Small-scale Technology Certificates Data Modelling for 2011 to 2013

FINAL REPORT

29 November 2010

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1. Abbreviations

ACT	Australian Capital Territory
ARIMA	Autoregressive Integrated Moving Average
CPI	Consumer Price Index
CPRS	Carbon Pollution Reduction Scheme
DOGMMA	Distributed Generation Market Model of Australia
HPWH	Heat Pump Water Heaters
kW	Kilowatt
kWh	Kilowatt hour
LRET	Large-scale Renewable Energy Target
MRET	Mandatory Renewable Energy Target
NSW	New South Wales
ORER	Office of the Renewable Energy Regulator
PV	Photovoltaic
PVRP	Photovoltaic Rebate Program
REC	Renewable Energy Certificate
RET	Renewable Energy Target
SGU	Small Generation Unit
SHCP	Solar Home and Communities Plan
SKM-MMA	Sinclair Knight Merz - McLennan Magasanik Associates
SRES	Small-scale Renewable Energy Scheme
STC	Small-scale Technology Certificate
SWH	Solar Water Heaters

2. Executive Summary

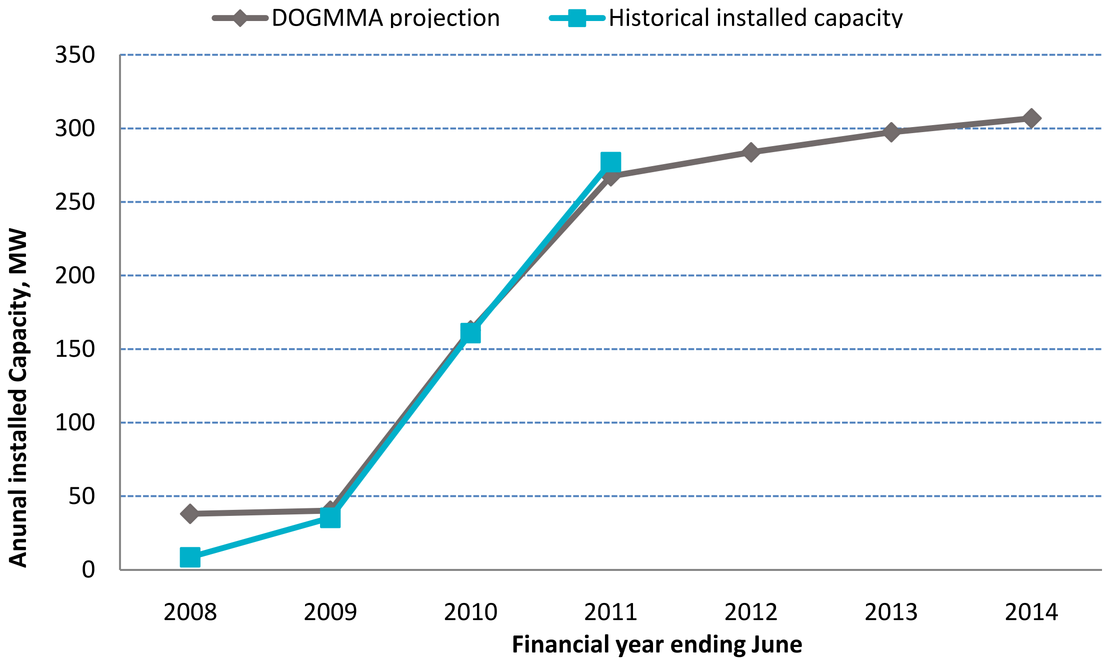
This report has been prepared for the Office of the Renewable Energy Regulator (ORER) and presents SKM-MMA's projections of the number of Small-scale Technology Certificates (STCs) expected to be created in the 2011, 2012 and 2013 calendar years. The modelling was carried out for two scenarios that had different schedules for the reduction of the Solar Credits multiplier, which can be received by all small generation units (SGUs). The Base scenario is as per the current legislation, where the 5x multiplier is replaced by the 4x multiplier from 1 July 2012, and the multiplier is progressively reduced each year thereafter. In the Reduced Multiplier scenario, the 4x multiplier is introduced one year earlier, commencing from 1 July 2011. A key assumption common to both scenarios is the commencement of emissions trading from July 2014, which impacts projected wholesale and retail electricity prices, and hence the net costs of installing the systems considered here.

Analysis of the dataset provided by ORER detailing the historical creation of all RECs by small-scale technologies revealed that the majority of RECs were created by PV systems, solar water heaters (SWHs) and heat pumps. STC projections from small-scale wind and hydro systems were therefore not considered in the analysis since they constitute a small fraction of the total.

Two modelling approaches were used to formulate the projections. The first approach used SKM-MMA's DOGMMA model, which is a structural model of distributed and embedded generation for all of Australia. It determines the uptake of small-scale renewable technologies based on comparing the net cost of generation against the net cost of grid delivered power. The second approach was through the construction of a time series model, which would determine the uptake of renewable technologies based on trends in historical data, also having regard to the historical and projected evolution of the net cost of system installation. DOGMMA does not have any provision for modelling uptake of solar water heaters or heat pumps, so all projections for these technologies were based on the time series model.

Exec Figure- 1 shows the projection of PV uptake capacity across Australia for the Base scenario derived from the DOGMMA model, and also includes the results of the calibration over the last three years. The fit of the model to the historical data is quite good, although 2007/08 has been overestimated. The 2010/11 "historical" data point is actually a simple projection of the year to date numbers, and DOGMMA also achieves good agreement with this point. Looking forward, DOGMMA predicts an increasing rate of uptake over the next few years. This increase in uptake reflects the projected long-term downtrend in the net cost of PV systems, and it represents the optimal solution for the DOGMMA model, which minimises the total system cost over the next fifteen years. The key to understanding this result is the large expected increase in wholesale electricity prices which would occur with the introduction of an emissions trading scheme. This in turn drives an increase in the retail price, which has been assumed to escalate at 2.5% per annum in real terms over the longer term.

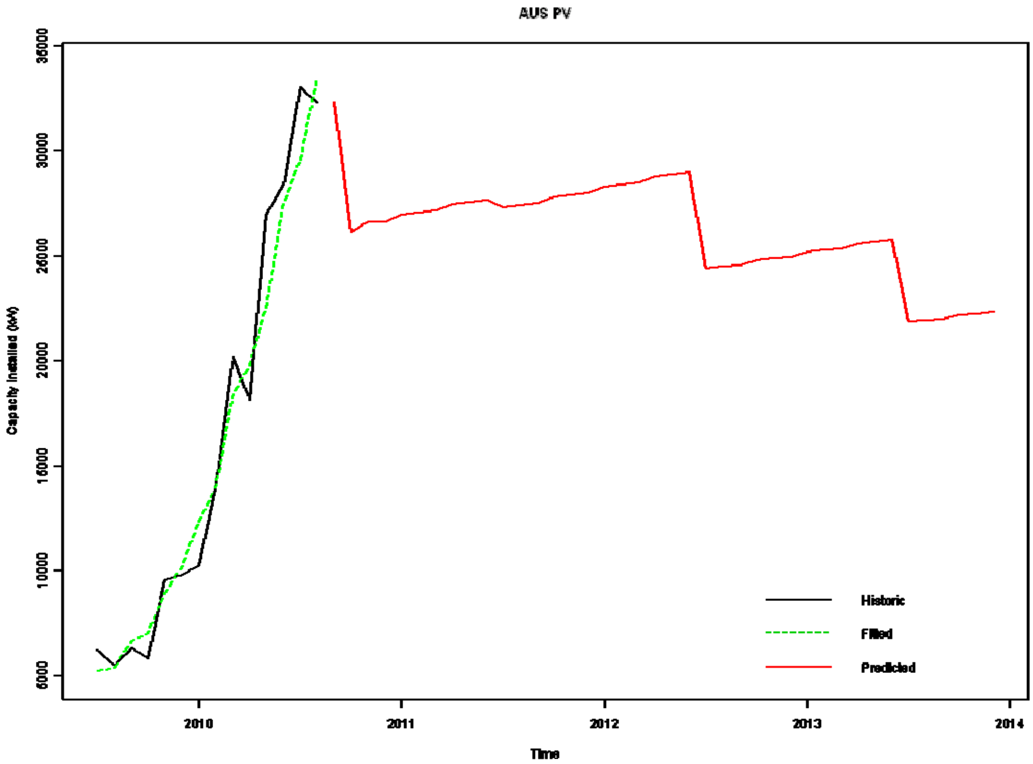
■ Exec Figure- 1 PV uptake capacity for Australia using DOGMMA – Base scenario



Exec Figure- 2 shows the projection of monthly PV uptake capacity across Australia for the Base scenario derived from the time series model. The solid black line on the left is the historical monthly PV capacity uptake, and the solid red line on the right is the projection. The green dotted line is the time series model's fit to the historical uptake capacity, which appears to be quite good. According to the time series model, the monthly PV uptake has already peaked and the model is projecting decreasing PV uptake over the next three years. However, this is starting from a high base because the projected capacity uptake for the 2011 calendar year is higher than the expected capacity uptake for the 2010 calendar year. The stark jumps evident in the monthly projections occur every July from July 2012 onwards. These are driven by the monthly PV net cost projection, and reflect the step down in the Solar Credits multiplier from 5 to 4 in July 2012, and then from 4 to 3 in July 2013. The positive slope in between these steps reflects a gradual lowering of costs through the assumed decline in PV capital costs and through an increase in the avoided costs of electricity, which is driven by rising wholesale and retail costs.

Exec Table- 1 shows the projected number of STCs for the Base scenario. It contains the two PV projections and the time series projection for STCs created by water heaters. The time series based STC projection for PV is almost 20% higher than that produced by the DOGMMA model in 2011, although by 2013 the time series projection is slightly lower than the DOGMMA result. STCs sourced from water heaters are projected to make up from 12% to 14% of total number of certificates produced in 2011, and about 18% of the total certificates produced in 2013.

■ Exec Figure- 2 PV uptake capacity for Australia using time series model – Base scenario



■ Exec Table- 1 Summary of projected STC creation – Base scenario

	2011	2012	2013
DOGMMA – PV	26,450,000	24,825,000	19,930,000
Time series – PV	31,455,000	27,642,000	19,195,000
Time series – water heaters	4,474,000	4,120,000	4,139,000
DOGMMA PV + water heaters	**30,924,000**	**28,945,000**	**24,069,000**
Time series PV + water heaters	**35,929,000**	**31,762,000**	**23,334,000**

Exec Table- 2 shows the projected number of STCs for the Reduced Multiplier scenario, which only impacts on STCs sourced from PV generation. Significantly less STCs are produced under this scenario from PV systems, and there is better agreement between the DOGMMA model and the time series model for PV-sourced STCs. STCs sourced from water heaters are projected to make up from 14% to 16% of total number of certificates produced in 2011, and from 23% to 26% of certificates produced in 2013.

■ Exec Table- 2 Summary of projected STC creation – Reduced Multiplier scenario

	2011	2012	2013
DOGMMA – PV	23,605,000	19,078,000	13,956,000
Time series – PV	26,403,000	18,365,000	11,783,000
Time series – water heaters	4,474,000	4,120,000	4,139,000
DOGMMA PV + water heaters	**28,079,000**	**23,198,000**	**18,095,000**
Time series PV + water heaters	**30,877,000**	**22,485,000**	**15,922,000**

In providing these projections of STC volumes over the 2011, 2012 and 2013 calendar years, SKM-MMA would like to underline the large level of uncertainty surrounding them. This is evident in the variation of the projections produced by the two separate methodologies for PV system uptake. The fundamental source of the uncertainty underlying the PV uptake predictions is the lack of market history at the current level of net installation cost. For example, the Solar Credits scheme was only introduced 16 months ago, and the total PV installation cost has only been at present levels for a similar amount of time.

SKM-MMA has more confidence in the STC volume projections for water heaters produced by the time series model since the model used almost six years of market history to make the predictions. However, these projections only form 12% to 26% of the annual number of STCs expected to be created over the next three years.

3. Background

The Department of Climate Change and Energy Efficiency through the Office of the Renewable Energy Regulator (ORER) is responsible for the implementation of the Australian Government's Renewable Energy Target (RET). The specific aim of the target is to assist the government with its commitment to achieving 20 percent of its electricity supply from renewable sources by 2020.

The RET legislation places a legal liability on wholesale purchasers of electricity to contribute towards the government's yearly targets. Wholesale purchasers meet this requirement by surrendering eligible certificates. A certificate is generally equivalent to 1MWh of renewable electricity and wholesale purchasers may create certificates through their own power stations or purchase them from the market.

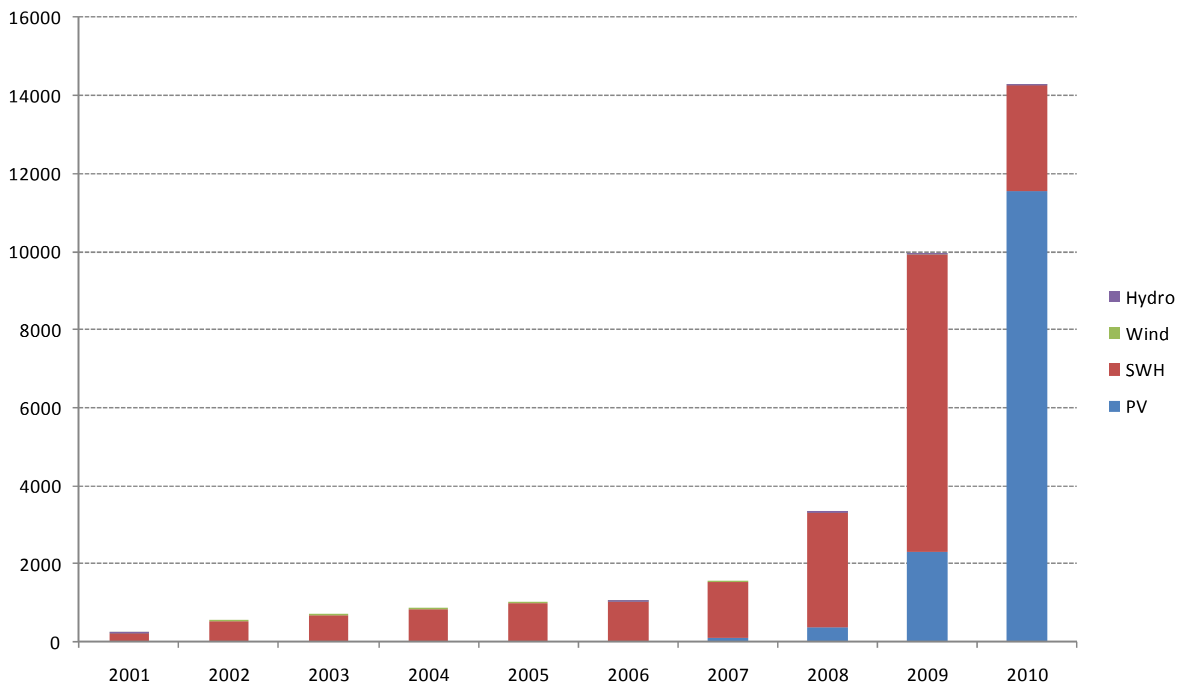
The Mandatory Renewable Energy Target (MRET) commenced in 2001. Since then, the government has announced a change which will see the existing RET scheme split into two parts; the Small-Scale Renewable Energy Scheme (SRES) and the Large-Scale Renewable Energy Target (LRET). These schemes will become effective from 1st January 2011.

The SRES scheme offers small-scale technology certificates (STCs) at a fixed price of $40 per certificate to purchasers of eligible solar water heaters (SWH), air source heat pump water heaters (HPWH) and small-scale photovoltaic (PV), wind and hydro systems. There is no cap to the number of STCs that can be created, which means that liable entities, through whom the scheme is funded, could potentially have significant costs to cover if there is a large uptake of these technologies.

The purpose of this report is to forecast the number of STCs that will be generated in the calendar years of 2011, 2012 and 2013. This will assist liable entities anticipate the extent of their liability over the coming years.

The number of RECs created historically by each of the small-scale technologies is shown on an annual time scale in Figure 3-1. REC creation has historically been dominated by solar water heater (SWH) installations, although this changed in 2010, where photovoltaic systems are now making the largest contribution. The two stand-out trends are: (i) the large volume of SWH RECs created in 2009, which was one factor responsible for the fall of the spot REC price at the time; and (ii) the even larger volume of photovoltaic RECs created thus far in 2010. The large increase in SWH RECs was driven by a change in the incentives offered to home owners by means of the Solar Hot Water Rebate, which commenced from 1 July 2009 and ended on 19 February 2010. This offered a rebate of up to $1600 to eligible householders for installing a SWH that replaced an electric hot water storage system. The large increase in small-scale PV installation from 2008 onwards can be explained by the increased rebate offered by the Federal Government's Photovoltaic Rebate Program (PVRP) (from $4000 to $8000, which lasted from November 2007 until June 2009) and, in particular, the subsequent issuance of Solar Credits for solar generation units (SGUs) under the expanded RET scheme from 9 September 2009 (this superseded the PVRP).

■ Figure 3-1 RECs created historically from small-scale technologies – Calendar years



The rest of this report has been set out as follows:

- **Financial incentives:** A discussion of federal and state incentives and feed-in tariffs that may influence a users' decision to take up small-scale renewable technologies;
- **Methodology:** Presents the key modelling assumptions and the methodologies underlying both SKM-MMA's DOGMMA model and the time series model developed in this assignment; and
- **Modelling results:** Presents the results of the modelling using both models and then translates these into projected STC volumes for the 2011, 2012 and 2013 calendar years.

4. Financial incentives

The number of STCs that will be generated in 2011, 2012 and 2013 is dependent on individuals' and households' uptake of eligible technologies which is in turn dependent on financial incentives such as federal and state rebates and the feed-in tariff.

4.1. Rebates

In order to address the high cost of installation and encourage individuals and household to adopt renewable technologies, Australian governments have initiated a number of Federal and State rebates. The rest of this section will discuss and summarise the rebates pertaining to solar PVs, solar water heaters and heat pumps.

The Australian Government through the Department of Climate Change and Energy Efficiency launched the Photovoltaic Rebate Program (PVRP) in 2000 where individuals and households, regardless of income received a rebate of $4,000 for installing solar PVs. In October 2007 the program was replaced by the Solar Home and Communities Plan (SHCP). This plan assisted with the installation of more than 100,000 systems and since then it has been replaced by the Solar Credits program.

In addition to the solar PV rebates, the Australian Government also provided support to individuals and households through the solar hot water rebate program. The program offered $1,600 and $1,000 in rebates for solar water heaters and heat pumps respectively. The program has since been replaced by the Renewable Energy Bonus Scheme.

In addition to the federal rebates, a number of state initiatives also provide assistance.

- Table 4-1 provides a summary of Federal rebates; and
- Table 4-2 provides a summary of solar hot water and heat pump rebates by state.

■ Table 4-1 Summary of rebates offered by the Federal Government

<table>
<tr><th>System</th><th>Information</th><th>Description</th></tr>
<tr><td rowspan="3">Solar PVs</td><td>Name: Photovoltaic Rebate Program (PVRP)
Valid: From 2000 to October 2007</td><td>A rebate of $4,000 and not subjected to a means test.</td></tr>
<tr><td>Name: Solar Homes and Communities Plan (SHCP)
Valid: November 2007 to 6 July 2009</td><td>The SHCP started out as the PVRP and provided support to households through a solar panel rebate. For the greater part of the plan, it was subjected to a means test of $100,000 or less. The SHCP offered the following rebate:
■ For new systems - Up to $8,000 ($8 per watt up to one kilowatt); and
■ For extensions to old systems - Up to $5,000 ($5 per watt up to one kilowatt)</td></tr>
<tr><td>Name: Solar credits
Valid: From 9 June 2009 to current</td><td>This scheme replaced the SHCP and the extent of the rebate is dependent on the size of the system and the date of installation.

A multiplier is applied to the first 1.5kW of eligible systems where the balance receives no multiplier. The multiplier will be gradually stepped down to reflect technological advances. The multipliers pertaining to each year are as follows:
<table>
<tr><td>Year</td><td>9th June 2010 to 30th June 2012</td><td>1st July 2012 to 30th June 2013</td><td>1st July 2013 to 30th June 2014</td><td>1st July 2014 to 30th June 2015</td><td>1st July 2015 and onwards</td></tr>
<tr><td>Multiplier</td><td>5</td><td>4</td><td>3</td><td>2</td><td>No multiplier</td></tr>
</table></td></tr>
<tr><td rowspan="2">Solar water heaters</td><td>Name: Solar hot water rebate program
Valid: Until 19 February 2010</td><td>A rebate of $1,600 and not subjected to a means test.</td></tr>
<tr><td>Name: Renewable Energy Bonus Scheme - Solar hot water rebate program
Valid: From 20 February 2010 to current</td><td>A rebate of $1,000 and not subjected to a means test.</td></tr>
<tr><td rowspan="2">Heat pump</td><td>Name: Solar hot water rebate program
Valid: Until 19 February 2010</td><td>A rebate of $1,000 and not subjected to a means test.</td></tr>
<tr><td>Name: Renewable energy bonus scheme - Solar hot water rebate program
Valid: From 20 February 2010 to current</td><td>A rebate of $600 and not subjected to a means test.</td></tr>
</table>

■ Table 4-2 Summary of solar hot water and heat pump rebates by State governments

State	Information	Description
Victoria	**Name:** Victorian solar hot water rebate **Valid:** From July 2008 until 31 December 2010	A rebate from $400 to $1600 and from $300 to $1500 for regional Victoria and metropolitan Melbourne respectively for both solar water heaters and heat pumps.
New South Wales	**Name:** NSW hot water system rebate **Valid:** From October 2007 to 30 June 2011	A rebate of $300 for a solar or heat pump hot water system
Queensland	**Name:** Queensland government solar hot water rebate **Valid:** From 13 April 2010 to current	▪ A $600 rebate for the installation of a solar hot water system or heat pump; or ▪ A $1000 rebate for pensioners and low income earners who install a solar hot water system or heat pump.
Northern Territory	**Name:** Solar hot water retrofit rebate **Valid:** From 1 July 1009 to 30 June 2010	Northern Territory households may be eligible for a Solar Hot Water Retrofit Rebate of up to $1,000 to help with the costs of installing a solar hot water system.
Australian Capital Territory	**Name:** HEAT Energy Audit **Valid:** From December 2004 to current	A $500 rebate is available for expenditure of $2,000 or more on the priority recommendations in the ACT Energy Wise audit report - which can include installing solar or heat pump water heating.
Western Australia	**Name:** Solar water heater subsidy **Valid:** From July 2010 to 30 June 2013	▪ A rebate of $500 for natural gas-boosted solar or heat pump water heaters; and ▪ A rebate of $700 for bottled LP gas-boosted solar or heat pump water heaters used in areas without reticulated gas.
South Australia	**Name:** South Australian Government's Solar Hot Water Rebate scheme **Valid:** From 1 July 2008 to current	A rebate of $500 for a new solar or electric heat pump water heater system. In order to be considered for this rebate, applicants must hold at least one of the following Australian government concession cards: ▪ Centrelink Health Care Card; ▪ Centrelink or Department of Veterans' Affairs Pensioner Concession Card; ▪ Department of Veterans' Affairs Gold Card - Totally and Permanently Incapacitated; ▪ Department of Veterans' Affairs Gold Card - War Widow; and ▪ Department of Veterans' Affairs - Extreme Disablement Adjustment.
Tasmania	**Name:** Solar and Heat Pump Hot Water Rebate Scheme **Valid:** 1 July 2007 to 31 December 2011 (solar hot water systems) **Valid:** 1 November 2008 to 31 December 2011 (heat pump water systems)	This scheme offers Hobart ratepayers a $500 incentive to install a solar or heat pump hot water system into their homes.

4.2. Feed-in tariff

Feed-in-tariffs in Australia for small-scale renewable energy generation are offered by the state governments. Table 4-3 presents a summary of the feed-in-tariffs offered by state.

- Table 4-3 Summary of feed-in tariff

State	Description
Victoria	Net feed-in-tariff of 60c/kWh commenced in November 2009
New South Wales	Gross feed-in-tariff of 60 c/kWh commencing in January 2010. The feed-in-tariff has now been reduced to 20 c/kWh from 27 October 2010
Queensland	Net feed-in-tariff of 44 c/kWh commencing in July 2008
Northern Territory	All PV-generated electricity receives the retail marginal cost of 19.23 c/kWh, which effectively makes this a gross feed-in-tariff. Customers on the Alice Springs grid receive 51.28 c/kWh for all PV-generated electricity
Australia Capital Territory	Gross feed-in-tariff of 50.5 c/kWh commencing in March 2009. The scheme was revised in April 2010, and the feed-in-tariff has now been reduced to 45.7 c/kWh
Western Australia	Net feed-in-tariff of 40 c/kWh commencing from August 2010
South Australia	Net feed-in-tariff of 44 c/kWh commencing in July 2008. The scheme was revised in August 2010, and the feed-in-tariff has now been increased to 54 c/kWh for the first 45 kWh per day
Tasmania	Net feed-in-tariff of 20c/kWh

5. Methodology

5.1. General methodology

The forecast of STC creation for calendar years 2011, 2012 and 2013 has been undertaken using SKM-MMA's structural model of distributed and embedded generation (called DOGMMA), and a time series model. The structural model determines the uptake of small-scale renewable technologies based on comparing the net cost of generation against the net cost of grid delivered power. The time series model determines the uptake of renewable technologies based on trends in historical data, also having regard to the historical and projected evolution of the net cost of installation. DOGMMA does not have any provision for estimating uptake of solar water heaters or heat pumps, so projections of these technologies will rely solely on the time series model.

The factors that will be considered in both models are as follows:

- State and Commonwealth incentive schemes influencing uptake, such as the applicable state-based Feed in Tariff for generating units, the Renewable Energy Bonus Scheme, any other rebates that may be on offer;
- Impact of the Solar Credits multiplier and/or the threshold to which the multiplier is applied;
- Impact of June 2010 RET legislative changes to eligibility;
- Impact of building codes, regulations and energy efficiency measures;
- Capital cost trends of eligible systems for each renewable technology, including the impact of the changing cost of raw materials; and
- Global financial conditions, which may impact financing assumptions.

5.2. Historical data set supplied by ORER

ORER supplied a comprehensive historical data set of small-scale renewable generation installations as well as installation of solar water heaters and heat pumps. There were over 183,000 records in the SGU dataset, with the data spanning 2001 until September 2010. The information supplied included:

- date of installation;
- date of REC registration;
- post code of installation address;
- state of installation address;
- technology type (PV, wind or hydro);
- capacity of the system;
- number of RECs registered by the system;
- whether the REC multiplier was received; and
- value of the multiplier received.

The data showed that the number of RECs created by small-scale PV systems was three or four orders of magnitude greater than RECs produced by small-scale wind and hydro. As such, certificate projections for small-scale wind and hydro will not be carried out as their contribution to the total would be negligible.

The dataset comprising SWHs and heat pumps contained over 590,000 records covering the same time span as the SGU dataset. Supplied information included:

- date of installation;
- date of REC registration;
- post code of installation address;
- state of installation address;
- technology type (SWH or heat pump);
- number of RECs registered by the system; and
- whether the system capacity was over 700 litres.

This data was primarily used to construct the historical time series data, thus enabling the utilisation of time series analysis. The SGU capacity data was also summarised in a form to allow the calibration of the DOGMMA model.

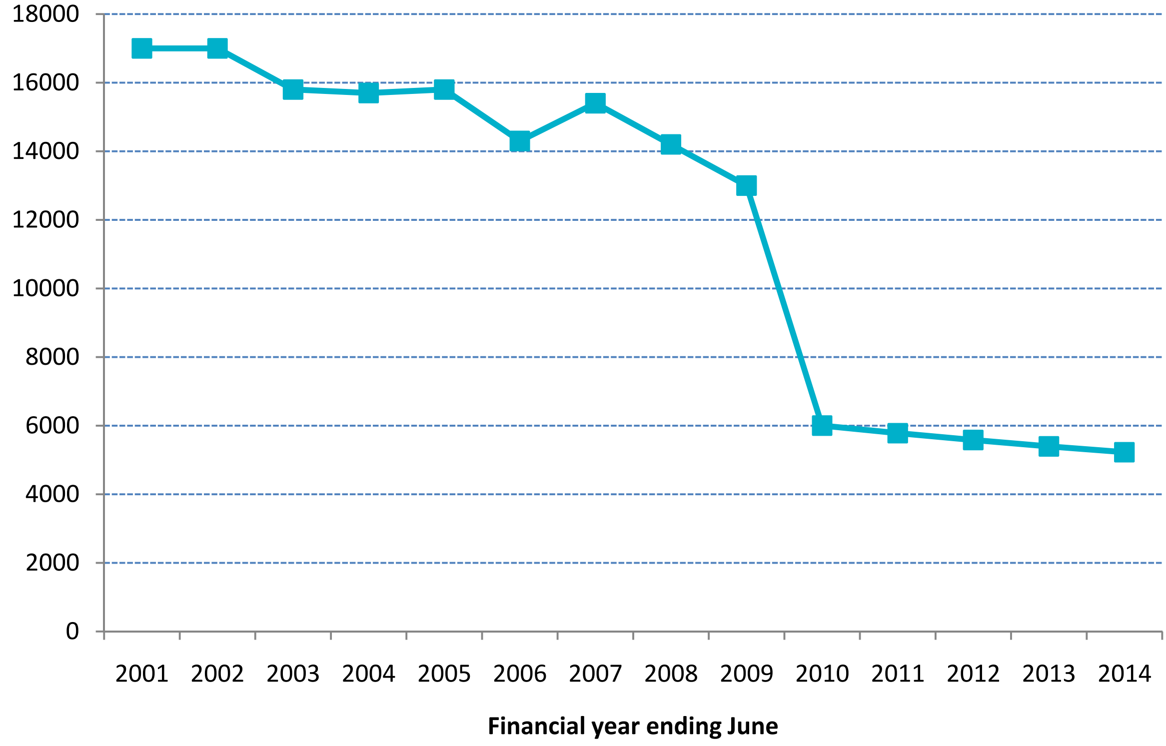
5.3. General assumptions

The following section presents our key modelling assumptions.

5.3.1. Capital cost assumptions for solar PVs

Figure 5-1 shows the assumed capital costs for an installed PV system in nominal dollars. This was converted into real dollars for the modelling using historical CPI and assuming CPI of 2.5% p.a. for projections. The most notable feature of the graph is the massive reduction in the capital cost which occurred during the 2009/10 financial year. The DOGMMA model also incorporates a decreasing capital cost as the system size increases, reflecting certain available economies of scale. These cost assumptions are further described in Appendix A.

■ Figure 5-1 Capital costs assumed for solar PVs – ($ nominal/kW)

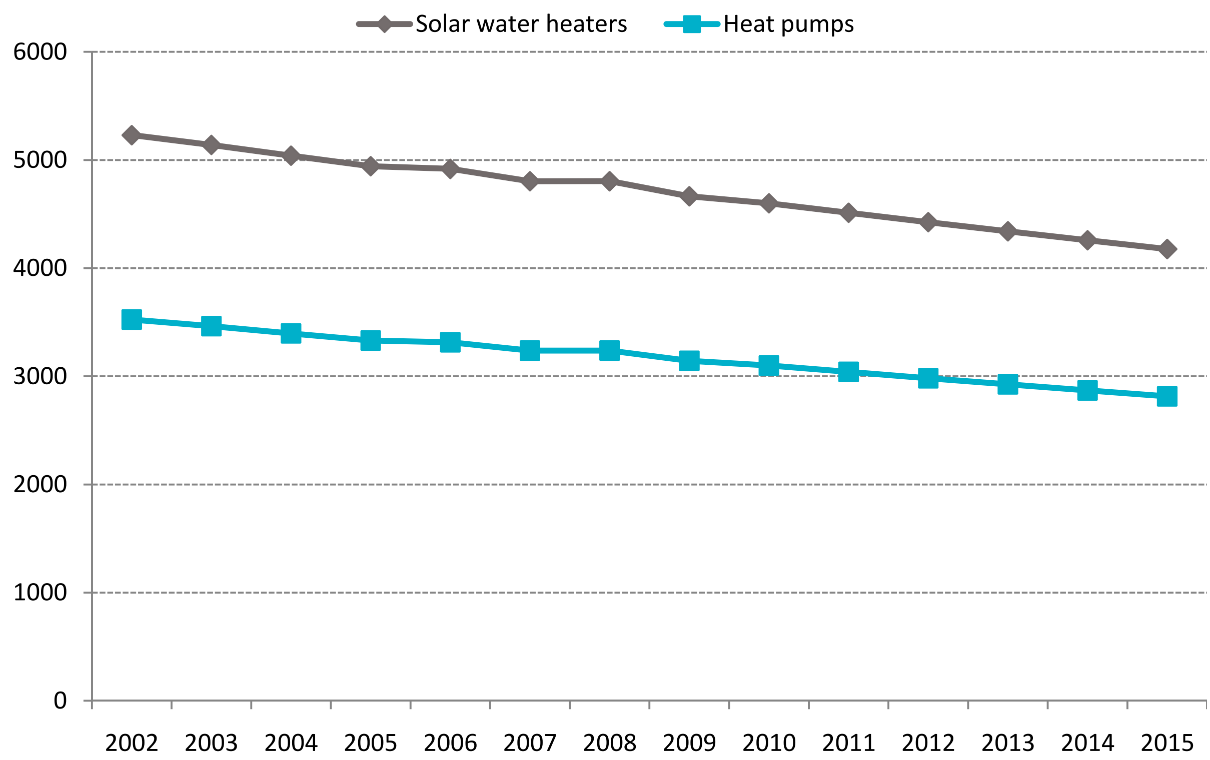


Source: MMA analysis with historical prices based on AECOM report to Industry and Investment NSW, *Solar Bonus Scheme: Forecast NSW PV Capacity and Tariff Payments*, October 2010

5.3.2. Capital cost assumptions for solar water heaters and heat pumps

Figure 5-2 shows the assumed capital costs for solar water heaters and heat pump in real 2010 dollars for a typical domestic unit. The curves show a fairly constant cost reduction in real terms.

■ Figure 5-2 Capital costs assumed for typical domestic SWH unit – ($ 2010)



5.3.3. Rebate assumptions

Table 5-1 shows the rebate assumptions at both the Federal level and the State level used in calculating both the net cost and the upfront cost of PV systems, SWHs and heat pumps. Where a range of possible rebates were available, SKM-MMA generally assumed a rebate at the lower range of the scale.

■ Table 5-1 Rebate assumptions used for calculating net technology costs (nominal dollars)

Technology	Government	Rebate	Dates applicable
PV	Federal	$4,000	Pre 2002 to Oct-07
PV	Federal	$8,000	Nov-07 to Jun-09
SWH	Federal	$1,000	Oct-07 to Feb-10
SWH	Federal	$600	Mar-10 to Dec-13
SWH, Heat pump	New South Wales	$300	Oct-07 to Jun-11
SWH, Heat pump	Queensland	$100	Jul-09 to Feb-10
SWH, Heat pump	Queensland	$600	Mar-10 to Dec-13
SWH, Heat pump	Victoria	$500	Jul-08 to Dec-10
SWH	Tasmania	$500	Jul-07 to Dec-11
SWH	Northern Territory	$400	Jul-09 to Jun-10
SWH, Heat Pump	Western Australia	$500	Jul-10 to Jun-13
SWH, Heat Pump	ACT	$500	Dec-04 to Dec-13
Heat pump	Federal	$1000	Oct-07 to Feb-10

Technology	Government	Rebate	Dates applicable
Heat pump	Federal	$600	Mar-10 to Dec-13
Heat pump	Tasmania	$500	Nov-08 to Dec-11

No rebate was assumed to apply for a typical SWH or heat pump installer in South Australia since the rebates in that state are only available to low-income earners.

5.3.4. Net cost assumptions for PV systems

The net cost for SGUs, SWHs and heat pumps proved to be the key variable explaining the uptake of these systems for the time series analysis, and was central to the uptake forecasts using the time series model. It also drives the output of the DOGMMA model, which is a forward looking optimisation model that seeks to minimise total system costs. The net cost is defined as follows:

- Sum of capital cost and installation cost
- Less
    - Value of any available government rebates
    - Revenue from the sale of RECs and/or STCs, including the effect of the Solar Credits multiplier
    - Net present value of future feed-in-tariff payments
    - Net present value of the avoided cost of electricity

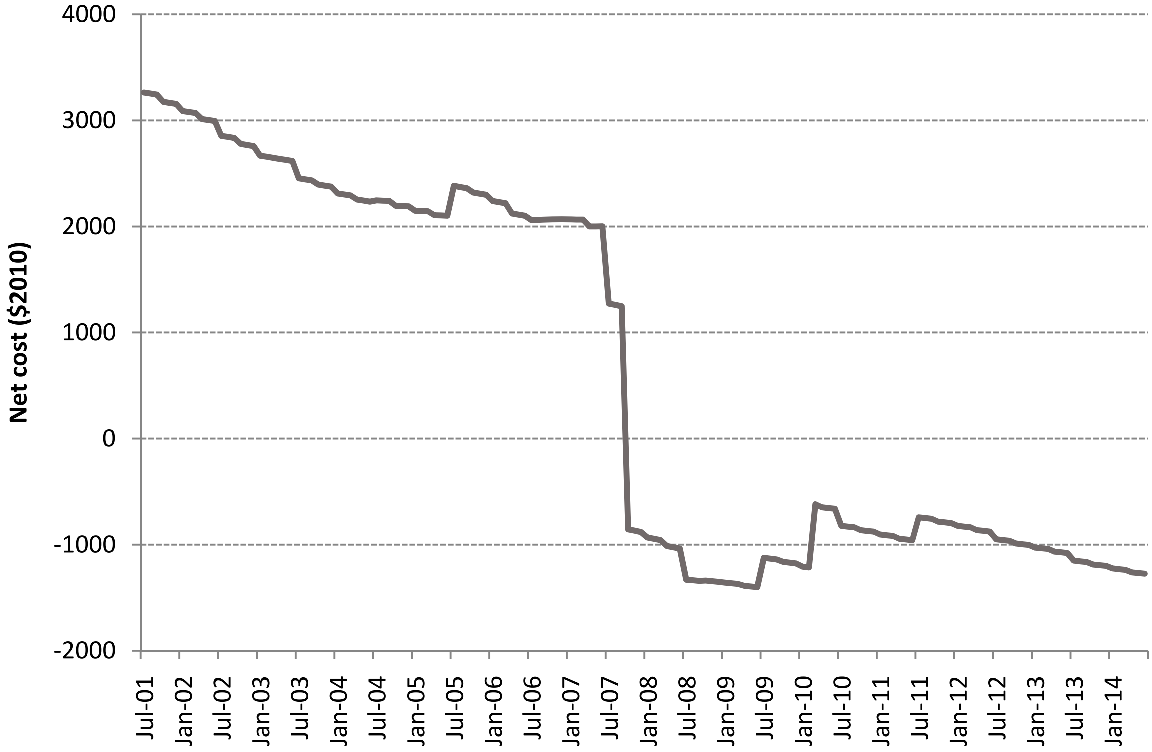
Figure 5-3 shows the net cost assumed for a 1.5 kW PV system installed in NSW, which is representative of the net cost trends in all Australian States and Territories. The historical net cost reduces gradually from 2001 until 2007, and then there is a significant drop in the net cost in late 2007, which corresponds to the increase in the Federal government's PVRP rebate from $4,000 to $8,000. The sudden increase in net cost in mid 2009 represents the abolition of the PVRP rebate and its replacement by the Solar Credits multiplier. This is followed by another steep decline in the net cost, which reflects the rapid reduction in PV capital costs, and in the NSW context it also reflects the introduction of the gross feed-in-tariff. The step increase in late 2010 corresponds to the reduction in the NSW gross feed-in-tariff from 60 c/kWh to 20c/kWh. This is followed by a series of line segments with negative slope, indicating decreasing costs, but these are interspersed with step increases in the net cost. The step changes reflect the progressive reduction of the Solar Credits multiplier, the last of which would occur in July 2015, when the multiplier is finally removed. The negative slope is important and it persists beyond 2015, so that eventually net costs do exhibit a long-term downtrend. The two drivers underlying the decreasing long term cost trend are the decreasing capital cost (see Figure 5-1) and the increasing avoided cost of electricity, which arises from the introduction of emissions trading (assumed to commence from July 2014). It is also assumed that retail costs will continue to increase in real terms at the rate of 2.5% per annum.

■ Figure 5-3 Net cost for 1.5 kW PV system installed in NSW

5.3.5. Net cost assumptions for water heaters

Figure 5-4 shows the net cost assumed for a typical domestic SWH system installed in NSW, which is representative of the net cost trends in all Australian States and Territories. The historical net cost reduces gradually from 2001 until 2007, and then there is a significant drop in the net cost in late 2007, which corresponds to the introduction of the Federal government's solar hot water rebate program. The increase in the net cost in early 2010 corresponds to the reduction in the Federal government's SWH rebate from $1,600 to $1,000. From 2010 onwards the net costs exhibits a distinct down trend, which is driven by decreasing capital cost (see Figure 5-2) and the increasing avoided cost of electricity.

Figure 5-4 Net cost for typical domestic SWH installed in NSW



5.3.6. Wholesale electricity price assumptions

SKM-MMA's base case wholesale electricity prices were used as the basis for calculating future electricity savings and/or revenues for SGUs, SWHs and heat pumps. The base case assumes medium economic growth, and that the Federal government's proposed CPRS is delayed until July 2014. The carbon price for the first year was assumed to be \$10/t CO_2e in nominal dollars, and in subsequent years the Federal Treasury's CPRS-5% carbon price path was used.

5.4. Scenario assumptions

Two scenarios relating to the application of the Solar Credits multiplier were considered in the assignment. These are presented in Table 5-2. The Base scenario is as per the current legislation, where the 5x multiplier is replaced by the 4x multiplier from 1 July 2012, and the multiplier is progressively reduced each year thereafter. In the Reduced Multiplier scenario, the 4x multiplier is introduced one year earlier, commencing from 1 July 2011.

Table 5-2 Solar Credits multiplier assumptions by scenario

Scenario	2010/11 FY	2011/12 FY	2012/13 FY	2013/14 FY	2014/15 FY	2015/16 FY onwards
Base	5	5	4	3	2	1
Reduced Multiplier	5	4	3	2	1	1

5.5. Structural model

5.5.1. Overview of model

DOGMMA is a structural model that recognises that the uptake of renewable technologies is affected by a number of factors. It determines the uptake of renewable technologies based on net cost of generation versus net cost of grid delivered power. Because the cost of renewable generation varies by location and load factors, the model attempts to calculate uptake based on renewable resources and load levels within distribution regions. Other factors that may impact on the decision are modelled as a premium prepared to be paid for small scale renewable generation. The premium currently assumed is based on market survey data and other published market data. The premium is assumed to decrease as the rate of uptake increases (reflecting the fact that the willingness to pay will vary among customers).

The cost of small scale renewable energy technologies is treated as an annualised cost where the capital and installation cost of each component of a small scale generation system is annualised over the assumed lifespan of each component, discounted using an appropriate weighted average cost of capital. Revenues include sales of electricity using time weighted electricity prices on the wholesale and retail market (which may be affected by emissions trading), avoidance of network costs including upgrade costs if these can be captured, and revenues from other Government programs such as the Solar Credits multipliers and the SRES scheme.

5.5.2. DOGMMA Methodology

The model was calibrated to reasonably fit the historical time series data by state on a financial year basis. The parameters that were adjusted to facilitate the calibration included constraints on the uptake by state of any particular technology type and size (domestic or commercial) and also the assumed net export of electricity into the grid by state, technology type and size. Adjusting these parameters proved to be enough to obtain a reasonable fit for all states apart from the 2009/10 NSW uptake. The results of the calibration are presented alongside the model projections in section 6.1.

The uptake projection was based on SKM-MMA's base case electricity market forecast, which provided a forecast of the electricity market component of the small scale generation's revenue.

5.5.3. Key model assumptions

The key model assumptions for the DOGMMA model are provided in Appendix A. These include assumptions about SGU uptake constraints, SGU capital cost assumptions and other technical assumptions.

5.6. Time series model

5.6.1. 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.

5.6.2. Data preparation

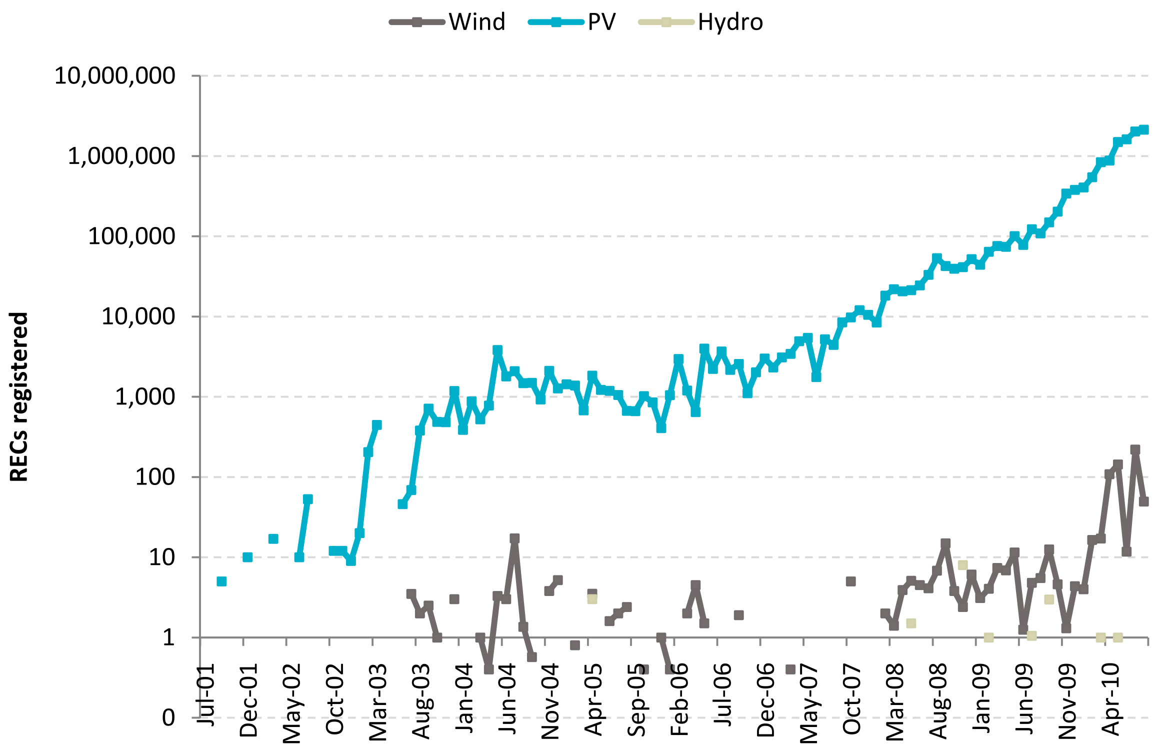
As detailed in Section 5.2, ORER provided SKM-MMA with data on all SGU and water heater installations for Australia (over 183,000 and over 590,000 installations respectively). For the purposes of the time series modelling, the data was processed and aggregated into monthly steps to create time series by technology for each state. It was important to separate the time series by state since each state has its own feed-in-tariff arrangement, which is a critical component of the economics of installing an SGU. A further level of disaggregation was introduced by differentiating large/commercial-sized systems from small/domestic systems. In the case of SWHs and heat pumps, the assumed REC creation cut-off point distinguishing a commercial system from a domestic system was refined throughout the modelling to achieve the best results (see section 5.6.4.5).

All time series modelling was conducted in R, a programming language and software environment for statistical computing. Among many other features, R provides a wide variety of time-series analysis algorithms, and its programming language allows users to add additional functionality as needed.

5.6.3. Time series model for SGUs

Figure 5-5 shows the time series corresponding to the total number of RECs registered per month for the different SGU technologies. The RECs are largely dominated by PVs, with RECs registered by small wind and small hydro projects being several orders of magnitude smaller than RECs registered by PVs. As the number of RECs generated by small wind and small hydro were insignificant relative to those generated by PVs, they were neglected in the modelling.

■ Figure 5-5 Number of RECs registered for SGUs



5.6.3.1. Choosing the dependent variable

Several different ways of aggregating the PV data were trialled in trying to determine the most appropriate way to predict future uptake. For example, the data was aggregated by the number of installations and by capacity installed. As will be made clear later, the main determinant for forecasting future trends of certificates produced from PVs is the future cost, and as such, it was important for there to be a high correlation between the number of certificates generated historically and the historical costs. Figure 5-6 shows the correlation between the net cost, the number of installations and the capacity installed for the last twelve months of historical data, where the net cost is defined as per section 5.3.4.

Figure 5-6 shows that for all states the net cost is better correlated with the capacity installed rather than the number of installations, and thus the use of capacity installed seems more promising. Additionally, the use of 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 quite variable over time especially for the smaller states with the sparser datasets.

■ Figure 5-6 Correlation of installation numbers and installed capacity to the net cost of PV

	ACT	NSW	NT	QLD	SA	TAS	VIC	WA
Installations	-0.92	-0.94	-0.79	-0.96	-0.87	-0.60	-0.85	-0.84
Capacity installed	-0.96	-0.95	-0.80	-0.98	-0.94	-0.69	-0.90	-0.94

5.6.3.2. Choosing the level of aggregation

It was hypothesised that separating the PV data according to the 1.5 kW multiplier size limit may reduce the noisiness of the data since it was thought that the behaviour of the two groups (below 1.5 kW and above 1.5 kW) may be significantly different. Separate models were therefore trialled for small and large PV systems, but the disaggregation increased the variance of the respective time series and therefore prediction error also increased. The expected benefit of separately modelling the installations in this way was therefore not enough to compensate for the increased prediction error.

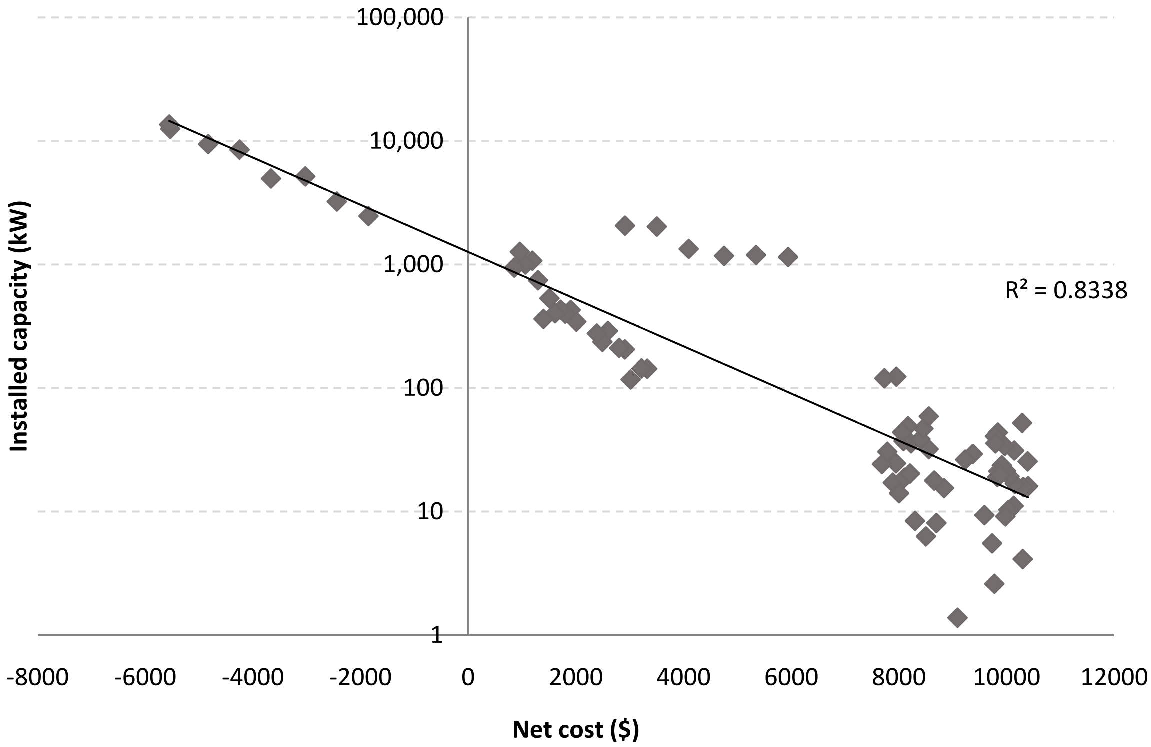
5.6.3.3. Form of the time series model

The time series at the state level were clearly non-stationary, showing both a changing mean and changing variance over time (technically known as heteroschedasticity). However, the logarithm of the original time series was found to be stationary after the trend was removed. Analysing the logarithm of the time series revealed that it had no significant level of seasonality, and thus the data lent itself nicely to an ARIMA model accompanied with an external regressor.

5.6.3.4. Choosing the external regressor

One may reasonably assume that there is an inverse relationship between the uptake of PV technology and its cost. The estimated historical net cost for a new PV installation by state was therefore trialled as an external regressor to fit the obvious trend displayed by the installation data. Since the only purpose for the net cost was to act as an external regressor, the main point of interest was its shape and relativity to the costs for other states and technologies, rather than on its absolute value. The installed capacity was indeed strongly correlated to the time series corresponding to the net cost, as shown in Figure 5-6 and as also exemplified in Figure 5-7 for the full NSW PV dataset.

■ Figure 5-7 PV installed capacity versus net cost for NSW

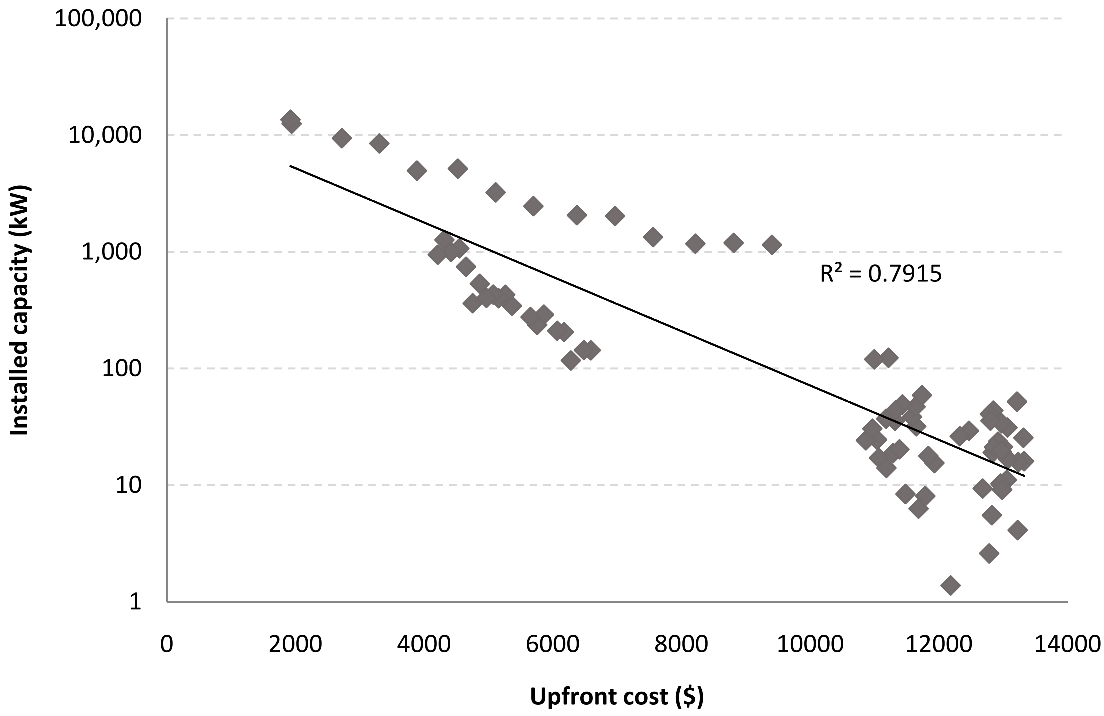


The upfront cost by state (consisting of the capital and installation cost less upfront revenue, such as REC/STC revenue) was also trialled as a regressor for the trend, as illustrated in Figure 5-8 for NSW. Although the upfront cost was well correlated to the installed capacity (especially starting from 2009), the net cost generally yielded a better fit and was therefore used in the modelling.

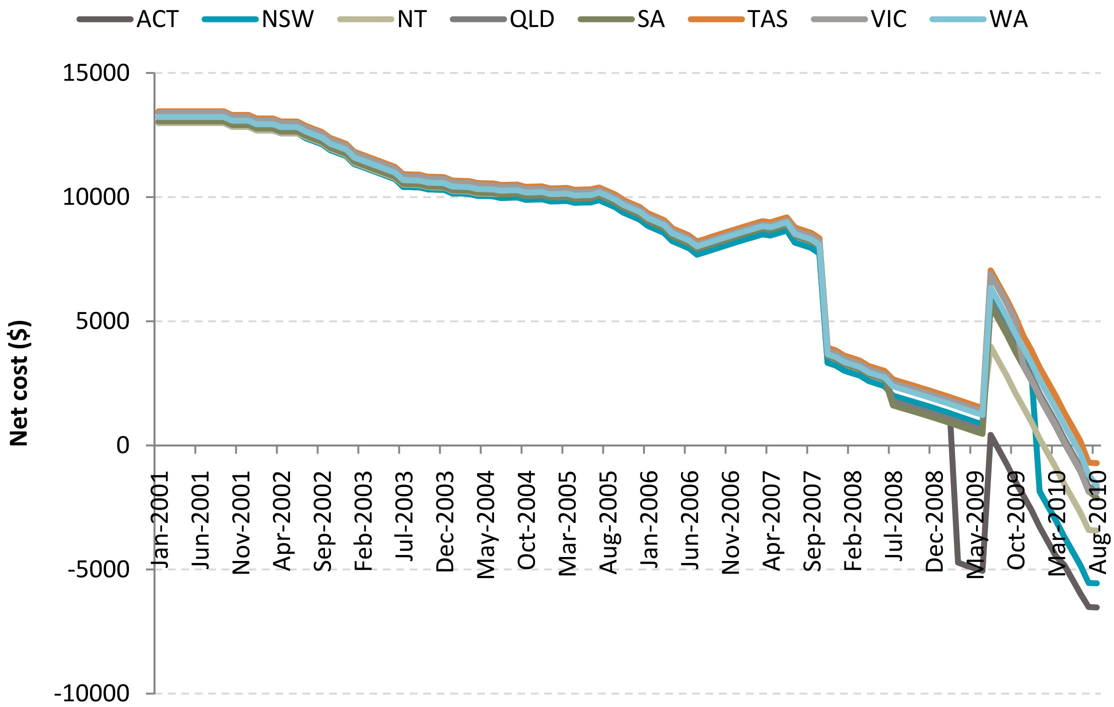
In summary, the time series analysis of the data for the SGUs was carried out by fitting univariate ARIMA models to the logarithm of the monthly PV installed capacity by state with the use of the net cost in each state as an external regressor. The historical PV net cost is shown in Figure 5-9, and appears to be reducing gradually until 2007. The significant drop in net cost in late 2007 corresponds to the increase in the Federal government's PVRP rebate from $4,000 to $8,000. The sudden increase in net cost in mid 2009 represents the abolition of the PVRP rebate and its replacement by the Solar Credits multiplier. This is followed by another steep decline in the net cost, which reflects the rapid reduction in PV capital costs, as explained in Figure 5-1.

All of the time series modelling was carried out in R, a statistical programming language, and the results are presented in section 6.3 and 6.4.

■ Figure 5-8 PV installed capacity versus upfront cost for NSW



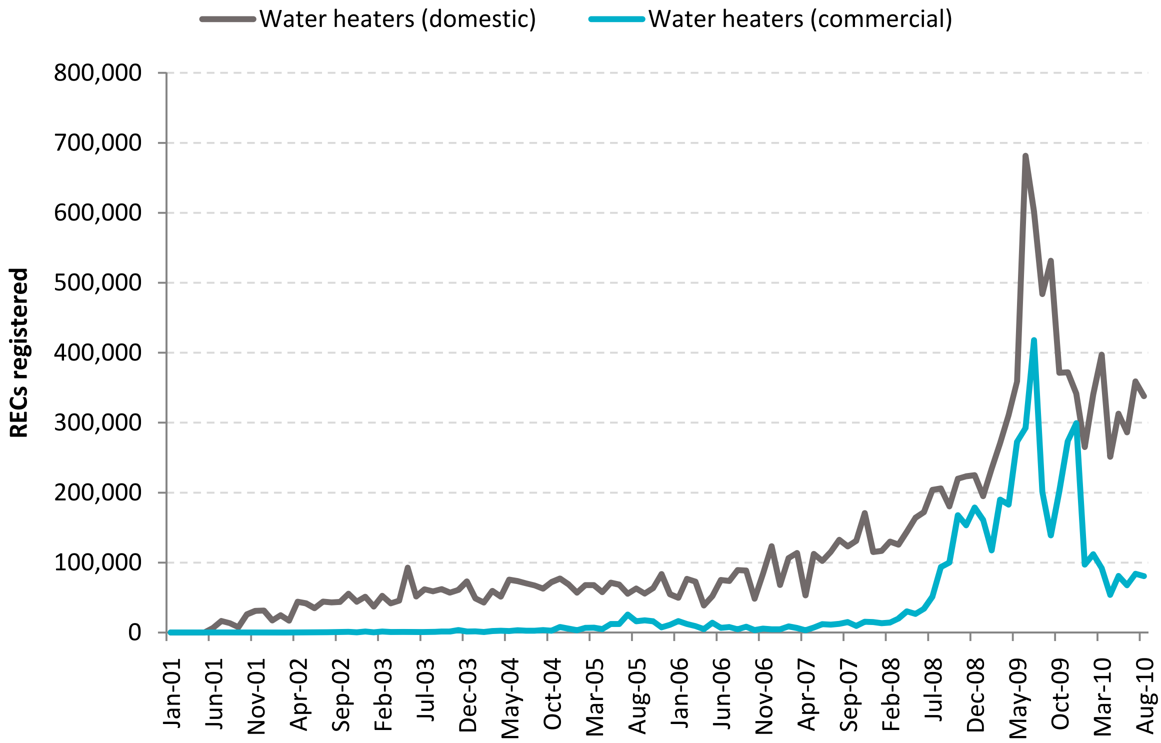
■ Figure 5-9 Historical PV net cost by state



5.6.4. Time series model for water heaters[1]

Figure 5-10 shows the time series corresponding to the total number of RECs registered per month for both commercial and domestic water heaters. Water heaters were defined as commercial if they received more than 40 RECs, which was a cut-off determined by trial and error (see section 5.6.4.5).

- Figure 5-10 RECs registered by water heaters



5.6.4.1. Choosing the dependent variable

The water heater data was aggregated in two different ways: by number of installations and by number of RECs registered. Both options were strongly correlated to the net cost, as observed in Figure 5-11, with the number of installations being slightly more correlated than the number of RECs for commercial installations, and the number of RECs slightly more correlated than the number of installations for domestic installations. With no clear advantages in terms of the correlation to the regressor it was decided to use the number of RECs registered as the dependent variable since this has the additional advantage of avoiding having to forecast the average number of RECs generated per installation, which would further increase the prediction error in the model.

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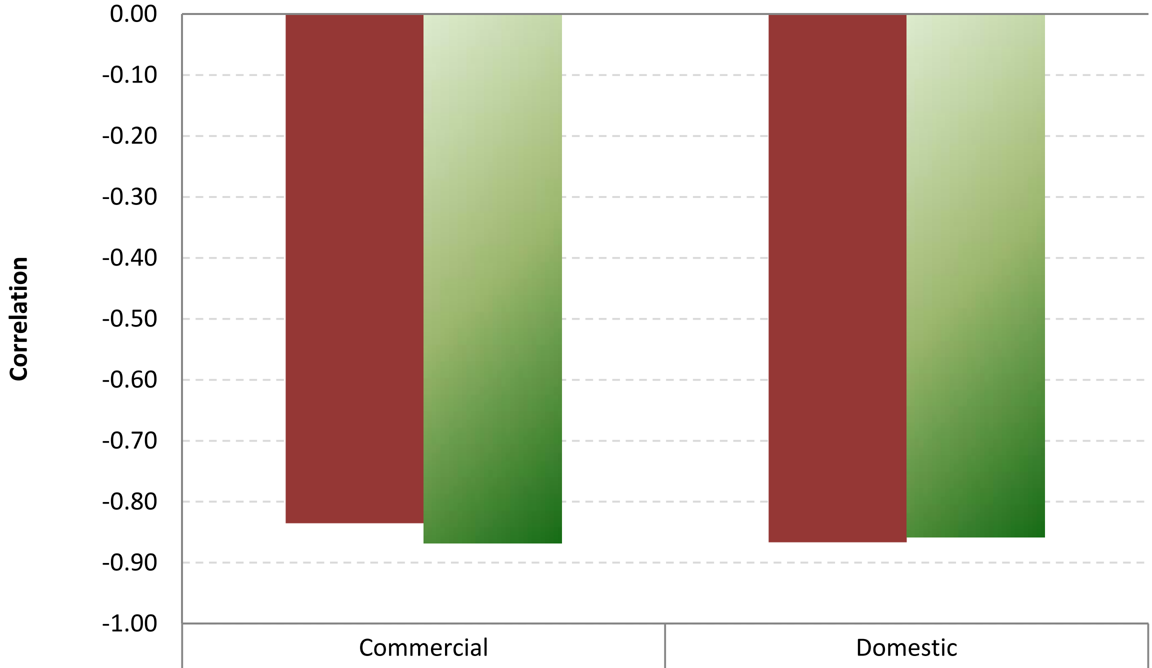
[1] The tern "water heaters" refers to solar water heaters and heat pump water heaters.

■ Figure 5-11 Correlation between installation numbers and number of RECs versus net cost for water heaters



	Commercial	Domestic
RECs	-0.84	-0.87
Installations	-0.87	-0.86

5.6.4.2. Form of the time series model

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 the data lent itself nicely to an ARIMA model with an external regressor.

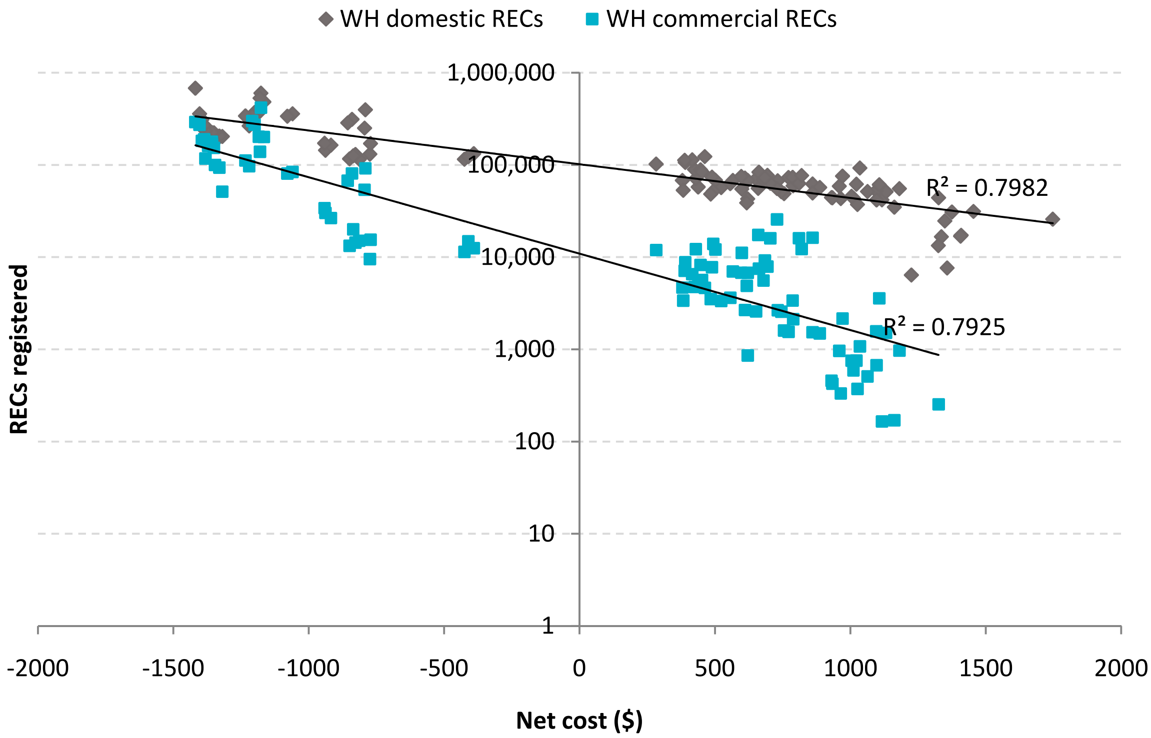
5.6.4.3. Choosing the external regressor

As with the SGU analysis, it was assumed that the net cost[2] would be the main explanatory variable underlying the distinct trend in water heater uptake. As such, the historical net cost was used as an external regressor to fit the trend in the data. The trend was strongly correlated to the time series corresponding to the net cost of the respective installation sizes, as exemplified in Figure 5-12 for all of Australia[3].

[2] See section 5.6.3.1 for the definition of net cost.

[3] The net cost shown here is a weighted average of the net costs across both the states and technologies. The main differentiator of net cost for each state would be the state-based rebates offered by each State government.

■ Figure 5-12 RECs created by water heaters versus net cost



The upfront cost was the other candidate trialled as the external regressor, but as in the case of the PV analysis, the net cost proved to be a better regressor for the trend.

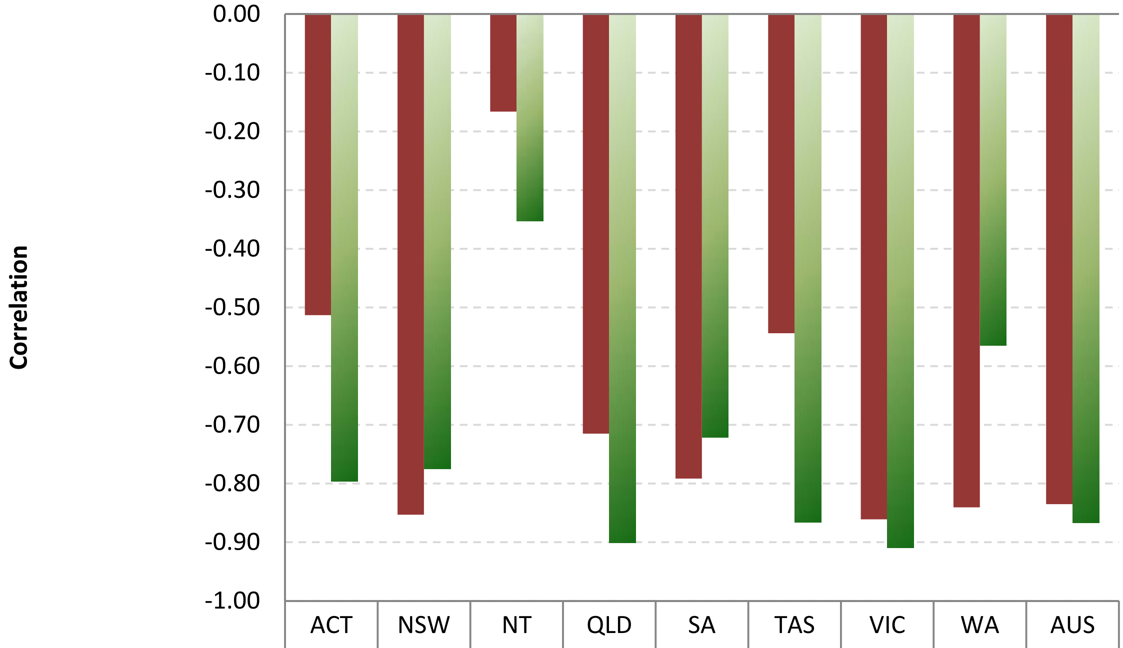
5.6.4.4. Choosing the level of aggregation

Separate models were initially trialled for heat pumps and for SWHs by state. However, it was found that this level of disaggregation significantly increased the variance of the time series and hence the error in the predictions. This was a result of the disaggregated time series being poorly correlated to the net cost, as shown in Figure 5-13 and Figure 5-14. Figure 5-13 shows that the correlation of RECs registered with the respective net cost[4] (for all water heaters independent of technology) is quite variable depending on the state, and is especially low in states with low installation numbers. Figure 5-14 shows that the correlation of RECs registered with the net cost[5] for all of Australia varies depending on the technology. Domestic water heaters retain a high correlation despite the disaggregation by technology, whereas the correlation for commercial water heaters deteriorates for the heat pump category when it is disaggregated.

[4] The net cost used for each state was the weighted average of the net costs across the technologies.

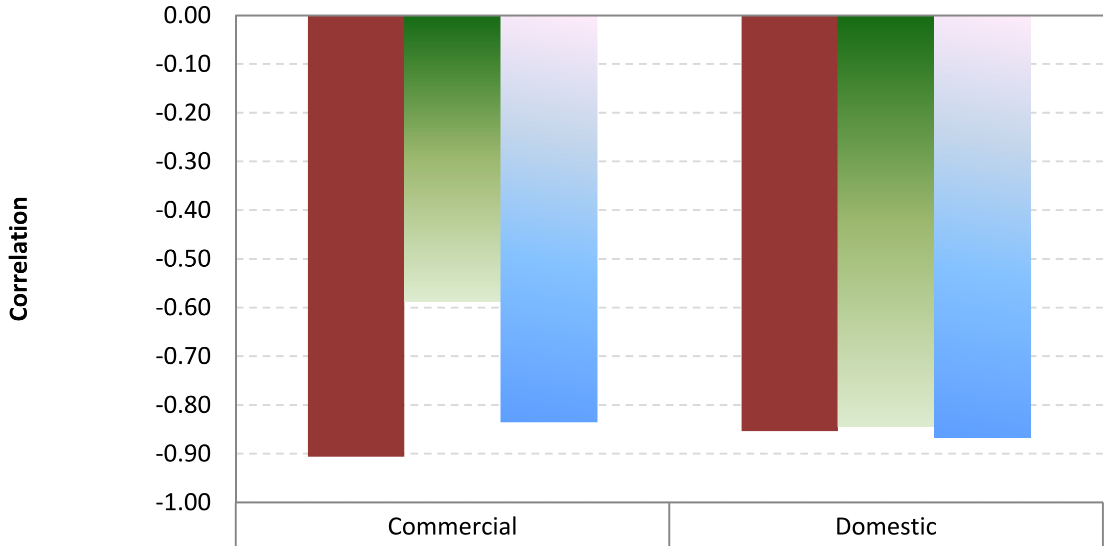
[5] The net cost used for each technology was a weighted average of the net costs across the states.

- Figure 5-13 Correlation of water heater categories versus net cost by state



	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	AUS
WH Commercial RECs	-0.51	-0.85	-0.17	-0.72	-0.79	-0.54	-0.86	-0.84	-0.84
WH Domestic RECs	-0.80	-0.78	-0.35	-0.90	-0.72	-0.87	-0.91	-0.56	-0.87

- Figure 5-14 Correlation between water heater uptake and net cost by technology

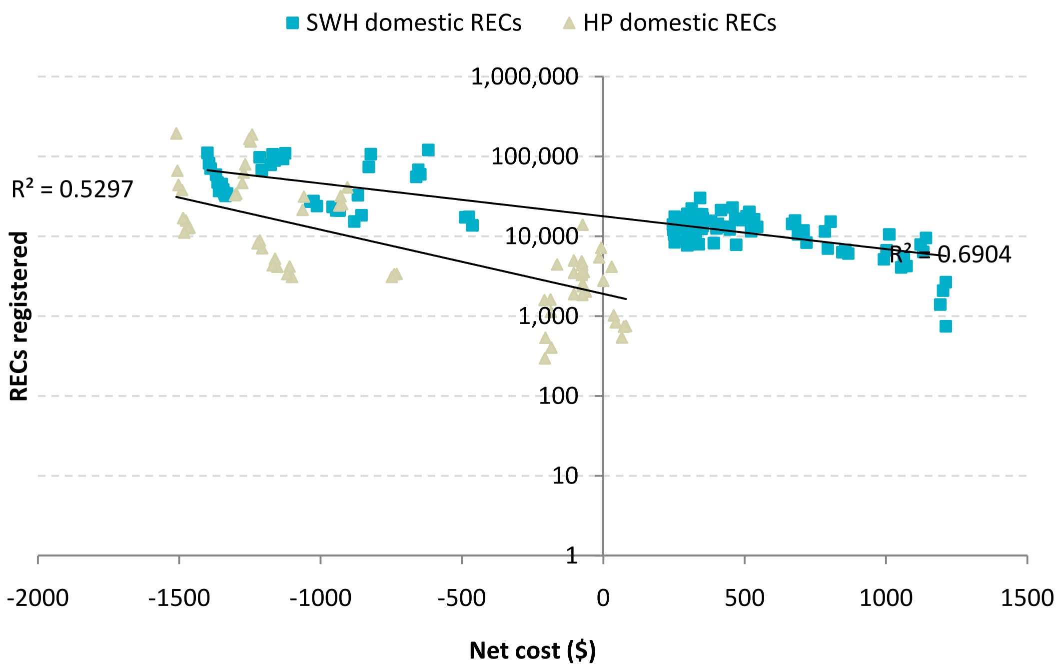


	Commercial	Domestic
Solar	-0.91	-0.85
Heat pumps	-0.59	-0.84
All water heaters	-0.84	-0.87

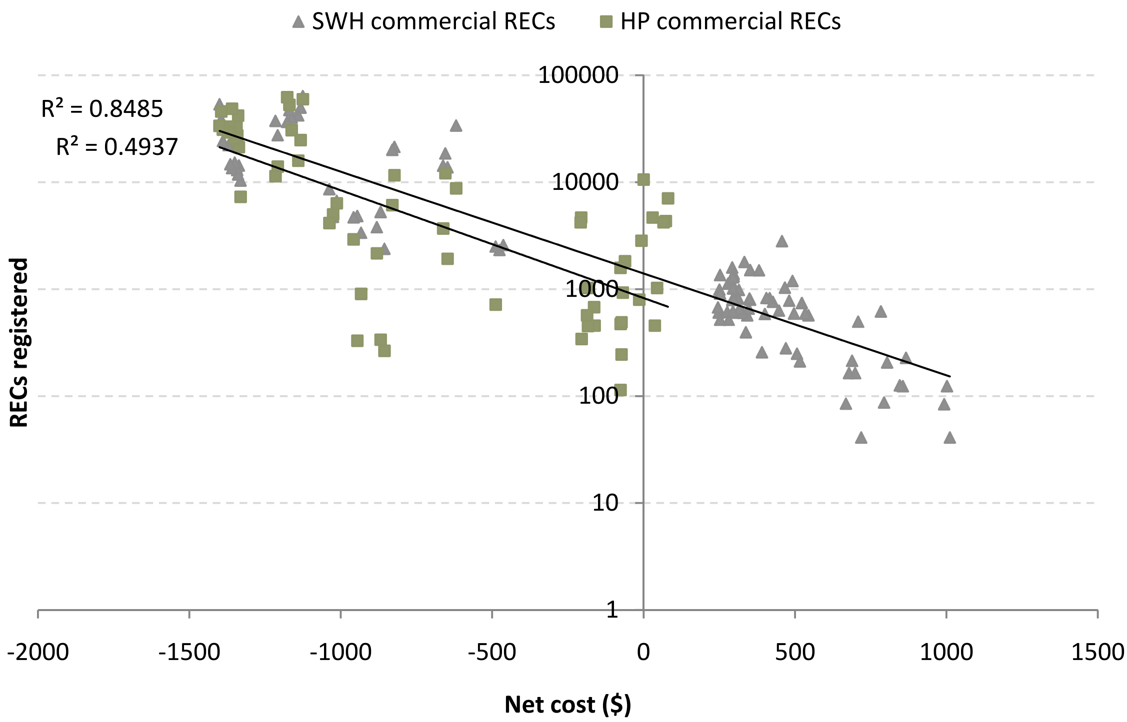
As a further example, Figure 5-15 and Figure 5-16 show the trend lines and correlation factors for NSW after disaggregating the data into four categories (domestic and commercial SWHs and domestic and commercial heat pumps). Even though NSW is the state with the largest the number of RECs registered for these technologies, the correlations were relatively low. The correlations for the other states, which had less registered RECs, were poorer.

After trialling a number of combinations of aggregation and disaggregation, it was found that the best results with respect to the correlation with net cost were obtained by aggregating across all states and both technologies, but retaining the distinction between commercial-sized systems and domestic-sized systems. The importance of maintaining the split between commercial and domestic systems will become apparent in the following section.

- Figure 5-15 RECs created by domestic water heaters versus net cost for NSW



- Figure 5-16 RECs created by commercial water heaters versus net cost for NSW



5.6.4.5. Correcting for SWH data distortion

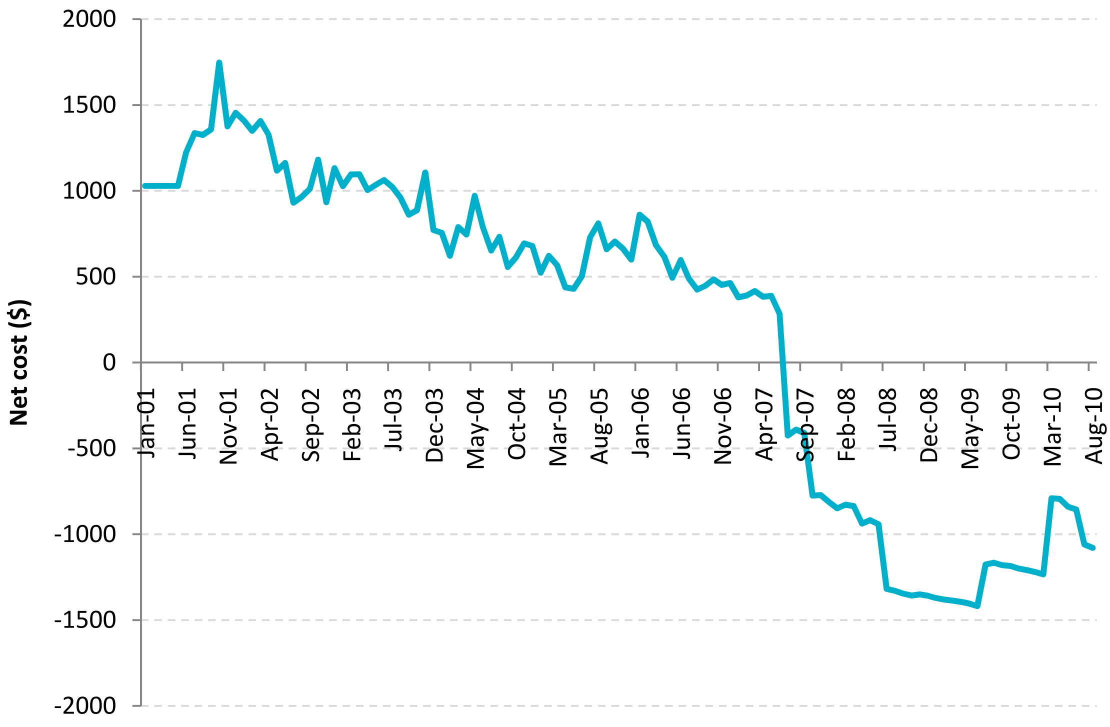
SKM-MMA is aware of an issue with the historical SWH uptake numbers for commercial systems, in that they appear to be inflated by provisions which allowed consumers to reduce their upfront cost by installing larger systems than they actually required, thereby claiming more RECs. This effect was corrected by the statutory declaration requirement, introduced in legislation from 9 September 2009, for SWHs with a volumetric storage capacity greater than 700 litres.

This anomaly, which is clearly present in the uptake data, was compensated for by grouping systems into a domestic and commercial category, with 55 RECs set as the initial cut-off point defining the two data sets. However, visual inspection of the data split up in this way showed that the inflation in uptake was still present in the domestic category. Trial and error revealed that the bump in uptake could be reduced, but not entirely eliminated, by changing the cut-off between domestic and commercial categories. As there was no objective way of choosing the cut-off based on the visual inspection, the best cut-off was chosen to be the one that maximised the correlation between the net cost and the uptake, since this would produce the least prediction error. Trial and error revealed that this could be achieved with a cut-off of 40 RECs.

The aforementioned distortion present in the time series for commercial water heaters was compensated for by replacing the number of RECs registered from March 2009 to December 2009 by the average of the three months preceding and following this time period, which is when the water heater uptake peaked.

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 RECs by water heaters, split into domestic and commercial categories, for all of Australia. The weighted average of the net cost in each state was used as an external regressor (illustrated in Figure 5-17). All of the modelling was carried out in R and the results are presented in Section 6.3.

■ Figure 5-17 Historical average water heater net cost



6. Modelling results

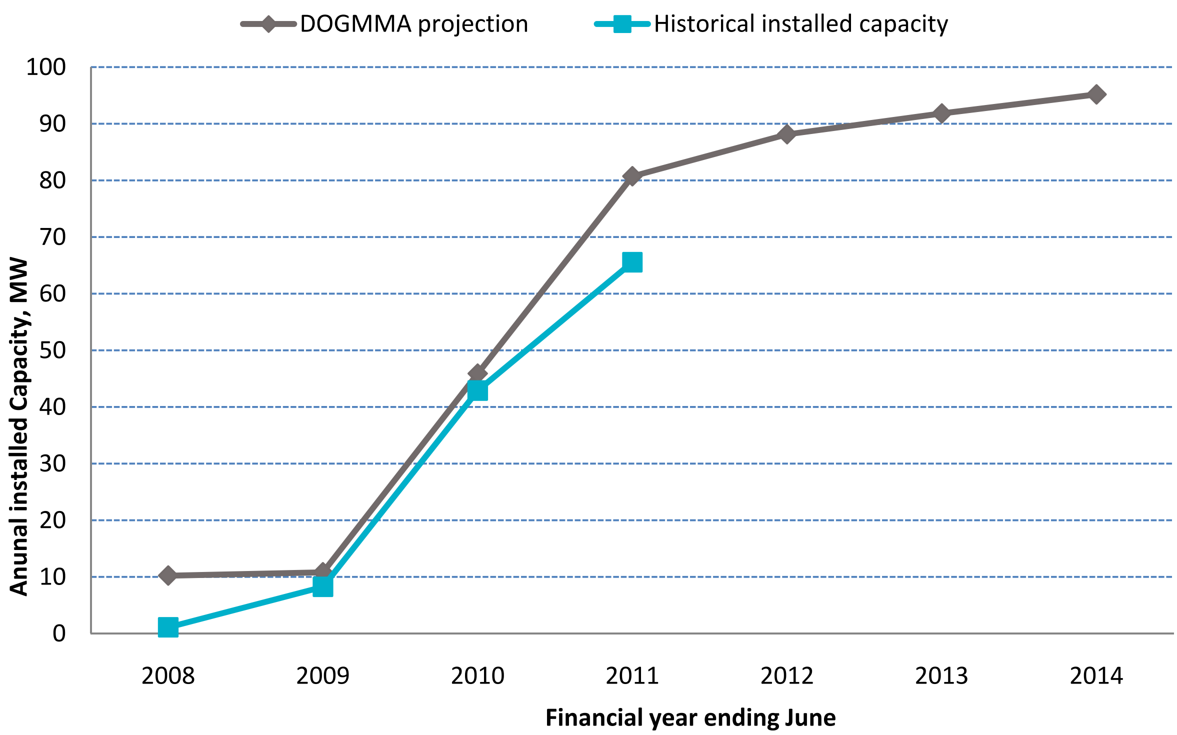
This section presents the results of the modelling for both the structural model and the time series model for both scenarios. These results, which are in the form of projected installed capacity for the SGU modelling, are then translated into STC volume projections for the 2011, 2012 and 2013 calendar years for both scenarios.

6.1. DOGMMA calibration results and projections for Base scenario

Figure 6-1 shows the historical and projected installed PV capacity for Queensland in financial years for the Base scenario. Note that the historical installed capacity shown for 2010/11 is a simple projection of the installed capacity data provided by ORER, which ranged from July 2010 until mid September 2010. The same applies to the rest of the charts in this section showing “historical” 2010/11 installed capacity.

The fit to the historical data is quite good and even though the 2007/08 uptake is too high, the model has adequately captured the rapid increase in uptake over the last two years. DOGMMA predicts a steadily increasing installation rate over the next three years, and also expects the 2010/11 installation rate to accelerate from the current trend.

- Figure 6-1 Historical and projected installed PV capacity for Queensland – Base scenario



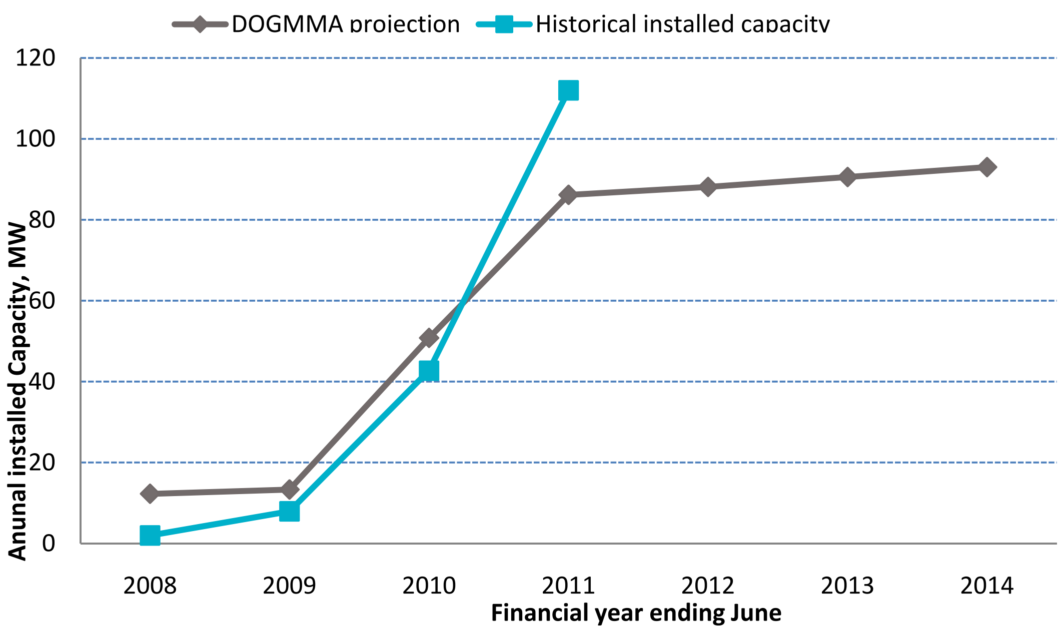
The steady increase in PV uptake projected for Queensland over the next four years reflects the long-term downtrend in the PV net cost, as described in section 5.3.4. This increase in uptake represents the optimal solution for the DOGMMA model, which minimises the total system cost over the next fifteen years. The key to understanding this result is the large expected increase in wholesale electricity prices which would occur with the introduction of an emissions trading scheme. This in turn drives an increase in the retail price, which has been assumed to escalate over the long term at 2.5% per annum in real terms.

Figure 6-2 shows the historical and projected installed PV capacity for New South Wales, and includes the ACT. The fit to the historical data is reasonably good, although there was an issue in obtaining a good fit to the 2009/10 uptake. This was corrected by constraining uptake in this year alone, which may reflect a lag in the initial uptake of PV systems following the introduction of the NSW gross feed-in-tariff, but may also be a part-year effect, since the NSW gross feed-in-tariff was introduced in January 2010, and lies in the middle of the 2009/10 modelled year. It is expected that the simple 2010/11 “historical” projection will be an overestimate of the actual installed capacity because it does not reflect the recent reduction in the NSW gross feed-in-tariff from 60 c/kWh to 20 c/kWh. The calibration was therefore adjusted down accordingly. Looking forward, DOGMMA projects a flattening off of the recent rapid uptake, which would be partly explained by the aforementioned feed-in-tariff reduction.

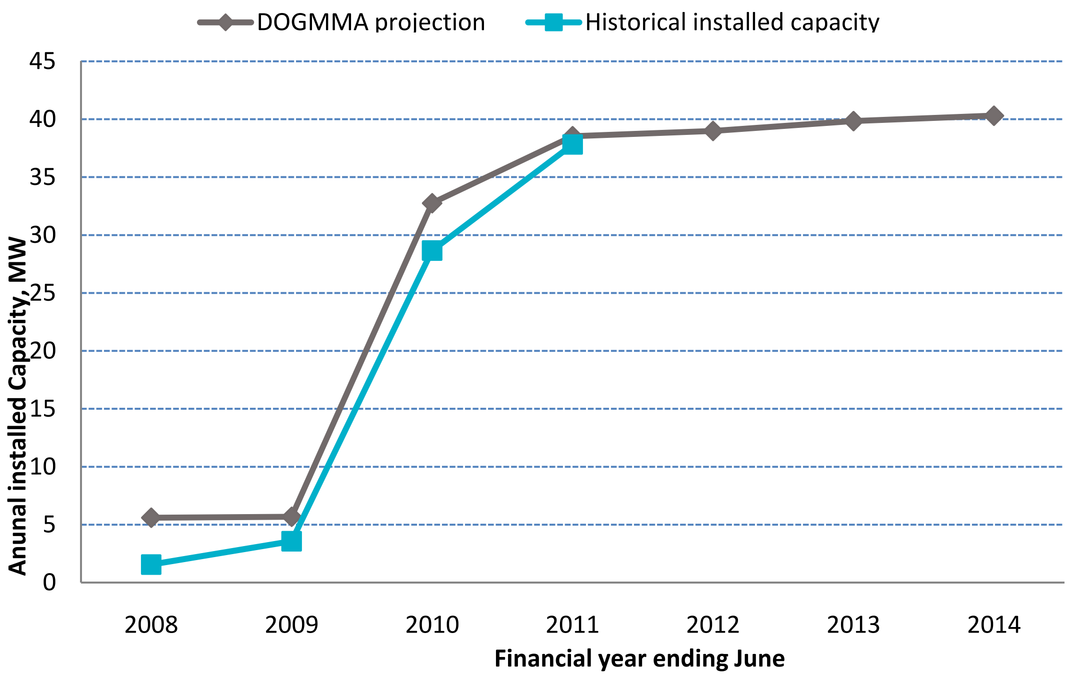
Figure 6-3 shows the historical and projected installed PV capacity for Victoria. The fit to the historical data is quite good, although is biased to the high side. DOGMMA is projecting a flattening off of the recent rapid uptake, which is somewhat similar to the NSW result.

Figure 6-4 shows the historical and projected installed PV capacity for Tasmania. The fit to the historical data is reasonably good, and the model is projecting an accelerated uptake for the 2010/11 year relative to the year to date uptake. DOGMMA is projecting an elevated uptake in 2011/12 and 2012/13 for Tasmania, followed by a decrease in uptake for 2013/14.

■ Figure 6-2 Historical and projected installed PV capacity for New South Wales – Base scenario



■ Figure 6-3 Historical and projected installed PV capacity for Victoria – Base scenario



■ Figure 6-4 Historical and projected installed PV capacity for Tasmania – Base scenario

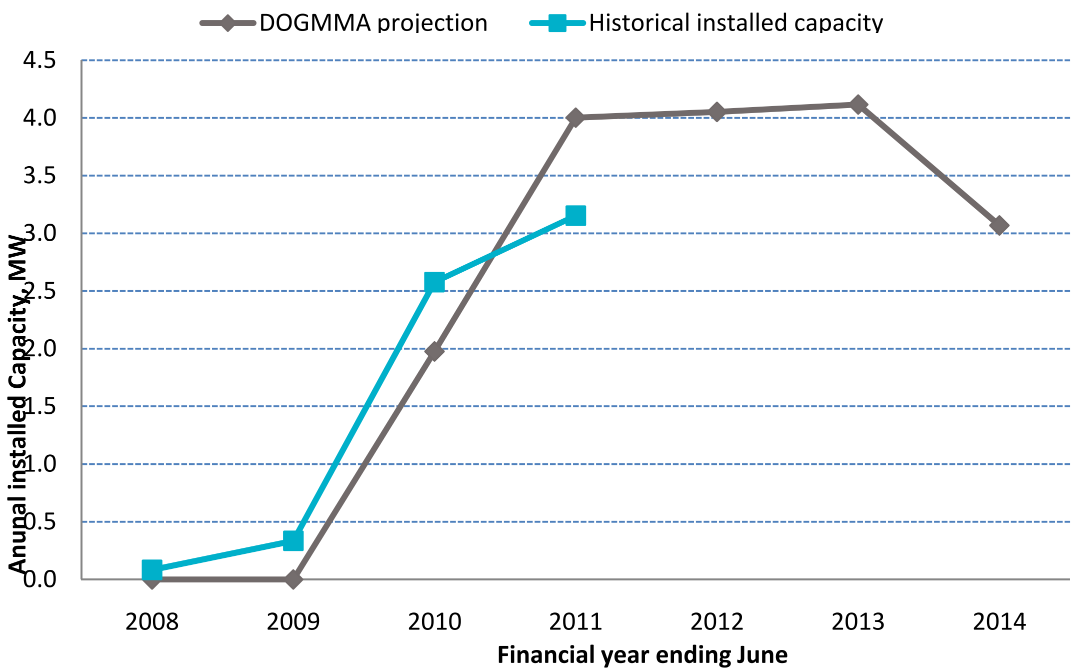
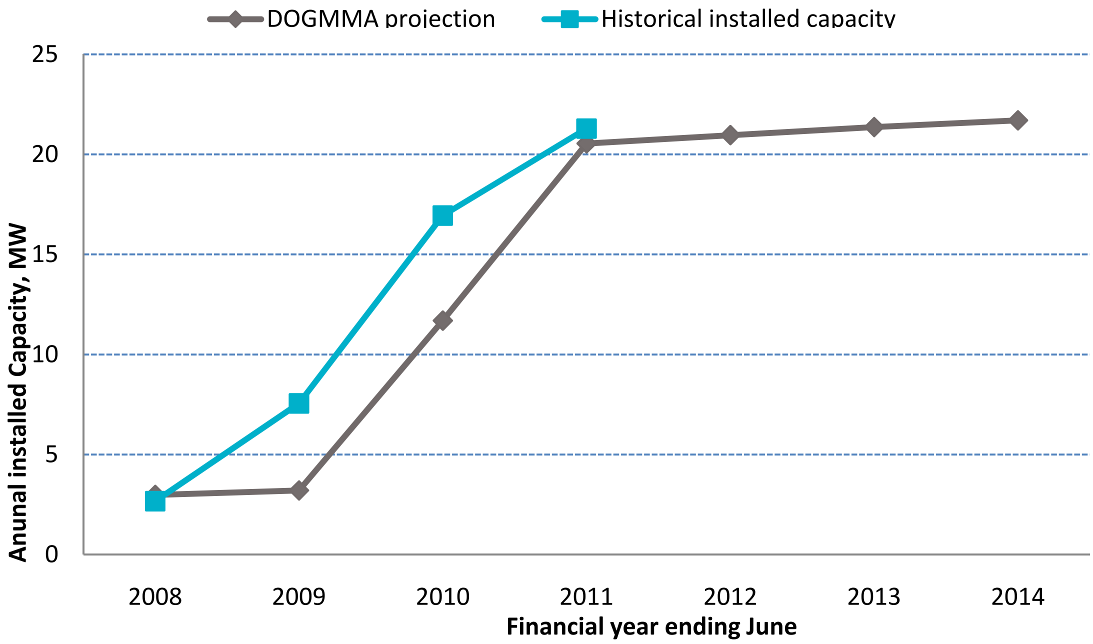


Figure 6-5 shows the historical and projected installed PV capacity for South Australia. The fit to the historical data is biased to the low side, although the model is in agreement with 2010/11 part-year projection. Looking forward, the projection is similar to that of NSW and Victoria in that it flattens off over the next three years.

Figure 6-6 shows the historical and projected installed PV capacity for Western Australia. The fit to the historical data is quite good and in agreement with the 2010/11 part-year projection. Unlike the eastern states, DOGMMA predicts that the current trend in uptake will continue over the next three years for Western Australia.

■ Figure 6-5 Historical and projected installed PV capacity for South Australia – Base scenario



■ Figure 6-6 Historical and projected installed PV capacity for Western Australia – Base scenario

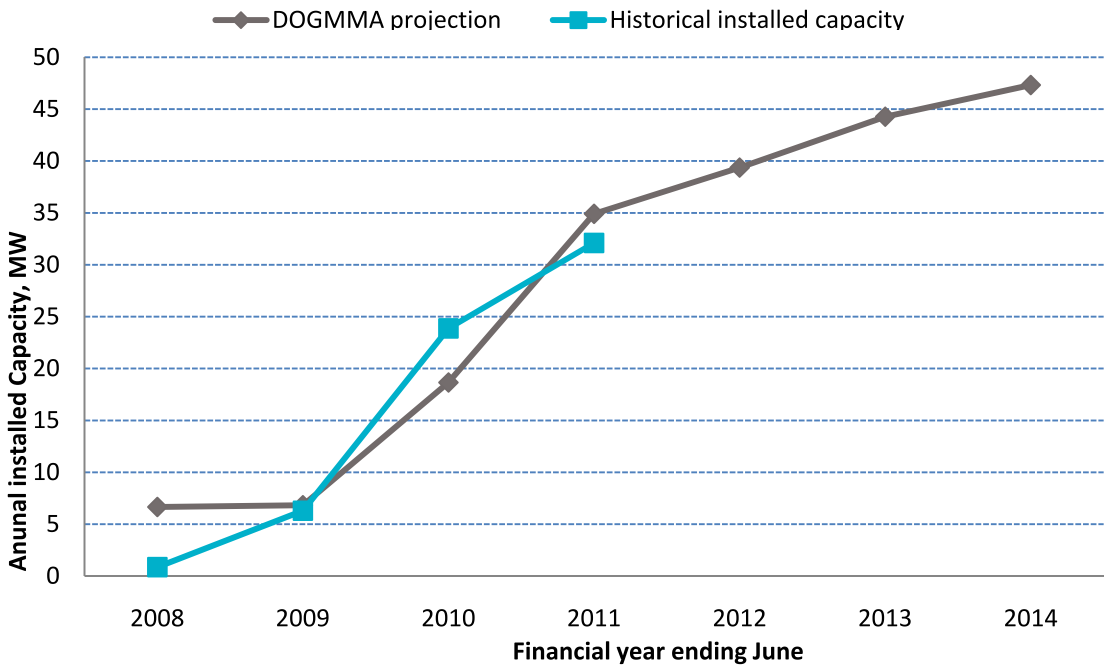
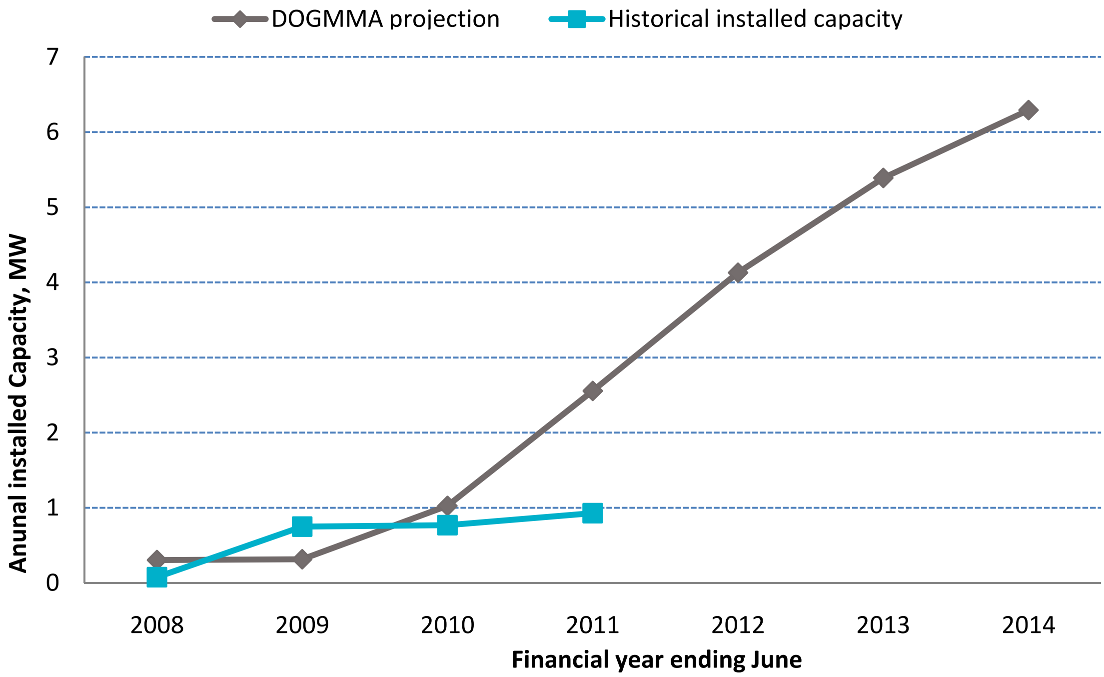


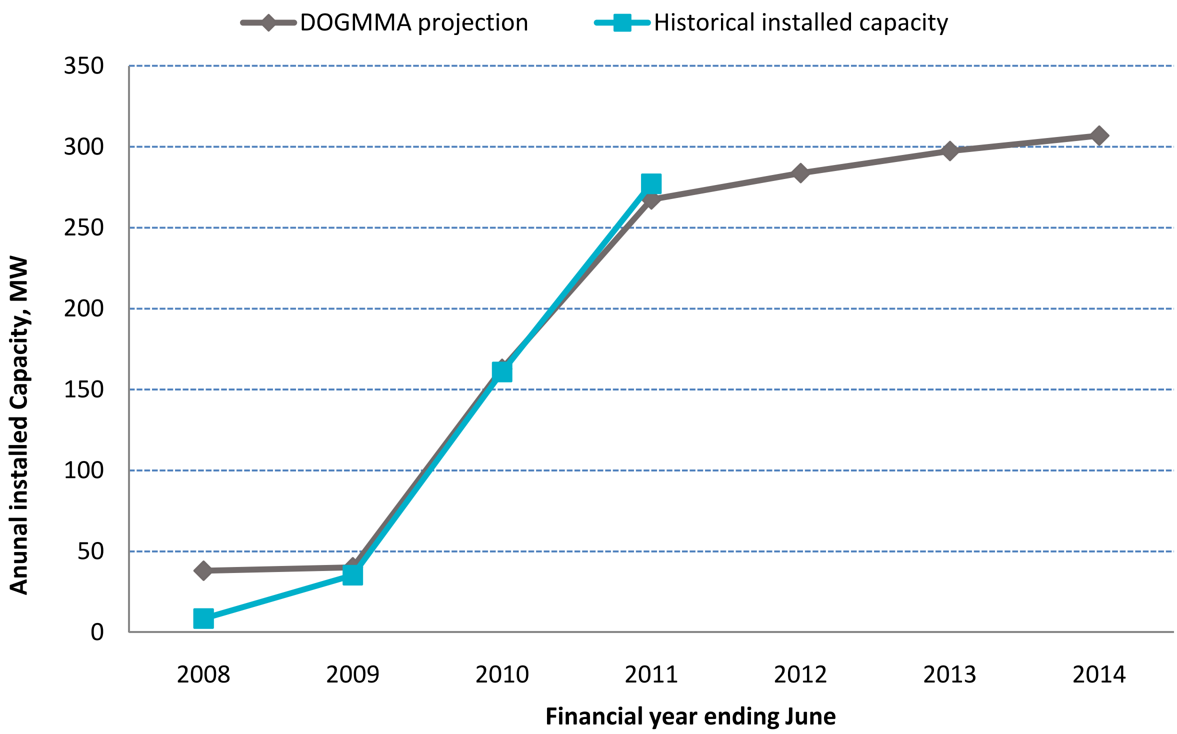
Figure 6-7 shows the historical and projected installed PV capacity for the Northern Territory. The uptake of small-scale PV in the Northern Territory has lagged that of the rest of Australia, which is rather surprising because PVs located there would have one of the highest load factors in Australia. This was also reflected in the model, since the maximum uptake constraint had to be halved relative to the other states in order to achieve a reasonable model fit. Even with this constraint in place, DOGMMA predicts a rapid escalation in uptake over the next three years, including an accelerated uptake for the 2010/11 year.

Figure 6-8 shows the historical and projected installed PV capacity aggregated across Australia. The fit to the historical data is quite good, although capacity uptake in 2007/08 has been overestimated. There is also good agreement between DOGMMA and the part year projection for 2010/11. Looking forward, DOGMMA predicts a moderate strengthening of uptake over the next three years, although this begins to flatten out in 2013/14.

■ Figure 6-7 Historical and projected installed PV capacity for Northern Territory – Base scenario



■ Figure 6-8 Historical and projected installed PV capacity for Australia – Base scenario

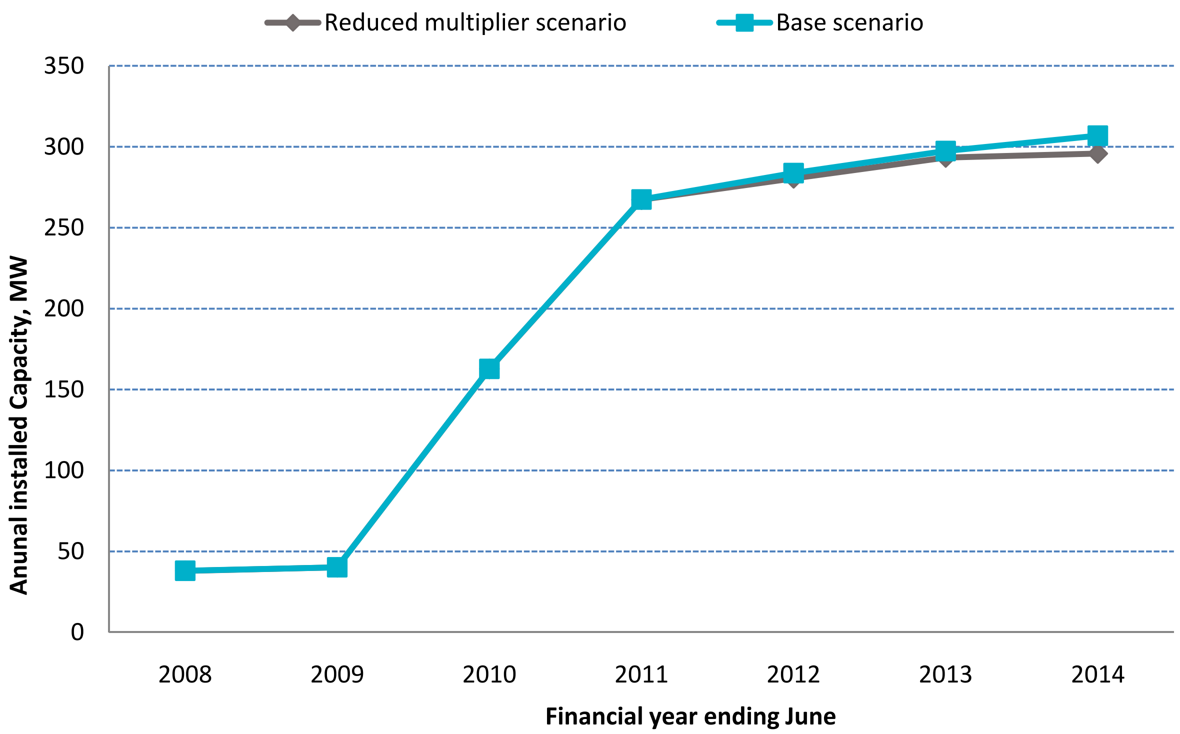


6.2. DOGMMA projections for Reduced Multiplier scenario

The Reduced Multiplier scenario was executed by using the same calibration parameters derived for the Base scenario, with the only difference being the Solar Credits multiplier input assumption. The resulting uptake in the DOGMMA model did not prove to be particularly sensitive to this change in multiplier, with only a slight reduction in installed capacity of less than 3% for any given year Australia wide. This is illustrated in Figure 6-9, which shows the Australia wide uptake capacity for the Reduced Multiplier scenario to be slightly below that of the Base scenario.

The reason for the lack of sensitivity in uptake is the fact that many of the optimal uptake solutions produced by DOGMMA for the Base scenario were situated on constraints in the model. These same constraints were in place for the Reduced Multiplier scenario, and if a particular solution was bounded by the same constraint, then the result would be identical between the two scenarios. However, even though the uptake capacity is similar between the two scenarios, the effect of the multiplier reduction is clearly reflected in the number of certificates produced (see section 6.5).

■ Figure 6-9 Historical and projected installed PV capacity for Australia by scenario – DOGMMA model



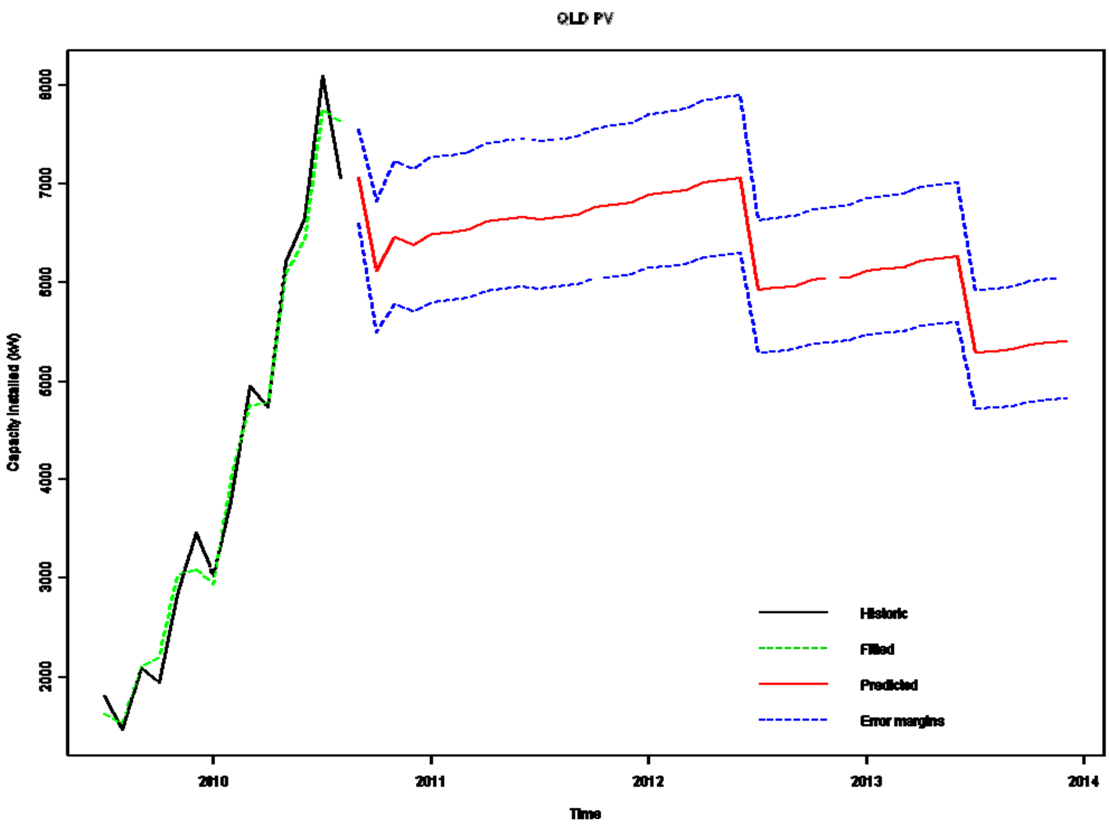
6.3. Time series projections for Base scenario

Figure 6-10 shows the time series projection for the installed monthly PV capacity in Queensland. The first time series on the left of the graph with the solid black line is the historical monthly time series, extending to August 2010, upon which the projection is based. The radical change to the incentives for installing PV which occurred in June 2009[6] completely threw out the time series model, and sensible projections could only be achieved by including data from July 2009 onwards, when the Solar Credits scheme took effect.

The green dotted line on the left gravitating around the solid black line is the model's fit to the historical data, which is quite accurate. The model's predicted monthly PV uptake capacity is represented by the solid red line on the right hand side of the graph, and the two dotted lines encompassing the projection represent the prediction plus and minus the standard error.

[6] That is, the abolition of the $8,000 PVRP rebate and the introduction of the Solar Credits scheme.

■ Figure 6-10 PV installed capacity projections for Queensland



According to the projection, the monthly installed capacity of new PV systems has peaked in Queensland and will be trending slightly downwards over the next three years. The stark jumps evident in the monthly projections occur every July from July 2012 onwards. These are driven by the monthly net cost projection, and reflect the step down in the Solar Credits multiplier from 5 to 4 in July 2012, and then from 4 to 3 in July 2013. The positive slope in between these steps reflects a gradual lowering of costs through the assumed decline in PV capital costs, and through an increase in the avoided costs of electricity, which is driven by rising wholesale and retail costs.

Figure 6-11 shows the time series projection for the installed monthly PV capacity in New South Wales. It is clear that the model's fit to the historical uptake capacity is not as accurate as the Queensland model, and this is reflected in the standard error of the projection which is relatively larger. A key feature of the projection is the large decline in uptake in late 2010. This reflects the recent reduction in the NSW gross feed-in-tariff from 60c/kWh to 20c/kWh. The projection is otherwise similar to that of Queensland in that the multiplier reductions in July 2012 and 2013 effect a shallow down-trend in uptake capacity.

■ Figure 6-11 PV installed capacity projections for New South Wales

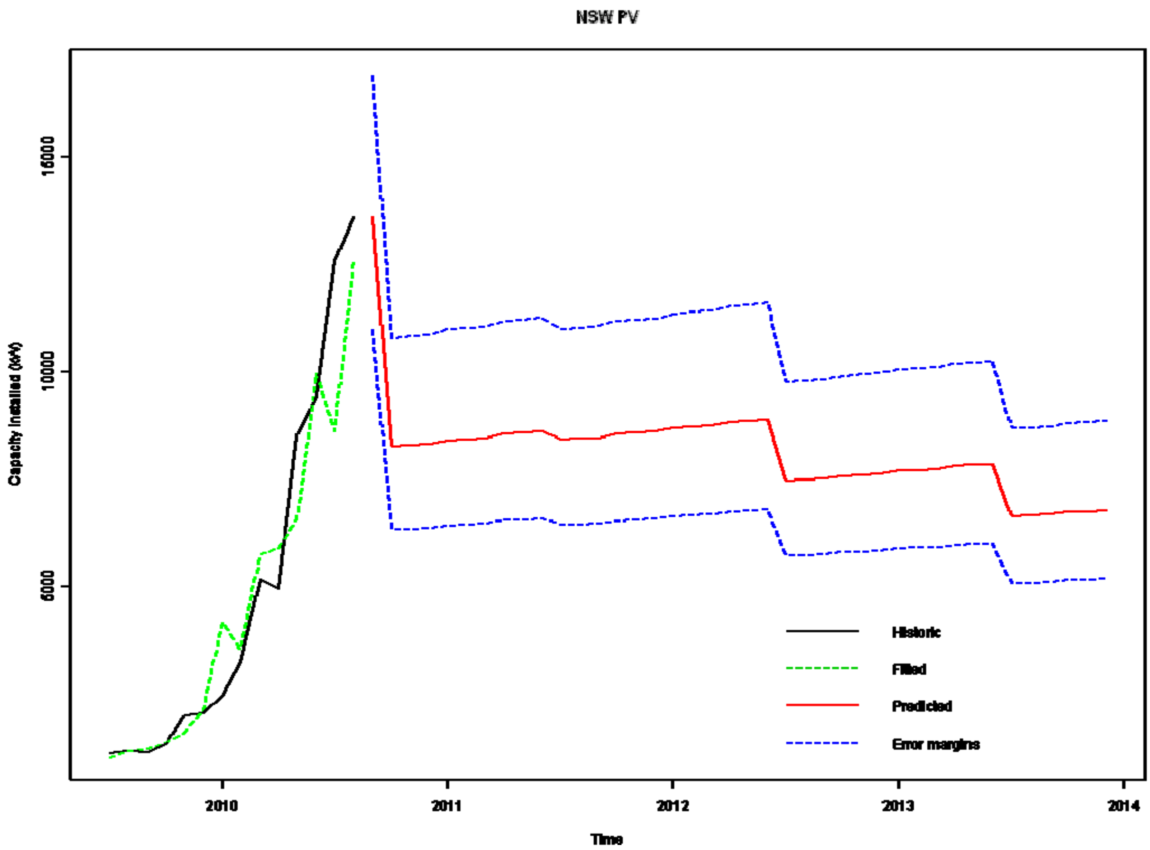


Figure 6-12 shows the time series projection for the installed monthly PV capacity in Victoria. The fit of the model appears to be worse than that of New South Wales, and the standard error of the prediction is noticeably larger in relative terms. Unlike the projections for Queensland and NSW, there is no immediate reduction in uptake capacity, but rather a slight uptrend is in place until July 2012, when the first multiplier reduction occurs. The projected uptake trend is still negative in the medium term, but is flatter than the NSW and Queensland trends.

■ Figure 6-12 PV installed capacity projections for Victoria

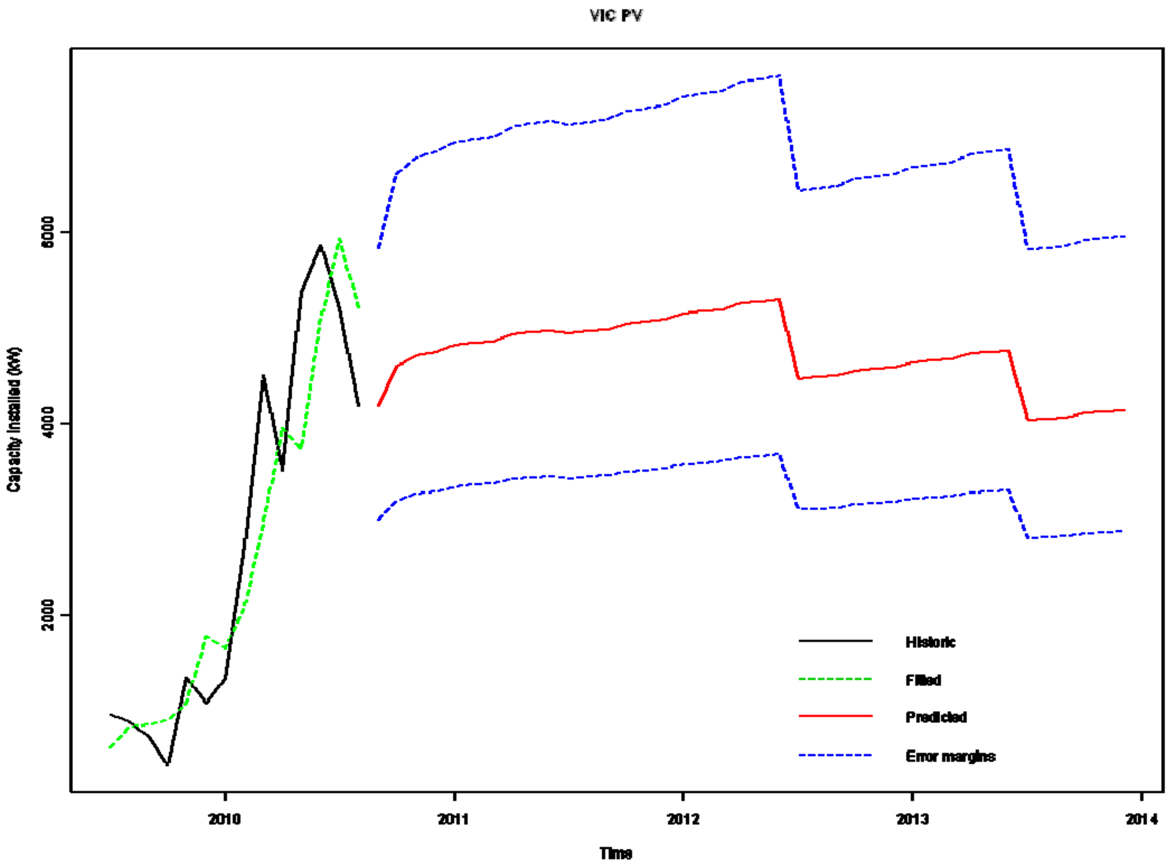
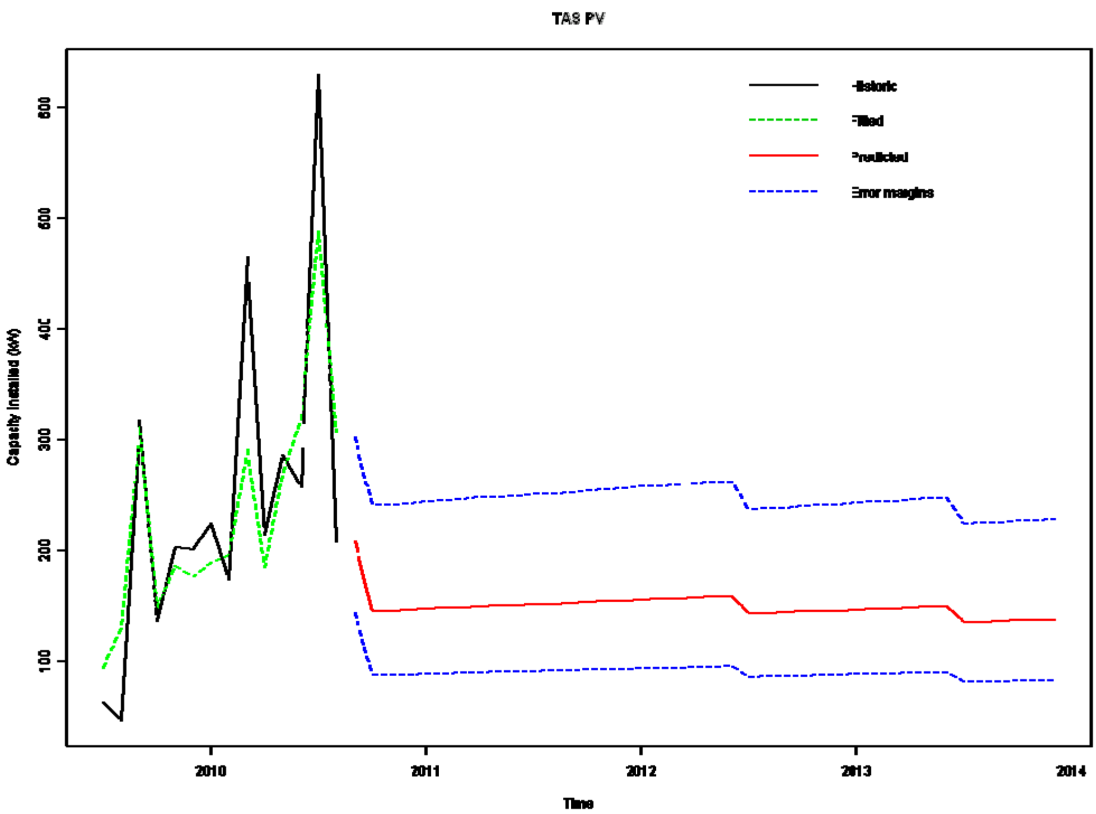


Figure 6-13 shows the time series projection for the installed monthly PV capacity in Tasmania. The historical monthly uptake time series is not as steep as that observed for the mainland states, which is what one may have expected, given that Tasmania has the lowest insolation levels of the Australian states and territories. Also noticeable is the poor model fit relative to that of the other states, and this results in a large standard error for the projected uptake. Apart from the large initial drop, the projection is relatively flat, and the effect of the multiplier reductions are not as pronounced as for the mainland states, probably because the uptake in Tasmania is relatively low to begin with.

Figure 6-14 shows the time series projection for the installed monthly PV capacity in South Australia. The model fit to the historical time series appears to be quite good. Unlike the other projections presented thus far, the South Australian uptake is yet to peak, and is projected to do so in June 2012. It otherwise has similar characteristics to the Queensland projection.

- Figure 6-13 PV installed capacity projections for Tasmania



- Figure 6-14 PV installed capacity projections for SA

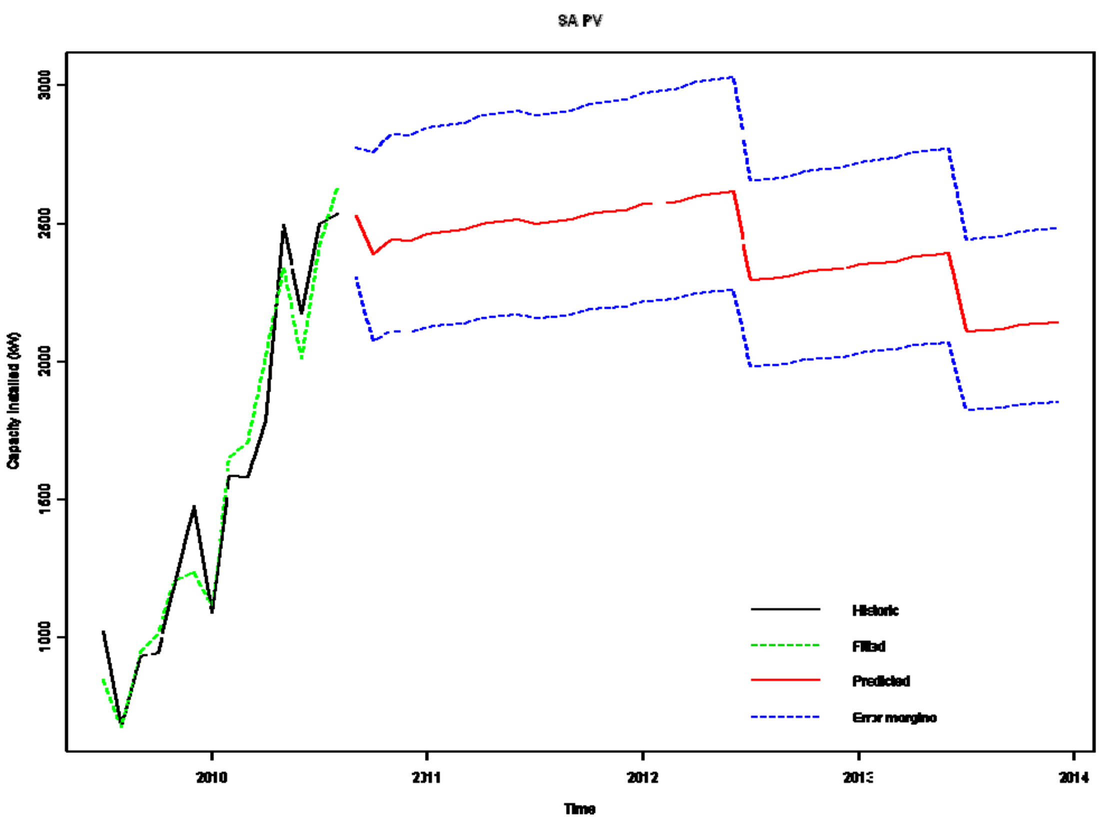


Figure 6-15 shows the time series projection for the installed monthly PV capacity in Western Australia. The model fit to the historical time series is reasonably good, and the projected uptake is similar to South Australia in that it is projected to peak in June 2012 followed by a decline in uptake due to the reduction in the Solar Credits multiplier.

■ Figure 6-15 PV installed capacity projections for Western Australia

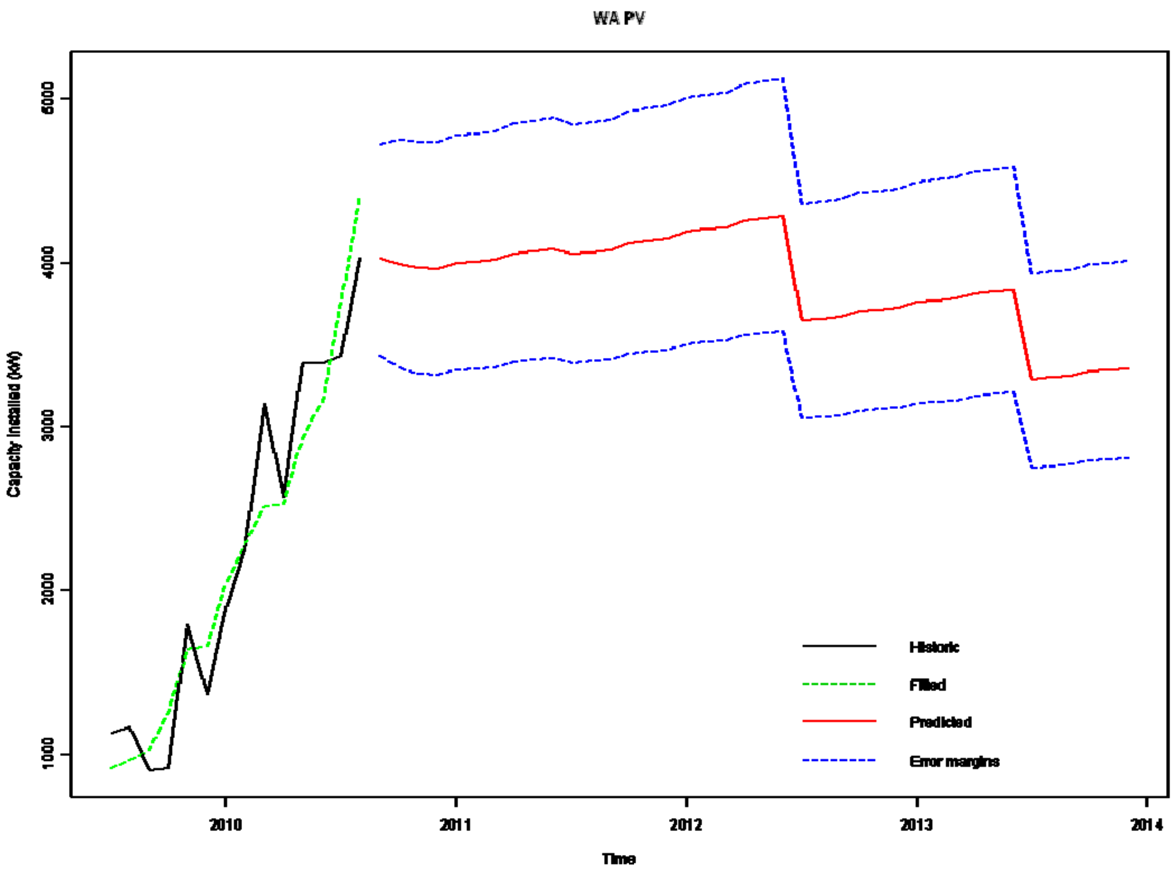
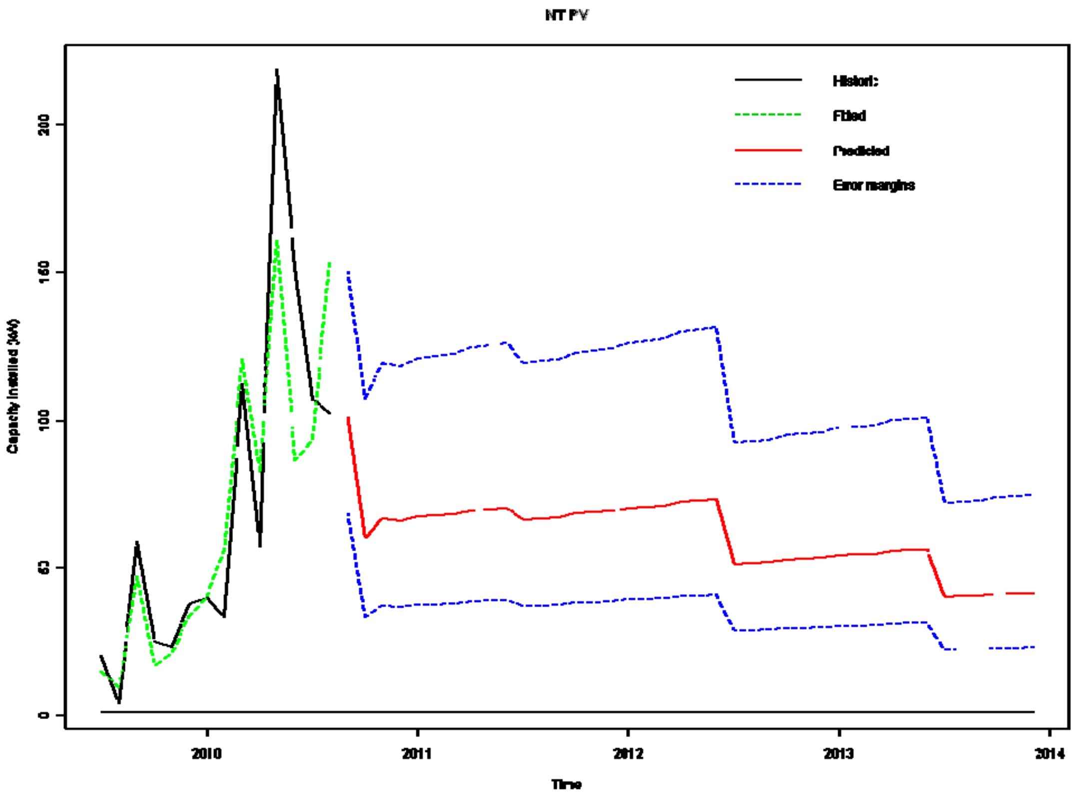


Figure 6-16 shows the time series projection for the installed monthly PV capacity in the Northern Territory. The historical uptake does not appear to have been as rapid as in the mainland states, although the model fit is quite reasonable. The time series model is predicting that the monthly uptake has already peaked, and is projecting a significant decline in uptake in late 2010, followed by a shallow down-trend in the medium term.

Figure 6-17 shows the time series projection for the installed monthly PV capacity in the Australian Capital Territory. The model fit to the historical time series is excellent, and the model is predicting that the peak monthly uptake is yet to occur. As with some of the other state projections, the effect of multiplier reduction is quite pronounced and leads to a downtrend in uptake.

■ Figure 6-16 PV installed capacity projections for Northern Territory



■ Figure 6-17 PV installed capacity projections for Australian Capital Territory

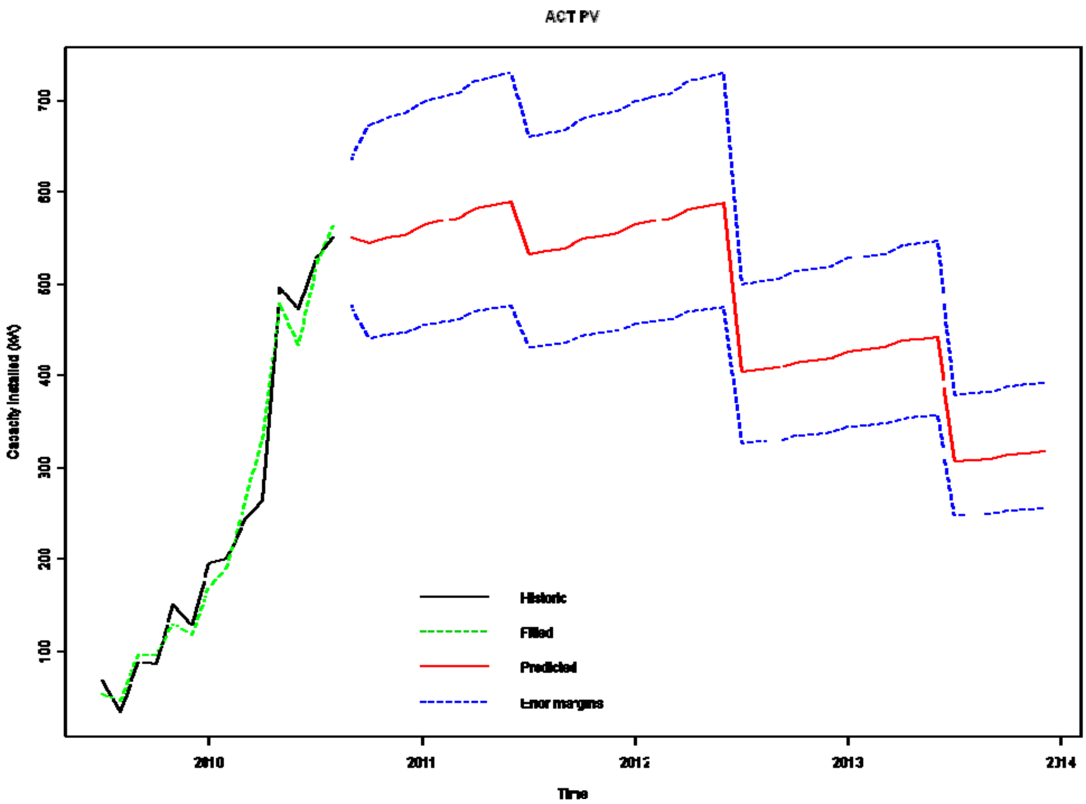


Figure 6-18 shows the sum of the state projections, which is effectively the projected PV installed capacity across Australia. The large initial drop in projected capacity for NSW is evident in the chart, as are the July 2012 and July 2013 step downs, which coincide with the scheduled reductions of the Solar Credits multiplier.

- Figure 6-18 PV installed capacity projections aggregated for all Australia

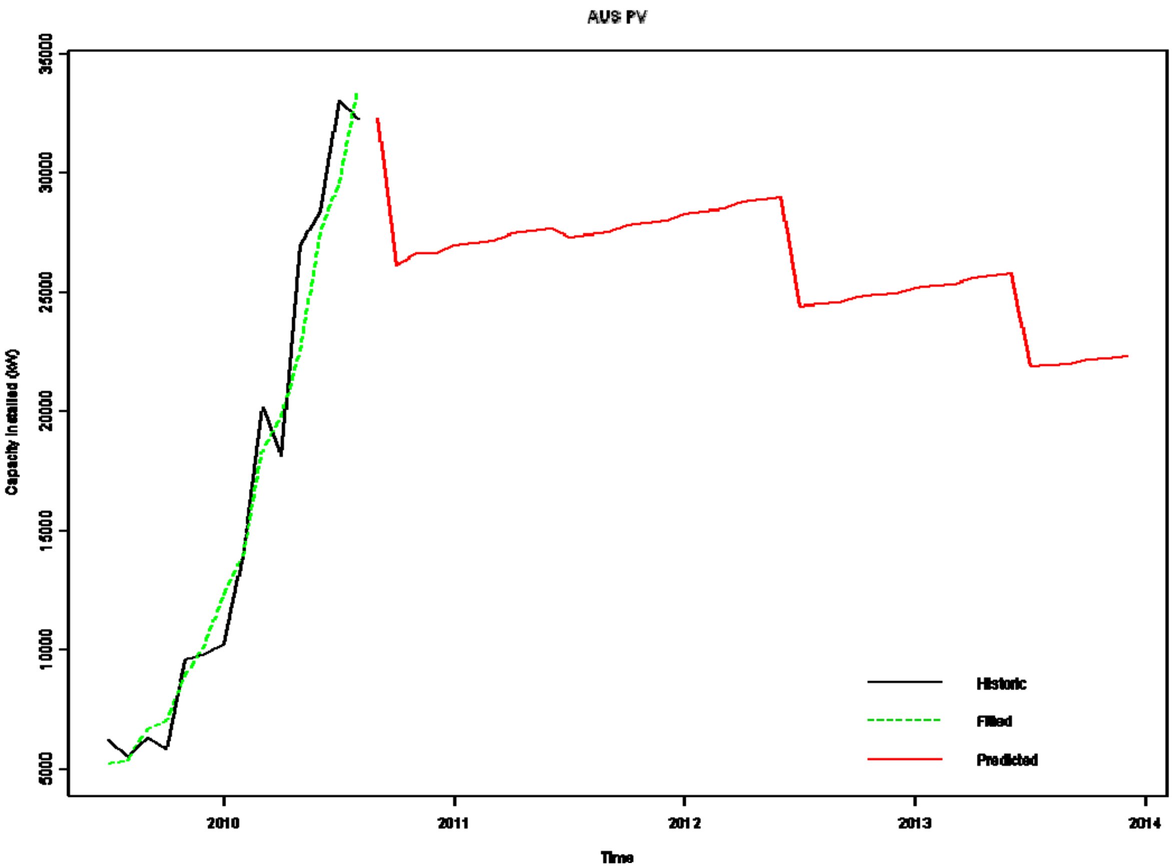


Figure 6-19 shows the time series projection for STC volumes created by commercial water heaters for the whole of Australia. Unlike the time series modelling for PV systems, most of the historical time series was able to be employed in projecting water heater STC volumes. This is because the changes to the government-based financial incentives driving the uptake of water heaters were not as pronounced as those for SGUs.

The time series model's fit to the historical time series appears to be reasonably good, although the uncertainty surrounding the projection indicates that the fit is perhaps comparable to that of the Tasmanian PV model. It should be noted that the flat portion of the historical time series data just prior to 2010 corresponds to the data adjustment described in section 5.6.4.5.

The projection of monthly STC creation from commercial water heaters indicates a gradual reduction in uptake across Australia from current levels, followed by a levelling off from about mid 2012. This is broadly consistent with the cessation of the various state based rebates between now and December 2013, although no state rebates cease in mid 2012, which is the point at which the uptake levels off. This latter effect is probably driven by the combination of a gradually decreasing capital cost and an increasing avoided electricity cost, which manifested itself as a shallow positive slope in the PV uptake projections.

■ Figure 6-19 Commercial water heater STC volume projections for Australia

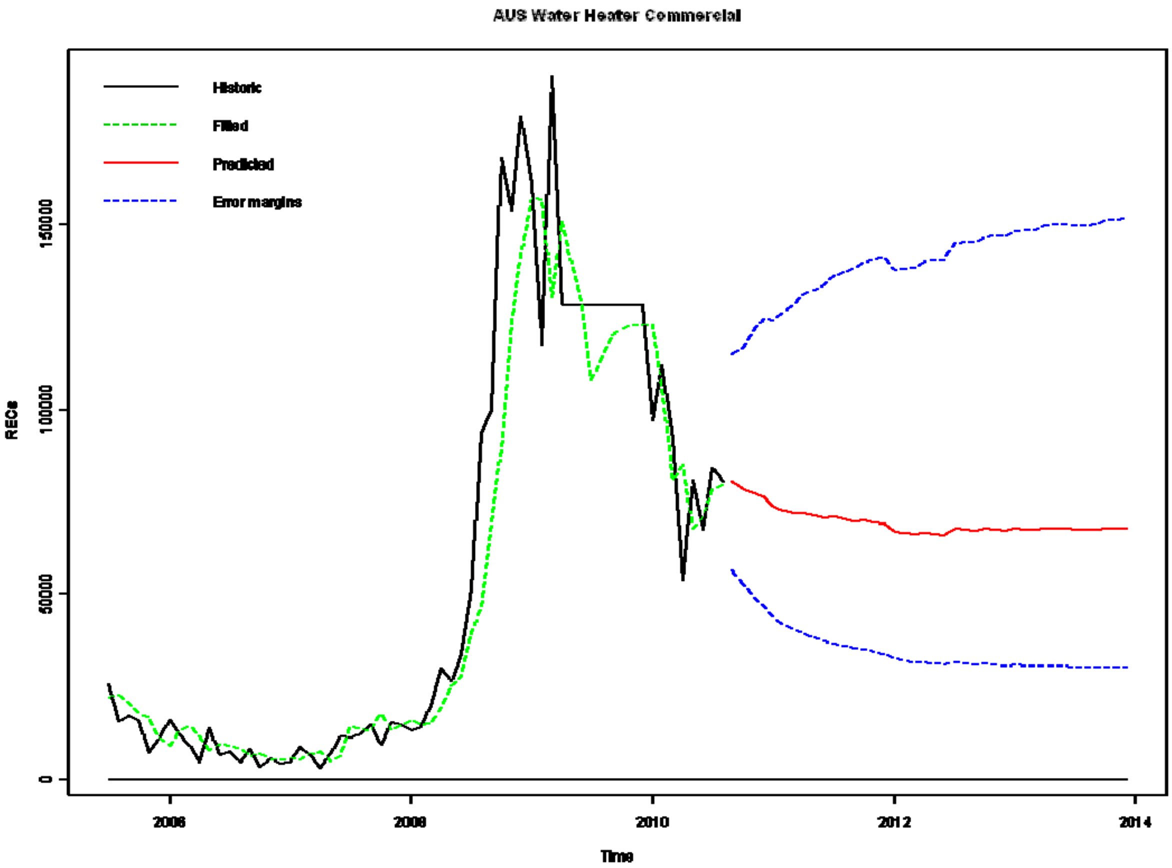
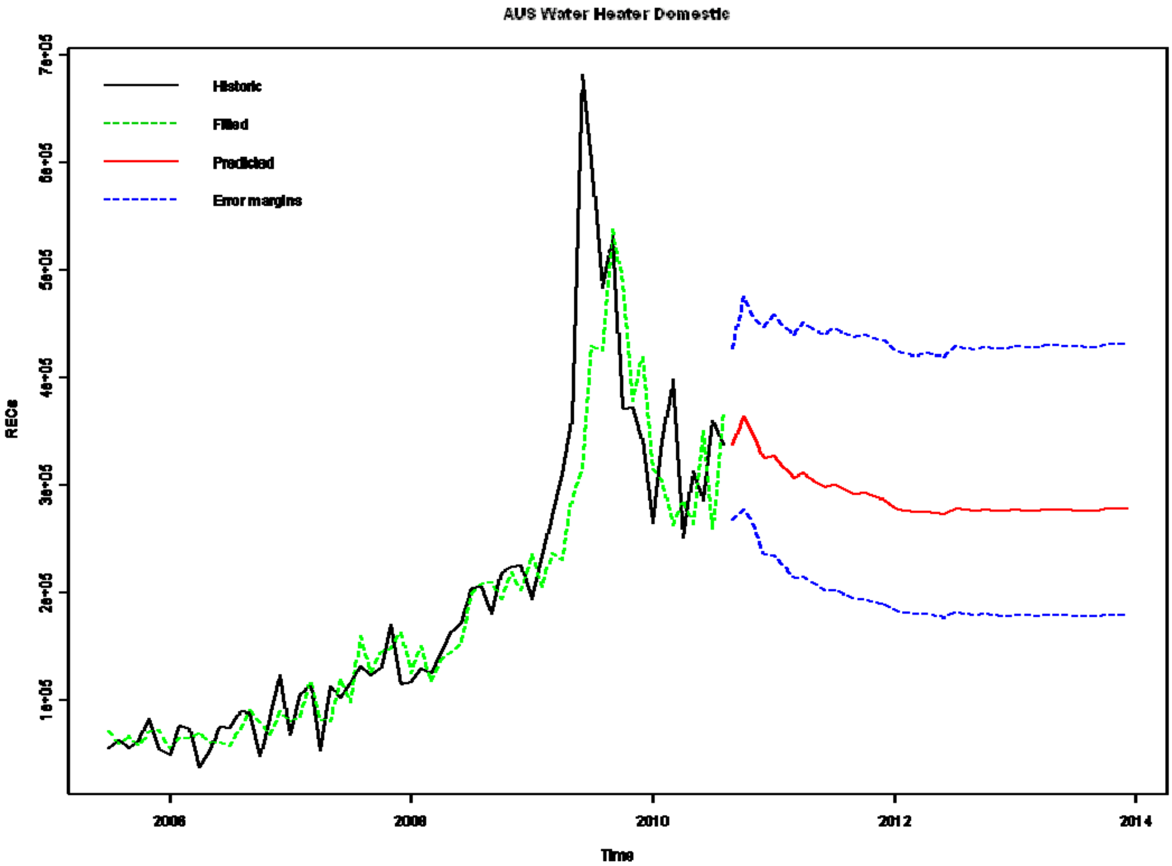


Figure 6-20 shows the time series projection for STC volumes created by domestic water heaters for the whole of Australia. The peak in the historical time series around mid 2009 coincides with the pronounced peak exhibited in the corresponding time series for commercial water heaters (see section 5.6.4.5), and is therefore considered to be somewhat artificially inflated. However, testing has shown that the effect of this peak does not lead to a large distortion in projected volumes, and so it was left in the time series unadjusted.

The model's fit to the historical time series is quite good, and is definitely better than the corresponding fit for commercial water heaters. The STC volume projections for domestic water heaters are similar to those for the commercial category in that there is a gradual reduction in uptake from current levels, and then a levelling off of uptake from about mid 2012. The drivers behind this behaviour would be identical to those described for the commercial category.

■ Figure 6-20 Domestic water heater STC volume projections for Australia

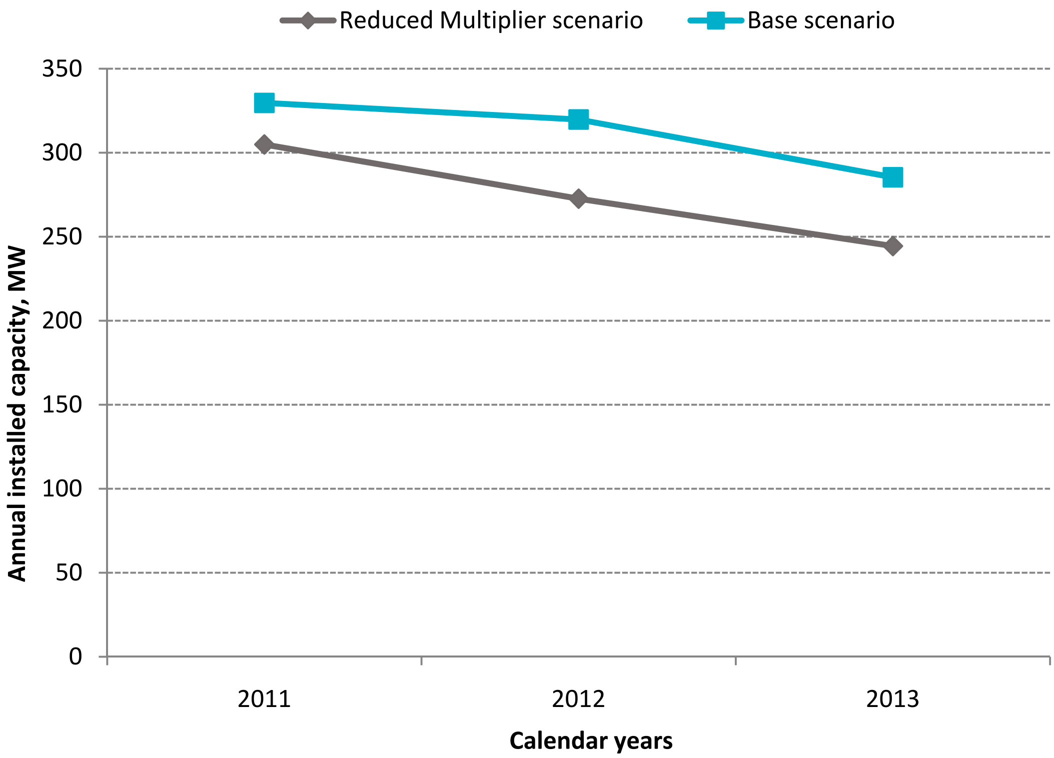


6.4. Time series projections for Reduced Multiplier scenario

The Reduced Multiplier scenario was executed by altering the projected net cost calculation to reflect the new multiplier assumptions, and then re-running the finalised time series model that was used to project the Base scenario. Note that this was only applicable to the PV uptake projections, since the Solar Credits scheme does not apply to water heaters.

Figure 6-21 shows the projected Australia-wide PV capacity uptake for the Reduced Multiplier scenario compared with the Base scenario. The differences in the projected uptake capacities between the two scenarios derived from the time series analysis are more pronounced than those of the DOGMMA model (compare with Figure 6-9). This is not surprising because the main driver behind the uptake numbers in the time series projection is the net cost, which is quite sensitive to any change in the multiplier. Thus, whereas in DOGMMA there was very little change in the uptake because the optimal solution was bounded by a constraint, in the case of the time series analysis the uptake capacity has been noticeably reduced.

■ Figure 6-21 Projected installed PV capacity for Australia by scenario – time series model



6.5. Certificate projections by scenario for DOGMMA

Table 6-1 shows the projected number of STCs created by small-scale PV technology by state for the next three calendar years under the Base scenario according to the DOMMA model. The reduction of STCs produced in 2012 relative to 2011 is due to the PV multiplier dropping from 5 to 4 on 1 July 2012. Most of STC reduction occurs in New South Wales and Victoria, where in the case of the former, almost 900,000 less certificates are created. The larger drop in STC creation in 2013 is the result of the PV multiplier dropping from 4 to 3 on 1 July 2013.

Table 6-2 shows the projected number of STCs created by small-scale PV technology under the Reduced Multiplier scenario. The reduction in certificates in all three years relative to the Base scenario is mainly driven by the reduction in the multiplier, rather than a reduction in uptake capacity (see section 6.2). This occurs because even though similar numbers of systems are installed in both scenarios, the number of certificates generated by these systems is significantly different since the applicable multipliers are different.

■ Table 6-1 Projected STCs created from PV under Base scenario using DOGMMA – Calendar years

	2011	2012	2013
Queensland	7,582,000	7,226,000	5,817,000
New South Wales	8,507,000	7,781,000	6,163,000
Victoria	4,174,000	3,814,000	3,015,000
Tasmania	343,000	312,000	218,000
South Australia	1,750,000	1,597,000	1,257,000
Western Australia	3,933,000	3,961,000	3,378,000
Northern Territory	162,000	134,000	81,000
Total	**26,450,000**	**24,825,000**	**19,930,000**

■ Table 6-2 Projected STCs created from PV under Reduced Multiplier scenario using DOGMMA – Calendar years

	2011	2012	2013
Queensland	5,709,000	6,791,000	5,616,000
New South Wales	6,713,000	7,635,000	6,035,000
Victoria	3,833,000	3,754,000	2,965,000
Tasmania	254,000	272,000	154,000
South Australia	1,366,000	1,578,000	1,246,000
Western Australia	2,814,000	3,455,000	2,994,000
Northern Territory	118,000	119,000	68,000
Total	**23,605,000**	**19,078,000**	**13,956,000**
Difference to Base scenario's total	**-2,845,000**	**-5,747,000**	**-5,974,000**

6.6. Certificate projections by scenario for time series model

6.6.1. Base scenario

Table 6-3 shows the projected number of STCs created by small-scale PV technology by state under the Base scenario for the next three calendar years using the time series model. The reduction of STCs produced in 2012 relative to 2011 is partly due to the PV multiplier dropping from 5 to 4 on 1 July 2012. Most of STC reduction occurs in Queensland, New South Wales, Victoria and Western Australia, all of which have a drop in certificate creation of at least 10%. The larger drop in STC creation in 2013 is the result of the PV multiplier dropping from 4 to 3 on 1 July 2013, and reductions in certificate creation of up to 40% occur in every state.

Table 6-3 Projected STCs created from PV under Base scenario using time series model – Calendar years

	2011	2012	2013
ACT	670,000	540,000	318,000
Queensland	7,520,000	6,648,000	4,609,000
New South Wales	10,169,000	8,845,000	6,107,000
Victoria	5,093,000	4,540,000	3,184,000
Tasmania	154,000	139,000	102,000
South Australia	2,573,000	2,278,000	1,624,000
Western Australia	5,188,000	4,579,000	3,206,000
Northern Territory	87,000	73,000	44,000
Total	**31,455,000**	**27,642,000**	**19,195,000**

Table 6-4 shows the projected number of STCs created by water heaters by domestic/commercial classification for the next three calendar years using the time series model. This forecast does not vary as much as the PV projection since there is no STC multiplier effect. There is less than a 10% variation in projected certificate creation over the next three years, although the trend in creation is down (a simple projection of the expected number of water heater RECs for the 2010 calendar year is about 4.8 million). This result is consistent with the cessation of the various state rebates for SWH and heat pump technologies over the next three years (see Table 5-1).

Table 6-4 Projected STCs created from water heaters under Base scenario using time series model – Calendar years

	2011	2012	2013
Commercial	853,000	804,000	813,000
Domestic	3,622,000	3,316,000	3,326,000
Total	**4,474,000**	**4,120,000**	**4,139,000**

6.6.2. Reduced Multiplier scenario

Table 6-5 shows the projected number of STCs created by small-scale PV technology by state under the Reduced Multiplier scenario using the time series model. The differences between the two scenarios are quite significant, ranging from about 15% in 2011 to almost 40% in 2013. This is due to the combined effect of a reduced uptake in PV capacity (see section 6.4) and the reduction in the Solar Credits multiplier under the Reduced Multiplier scenario.

■ Table 6-5 Projected STCs created from PV under Reduced Multiplier scenario using time series model – Calendar years

	2011	2012	2013
ACT	541,000	320,000	175,000
Queensland	6,272,000	4,359,000	2,792,000
New South Wales	8,583,000	5,939,000	3,786,000
Victoria	4,258,000	2,995,000	1,940,000
Tasmania	132,000	97,000	66,000
South Australia	2,187,000	1,561,000	1,027,000
Western Australia	4,360,000	3,052,000	1,973,000
Northern Territory	70,000	42,000	24,000
Total	**26,403,000**	**18,365,000**	**11,783,000**
Difference to Base scenario's total	**-5,052,000**	**-9,277,000**	**-7,412,000**

6.7. Combined STC volume projections

6.7.1. Summary of STC projections – Base scenario

Table 6-6 shows a summary of the STC volume forecast produced by the DOGMMA model and the two forecasts produced by the time series model for the Base scenario. Table 6-6 also shows the total number of STCs projected across Australia using the PV projections for the DOGMMA model and time series model respectively. This is also illustrated in Figure 6-22.

■ Table 6-6 Summary of Australia-wide STC projections – Base scenario

	2011	2012	2013
DOGMMA – PV	26,450,000	24,825,000	19,930,000
Time series – PV	31,455,000	27,642,000	19,195,000
Time series – water heaters	4,474,000	4,120,000	4,139,000
DOGMMA PV + water heaters	**30,924,000**	**28,945,000**	**24,069,000**
Pure time series	**35,929,000**	**31,762,000**	**23,334,000**

■ Figure 6-22 Australia-wide STC projections for both models – Base scenario

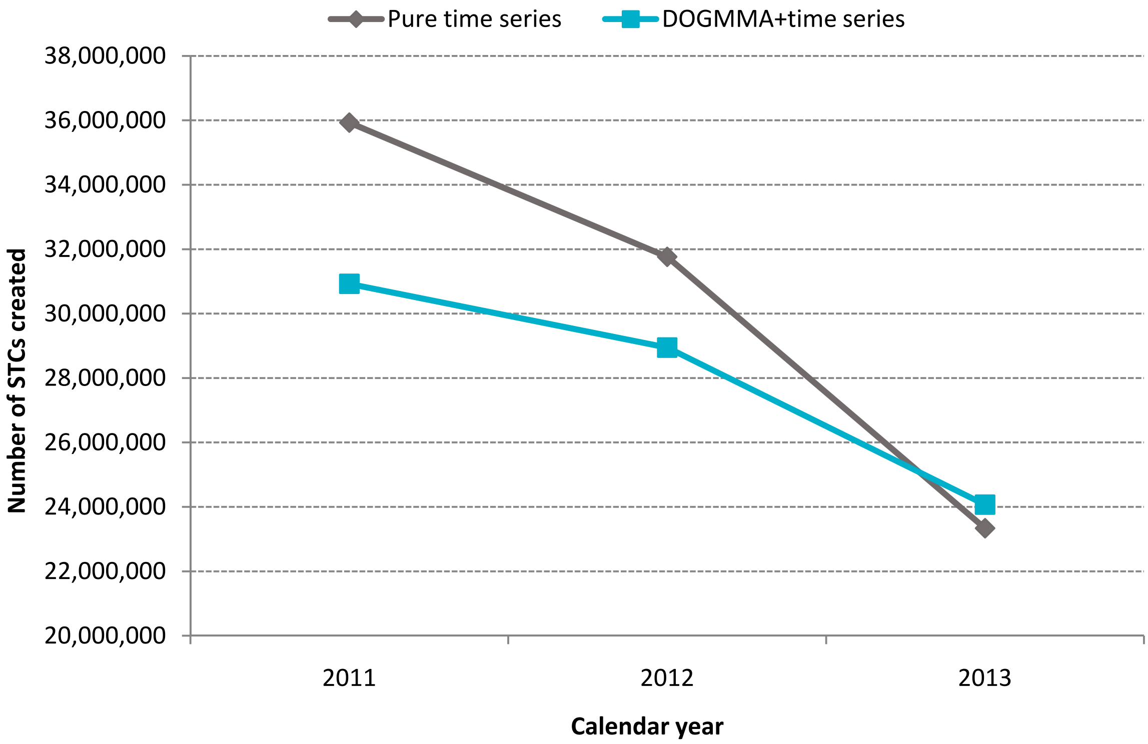


Table 6-7 shows the difference between the STC projection created by PV systems produced by DOGMMA and that of the time series model. The greatest difference between the models occurs in 2011 with the time series predicting the creation of 18.9% more certificates relative to the DOGMMA model. The forecasts converge together over time, with the time series projection dropping slightly below the DOGMMA projection in 2013.

■ Table 6-7 Difference between DOGMMA and time series STC forecast for PV systems – Base scenario

	2011	2012	2013
Difference	5,005,000	2,817,000	-735,000
% Difference	18.9%	11.3%	-3.7%

6.7.2. Summary of STC projections – Reduced Multiplier scenario

Table 6-8 shows a summary of the STC volume forecast produced by the DOGMMA model and the two forecasts produced by the time series model under the Reduced Multiplier scenario. Table 6-8 also shows the total number of STCs projected across Australia for this scenario using the PV projections for the DOGMMA model and time series model respectively. This is also illustrated in Figure 6-23.

Table 6-8 Summary of Australia-wide STC projections – Reduced Multiplier scenario

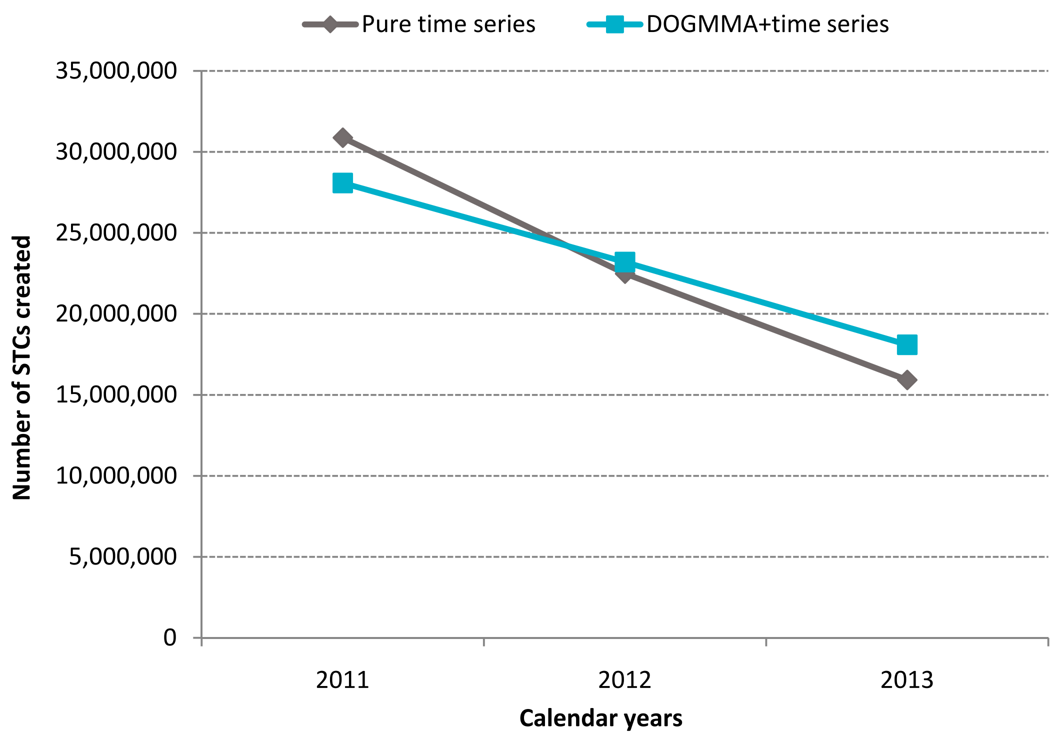
	2011	2012	2013
DOGMMA – PV	23,605,000	19,078,000	13,956,000
Time series – PV	26,403,000	18,365,000	11,783,000
Time series – water heaters	4,474,000	4,120,000	4,139,000
DOGMMA PV + water heaters	**28,079,000**	**23,198,000**	**18,095,000**
Pure time series	**30,877,000**	**22,485,000**	**15,922,000**

Table 6-9 shows the difference between the STC projection created by PV systems produced by DOGMMA and that of the time series model for the Reduced Multiplier scenario. The projections from the two methodologies are in better alignment under this scenario because the time series projection has decreased more than the DOGMMA projection relative to the Base scenario. The greatest difference between the models now occurs in 2013 with the time series predicting the creation of 15.6% less certificates relative to the DOGMMA model. As with the Base scenario, the time series model predicts a more rapid decline of STC creation from 2011 to 2013.

Table 6-9 Difference between DOGMMA and time series STC forecast for PV systems – Reduced Multiplier scenario

	2011	2012	2013
Difference	2,798,000	-735,000	-2,173,000
% Difference	11.9%	-3.7%	-15.6%

Figure 6-23 Australia-wide STC projections for both models – Reduced Multiplier scenario



7. Concluding remarks

In providing these projections of STC volumes over the 2011, 2012 and 2013 calendar years, SKM-MMA would like to underline the large level of uncertainty surrounding them. This is evident in the variation of the projections produced by the two separate methodologies. On the one hand, DOGMMA is forward-looking longer-term model and it predicts a slight increase in the rate of PV capacity uptake from the current rate, followed by a levelling off of the uptake rate. The basis for this result is the expectation of elevated electricity prices resulting from the introduction of emissions trading within the next decade, coupled with the continuation of the long-term downtrend in PV capital costs denominated in Australian dollars.

On the other hand, the time series model is much more sensitive to short-term trends since it is primarily driven by the immediate net cost. Meaningful predictions for PV uptake could only be achieved by truncating all but the last 14 months of the time series, and this was reflected in the large standard errors associated with the predictions. The time series model for PV uptake generally predicted an elevated uptake in capacity for 2011, and this was followed by decreasing uptake over the next two years, which was accentuated whenever the Solar Credits multiplier was reduced.

The fundamental source of the uncertainty underlying the PV uptake predictions is the lack of market history at the current level of net installation cost. For example, the Solar Credits scheme was only introduced 16 months ago, and the total PV installation cost has only been at present levels for a similar amount of time.

SKM-MMA has more confidence in the STC volume projections for water heaters produced by the time series model since the model used almost six years of market history to make the predictions. However, these projections only form 12% to 26% of the annual number of STCs expected to be created over the next three years.

Appendix A DOGMMA model assumptions

A.1 Constraints

A number of constraints that limit the uptake of distributed generation are included in the model:

- *Economic constraints.* As the capacity of distributed generation in a region increases, the unit cost of generation also increases[7]. In the case of wind generation, this is modelled as reduced capacity factor as more wind generation is selected (to reflect the fact that as more wind farms are built, they are likely to locate in less windy areas). In the case of PV, this is modelled as increasing capital cost to represent the likely increase in installation costs where demand increases faster than the capacity of installers, and reduced energy output per kW of capacity as less favourable sites are chosen.
- *Technical and regulatory constraints.* A number of maximum capacity limits are imposed to mimic the impact of technical limits to uptake in a region or regulatory impediments. The maximum capacity limits can also be used to model the effect of social issues such as the amenity affect of wind generation in residential areas and some sensitive sites.
- *Geographic constraints.* The off-take nodes have been divided into metropolitan and rural nodes and have been utilised to assign the availability of potential capacity in a region for wind and hydro resources.
- *General constraint.* The capacity of distributed generation is not allowed to exceed the local peak demand (as this would entail the need to export power to other regions which would incur additional costs not modelled).

A.2 Local demand

Forecasts of local demand at each node were derived by taking the actual peak demand for 2006/07, as published by state based transmission planners, and then applying the state-wide peak demand growth rate as forecast by the Electricity Statement of Opportunities. The larger states were represented by multiple nodes, whereas South Australia and Tasmania were each treated as single node regions.

Energy consumption for each region was calculated from peak demand by using the state-wide load factor. A correction factor was applied to ensure that the sum of energy consumption at each node equalled state-wide energy consumption.

A.3 Technical assumptions

Assumed technical parameters for each of the distributed generation options are shown in Table A.1 . Although the model can handle variations in the assumptions by region, we assumed that the technical assumptions for each generation technology were the same in each region. However, the capacity factor for wind generation shown in the table represents the maximum capacity factor achievable in the region. The actual capacity factor decreases as the level of wind generation increases within a region.

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[7] This is done to represent the actual likelihood of rising costs as supply increases, and to avoid what is known as the “flip flop” effect that occurs with average cost assumptions, where the model chooses nothing but distributed generation once the cost of distributed generation is lower than the cost of grid supplied electricity.

Table A- 1 Technical assumptions for distributed generation options

Parameter	Rooftop PV	Small Wind	Small Hydro
Annual uptake limit as a maximum proportion of total demand, %	0.01	0.001	0.0001
Maximum plant size, MW	0.0015 – 0.300	0.003 – 0.03	0.001
Capacity factor, %	11 - 18	16 -38	30
Outage rates, % of year	3	3	3
Emission intensity of fuel, kt of CO_2e/PJ	0.0	0.0	0.0

Note: PV capacity factors vary by region according to solar insolation levels. Wind capacity factor varies by the amount of wind generation in a region. Source: SKM-MMA analysis.

It is assumed that in each region, the actual plant size will be equal to maximum allowed size except for the last plant chosen, which may have a lower capacity.

Unit capital costs are also assumed to decrease over time, reflecting long-term trends. Wind capital costs are assumed to decline 2% per annum by 2020 and 1% per annum thereafter. Photovoltaic system capital costs are assumed to decline by 5% per annum until 2020 and then at 3%, and mini hydro systems are assumed to decline at 1% per annum.

Capital costs are annualised over the life of the plant, assumed to be 25 years for all plants. Costs are annualised using a real weighted average cost of capital set at 5% above the risk-free long-term bond rate (which, based on latest 10 year treasury bond rates, is about 5.3% per annum in real terms).

A.4 Photovoltaic system parameters

A.4.1 Costs

The average installed system cost for residential PV has dropped dramatically over the last 12 months and is now around $6,000/kW in Australia for a typical 1.5 kW roof top system. Smaller systems cost a little more and larger systems a little less by achieving some economies of scale and bulk purchase of panels.

There is an international market for PV modules, which keeps pricing in individual countries reasonably linked. Module prices increased from 2003 to 2008 due to very strong demand for PV, driven by strong government incentive programs in countries such as Germany, Japan and California and a shortage of crystalline silicon feedstock. Manufacturers have responded by investing heavily in more manufacturing capacity at larger scale to achieve economies of scale of production. Combining this with a drop in demand due to the financial crises and falling subsidy support led to 30% decrease in prices in 2009, with a further fall of 20% in 2010.

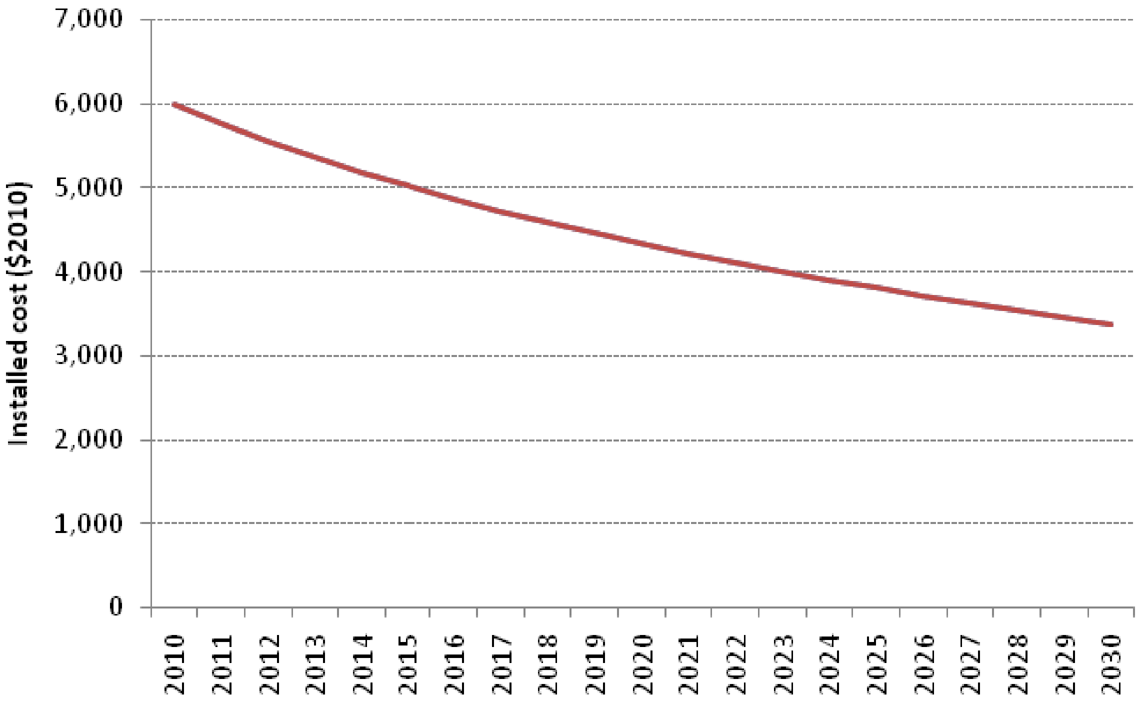
Predicting the future price of any product is difficult and subject to large uncertainties. The key parameters that will determine the future cost of PV cells include:

- Raw material cost.
- Other input costs.
- Economic conditions.
- Demand and production levels.
- Technology.

Many of these parameters are interlinked and improvement in one may force higher costs in another. For example, as costs fall due to increased economies of scale in manufacturing, upward cost pressure may result from the increased demand forcing up raw material costs. However, technology improvements may reduce the quantity of raw material required or the type of material necessary.

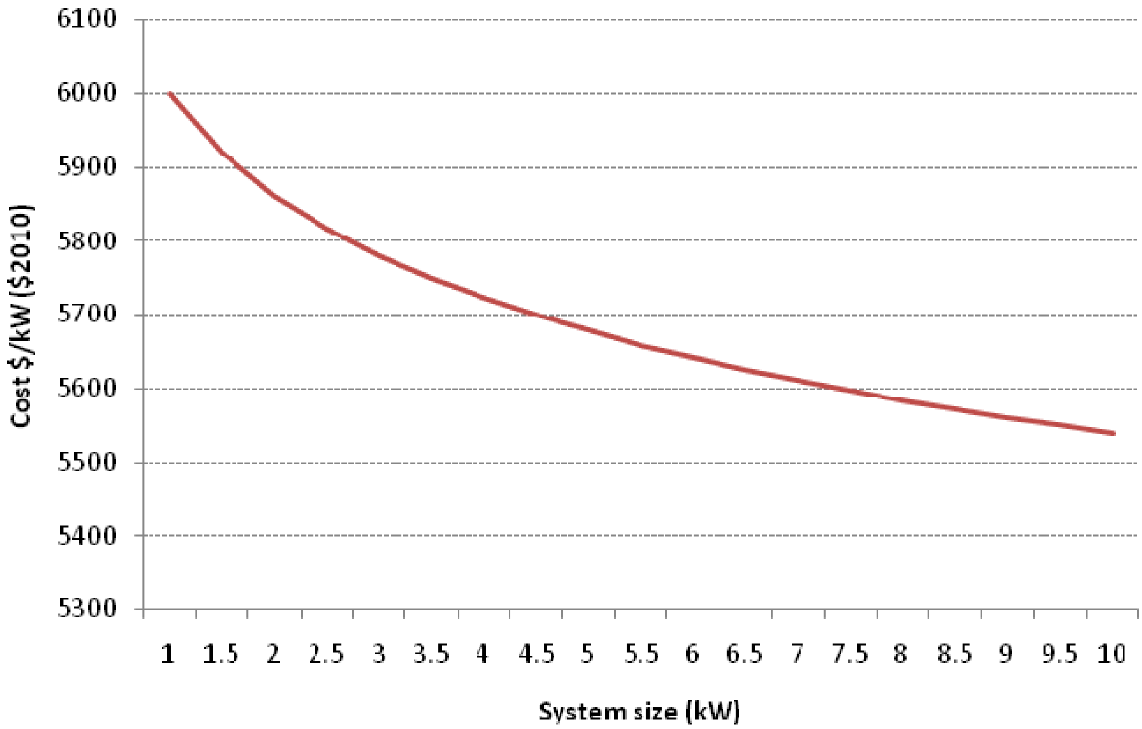
Data over the past 25 years have revealed that there has been a 20% cost reduction for every doubling of the cumulative production of PV cells. This linear behaviour of cost with cumulative volume is typical of most manufacturing, and is expected to continue at the historical rate of 20% for each doubling of cumulative production volume. It is expected that installed costs will fall by approximately 4% in 2011 falling to 2.3% in 2030, assuming that global demand continues to rise to encourage technology improvements and that manufacturing capacity can keep pace with this demand. SKM-MMA's assumed installed cost for PV systems over the next twenty years is shown in Figure A- 1.

- Figure A- 1 Assumed installed cost for PV systems, 1 kW capacity



Based on industry data, capital costs are also assumed to decline with system size, as shown in Figure A.2.

▪ Figure A- 2 Capital cost of PV systems as capacity varies



A.4.2 Capacity factors

Photovoltaic cell output is directly related to the intensity of the sunlight falling on the panel. The sunlight intensity or solar insolation varies with global position (effectively distance from the equator), and local climate, such as cloud cover. Across Australia the solar insolation varies significantly and the output of a given solar array is dependent on its location. To account for these variations we have estimated the PV system capacity factors at each of the transmission nodes employed in the analysis using the RET Screen PV Energy Model[8]. The key inputs for this analysis are the geographic coordinates of the locations involved, the orientation, configuration, and tracking of the panel, and the monthly average temperature and solar radiation. The climate data are available from the NASA Surface Meteorology and Solar Energy Data Set[9].

The resulting system capacities range from 11% (Tasmanian location) to 18% (northern Australia).

A.5 Small wind parameters

A.5.1 Costs

Distributed wind generation at a scale greater than 0.5 kW has reached a reasonable level of maturity in the market for off-grid power, and is now becoming available and installed in grid-connected applications.

Based on available systems in the 0.5 kW to 20 kW size range, and including all ancillary equipment and installation costs, a correlation between system size and cost has been developed. These costs are based on retail equipment prices and include GST but do not include any government rebates or incentives. Costs for grid-connected wind turbines have become relatively constant over a capacity

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8 RETScreen Energy Project Analysis Software, Clean Energy Decision Support Centre, www.retscreen.net

9 http://eosweb.larc.nasa.gov/sse/RETScreen/

range of 0.5 kW to 20 kW and are in the vicinity of $6,500/kW but may increase to around $15,000/kW for sub 0.5 kW units.

A.5.2 Capacity factors

The capacity factor of a wind turbine is a function of the local wind regime and the generation characteristics of the turbine. As an example we have determined average annual wind speeds at each of the regional locations utilised in the modelling of the Victorian nodes using the interactive wind map on the Sustainability Victoria website.10 For other states, we have used data provided by Government authorities or prorated to available wind generation capacity factors.

The capacity factors for wind turbines have been adjusted for the fact that they operate at lower altitudes than were measured for the wind maps and available wind farm data. Most wind turbine manufacturers publish the wind speed to power output relationships of their turbines, and these allow the average wind speed to be transformed into an annual energy output that allows the capacity factors to be calculated in each region. We have based the wind-to-energy conversion on the data for a 1.8 kW grid connected turbine manufactured by Southwest Wind Power, but have reduced the outputs by 20% to account for the lower output one would expect in siting conditions that are likely to be less than the ideal. Capacity factors are assumed to range from 15% to 25% throughout Australia.

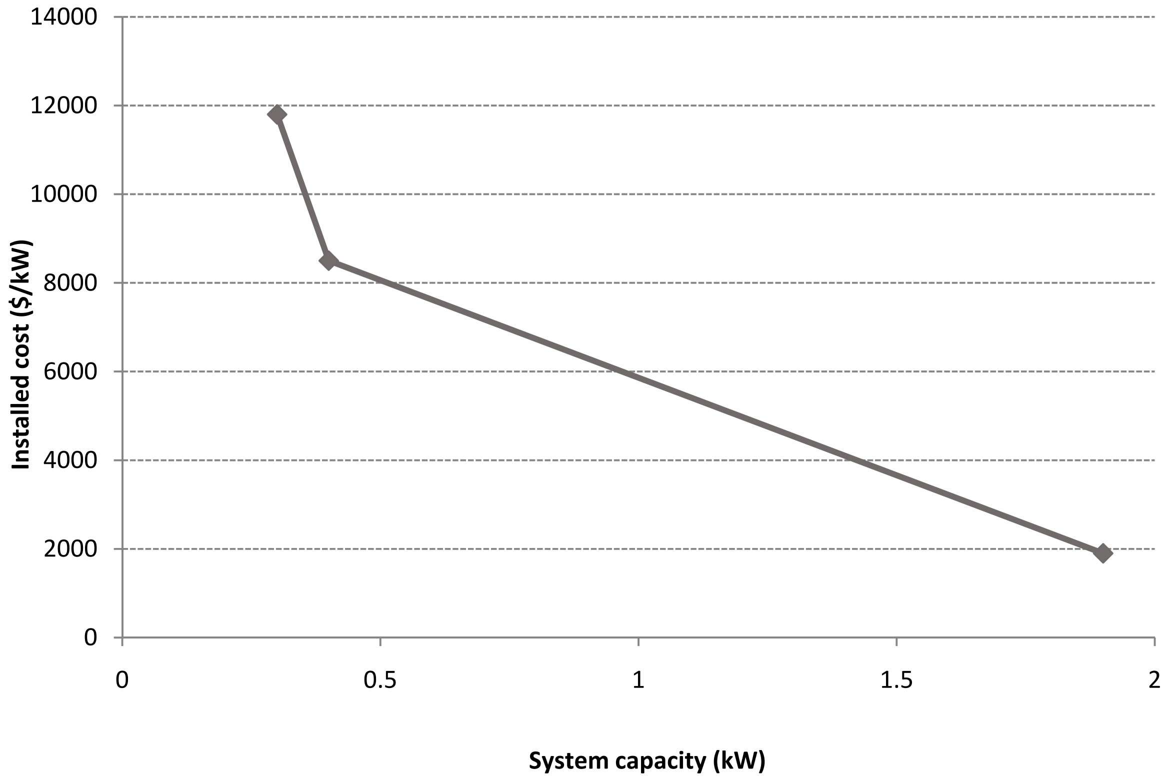
Note that the capacity factor estimates for each state represents maximum estimates for each region. As small scale wind generation capacity increases, the capacity factors decrease.

A.6 Mini Hydro

The application of mini and micro hydro systems is rather limited depending on location, and these systems depend on a flowing stream of water. We have determined the costs of mini hydro based on a small number of these systems we have identified. The costs appear to be highly sensitive to size as shown in Figure A- 3.

[10] http://www.sustainability.vic.gov.au/www/html/2123-wind-map.asp?intSiteID=4

■ Figure A- 3 Installed cost of mini-hydro systems



A.7 System parameters

Costs over time for small-scale technologies have been assumed to decrease according to historical price reductions in each of the technologies modelled. The reductions have also been assumed to decline in the future as the technologies become more mature. The rates of these cost reductions are shown in Table A- 2, with the capacities, initial 2010 costs and other operating parameters.

■ Table A- 2 Modelled system parameters

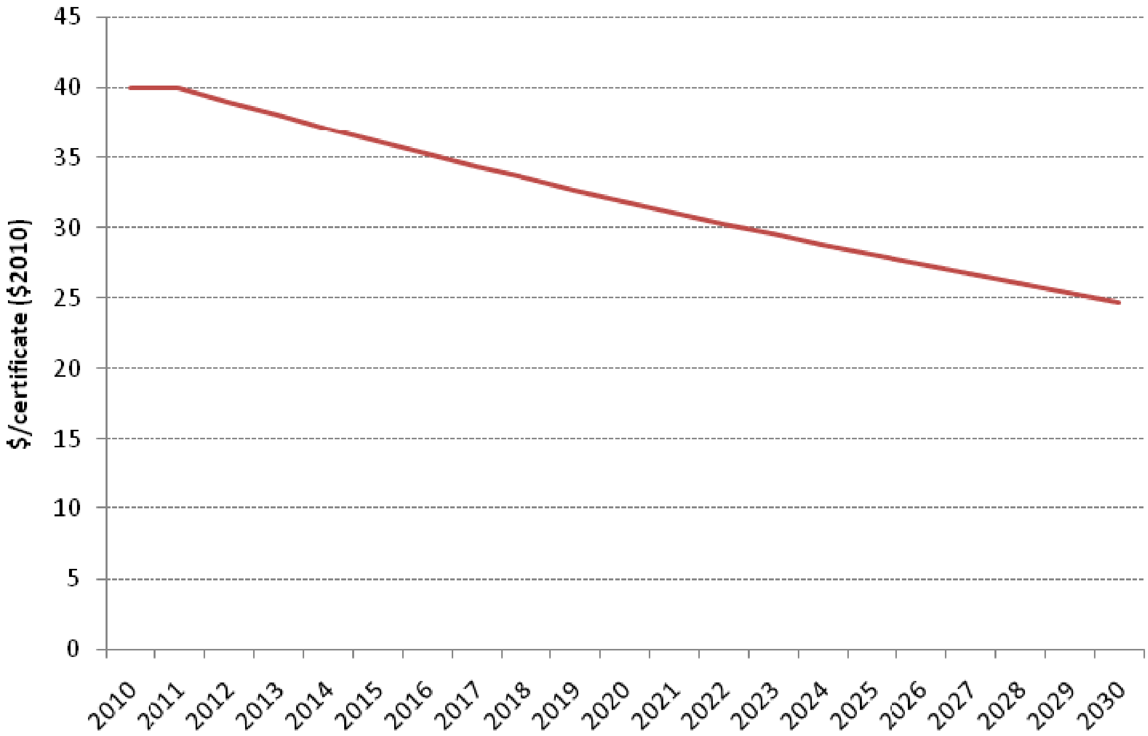
Parameter	Units	PV System	Wind System	Hydro System
System Size	kW	1.5	1.5	0.1
2010 Installed Cost	$/kW	$5,919	$6,900	$16,000
Capital Decline Factor 2010-2015	%	5.0%	2.0%	0.0%
Capital Decline Factor 2016-2020	%	5.0%	1.5%	0.0%
Capital Decline Factor 2020-2030	%	3.0%	1.0%	0.0%
Capacity Factor - Max	%	18%	38%	30%
Capacity Factor - Min	%	11%	15%	20%
Annual Energy Output - Max	kWh	2,536	4,993	263
Annual Energy Output - Min	kWh	1,708	2,168	175
Max % of total Load	%	0.010%	0.001%	0.0001%

A.8 Other revenues

Small scale renewable generators will be assumed to earn revenue from the sale of renewable energy certificates. An average system was assumed to be deemed to earn certificates equivalent to their generation levels over a 15 year period, with the value of each STC assumed to earn $40/MWh in 2011, deescalating at the inflation rate thereafter, as shown in Figure A- 4.

In addition, some customer groups are willing to adopt PV systems at above the equivalent cost of grid-supplied electricity. The value of this premium was assumed to be around $2,000.[11] This applied to additional cumulative systems installed of 30,000, after which no premium was applied.

■ Figure A- 4 STC price projections



[11] This was estimated by adjusting the premium until historical sale numbers are achieved.

Appendix B PV payback calculations

ORER requested SKM-MMA to estimate the payback period for a 1.5 kW PV system by state assuming Solar Credit multipliers of 5, 4, 3, 2 and 1. SKM-MMA assumed the installation would occur in the 2011 financial year and performed the calculation by modifying its net cost calculation, which is presented in section 5.3.4.

The components of the calculation were as follows:

- The sum of the capital cost and the installation cost
    - This was assumed to be $9,000 for a 1.5 kW system in all states and territories.
- An upfront REC/STC payment, which includes the Solar Credits multiplier
    - The assumed REC price was $39/MWh in June 2010 dollars, assuming a 2.5% CPI rate.
- Revenue from the relevant state-based feed-in-tariff
    - These are summarised in Table 4-3.
- Revenue from the export of electricity into the grid when the feed-in-tariff ceases
    - This assumes that 30% of the generated energy is diverted back into the grid. The load factor used to determine the annual generated energy varies by state and is sourced from the DOGMMA model.
- The avoided cost of electricity
    - This is based on the generated electricity used in the premises, which would be 70% if the assumption is that 30% is exported back to the grid.

As expected, the payback period was found to increase as the Solar Credits multiplier decreased. The jurisdiction with the fastest payback period was the ACT, whereas Tasmania had the slowest payback period. Eliminating the Solar Credits multiplier altogether resulted in a payback period of greater than fifteen years for all jurisdictions apart from the ACT.