Small-scale Technology Certificate Modelling

Clean Energy Regulator

RO201100 | 1

11 February 2019

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Project No:	RO201100
Document Title:	Small-scale technology certificate modelling
Document No.:	Draft Report
Date:	11 February 2019
Client Name:	Clean Energy Regulator
Project Manager:	Sandra Starkey
Author:	Sandra Starkey
File Name:	I:\MMA\Projects\RO201100 CER\WF\Second Tranche Data\Report\RO201100 CER Final Report 16 January 2019 - Copy.docx

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Azara 841, Piso 1
Ciudad Autonama de Buenos Aires
Buenos Aires, Argentina
ARBUAC 1267
T +54 114 309 0200

www.jacobs.com

Contents

Executive Summary

The Clean Energy Regulator (CER) is responsible for the regulation of the Australian Government's climate change laws and programmes, one of which is the Renewable Energy Target (RET). One of its functions is to administer the Small-scale Renewable Energy Scheme. The SRES scheme is designed to achieve generation of electricity from small-scale renewable sources, reduce emissions of greenhouse gases in the electricity sector, and ensure that renewable energy sources are ecologically sustainable.

The SRES scheme offers small-scale technology certificates (STCs) at a fixed price of $40 per certificate through the STC clearing house to purchasers of eligible solar water heaters (SWH), air source heat pump water heaters (HPWH) and small-scale photovoltaic (PV), wind and hydro systems. STCs are traded on the open market.

There is no cap for the number of STCs that can be created. Up until 2017, each installed system could create certificates equivalent to 15 years of expected generation from the system for a small-scale renewable generator and equivalent to 10 years for a renewable water heater. From 2016, the number of STCs generated per unit is one year less than previous, with the view that the scheme tapered off in a gradual linear manner.

The purpose of this report is to forecast the number of STCs that will be generated in the calendar years of 2019, 2020 and 2021. This will assist in determining the number of STCs each electricity retailer is obliged to surrender each year and thereby maintain the market value of STCs at approximately $40 per certificate.

Historically, the majority of uptake has been through solar hot water units and residential solar PV generation. Uptake in solar PV generation has now largely supplanted uptake from solar hot water and has been influenced by reductions in the installed cost of new solar PV systems, growing market acceptance of these technologies, increasing electricity retail prices and government incentives.

Soaring electricity prices in 2017 saw a massive growth in the rate of PV installations. This has resulted in strong levels of growth projected for commercial installations over the forecasting period driven by sound economic benefits. In 2019 we see the results of generous state-based incentives in Victoria and South Australia cause an increase in STC creation despite forces such as housing saturation and a reduction in electricity prices driving a decreasing trend in the market for solar PV installations. Table 1 shows our projections of STC creation. These projections are based on our time-series modelling approach.

Table 1: Projected STCs, thousands

	2018	2019	2020	2021
Commercial STCs	6076	5578	5,229	4,860
Residential STCs	20,974	20,937	18,740	16,914
QLD	5,611	5,419	4,624	4,095
NSW	5,709	4,970	3,934	3,374
ACT	305	182	127	99
VIC	3,611	4,694	4,445	3,991
TAS	198	205	200	185
SA	2,162	1,722	1,542	1,394
WA	3,092	3,467	3,654	3,613
NT	286	278	213	164
VPP STCS	45	715	1,236	1,124
NSW Low Income Scheme		47	43	39
Australia SWH STCs	1925	1688	1521	1405
Commercial	76	61	44	31
Domestic	1,849	1,627	1,476	1,374
All STCs	29,020	28,966	26,769	24,341

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to project STC volumes for calendar years 2019, 2019 and 2021 in accordance with the scope of services set out in the contract between Jacobs and the Clean Energy Regulator (CER).

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the CER and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the CER and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

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1. Introduction

The Clean Energy Regulator (CER) is responsible for the regulation of the Australian Government's climate change laws and programmes. One of its functions is to administer the Small-scale Renewable Energy Scheme. The SRES scheme is designed to achieve the following objectives:

- Generation of electricity from renewable sources;
- Reduced emissions of greenhouse gases in the electricity sector; and
- Ensuring that renewable energy sources are ecologically sustainable.

The SRES scheme offers small-scale technology certificates (STCs) at a fixed price of $40 per certificate through the STC clearing house to purchasers of eligible solar water heaters (SWH), air source heat pump water heaters (HPWH) and small-scale photovoltaic (PV), wind and hydro systems. STCs are also traded on the open market, typically at a discount to the clearing house price. There is no cap for the number of STCs that can be created.

The number of STCs created is based on an estimate of electricity generated or displaced by the renewable energy sources over their economic lifetime. The number of STCs created is also influenced by geographical location.

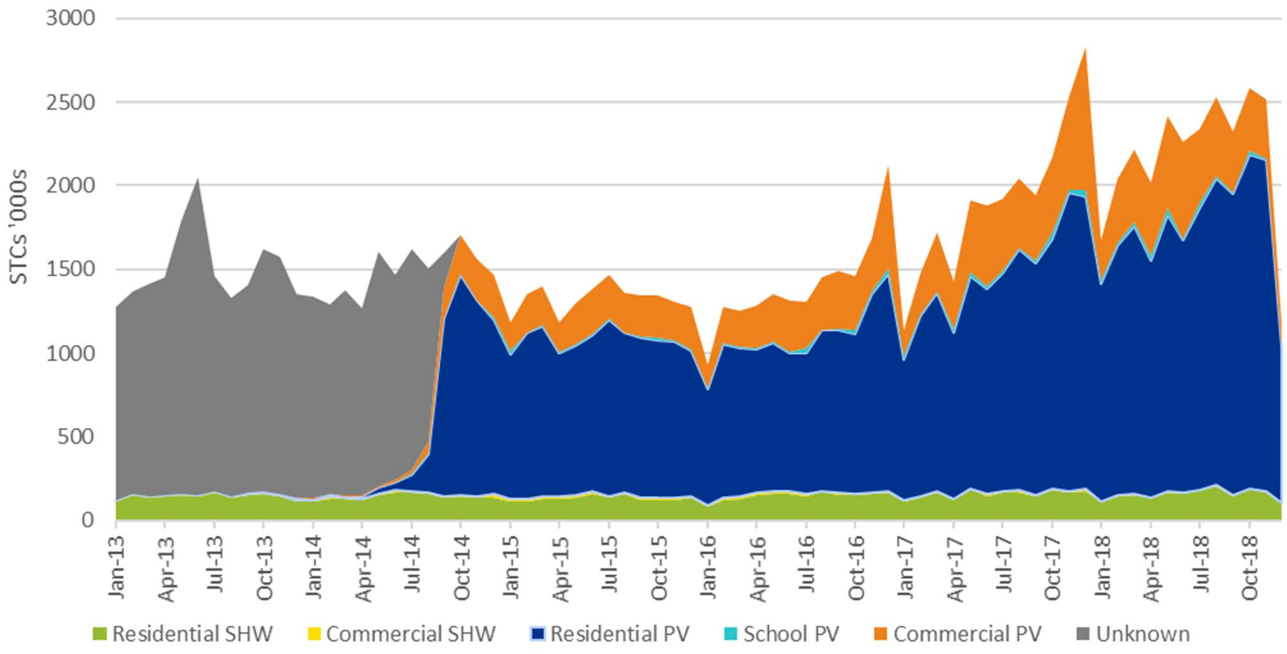
The purpose of this report is to forecast the number of STCs that will be generated in the calendar years of 2019, 2020 and 2021. This will assist liable entities to anticipate the extent of their liability over the coming year. Historical data has been supplied by the CER containing detailed information on the number of STCs created and registered including the type and location of unit installed. Data was provided from 2004 until 1 January 2019 to assist with the forecasts. All analysis and forecasts in this study are based upon STCs created in the month of installation and STCs are only considered if they have passed validation.

2. Trends in Uptake

2.1 Certificate creation

Figure 1 illustrates the trends in STC creation by the various categories. Dominance of residential PV installations remains, with the STCs created via installation of commercial systems having a growing influence within the mix. No small-scale wind or hydro SGU have had validated STCs produced since 2017. Domestic solar hot water systems are defined as systems that create less than 40 STCs upon installation, these systems have continued to make a relatively consistent contribution to the market since January 2013. Commercial sized hot water systems and school PV units make a very small contribution to the market.

Figure 1: Monthly trend in STC creation by category since January 2013



Source: CER data

2.1.1 Residential PV Systems

Figure 2 illustrates a surge in the growth of STCs across all states and territories since 2017. The large spike in STC creation in the last 3 months of Victoria is attributed to the new state based incentives launched by the state Labor government in August 2018 (see section 3.1).

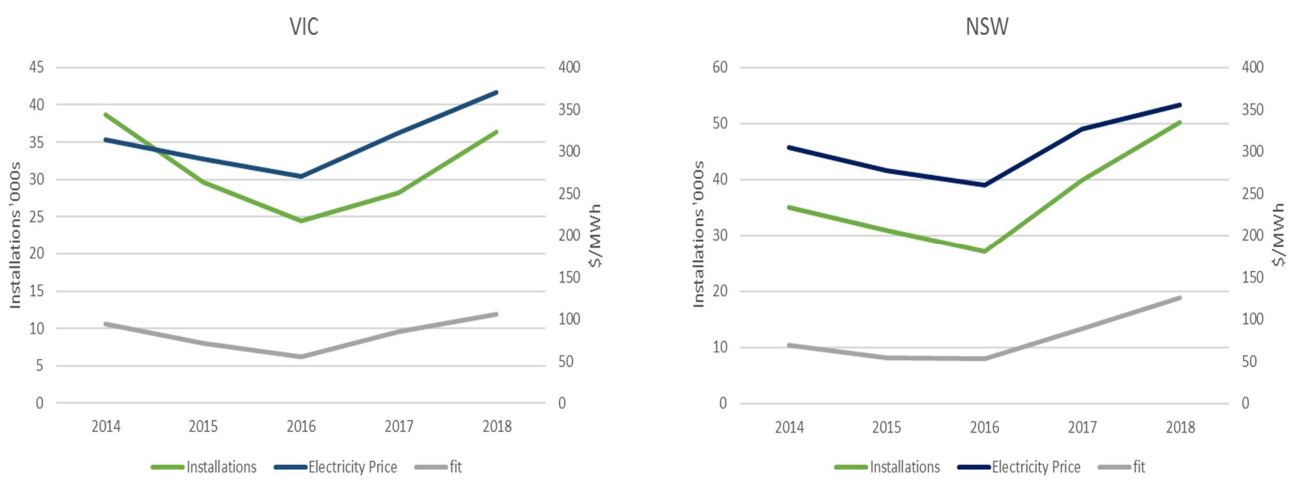
We see the rise in STC creation in 2017 and 2018 primarily attributed to the surge in electricity prices in addition to higher feed-in tariff incentives. The retail price of electricity has increased substantially in NEM states in 2017, largely driven by rising wholesale costs occurring resulting from higher wholesale gas prices and the retirement of the Hazelwood power station. Higher wholesale prices also flow through indirectly to the feed-in tariffs offered as the value of solar exports to an energy retailer is proportional to the wholesale price of electricity. Feed-in-tariffs jumped in 2016 and 2017 to levels double those in prior years.

Figure 3 shows the association between residential installations in selected states with the average retail electricity price and feed-in tariffs. With the exception of WA and the NT, most states exhibit strong parallels between the number of installations, the average electricity price and FiT in recent years (see Appendix A and Appendix B for further details).

Figure 2: Monthly trend in STC creation from residential solar PV across states and territories

Source: CER data. Creation is recorded as the date of installation.

Figure 3 Relationship between annual average electricity price, average FiT and number of installations in selected states



Source: Jacobs Analysis. Market research and CER data. Creation is recorded as the date of installation.

2.1.2 Saturation in residential sector

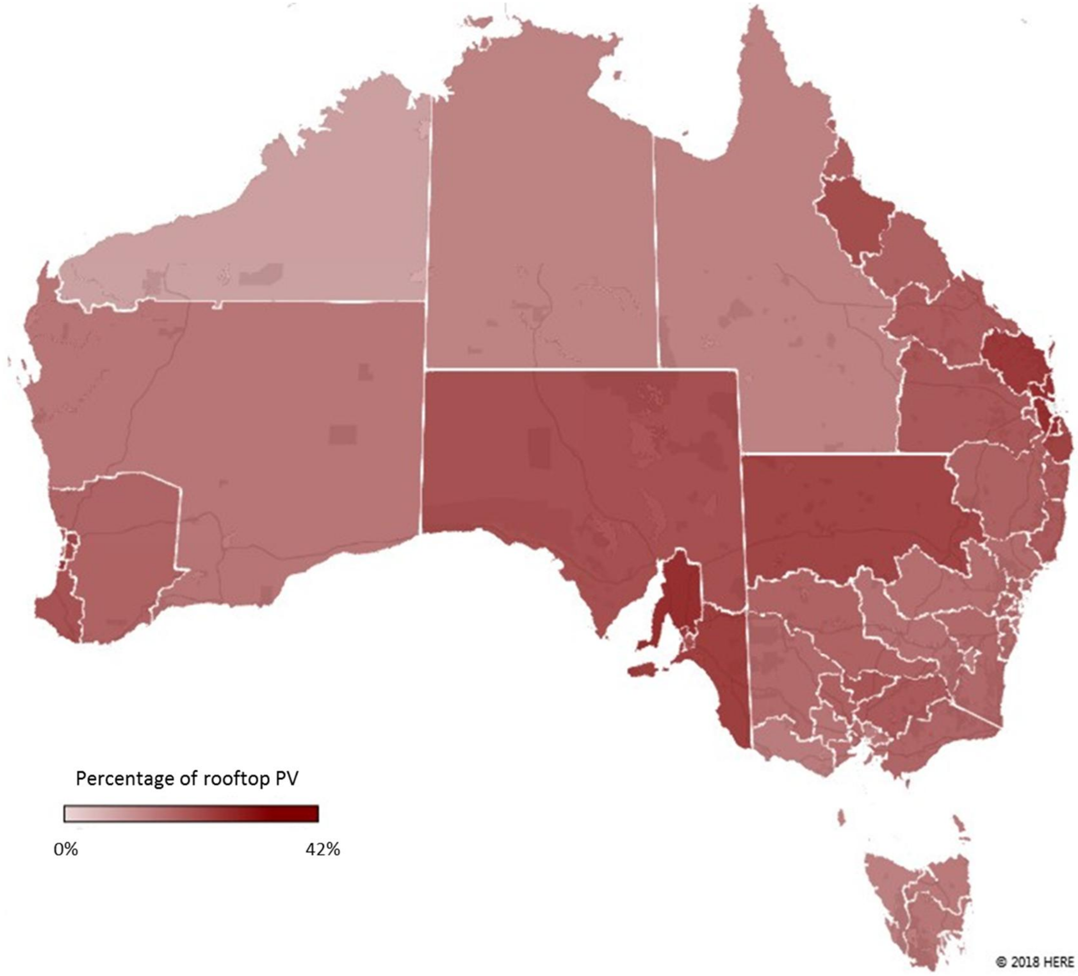
Limitations to the number of households that will install PV systems will be influenced by:

- Type of Dwelling – rising level of high density apartments
- Other physical impediments – such as rooftop subject to shading and aesthetics
- Home ownership –Property owners may be less likely to install systems on investment properties

Figure 4 shows the percentage of households with rooftop solar PV by region (statistical area 4). Levels of saturation differ significantly, with the lowest being inner Sydney with 1% of dwellings with rooftop solar, compared with the East Brisbane region containing 42% households with rooftop solar (Appendix C). While saturation is acknowledged as being an important contributor to the growth rates of solar installation, it is not used as a specific input into the forecasting model utilised in this study, with view that these trends are factored into the time series component of the modelling for the duration of the forecasting period.

According to the latest Census data (2016), a total of 78% of 9,924,972 dwellings in Australia are classified separate houses or semi-detached with one-storey, and around 62% of these residents are owner occupiers.

Figure 4: Percentage of dwellings with rooftop solar installed by region, 2018

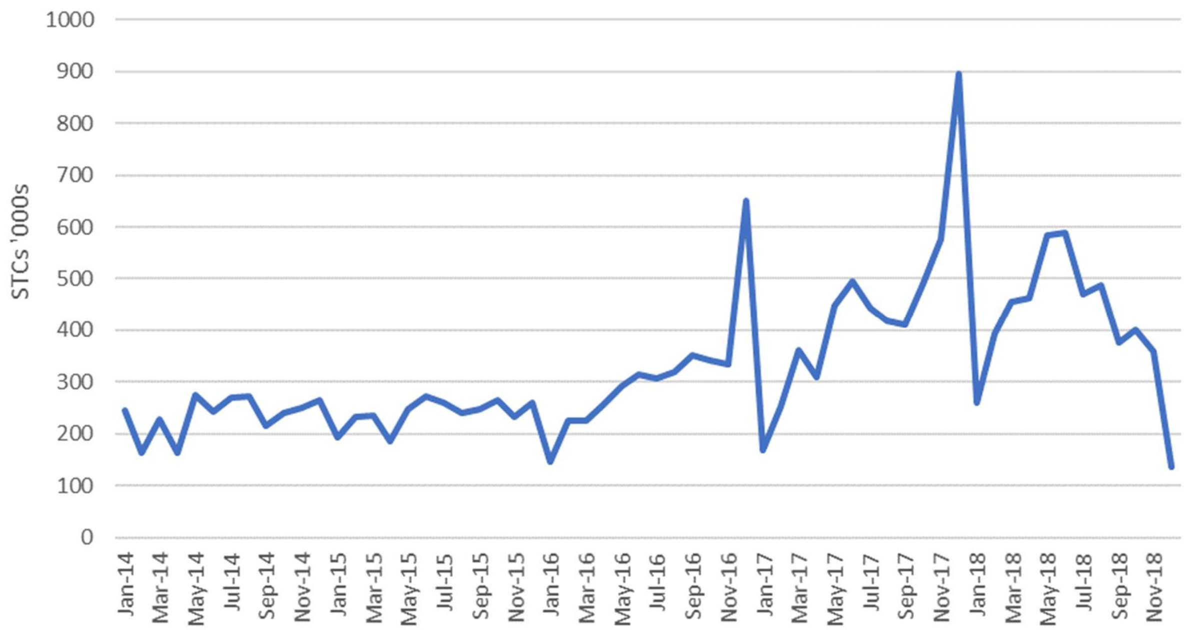


Source: Jacobs analysis. CER and ABS data.

2.1.3 Commercial PV Systems

Figure 5 illustrates the recent trends in STC creation by schools and businesses. Growth in uptake continued in the first half of 2018, continuing a growth phase that started in 2017. A distinct seasonal trend has emerged as business hastens to commit to installations prior to annual step down in rebates applied to small scale technology. This highlights the sensitivity of commercial installations to economic incentives.

Figure 5: Monthly trend in STC creation from commercial solar PV installations

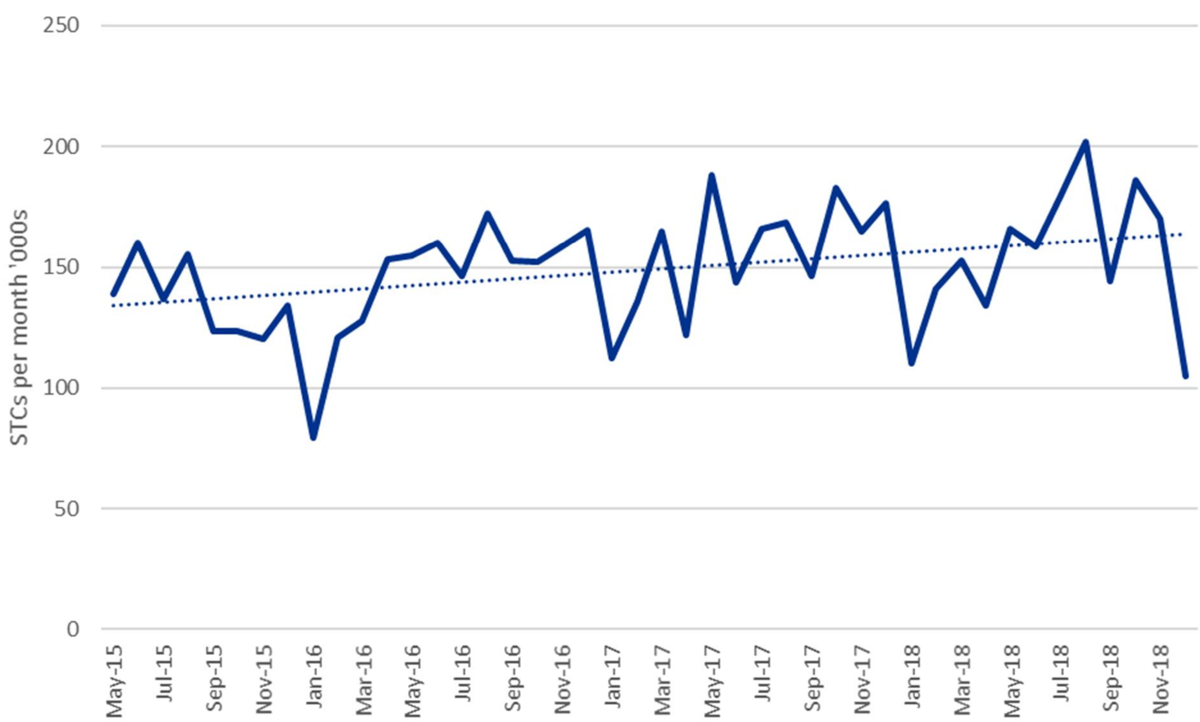


Source: CER data

2.1.4 Solar water heaters

Figure 6 shows the trend in creation of STCs by the installation of residential solar hot water systems since 2015. The market has shown strong growth in the last few years, with the year 2016 and 2017 having an increase of 10.4% and 7.3% respectively over their previous calendar years.

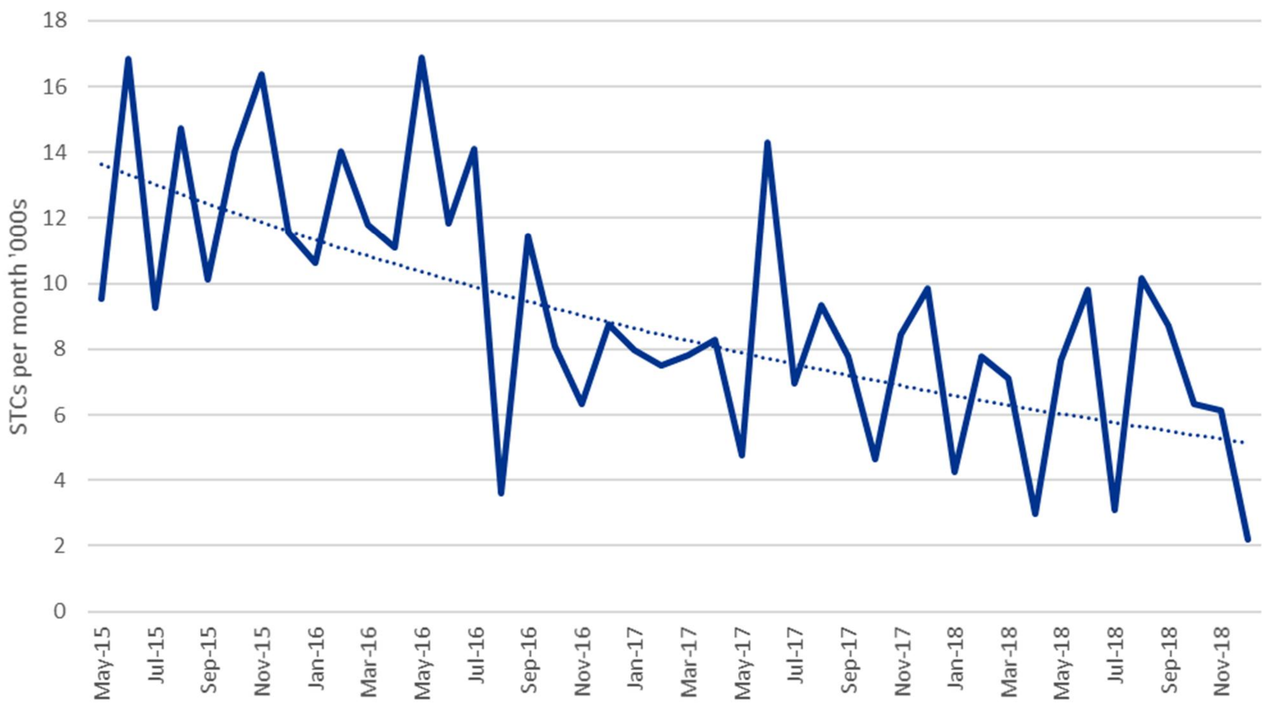
Figure 6: Monthly trend in STC creation from residential SHW



Source: CER data

In stark contrast to residential size systems, the number of STCs created by commercial size SHW units has plummeted within the last few years, as depicted in Figure 7. There was a decrease of 18% of STC creation in 2016, and a further 24% reduction in 2017.

Figure 7: Monthly trend in STC creation from commercial SHW



Source: CER data

2.2 Time lag to creation

As there is a 12-month window from the date of installation in which to register systems, the most recent registrations database will be missing records of systems that have already been installed, but which have not yet been registered. If not corrected for, this will lead to an underestimate in the number of systems installed in the most recent few months. This is particularly relevant for the time-series forecasting, which is sensitive to the most recent data points.

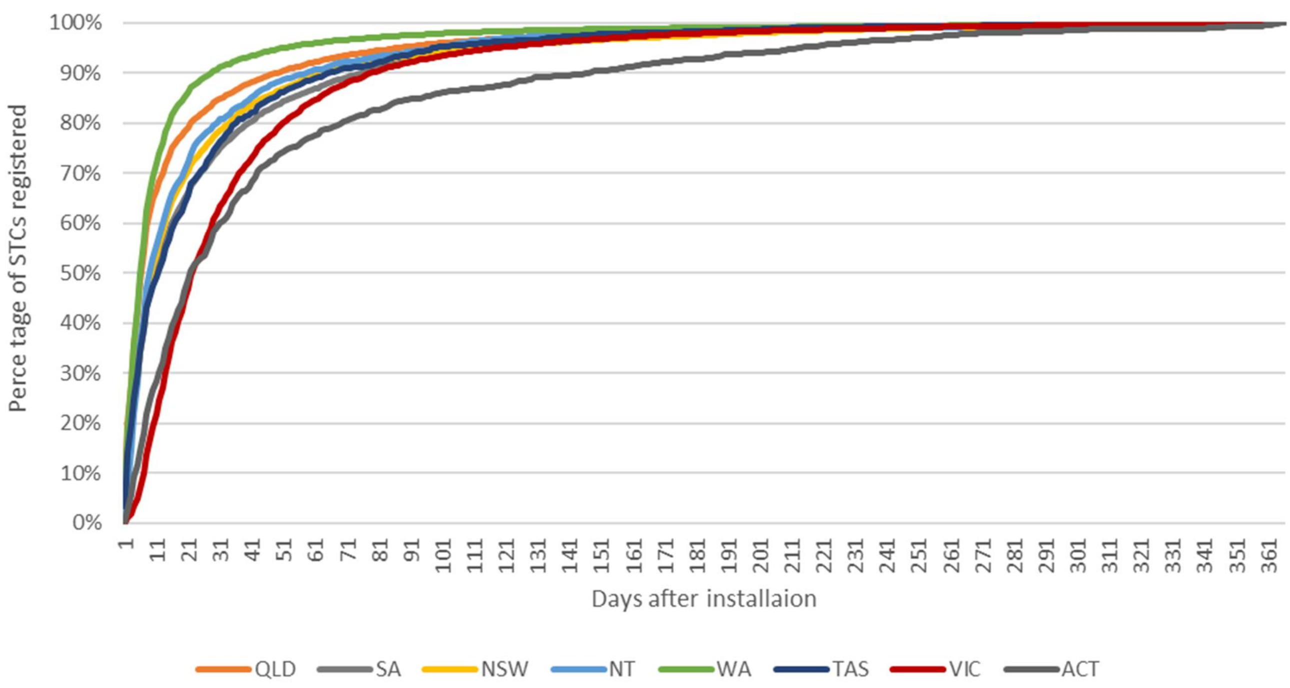
We have examined how long it takes before eligible systems are registered for STCs.

The data provided by the CER includes both the date of system installation and of STC creation, so we can calculate how many systems are registered one, two, three, or more months after the system itself was installed.

Data was analysed for the period of calendar year of 2017, with the assumption that all PV systems installed in 2017 were registered by 31st of December 2018. This period was selected due to its recency in reflection of current trends whilst still maintaining an adequate sample the avoidance seasonal trends. Months for the year of 2018 were not incorporated in this analysis due the bias that would occur that would favour the population who install early rather than later, resulting in an underestimate of time taken to register PV systems. Figure 8 shows the typical delay in registration for residential system installations, by state.

We have elected not to use registrations for the month of December 2018 in our analysis (1 month prior to the extraction of the data), as the uncertainty in actual capacity installed is too high. For the months of August through to November, the residential installed capacity was divided by the percentage of registered installations for the expected percentage of installations for the respective month as shown in Table 2.

Figure 8: Delay in STC creation from installation, 2017 residential SGUs



Source: CER data

Table 2: Expected percentage of installed capacity used in modelling for residential and commercial systems

Month	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Commercial
Nov 2018	60%	79%	81%	85%	76%	77%	64%	91%	82%
Oct 2018	78%	90%	91%	92%	87%	89%	85%	96%	91%
Sep 2018	85%	94%	94%	95%	93%	94%	92%	98%	94%
Aug 2018	88%	95%	97%	97%	95%	96%	95%	98%	96%

3. Government Incentives and Policies

The number of STCs that will be generated in the future is dependent on uptake of eligible technologies by households and businesses which is in turn influenced by financial incentives and regulations such as federal and state rebates, the state-based FiT schemes, and building standards. The energy efficiency building standards in place still impact the choice of hot water heaters installed in new houses.

Amidst a high degree of political uncertainty surrounding federal energy policy and the recent surge in energy prices, both Victorian and South Australian state governments have now initiated rebates for distributed renewable energy production and storage devices.

The state-wide blackout in South Australia during September 2016 has shifted the state government from incentives based purely on energy saving and renewable generation to focus more on energy security in the form of batteries. This has made the government increase incentives towards residential battery storage systems.

This section outlines federal and state-based schemes and regulations that could influence the uptake of solar PV and hot water system.

3.1 Solar Homes Rebate

In August 2018, the Victorian Labor government announced a new solar rebate scheme for the installation of eligible rooftop solar PV. The plan is means tested to households of income less than $180,000 and is expected to fund the installation of PV systems on 650,000 homes over a 10 year period. With the latest Census data suggesting that the median household income for Australians is around $84,000, the majority of Victorian households would be eligible for this rebate.

The offer is currently open to Victorian households who installed solar panels on or after 19th August 2018 and can apply for a rebate to cover half the cost of a solar PV system or up to a maximum of $2,225. From July 2019, eligible Victorian residents will also be able to receive an interest free loan for a period of 4 years to finance the remainder of the capital cost of installation. Rebates of up to $1,000 are also being offered for the installation of solar hot water units in dwellings that are unsuited for solar PV installations.

In addition to this, the Victorian Labor Party has pledged to support uptake of solar on rental properties. This component involves an additional $82 million package of 50,000 rebates to be delivered over a 10-year period to eligible tenants and landlords that agree to share the remaining costs of the system.

3.2 Home Battery Scheme

The South Australian Home Battery Scheme comprises $100 million in government subsidies available for 40,000 homes for the installation of the battery component. Participating households are eligible to apply for finance via the Commonwealth Clean Energy Finance Corporation.

The battery subsidy is based upon the size of the battery and is currently set at $600 per kWh storage for energy concession holders and $500 per kWh for all other households. Strict specifications need to be met to ensure that batteries can also be aggregated to the Virtual Power Plant, although the participating household can choose whether to operate their battery as part of this system. The subsidy is open to household applications from October 2018.

While the batteries themselves will not contribute to STC creation, it is expected that the increase in benefit to households via load shifting may encourage the installation of rooftop PV and battery packages.

3.3 Virtual Power Plant

In early 2018, the South Australian government announced plans to engage with Tesla to develop a Virtual Power Plant in that State in a scheme that aims to aggregate 50,000 residential batteries to work together. The expected

$800 million scheme is expected to add 250 MW of dispatchable power to the grid over an approximate 4-year period.

The Virtual Power Plant is set to roll out in 3 stages.

1. A trial of 1,100 housing trust properties, each provided a 5 kW solar panel system and 13.5 kWh Tesla Powerwall battery, installed at no charge and financed via the sale of electricity throughout 2018.

2. Systems set to be installed to a further 24,000 housing trust properties in South Australia.

3. Similar deal offered to all low-income households available from mid-2019.

Tesla anticipates that the full scheme will see up to 50,000 homes having a Powerwall and 5 kW solar system package installed by June 2022.

3.4 NSW Solar for low-incomes scheme

In September 2018, the NSW government announced an initiative to install free rooftop PV systems in place of a cost living rebate targeted to low income households. The $15 million scheme offers eligible households the option to forego the $285 energy bill deduction “living rebate” payment in exchange for the installation of a 2.5 kW rooftop solar system. The scheme is available for up to 3,400 eligible households, with an expectation that they will be up to $300 better of per year by accepting this offer.

3.5 ACT Solar for low income households program

From December 2017, pensioners in the ACT are eligible to apply for a rebate of up to 60% on costs for the supply and installation of a rooftop solar PV system capped at $3000. A 3-year interest free loan to ActewAGL is also available to pay back the remaining cost over a 3 year period. The scheme is available to pensioners only and is expected to assist approximately 500 households.

3.6 Queensland household solar schemes – Affordable Energy Plan

As part of “The Affordable Energy Plan”, the Queensland government currently has 3 initiatives to encourage the uptake of distributed renewable generation and storage.

1) An $4500 interest free loan for up to 7 years is available for homeowners that receive the family Tax Benefit Part B. Eligible households not only must receive this benefit, but also must have had electricity costs greater than $1000 for the past 6 months or $2000 for the past year. This was available from June 2018.

2) From 19th of November, Queensland householders can apply for interest free loans for up to $10,000 and grants of $3,000 to purchase combined solar-battery systems. Small businesses are also eligible to apply for the grant.

3) Grants of $3000 and interest free loans of up to $6000 are available for households that already have solar to install batteries.

The government has allocated $21 million over three years to fund the no-interest loans and rebates. The funding is restricted to 3500 solar assistance packages and 1000 solar and battery systems and 500 battery only systems and will be available for Queensland residents until the funding is exhausted or until 30 June 2019.

3.7 Regulations for hot water systems

Since 2010, the Building Code of Australia specifies that all hot water systems installed in new houses are required to comply with minimum greenhouse intensity and/or energy efficiency standards. Now, all Australian states and territories other than Tasmania, Queensland and the Northern Territory have rules restricting the use of greenhouse gas intensive water heaters in new Class 1 buildings (i.e. detached, terrace, row and town houses), either through their own building regulations or by reference to the relevant clauses in the National Construction Code. These codes have resulted in the reduction of conventional electric resistance water heaters in favour of solar, heat pump and natural gas water heaters.

The National Construction Code was developed to incorporate the Building Code of Australia and the Plumbing Code of Australia into a single code. The Code supports the installation of solar and heat pump water heaters compliant to minimum performance requirements, gas water heaters rated not less than 5 stars and electric resistance water heaters of not more than 50 litres (requirements vary by jurisdiction). Victoria has had a 6-star standard for homes since 2011, which requires the installation of either a SWH or a rainwater tank in new homes. In NSW, the BASIX rating scheme, introduced in 2004, allows the use of electric resistance water heaters in new and existing buildings, but imposes such a high rating penalty that builders must compensate with much stricter levels of ‘thermal performance’ or more energy efficient lighting or fixed appliances.

The NCC does not apply to water heater installations in existing buildings, and each state and territory has its own requirements. South Australia and Queensland have had regulations (metropolitan and nearby areas for South Australia and gas reticulated areas for Queensland) restricting the replacement of electric resistance water heaters since 2008 and 2010 respectively. Since February 2013, Queensland no longer has regulations restricting the replacement of electric resistance water heaters. In South Australia, the water heater installation requirements were changed in January 2014, and the type of water heater that can be installed in an established home depends on the type of dwelling, and whether the property has a reticulated gas connection.

4. Method

The forecast of STC creation for calendar years 2019, 2020 and 2021 has been undertaken using our time-series model. Using this approach, the uptake of renewable technologies is determined based on regressed trends in historical data, including testing for inclusion of the use of net economic consumer benefit - or a mix of upfront costs and system benefits - as regression variables.

The most significant change in the time-series model this year is the separation of residential PV system installations from commercial based unit. The other notable change is the inclusion of a net benefit variable for battery installation to assist in modelling the South Australian Home Battery Scheme.

4.1 Time series model

4.1.1 Overview

A time series is a sequence of data points measured at different points in time, and its analysis comprises methods for extracting meaningful characteristics of the data (e.g. trend, seasonality, autocorrelation). Forecasting using time series techniques involves predicting future events based on a model of the data built upon known past events. Unlike other types of statistical regression analysis, a time series model accounts for the natural order of the observations and will reflect the fact that observations close together in time will generally be more closely related than observations further apart.

The historical time series of small-scale technology uptake can be adequately described through an autoregressive integrated moving average (ARIMA) model. The R statistical package is employed to undertake this process, and the process enables consideration of an independent variable that may influence uptake of installed capacity.

4.1.2 Time series model for SGUs

Small generation unit installations in the data supplied by CER are classified as either Unknown, Residential, Commercial, or School. All data is flagged as ‘Unknown’ prior to September 2013, though by October 2014 all data is classified as type of installation. For use in the time-series modelling, unknown property types were classified as commercial or residential based on their capacity - those less than 10 KW were considered residential, and those 10 KW or above were considered commercial. Schools were combined with the commercial data due to their similarity in size and function. The residential data was then processed and aggregated into monthly steps to create time series by technology for each state. Due to the limited number of commercial installations, commercial data remained at a nationally aggregated level.

The basic method to benchmark the models was to trial various ARIMA configurations using as few parameters as possible. We choose the best model using a statistical measure called the Akaike information criterion (AIC). An AIC test provides a way to select between models that have a better fit to data, and which have fewer variables. Model fit is deemed to be sufficiently good when the residuals of the fit displayed the characteristics of white noise.

4.1.3 Variables in residential SGU modelling

As with the previous study, we have restricted our model development to SGU data from January 2011 onwards only. Our previous study indicated that when incorporating data prior to 2011 during the growth phase of the PV technology included large swings in policy changes, subsequent economic benefits and other behavioural factors such as early adopters or environmental decisions affecting uptake which is difficult to model utilising our net economic benefit based approach. After 2010 however, the uptake behaviour of PV reflects the characteristics of a more mature technology and we therefore limit our solar PV modelling to this period.

There exists a relationship between the uptake of PV technology and consumer net benefit. The net benefit to consumer is further broken down into net capital cost and net lifelong benefits to better capture behavioural relationships associated with instant capital expenditure versus more calculated long term benefits of cost reduction and/or FIT gains.

A policy shock variable used as an indicator of sudden policy changes was utilised successfully in our last study and is once again included in our suite of potential independent variables for each model. The variable was specifically introduced to predict the behaviour of household residents associated with the step-down in deeming period as the forecasts enter a new calendar year. The policy shock variable was historically based upon the effective increase in cost to the consumer of the step down in STC multipliers in the years 2011, 2012 and 2013, then utilised in the model to forecast the upswing in installations in the month prior to the step down in deeming period at the beginning of each calendar year.

The use of STC creation as the dependent variable in the time series analysis for residential PV uptake was tested. However, this was not considered the best choice due to the solar credits multiplier that was implemented prior to 2013.

The two remaining choices for the dependent variable were installed PV capacity, or number of PV installations. Using installed capacity as the dependent variable avoids having to convert from number of installations to installed capacity. This would have required the prediction of the average installation size which, according to the historical data, is variable over time especially for the smaller states with the sparser datasets.

Installed capacity was therefore retained as the dependent variable in the analysis.

4.1.4 Variables used in commercial SGU modelling

Due to the limited data available for commercial systems and sparseness of large system installations prior to 2013, a period beginning from January 2014 was trialled in the modelling and proved to have robust results. It was our preference to utilise data from this period to capture the majority of recorded data for commercial installations, as a preference to utilising our estimates of “unknown” installations.

It was decided to regress against STC creation as the dependent variable as STC creation from January 2014 was not distorted by any multiplier effect.

The upfront capital cost, lifelong benefits and total net benefit variables were tested as independent variables in the model. The policy shock variable was also tested as independent variable.

4.1.5 Model fitting

The time series at the state level were stationary when modelled using the extended benefit and shock variables, showing no evidence of changing mean or variance over time. The models were examined for stationarity and autocorrelation, through analysis of autocorrelation and partial autocorrelation functions within the Auto Regressive Integrated Moving Average (ARIMA) approach.

The time series analysis of the data for the SGUs was carried out by fitting univariate ARIMA models to the monthly PV installed capacity of each state.

Each approach was initially tested on a subset of data starting from a selected year between 2011 and 2014 to mid-2018. The models generally performed better including data from 2011, and the regression period was set from January 2011 to June 2018.

Once the modelling window was determined, we examined different formulations of the model, including time-series only analysis, single regression variable models, and combinations of variables, rejecting any models that were statistically inadequate. Inadequate models included:

- Models with a statistically poor fit as measured through the Ljung-Box portmanteau goodness of fit test.
- Non-stationary models as assessed with the augmented Dickey–Fuller test.
- This approach left a number of plausible models to choose from, and in some cases there were relatively minor differences in the sum of squared errors on the test window dataset with respect to choice of start year.

The PV residential and commercial modelling was undertaken on monthly data. The regression model structures adopted were:

- Dynamic regression approach using net upfront cost, system benefit, and a policy shock variable as regressors, and applying ARIMA modelling to the residuals of the regression model. This approach allows the modelling to consider external cost functions in developing projections but also allows for appropriate consideration of recent time trends which is useful in time series approaches because of inherent autocorrelation in the dataset. This approach was used to model NSW, Queensland, Tasmania and Northern Territory.
- Dynamic regression approach using net upfront cost, system benefit, and a lagged policy shock variable as regressors, and applying ARIMA modelling to the residuals of the regression model. This approach differs from the above in that effects of policy shocks such as the reduction of Solar Multipliers were found to influence uptake several months afterwards in a way that ARIMA modelling was unable to compensate for. This approach was used to model Victoria, Western Australia and the ACT.
- Dynamic regression approach using net cost and a policy shock variable as regressors and applying ARIMA modelling to the residuals of the regression model. This approach allows the net benefit of a battery and solar PV system, without applying excess penalty for the high upfront cost of such a system. This approach was used to model the South Australia.
- Dynamic regression approach using net benefit, lifelong benefit and policy shock variable as regressors and applying ARIMA modelling to the residuals of the regression model.

In all cases, the resulting model residuals were tested to be reflective of ‘white noise’ without any evidence of remaining autocorrelation.

4.1.6 Time series model for water heaters[1]

In the case of SWHs and HPWHs, the assumed STC creation cut-off point distinguishing a commercial system from a domestic system was retained from the last modelling study, as this point has now settled down.

Analysis conducted in previous studies trialled disaggregating water heaters by state. However, it was found last year that this level of disaggregation significantly increased the variance of the time series and the errors in the predictions. The best result was achieved by aggregating data across all states and for both water heater technologies but retaining the distinction between commercial-sized systems and domestic sized systems. This approach has been retained for the current modelling.

In the last study undertaken by Jacobs, it was determined that net cost has not continued to be correlated with uptake of systems, and therefore the use of net cost as a regressor was dropped. This is maintained for the present study. Possible reasons for this insensitivity may involve uptake taking place mainly in new homes and may be driven by building or energy efficiency standards rather than benefit.

The water heater data were modelled by number of STCs registered since, unlike PV, these time series were not distorted by a multiplier and they were also directly reflective of water heater uptake volumes.

The original water heater time series were non-stationary, showing both a changing mean and changing variance over time.

However, the logarithm of the original time series was found to be stationary after the trend was removed. Seasonality in the time series was insignificant and a standard ARIMA model was fitted.

In summary, the time series analysis of the data for the water heaters was carried out by fitting univariate ARIMA models to the logarithm of the monthly number of registered STCs by water heaters, split into domestic and commercial categories for all of Australia. All the modelling was carried out in R.

[1] The term ‘water heaters’ refers to solar water heaters and heat pump water heaters

4.1.7 STC zoning

CER divides Australia into four regional zones based on the estimate of renewable energy that can be effectively generated by a solar panel in a given area, so installations based in areas with high insolation will create more certificates per kW installed than rooftop installations based in areas in the south of the country. Zones are defined by the postcode. To convert the capacity of solar panels installed in a particular state to the number of STCs produced, the average STC per kW of installed capacity was calculated for the years 2013 to 2016 for each state and territory, the effective period when STC generation was not affected by multipliers or reduced deeming periods. The average commercial STC per kW of solar PV installed was calculated for this period too at a national level. Table 3 shows the effective multiplier for each state and commercial installations utilised for conversion of the forecast capacity into STCs.

Table 3: Average STC generated per kW PV installed

Region	STCs per kW
Residential	
ACT	20.7
NSW	20.8
NT	23.3
QLD	20.8
SA	20.6
TAS	17.8
VIC	17.9
WA	20.7
Commercial	
National	20.2

5. Assumptions

This section outlines the key modelling assumptions utilised for the forecasting models.

5.1 Net benefit

The net benefit for SGUs, SWHs and HPWHs is an indicator of the economic advantages of these systems and is utilised in the model to forecast subsequent uptake. The time-series model utilises historical and forecast calculations of the net benefit and its two primary components as potential regressors.

The net benefit is defined as follows:

- Lifetime benefit of system
  - Net present value of future feed-in tariff payments and/or retailer payments for export to the grid
  - Net present value of the avoided cost of electricity
- Less upfront cost
  - Cost of installation of system
  - Less value of any available government rebates
  - Less revenue from sale of RECS and/or STCs.

Critical assumptions in the calculation of the upfront cost is the historical and forecast capital cost of installation of a PV or SHW system, capacity of the system, potential STC benefits from installation and any other state or federal based rebates.

Key factors to assess the lifetime benefit of a system include assumptions surrounding the retail electricity cost and capacity of the system. For small generation units, the feed in tariffs and expected net export of electricity to the grid also important considerations. Both battery and solar PV units are expected to have a life of 15 years, and batteries are rated at an 85% round trip efficiency.

5.2 Rebate assumptions

For the purposes of this study, the South Australian government's battery scheme, Virtual Power Plant scheme, ACT Solar for low incomes, Queensland's Affordable Energy Plan, NSW solar rebates and Victorian rebates will be treated in different methods.

5.2.1 Victorian Solar Rebate Scheme

With the recent Victorian solar rebate scheme announcement and commencement on August 19th 2018, we are assuming that this will affect the number of installations from the month of September. Our upfront capital cost variable directly considers any rebates offered by state and federal governments, and the rebate will be incorporated into this variable. The average Victorian PV system capacity is already above 4 KW, so the maximum rebate of $2,225 will be assumed.

The input assumptions into this model essentially target the upfront capital cost variable as one of the regressors in the time-series model in the following ways:

1. A flat rebate of $2225 was assumed to residential Victorian homes up until June 2019.
2. From July 2019 onwards, the rebate was calculated as the $2225, plus the levelized cost of half the capital cost of the system annual interest repayments discounted at a rate of 5.2% for a period of 4 years.

5.2.2 South Australian Battery Rebate Scheme

To model the impact of the South Australian Battery scheme, the net cost of installing a combined household battery and PV system was calculated and the maximum of either a PV system alone or the PV and battery system used as the final net cost value.

The net cost of installing an additional battery system was calculated in a similar method to the PV system alone. The capital cost of batteries was estimated (section 5.3), less any government rebate.

The lifetime benefit of the battery system was measured by approximating the average net export of electricity to the grid, which would be markedly reduced with the assistance of a battery when utilised in combination with relatively large household PV systems. The percentage net export of solar generation then determines the revenue gained via FITs and the electricity cost savings by utilising solar generated energy.

The difference between cost savings derived from a reduction in the need to purchase energy from the grid, and the loss in FIT revenue forms the basis of the benefit of a solar battery package over a solar system alone. Batteries were assumed to have a round trip efficiency of 85%.

Battery storage capacities are assumed to be 1.5 times the maximum capacity of the average solar system installed. The battery rebate is set to be the lesser of $500 multiplied by the storage capacity of the battery or $5000.

The $100 million scheme is set to be open for applicants in October 2018. In addition, according to the CER data, there are approximately 1500 solar installations per month for the first half of 2018 in South Australia. At this rate, with a fund of $100 million, we have estimated this scheme to last 20 months from October 2018 until April 2020.

5.2.3 South Australian Virtual Power Plant Scheme

With the scheme primarily aimed at residents living in public housing and other low-income earners, we have made the assumption that the 250 MW of capacity installed under this scheme will be additional capacity to what would otherwise be installed. Therefore, this capacity will be added to the time series modelled results.

Tesla has begun installation of the first stage of the 1,100 units committed to the scheme and it is expected that this stage will be finalised by mid-2019, with the remaining 49,000 units installed over the next 4-year period, and finishing by June 2022. For this study, we have assumed that the 49,000 units will be installed evenly across this period beginning from July 2019. STCs are then calculated utilising the approximated number of 5 kW units, the effective STC multiplier for South Australia and the fraction of deeming period associated with each calendar year.

Table 4: South Australian Virtual Power Plant scheme assumptions

Year	Deeming Period	Installations	Capacity (kW)	STC '000s
2018	13	500	2,500	41
2019	12	8,667	43,333	652
2020	11	16,333	81,667	1,126
2021	10	16,333	81,667	1,024
2022	9	8,667	43,333	489

5.2.4 Queensland Affordable Energy Plan

The first component of the Queensland Affordable energy plan, available to 3,500 households has been running since June 2018 and is expected to close at the end of June 2019. At such a rate, we have assumed that at least half of these installations have occurred in the 6 months to December 2018, and as such have already been incorporated into the data and that the time series component of the model would have factored this growth into the model.

The second component of the scheme offers 1000 households a $3000 grant plus $10000, 10 year interest free loan to install a solar battery package. With household batteries still commanding a considerable upfront cost, it is not expected that households not already considering solar PV will take on additional debt, and therefore drive up. Our assumption is that that only households already considering installing PV in 2019 will undertake this grant, and therefore may shift the frequency of installations into the first half of 2019, however will not have a substantial impact on the overall capacity installed in the calendar year 2019. We have decided not to incorporate this scheme into the model.

5.2.5 NSW Solar Rebate

With this scheme targeted at low-income households, the assumption is that the capacity installed under this scheme will be additional to what would otherwise be installed.

The rebates are open to residents from December 2018, and under the assumption the 3,400 installations will be installed over a three-year period, from 2019 to 2021. Under this assumption, with installations of 2.5kW systems, the STCs are then calculated utilising the effective STC multiplier for NSW and the fraction of deeming period associated with each calendar year. Table 5 shows the capacity and STC's that are assumed to be generated under this scheme.

Table 5: NSW Solar Rebate Scheme Assumptions

Year	Deeming Period	Installations	Capacity (kW)	STC '000s
2019	12	1,133	2,833	47
2020	11	1,133	2,833	43
2021	10	1,133	2,833	39

5.2.6 ACT Solar for Low Income Households

The ACT solar for low income household scheme is expected to affect approximately 500 pensioner households. With the assumption that these 500 installations of 4 kW will occur evenly over a 3-year period, the assumption is that a third of the capacity expected to be installed under this scheme would have occurred in the year 2018. Furthermore, as these installations are included as part of the dependent variable in the ARIMA model, it is assumed that the time-series component has factored in the growth rate under this additional scheme, and for these reasons the STC's assumed as part of this scheme will not be added to our time-series model output results.

Table 6: ACT Solar for Low Income Households Scheme Assumptions

Year	Deeming Period	Installations	Capacity (kW)	STC '000s
2018	13	167	667	12
2019	12	167	667	11
2020	11	167	667	10

5.3 Capital cost

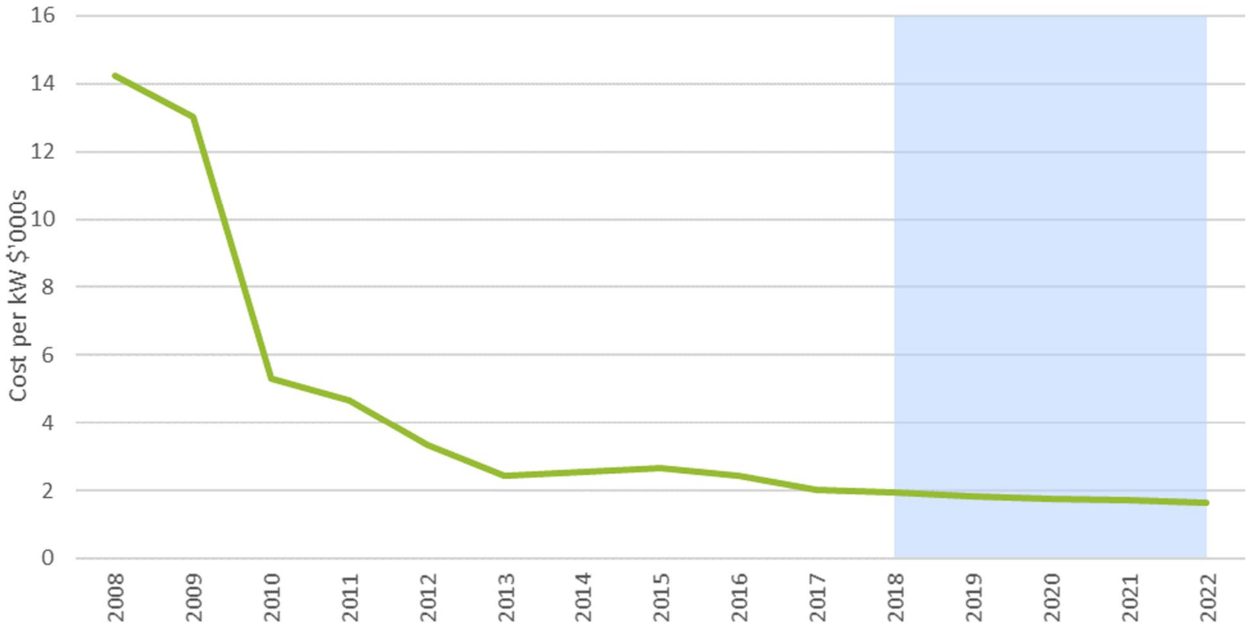
System prices are expected to gradually fall over the coming years. The global oversupply on PV module manufacturing capacity has apparently diminished, though trends in global markets such as U.S. import tariffs on Chinese panels and availability of rare elements used in panel manufacturing continue to have the potential to influence the prices paid by Australian installers in the short term.

Capital cost assumptions for PVs in 2018 are based on the Solar Choice website's[2] monthly unit pricing overview, which is based on price data from 125 solar installation companies across Australia. These were converted into real dollars for the modelling using historical CPI and assuming 2.5% annual growth in CPI for the projections.

For residential systems, the price per system per KW for capacity sizes of 1 to 5 KW was trended over time, and forecasts for each State were performed by fitting power trend functions across the historical data, which were then extrapolated to 2021. Figure 9 shows the average historical and forecast cost per KW for a residential system across all states, with a gradual tapering of prices as consistent with our assumptions.

An increase in cost per KW is observed for systems of 7 kW, likely due to the fact there are many network restrictions on inverter size to 5 kW AC residential properties, which handles solar panel systems up to 6.6 kW. The 7 kW size price projections were utilised to price systems where the average was expected to be between 6.7 kW and 10 kW.

Figure 9: Capital cost assumed for residential solar PV systems ($ nominal/kW)



Source: Jacobs' market analysis, Solar Choice monthly system cost estimates 2012 – 2018

A similar method was applied to costs of commercial systems, by utilising the data for systems between 10 kW and 100 kW. Due to the limited number of commercial systems installed, and therefore subject to outliers when filtered to state level, it was decided to aggregate the commercial systems at a national level. The average cost was plotted for all states, and a power curve fitted for values between 2011 and 2018.

The economies of scale were also less apparent in commercial systems, with little difference between cost per kW for a 10 kW system versus a 100 kW system. Therefore, a ratio for economies of scale was not applied, and rather the cost per unit was assumed to be constant.

Figure 10 shows the historical and forecast costs assumed for commercial systems.

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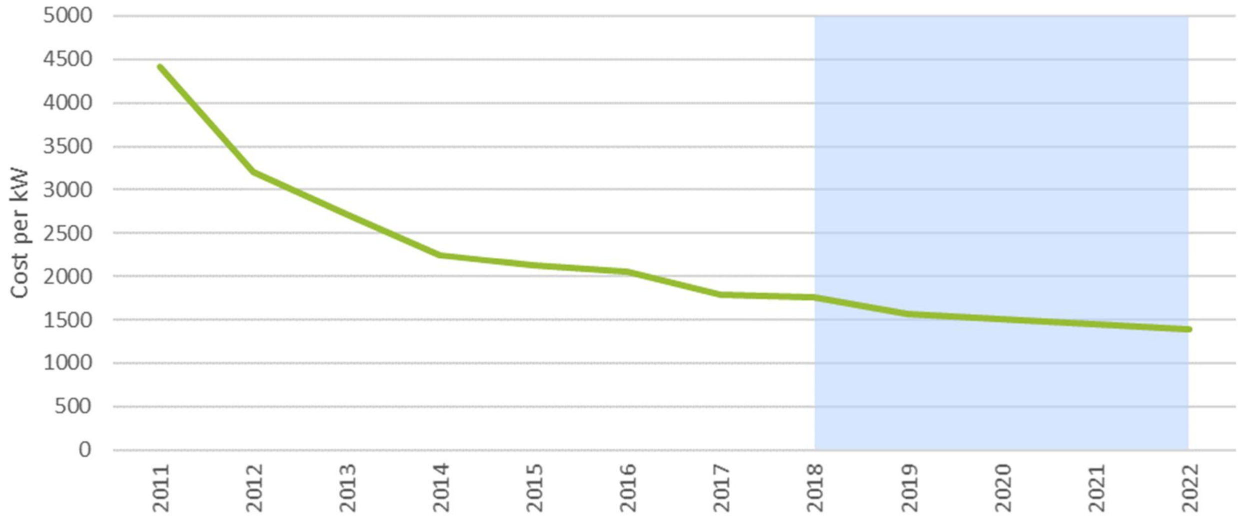
[2] http://www.solarchoice.net.au/blog/

Figure 10: Capital costs assumed for commercial solar PV systems ($ nominal/kW)

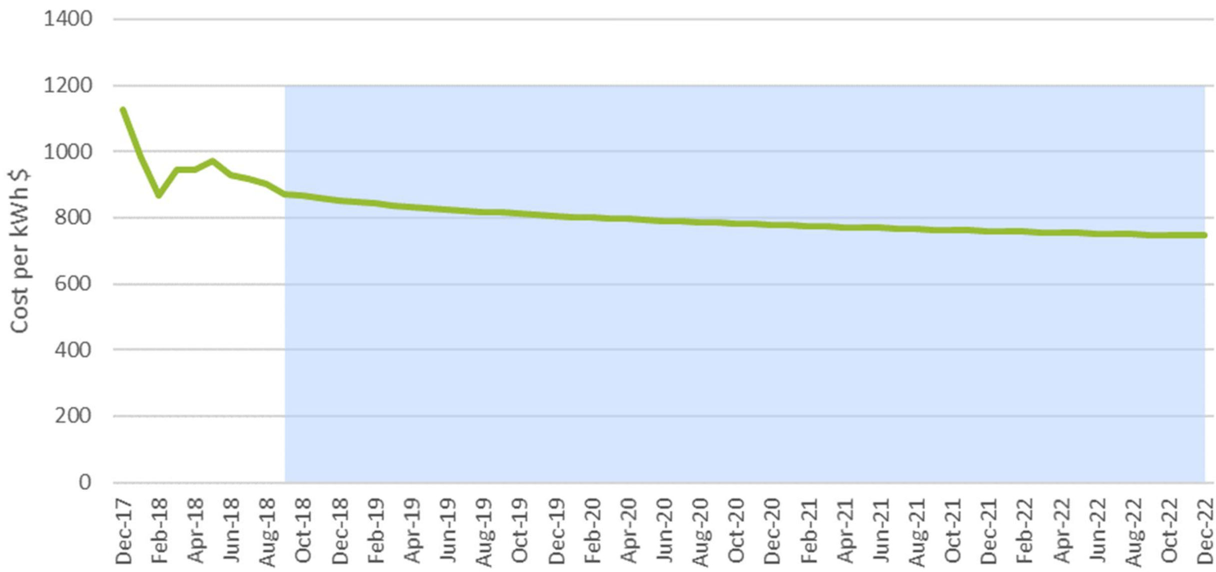


Source: Jacobs' market analysis, Solar Choice monthly system cost estimates 2012 – 2018

Capital cost assumptions for batteries in 2018 are based on the Solar Choice website's[3] monthly unit pricing overview. The average cost per kWh of battery only installations for the first 6 months of 2018 according to market research for Solar Choice based on 3, 8, 13 and 18 kWh systems is $940.

Reductions in household battery prices were observed in late 2016 with Tesla's introduction of the Powerwall 2. However, no significant reductions in the cost of battery systems has occurred since, and battery prices actually increased in February 2018. The jump in price of cobalt is one of the reasons attributed for increases in battery prices for those companies utilising this chemistry exposed to this market[4]. For these reasons, a conservative power curve was used to forecast battery prices for the next three years.

Figure 11: Capital costs assumed for household battery systems ($ nominal/kWh)



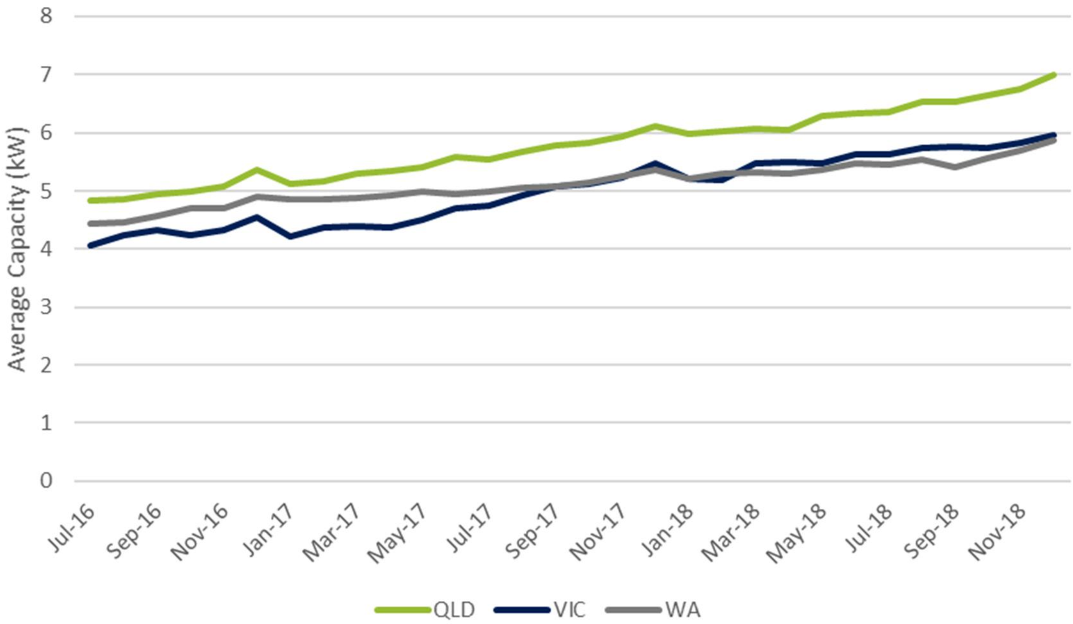
Source: Jacobs' market analysis

[4] https://reneweconomy.com.au/tesla-enphase-lift-household-battery-storage-prices-23273/

5.4 Residential system size

Figure 12 shows the trends in average PV system sizes being installed since July 2016. The graph shows that average system size has continued to grow at a consistent rate over the last six months, consistent with growth patterns since mid-2016.

Figure 12: Monthly trends in average residential PV system capacity, July 2016 – November 2018

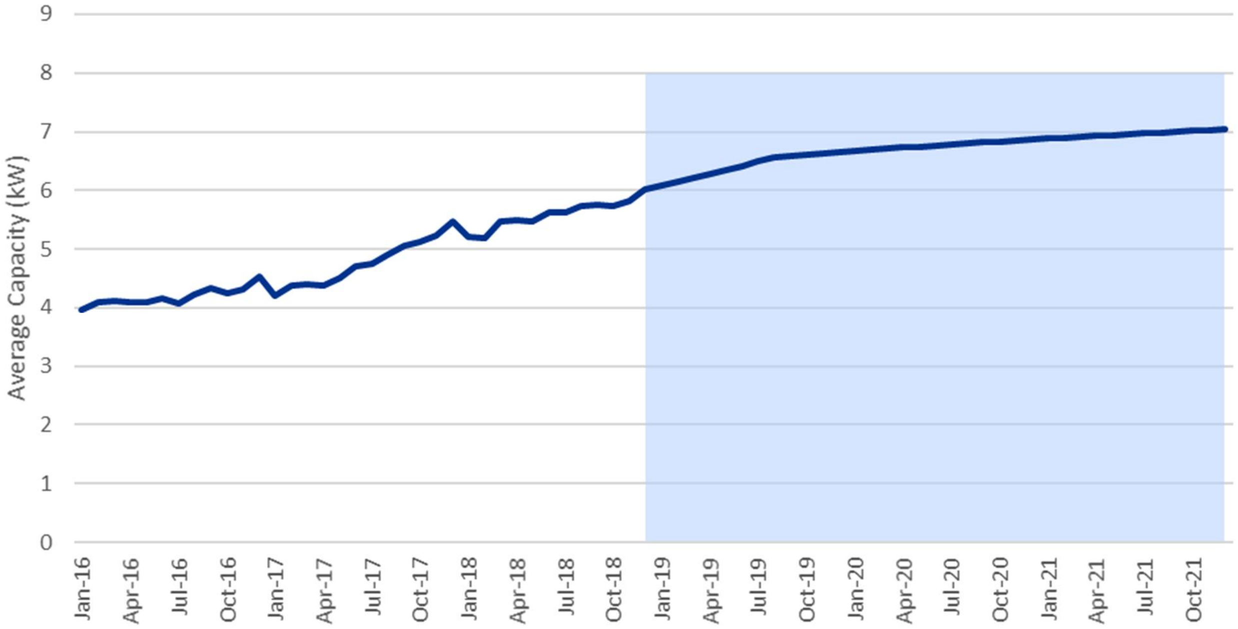


Source: Jacobs' analysis of CER data

We expect that average system sizes will not grow at the linear rate observed in the past indefinitely. Residential system sizes will become constrained by available roof space, and most states have a restricted inverter capacity of 5 kW_{ac} for residential phase 1 systems, which limits many residential PV systems to a capacity of 6.6 kW. We expect this restriction in combination with the availability of roof space to have a significant impact on curtailing the average growth in system size for residential properties.

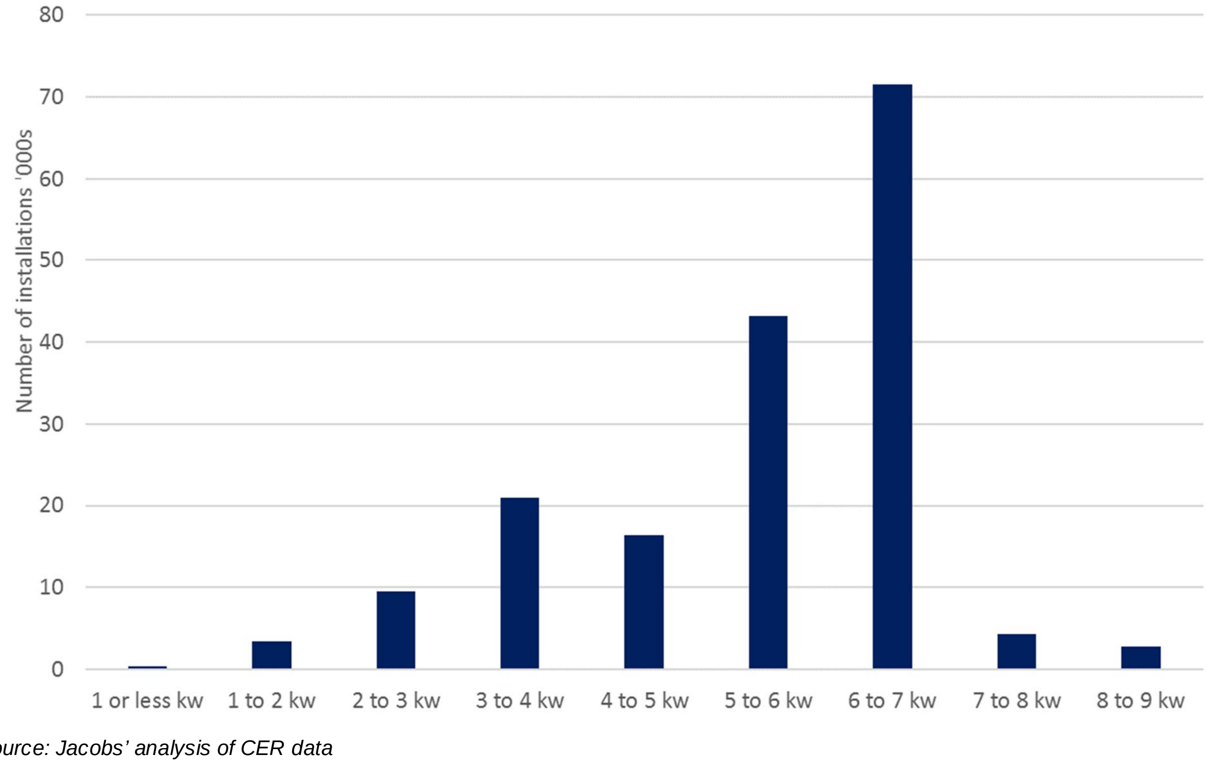
The assumption is that the average growth rate will occur at the linear rate observed recently, with the growth rate slowing after a capacity of 6.6 kW is reached. Power curves have been fitted in each state to reflect the assumed reduction in growth rate after a 6.6 kW average capacity is reached.

Figure 13: Monthly trend and forecast for average residential PV solar system size, Victoria



Source: Jacobs' analysis of CER data

Figure 14: Number of residential PV installations by system capacity, 2018



Source: Jacobs' analysis of CER data

5.5 Trends in commercial and school system sizes

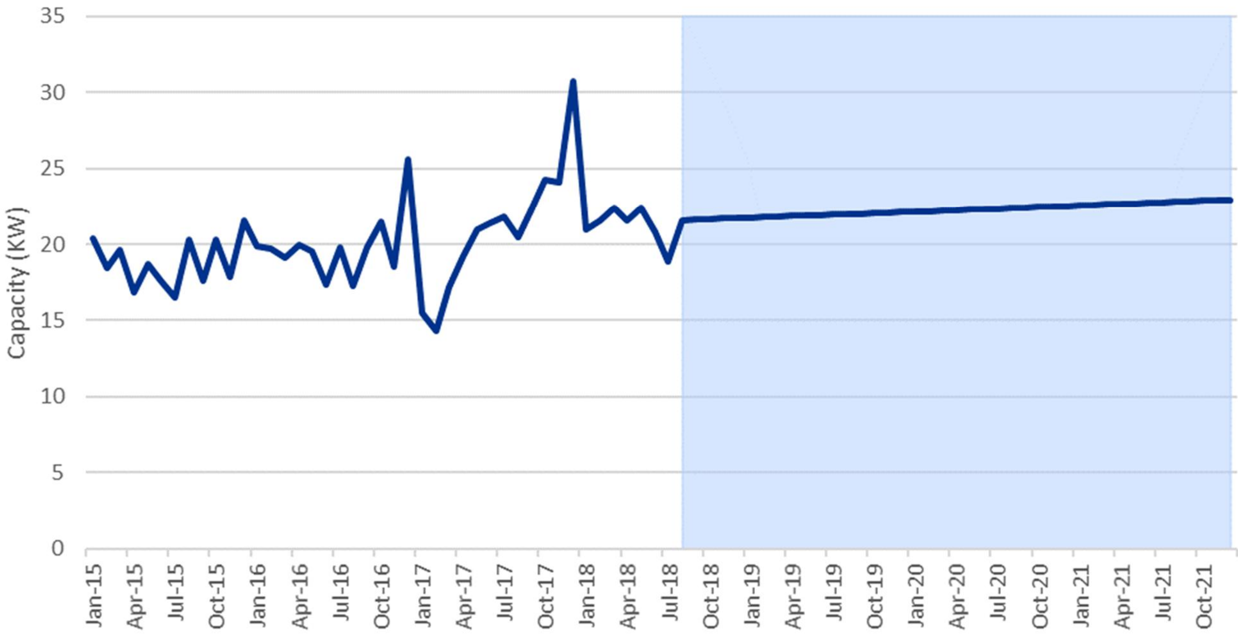
Table 7 shows the average capacity and growth rates for each calendar year since 2014. The simple average growth rate since 2014 is 2%, and it is assumed that the system size will continue to grow at this rate for the forecasting period.

Table 7: Size of commercial solar PV systems installed across Australia

Year	Average Capacity (kW)	Growth rate
2015	18.8	-6%
2016	19.8	5%
2017	21.0	6%
Simple average		2%

As with the number of installations, the average capacity of systems installed has also began to take on a distinct seasonal trend consistent with the sudden reduction in STC deeming period at the beginning of each calendar year, illustrated in Figure 15. As the final results are annualised, it was decided to simplify this forecast without the seasonal impacts.

Figure 15: Monthly historical and forecast average commercial solar PV system size (kW)



Source: Jacobs' analysis

5.6 Electricity price projections

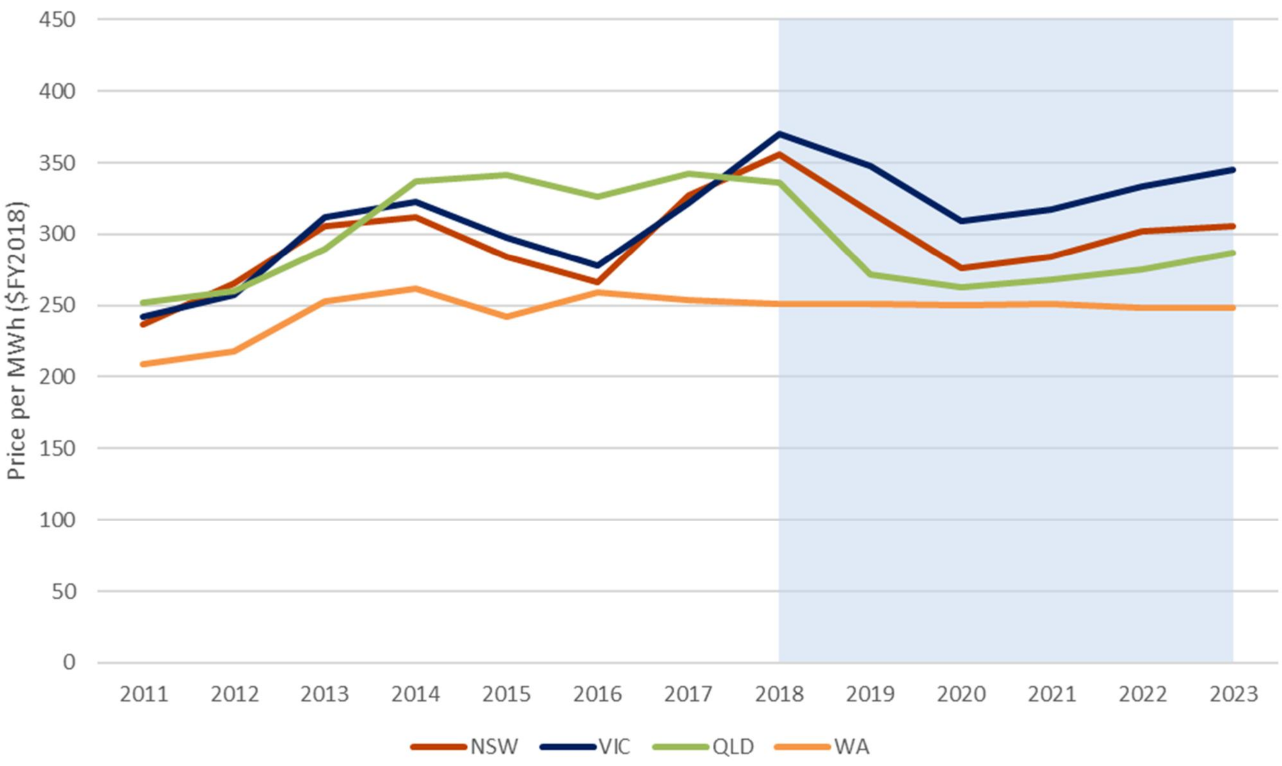
Jacobs' wholesale electricity price predictions were used as the basis for estimating retail electricity prices, which in turn were used in calculating future electricity savings and/or revenues for SGUs (see Appendix E for further details).

The wholesale prices were based upon market modelling studies employing a set of neutral assumptions in 2018, including medium economic demand growth, medium gas price and medium technology cost projections. A separate model was then used to convert wholesale prices to retail prices by applying average network tariffs, retail marketing expenses in each state across the NEM. These wholesale prices were also utilised to project commercial retail prices for SMEs which were utilised for forecasting the economic benefits of commercial based solar installations.

Figure 16 shows the residential electricity prices used in the modelling for selected states. Electricity prices in NEM states are expected to peak in 2018, before a downward trend is projected over the period of 2019 to 2020. This is primarily due to the influx of large scale renewable plant expected during 2019, and to a lesser extend a reduction in network tariffs expected in Victoria. Slight increases are again observed in the year 2021 driven by plant retirements.

Electricity prices in Western Australia and Northern Territory are assumed to increase at the electricity consumer price index over the three-year forecasting period.

Figure 16: Residential retail price tariff trend and forecast for selected states, 2011-2022 ($FY2018)



Source: Jacobs Analysis

5.7 Feed-in tariffs

Feed-in tariffs in Australia for small-scale renewable energy generation are offered by the retailers and in some instances they have an obligation imposed by the relevant state government to offer a minimum tariff. Where the required data of retailers' tariffs and customers' per retailer were available, a price based on the weighted average retail offer of the three largest retailers and combination of remaining retailers was assumed in the modelling. In ACT, where ActewAGL supplies the bulk of the market, the ActewAGL tariff was selected. Table 8 presents a detailed summary of the FiTs offered and the assumptions we have made.

Due to the projected decreases in retail electricity prices over the forecasting period for NEM states, the FIT for each state was then calculated as a percentage of the most recent retail price. Moving forward, the FIT was then assumed to move relative to the retail price based on this initial proportion.

Table 8: Summary of feed-in-tariffs

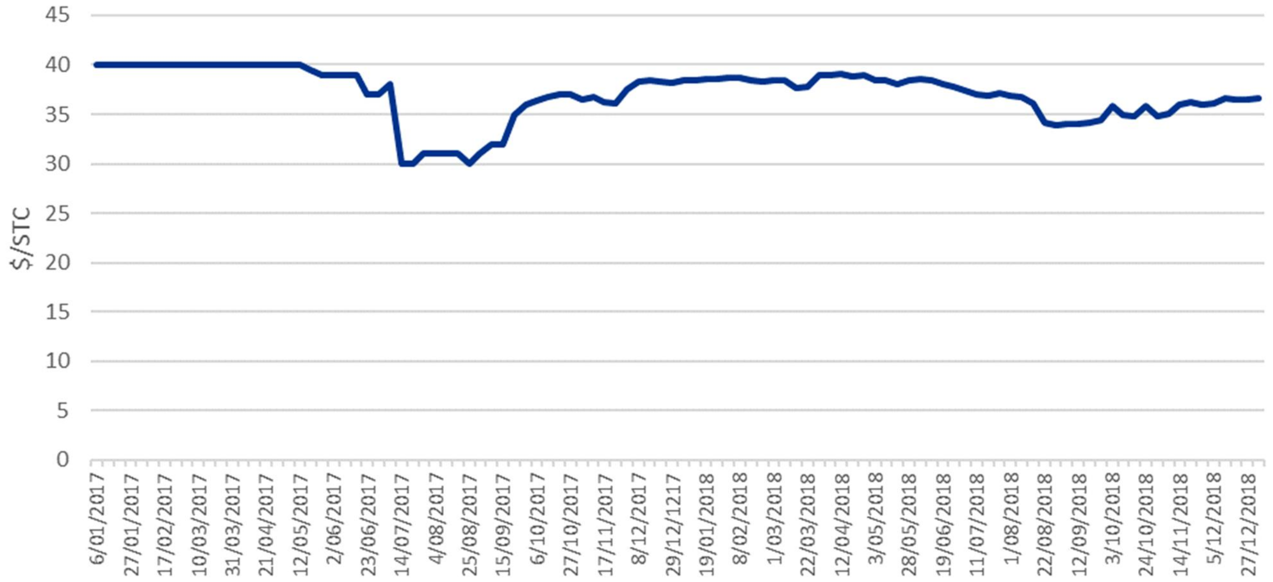
State/Territory	Current arrangement	Jacobs assumptions for 2019-2021
Victoria	As of 1 July 2018, a mandatory minimum net feed-in tariff rate of 9.9 c/kWh for systems up to 100 kW in size, offered by the retailers.	Net FiT of 9.9 c/kWh in July 2018, then 27% of the retail cost in nominal terms over the remainder of the modelling horizon.
New South Wales	No mandatory retailer contribution. Net FiTs offered by retailers range from 9 c/kWh to 12 c/kWh.	Net FiT of 14.0 c/kWh in July 2018, then 39% of the retail cost in nominal terms over the remainder of the modelling horizon.
Queensland	No mandatory FiT for residential customers in SE QLD. Net FiTs offered by retailers range from 7 c/kWh to 16 c/kWh. Mandatory minimum of 10.1 c/kWh for regional customers.	Net FiT of 10.9 c/kWh in July 2018, then 32% of the retail cost in nominal terms over the remainder of the modelling horizon.
Northern Territory	Net 1-for-1 FiT, where consumer is paid for all electricity exported to grid at their consumption tariff.	Net FiT of 26.86 c/kWh for eligible customers
Australian Capital Territory	No mandatory retailer contribution. Net FiTs offered by retailers range from 9 c/kWh to 17 c/kWh.	Net FiT of 9.8 c/kWh in July 2018, then 28% of the retail cost in nominal terms over the remainder of the modelling horizon.
Western Australia	No mandatory retailer contribution. Synergy and Horizon have two 2 Solar Buyback Schemes in place with varied rates from 7.135 c/kWh to 50 c/kWh.	Net FiT of 7.135 c/kWh, then 28% of the retail cost in nominal terms over the remainder of the modelling horizon.
South Australia	No mandatory retailer contribution. Net FiT offered by retailers range from 7 c/kWh to 22 c/kWh.	Net FiT of 15 c/kWh, then 31% of the retail cost in nominal terms over the remainder of the modelling horizon.
Tasmania	No mandatory retailer contribution. Net FiT offered by Aurora is 8.5 c/kWh.	Net FiT of 8.5 c/kWh, then 25% of the retail cost in nominal terms over the remainder of the modelling horizon.

5.8 STC Pricing Assumptions

The historical spot price for STC was utilised in calculating the estimated federal rebate for solar PV systems installed. An average of 4 weekly closing spot prices was collected to obtain a monthly estimate of the STC value that was utilised in the model. Figure 17 shows the weekly historical prices utilised in the forecasting models. A STC price of $40 per certificate is assumed for all future forecasting calculations.

STC prices have continued to hover below the target $40 throughout 2018, indicating that a surplus of STCs is being generated in the market.

Figure 17 Weekly historical STC price (nominal) Jan 2017 – Dec 2018



Source: Greenmarkets and Demand Manager, some data estimated

6. Results

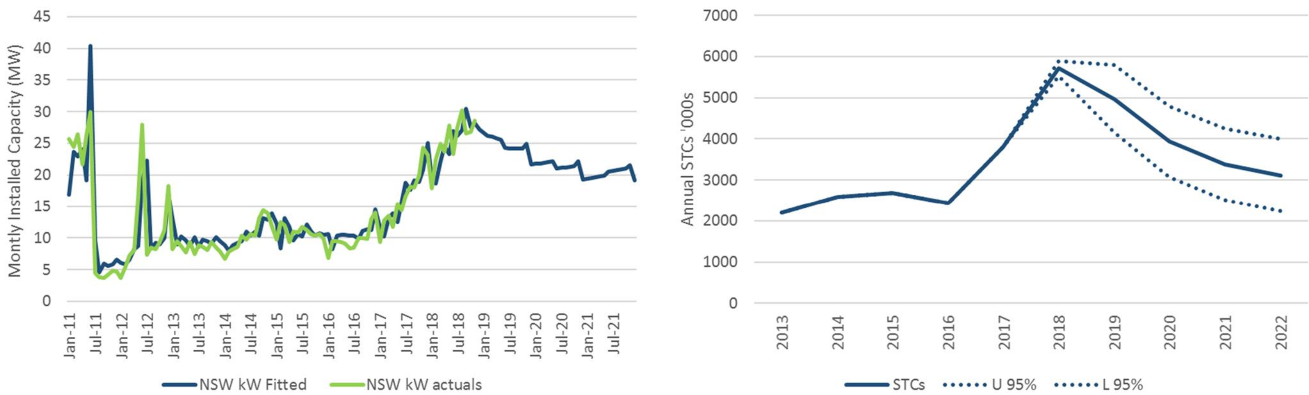
This section presents the results of the modelling for the time series model. In all cases results are presented in calendar years.

6.1 Residential system projections

The state based residential forecasts were derived by first projecting installed capacity for PV systems and then converting these to STCs by inferring the STCs per unit of installed capacity from historical data. Detailed capacity forecasts for state based residential installation are available in Appendix D. Because the entire history for STC created from small-scale generation includes data based on 15 years of credited generation, forecasts for 2019, 2020 and 2021 were required to be adjusted by 12/15, 11/15 and 10/15 respectively. The STC projections for Figure 18 to Figure 26 are displayed with their 95% confidence limits.

Figure 18 shows the historical actual and fitted data and projected total STCs created for residential systems in New South Wales. STC creation is expected to peak in 2018, then decrease by 12% to approximately 5.2 million in 2019. This decrease is greater than the expected 1/15 or 6.7% resulting from the extra step down in deeming period of the STC scheme. Other factors contributing to the decrease in trend include the expected decline of electricity prices following a peak in 2018, the annual reduction in financial grants, maturing of the PV technology and the gradual saturation of PV systems within the housing market.

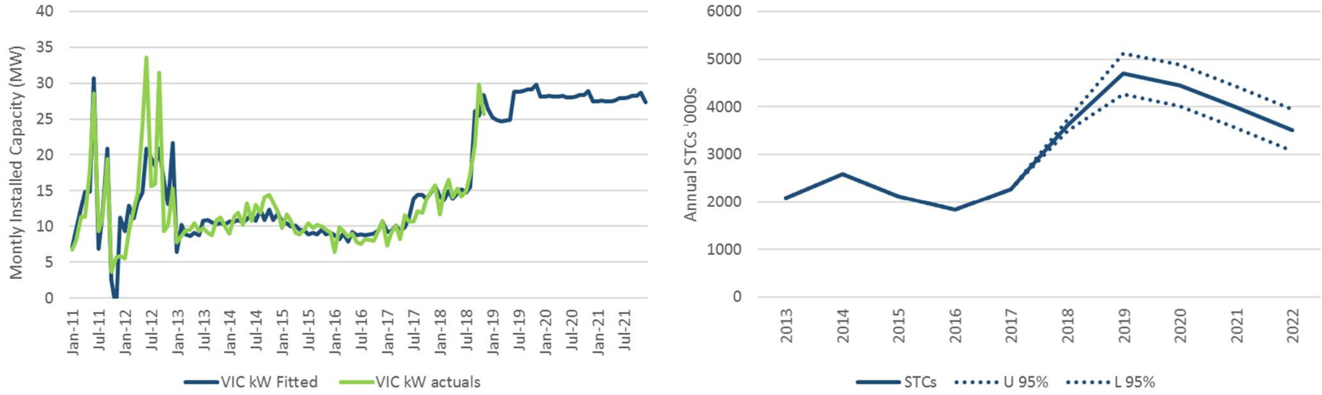
Figure 18: Historical and projected installed capacity and STCs generated for New South Wales residential properties, excluding the NSW solar scheme



Source: Jacobs Analysis

Figure 19 shows the historical actual and fitted data and projected total STCs created for residential systems in Victoria. A dramatic increase in STC creation is observed in September 2018, associated with the commencement of the Labor government Solar Homes rebate scheme, and again in July 2019 as the second stage of scheme with no interest loans kicks in. The installed capacity is expected to peak in 2020 with the scheme in full swing and 338 MW of residential panels predicted to be installed (Appendix D). With the generous scheme expected to continue for the remainder of the forecasting period, no major decline in installed capacity is predicted and the rate of STC generation is expected to decline at a rate relatively consistent with the step down in deeming period of the program.

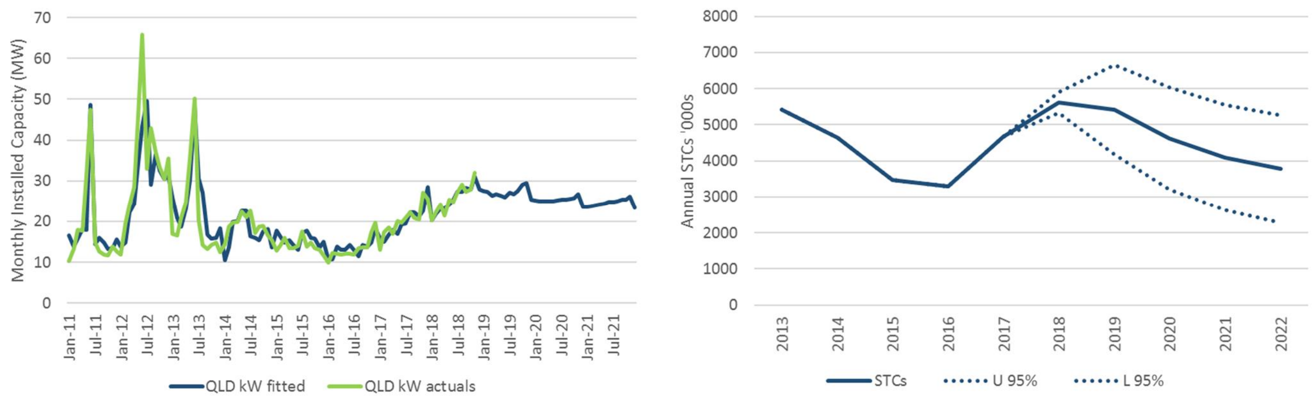
Figure 19: Historical and projected installed capacity and STCs generated for Victorian residential properties



Source: Jacobs Analysis

Figure 20 shows the historical actual and fitted data and projected total STCs created for residential systems in Queensland. From a peak in 2018, the STCs created are expected decrease by 1.9% in 2019, indicating that there is still growth in the market when the decrease is corrected for the deeming period. Strong insolation levels along with the highest projected housing growth rate within Australia are contributing to maintaining relatively high levels of STC production despite the reduction in electricity prices and STC financial incentives.

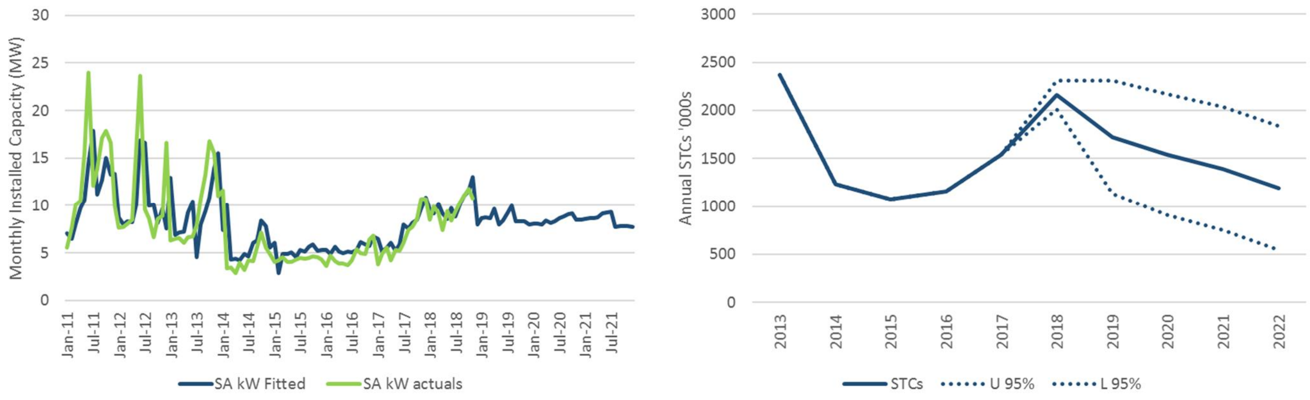
Figure 20: Historical and projected installed capacity and STCs generated for Queensland residential properties



Source: Jacobs Analysis

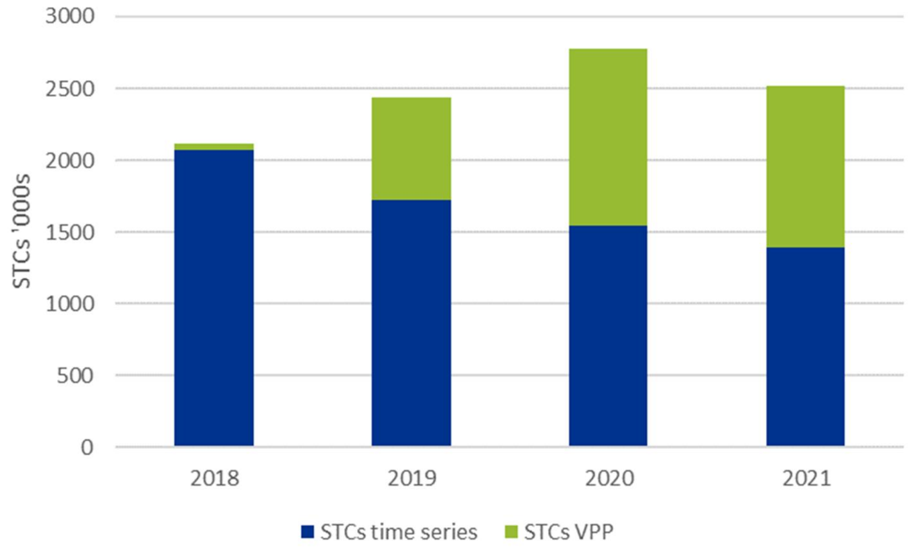
Figure 21 shows the historical actual and fitted data and projected total STCs created for residential systems in South Australia prior to including Virtual Power Plant scheme. Despite the additional incentives provided by the government to install household batteries in the Household Battery Scheme, a decline in STC creation still expected in 2019. Our modelling found that home battery installations did not produce a significant benefit over PV systems alone even with the $5000 rebate, largely due to the high capital costs and relative generous feed-in-tariffs. Furthermore, a high upfront capital cost appears to be a deterrent for installation of such systems. Figure 22 illustrates the forecasts expected for South Australia including the Virtual Power Plant scheme. This far more generous scheme, predominantly aimed at households that would otherwise not make such investments, has a much greater impact on the creation of STCs with a 15% increase in STC creation forecast in 2019 compared to 2018 levels.

Figure 21: Historical and projected installed capacity and STCs generated for South Australian residential properties excluding Virtual Power Plant



Source: Jacobs Analysis

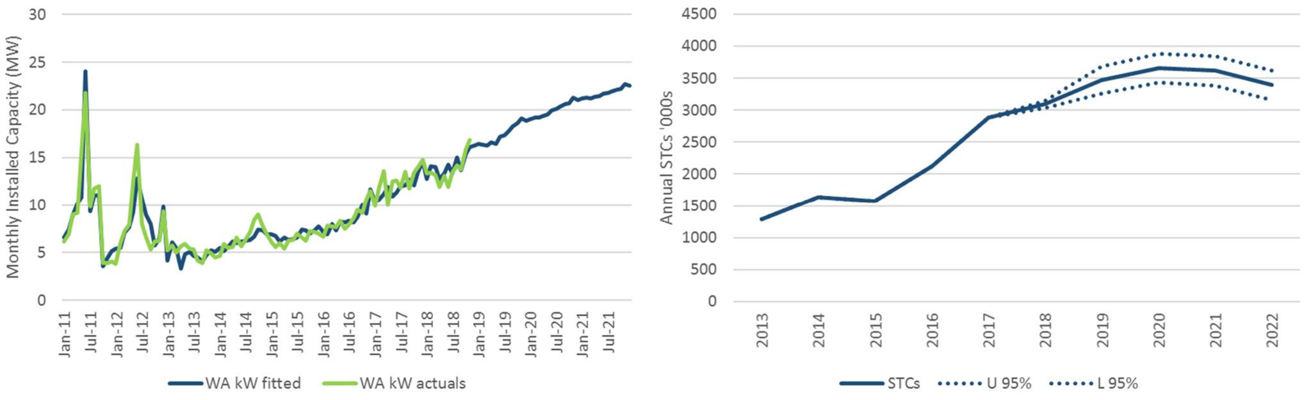
Figure 22: Annual projected STC creation for South Australian residential properties including Virtual Power Plant



Source: Jacobs Analysis

Figure 23 shows the historical actual and fitted data and projected total STCs created for residential systems in Western Australia. Unlike most other states, STC creation is expected to increase in 2019 without the assistance of state based incentives. This is likely to be attributed to good insolation levels, solid economic benefits and the weak association between the recent surge in rate of PV installations in Western Australia and the state based electricity tariffs (Appendix A).

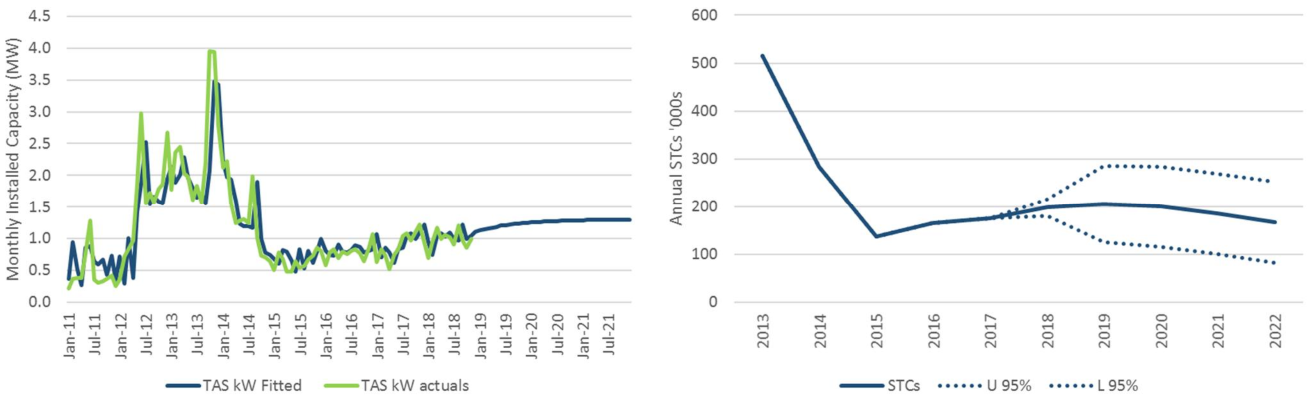
Figure 23: Historical and projected installed capacity and STCs generated for Western Australian residential



Source: Jacobs Analysis

Figure 24 shows projected forecasts for STC creation in Tasmania. The low insolation levels in combination with low GDP growth in 2017[5] only saw modest growth of STC creation in the years 2017 and 2018. However, unlike most other states in the NEM, this growth is expected to continue into 2019 before showing entering the expected decreasing phase as the STC deeming period tapers off.

Figure 24: Historical and projected installed capacity and STCs generated for Tasmanian residential properties

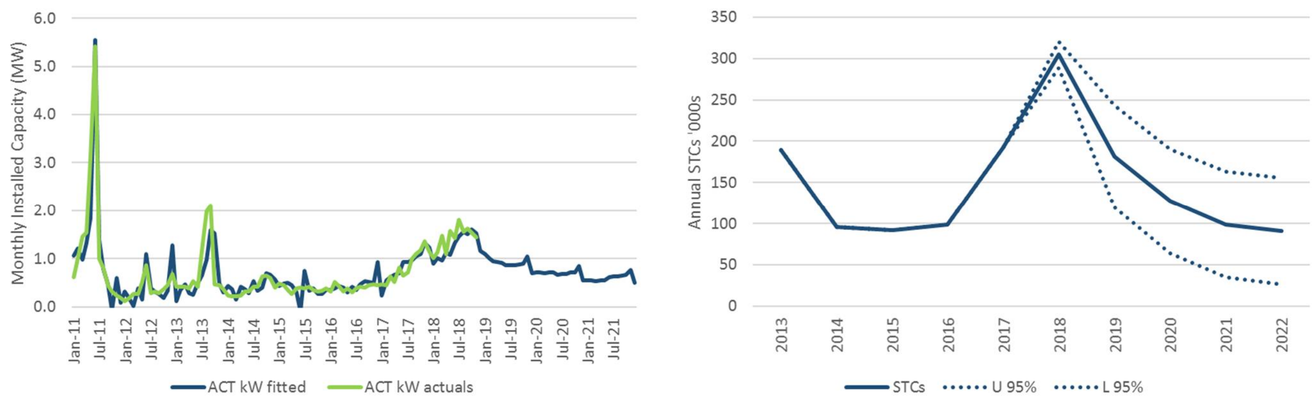


Source: Jacobs Analysis

Figure 25 shows projected forecasts for STC creation in the Australian Capital Territory. The year 2019 sees a sharp decline in the STCs produced via residential PV systems. This is consistent with the expected reduction in electricity prices in the NEM in combination with the reduction in deeming period. Small sample sizes in the ACT, however, makes the historical time-series more erratic and difficult to predict.

[5] https://www.treasury.tas.gov.au/BudgetPapersHTML/Budget2018/BP1/2018-19-BP1-2-Tasmanian-Economy.htm

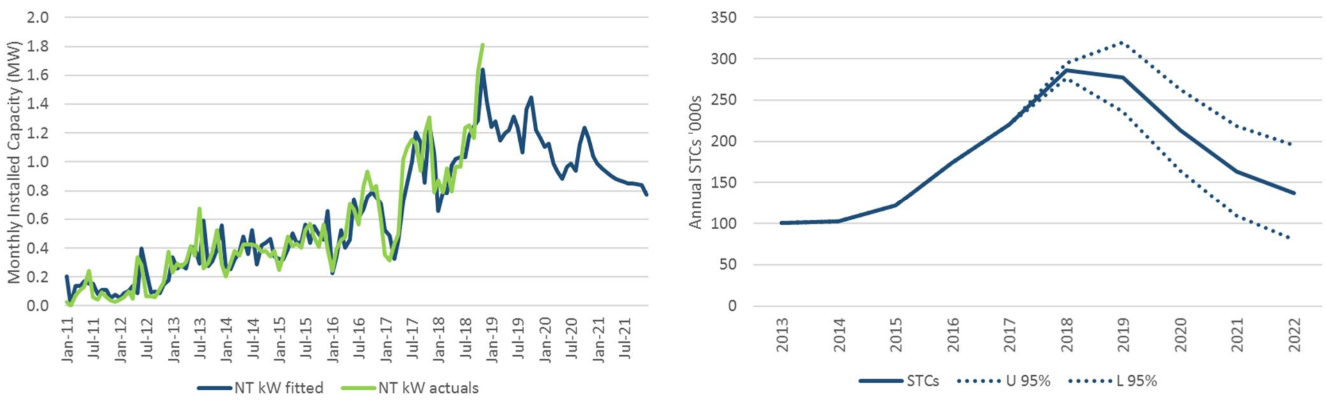
Figure 25: Historical and projected installed capacity and STCs generated for Australian Capital Territory residential properties



Source: Jacobs Analysis

Figure 26 shows the projected residential STC creation for the Northern Territory. An increase in expected capacity installation is expected in 2019 resulting in an equivalent number of STCs forecast after the step down in deeming period is applied. Good insolation levels and high FiTs may help lessen the downward economic pressures with the decrease in the Northern Territory's expected GDP growth from 4% in 2017 to 2.1% in 2019, and the associated negative population growth[6].

Figure 26: Historical and projected installed capacity and STCs generated for Northern Territory residential properties



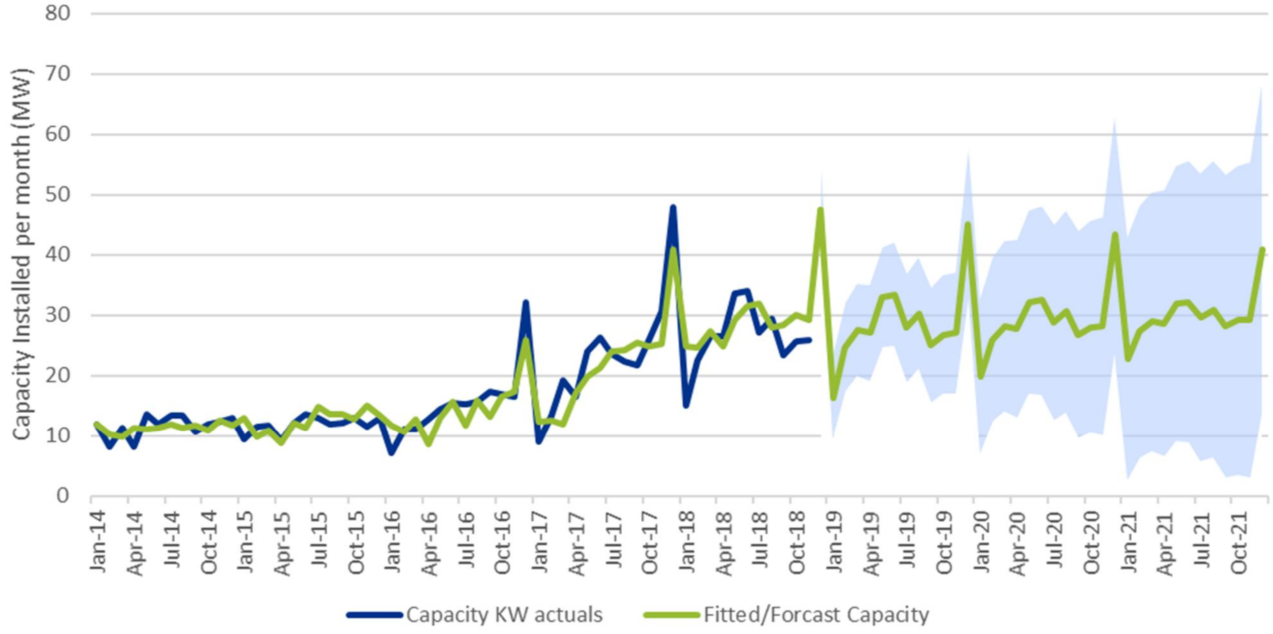
Source: Jacobs Analysis

6.2 Commercial SGU systems

Figure 27 shows the historical and projected total STCs created by commercial installations. The striking feature is the distinct seasonal pattern, which the time-series model has identified and modelled into the future years, highlighting the sensitivity of commercial installations to economic benefits. As with residential systems, a distinct increase is observed during 2017, driven by surges in electricity prices and a continual downward trend in capital cost. As opposed to residential systems, we see an increasing trend in installations and subsequent STC creation throughout the duration of the forecast. Although these small commercial systems are subject to similar drivers as the residential systems, such as an expected reduction in electricity prices and reduction in STC rebates, other factors are potentially driving the increase such as the closer match of demand with solar PV generation and limited market saturation.

[6] https://budget.nt.gov.au/__data/assets/pdf_file/0015/501018/Economy-Overview-2018-19.pdf

Figure 27: Historical and forecast commercial PV capacity installations by month (MW)

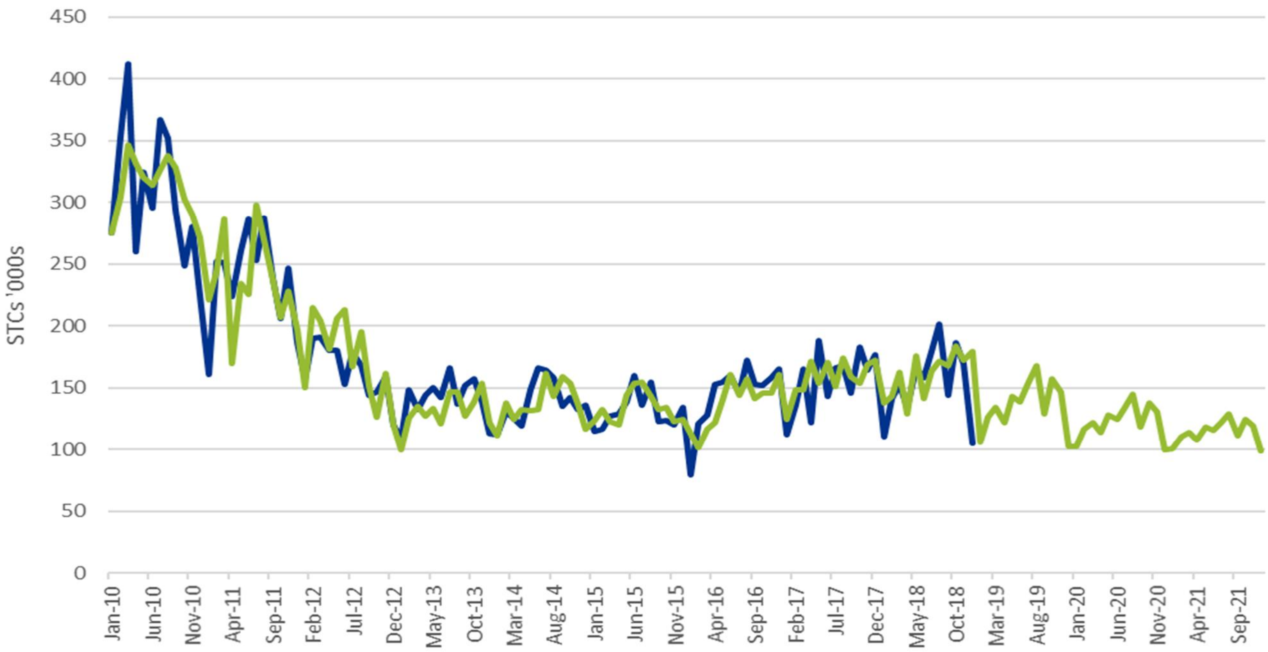


Source: Jacobs Analysis

6.3 Time series modelling of SHW systems

Figure 28 shows the historical actual, fitted and forecast data for the creation of STCs via solar hot water residential installations. The estimate for 2019 is a creation of 1.63 million STCs, or a 12% decrease from 2018 levels of STC generation from residential SHW units. Our modelling suggests that net economic benefit is not a strong driver of the installation of such systems, and the increasing trend is more likely attributed to the growth in housing market.

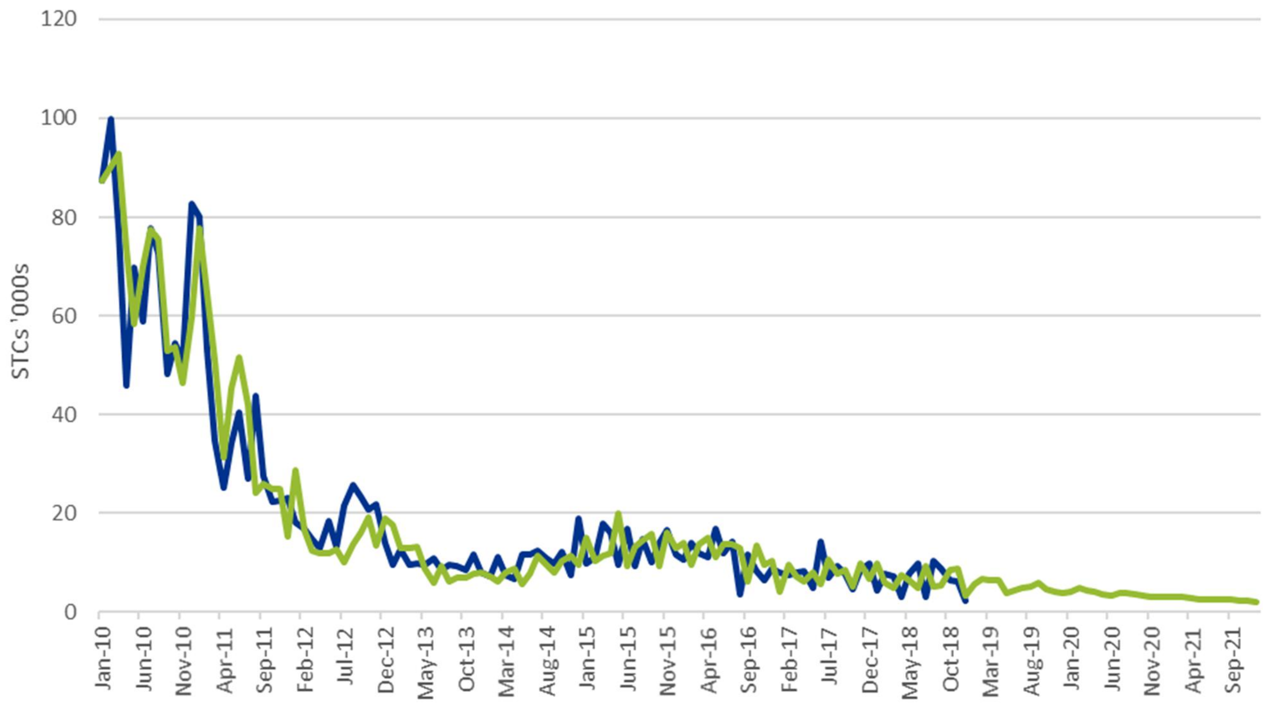
Figure 28: Residential SHW STC creation



Source: Jacobs' analysis

Figure 29 shows the historical actual, fitted and forecast data for the creation of STCs via solar hot water systems classified as commercial sized units. The estimate for 2019 is a creation of 61,000 STCs, or a 19.5% decrease from 2018 levels of STC generation. This is in contrast with the commercial installation of small scale solar PV systems, which have been experiencing a growth rate over the same period. It is likely that this is no coincidence as the elevated cost of electricity and the net benefit of such systems begin to far out-weigh the economic benefit that solar hot water heaters would bring on competing roof space.

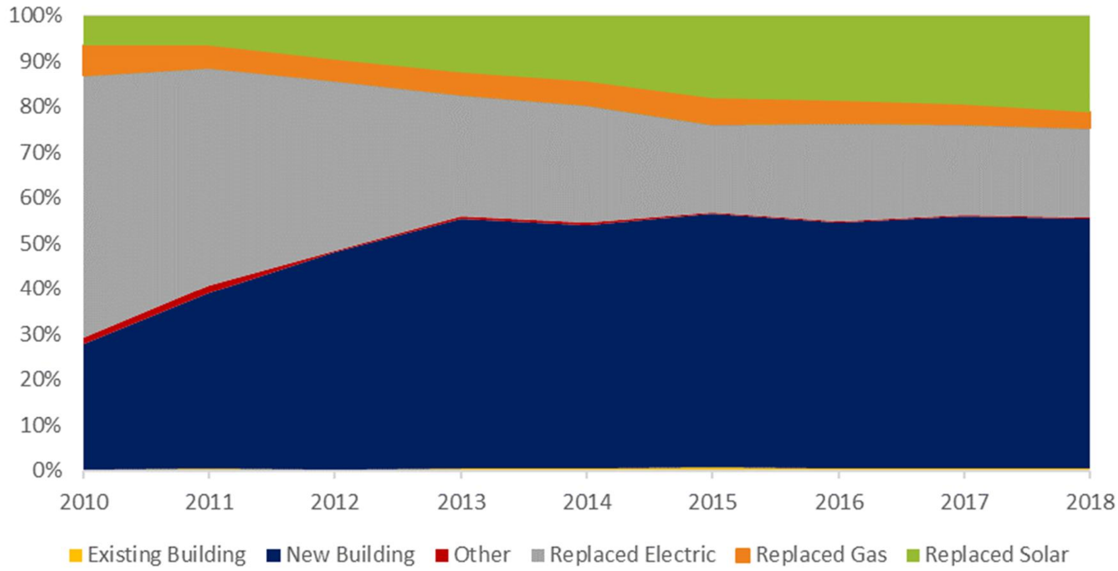
Figure 29: Commercial SHW STC creation, historical and forecast



Source: Jacobs' analysis

Figure 30 shows the proportion of STCs created via hot water systems by the reason for installation. The market is dominated by installations at new buildings, reflecting the regulations on energy efficiency in new homes, with around 55% of the STCs created from solar water heaters are due to installations in new buildings. Replacement of solar systems (21%) during 2018 has overtaken replacement of electric hot water systems (20%) as the next most dominant category. This is further evidence that the uptake of solar hot water systems is driven more by building regulations or the need to replace a faulty system rather than necessary the economic benefits.

Figure 30: Solar water installations by category



Source: Jacobs' analysis of CER solar water heater data

6.3.1 Results summary

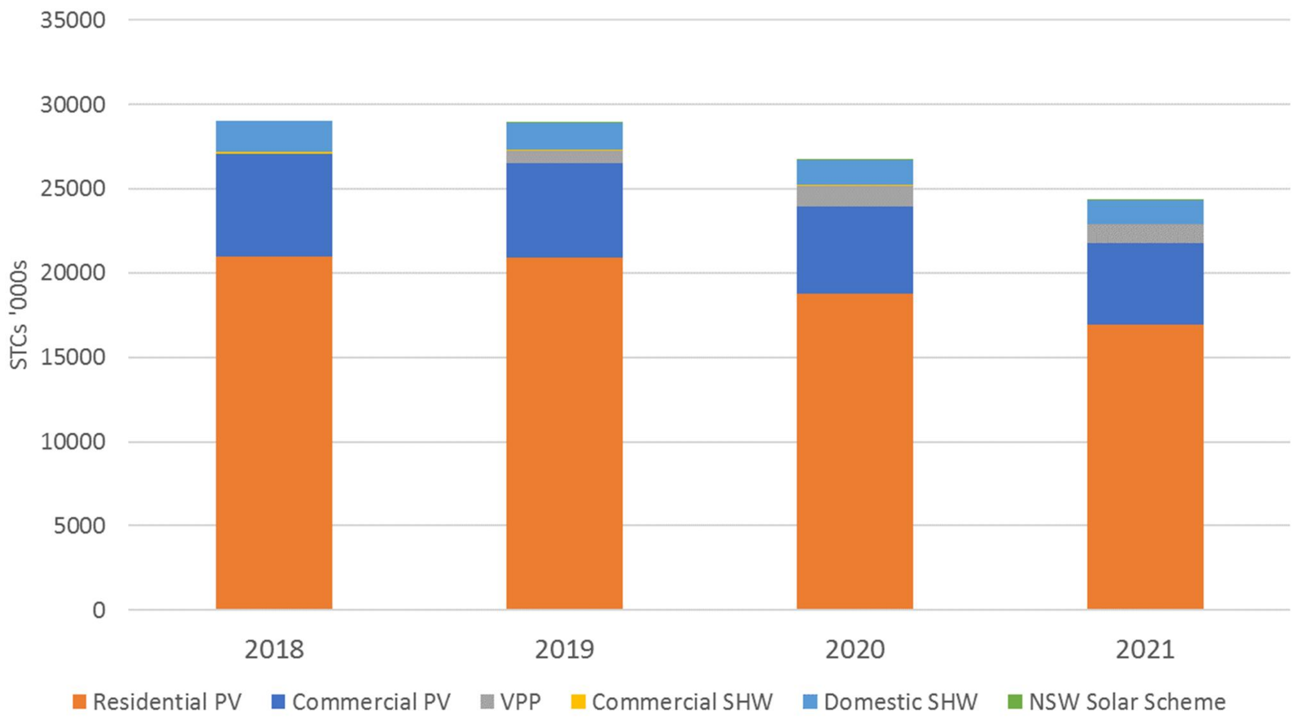
Time series projections and our estimates of the STCs created via the South Australian Virtual Power Plant Scheme are summarised in Table 9. These projections include STCs created through both solar PV and hot water systems (wind and hydro STCs make up a negligible portion). In 2019 we project a total of 29 million STCs generated despite the STC scheme entering another year of scaling down by a ratio of 1/15 or 6.7% when compared with 2018.

Table 9: Summary of STC forecasts, '000s

	2018	2019	2020	2021
Commercial STCs	6076	5578	5,229	4,860
Residential STCs	20,974	20,937	18,740	16,914
QLD	5,611	5,419	4,624	4,095
NSW	5,709	4,970	3,934	3,374
ACT	305	182	127	99
VIC	3,611	4,694	4,445	3,991
TAS	198	205	200	185
SA	2,162	1,722	1,542	1,394
WA	3,092	3,467	3,654	3,613
NT	286	278	213	164
VPP STCS	45	715	1,236	1,124
NSW Low Income Scheme		47	43	39
Australia SWH STCs	1925	1688	1521	1405
Commercial	76	61	44	31
Domestic	1,849	1,627	1,476	1,374
All STCs	29,020	28,966	26,769	24,341

Source: Jacobs' analysis

Figure 31: Summary of STC forecasts Australia, 2018 to 2021



Source: Jacobs' analysis

The separation of commercial and residential SGU systems for modelling has highlighted some interesting insights into the small-scale PV industry. Modest levels of growth are projected for commercial installations over the forecasting period driven by sound economic benefits, however this growth is not enough to overcome the inevitable downward trend as the STC scheme tapers to completion by 2030.

The creation of STCs from residential PV units across regions in 2019 Australia shows mixed results. In the NEM, the reduction in growth of STCs in NSW, ACT and QLD is driven primarily by the projected decrease in electricity prices in 2019 that have fed into both the avoided cost of electricity and state feed-in tariffs for new customers. Other factors contributing to the decline in trend is the decrease in STC financial incentives, the slowing of growth of average residential capacity sizes due to rooftop size constraints and inverter limitations and the gradual saturation of the market.

The South Australian Virtual Power Plant scheme offering 5kW PV systems to households that are assumed not otherwise in a position to take on such an investment contributes to the growth in STCs in South Australia of 15% in 2019. According to our modelling, the South Australian Home Battery scheme did not have a significant contribution to the generation of STCs.

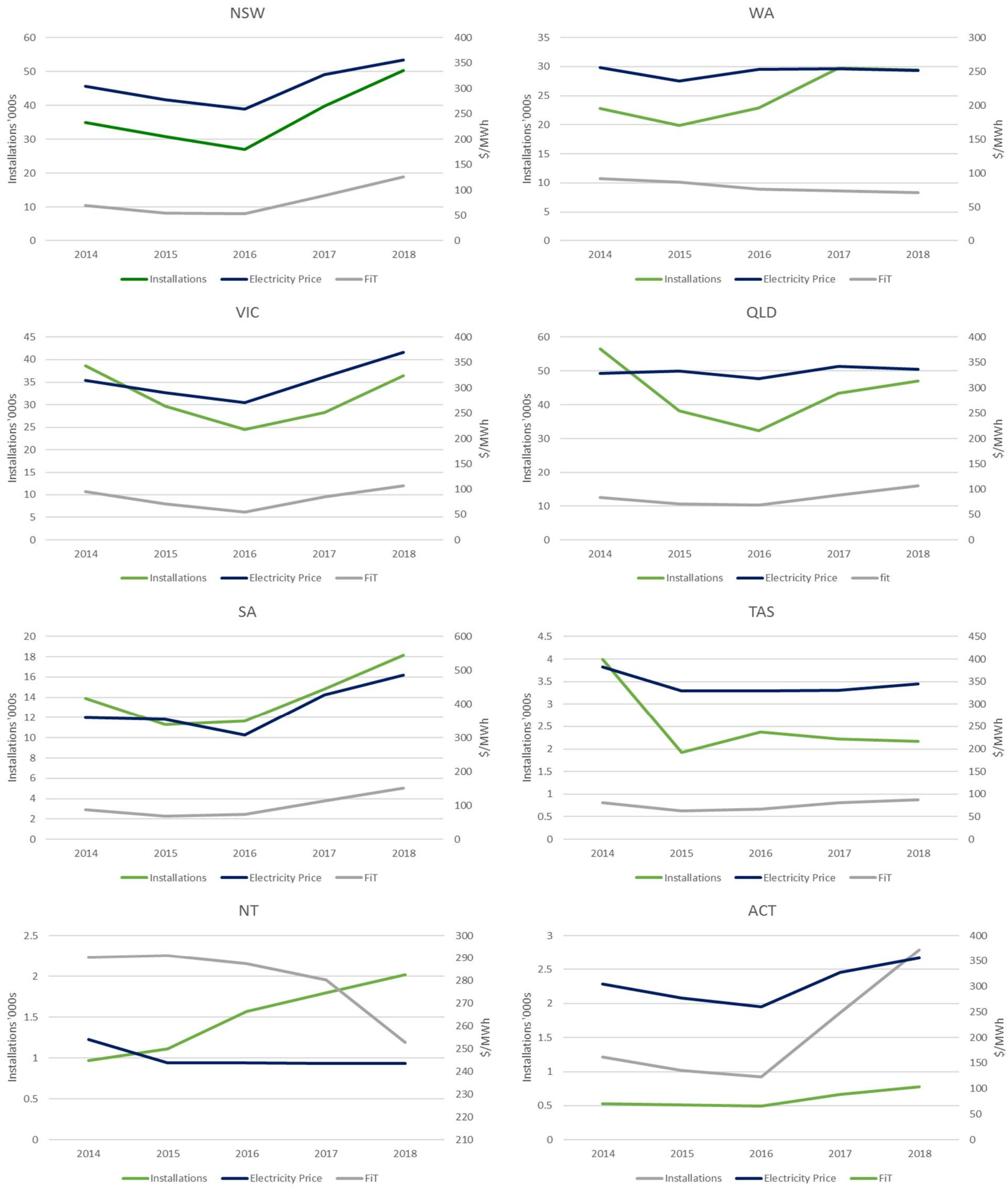
The Victorian Solar Homes Scheme results in a massive 35% increase in STCs projected in 2019 from the expected levels generated 2018. This equates to an estimated additional 325 MW of solar capacity in Victoria from residential rooftop installations alone in 2019. With an additional 303 MW and 295 MW projected for 2020 and 2021 respectively, the decline in STCs over these years is largely in line with the step down in deeming period of the STC program.

Commercially sized SHW units are expected to continue their declining trend and are not expected to have considerable influence on small-scale technology certificate creation for the duration of the forecasting period. Domestic size solar hot water systems are expecting modest growth over the forecasting period, largely attributed to the growth in housing and the increasing need to replace existing solar hot water heaters.

Appendix A. Electricity Price and Residential Installation

These figures illustrate the trends between number of residential solar PV installations per year and average retail electricity price per year since 2014. New South Wales, Victoria, the ACT, Tasmania and South Australia indicate a relatively strong relationship between electricity price and the number of installations. A weaker association between price and number of installations is observed in Queensland and Western Australia.

Figure 32 Relationship between average electricity price, average FiT and number of installations in states and territories



Source: Jacobs' analysis

Appendix B. Historical Feed-in-Tariff assumptions

Table 10 Detailed historical feed-in tariff assumptions

State/Territory	Historical Feed-In Tariffs and Schemes	Jacobs assumptions (c/kWh)
Victoria	The Victorian Government introduced a premium feed-in tariff of 60c/kWh in 2009 and closed it to new applicants at the end of 2011. The transitional feed-in tariff was then introduced at a rate of 25c/kWh until the end of 2012. The Essential Services Commission (ESC) in Victoria is required to determine the minimum electricity feed-in tariff that is paid to small renewable energy generators. In 2013 this was set to be 8c/kWh, 6.2c/kWh in 2015 and 5c/kWh in 2016, 11.3c/kWh in July 2017. As of 1 July 2018, a mandatory minimum net feed-in tariff rate of 9.9 c/kWh for systems up to 100 kW in size, offered by the retailers.	1/1/2009 to 31/12/2011 60c 1/1/2012 to 31/12/2012 25c 1/1/2013 to 31/12/2014 8c 1/1/2015 to 31/12/2015 6.2c 1/1/2016 to 30/6/2017 5c 1/7/2017 to 30/6/2018 11.3c 1/7/2018 to 30/6/2019 9.9c
New South Wales	The NSW Solar Bonus scheme began in 2009 offering payment of 60c/kWh on a gross basis, which reduced to 20c/kWh after October 2010. This program closed to new customers in May 2011. The independent Pricing and Regulatory Tribunal's assessment for the 2013-2014 financial year is that a fair and reasonable value for net electricity exported to the grid was in the range of 6.6 to 11.2 c/kWh. IPART determined Fit for 2014-2015 net Fit be 5.3c/kWh, 2015-2016 should be 4.4-4.8 c/kWh. In June 2016, IPART made decision for 2016-2017 should be 5.5-7.2c/kWh. In FY2018, net FiTs offered by retailers range from 9 c/kWh to 12 c/kWh and in CY2018 average range was 13.97c/kW.	1/1/2009 to 31/10/2010 60c 1/11/2010 to 30/4/2011 20c 1/5/2011 to 30/6/2014 6.6c 1/7/2014 to 30/6/2015 5.3c 1/7/2015 to 30/6/2016 4.4c 1/7/2016 to 30/6/2017 5.5c 1/7/2017 to 30/6/2018 11.6c 1/7/2018 to 30/6/2019 13.97c
Queensland	Queensland solar bonus scheme provided a 44c feed-in tariff for customers before 10 July 2012. This was replaced with a minimum 8c Feed-in tariff until 30 June 2014. From 1 July 2014 retailers are required to provide a feed-in tariff that represent benefit that the retailer receives in South East Queensland. The feed-in tariff provided in 2015-2016 to customers in the Essential Energy network was 6.348 c/kWh. In 2017 – 2019 net FiTs offered by retailers for SE Queensland ranged from 7 c/kWh to 16 c/kWh. Mandatory minimum of 10.1 c/kWh for regional customers.	1/1/2011 to 30/6/2012 44c 1/7/2012 to 30/6/2014 8c 1/7/2014 to 30/6/2017 6.348c 1/7/2017 to 30/6/2018 10.6c 1/7/2018 to 30/6/2019 10.9c
Northern Territory	Net 1-for-1 FiT, where consumer is paid for all electricity exported to grid at their consumption tariff.	Retail rate
Australian Capital Territory	In July 2008 the feed-in tariff was 50.05c/kWh for systems up to 10kW in capacity for 20 years and 45.7c/kWh for systems up to 30kW in capacity. The feed-in tariff scheme closed on 13 July 2011. One	1/1/2011 to 30/6/2011 50.05c 1/7/2011 to 30/6/2013 retail rate 1/7/2013 to 30/6/2017 6c

State/Territory	Historical Feed-In Tariffs and Schemes	Jacobs assumptions (c/kWh)
	for one Feed in Tariff for applications submitted prior to June 30 2013. From July 2011 to June 2017, Feed-in tariff assumed to range between 6 and 7.5c/kWh for systems up to 10kW in capacity. No mandatory retailer contribution. Net FiTs offered by retailers range from 9 c/kWh to 17 c/kWh.	1/7/2017 to 30/6/2018 11.0c 1/7/2018 to 30/6/2019 9.8c
Western Australia	On August 1 2010, the net feed-in tariff offered by the state government was 40c/kWh, while Synergy offered 7c/kWh via the Renewable Buyback Scheme. Customers were eligible for both incentives. On August 1 2011, the government suspended all new applications. From July 2012, a minimum buyback rate of 10c/kWh and applied to Horizon customers. No mandatory retailer contribution. Regional areas of WA who have Horizon have two 2 Solar Buyback Schemes in place with varied rates from 7.135 c/kWh to 50 c/kWh – depending on location.	1/1/2011 to 30/6/2011 40c 1/7/2011 to 31/7/2011 20c 1/8/2011 to 30/6/2014 8.0c 1/7/2014 to 30/6/2015 8.9c 1/7/2015 to 30/6/2019 7.135c
South Australia	In July 2008 the South Australian government introduced a feed-in tariff scheme providing 44c/kWh for 20 years. In 2011 this rate was reduced to 16c/kWh. This scheme was closed to new customers in September 2013. For the remainder of 2013, the minimum retailer tariff set by the SA regulator (Essential Service Commission of South Australia) was 9.8c/kWh. For the first half of 2014, this rate reduced to 7.6c/kWh. From 1 of July 2014, a minimum of 6.0c/kWh was set, from January 2015 this was reduced to 5.3c/kWh and in 2016 set to 6.8c/kWh. As of 1 of January 2017 no minimum amount has been set. Net Feed-in tariffs in 2017 to 2018 from retailers ranged from 7c to 22c/kWh. No mandatory retailer contribution. Net FiT offered by retailers range from 7 c/kWh to 22 c/kWh.	1/7/2013 to 31/12/2013 9.8c 1/1/2014 to 20/6/2014 7.6c 1/7/2014 to 31/12/2014 6.0c 1/1/2015 to 31/12/2015 5.3c 1/1/2016 to 31/12/2016 6.8c 1/1/2017 to 30/6/2017 7.6c 1/7/2017 to 30/6/2018 15c 1/7/2018 to 30/6/2019 15.3c
Tasmania	Aurora offered a feed-in tariff one for one (27.785) at regulated electricity tariff for residential customers. This closed in August 2013 and was replaced with transitional feed-in tariff of 20c/kWh. Tasmanian regulator stipulated smaller rates which were 8.282c/kWh for first half of 2014, then 5.551c/kWh for FY2015 and 5.5c/kWh for FY2016. From July 2016, the rate was 6.671 c/kWh. For FY2018 solar buyback available through Aurora Energy of 8.9c/kWh for systems up to 10kW.	1/1/2011 to 30/8/2013 27.785c 1/9/2013 to 31/12/2013 20c 1/1/2014 to 30/6/2014 8.282c 1/7/2014 to 30/6/2015 5.551c 1/7/2015 to 30/6/2016 5.5c 1/7/2016 to 30/6/2017 6.671c 1/7/2017 to 30/6/2018 8.9c 1/7/2018 to 30/6/2019 8.5c

Sources: https://www.treasury.wa.gov.au/uploadedFiles/Site-content/Public_Utilities_Office/Solar_PV/Feed-in-Tariff-Frequently-Asked-Questions.pdf; https://www.energymatters.com.au/rebates-incentives/feedintariff/; https://wattever.com.au/retailer-solar-feed-in-tariffs-by-state-and-territory/; https://www.solarquotes.com.au/systems/feed-in-tariffs/wa/

Appendix C. Percentage of households with Solar PV

Percentage of residential rooftop PV installations by region (SA4). Installations based on valid residential postcode.

Table 11 Number of dwellings and residential PV installations per region (SA4)

SA4 Code	SA4 Name	Dwellings	PV Installations	Percentage PV
101	Capital Region	94363	18274	19%
102	Central Coast	118124	17882	15%
103	Central West	90687	15995	18%
104	Coffs Harbour - Grafton	65087	15578	24%
105	Far West and Orana	55635	17217	31%
106	Hunter Valley exc Newcastle	142052	26117	18%
107	Illawarra	120437	16166	13%
108	Mid North Coast	103443	24855	24%
109	Murray	52518	11122	21%
110	New England and North West	82224	17877	22%
111	Newcastle and Lake Macquarie	153291	24452	16%
112	Richmond - Tweed	110364	35026	32%
113	Riverina	70455	12130	17%
114	Southern Highlands and Shoalhaven	55764	9850	18%
115	Sydney - Baulkham Hills and Hawkesbury	78802	14893	19%
116	Sydney - Blacktown	100620	18953	19%
117	Sydney - City and Inner South	134195	1846	1%
118	Sydney - Eastern Suburbs	109233	3847	4%
119	Sydney - Inner South West	218521	16240	7%
120	Sydney - Inner West	147911	7059	5%
121	Sydney - North Sydney and Hornsby	186729	13033	7%
122	Sydney - Northern Beaches	101620	8273	8%
123	Sydney - Outer South West	91795	17476	19%
124	Sydney - Outer West and Blue Mountains	117766	20235	17%
125	Sydney - Parramatta	153267	12485	8%
126	Sydney - Ryde	52951	3647	7%
127	Sydney - South West	130114	19707	15%
128	Sydney - Sutherland	84309	7957	9%
201	Ballarat	65849	10348	16%
202	Bendigo	66260	14472	22%
203	Geelong	135252	22742	17%
204	Hume	81247	19441	24%
205	Latrobe - Gippsland	143642	29677	21%
206	Melbourne - Inner	344508	15137	4%
207	Melbourne - Inner East	187044	16985	9%
208	Melbourne - Inner South	175449	15280	9%

SA4 Code	SA4 Name	Dwellings	PV Installations	Percentage PV
209	Melbourne - North East	211551	27201	13%
210	Melbourne - North West	86835	16418	19%
211	Melbourne - Outer East	163908	25353	15%
212	Melbourne - South East	262092	45933	18%
213	Melbourne - West	270714	46164	17%
214	Mornington Peninsula	137016	19633	14%
215	North West	71135	13585	19%
216	Shepparton	54283	13768	25%
217	Warrnambool and South West	60869	8265	14%
301	Brisbane - East	59815	24981	42%
303	Brisbane - South	442587	107230	24%
306	Cairns	113170	24699	22%
307	Darling Downs - Maranoa	40518	10124	25%
308	Central Queensland	105080	25020	24%
309	Gold Coast	278909	77703	28%
310	Ipswich	110730	41693	38%
311	Logan - Beaudesert	81069	31380	39%
312	Mackay - Isaac - Whitsunday	76690	16780	22%
313	Moreton Bay - North	192428	73037	38%
315	Queensland - Outback	23799	2808	12%
316	Sunshine Coast	157602	56983	36%
317	Toowoomba	59392	13268	22%
318	Townsville	101100	28561	28%
319	Wide Bay	136132	47442	35%
401	Adelaide - Central and Hills	121804	31914	26%
402	Adelaide - North	148551	49295	33%
403	Adelaide - South	154432	49662	32%
404	Adelaide - West	133473	33977	25%
405	Barossa - Yorke - Mid North	61671	23309	38%
406	South Australia - Outback	47783	12984	27%
407	South Australia - South East	98759	32480	33%
501	Bunbury	83457	21875	26%
502	Mandurah	48607	17828	37%
503	Perth - Inner	68996	8122	12%
504	Perth - North East	106574	31241	29%
505	Perth - North West	228394	62856	28%
506	Perth - South East	199839	57694	29%
507	Perth - South West	168431	51514	31%
509	Western Australia - Wheat Belt	67208	14207	21%
510	Western Australia - Outback (North)	42350	1355	3%
511	Western Australia - Outback (South)	59081	9156	15%
601	Hobart	98378	12906	13%
602	Launceston and North East	66274	9300	14%

SA4 Code	SA4 Name	Dwellings	PV Installations	Percentage PV
603	South East	25436	3819	15%
604	West and North West	52443	6353	12%
701	Darwin	61048	7289	12%
702	Northern Territory - Outback	24961	2808	11%
801	Australian Capital Territory	151544	19697	13%
901	Other Territories	0	0	0%
	TOTAL	9838446	1941944	20%

Appendix D. Forecast additional Capacity

Our projected total installed capacity for residential and commercial PV systems our outlined in Table 12.

Table 12 Projected PV residential and commercial installed capacity, MW

	2018	2019	2020	2021
Commercial MW	348	345	352	360
Residential MW	1205	1350	1361	1352
QLD	313	325	303	295
NSW	318	298	257	243
ACT	17	11	8	7
VIC	233	327	338	334
TAS	13	14	15	16
SA	121	104	102	101
WA	173	209	241	262
NT	14	15	12	11
VPP Scheme SA	3	43	82	82
NSW Low Income Scheme		3	3	3
Total Capacity (MW)	1,553	1,695	1,714	1,712

Appendix E. Jacobs Electricity Pricing Model

Jacobs has prepared our retail price projections using a bottom up approach identical to the approach we provided for AEMO in 2017 (Jacobs-Retail-electricity-price-history-and-projections_Final-Public-Report-June-2017.pdf).

This approach involves developing projections for each cost component that retailers face. These include network charges, wholesale charges, environmental scheme costs, market operator charges and retailer charges and margins.

The wholesale prices were developed using Jacobs' market modelling tools which combine the use of Strategist software integrated with Jacobs' databases and models collected over the last 3 decades.

The market forecasts account for regional demand forecasts, generating plant performance, timing of new generation including embedded generation, existing interconnection limits, and the potential for interconnection development. Jacobs used its Strategist and REMMA models to develop long-term time weighted prices to the year 2050. Strategist is a model of the NEM and the WEM, whilst REMMA models the details of the renewable energy market subject to the Large-scale Renewable Energy Target (LRET).

The dynamic programming method in Strategist selects new capacity on a least-cost basis. In Jacobs' experience the model is generally accurate in the prediction of the future generation mix, with the main deviations from predicted investment the result of:

- Economies of scale.
- Pre-emptive new entry.
- Fuel supply arrangements.
- Interconnection upgrades are included in the Strategist modelling as development options in competition with new generation capacity.

Future wholesale electricity prices and related market outcomes are essentially driven by the supply and demand balance, with long-term prices being effectively capped near the cost of new entry on the assumption that prices above this level provide economic signals for new generation to enter the market. Consequently, assumptions on the fuel costs, unit efficiencies, and capital costs of new plant and emissions intensity threshold will have a noticeable impact on long-term price forecasts. Year-to-year prices will deviate from the new entry cost level based on the timing of new entry. In periods when new entry is not required, the market prices reflect the cost of generation to meet regional loads, and the bidding behaviour of the market participants as affected by market power.

Key assumptions used in the modelling include:

- Capacity is installed to meet the target reserve margin for the NEM in each region. Some of this peaking capacity may represent demand side response rather than physical generation assets. It is assumed that this is already included in the demand forecasts provided by AEMO.
- Wind generation is based on observed wind power generation profiles for each region.
- Generators behaving rationally, with uneconomic capacity withdrawn from the market and bidding strategies limited by the cost of new entry. This is a conservative assumption as there have been periods when prices have exceeded new entry costs when averaged over 12 months.
- Infrequently used peaking resources are bid near Market Price Cap or removed from the simulation to represent strategic bidding of these resources when demand is moderate or low. Torrens Island A capacity is an example when some plant is never indicated to be required for median peak demand.
- The LRET target is for 33,000 GWh of renewable generation by 2020.
- Additional renewable energy is included for expected GreenPower and desalination purposes.

Specific market assumptions are outlined in Table 13.

Table 13: Key Scenario Assumptions

Parameter	Central scenario
Commonwealth Emissions Policy	International emissions reduction obligations are met (26% emissions reductions by 2030 relative to 2005).
Demand growth	AEMO August 2018 ESOO neutral demand scenario.
Gas Price	In the NEM starting from approximately $10.1/GJ for new entrants, rising to $10.5/GJ representing the mid-term supply constraint in the market. Prices decline in the mid-term to $9.5/GJ and then commence an upward long-term trend to $10.8/GJ reflecting world gas price trends.
Utility scale wind learning rates	NREL 2018 renewable technology cost assumptions - steadily declining learning rate from 1.9% in 2019 to 0.4% in 2050.
Utility scale solar learning rates	NREL 2018 renewable technology cost assumptions - steadily declining learning rate from 3.8% in 2019 to 1.2%
Treatment of coal fired power stations	All power stations retire when they can no longer recover their non-avoidable costs. Liddell retires in 2022. Yallourn to retire progressively from 2031 to 2034 as its fuel supply is exhausted.
Interconnectors	QNI upgraded by 300 MW in both directions by 2023.
Snowy Hydro	The Snowy Hydro Expansion is not included in the model.
Renewable generation inclusion	All committed renewable generation in the NEM (based on documented evidence that projects have reached financial close).