 10kW were residential. This approach has been consistent with industry conventions at the time and was supported by detailed review by one of the largest certificate creators at the time. With the continued increase in average system size the notional capacity cut-off between residential and commercial has also increased and we expect it is now closer to 15 kW.

1. Modelling new residential PV system installations

Our projections for new residential PV systems are based on isolating the factors that have influenced the historical uptake of PV. The predominant influencing uptake is financial attractiveness. We use a simple payback calculation as the proxy for financial attractiveness.

Forecasting PV payback periods

Payback period is modelled using Green Energy Markets’ payback model. Research, including interviews with a range of industry participants, indicates that consumers tend to analyse the financial attractiveness of solar systems based on a backward looking and short-term perspective. Consequently the payback (in years) in the year of installation is determined in the model by dividing the installed system cost by the average of the expected annual savings (or revenue) delivered by the solar system using only the prices assumed to prevail in the year of installation and the year prior to installation (refer to Attachment 2).

- The expected savings is determined by the sum of (i) the value of avoided electricity purchases in the year of installation and (ii) the value of electricity exports in the year of installation.
- The installed system cost is derived by the total cost of the system less the value of STCs less any other rebates available.

In estimating payback the model analyses not just the revenue and cost of a solar system but also a solar system combined with a battery. In the event that combining a battery with the solar system provides a shorter payback than a solar system alone, then this shorter payback will be used in evaluating PV demand. For the first few years of the projections batteries do not act to reduce payback time in any state under either the Base Case or High DER Case. However, for South Australia and NSW batteries do act to shorten payback time in the year 2025 under the Base Case and in the High DER Case they shorten payback in these two states from a year earlier in 2024.

The assumptions used in the model are summarised in Section 3.

PV Demand

We forecast the level of demand for each state with reference to the following four factors:

- Relative financial attractiveness - as represented by simple payback
- Relative level of saturation – represented by scaling factor that reduces as saturation increases, we have calibrated this as being 1.0 (no discount) at saturation levels of 20% or less and then reduces to 0.5 (50% discount) at saturation levels of 80%. This is then also converted into an index with an average of 2019 as the base.
- Relative customer awareness – heightened media concerns over high power prices has been demonstrated (through market interviews, refer to Section 4.1) to be a major contributing factor to customer preparedness to consider solar. We have developed a scaling factor that considers the impact in each year and then convert this into an index with 2019 as the base; and
- Relative solar industry competitiveness and marketing – the level of new market entrants (and exit), general industry competitive environment together with the level of marketing and promotion will also have an impact on solar PV uptake. We have developed a scaling factor that considers the impact in each year and then convert this into an index with 2019 as the base.

The last two factors (customer awareness and industry competitiveness and marketing) are extremely subjective but have clearly impacted on the level of demand particularly over the last two years (refer to Figure 4.1).

We have re-assessed our baseline year to be an average of the 2019 and 2020 level of installations by state. We believe that this better reflects the current market characteristics and reflects a level of market maturity. This provides a reasonably large market size ranging from 234,000 new systems in 2019 to 309,000 systems in 2020. Interviews with industry participants have been a key component in gauging factors and issues that are actually working on the ground influencing customer purchasing decisions, beyond just financial attractiveness.

We have developed linear equations that represent the relationship between the level of installation and the adjusted payback in that year.

Our approach can be represented by the following formula:

Demand (year) = Systems derived from Payback equation (year) x Relative Level of Saturation (year) x Relative Customer Awareness Index (year) x Relative Solar Industry Competitive Index (year)

2. Modelling new non-residential (commercial) PV systems

The commercial or non-residential sector continues to be seen as an attractive market by the solar industry, now representing over 20% of installed capacity.

This market sector is also now reasonably mature and we use a similar approach to new residential systems with an average of 2019 and 2020 installations as our base. Forecast installations are based on relative financial attractiveness (relative to the 2019/20 base year). We have also incorporated a consumer awareness and industry competitiveness scaling factor to reflect improved industry attractiveness as more solar businesses target this sector.

3. Modelling upgrades and expansions of residential and commercial systems

The Upgrade market is more extensive than we previously expected. New system information collected by the CER from late 2020 indicates that the level of upgrades was more than 70% higher as it now includes both the upgrade of existing system as well as the replacement of older systems. Only 5 months of data was available using the new data field and we have pro-rated these levels back to 2015.

This market sector is increasing albeit from a very low base. Many small systems (less than 1.6 kW) were installed over the 2010 to 2013 period and a number of customers are expanding their systems in response to higher power prices and lower panel prices. While this market sector is still relatively small we expect it to continue to grow and become a much more important feature of the industry in future years as saturation increases and customers come off attractive historical feed-in tariffs. We use expected 2021 installations as the baseline and then overlay this with relative financial attractiveness and then allow for a market growth rate of 15% per annum to reflect a progressive replacement of older smaller systems as they age beyond 10 years.

The commercial upgrade market at an estimated 80 to 100 MW is probably not that material, however we believe it is worth separating as it has scope to grow in future and it is also important to exclude these systems when considering saturation levels.

4. Modelling solar water heating certificates

Water heater systems are essential appliances and subject to state regulations increasingly limiting choice in some applications. As such, water heater system choices are based on different factors which include: the existing system type (if being replaced); the relevant state regulations; the type of premises; access to reticulated gas, and also net system up-front costs (after taking incentives into account). Operational costs, such as future electricity and gas prices (particularly in the case of LPG) are also factors that may be considered.

The solar water heater (SWH) market (including heat pump water heaters) has two key sub-markets which are each subject to different incentives and regulations – these are the new building market (residential) and the replacement market (for existing water heaters in residences). The commercial market which had been important previously is not significant and will not be separately analysed.

SWH systems in each state and each sub-market are separately modelled. Major inputs into this analysis will include building forecasts (new and total), system replacement rates and market shares for each water heater technology by year.

The model will consider relative market shares together with the following key factors largely impacting future installations:

- State regulations for new/replacement systems
- Relative financial and market attractiveness
- Other state and federal government incentives (if any)

System installation forecasts will be combined with average system certificate creation (based on recent data) to estimate total certificate creation in each state and each submarket.

5. Modelling other small generation unit certificates

Certificate creation for small wind and hydro power systems are presently not material and are not included.

3. Assumptions

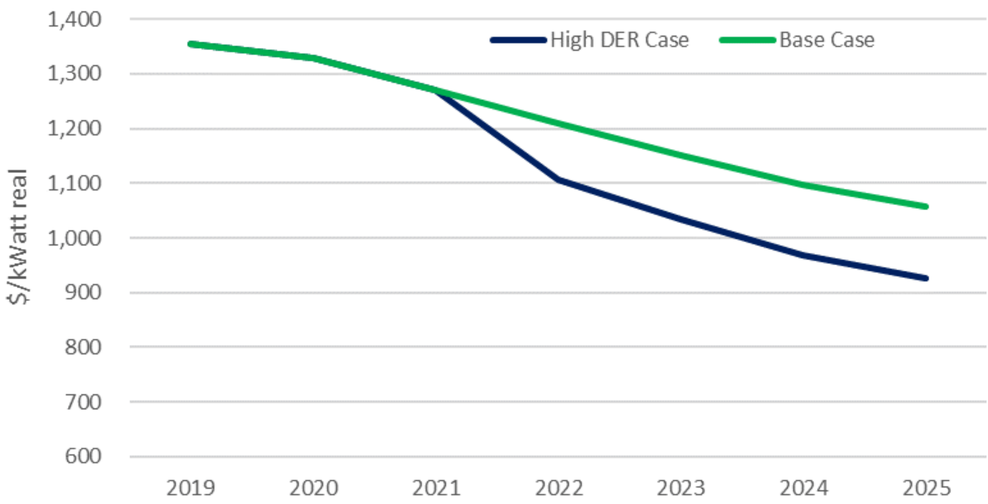
We have updated our assumptions and slightly refined our modelling approach in developing our STC forecasts for the 2021 to 2025 period. Key assumptions used are outlined in this section.

3.1 Forecasting Installed PV costs

We assume a typical residential solar system cost to be $1270 per kW in 2021 and we expect this to reduce in real terms (2021 dollars) to reach $1,057 in 2025. Under our High DER scenario we assume that installed costs reduce to $926/kW in 2025 (refer to Figure 3.1)

Ongoing cost reductions 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.

Figure 3.1 Forecast installed PV Cost (6.6kW system)



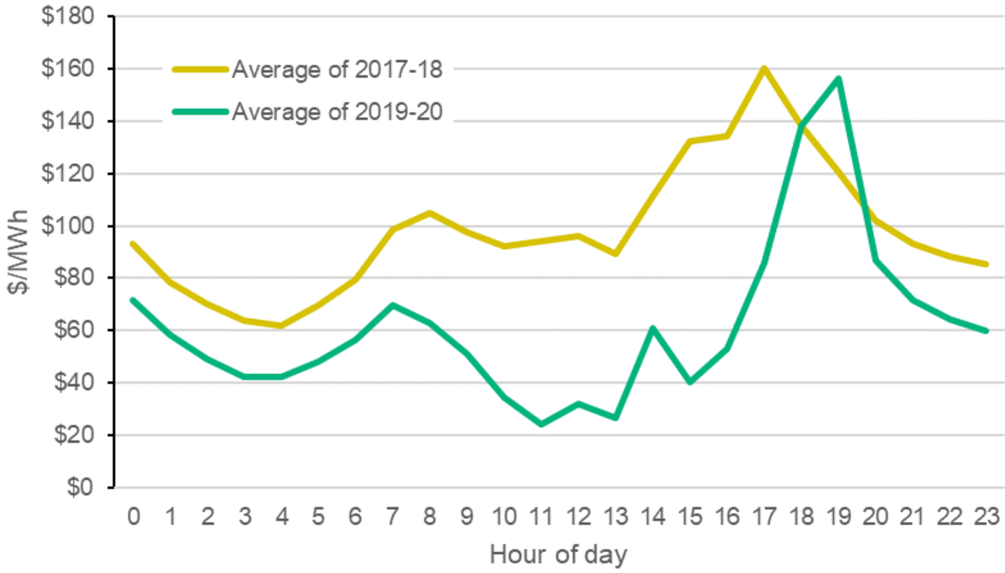
3.2 Wholesale electricity prices

The amount of solar generating capacity that has been added to the National Electricity Market and Western Australia's SWIS since 2017 now represents a large proportion of average demand. In addition, further gigawatts of capacity are likely to come over the next two years from both behind the meter rooftop installations and solar farms which are already under construction. We can now see this is having a significantly depressive impact on wholesale power prices during daylight periods relative to what was experienced in the past. This is most obvious in Queensland and South Australia which have the highest penetration of rooftop solar capacity in Australia, but other states should not be far behind given they are also installing significant amounts of solar capacity.

Wholesale power prices in the NEM 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.

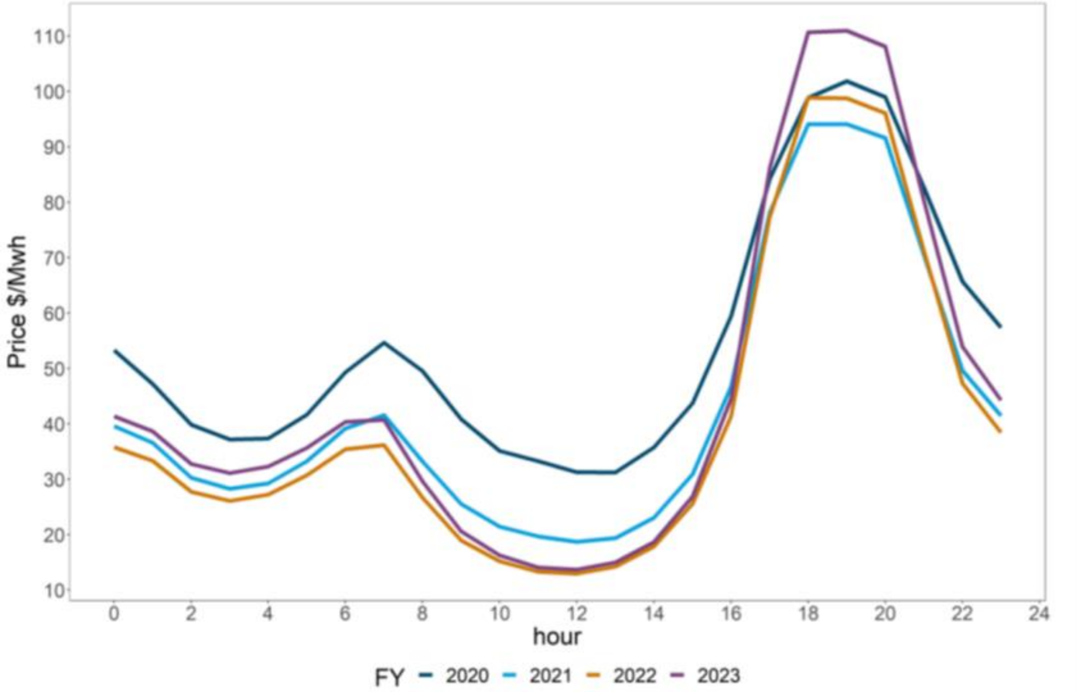
Figure 3.1 illustrates the depressive impact on wholesale prices from solar in SA. It shows the average wholesale power price in SA by hour of the day for 2017-18 (yellow line) and then for the prior financial year of 2019-20 (green line). While prices are generally down across all hours of the day for 2019-20 (likely due to much lower gas prices), the difference in prices becomes substantially greater in the hours of highest solar output. Over 10am to 1pm when solar generation is likely to be at its greatest prices are stuck below $40/MWh.

Figure 3.1 Average SA wholesale prices by hour – 2017-18 vs 2019-20



Looking forward the AEMC in their 2020 Residential Price Trends report forecasts that this daytime price depression is expected to become even more pronounced and also to spread across all states. Figure 3.2 taken from the AEMC report, illustrates the noticeable depression in prices in the middle of the day for Queensland, and how they expect the daytime price to get lower over time such that it is noticeably lower than even the 2am to 4am period when consumption of electricity is at its lowest. The AEMC projects similar outcomes in other states, albeit with a lag for NSW and Victoria relative to Qld and SA. Our analysis of Western Australian Energy Market balancing prices shows a similar daytime depression impact from solar.

Figure 3.2 AEMC forecast of QLD wholesale power prices by hour of day- 2020 to 2023



Source: AEMC (2020) Residential Electricity Price Trends 2020

Wholesale energy costs are assumed to be recovered from NEM customers based upon a three-part time-of-use structure involving the following:

- Peak period between 3pm to 10pm on weekdays;
- A daylight solar period between 9am to 3pm every day; and
- Off-peak which is all remaining times.

The daylight solar period prices are structured to reflect what we are now seeing in the wholesale markets of SA, Queensland and illustrated in Figure 3.1 and

Figure **3.2**. Our analysis indicates WA's SWIS already experiences similar patterns and, as the AEMC projects, other NEM states will soon follow in the footsteps of QLD and SA given Victoria and NSW are experiencing rapid growth in solar capacity and Tasmania's prices will be heavily influenced by those in Victoria.

For the NEM states wholesale prices until 2023 are derived from the AEMC's projections detailed in the 2020 Residential Price trends report. Prices remain at similar levels to 2023 until 2025. This involves the solar period wholesale price falling to around 2.5c to 3.3c/kWh by 2023 and remaining around this level to 2025. On top of the analysis prepared by the AEMC which partially incorporates the closure of Liddell Power Station in 2023, these low daytime prices are expected to persist based on electricity market supply-demand analysis prepared by Green Energy Markets and the Institute of Energy Economics and Financial Analysis detailed in the report, *Fast Erosion of Coal Plant Profits in the National Electricity Market*[1]. The persistence of low wholesale prices in spite of the closure of Liddell over 2022 and 2023 is supported by current wholesale electricity forward contract prices which are currently trading at prices for the 2024 year that are lower than 2023 for all regions that are traded (South Australia, Victoria, NSW and Queensland)[2].

NT and WA customers on the other hand are assumed to be charged for energy based on charges that are more smeared across peak and non-peak periods and so see much higher energy charges during the daytime period.

Solar feed-in tariffs offered to residential customers had been expected to closely match the value of solar generation in the wholesale electricity market except where government policy specifically regulated an alternative rate. However, it has become apparent that in regions where the feed-in tariff is unregulated (QLD, SA and NSW) most of the major electricity retailers offer at least one product that provides a feed-in tariff noticeably higher than what a solar generation profile could expect to receive from the wholesale electricity market. Our understanding is that power retailers use the feed-in tariff rate as a marketing tool to attract some types of customers whose choice of retailer is predominantly driven by the feed-in tariff above other factors. In our research we find that while retailers will often also offer other products with lower energy import and fixed charges coupled with a lower feed-in tariff, the owner of a solar system sized at 6.6kW will usually be better off with the higher feed-in tariff product from a particular given retailer. This practice of offering a high feed-in tariff product is widespread across many electricity retailers and has remained commonplace even as the wholesale value of solar generation has dropped dramatically over the last two years.

Due to the widespread nature of this practice, our model's estimate of feed-in tariffs for the residential sector now incorporates a 3 cent per kWh premium on top of the wholesale market energy rate. This premium is derived from a review of major retailers offers provided on the EnergyMadeEasy retailer comparison website across QLD, SA and NSW with an adjustment to partially account for the higher fixed and energy import charges.

While it is expected that wholesale power prices will fall significantly during daylight hours and with them feed-in tariffs paid for solar generation exported to the grid, batteries can mitigate this fall in revenue. In our model batteries charge up when solar generation exceeds the customer's load, using the generation that would otherwise only earn the feed-in tariff. Then once solar generation is insufficient to cover the site's load the battery will discharge to cover the remaining load. This typically occurs towards

[1] See this weblink for the report: http://greenmarkets.com.au/images/uploads/Coal-Plant-Profitability-Is-Eroding_February-2021.pdf

[2] This is based on ASX baseload calendar contracts obtained from https://www.asxenergy.com.au/ on 9 July 2021. Prices per MWh were SA: 2023-$48.64/2024-$48.17. NSW: 2023-$61.77/2024-$59.51. VIC: 2023-$44.15/2024-$43.53. QLD: 2023-$51/2024-$48.78

the late afternoon or early evening for residential premises when the customer is also expected to face peak retail pricing.

In this way the battery allows the customer to shift solar generation from earning revenue that is tied largely to values in the wholesale market to instead avoiding the cost of electricity tied to retail prices. We incorporate the impact of state battery incentive schemes, where they exist, in our payback model. Northern Territory and Tasmania do not have incentives.

3.3 Forecasting STC prices

We assume that over the forecast period the STC market comes into better balance and that the Clearing House does not go into deficit. We are forecasting an underlying STC spot price of $39 from 2022 to 2025 and after allowing for 47 cents registration cost we have used $38.53 per STC to incorporate into our payback model.

3.4 Forecasting new residential and commercial PV payback periods

As explained previously in section 2, we adopt a simple payback approach to represent the relative financial attractiveness of PV to consumers in each state. The system payback is derived by dividing the installed cost of the system (less the value of STCs) by the average value of electricity produced based on prices prevailing in the year of installation and the year prior to installation. In addition to the installed system cost, STC price and electricity price assumptions covered above, we have also incorporated the following assumptions:

For residential systems:

- For payback modelling purposes we have used a generic average system size for each state that is typical of what is currently being installed and is assumed to be generally 6.6 kW. For payback purposes we use a constant 6.6kW size to 2025 (effectively represents the median). For estimating the level of STCs we assume that the average system increase modestly over time; and
- Electricity output of the solar system differs by state and is based on annual average output per kilowatt estimated by the Clean Energy Council. Exports are determined by state based on expected average irradiance levels for the given state's capital city sourced from the Bureau of Meteorology relative to an average hourly electricity load derived from data sourced from the Smart Grid Smart City trial.

For commercial systems:

- We model commercial paybacks on a state by state basis. Most business sites consume less than 160 MWh of electricity per annum and pay electricity tariffs that are broadly similar to residential customers. The average system size is assumed to be 20 kW which is consistent with the average system size installed over the last few years; and
- The distribution of load over each hour is derived from data from substations serving predominantly business premises. The load profile is then scaled to a level that matches with feedback from interviews with solar industry participants that they typically apply a rule of thumb in sizing solar systems that aims to keep exported generation (or spilled generation where the system is prevented from exporting) to around 20% or less of total annual solar generation. Industry feedback is that the financial attractiveness of a system to customers usually significantly deteriorates once exports exceed 20% of total annual generation. For the purposes of payback calculations the generation excess to site load is assumed to generate no revenue. This is in line with the fact that many commercial systems will be prevented from exporting to the grid as a condition

of connection or in some cases are unable to secure a feed-in tariff from their retailer.

Average system paybacks dropped dramatically in most NEM states since 2018 due to high wholesale prices. With the expected reduction in the value of exported electricity and lower avoided import prices combined with reducing STC value, paybacks across all states are expected to increase over the forward period (Figures 3.3 and 3.4).

Figure 3.3 Simple Payback (real) for typical residential PV system (6.6 kW)

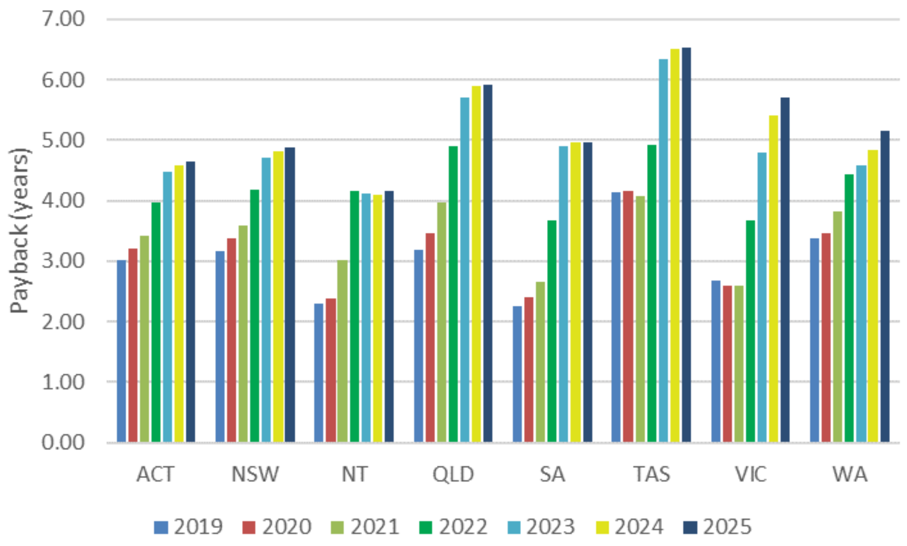
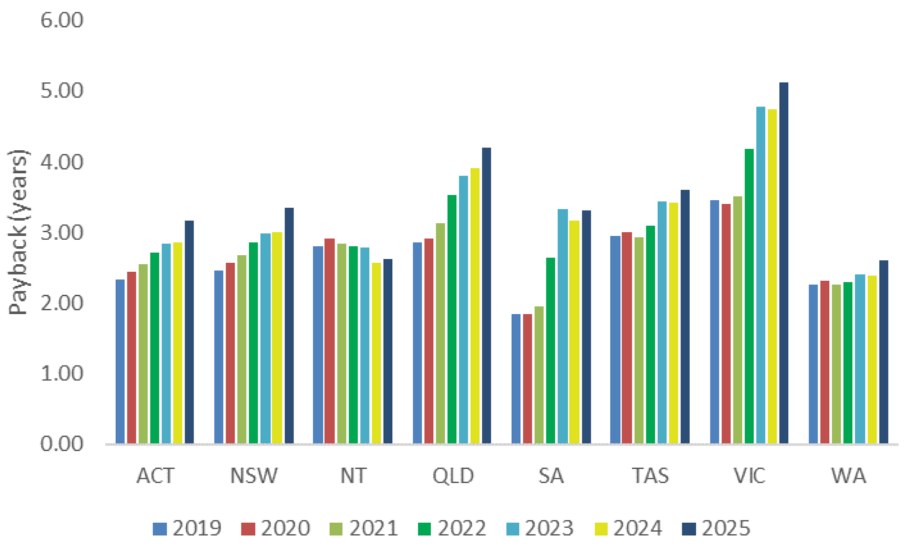


Figure 3.4 Simple Payback (real) for typical Commercial PV system (20kW)



4. Updated STC Forecasts for solar PV

We have updated our assumptions and slightly refined our modelling approach in developing our STC forecasts for the 2021 to 2025 period.

4.1 Solar industry participant interviews

As part of refining the model, select interviews were undertaken with a range of industry participants as part of this project that when combined provide a useful overview of the state of the Australian market for solar PV.

These interviews indicate that the level of customer inquiries and interest in solar remains high relative to levels from 2017 to 2019 but are down on 2020 levels.

Interviewees revealed that in 2020 sales benefitted from a one-off lift that flowed from the effect of COVID-19 restrictions on household consumer behaviour. COVID-19 restrictions on travel and hospitality and greater confinement of people within their own homes appear to have had the unanticipated effect of stimulating household expenditure on goods related to the home. Retailers selling household durable goods and home improvement hardware saw substantial increases in sales[3]. Solar suppliers appear to be another beneficiary of this COVID19-induced home improvement expenditure effect, especially given increased incidence of working from home would have increased daytime electricity consumption.

While STC creation data shows noticeably greater amounts of capacity being registered with the CER over 2021 to date relative to the same months in 2020, we suspect that this is actually a lingering effect of highly buoyant sales levels in 2020. A number of retailers/installers of solar built-up a significant back-log of contracted sales which in a number of cases are taking them several months to actually fulfil by installing the system. This means the STC creation data coming through over the past 6 months reflects to a large degree sales contracts secured back in 2020. The more sub-dued level of customer interest in purchasing solar in recent months will take some time before it manifests in lower installations. Yet it suggests that - consistent with our model's assumptions - the falling retail and feed-in tariff prices for electricity and deteriorating payback will lead to lower solar uptake. It's just that the one-off impact of COVID-19 restrictions and backlogs have delayed the point at which deteriorating payback is flowing through to installations relative to what we have previously assumed.

4.2 Estimated STCs to be created for 2021 Installations

We have analysed the level of STCs that have been submitted for creation on a weekly basis by year of installation for the key market sectors. We have assumed that the average lag in 2021 creation will be similar to that experienced in 2019 and 2020 with adjustments for the following:

- Observed quicker submittal of STC claims to the CER with the increasing use of Serial Panel Number Verification;
- Significant growth in NSW and South Australia during 2020 likely due to (i) Covid-19 restrictions, particularly limitations on travel and entertainment has meant families have additional disposable expenditure which has been

[3] S. Mitchell (2020) *'Cocooning' boom could go on for years: Gerry Harvey*, Australian Financial Review, 25 November 2020, https://www.afr.com/companies/retail/harvey-norman-profits-rocket-as-consumers-cocoon-at-home-20201125-p56hpq; S. Marsh (2020) *Bunnings, Officeworks shine as Wesfarmers delivers $1.7 billion profit*, 9News.com.au, 20 August 2020, https://www.9news.com.au/national/wesfarmers-fy20-financial-results-bunnings-kmart-officeworks-giant-booms-during-covid19/0f370d5a-9bb1-4a64-a4d3-e7b69d9ab583

directed to solar and (ii) Solar retailers active in multiple states redirecting resources from Victoria to other states (including relocating installation teams); and
- Impact of the extended Lockdown stage 4 in Victoria where installations in metropolitan Melbourne ground to a halt for a number of weeks in 2020.

The lag in creation for all market sectors is summarised in Attachment 9.

4.3 Forecasting new residential PV installations and STCs created

We have adopted the same approach as we have in our previous modelling exercise in developing demand for new residential solar PV systems (refer to Section 3). We have made a number of revisions to improve the accuracy of our projections including:

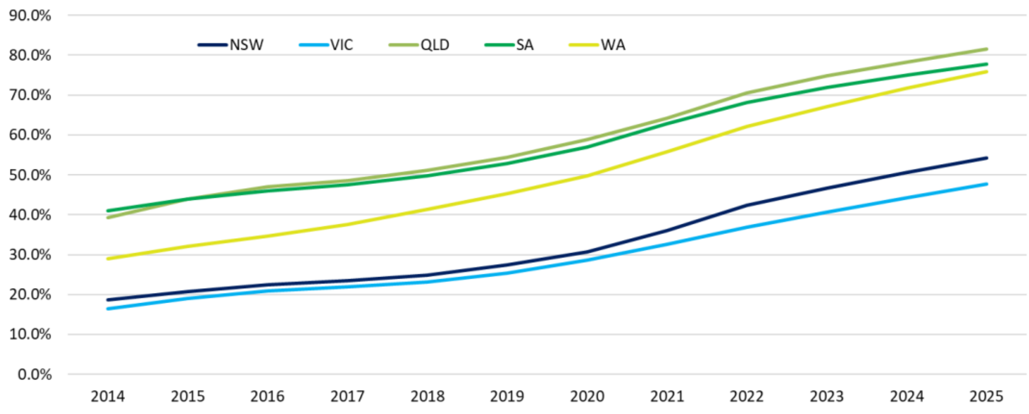
- In our modelling with have assumed that the enhanced industry competitiveness and customer awareness remains in place for 2021 similar to 2020 levels and then proceeds to get back to more normal levels by 2023; and

- We have assumed that the level of new residential installations in Victoria will be governed by the Victorian Solar Homes Program with the desire to support 650,000 residential PV systems over 10 years. We have assumed that the program parameters will be adjusted to ensure that the policy commitment of 650,000 solar PV systems will be achieved.

The level of projected system installations by state is outlined in detail in Attachment 2 together with expected penetration levels.

Penetration levels for new PV system sales reach very high levels when measured against owner occupied detached and semi-detached homes. Queensland, South Australia and WA all reach levels exceeding 70% by 2025. This may seem quite high and potentially unrealistic. Using historical owner occupied homes as a metric becomes potentially less effective over time as homes move from owner occupied to rental and a number of rental homes install solar. Over time a more accurate representation of saturation may be to include all detached and semi detached homes. For modelling purposes to estimate future demand relative to the baseline 2019 installations, we believe that owner occupied homes is still an effective metric.

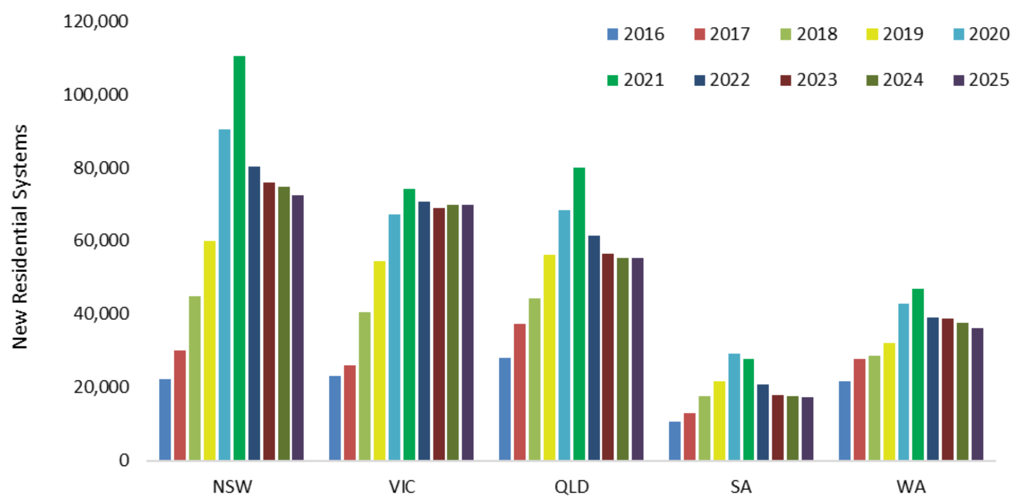
Figure 4.1 Penetration level by key state



Note: Penetration rate represents the cumulative proportion of residential systems installed as a proportion of owner occupied houses (separate and semi-detached)

New residential system installations are expected to decline over the next four years as financial attractiveness deteriorates. The only exception is Victoria where installations are supported under the Solar Homes program (Figure 4.2).

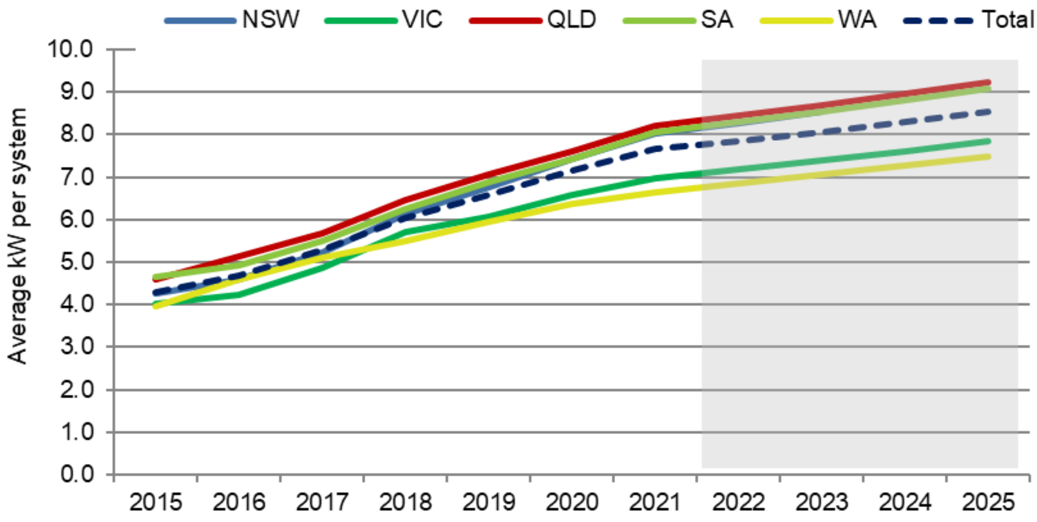
Figure 4.2 New residential installations by key state



We are expecting only a modest slowdown in the increase in the average system size that has been experienced over the last few years. The soft electricity network constraint we had assumed in the past (limiting system size to between 6.5 to 7 kW) appears to no longer be the case.

We have assumed that the average system size increase by approximately 3% per annum increasing from 7.66 kW per system in 2021 to 8.54 kW per system by 2025.

Figure 4.3 Average system size for NSW, Qld, SA, Vic and WA



The capacity installed and resultant STCs created by state are included in Attachment 3. A summary of results is outlined in Figure 4.4 below:

Figure 4.4 New residential solar installations and STC creation

Year of installation	Estimate 2020	Estimate 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025
Number of Systems Installed	308,535	350,377	281,267	266,576	263,718	259,361
Avge kW/system	7.14	7.66	7.84	8.05	8.29	8.54
Avge Certificates/kW	14.7	13.4	12.0	10.7	9.3	8.0
MW Installed	2,202.5	2,684.7	2,204.7	2,147.3	2,186.7	2,215.2
Eligible Certificates ('000)	32,451	35,975	26,470	22,894	20,383	17,689

4.4 Forecasting new commercial PV installations and STCs created

We identified in Section 2 of this report, that the CER has been collecting data on the type of premises that the system was installed since mid-2014. We have used the CER's delineation from 2015 when a full year's data was available. For systems installed prior to 2015 we have continued to use systems greater than 10 kW as a proxy for non-residential systems.

We have adopted the same approach as previous modelling exercises in developing our estimates for new commercial PV installations. As opposed to residential installations demand is not significantly constrained by high levels of saturation. The commercial sector therefore is expected to be an attractive market for the solar industry as the residential market declines.

Assumptions used and methodology are summarised in Sections 2 and 3. The expected reduction in wholesale prices combined with a reduction in the contribution of STCs will see a modest increase in payback periods from 2020 (Figure 3.4).

For the forecast period, we have assumed that the average system size in each state over the 2020 and 2021 years generally applies in future.

The total number of systems installed, and associated certificates created for the non-residential PV market is detailed in Attachment 4 and summarised in Figure 4.5.

Figure 4.5 New non-residential solar installations and STC creation

Year of installation	Estimate 2020	Estimate 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025
Number of Systems Installed	18,176	21,879	19,594	18,779	18,750	18,083
Avge kW/system	22.18	21.01	21.68	21.01	21.68	21.68
Avge Certificates/kW	14.7	13.4	12.1	10.7	9.4	8.0
MW Installed	402.9	459.7	424.7	407.2	406.7	393.0
Eligible Certificates ('000)	5,942	6,170	5,126	4,368	3,818	3,161

4.5 Forecasting upgrade residential and commercial PV installations and STCs created

We have separately analysed the solar PV systems that have created certificates at an address that already had a system installed. These installations will either represent instances where a solar system has been upgraded (ie. the capacity has been increased) or where the previous system has been replaced. From 1 February 2018 replacement systems will no longer be eligible to create certificates. We have segmented these installations into residential and non-residential.

With rising penetration in the new residential market segment solar resellers and installers are increasingly targeting their existing customers to upgrade their systems. More than 600,000 solar PV systems were installed before 2012, the vast majority of which were less than 1.6 kW. With the average size of new residential systems installed in recent years being above 6 kW there is enormous potential for the progressive upgrading of these systems. There is however a disincentive to upgrade systems where attractive feed-in tariffs are in place.

The total number of systems installed, and associated certificates created for the upgrade PV market is detailed in Attachment 6 and summarised in Figures 4.10 and 4.11.

Figure 4.6 Upgrade residential solar installations and STC creation

Year of installation	Estimate 2020	Estimate 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025
Number of Systems Installed	41,467	64,917	61,523	61,257	67,869	76,543
Avge kW/system	6.48	7.08	7.29	7.08	7.29	7.51
Avge Certificates/kW	10.7	13.6	12.3	10.9	9.6	8.2
MW Installed	268.8	459.5	448.6	460.2	525.8	611.3
Eligible Certificates ('000)	2,888	6,252	5,497	5,020	5,022	5,006

Figure 4.7 Upgrade non-residential solar installations and STC creation

Year of installation	Estimate 2020	Estimate 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025
Number of Systems Installed	2,811	3,023	3,391	3,578	4,109	4,367
Avge kW/system	32.49	25.39	25.39	25.39	25.39	25.41
Avge Certificates/kW	15.0	13.6	12.3	10.9	9.6	8.2
MW Installed	91.3	76.8	86.1	90.9	104.1	110.7
Eligible Certificates ('000)	1,367	1,044	1,056	992	995	906

4.6 Summary of number of systems and capacity installed by state

A summary of the expected number of systems sold and capacity to be installed under both the Base Case and High DER Scenario are summarised in Figure 4.7 and 4.8.

Figure 4.7 Number of PV systems installed by state

Base Case

	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Total
2021	7,089	140,210	1,782	109,740	35,744	4,392	84,917	56,324	440,196
2022	5,355	108,867	2,604	89,347	27,384	3,181	80,592	48,444	365,775
2023	5,034	104,936	2,626	83,987	23,765	3,001	78,104	48,736	350,190
2024	5,062	106,567	2,665	85,311	24,017	3,038	79,281	48,504	354,445
2025	5,109	107,202	2,673	88,498	24,343	3,104	79,597	47,827	358,354

High DER

	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Total
2021	7,663	157,286	1,782	111,623	38,032	4,696	86,341	59,829	467,254
2022	6,545	134,042	3,203	106,594	32,290	3,490	93,493	56,445	436,102
2023	6,235	131,372	3,565	102,219	28,168	3,294	92,483	58,062	425,399
2024	7,415	158,975	3,215	106,908	30,985	3,377	96,319	59,385	466,578
2025	8,028	172,232	3,242	111,093	33,956	3,466	96,449	59,181	487,644

Figure 4.8 PV capacity installed by state (GW)

Base Case

	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Total
2021	0.06	1.20	0.02	0.96	0.32	0.03	0.68	0.40	3.68
2022	0.05	0.97	0.03	0.81	0.26	0.03	0.66	0.36	3.16
2023	0.05	0.96	0.03	0.79	0.23	0.03	0.66	0.37	3.11
2024	0.05	1.00	0.03	0.82	0.24	0.03	0.68	0.38	3.22
2025	0.05	1.02	0.03	0.86	0.25	0.03	0.70	0.39	3.33

High DER

	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Total
2021	0.07	1.34	0.02	0.97	0.34	0.04	0.69	0.43	3.89
2022	0.06	1.19	0.03	0.97	0.31	0.03	0.76	0.42	3.77
2023	0.06	1.19	0.04	0.96	0.28	0.03	0.77	0.44	3.77
2024	0.07	1.47	0.03	1.03	0.31	0.03	0.83	0.46	4.23
2025	0.08	1.62	0.03	1.09	0.34	0.03	0.85	0.48	4.51

5. Updated STC Forecasts for SWH and ASHP

Overview

We estimate that more than 89,000 SWH and ASHP systems will be installed and create certificates in 2021 which is a 18% increase on 2020 levels. The most important drivers of uptake have been the level of new home building and policy support measures such as building regulations and energy efficiency schemes.

New building market

The number of systems installed by state in the new building market has been reasonably stable on a year to year basis (refer to Attachment 7). This is in sharp contrast to the replacement market.

The primary drivers behind purchase behaviour in the new home market segment is the number of new dwellings and building regulations.

SWH and ASHP sales data, sourced from Industry, suggests that the number of systems that create certificates is between 10 to 15% lower than the total number of systems sold. This is not a new trend, and we see no reason for this to change. The systems that do not create certificates are generally thought to be the result of difficulties that home builders/renovators face when faced with the prospect of creating certificates. The difficulties arise from the confusion and uncertainty as to who has the right to create the certificates. Specifically, when the future owner of the home/building may not own the system at the time it was installed. This means that using SWH that create certificates as the data point will understate the real level of SWH installations in new homes by 20-25%.

Using the data provided by the CER we have isolated the SWH systems installed in new buildings and analysed historic trends. We use this analysis as the basis for forecasting the level of installations for the new-build submarket.

The level of new home commencements is expected increase as Covid recovery gets underway. We have used the latest forecast by the Master Builders Association (updated in August 2020) which incorporates an assessment of the impact of the economic downturn in 2020/21 (Figure 5.1), We have derived state figures in Figure 5.1 based on the MBA's February forecast and then applied an adjustment following their August revision.

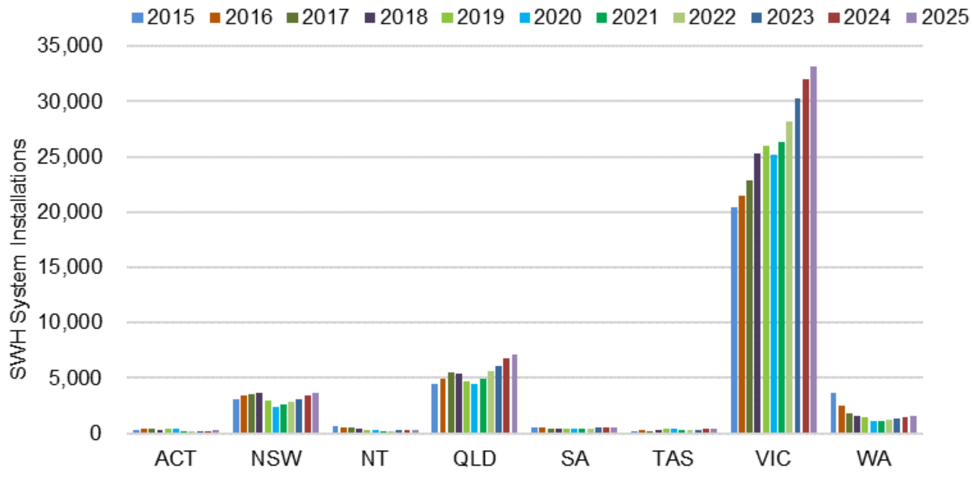
Figure 5.1 Master Builders Association (MBA) – New Home commencements

	2019	2020	2021	2022	2023	2024
ACT	0.97%	-12.97%	-2.13%	-0.82%	-7.52%	6.17%
NSW	-13.90%	-24.97%	-11.56%	5.88%	5.37%	13.16%
NT	-19.73%	-22.17%	-3.06%	17.47%	17.30%	20.69%
QLD	-15.59%	-17.61%	-1.61%	10.19%	6.25%	11.54%
SA	-9.51%	-19.47%	-18.13%	-2.20%	0.41%	11.06%
TAS	3.74%	-15.85%	-14.24%	-2.08%	-2.27%	8.84%
VIC	-9.04%	-19.76%	-12.68%	4.51%	4.95%	11.77%
WA	-12.26%	-16.11%	-3.20%	8.69%	7.02%	14.72%
	-11.71%	**-20.04%**	**-9.29%**	**6.00%**	**5.08%**	**12.29%**

We do not envisage any changes to new building regulations over the forecast period that will have a material impact on the level of SWH and ASHP installations. We have assumed that there is not a material impact from any possible future measures from the National Construction Code 2022 Energy Efficiency project. We have used the MBA forecast of new home commencements as the basis for our projections. We have also incorporated a market growth factor of 2.5% per annum which is the observed growth in the level of SWH installations over the last four years beyond what would have been suggested by the level of new home starts.

The combined level of SWH and ASHP systems creating certificates is summarised in Figure 5.2 and is included in detail in Attachment 7. Victoria which has the most progressive new building regulations remains the leading state for this segment.

Figure 5.2 SWH and ASHP Systems claiming certificates for New Homes by state



Replacement submarket

At the time of replacement, most hot water systems are replaced with the same or similar type of system. The dynamics of the replacement market, which are often dictated by a rush to replace a broken or failed water heater, mean there is little time and/or financial liquidity to make thoroughly researched decisions. Thus, historically, the majority of water heater replacements have been on a 'like-for-like' basis.

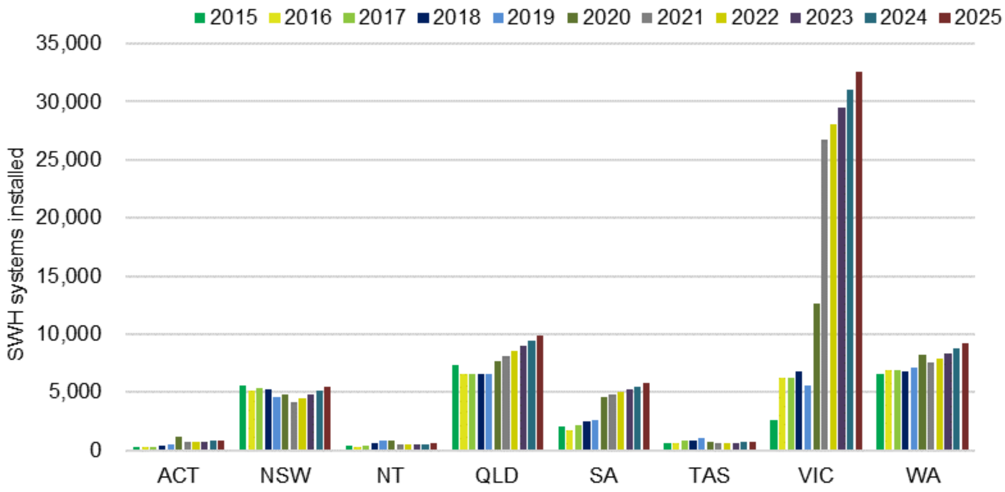
There have been a range of state-based schemes, incentives and/or regulations, particularly for the replacement of electric resistance water heaters (EWH).

The only material rebates that are currently available are in Victoria through the Victorian Energy Upgrade (VEU) which includes SWH as an eligible activity and the Governments new Solar Program. Under the VEU, a EWH system replaced by a SWH system can generate approximately 30 Victorian Energy Efficiency Certificates (VEECs). With the recent increase in the VEEC price following the announcement of the expansion of the scheme, VEECs provide an added financial incentive of more than $2000 per system. This has helped drive extra SWH and ASHP system installations in Victoria. Under the Solar Homes Program a $1000 rebate will be available on the installation of a SWH or ASHP system. In addition we have seen the emergence of new competitors (selling and installing ASHPs) in this market which has resulted in a higher level of overall installations.

We forecast that the replacement market will grow over the coming four-year period as increasing numbers of SWH systems installed in 2009 and 2010, where the market surged due to expanded government grants, will start to be replaced. We have factored in average growth rates of 5% per annum to reflect this development.

The combined level of SWH and ASHP systems creating certificates is summarised in Figure 5.3 and is included in detail in Attachment 8. Victoria which has the most attractive incentive scheme (through the VEU program) is again the leading state for this segment.

Figure 5.3 Replacement SWH and ASHP Systems claiming certificates by state



Certificates created from the installation of SWH and ASHP systems

We have assumed that the average certificates per system (on a state basis) for the 2022 to 2025 forecast period will be similar to the average levels achieved over the 2020 to 2021 period adjusted for the reduction in the numbers of years deeming.

Figure 5.4 Certificate creation from SWH and ASHP Systems

Year of installation	Estimate 2020	Estimate 2021	Forecast 2022	Forecast 2023	Forecast 2024	Forecast 2025
New Buildings						
Number of Systems Installed	34,799	36,181	39,034	42,001	45,225	47,214
Avge Certificates/System	29.9	30.1	26.8	23.8	20.9	17.9
Eligible Certificates ('000)	1,040	1,088	1,047	1,001	944	844
Replacement						
Number of Systems Installed	40,680	53,118	55,876	58,781	61,839	65,058
Avge Certificates/System	30.9	31.4	28.3	25.1	22.0	18.9
Eligible Certificates ('000)	1,258	1,670	1,581	1,478	1,361	1,227
Total						
Number of Systems Installed	75,479	89,299	94,910	100,782	107,064	112,272
Avge Certificates/System	30.4	30.9	27.7	24.6	21.5	18.5
Eligible Certificates ('000)	2,298	2,758	2,628	2,479	2,304	2,071