Post-modelling adjustments of energy and peak demand forecasts for Endeavour Energy's long-term demand forecasts

A report
ENDEAVOUR ENERGY

Prepared by the
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1. Introduction and background

Endeavour Energy commissioned the National Institute of Economic and Industry Research (NIEIR) to prepare a report which assesses the need for, and estimates of, post-modelling adjustments for electrical energy and maximum demands.

The background and scope of works for this work is reproduced below.

1.1 Background

Endeavour Energy is one of NSW's largest state-owned energy corporations, distributing electricity network and value-added services to 933,557 customers, or 2.2 million people, in households and businesses across a network franchise spanning 24,800 square kilometres in Greater Western Sydney, the Illawarra, the Blue Mountains, Southern Highlands, and the South Coast.

Endeavour Energy is required to prepare long-term demand forecast for network planning purposes and submits the forecast to TransGrid, AEMO and the AER for their use and review. We are revising our demand forecasting techniques to adopt the industry standard methodology in terms of processes and inputs. This involves analysing historical trends in electricity demand and correlating these trends against the drivers of electricity demand. It also involves making post-model adjustments to the forecast to take into account the changes in electrical demand resulting from several energy reduction policies, programs and other drivers. While this approach produces statistically sound forecasting models, Endeavour is mindful that to improve the accuracy of demand forecasts an up-to-date understanding of the changing trends and future new drivers of consumption and technologies is required.

Endeavour Energy currently use two post-model adjustment reports produced in August 2013 and September 2013 to incorporate demand and energy adjustments into their forecast. These reports were originally produced primarily for the energy forecasts and do not present the information required in the correct format for the demand forecast adjustments or contain the sufficient background understanding of the activities that make up the numbers and that affect energy and demand reductions.

This project is seeking to produce a new Post Model Adjustment report with additional focus on peak demand and will require the consultant(s) to provide advice on the extent to which Endeavour's demand forecasts should be adjusted to reflect the impact of changing consumption/peak demand developments by policy/driver type and customer type. The consultant(s) also need to update the annual energy adjustments.

1.2 Detailed requirements

The consultant is required to provide an assessment of the annual post-model adjustments for Endeavour Energy by policy/driver type, customer type and season for both peak demand and energy consumption. The required policy/driver types are shown as an example in Attachment 1 for peak demand and Attachment 2 for energy. The energy adjustment table includes hot water (refer Attachment 2) but this is not required for peak demand adjustments. Also required as a deliverable is the background information making up the figures, a listing the source information where the data has been obtained and any assumptions made to arrive at the demand adjustments is to be included. This information should be provided in the report under the discussion for each policy/driver.

The consultant(s) will need to focus on and address potential overlaps and double counting of demand reductions resulting from each policy/driver area. For example, the EES, building energy efficiency and MEPS schemes could potentially include demand reduction statistics in their individual report that are also attributable to other areas. The consultant(s) will identify these areas and attempt to remove these effects for each policy/driver and report on their findings. Any assumptions made in the quantification of overlaps will be reported separately.

The data for energy reduction is to be provided as a per annum adjustment to the year 2025-26 (as shown is Attachment 2) and by summer and winter for annual peak demand adjustments also to 2025-26 (as shown in Attachment 1). The summer and winter peak demand data are to be in separate tables.

The data for annual peak demand adjustments is to be provided as absolute annual adjustment figures and not marginal 'above trend' adjustments which would not have been factored into the Endeavour's baseline demand. The data for annual energy adjustments is to be provided as 'above trend' adjustments. Alternatively, the absolute annual adjustment figures may be provided with the trend-line for each policy/driver area.

Endeavour will be seeking to work with the consultant(s) during the investigation to ensure a greater level of understanding of the data. This may be achieved by regular meetings or updates. The data is to be provided in spreadsheets as well as in a report.

It may be difficult to obtain the demand reduction data split into the three customer types listed in Attachment 1 or it may not be relevant for all policy/driver area. The consultant(s) may ignore the customer type in this situation, combine industrial and commercial into business or insert N/A. Other policy/driver categories may be suggested for inclusion in the analysis that the consultant(s) consider have a significant impact on demand and energy consumption in the foreseeable future.

1.3 Deliverables

A report is to be produced containing:

- a table detailing the summer and a table detailing winter demand reductions (in MW) for each policy/driver in absolute terms, as shown in Attachment 1;
- a table detailing the annual energy reduction for each policy/driver in above trend terms, as shown in Attachment 2;
- models/methods used to estimate the past and future impacts on electricity demand and energy from each policy/driver and the assumptions used in the analysis;
- results of the above models/methods for estimating the impacts on electricity demand and energy;
- a commentary on the economic, regulatory, environmental, social and technological impacts on future electricity demand and energy and the assumptions used for the analysis;
- a commentary on the material and documents reviewed and assumptions made for each policy/driver;
- review of the validity of past figures provided and areas of potential double counting; and
- tables of results to also be provided in spreadsheets.

Also required are regular updates during the report development in for form of meetings or emails.

The report is to be completed in 6 to 8 weeks. If a longer period is required please indicate in your submission.

1.4 Evaluation criteria

We will assess quotations on the basis of their value for money proposition and evaluation criteria set out below (not listed in any order of preference):

(a) a demonstrated knowledge of energy efficiency programs, particularly government implemented policy and programs;

(b) a demonstrated capability to interpret and analyse data to determine the required information;

(c) company resources and experience; and

(d) an efficient approach and methodology for analysing data.

Attachment 1

<table>
<tr><th colspan="7">Table 1.1 Recommended post-modelling peak demand adjustments for Endeavour Energy</th></tr>
<tr><th colspan="2">Policy/Driver area</th><th colspan="5">Recommended post-modelling adjustments to demand forecasts
Summer/Winter (MW)</th></tr>
<tr><th colspan="2">2017 means Summer 2016-17 ----------→</th><th>2017</th><th>2018</th><th>2019</th><th>Each year ----------→</th><th>2026</th></tr>
<tr><td rowspan="3">NSW Energy Savings Scheme (ESS)</td><td>Commercial</td><td>xxx</td><td>xxx</td><td>xxx</td><td>………. xxx ……….</td><td>xxx</td></tr>
<tr><td>Industrial[1]</td><td>xxx</td><td>xxx</td><td>xxx</td><td>………. xxx ……….</td><td>xxx</td></tr>
<tr><td>Residential[1]</td><td>xxx</td><td>xxx</td><td>xxx</td><td>………. xxx ……….</td><td>xxx</td></tr>
<tr><td>Building energy efficiency standards</td><td rowspan="5">Same details as in the above ESS template row are required for each policy/driver area.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Minimum energy performance standards (MEPS)</td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Other area[2]</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Note 1: The consultant will be provided with Endeavour Energy's historical demand data to provide a guide in allocating the recommended post-modelling impacts across customer segment categories.

Note 2: Include other energy reducing programs or technologies you consider significant.

Attachment 2

Table 1.2	Recommended post-modelling energy adjustments for Endeavour Energy					
Policy/Driver area		**Recommended post-modelling adjustments to energy forecasts** **Annual (GWh)**				
2017 means financial year 2016-17 ----------→		**2017**	**2018**	**2019**	**Each year ----------→**	**2026**
NSW Energy Savings Scheme (ESS)	Commercial	xxx	xxx	xxx	………. xxx ……….	xxx
	Industrial[1]	xxx	xxx	xxx	………. xxx ……….	xxx
	Residential[1]	xxx	xxx	xxx	………. xxx ……….	xxx
Building energy efficiency standards	**Same details as in the above ESS template row are required for each policy/driver area.**					
Minimum energy performance standards (MEPS)						
Solar PV impact						
Electric vehicle (EV) penetration						
Electric hot water						
Other area[2]						

Note 1: The consultant will be provided with Endeavour Energy's historical energy consumption to provide a guide in allocating the recommended post-modelling impacts and across customer segment categories. Endeavour Energy requires that the impacts be allocated across the following tariff categories:

- Residential consisting of Domestic and Controlled Load,
- Commercial consisting of General Supply Non TOU, General Supply TOU and Unmetered Supply; and
- Industrial consisting of Low Voltage TOU Demand, High Voltage TOU Demand, Sub-transmission TOU Demand and Bulks & Inter-distributors.

Officers from Endeavour Energy will work closely with the consultant to achieve this detailed allocation.

Note 2: Include other energy reducing programs or technologies you consider significant.

1.5 Summary of results

Table 1.3 Summary table: Recommended post-modelling adjustments to energy forecasts – Annual (GWh)

Policy driver area		Financial years 2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
NSW Energy Savings Scheme (ESS)	Commercial	283.9	325.2	351.8	365.7	363.7	345.6	311.1	290.0	266.7	257.0	159.4
	Industrial	55.3	68.1	81.2	94.8	106.9	117.2	126.2	132.7	136.4	140.9	88.9
	Residential	29.5	49.2	77.2	113.7	153.7	196.0	243.0	274.7	298.9	318.4	202.4
Building energy efficiency standards	Commercial	-	-	-	-	-	-	-	-	-	-	-
	Industrial	-	-	-	-	-	-	-	-	-	-	-
	Residential	-	-	-	-	-	-	-	-	-	-	-
Minimum Energy Performance Standards (MEPS)	Commercial	-	-	-	-	-	-	-	-	-	-	-
	Industrial	-	-	-	-	-	-	-	-	-	-	-
	Residential	-	-	-	-	-	-	-	-	-	-	-
Solar PV impact	Commercial	0.4	1.0	1.6	2.2	2.9	3.6	4.4	5.1	6.0	6.7	7.4
	Industrial	0.8	1.8	2.9	4.0	5.2	6.5	7.8	9.2	10.7	12.1	13.3
	Residential	28.8	95.3	167.9	202.1	232.5	262.3	291.0	320.4	350.6	381.6	413.4
Battery storage	Commercial	0.0	0.1	0.3	0.6	1.1	1.7	2.3	2.9	3.5	4.1	4.7
	Industrial	0.1	0.2	0.5	1.1	1.9	3.0	4.1	5.2	6.3	7.4	8.5
	Residential	0.0	2.3	7.0	13.8	23.1	32.9	43.2	54.0	65.2	76.8	88.9
Electric vehicle (EV) penetration	Commercial	- 0.3	- 0.9	- 1.7	- 2.8	- 4.9	- 8.3	- 13.0	- 19.6	- 25.5	- 37.6	- 51.8
	Industrial	-	-	- 0.1	- 0.1	- 0.5	- 0.7	- 1.0	- 1.4	- 1.9	- 2.8	- 3.8
	Residential	- 1.1	- 2.0	- 3.5	- 5.6	- 9.1	- 13.4	- 18.6	- 24.7	- 35.3	- 51.9	- 71.6
	Commercial	**284.0**	**325.5**	**352.1**	**365.7**	**362.8**	**342.6**	**304.8**	**278.5**	**250.6**	**230.2**	**119.8**
	Industrial	**56.2**	**70.2**	**84.5**	**99.7**	**113.6**	**126.0**	**137.2**	**145.8**	**151.6**	**157.6**	**106.9**
	Residential	**57.2**	**144.8**	**248.6**	**324.0**	**400.3**	**477.8**	**558.6**	**624.3**	**679.4**	**724.9**	**633.1**
	Total	**397.4**	**540.5**	**685.2**	**789.4**	**876.7**	**946.4**	**1,000.6**	**1,048.6**	**1,081.6**	**1,112.7**	**859.8**

Table 1.4 Summary table: Recommended post-modelling adjustments to energy forecasts – Summer (MW)												
		Financial years										
Policy driver area		**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
NSW Energy Savings Scheme (ESS)	Commercial	11.2	12.8	13.9	14.4	14.3	13.6	12.3	11.4	10.5	10.1	6.3
	Industrial	1.6	1.9	2.3	2.7	3.0	3.3	3.6	3.8	3.9	4.0	2.5
	Residential	1.1	1.8	2.8	4.1	5.5	7.0	8.7	9.9	10.7	11.4	7.3
Building energy efficiency standards	Commercial		-	-	-	-	-	-	-	-	-	-
	Industrial		-	-	-	-	-	-	-	-	-	-
	Residential		-	-	-	-	-	-	-	-	-	-
Minimum Energy Performance Standards (MEPS)	Commercial		-	-	-	-	-	-	-	-	-	-
	Industrial		-	-	-	-	-	-	-	-	-	-
	Residential		-	-	-	-	-	-	-	-	-	-
Solar PV impact	Commercial	0.4	0.6	0.8	0.9	1.2	1.4	1.6	1.8	2.1	2.3	2.5
	Industrial	0.7	1.0	1.4	1.7	2.1	2.5	2.9	3.3	3.7	4.1	4.4
	Residential	64.7	73.1	82.0	90.7	99.8	108.1	116.6	125.3	134.3	143.5	152.9
Battery storage	Commercial	0.0	0.0	0.1	0.1	0.2	0.4	0.5	0.6	0.7	0.9	1.0
	Industrial	0.0	0.1	0.2	0.3	0.4	0.6	0.9	1.1	1.3	1.6	1.8
	Residential	0.0	0.9	2.6	5.0	8.2	11.4	14.6	17.7	20.9	24.1	27.3
Electric vehicle (EV) penetration	Commercial	- 0.1	- 0.3	- 0.6	- 1.0	- 1.7	- 2.9	- 4.8	- 7.5	- 9.7	- 14.5	- 20.3
	Industrial	-	-	- 0.0	- 0.0	- 0.1	- 0.2	- 0.3	- 0.4	- 0.6	- 0.8	- 1.2
	Residential	- 0.2	- 0.3	- 0.5	- 0.8	- 1.3	- 2.0	- 2.8	- 3.8	- 5.5	- 8.1	- 11.4
	Commercial	**11.5**	**13.2**	**14.2**	**14.6**	**14.1**	**12.4**	**9.5**	**6.4**	**3.6**	**- 1.2**	**- 10.5**
	Industrial	**2.3**	**3.0**	**3.8**	**4.6**	**5.4**	**6.2**	**7.0**	**7.7**	**8.4**	**8.8**	**7.6**
	Residential	**65.6**	**75.5**	**86.9**	**98.9**	**112.2**	**124.5**	**137.1**	**149.2**	**160.5**	**170.9**	**176.1**
	Total	**79.4**	**91.7**	**104.8**	**118.1**	**131.7**	**143.1**	**153.6**	**163.3**	**172.5**	**178.5**	**173.2**

Table 1.5 Summary table: Recommended post-modelling adjustments to energy forecasts – Winter (MW)

Policy driver area		Financial years										
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
NSW Energy Savings Scheme (ESS)	Commercial	14.0	16.0	17.3	18.0	17.9	17.0	15.3	14.3	13.1	12.7	7.9
	Industrial	2.1	2.6	3.1	3.6	4.0	4.4	4.8	5.0	5.1	5.3	3.4
	Residential	3.2	5.3	8.3	12.2	16.5	21.1	26.1	29.5	32.1	34.2	21.8
Building energy efficiency standards	Commercial		-	-	-	-	-	-	-	-	-	-
	Industrial		-	-	-	-	-	-	-	-	-	-
	Residential		-	-	-	-	-	-	-	-	-	-
Minimum Energy Performance Standards (MEPS)	Commercial		-	-	-	-	-	-	-	-	-	-
	Industrial		-	-	-	-	-	-	-	-	-	-
	Residential		-	-	-	-	-	-	-	-	-	-
Solar PV impact	Commercial		-	-	-	-	-	-	-	-	-	-
	Industrial		-	-	-	-	-	-	-	-	-	-
	Residential		-	-	-	-	-	-	-	-	-	-
Battery storage	Commercial	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.3
	Industrial	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.4	0.4	0.5	0.6
	Residential	0.0	0.3	0.9	1.7	2.7	3.8	4.9	5.9	7.0	8.0	9.1
Electric vehicle (EV) penetration	Commercial	- 0.1	- 0.2	- 0.4	- 0.7	- 1.2	- 2.1	- 3.5	- 5.4	- 7.0	- 10.5	- 14.6
	Industrial	-	-	- 0.0	- 0.0	- 0.1	- 0.1	- 0.2	- 0.3	- 0.4	- 0.6	- 0.8
	Residential	- 0.2	- 0.3	- 0.5	- 0.9	- 1.4	- 2.1	- 3.0	- 4.0	- 5.8	- 8.7	- 12.1
	Commercial	**13.9**	**15.8**	**17.0**	**17.4**	**16.8**	**15.0**	**12.0**	**9.1**	**6.4**	**2.5**	**- 6.4**
	Industrial	**2.1**	**2.6**	**3.1**	**3.7**	**4.1**	**4.5**	**4.8**	**5.1**	**5.2**	**5.2**	**3.1**
	Residential	**3.0**	**5.3**	**8.6**	**13.0**	**17.8**	**22.7**	**28.0**	**31.4**	**33.3**	**33.6**	**18.7**
	Total	**19.0**	**23.7**	**28.7**	**34.1**	**38.7**	**42.2**	**44.8**	**45.6**	**44.8**	**41.3**	**15.4**

2. Methodological approach to post-modelling adjustments for Endeavour Energy

2.1 Post-modelling adjustments

Electricity demands are influenced by a very diverse range of factors including (among others):

- economic factors: economic activity, income;
- demographic factors: population, household formation growth;
- energy market factors: price of electricity and other fuel sources;
- technological and lifestyle factors: dwelling and appliance energy efficiency and use;
- weather factors: temperature; and
- government policies factors: energy and environmental initiatives and programs.

In most part, the models used by NIEIR capture the main drivers of underlying electricity demand. Ongoing government policies and recent new technologies may already fully captured within historical trends. In this case, no adjustment will be required to the underlying models. However, some government initiatives and technological developments may not be fully reflected in the models. This is because for a variety of reasons these factors don't easily fit in an econometric equation.[1] Accordingly, results from the econometric modelling may need to be adjusted to ensure that the impacts of these factors are adequately reflected.[2]

There are some factors that are new or likely to change going forward that need to be accounted in forecasts; it is these factors that are the primary focus of post-modelling adjustments. The figure below illustrates the conceptual basis for the post-modelling adjustments.

Electricity demand is unusually different to the demand for many other goods and services. Electricity by itself does not provide any utility to consumers. Electricity is only useful in conjunction with the operation of a purchased electrical appliance or equipment. Hence, electricity demand cannot be viewed in isolation from the electrical equipment in use and the circumstances the equipment is used for (for instance, cooling or heating).

Changes in the stock and the technology of the electrical equipment can have a significant effect on the level of electricity demand over time. Government policies often aim to impact level of electricity demand by influencing the choice of technologies available to electricity consumers. The figure below illustrates the interaction between selected policy measures and technologies. This complex interaction between technology and policy measure makes distinguishing the impact of the policy measures from on-going developments difficult.

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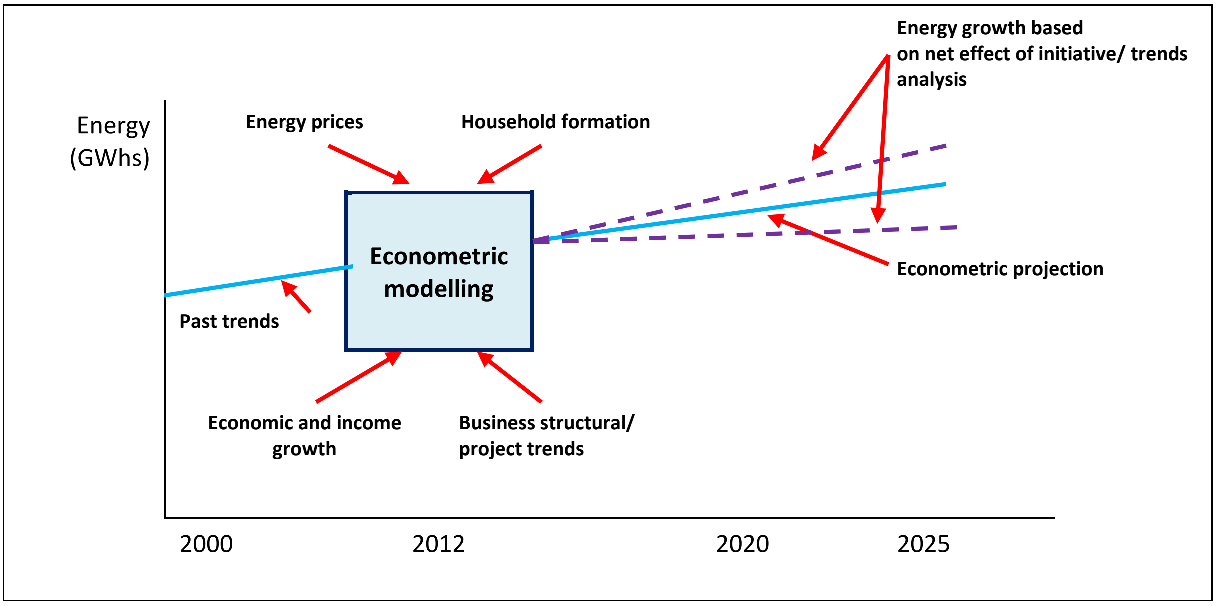
[1] For instance, there may be limited statistical information or historical profiles do not provide a representative guide to future movements.

[2] These types of modelling issues are common to most modelling exercises and certainly common to most electricity demand modelling and forecasting; these are not issues particular to the models and forecasts in this study. All econometric models are a simplified representation of a far more complex relationship between a variable of interest and its underlying factors.



Consumer demand for a specific appliance technology will evolve over time in response to a range of factors including the price, household income, the design and functionality of the technology (and its close substitutes) as well as government initiatives impacting its uptake or use. Disentangling and separating the impacts of each of these factors is difficult given the limited consumer-level information appliance purchase and use.

NIEIR has conducted detailed analyses of potential overlap areas, carefully considered and addressed **potential overlaps and double counting** of demand and energy impacts resulting from policy drivers. Areas where this is a particular concern are the NSW Energy Efficiency Scheme (EES), the Federal Emissions Reduction Fund (ERF), building energy efficiency (BASIX) and MEPS/GEMS. These policies/programs potentially include demand reduction and energy reduction estimates in their individual reports, often without impact attributions. Where applicable, NIEIR has removed these areas of double counting.

Also reported on are the effects of additionality (beyond business-as-usual) impacts of measures, rebound (energy user response to measures and compliance with measures (particularly important for new residences under BASIX): non-compliance will reduce the demand and energy reduction impacts of measures.

Data for annual peak demand adjustments, was as required by Endeavour, provided in **absolute** annual adjustment figures and **NOT** marginal 'above trend' adjustments which would not have been factored into Endeavour's baseline demand. For example, the demand impacts (in cohort MWs) for plug-in electric vehicles (PEVs) are for the entire stock of vehicles charging coincident to Endeavour peak demand.

The data for annual energy adjustments are provided as 'above trend' adjustments. In the case of PEVs, the annual energy adjustment is close to both absolute and above trend as PEV penetration is currently so low.

NIEIR notes that in Attachments 1 and 2 the listing of Policy/Driver areas does not include electricity storage which, although probably associated with solar PV, need not be: that is, grid electricity could be stored if permitted by the regulatory regime.

In New South Wales under the gross Feed-in-tariff (FIT) regime the FIT would apply to all PV generation (or other self-generation) and own-use (behind-the-meter) would be purchased from the grid. If the regulatory regime permitted self-generation storage, grid demands would be reduced and a PMA could be estimated. The impact of storage on net meters also requires PMA calculation. NIEIR has a storage model and notes that AEMO has made storage estimates for the NEM, including New South Wales (1,043 MWh and 209.6 MW, summer in 2024-25). NOTE also that if storage of self-generation were permitted in New South Wales this would likely stimulate an increase in PV beyond a no storage scenario.

Over very many years, NIEIR has built up considerable expertise analysing government policy measures and how they impact electricity demand. NIEIR continually monitors and assesses existing and new policy initiatives. Each policy initiative is reviewed on case-by-case basis with a focus on their interaction with consumer technologies.

A review of a policy initiative typically encompasses a forensic-type analysis of the available data on the policy including the expected energy savings announced with policy and any studies to supporting the announced savings. It also encompasses an examination of the available literature in Australia and overseas on comparable policy initiatives. Also where possible, the policy initiatives may be analysed with a cost-benefit model of consumer's response to the specific initiative.

A special focus is also given to compliance issues around the policy initiative. Many programs are sometimes lightly monitored for their effectiveness to deliver the announced energy savings. New building standards are a good example of this. In light of this, a comprehensive review of the performance of past programs is undertaken. The findings into this review are taken into consideration when developing estimates of the impact of the policy initiative on electricity demand.

NIEIR has reviewed the need for the following post-modelling adjustments for energy, summer and winter peak demands for the Endeavour Region. A post-modelling adjustment is only estimated for each program and/or technology if it is required upon program review.

- New South Wales Energy Savings Scheme (ESS);
- Building Energy Efficiency Standards;
- Minimum Energy Performance Standards and Greenhouse Energy Minimum Standards;
- photovoltaics systems and battery storage;
- plug-in electric vehicles;
- lighting (not covered by ESS); and
- hot water.

NIEIR has also reviewed other government programs, technological developments and changes in the electricity industry that have the potential to influence future electricity demand. Other programs and developments include:

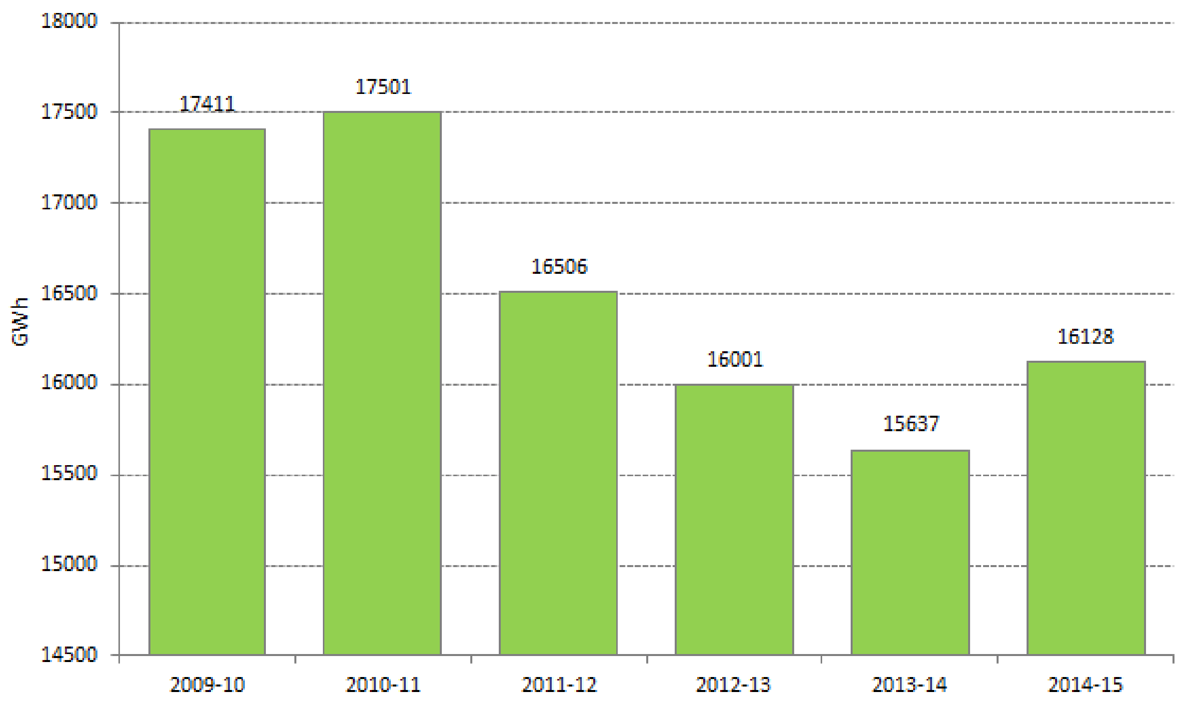
- the Emissions Reduction Fund;
- Commercial Building Disclosure Program; and
- cost reflective pricing.

Post-modelling adjustments are allocated across residential, commercial and industrial customer segments by reviewing each program and using customer and energy data supplied by Endeavour Energy as a guide.

2.2 Endeavour Energy sales

Figure 2.1 shows total Endeavour Energy electricity sales over the period 2009-10 to 2014-15.

Figure 2.1: Total Endeavour Energy electricity sales – 2009-10 to 2014-15

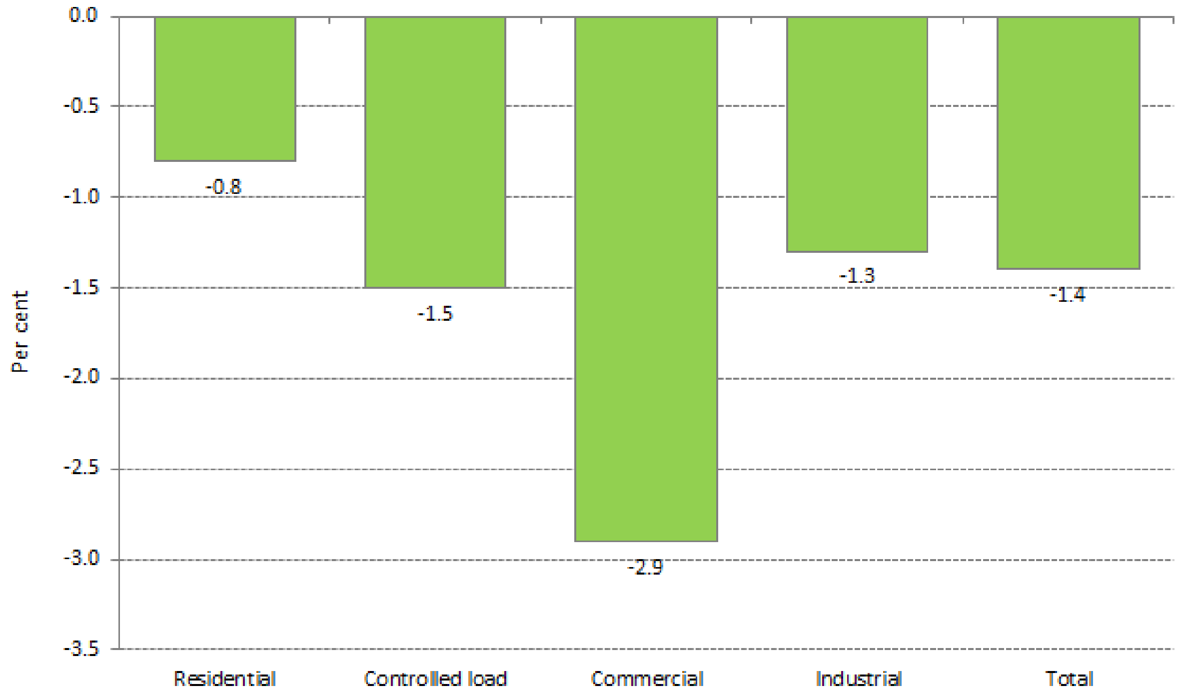


Over the last five years, Endeavour Energy electricity sales have fallen some 1,280 GWh, or at a rate of 1.5 per cent per annum. Table 2.1 shows Endeavour Energy electricity sales on an actual and weather normalised basis by class.

Table 2.1	Actual and weather normalised electricity sales by class – Endeavour Energy – 2009-10 to 2014-15 (GWh)					
	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Actual sales						
Domestic	4872	4878	4506	4467	4288	4619
Controlled Load	961	978	990	900	859	889
Dom & CLd	5833	5857	5496	5367	5147	5509
General Supply Non TOU	1928	1843	1801	1741	1690	1679
General Supply TOU	379	322	313	317	336	305
Unmetered -	157	127	119	142	144	141
Commercial	2463	2292	2233	2200	2169	2125
Low Voltage TOU Demand	3367	3441	3438	3480	3456	3568
High Voltage TOU Demand	1740	1774	1629	1663	1637	1617
Bulk & Inter-distributor Transfer	1961	2029	1589	1429	1376	1443
Sub Transmission TOU Demand	2047	2109	2120	1862	1852	1866
Industrial	9115	9353	8777	8434	8321	8494
Total	**17411**	**17501**	**16506**	**16001**	**15637**	**16128**
Weather normalised sales						
Domestic	4742	4745	4527	4429	4332	4565
Controlled Load	961	978	990	900	859	889
Dom & CLd	5703	5723	5517	5329	5191	5454
General Supply Non TOU	1916	1830	1803	1737	1694	1674
General Supply TOU	375	319	314	316	337	304
Unmetered -	157	127	119	142	144	141
Commercial	2448	2276	2236	2196	2175	2118
Low Voltage TOU Demand	3340	3413	3443	3472	3465	3557
High Voltage TOU Demand	1740	1774	1629	1663	1637	1617
Bulk & Inter-distributor Transfer	1961	2029	1589	1429	1376	1443
Sub Transmission TOU Demand	2047	2109	2120	1862	1852	1866
Industrial	9087	9324	8781	8426	8330	8482
Total	**17238**	**17323**	**16534**	**15951**	**15695**	**16054**

On a weather normalised basis total sales fell by 1.4 per cent between 2009-10 and 2014-15. Figure 2.2 shows the percentage decline in sales over this five year period by class for Endeavour Energy.

Figure 2.2: Annual average percentage change in Endeavour Energy electricity sales by class – 2009-10 to 2014-15



The absolute decline in sales between 2009-10 and 2014-15 was some 1,184 GWh. The industrial sector accounted for 51 per cent of this decline, commercial 28 per cent and residential and controlled load 21 per cent. Industrial sales over the period partly reflects some major load losses and closures.

Weather normalised sales on a per customer basis is shown in Table 2.2. As indicated in Table 2.2, domestic average usage has fallen from 6,046 kWh per customer to 5,406 kWh per customer, partly reflecting the lagged impact of high electricity prices, increasing PV penetration, energy savings schemes and a shift in the dwelling stock from houses to townhouses and apartments.

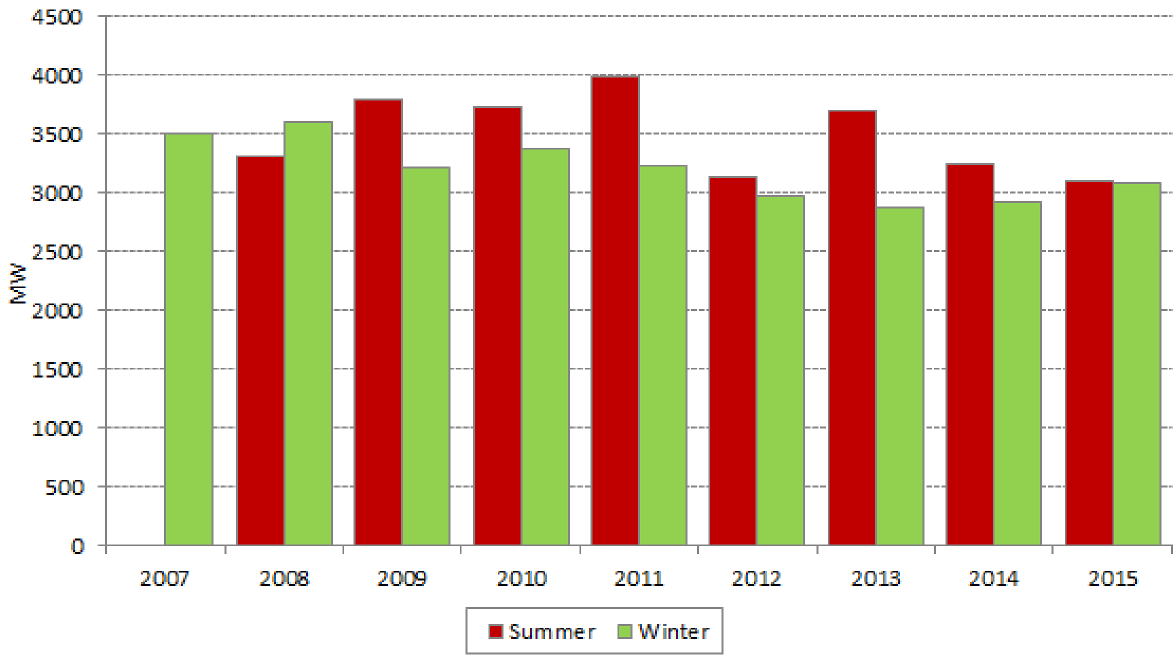
Average commercial and industrial sales per customer have also fallen significantly over the last five years for Endeavour Energy.

Table 2.2	Average weather normalised sales per customer by class – Endeavour Energy – 2009-10 to 2014-15 (kWh)						
	2009-10	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**Percentage change**
Weather normalised sales per customer							
Domestic	6,046	5,981	5,665	5,455	5,213	5,406	-2.22
Controlled Load	2,794	2,858	2,917	2,640	2,505	2,602	-1.41
Dom & CLd	7,271	7,214	6,904	6,563	6,246	6,459	-2.34
General Supply Non TOU	26,166	24,782	24,282	23,042	21,877	21,814	-3.57
General Supply TOU	172,590	149,580	147,109	141,190	139,300	117,675	-7.37
Unmetered -	11,249,979	11,280,607	18,285,668	26,279,926	9,425,323	8,479,957	-5.50
Commercial	32,461	29,949	29,264	28,281	27,228	26,710	-3.82
Low Voltage TOU Demand	913,579	857,145	841,372	833,890	824,637	808,498	-2.41
High Voltage TOU Demand	6,583,929	6,521,140	5,896,482	6,005,868	5,909,732	5,837,001	-2.38
Bulk & Inter-distributor Transfer	245,145,860	253,628,684	198,674,523	178,600,153	172,010,311	180,346,488	-5.95
Sub Transmission TOU Demand	38,375,361	36,250,995	33,690,762	29,252,197	28,635,517	27,042,753	-6.76
Industrial	2,282,549	2,158,548	1,978,105	1,867,382	1,830,073	1,784,572	-4.80
Total	**19,958**	**19,830**	**18,791**	**17,839**	**17,144**	**17,291**	**-2.83**

2.3 Endeavour Energy network peak demand

Figure 2.3 shows the summer and winter peak demands for the Endeavour Energy network. With the exception of 2008, annual peak demand has occurred during summer over the 2008 to 2015 period.

Figure 2.3: Summer and winter peak demand – Endeavour Energy (MW)



Source: Endeavour Energy half-hourly demand.

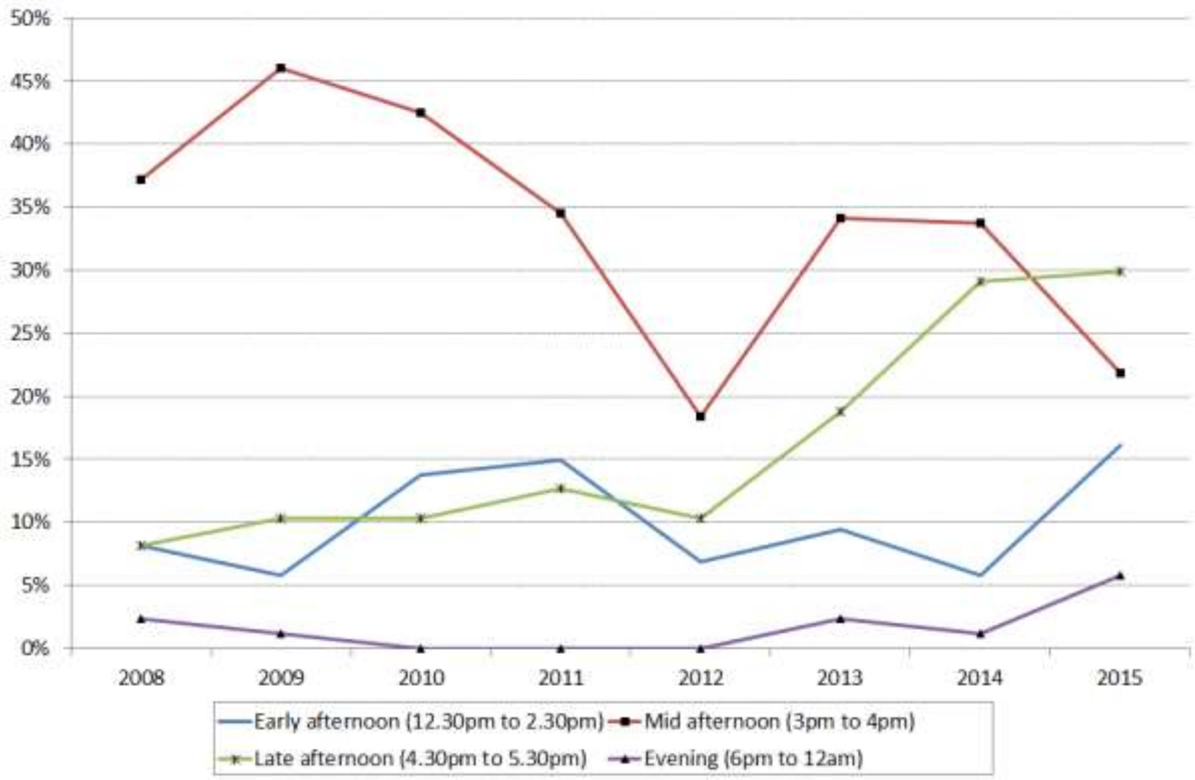
Table 2.3 shows the most recent summer peak demand events to have occurred in the Endeavour Energy region alongside timing and temperature. The highest peak occurred in 2010-11 with a demand of 3,995 MW. The day reached a hot maximum of 41.6 degrees, and followed an equally hot day with the previous day average temperature of 29.3 degrees. The smallest peak occurred over 2014-15 of 3,107, during a mild summer and mild peak day with a maximum temperature of 32.2 degrees.

Post-modelling adjustments for peak demand must assume a particular time that peak demand occurs for each season. This may include the potential for a changing peak time. Summer peak demand events since 2010-11 for the Endeavour Energy network have typically occurred in the afternoon at 4.30 pm. Over 2007-08 to 2009-10 the summer peak demand has occurred most frequently at 4.00 pm. This suggests the Endeavour Energy summer peak demand may have already shifted by about half an hour since 2007-08, but is difficult to determine based on the top peak alone. This could be a response to the large number of PV systems installed in New South Wales over 2010 and 2011. As more PV systems are installed, more electricity demand is met at the household and business level, which reduces demand from the grid. Generally, PV generation decreases throughout the afternoon, such that there is less PV generating at 4.30pm than there was at 4.00pm. All else being equal, this has the potential to shift peak demand from the Endeavour Network to a later time interval. While new installations of PV systems have continued in NSW, they have not reached the same levels since 2011 (in number or capacity installed in a calendar year).

Table 2.3	Observed maximum demand for recent summers						
		Endeavour Energy		Temperature (Degrees Celsius)			
Summer	Date	Demand (megawatts)	Time	Max	Min	Ave	Ave (t-1)
2014-15	Friday, 23 January 2015	3,107	4:30 PM	32.2	21.1	26.7	25.0
2013-14	Friday, 20 December 2013	3,250	4:30 PM	40.1	17.6	28.9	22.5
2012-13	Friday, 18 January 2013	3,694	3:30 PM	46.1	20.5	33.3	25.0
2011-12	Monday, 30 January 2012	3,125	4:30 PM	32.9	21.8	27.4	23.4
2010-11	Tuesday, 1 February 2011	3,995	4:30 PM	41.6	20.4	31.0	29.3
2009-10	Thursday, 17 December 2009	3,722	4:00 PM	41.2	19.9	30.6	26.2
2008-09	Friday, 6 February 2009	3,798	4:00 PM	35.6	22.4	29.0	28.2
2007-08	Thursday, 31 January 2008	3,313	3:30 PM	32.2	21.0	26.6	26.5

By definition maximum demand occurs only once over summer, so it can be difficult to make an assessment of the potential for peak shifting based on the top peak alone. To further investigate the timing of the historical peaks, NIEIR has calculated daily peaks across each summer weekday. The results for summer afternoons are summarised in Figure 2.4.

Figure 2.4: Share of daily summer weekday peak demands (per cent)



Notes:

1. The summer season represented in this figure is extended, December through to March. Total weekdays during summer are on average around 87 days per season.
2. Daily peaks prior to the 12.30pm interval are not shown. In 2015 these accounted for around 23 per cent of total daily summer peaks.

The most prevalent trend is the shifting from mid-afternoon peaks toward late afternoon peaks from 2008 to 2015. In 2009, 46 per cent of daily peaks occurred across the 3:00 pm and 4:00 pm intervals, while only around 10 per cent of peaks occurred in between 4:30 pm and 5:30 pm.

The proportion of late afternoon peaks has accelerated from close to 10 per cent in 2012 toward 30 per cent in 2015. The 2015 summer was the first to have a greater proportion of peaks occur in the late afternoon than during the mid-afternoon. In 2015, only 22 per cent of peaks occurred between 3pm and 4:00 pm. This provides further support that summer peak demand has shifted to later in the day.

In contrast, winter peak demand has consistently peaked at either 6.00 pm or 6.30 pm without any signs of historical peak shifting. This is due to low light conditions, and therefore negligible PV generation at winter peak. Table 2.4 summarises the historical winter peak demands for Endeavour Energy. Overall, there appears to be a downward trend in the non-weather corrected winter peaks from 2008. The Endeavour Network has peaked at around 3,000 MW on average over the past five winters.

Table 2.4 Observed maximum demand for recent winters

Winter	Date	Endeavour Energy Demand (megawatts)	Time	Temperature (Degrees Celsius) Max	Min	Ave	Ave (t-1)
2015	Thursday, 16 July 2015	3,090.09	6:30 PM	12.30	6.50	9.40	8.85
2014	Monday, 11 August 2014	2,916.71	6:30 PM	15.00	2.60	8.80	13.65
2013	Monday, 24 June 2013	2,871.94	6:00 PM	13.90	9.50	11.70	11.85
2012	Tuesday, 5 June 2012	2,974.63	6:00 PM	16.00	7.80	11.90	16.20
2011	Tuesday, 19 July 2011	3,230.43	6:30 PM	14.80	3.00	8.90	12.80
2010	Tuesday, 29 June 2010	3,371.65	6:30 PM	13.90	-0.30	6.80	9.00
2009	Monday, 6 July 2009	3,218.16	6:30 PM	15.50	1.60	8.55	11.00
2008	Monday, 28 July 2008	3,607.46	6:30 PM	13.70	5.00	9.35	9.15

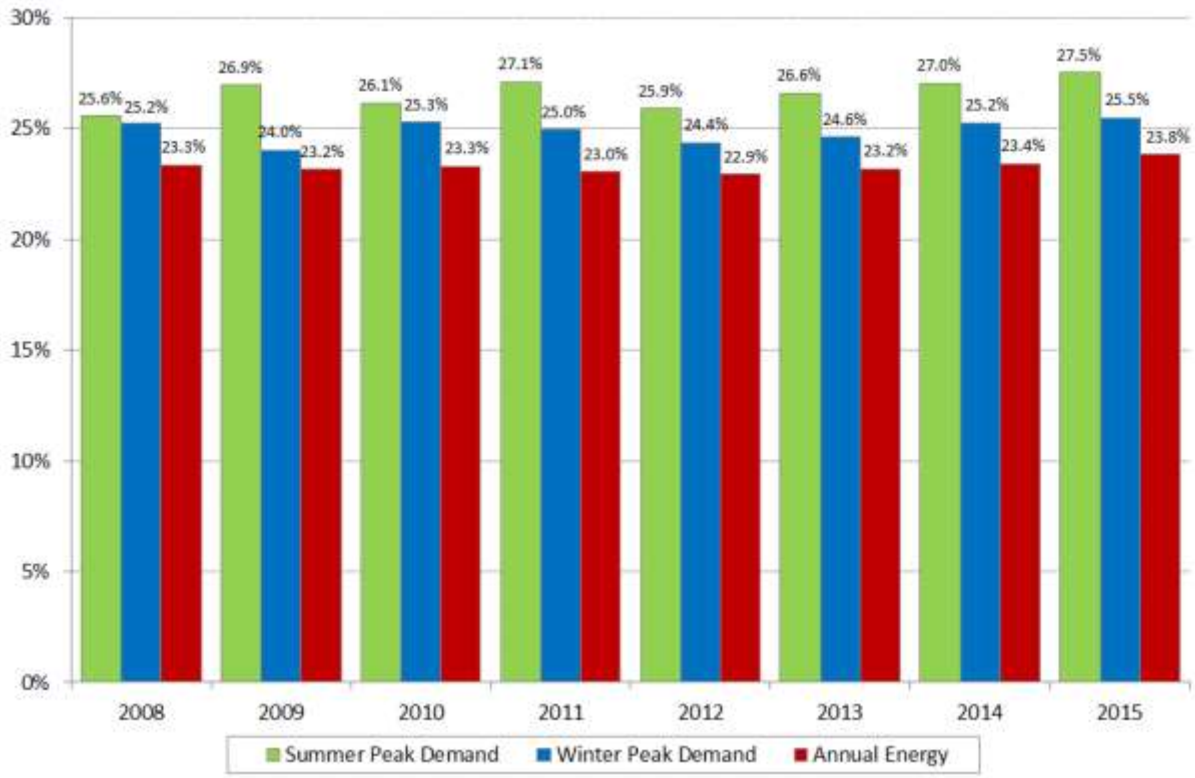
2.4 Endeavour and New South Wales electricity demand

Where it is difficult to estimate regional impacts for new policy and technology, post-modelling adjustments are estimated at the New South Wales state level and attributed according to the Endeavour share of New South Wales energy.

Figure 2.5 shows the share of summer and winter peak demand for Endeavour Energy, coincident to New South Wales operational demand. On average, Endeavour Energy accounts for 26.6 per cent of summer maximum demand, and 24.9 per cent of winter maximum demand.

Figure 2.5 also shows the proportion of annual energy consumption that is attributable to the Endeavour Energy Network. Endeavour Energy accounts for 23.3 per cent of New South Wales energy consumption on average. These proportions have not been adjusted for major loads which are likely unaffected by major policies and new technology. These have also not been adjusted for transmission customers, embedded generation or losses; as such these shares are used only as an initial guide. Regulatory Information Notices (RIN) responses from Ausgrid, Endeavour Energy and Essential Energy suggest an average annual share of around 29 per cent of annual delivered energy. Where applicable, NIEIR have assumed a discounted proportion of a 26.5 per cent share for Endeavour Energy.

Figure 2.5: Endeavour Energy shares of demand



Source: Endeavour Energy and AEMO.

3. Small scale photovoltaic (PV) systems and battery storage

This section outlines the projections for small scale photovoltaic systems (PV) and battery storage for Endeavour Energy to 2025-26. The continuing steady take-up of PV by both the residential and commercial sectors in New South Wales will have significant impacts of forecast energy and peak demands.

Battery storage is a new technology currently being introduced into Australian energy markets. The take-up of this technology is expected to be quite slow given the capital costs and the lack of any incentives to date.

3.1 PV in New South Wales – Background

In New South Wales, the Solar Bonus Scheme (SBS) was introduced on 1 January 2010. The Scheme provides a feed-in-tariff (FIT) for small solar and wind generators that are connected to the grid.

The Solar Bonus Scheme offered a tariff for electricity exported to the grid, both 'gross' and 'net' tariffs. Customers under a gross tariff are paid for all the electricity produced and exported by their renewable energy generator. These customers are separately metered for their own 'in-house' usage. Customers under a net tariff are paid for only the net electricity exported by their renewable energy generator. That is, when generation exceeds in-house usage. The choice of gross or net metering is left to the customer.

Customers eligible to participate in the Solar Bonus Scheme are known as small retail customers (sometimes referred to as mass market). These are customers with an annual electricity consumption of less than 160 megawatt hours per year. Solar photovoltaic (PV) systems or wind turbines (up to 10 kW in capacity) that connect through an inverter were eligible for the Scheme.

In October 2010, the former New South Wales Government announced changes to the Solar Bonus Scheme. The Government reduced the feed-in-tariff from 60 cents to 20 cents and introduced a scheme capacity limit of 300 MW.

The New South Wales Solar Bonus Scheme was closed to new applicants in 2011. Customers who applied to join the Scheme by 28 April 2011 were still eligible to join provided their renewable generator was connected by 30 June 2012. This only applied to customers who lodged an application to connect by 28 April 2011.

With the conclusion of the Solar Bonus Scheme payments on 31 December 2016, customers will migrate from gross to net tariffs. This could result in an increase in the 'in-house' usage by customers who participated in the SBS as they shift from gross to net metering for their solar power system. This would impact the revenue of distribution businesses.

New (post-11 April) PV applicants can negotiate a tariff for exports to the grid with a retailer.

3.2 PV data – customers, capacity, generation

Endeavour provided data on a monthly basis covering customers, generation and capacity. It included a split between the SBS and non-SBS customers. A split between gross and net was also provided, as well as a split between the 60 cents and 20 cents feed-in-tariffs. The data was also provided by tariff class, enabling a split between residential and business PV to be made for Endeavour Energy.

The data provided was quite satisfactory and robust, and covered the July 2006 to December 2015 period.

3.3 Modelling methodology for PV

NIEIR's approach to modelling PV for Endeavour is explained below. For PV, five types of customers were modelled. These included:

- SBS 60 cents gross customers;
- SBS 60 cents net gross customers;
- SBS 20 cents gross customers;
- SBS 20 cents net customers; and
- non-SBS customers.

As the SBS has been closed, this segment is relatively straight forward to model. The key features being the following:

- the gradual fall in customer numbers and capacity as contracts become void where dwellings change ownership; and
- the migration of gross to net for both the 60 cents and 20 cents feed-in-tariff in calendar 2016-17.

The SBS customers were not separated into residential and business customers.

The non-SBS segment represents old and new customers now (and previously) installing small scale PV without the generous feed-in-tariffs. The non-SBS customers were separated into residential and business customers using tariff data provided by Endeavour Energy in 2016.

Table 3.1 summarises the key modelling assumptions for Endeavour Energy for the period 2015-16 to 2025-26.

Table 3.1 Key modelling assumptions – Endeavour			
1. Energy assumptions (number)			
Average generation/kW (KWhs generated per installed kW)			1,250
In-house usage (kWhs per kW installed)			981
2. New customer assumptions (number)	**Residential**	**Business**	**Total**
Customers/month			
2016 – 2018	860	40	900
2019 – 2026	790	45	835
3. Peak demand assumptions (per cent)			
Discount (per cent) for inverter/panel size mismatch			20
Discount (per cent) for availability of PV output at MD			(Varies by time of peak)

Ausgrid published data on gross metered PV installations in 2011, 2012 and 2013 for some 300 PV customers. This data was on a half hourly basis covering:

- general consumption;
- controlled load; and
- gross generation.

From these data NIEIR calculated the difference between gross generation and general consumption on a half hourly basis across the whole sample of 300 customers. A positive value indicated exports to the grid from this customer group. A negative number indicated imports from the grid.

Table 3.2 summarises the key findings from this sample data from 2010-11 to 2012-13.

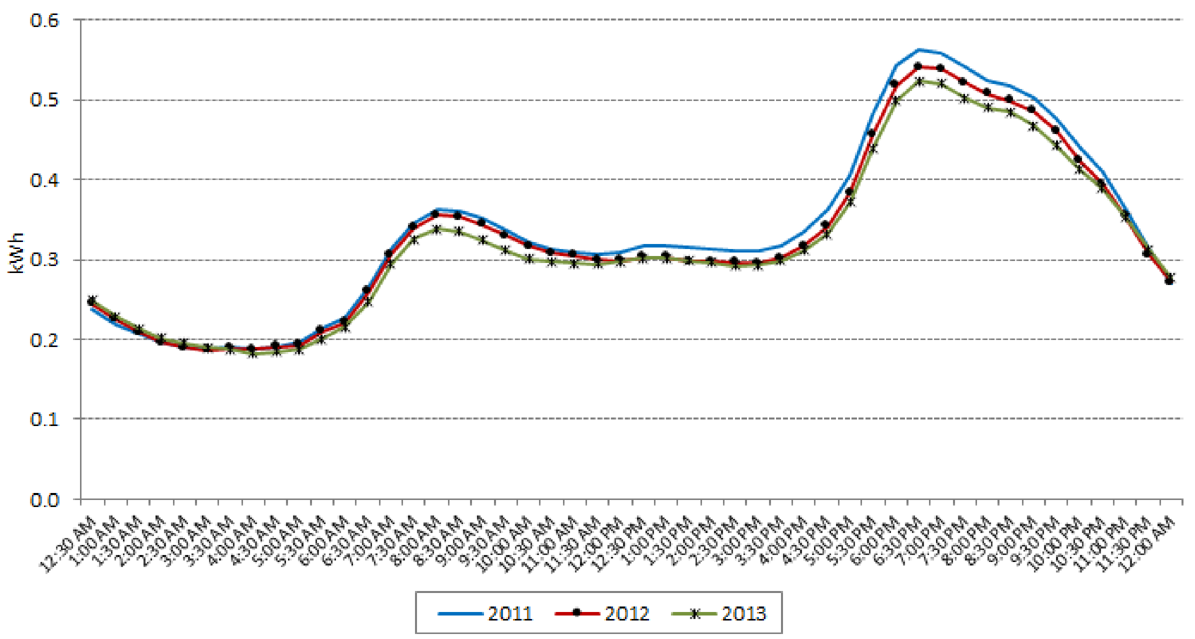
Table 3.2 Summary of PV customer use, exports and own use

	2010-11	2011-12	2012-13
Total consumption (MWh)	1,828.9	1,721.7	1,676.3
Total generation (MWh)	635.6	625.0	654.3
Total exports (MWh)	136.8	142.2	155.2
Export share of generation (per cent)	21.5	22.8	23.7
Own use of PV (per cent)	78.5	77.2	76.3

Figures 3.1 to 3.4 show, respectively, the total average daily consumption, total average daily generation, total average daily consumption less generation and total average daily exports, all by half hour. These are shown in kWh.

The metrics shown in the figures were calculated from a sample of 300 Ausgrid customers with photovoltaic systems, measured by a gross meter over the financial year 2010-11, 2011-12 and 2012-13.[3]

Figure 3.1: Total average daily electricity consumption by half hour (kWh) – 2011, 2012 and 2013



3 This data is downloaded from the Ausgrid website at http://www.ausgrid.com.au/Common/About-us/Sharing-information/Data-to-share/Solar-household-data.aspx#.UqUyAfQW364.

Figure 3.2: Total average daily electricity generation by half hour (kWh) – 2011, 2012 and 2013

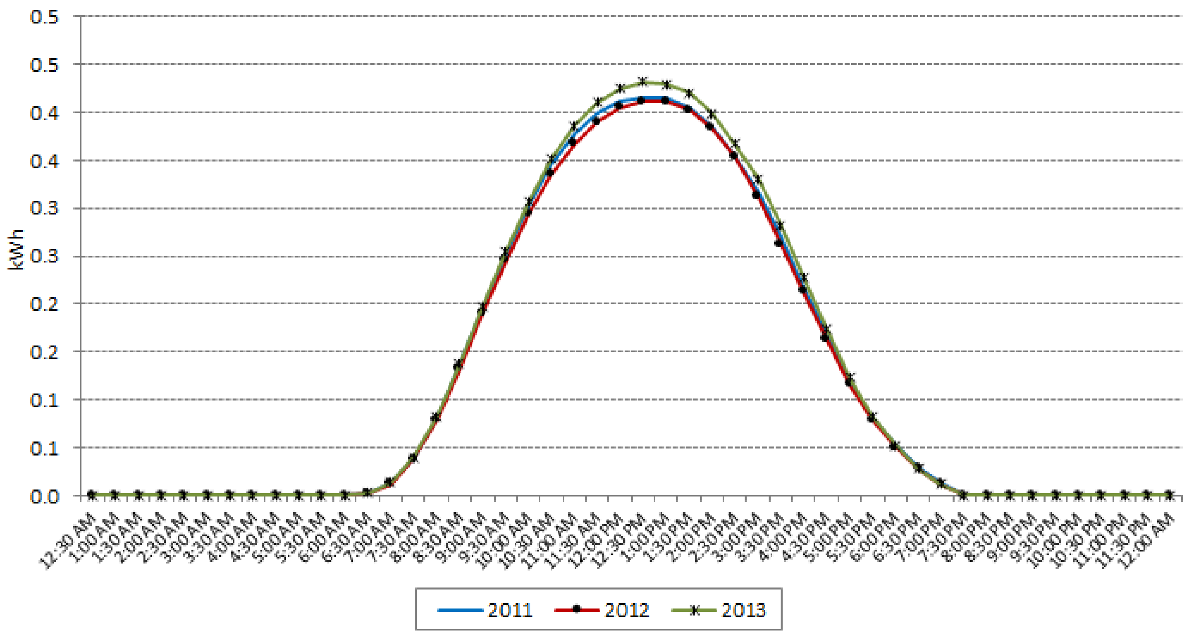


Figure 3.3: Total average daily electricity consumption less generation by half hour (kWh) – 2011, 2012 and 2013

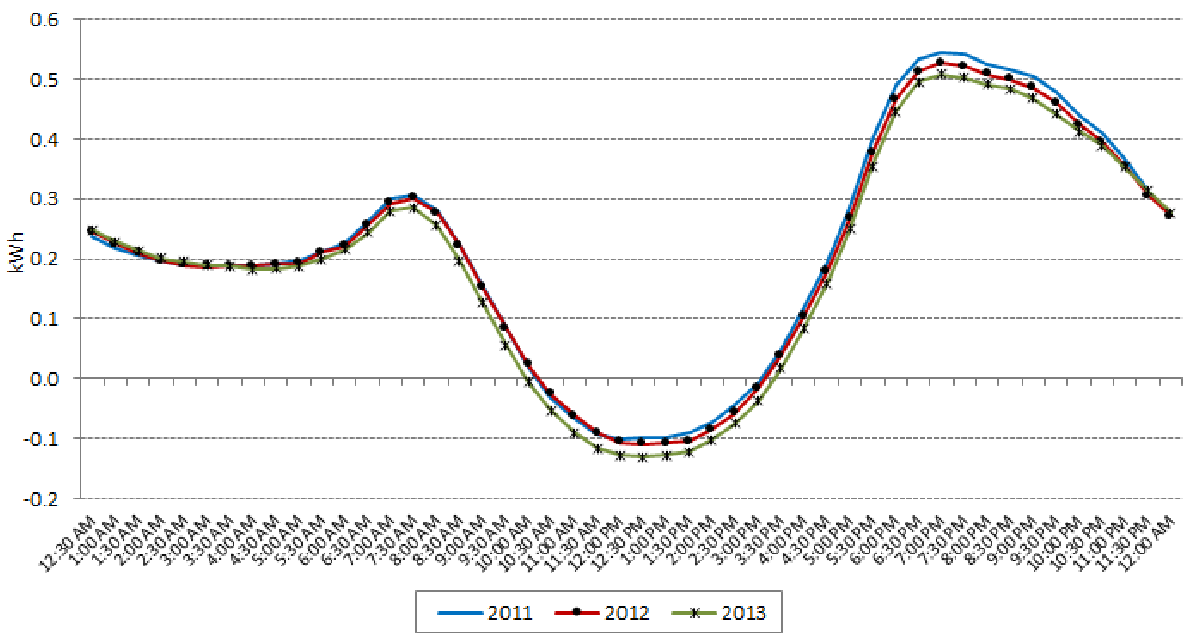
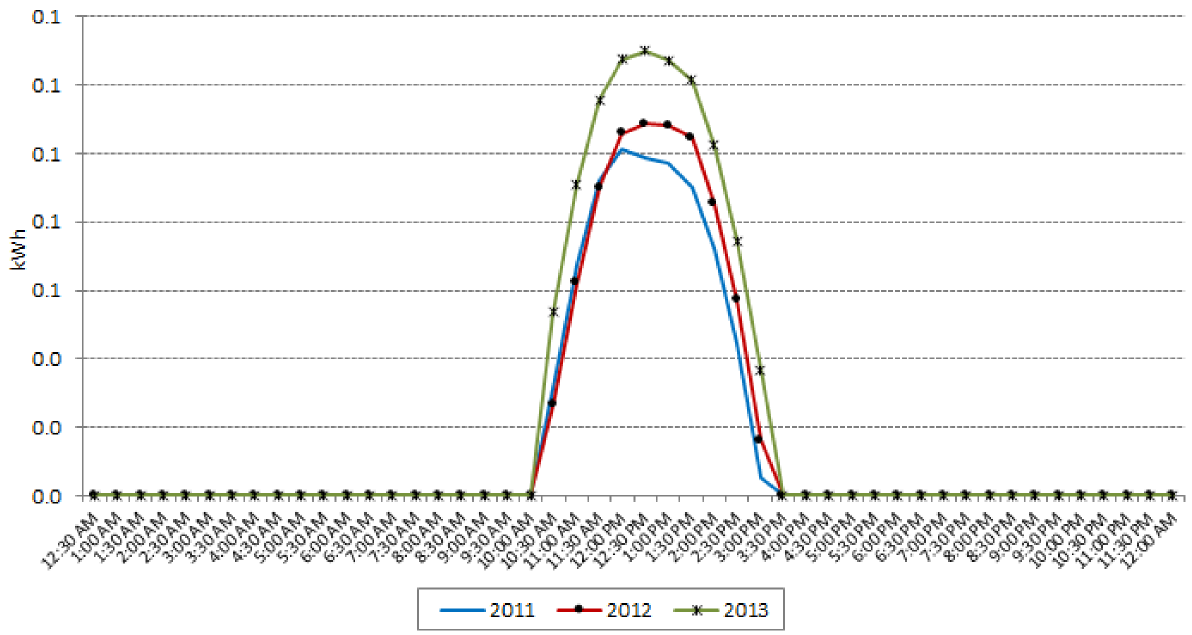


Figure 3.4: Total average daily electricity exports by half hour (kWh) – 2011, 2012 and 2013



3.4 Modelling results for PV

The customer assumptions to 2018 are based on current connection rates for Endeavour. Basically, the payback on a typical PV system **without** the generous REC credits and SBS feed-in-tariffs is around 6 years, compared to 2 to 3 years in 2010.

The key uncertainties regarding PV penetration in New South Wales are:

- future PV system costs relative to electricity prices (these could increase or reduce paybacks);
- possible introduction of new Solar Bonus type schemes or feed-in-tariffs.

Figures 3.5 to 3.11 show total customers, total capacity, average capacity and other indicators for PV systems in New South Wales to 2025-26. The forecasts are presented in Table 3.3 for total Endeavour Energy.

Customer demands would, on these bases, be reduced (post-modelling adjusted) by the in-house PV use estimates.

Forecasts for residential and business customers are presented in Tables 3.4 and 3.5 for **non-solar bonus customers**. Business customers include both commercial and industrial customers.

Table 3.3	Small scale PV generation – Total – Endeavour Energy									
	Customers	Capacity	Average	Total energy	Export to grid	In-house	Generation at selected half hourly intervals				
	June 30th (no.)	Total (MW)	Unit size (kW)	Produced (GWh)	(GWh)	Usage (GWh)	4:30 pm (MW)	5:00 pm (MW)	5:30 pm (MW)	6:00 pm (MW)	6:30 pm (MW)
2010	5783	10.35	1.79	3.05	3.03	0.02	2.48	2.06	1.65	1.15	0.49
2011	37220	96.17	2.58	47.98	47.81	0.17	22.66	18.88	15.11	10.57	4.53
2012	58687	139.42	2.38	119.90	106.14	13.76	30.92	25.77	20.61	14.43	6.18
2013	75301	181.11	2.41	164.96	122.66	42.30	43.47	36.22	28.98	20.28	8.69
2014	83853	203.90	2.43	198.26	129.60	68.66	48.94	40.78	32.62	22.84	9.79
2015	94638	240.06	2.54	226.33	132.03	94.30	57.62	48.01	38.41	26.89	11.52
2016	105138	274.40	2.61	268.35	144.03	124.32	65.86	54.88	43.90	30.73	13.17
2017	115640	311.35	2.69	305.53	113.09	192.44	74.72	62.27	49.82	34.87	14.94
2018	126144	350.27	2.78	346.76	80.15	266.61	84.06	70.05	56.04	39.23	16.81
2019	135870	388.75	2.86	385.49	82.88	302.61	93.30	77.75	62.20	43.54	18.66
2020	145598	429.24	2.95	426.68	91.74	334.94	103.02	85.85	68.68	48.08	20.60
2021	155328	466.28	3.00	467.12	100.43	366.69	111.91	93.26	74.61	52.22	22.38
2022	165059	504.38	3.06	506.31	108.86	397.45	121.05	100.88	80.70	56.49	24.21
2023	174793	543.53	3.11	546.60	117.52	429.08	130.45	108.71	86.96	60.87	26.09
2024	184529	583.73	3.16	587.99	126.42	461.58	140.10	116.75	93.40	65.38	28.02
2025	194267	624.37	3.21	630.17	135.49	494.68	149.85	124.87	99.90	69.93	29.97
2026	204007	665.97	3.26	673.06	144.71	528.36	159.83	133.19	106.55	74.59	31.97

Table 3.4	Residential small scale PV generation – Total – Endeavour Energy									
	Customers	Capacity	Average	Total energy	Export to grid	In-house	Generation at selected half hourly intervals			
	June 30th (no.)	Total (MW)	Unit size (kW)	Produced (GWh)	(GWh)	Usage (GWh)	4:30 pm (MW)	5:00 pm (MW)	5:30 pm (MW)	6:00 pm (MW)	6:30 pm (MW)
2010	5774	10.34	1.79	3.04	3.03	0.01	2.48	2.06	1.65	1.15	0.49
2011	37091	95.86	2.58	47.81	47.77	0.04	22.59	18.82	15.06	10.54	4.52
2012	58437	138.77	2.37	119.40	106.03	13.37	30.76	25.64	20.51	14.36	6.15
2013	74878	179.92	2.40	164.01	122.45	41.55	43.18	35.98	28.79	20.15	8.64
2014	83272	202.16	2.43	196.73	129.27	67.46	48.52	40.43	32.35	22.64	9.70
2015	93712	237.10	2.53	223.87	131.50	92.37	56.90	47.42	37.94	26.56	11.38
2016	103732	269.62	2.60	264.31	143.16	121.15	64.71	53.92	43.14	30.20	12.94
2017	113754	304.56	2.68	299.50	111.80	187.70	73.09	60.91	48.73	34.11	14.62
2018	123778	341.51	2.76	338.65	78.41	260.25	81.96	68.30	54.64	38.25	16.39
2019	132964	377.71	2.84	375.16	80.66	294.50	90.65	75.54	60.43	42.30	18.13
2020	142152	415.80	2.93	413.91	88.99	324.92	99.79	83.16	66.53	46.57	19.96
2021	151342	450.34	2.98	451.79	97.14	354.66	108.08	90.07	72.05	50.44	21.62
2022	160533	485.82	3.03	488.32	104.99	383.33	116.60	97.16	77.73	54.41	23.32
2023	169727	522.25	3.08	525.82	113.05	412.77	125.34	104.45	83.56	58.49	25.07
2024	178923	559.62	3.13	564.32	121.33	442.99	134.31	111.92	89.54	62.68	26.86
2025	188121	597.95	3.18	603.81	129.82	473.99	143.51	119.59	95.67	66.97	28.70
2026	197321	637.22	3.23	644.28	138.52	505.76	152.93	127.44	101.95	71.37	30.59

Table 3.5	Business small scale PV generation – Total – Endeavour Energy										
	Customers	Capacity	Average	Total energy	Export to grid	In-house	Generation at selected half hourly intervals				
	June 30th (no.)	Total (MW)	Unit size (kW)	Produced (GWh)	(GWh)	Usage (GWh)	4:30 pm (MW)	5:00 pm (MW)	5:30 pm (MW)	6:00 pm (MW)	6:30 pm (MW)
2011	129	0.31	2.40	0.17	0.04	0.13	0.07	0.06	0.05	0.03	0.01
2012	250	0.65	2.60	0.50	0.11	0.39	0.16	0.13	0.10	0.07	0.03
2013	423	1.18	2.80	0.96	0.21	0.75	0.28	0.24	0.19	0.13	0.06
2014	581	1.74	3.00	1.53	0.33	1.20	0.42	0.35	0.28	0.20	0.08
2015	926	2.96	3.20	2.45	0.53	1.93	0.71	0.59	0.47	0.33	0.14
2016	1406	4.78	3.40	4.04	0.87	3.17	1.15	0.96	0.76	0.54	0.23
2017	1886	6.79	3.60	6.04	1.30	4.74	1.63	1.36	1.09	0.76	0.33
2018	2366	8.75	3.70	8.11	1.74	6.36	2.10	1.75	1.40	0.98	0.42
2019	2906	11.04	3.80	10.33	2.22	8.11	2.65	2.21	1.77	1.24	0.53
2020	3446	13.44	3.90	12.77	2.75	10.02	3.23	2.69	2.15	1.51	0.65
2021	3986	15.94	4.00	15.33	3.30	12.03	3.83	3.19	2.55	1.79	0.77
2022	4526	18.56	4.10	18.00	3.87	14.13	4.45	3.71	2.97	2.08	0.89
2023	5066	21.28	4.20	20.78	4.47	16.31	5.11	4.26	3.40	2.38	1.02
2024	5606	24.11	4.30	23.67	5.09	18.58	5.79	4.82	3.86	2.70	1.16
2025	6146	26.43	4.30	26.36	5.67	20.69	6.34	5.29	4.23	2.96	1.27
2026	6686	28.75	4.30	28.78	6.19	22.59	6.90	5.75	4.60	3.22	1.38

Note: Business customers include both commercial and industrial customers.

Figure 3.5: Total customers – PV – Endeavour Energy

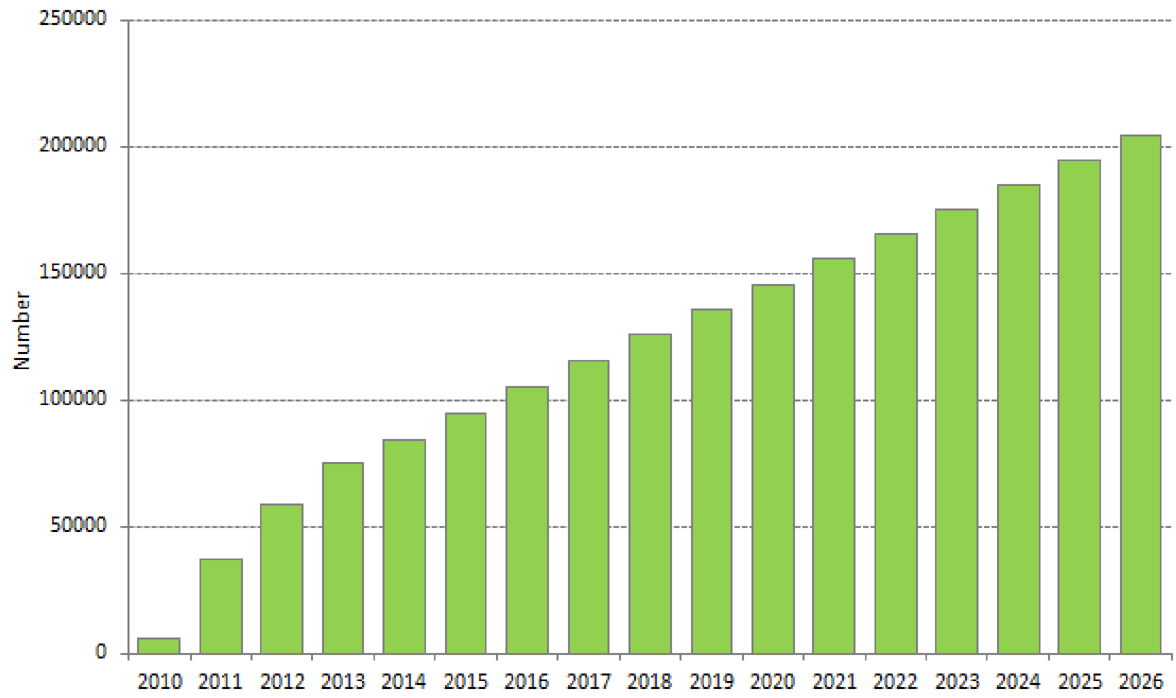


Figure 3.6: Total generation capacity – PV – Endeavour Energy

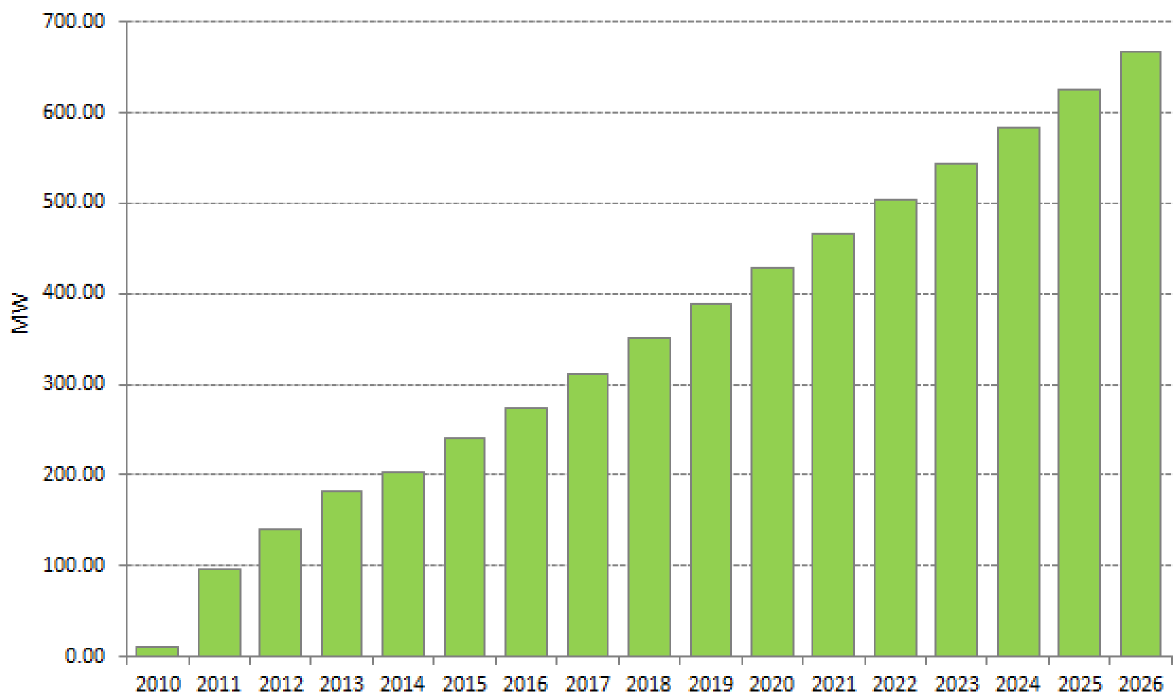


Figure 3.7: Average generation capacity – PV – Endeavour Energy

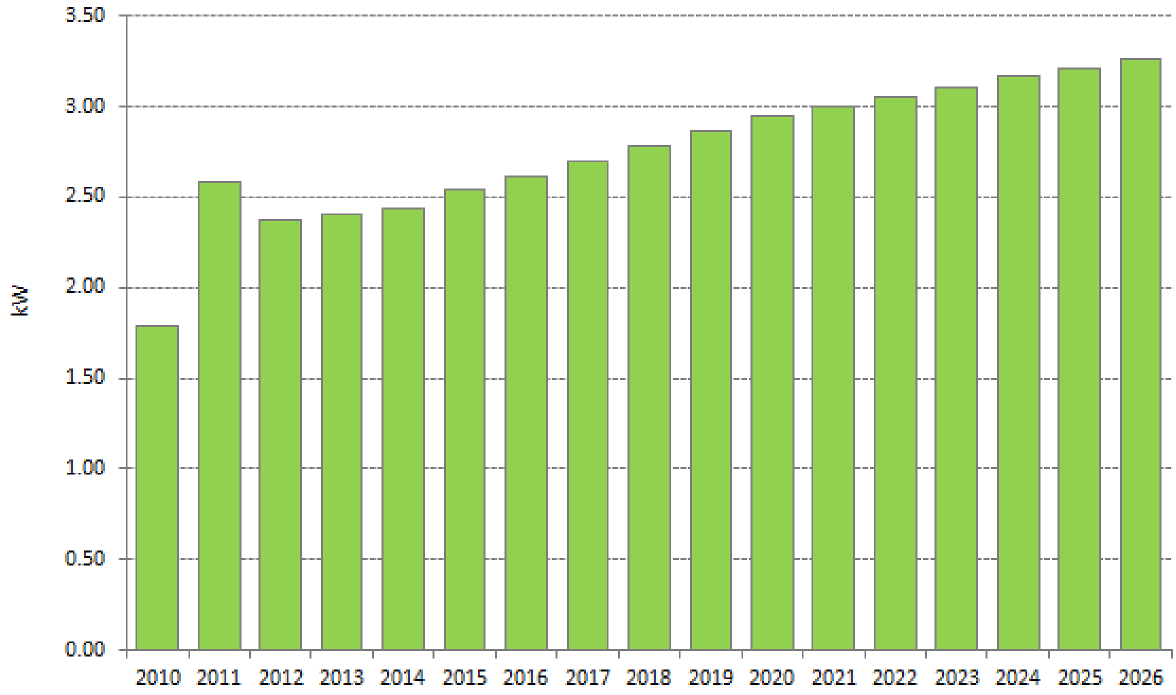


Figure 3.8: Total electricity energy produced – PV – Endeavour Energy

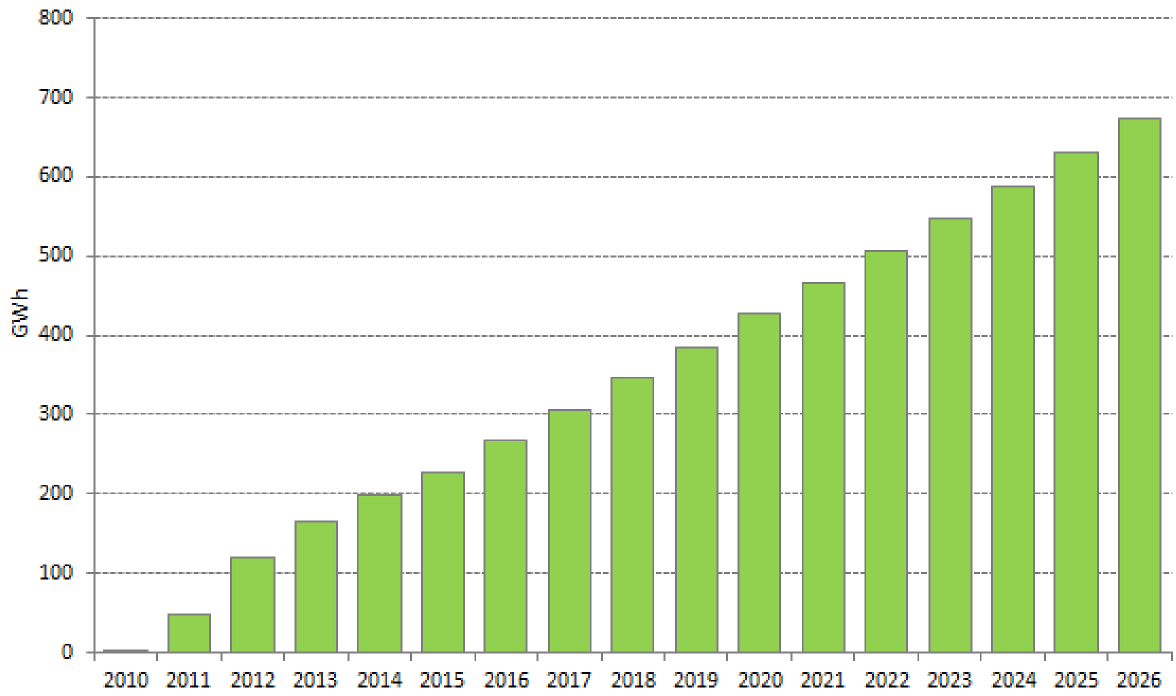


Figure 3.9: Electricity exports to grid – PV – Endeavour Energy

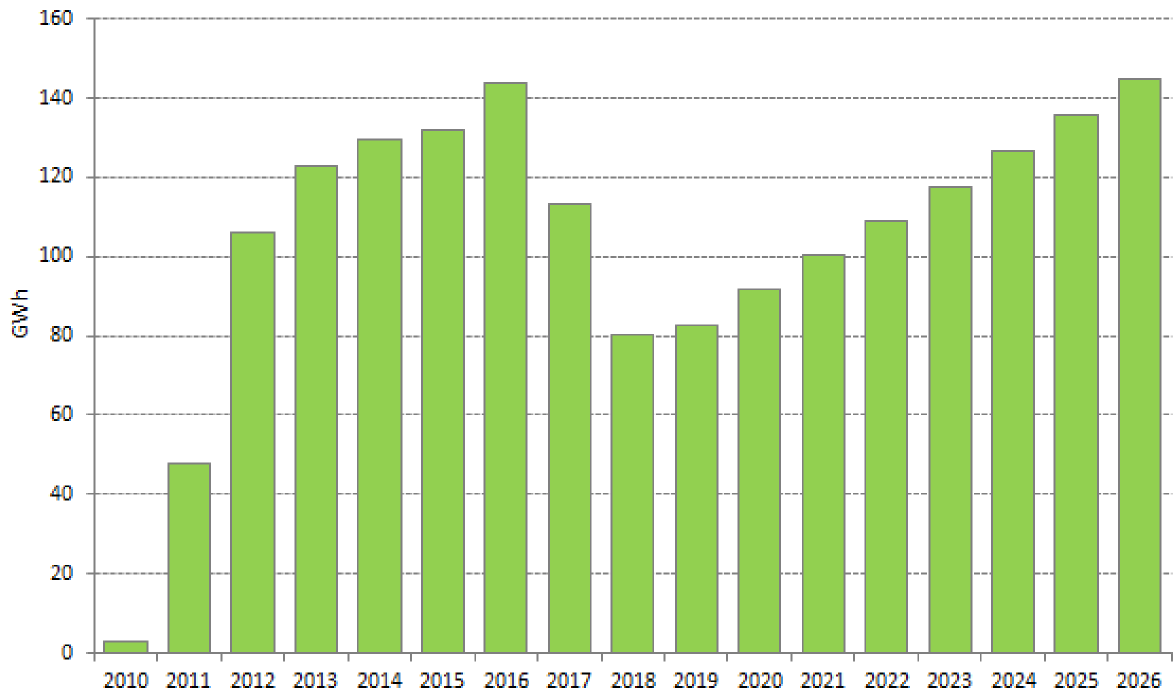


Figure 3.10: Electricity own use – PV – Endeavour Energy

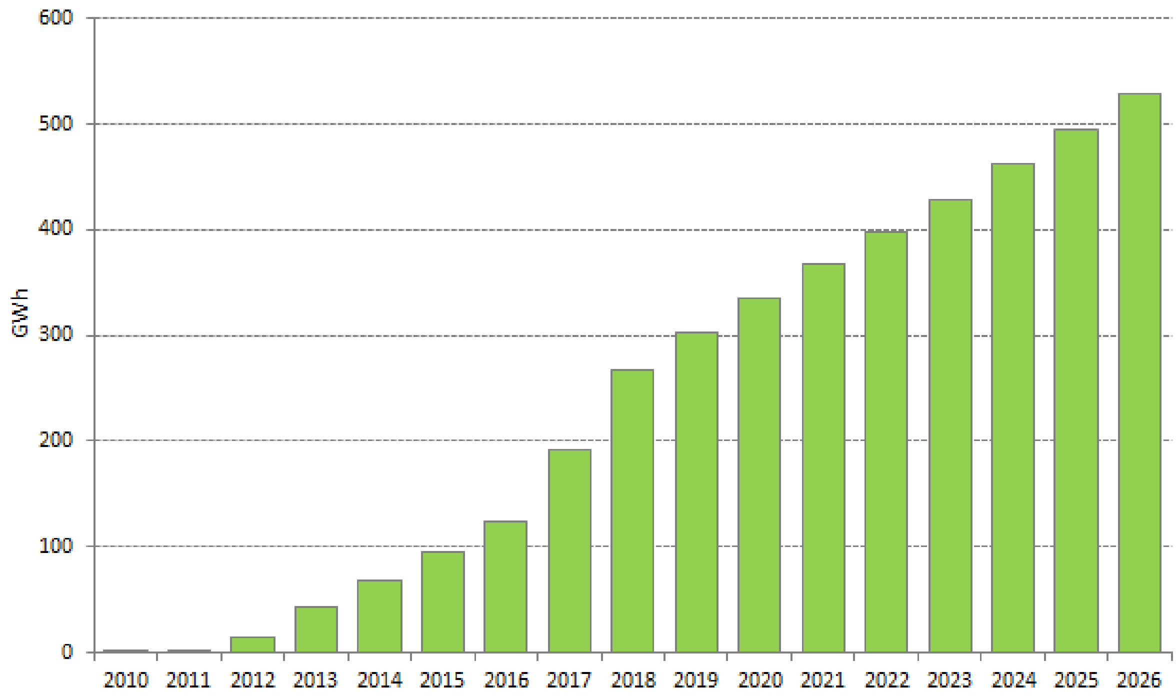
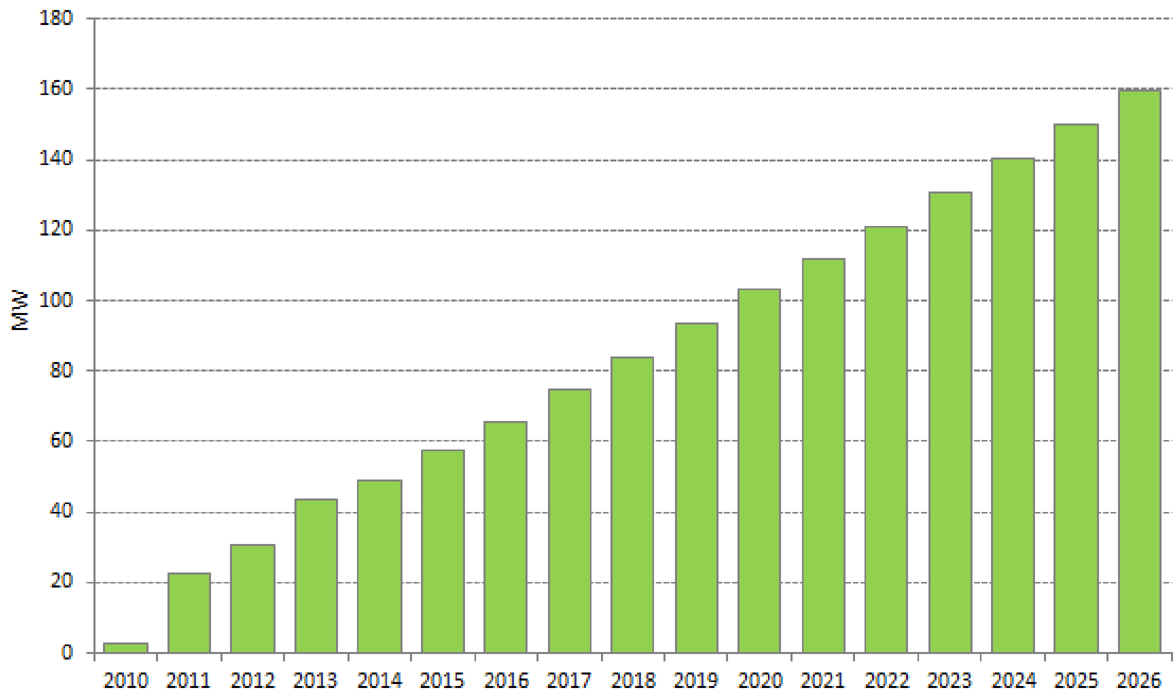


Figure 3.11: Generation capacity at summer MD – 4:30 pm – Endeavour Energy

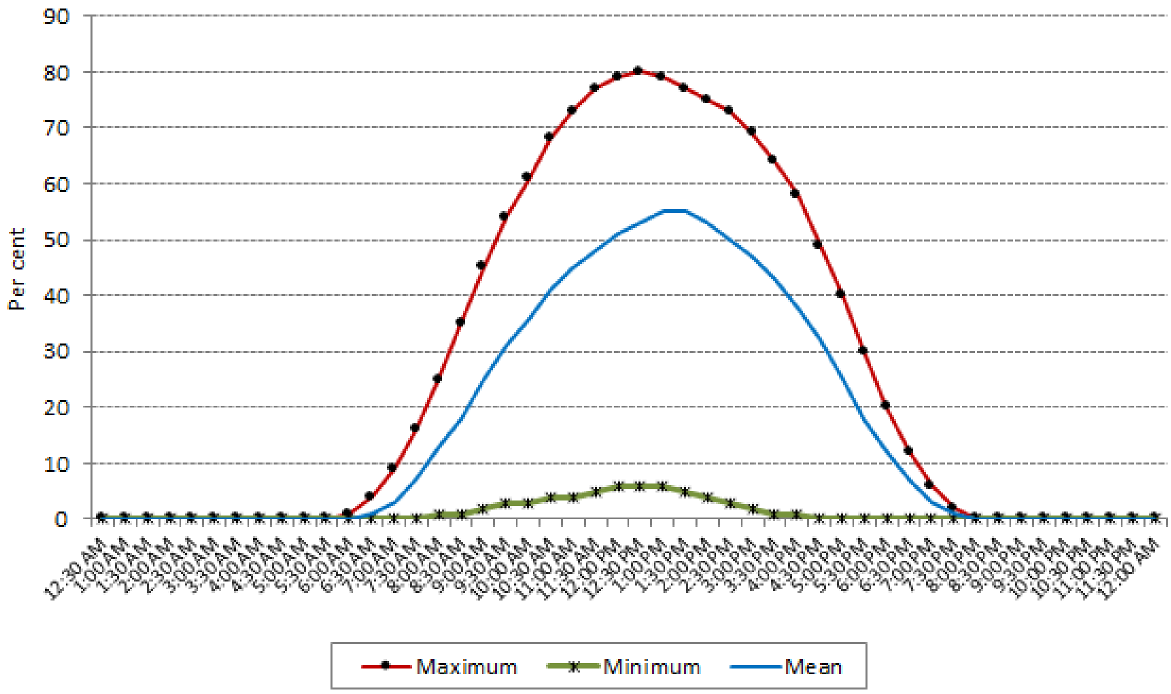


As indicated in Table 3.3, the impacts on peak demand of PV are tabulated by time interval. The time intervals cover from 4:30 pm to 6:30 pm. The assumed load factors for PV systems are as follows for summer.

4:30 pm	30 per cent
5:00 pm	25 per cent
5:30 pm	20 per cent
6:00 pm	14 per cent
6:30 pm	6 per cent

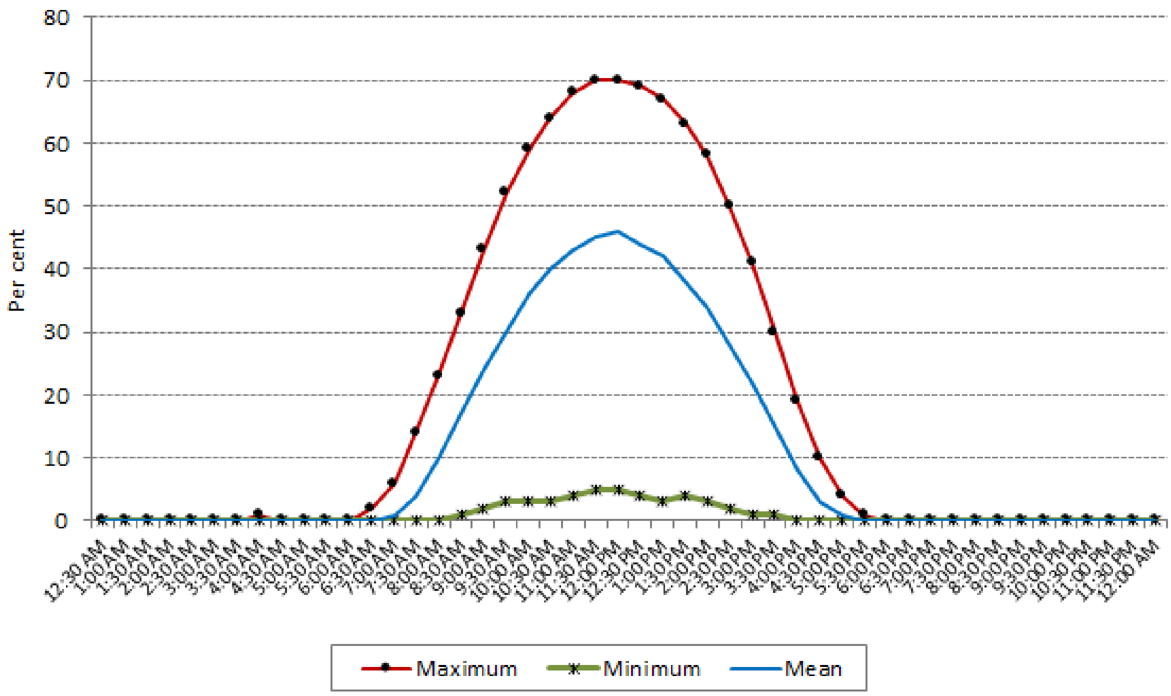
The load factor for Endeavour winter MDs is zero per cent. Generation load factors were calculated for the Ausgrid 300 PV customers for summer 2012-13 and winter 2012 by half hour. Mean, maximum and minimum generation load factors for summer and winter are shown in Figures 3.12 and 3.13 below.

Figure 3.12: Summer generation load factors for PV by half hour summer – 2012-13



Note: Summer = December, January and February.

Figure 3.13: Winter generation load factors for PV by half hour winter – 2012



Note: Winter = June, July and August.

Table 3.6 shows the new annual energy impacts of PV by tariff for Endeavour Energy.

Table 3.6	Total annual energy impact of PV by residential, commercial and industrial tariffs – Endeavour Energy (GWh)			
	Domestic	General supply non-TOU	General supply TOU	Low voltage supply TOU
2016	28.78	0.38	0.07	0.80
2017	66.55	0.47	0.09	1.01
2018	72.54	0.49	0.09	1.05
2019	34.25	0.53	0.10	1.12
2020	30.42	0.58	0.11	1.23
2021	29.74	0.61	0.11	1.29
2022	28.67	0.63	0.12	1.35
2023	29.44	0.66	0.12	1.40
2024	30.22	0.69	0.12	1.46
2025	31.00	0.64	0.12	1.36
2026	31.77	0.57	0.10	1.22

3.5 Electricity storage and Endeavour Energy

Electricity storage with batteries behind-the-meter with PV systems has been attracting considerable interest in the media. Marketing of storage options emerged in 2016 including energy companies such as AGL and Bradford Solar (CSR).

Without tariff or financial incentives the take up of battery storage may not be significant until 2020. Existing PV customers are unlikely to take up battery storage as the average size of PV installed is too small to support battery storage and storage installation costs are higher.

NIEIR has assumed that storage is taken up by new residential and business customers only. Business customers include both commercial and industrial customers. Older PV customers with large PV systems (greater than 3.5 kW), or with systems that have the capacity to expand, could also take up storage options. Table 3.7 shows some indicative costs for new PV/battery storage solutions being offered by AGL Solar. As indicated in Table 3.7, the minimum cost is some $13,000 for a 3 kW PV and battery system.

Table 3.7 Battery storage and PV options

Measure	Units	AUO Power Legato	Sunverge SIS 11.6	Sunverge SIS 19.4	Tesla Powerwall
Capacity	kWh	7.2	11.6	19.4	7.0
Usable	kWh	6.5	9.9	16.5	6.4
System size (PV)	kW	3.0 to 4.5	4 to 5	4 to 5	3 to 4
Bundle price	$	12,990	19,990	24,990	17,250
Battery only	$	9,900	14,990	19,990	n.a.

Source: www.aglsolar.com.au (May 2016).

Table 3.8 shows the key assumptions for battery storage for Endeavour Energy. This includes take up rates, system sizes, depth of discharge and rates of degradation. A key NIEIR assumption for this exercise is that the up-take of battery storage is neutral on own-use and export for total PV. This means that the additional energy for storage is met by increased PV capacity at each battery installation.

Table 3.8 Endeavour Energy battery storage assumptions

			Residential (%)	Business (%)
1.	**Take up rate (per cent of new PV customers)**			
	2016		0.1	0.4
	2018		10	15
	2020		20	30
	2022 – 2026		20	40
2.	Depth of discharge	80 per cent		
3.	Battery degradation	4 per cent per annum		
4.	**Storage system size (kWh)**			
	2016		7.0	9.0
	2020		7.8	12.0
	2024 – 2026		8.6	13.0
5.	Exports to grid	5 per cent		

Note: Business includes commercial and industrial customers.

Table 3.9 shows total small scale battery storage for Endeavour Energy to 2025-26. Tables 3.10 and 3.11 show the corresponding forecasts for residential and business customers.

Table 3.9 Total small scale battery storage – Endeavour Energy

	Customers	Capacity gross	Average battery	Total energy	Export to grid	Additional in-house	Impact on peak demand	
	June 30th (no.)	Total per year (GWh)	Unit size (KWh)	Stored (GWh)	(GWh)	Usage (GWh)	Summer (MW)	Winter (MW)
2010	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2011	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2012	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2013	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2014	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	0	0	0.00	0.0	0.0	0.0	0.0	0.0
2016	30	0.2	8.3	0.2	0.0	0.1	0.0	0.0
2017	594	4.4	7.4	2.8	0.1	2.7	1.0	0.3
2018	1698	12.9	7.6	8.3	0.4	7.9	2.9	1.0
2019	3228	25.4	7.9	16.2	0.8	15.4	5.4	1.8
2020	5286	42.9	8.1	27.5	1.4	26.1	8.9	3.0
2021	7371	62.0	8.4	39.7	2.0	37.7	12.4	4.1
2022	9483	81.7	8.6	52.3	2.6	49.7	15.9	5.3
2023	11595	102.1	8.8	65.4	3.3	62.1	19.5	6.5
2024	13707	123.4	9.0	78.9	3.9	75.0	23.0	7.7
2025	15819	145.3	9.2	93.0	4.7	88.4	26.6	8.9
2026	17931	168.1	9.4	107.6	5.4	102.2	30.1	10.0

Table 3.10 Residential small scale battery storage – Endeavour Energy

	Customers	Capacity gross	Average battery	Total energy	Export to grid	Additional in-house	Impact on peak demand	
	June 30th (no.)	Total per year (GWh)	Unit size (KWh)	Stored (GWh)	(GWh)	Usage (GWh)	Summer (MW)	Winter (MW)
2010	0	0.00	0.00	0.00	0.00	0.00		
2011	0	0.00	0.00	0.00	0.00	0.00		
2012	0	0.00	0.00	0.00	0.00	0.00		
2013	0	0.00	0.00	0.00	0.00	0.00		
2014	0	0.00	0.00	0.00	0.00	0.00		
2015	0	0.00	0.00	0.00	0.00	0.00		
2016	10	0	7.00	0.05	0.00	0.04	0.0	0.0
2017	526	4	7.20	2.43	0.12	2.30	0.9	0.3
2018	1558	12	7.40	7.38	0.37	7.01	2.6	0.9
2019	2980	23	7.60	14.50	0.72	13.77	5.0	1.7
2020	4876	38	7.80	24.34	1.22	23.13	8.2	2.7
2021	6772	54	8.00	34.67	1.73	32.94	11.4	3.8
2022	8668	71	8.20	45.49	2.27	43.22	14.6	4.9
2023	10564	89	8.40	56.79	2.84	53.95	17.7	5.9
2024	12460	107	8.60	68.58	3.43	65.15	20.9	7.0
2025	14356	126	8.80	80.85	4.04	76.81	24.1	8.0
2026	16252	146	9.00	93.61	4.68	88.93	27.3	9.1

Table 3.11	Business small scale battery storage – Endeavour Energy							
	Customers	Capacity gross	Average battery	Total energy	Export to grid	Additional in-house	Impact on peak demand	
	June 30th (no.)	Total per year (GWh)	Unit size (KWh)	Stored (GWh)	(GWh)	Usage (GWh)	Summer (MW)	Winter (MW)
2011	0	0.00	0.00	0.00	0.00	0.00		
2012	0	0.00	0.00	0.00	0.00	0.00		
2013	0	0.00	0.00	0.00	0.00	0.00		
2014	0	0.00	0.00	0.00	0.00	0.00		
2015	0	0.00	0.00	0.00	0.00	0.00		
2016	19	0	9.00	0.11	0.01	0.11	0.0	0.0
2017	67	1	9.00	0.39	0.02	0.37	0.1	0.0
2018	139	1	10.00	0.89	0.04	0.85	0.2	0.1
2019	247	3	11.00	1.74	0.09	1.65	0.4	0.1
2020	409	5	12.00	3.14	0.16	2.99	0.7	0.2
2021	598	8	13.00	4.98	0.25	4.73	1.0	0.3
2022	814	11	13.00	6.77	0.34	6.44	1.4	0.5
2023	1030	13	13.00	8.57	0.43	8.14	1.7	0.6
2024	1246	16	13.00	10.37	0.52	9.85	2.1	0.7
2025	1462	19	13.00	12.17	0.61	11.56	2.5	0.8
2026	1678	22	13.00	13.96	0.70	13.26	2.8	0.9

Note: Includes commercial and industrial tariff groups.

Figure 3.14: Total battery storage customers – Endeavour Energy (number)

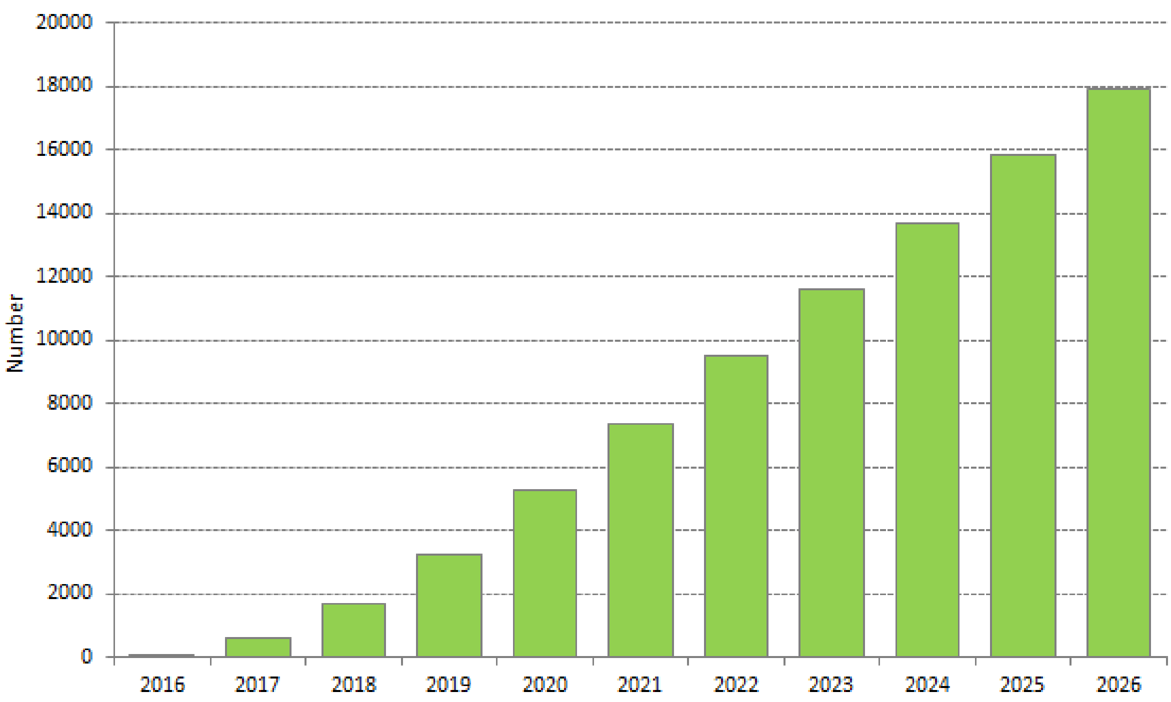


Figure 3.15: Total gross capacity battery storage – Endeavour Energy (GWh)

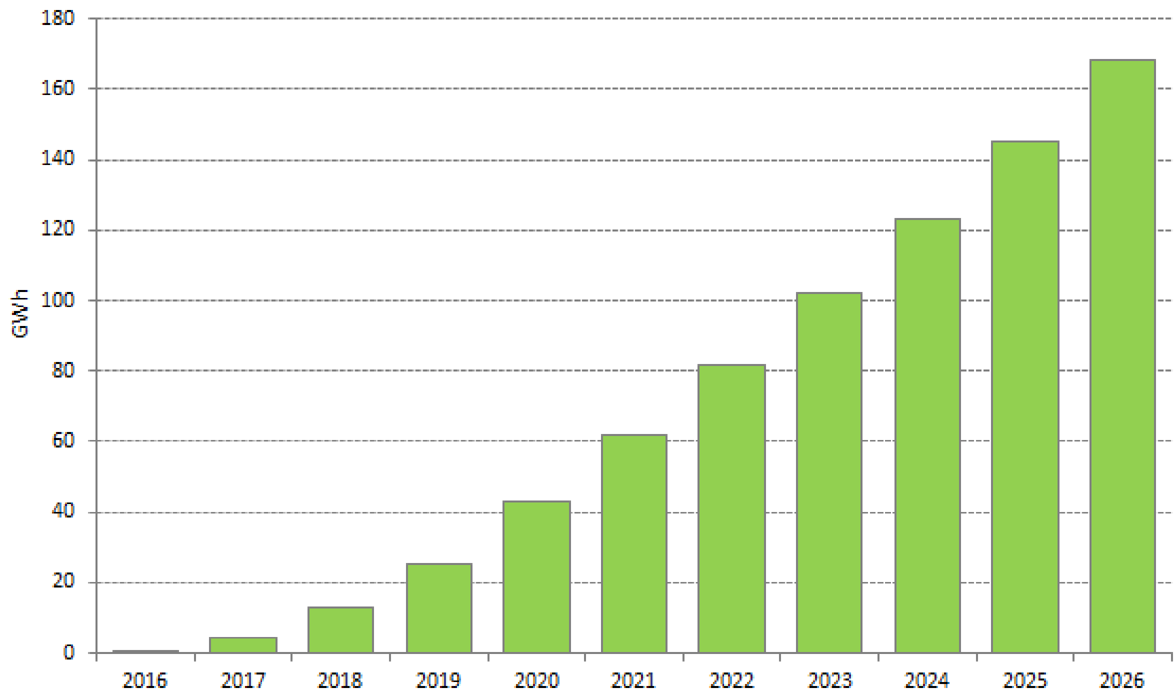


Table 3.12 shows the new annual impact of battery storage for Endeavour Energy by network tariff.

Table 3.12 Total annual energy impact of battery by tariff – Endeavour Energy (GWh)

	Domestic	General supply non-TOU	General supply TOU	Low voltage supply TOU
2010	0.0	0.0	0.0	0.0
2011	0.0	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0
2013	0.0	0.0	0.0	0.0
2014	0.0	0.0	0.0	0.0
2015	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.1
2017	2.3	0.1	0.0	0.2
2018	4.7	0.1	0.0	0.3
2019	6.8	0.2	0.0	0.5
2020	9.4	0.4	0.1	0.9
2021	9.8	0.5	0.1	1.1
2022	10.3	0.5	0.1	1.1
2023	10.7	0.5	0.1	1.1
2024	11.2	0.5	0.1	1.1
2025	11.7	0.5	0.1	1.1
2026	12.1	0.5	0.1	1.1

4. Residential hot water

Residential hot water in New South Wales has traditionally been by electric resistance hot water (ERHW) units predominantly storage systems heating water in off-peak periods (see Table 4.1 below).

However, rising off-peak prices increasing availability of gas and policy initiatives such as BASIX (Building Sustainability Index) requirements for residences, and Federal and State subsidies for solar hot water (SHW) and heat pumps (HPs) have resulted in some switch away from ERHW to alternative water heating options: gas hot water (GHW), solar hot water and heat pumps.

ERHW units had been particularly prevalent in multi-unit buildings due to cost issues and technical problems with installing alternatives. Pre-BASIX, 2005-06, multi-unit dwellings mainly installed ERHW units. Under BASIX requirements, however, this fell to 0.2 per cent in 2008-09 when installations were: 72 per cent gas; 18 per cent solar; 10 per cent heat pumps.

A national (COAG supported) policy to phase out ERHW units in existing residences to complement new residence hot water regulations has, however, been rejected by the NSW Government and replacement of ERHW units has slowed to the trend since 2000.

Trends in New South Wales residential water heating over 2005-2011 are presented below.

Table 4.1 New South Wales residential hot water trends, percentage of system types – 2005-2011

	2005	2011	2014
Electricity	63.8	64.0	65.9
Gas (mains)	23.9	26.4	29.1
Solar	2.5	6.8	8.5
Other (wood, propane, etc.)	9.8	2.8	5.5

Source: Survey data in ABS 4602, March 2014.

Over the period (2005 to 2014) the electric (ERHW) proportion was virtually constant, that for gas increased (availability, convenience, costs), that for solar (includes heat pumps) increased (rebates) and that for other decreased (inconvenience, costs).

No separate survey data is provided for electric heat pumps (HPs), which are included under solar. Data on HPs, potentially a significant water heating technology, in an E3 report (Product Profile: Heat Pump Water Heaters, Air Source Heat Pump Water Heaters in Australia and New Zealand, June 2012) indicates significant HP installations in 2009 when HP subsidies (Federal, State) peaked, with most HP installations in New South Wales (approximately 47,000) by 2011.

In the future heat pump (and solar-hybrid systems) installations will depend on:

- heat pump water heater performance (coefficient of performance) with technological improvements;
- electricity and gas prices;
- subsidy/rebates for heat pump installations;
- promotion of heat pump hot water units by suppliers to enhance consumer acceptance of the units; and
- regulation of water heating technologies.

Overall residential hot water (HW) trends

HW projections depend on the following:

- electricity and gas prices (current, projected);
- gas availability in each area (current, trends);
- SHW and HP subsidies, penetrations and costs (current, projected);
- SHW and HP technology improvements; and
- assessment of like-for-like and replacement before and at end-of-life considerations. (That is, at end-of-life hot water system options must consider the difference in capital cost of options and the convenience of like-for-like replacements.)

Risk analysis of potential impacts on revenue or demand of changes in the hot water operating environment could be undertaken, but is beyond the scope of this study.

Trends in hot water energy use could reduce hot water electricity use below that projected by econometric analysis. But current uncertainty on the environment (energy cost, policies) in which water heating operates means no post-modelling adjustments are feasible at this time.

5. Building standards for new residences

Building standards for new homes have been significantly tightened since 2004, resulting in lower energy demands (MWhs, kW) per m^2. In terms of actual energy use per residential unit, this improved design shell/envelope thermal performance has been offset to some extent by increases in conditioned floor area, increased space comfort levels, higher lighting intensities and **as-built** non-compliance with pre-build design on building permits. For example, incorrect installation of insulation and lack of adequate attention to air tightness.

Currently the nationally accepted standard is a 6-star shell. But there are regional variations. For example, inclusion of water heating, supply and use in Victoria, **the use of BASIX design criteria in New South Wales** and 5-star in Tasmania.

Accordingly, estimated actual performance is used in NIEIR's new home modelling by taking account of State/Territorial variations and discounting the design performance for non-compliance.

The BASIX (Building Sustainability Index) criteria for new residences in New South Wales, introduced in 2004, are more comprehensive than new building codes in other jurisdictions (under the National Construction Code, previously the Building Code of Australia).

BASIX uses a minimum points rating to attain a target, not a star rating system for new residences, and has separate levels for heating and cooling loads and covers water use, thermal comfort and energy use. Its 12 February 2012 draft upgrade is probably equivalent to a 5.5 to 6.5 star, compared with a minimum 6 star rating in other jurisdictions. That is, the BASIX requirements are likely to have a similar impact on the energy performance of new residences to requirements in other jurisdictions (note that requirements are lower in Tasmania).

Compliance, **as built**, with designs to meet standards is a significant issue. We are not aware of any BASIX compliance studies but have reviewed non-compliance issues studies in other jurisdictions.

The compliance issue has been the subject of two respected reports, one by CSIRO for the Federal Department of Industry and one by pitt and sherry and Swinburne University of Technology for CoAG. The reports concern the significant non-compliance of new residences with the mandated building code. These reports do not cover the New South Wales BASIX code but it is unlikely that the compliance situation is significantly different in New South Wales. This non-compliance results in higher operating costs for residents/householders and higher greenhouse gas emissions than would be the case if these new residences complied with code requirements.

Despite the findings of these reports and their implications, thus far there appears to be little interest in taking action on remedying the situation. This is very surprising and worrying given the implications of this widespread non-compliance with the mandated code.

Key findings from the CSIRO study are summarised below.

Some key CSIRO study results

Rating results: Melbourne (Climate Zone 6)

Original design rating:	97 per cent ≥5-stars.	
Re-rating (tests on completed residence)	31 per cent ≥5-stars	17 per cent <4-stars.
	Over time (2003 to 2010) as rating requirements increased compliance has decreased.	

Meeting star rating requirements: Melbourne

Insulation:	16 per cent in poor condition.
	Large gaps left around downlights (safe light fitting coverings rarely used).
	Internal wall insulation rarely used.
Double glazing:	13.3 per cent in ≥5-stars.
	28 per cent of home owners thought they had double glazing.
Weather sealing:	20 Melbourne homes blower-door tested.
	10 to 15 ACPH at 50 Pa recommended.
	Average of tested homes 19.7 ACPH at 50 Pa.
	Only one home <10 ACPH at 50 Pa.
Lighting:	81 per cent inefficient halogens; 66 per cent thought they had efficient lighting.
Energy use:	50 per cent less gas for space heating in ≥5-stars due to efficiency and reverse cycle air conditioner (RAC) usage.
	8 per cent more electricity use in ≥5-star homes.

Two very important aspects of the CSIRO work are:

- the sample/cohort houses were re-rated **by physical testing** as-occupied; that is, after construction and the re-rated star-rating results compared with the **design** star ratings. We have been arguing the need for this over the past 10 years. Re-rating in the future would preferably be undertaken after construction completion but before occupation; and
- it provides a sample/cohort of houses (only detached) that can be monitored over time for energy use trends in these houses as they are modified, equipment/appliance use changes, weather changes and occupation characteristics change.

A key finding of the pitt and sherry/Swinburne study is that the building industry perceives little risk that cutting corners on energy performance will be discovered or, if it is, that there will be any serious consequences.

Over 2000 to 2015 we estimate that **new** building standards reduced space conditioning use/m^2 by about 30 per cent on average, allowing for non-compliance with design (which is significant) and rebound, as star ratings increased from about 3 in 2000 to 5 in 2005 and 6 in 2012. This is mainly based on examination of non-New South Wales' studies and data from distributors on energy use in new residences.

Average occupied area per household increased by about 15 per cent in new residences (BREE, May 2012, *Economic Analysis of End-use Energy Intensity in Australia* and *Average Floor Area of New Residential Buildings,* ABS Building Approvals, 8731, February 2010). And increased space comfort levels would have further offset the efficiency improvement from the new building standards. Allowing for **activity** increases, there was perhaps a net effect of a 10 per cent reduction in space conditioning and water heating energy use in new homes compared with **no** new building standards over 2000-2015.

These trends should be picked up by historical data for both electricity and gas used in modelling complemented by input data (economic, prices and household formation) for the future environment.

We consider that the impact of new building standards is adequately reflected in econometric modelling and, in this area, no post-modelling adjustments are necessary.

6. Minimum Energy Performance Standards (MEPS)

6.1 Introduction

Improving the energy efficiency of appliances and products has significant economic and environmental benefits for Australia by reducing greenhouse gas emissions and energy sales and demands. Energy efficiency improvement reduces the running costs of appliances and products for households and businesses thereby increasing energy productivity.

Up until October 2012, the main policy tools used to achieve reductions in energy use from these products were mandatory **Minimum Energy Performance Standards** (MEPS) and **Energy Rating Labels** (ERLs) which were first developed and implemented in the 1990s and steadily upgraded and extended to a greater range of appliances and products. Since October 2012, Australia's **Greenhouse and Energy Minimum Standards** (GEMS) legislation has commenced under the Equipment Energy Efficiency (E3) program.[4] Under the new legislation, the Australian GEMS Regulator will replace state regulators in enforcing regulations and creates a national framework by replacing seven overlapping pieces of state legislation within the Equipment Energy Efficiency (E3) framework. This framework aims to provide enhanced monitoring, verification and enforcement and allows the scope of the previous energy efficiency improvement initiatives to be expanded.

While there have been improvements in energy efficiency of many residential buildings and household technologies (refrigerators, furnaces, air conditioners, etc.) over the last 40 years, many efficiency gains have been offset by preferences for larger houses, increased air conditioning use and market penetration of a greater variety of new appliances and electronics. Hence, unless residential customers are actively engaged in more proactive home energy management activities, efforts to reduce household energy consumption will be constrained. That is, expansion of appliance and equipment energy use activities can more than offset energy efficiency improvement gains.

Table 6.1 shows Australian appliances and equipment covered by MEPs and energy labelling.

Major electrical appliances are subject to GEMS/MEPS performance standards and mandatory labelling under the national E3 (energy, efficiency, environment) program. As the standards and labelling initiatives have been operating since 1999 for major appliances, and as additional appliances have been gradually added (TVs, etc.), and as the performance standards have been and will in the future be gradually made more stringent, it is likely that the impacts of E3 initiatives will be adequately reflected in econometric projections.

We conclude post-modelling adjustments are not necessary for major electrical appliances.

[4] E3 is a joint initiative of the Australian Commonwealth, State and Territory Governments and the New Zealand Government.

Table 6.1	Australian appliances equipment covered by MEPS and labelling		
	MEPS	**Energy Rating Label**	**Australia**
Air conditioners – single phase	Yes	Yes	GEMS determination
Air conditioners – three phase	Yes	Yes Voluntary	GEMS determination
Air conditioners – evaporative	No	No	–
Air conditioners – single duct and portable	No	No	Under consideration
Ballasts for fluorescent lamps	Yes	Oth	GEMS determination
Battery chargers	No	No	–
Close control air conditioners (computer rooms)	Yes	No	GEMS determination
Clothes dryers	Yes	Yes	GEMS determination
Clothes washing machines	No	Yes	GEMS determination
Commercial chillers	Yes	No	GEMS determination
Compact fluorescent lamps	Yes	Oth	GEMS determination
Computers	Yes	No	GEMS determination
Computer monitors	Yes	Yes	GEMS determination
Data centres	No	No	–
Dishwashers	No	Yes	GEMS determination
Distribution transformers	Yes	No	GEMS determination
Electric motors (three phase)	Yes	Oth	GEMS determination
Electric storage water heaters	Yes	No	GEMS determination
External power supplies	Yes	No	GEMS determination
Fans – non-domestic	No	No	–
Gas space heaters	No	No	–
Gas storage water heaters	Yes	Labelled by industry group	GEMS determination
Heat pump water heaters	No	No	
Incandescent lamps	Yes (Australia only)	Oth	GEMS determination
Instantaneous electric water heaters	No	No	–
Instantaneous gas water heaters	Yes	Labelled by industry group	GEMS determination
Light emitting diodes	No	No	Under consideration
Linear fluorescent lamps	Yes	No	GEMS determination
Refrigerated display cabinets (RDCs)	Yes	No	GEMS determination
Refrigerated storage cabinets (RSCs)	No	No	Under consideration
Refrigerators and freezers (household refrigerating appliances)	Yes	Yes	GEMS determination
Set top boxes	Yes	No	GEMS determination
Solar water heaters	No	No	Under consideration

Table 6.1 Australian appliances equipment covered by MEPS and labelling (continued)			
	MEPS	**Energy Rating Label**	**Australia**
Street and public lighting	Yes Voluntary	No	–
Swimming pool pumps	No	Yes Voluntary	–
Televisions	Yes	Yes	GEMS determination
Transformers and converters for halogens	Yes	Oth	GEMS determination
Video game consoles	No	No	–
Video recorders	No	No	–

Source: energyrating.gov.au.

6.2 MEPS, GEMS for air conditioners

In 2011, as can be seen in Table 6.2 below, 64 per cent of households reported having at least one space cooler in use, up from 58.9 per cent in 2008, 54.1 per cent in 2005, and 43.5 per cent in 2002. Over the next 10 years the air conditioning penetration on this basis will approach 80 to 85 per cent.

Many households now have more than one air conditioner unit which are now mainly reverse cycle units which can also be used for space heating. On this basis (more than one unit per household), the overall penetration will exceed 100 per cent.

Table 6.2 Coolers in dwellings

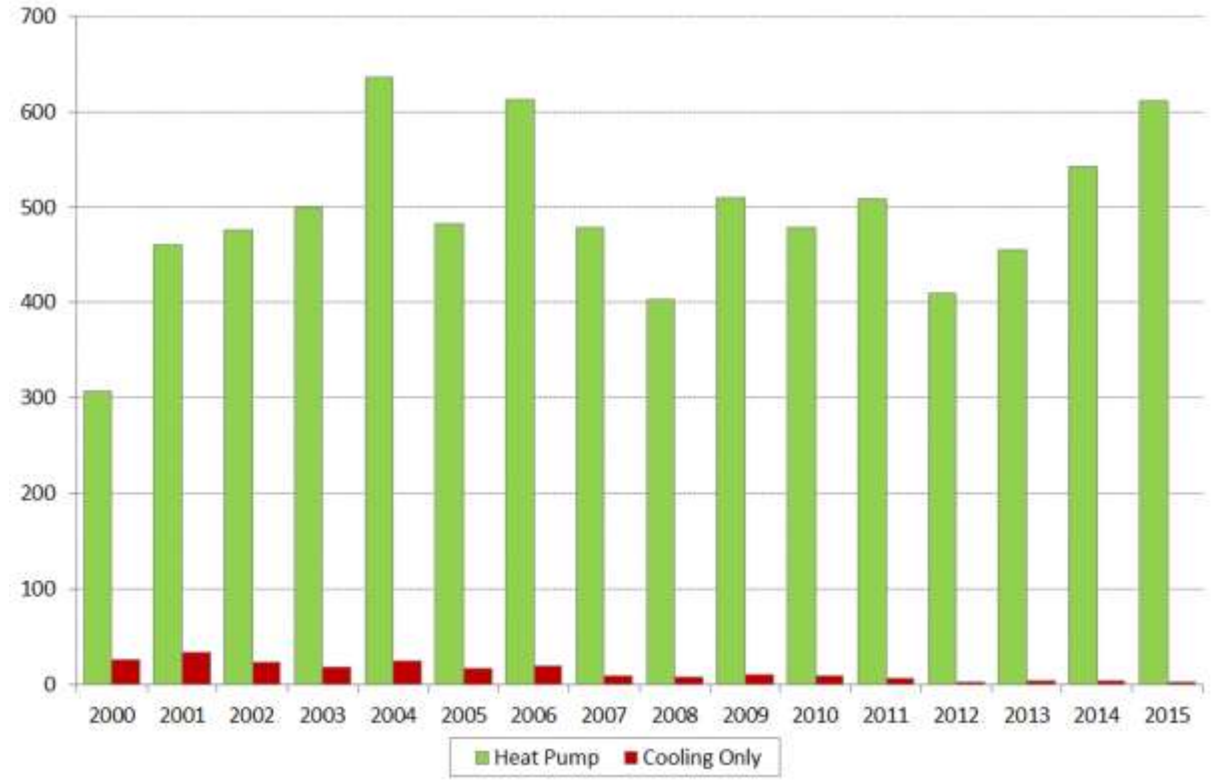
Year	Per cent of households with cooler, New South Wales
1994	30.8
1999	27.6
2002	43.5
2005	54.1
2008	58.9
2011	64.2
2014	64.0

Source: ABS Catalogue No. 4602.0.55.001, from Table 4.11, page 63 and NIEIR estimates.

Note also that the dominant air conditioner units sold are reverse cycle air conditioners which can be, and are increasingly, used for space heating in apartments and small townhouses. Efficiencies of air conditioning units have been improving over the past 15 years.

Regulatory requirements for air conditioners and heat pumps are now set under the GEMS Determination 2013, with this Determination set to come into force from 1 April 2014. This Determination will regulate multi-split air conditioners and heat pumps for the first time by calling up requirements set out in AS 3823.2-2013.

Figure 6.1: Sales of new air conditioning – New South Wales



Latest GEMS/MEPS actions are:

- **1 October 2011:** More stringent MEPS, as defined within AS/NZS 3823.2 – 2011, for all applicable products except ducted systems (from 10 kW to <19 kW, both single and three phase); and
- **1 April 2012:** More stringent MEPS, as defined within AS/NZS 3823.2 – 2011, for ducted systems (from 10 kW to <19 kW, both single and three phase).

Figures 6.2 to 6.6 show the coefficient of performance and the energy efficiency ratio over the period 2001 to 2015 by type of air condition system.

Figure 6.2: Efficiency and COP and MEPS for non-ducted split systems less than 4 kW

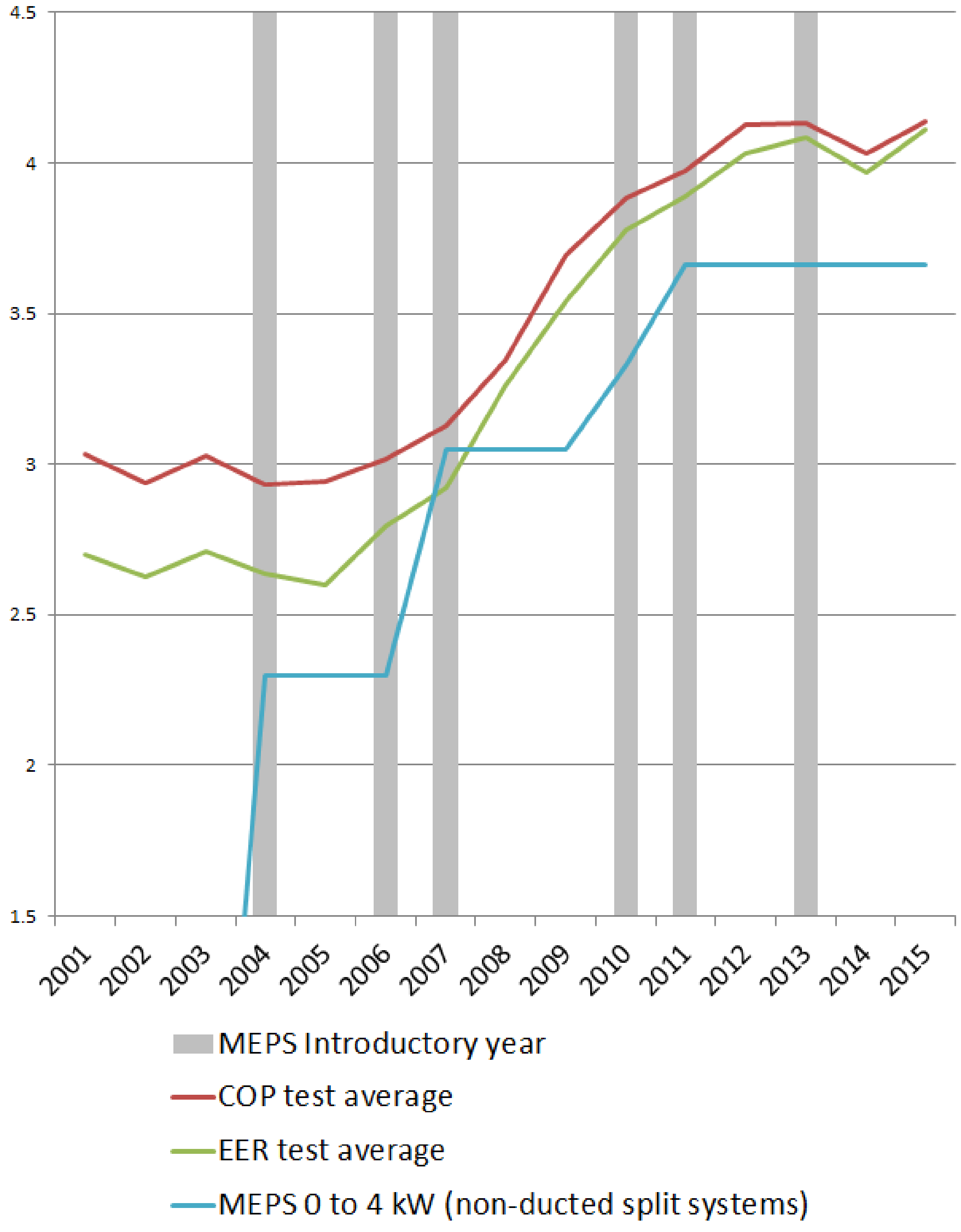


Figure 6.3: Efficiency and COP and MEPS for non-ducted split systems – 4-10 kW

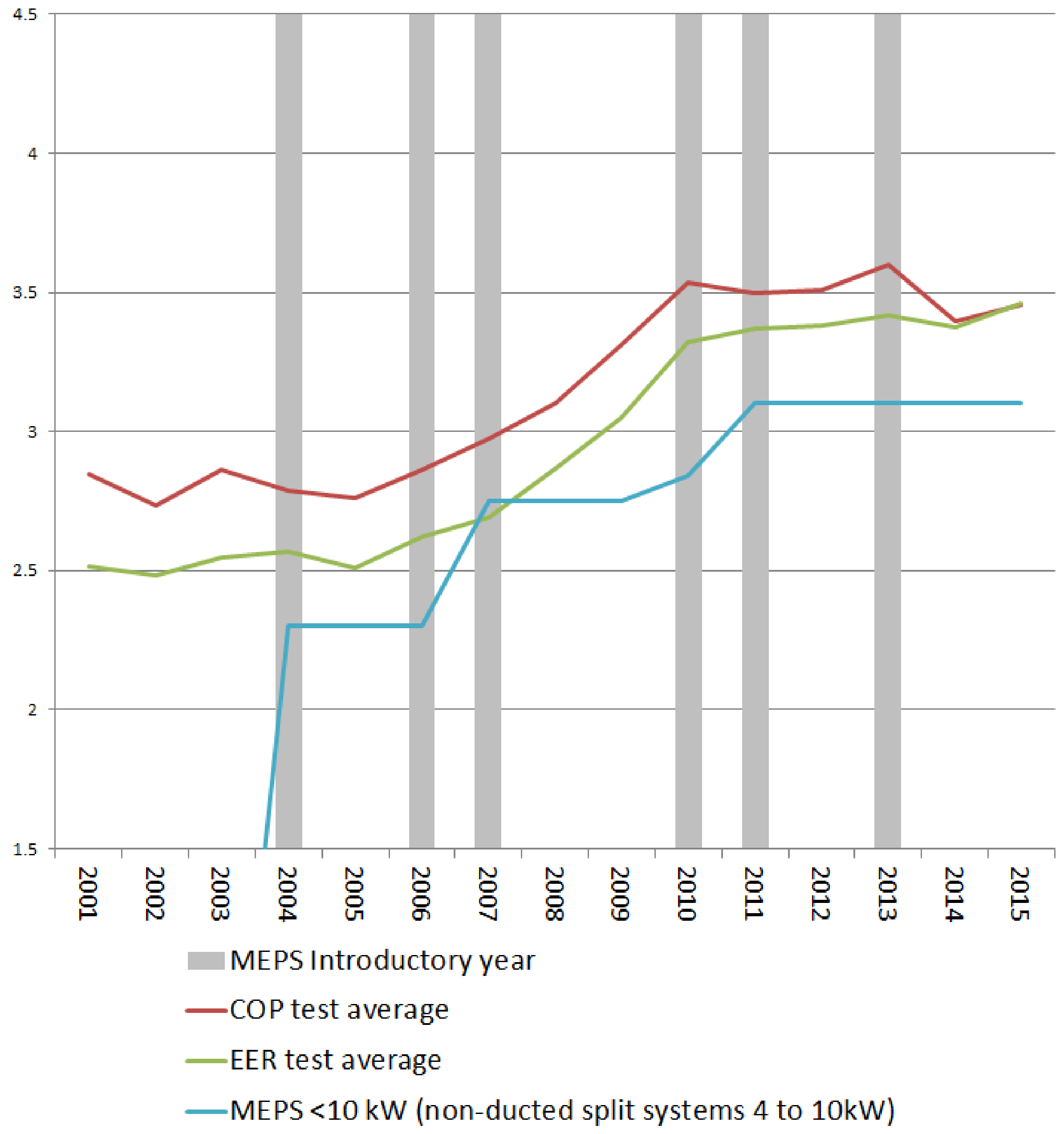


Figure 6.4: Efficiency and COP and MEPS for non-ducted split systems – 10-19 kW

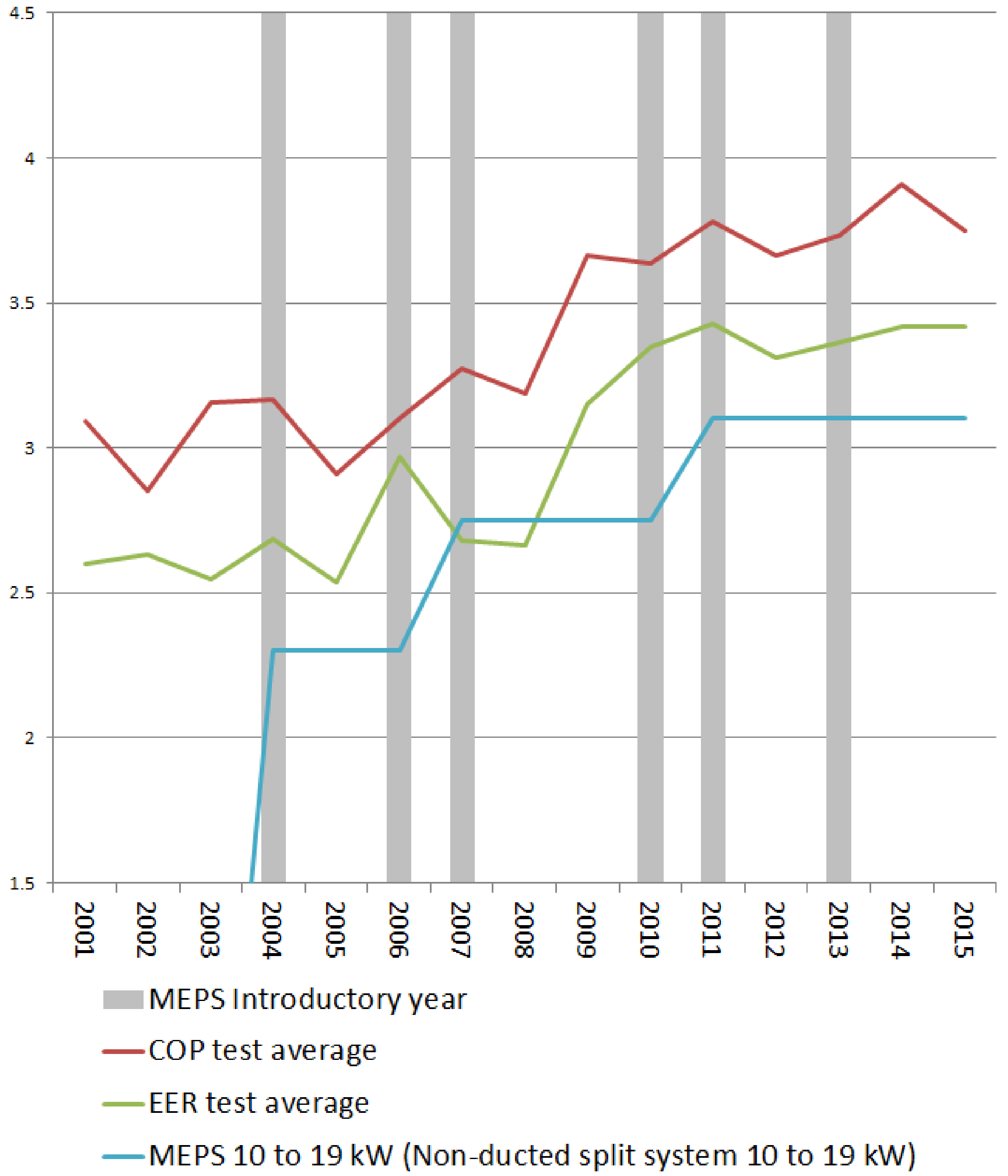


Figure 6.5: Efficiency and COP and MEPS for ducted systems – less than 10 kW

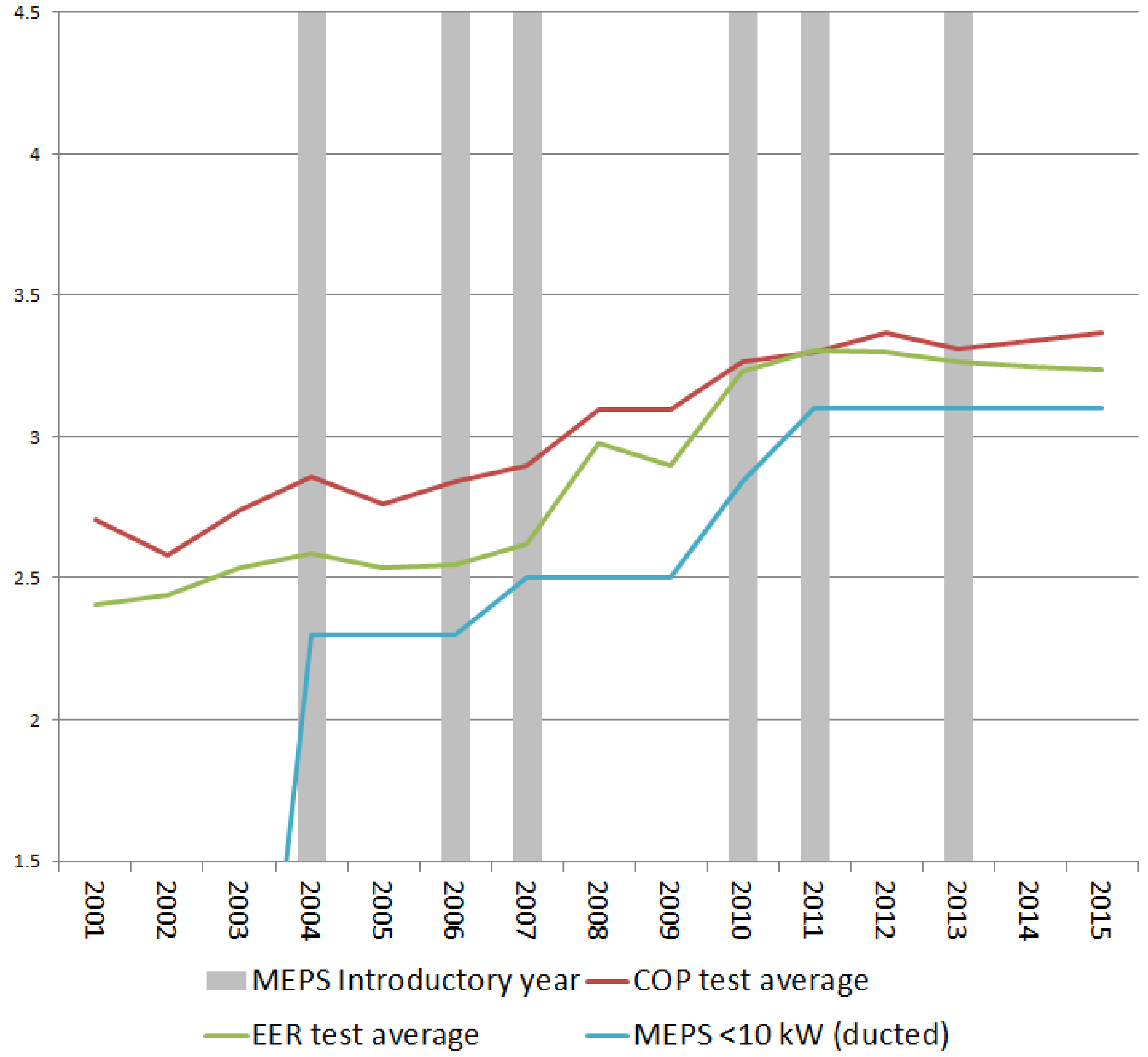
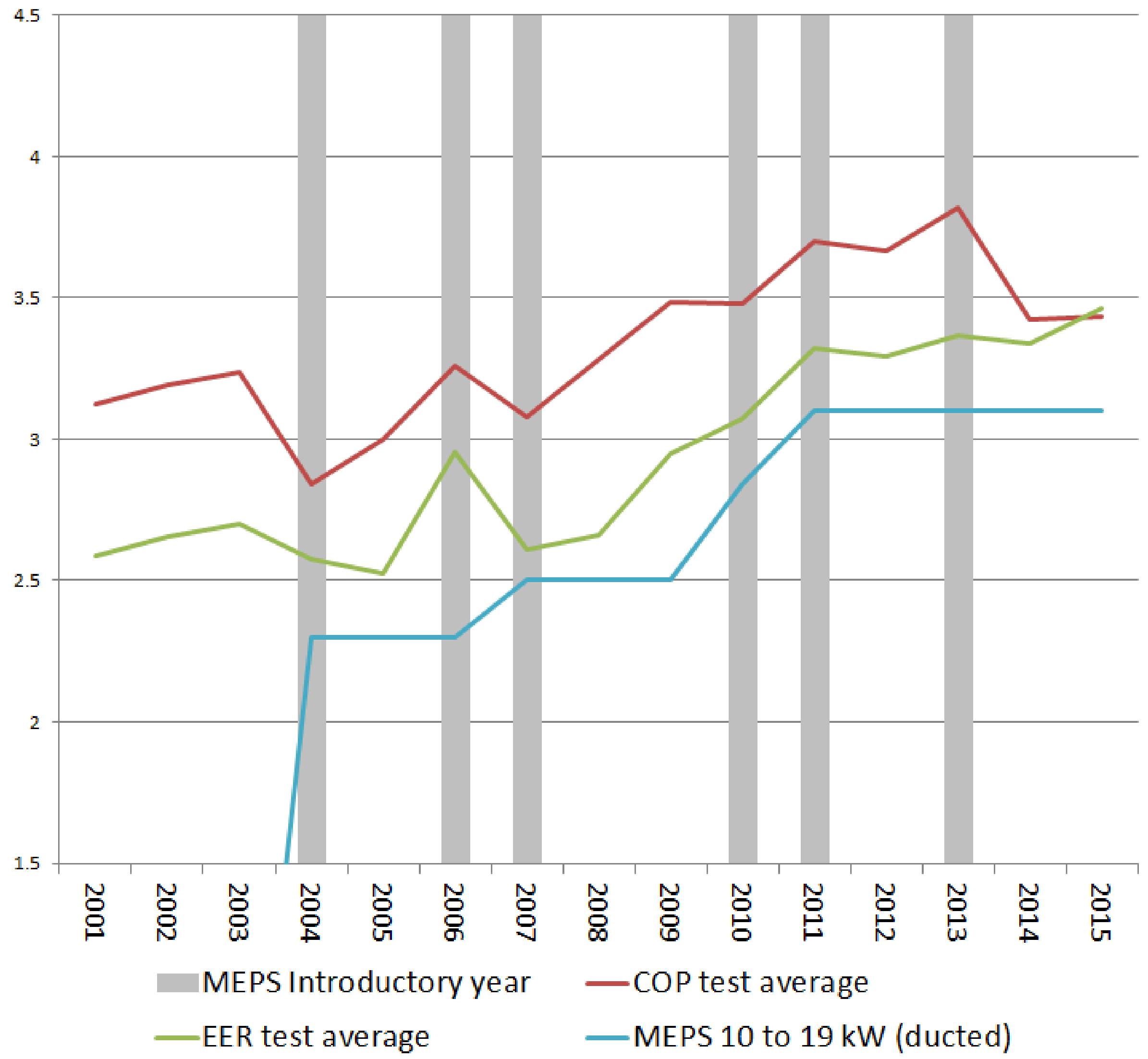


Figure 6.6: Efficiency and COP and MEPS for ducted systems – 10-19 kW



Currently no MEPS or energy labels apply to portable air conditioners in Australia. A Regulatory Impact Statement was released on 18 March 2016 covering these air conditioning equipment. These represent a small portion of the market but could be significant in older rental properties.

Given the marked increase in air conditioner efficiency over the last 15 years, we do not consider post-modelling adjustments are required.

6.3 Reverse cycle air conditioners (RACs)

The penetration of RACs continues to increase, as does their use for space heating where their high and increasing efficiencies are competitive with gas space heating.

RACs are increasing peak loads, which pose challenges for distributors, but their increased use for space heating is increasing their electrical energy demands in winter.

Table 6.2 indicates 64 per cent of New South Wales residences had air conditioning units in 2014, of which 52 per cent (or 81 per cent) were RACs which could potentially be used for space heating.

Table 6.3 shows the proportion of households in New South Wales using heaters by fuel type. The share of electric heaters has remained relatively stable over the last 10 years at around 44 per cent. Gas heating has increased and wood heating has fallen.

Table 6.3 Space heating proportion of New South Wales dwellings by fuel type – 1994 to 2014

	1994	1999	2002	2005	2008	2011	2014
Electric	46.3	42.2	44.4	44.3	43.1	44.0	44.3
Gas	19.7	21.9	23.7	21.2	21.2	22.4	24.8
Wood	17.1	14.8	11.8	10.9	10.3	11.4	10.2
Other	1.7	0.7	0.2	0.3	1.3	1.0	0.0
No heater used	11.7	17.8	18.3	22.5	23.9	18.9	19.5

Source: ABS 4602.0 various issues.

However, as data is not available on how much is used where RACs are installed, or potentially could be, it is not possible at this time to estimate the use, and potential use, of RACs for space heating in New South Wales. The actual and potential use is, however, significant, particularly in non-gas areas. Accordingly, distributors and retailers may consider further research on this issue.

It is noted that an increasing penetration of RACs in New South Wales will see a shift to more efficient electric space heating: that is, fewer rooms heated by electric resistance and radiant heating and more heated by RACs. Increasing availability of gas might also result in a shift of homes from electric resistance, but increased gas prices and restrictions around unflued gas in bedrooms is likely to hinder any strong growth in the use of gas for space heating. The growth in ducted and non-ducted RACs is more likely to result in a decline in winter peak demand from homes and potentially a decline in the number of winter peaking zones as electric resistance space heating declines.

Our conclusion is that no post-modelling adjustment for space heating use of RACs in New South Wales is feasible at this time.

7. Plug-in electric vehicles

The future penetration of EVs (plug-in only vehicles) is currently quite uncertain, but the potential impacts on the electricity system are significant, particularly post-2016. NIEIR, in association with other consultants, prepared EV forecasts for New South Wales DECCW in 2010-11 and estimates in this work were updated and used for EV projections and electricity system impacts in this study.

Impacts on the electricity system (MWs, GWhs) of these penetrations will depend on their actual on-road energy performance and use characteristics (kilometres travelled, charging time: levels and timing). MW impacts on peaks could be managed by time-of-use (tou) tariffs (with or without direct controls) and the use of smart grid techniques.

Post-modelling adjustments are necessary to consider as potential EV impacts are not included in econometric modelling forecasts.

7.1 Plug-in electric vehicles

There are three types of electric vehicles available to purchase in Australia. These include:

- Hybrid Electric Vehicles (HEV);
- Battery Electric Vehicles (BEV); and
- Plug-in Hybrid Electric Vehicles (PHEV).

Hybrid electric vehicles have been available since the early 2000s and combine the use of an internal combustion engine as well as an electric engine for propulsion. HEVs have improved fuel efficiency by utilising techniques such as regenerative breaking to store and power the electric engine. These do not place any additional load onto electricity networks as they do not plug-in to a charger for electricity as it is internally generated.

Battery Electric Vehicles use only an electric engine for propulsion by using stored electricity from a battery pack. These need to plug-in to a charger. Plug-in Hybrid Vehicles combine both an electric and an internal combustion engine, but are able to charge their batteries by plugging in. Both of these also make use of fuel efficient techniques to capture waste energy (braking, idling etc.). Collectively these are known as Plug-in Electric Vehicles (PEVs).

The PEV market in Australia is currently a very small niche within the car market. While future penetration still remains uncertain, PEVs do have the potential to have a substantial impact on energy sales and peak demand.

Hydrogen Fuel Cell Electric Vehicles are also starting to go on sale with the Hyundai Tucson Fuel Cell introduced into the US in 2015. These could displace some of the demand for clean vehicles that would otherwise be met by PEV sales.

7.2 The market for plug-in electric vehicles

The Centre for Solar Energy and Hydrogen Research (ZSW) reports that there were around 550,000 plug-in electric vehicles registered worldwide over 2015, which increased the total global fleet by 74 per cent to 1.3 million plug-in electric vehicles. The top 3 leading countries for PEV sales are the USA, Japan and China[5] with current fleet sizes of over 400,000 for the USA and about 150,000 for Japan. China, registered around 200,000 electric vehicles in 2015 which increasing China's stock to about 350,000. Collectively, these markets make up about 70 per cent of the plug-in electric vehicles sold to date.

Sales in these markets are driven largely by non-economic factors. Reasons for early adoption of PEV's include:

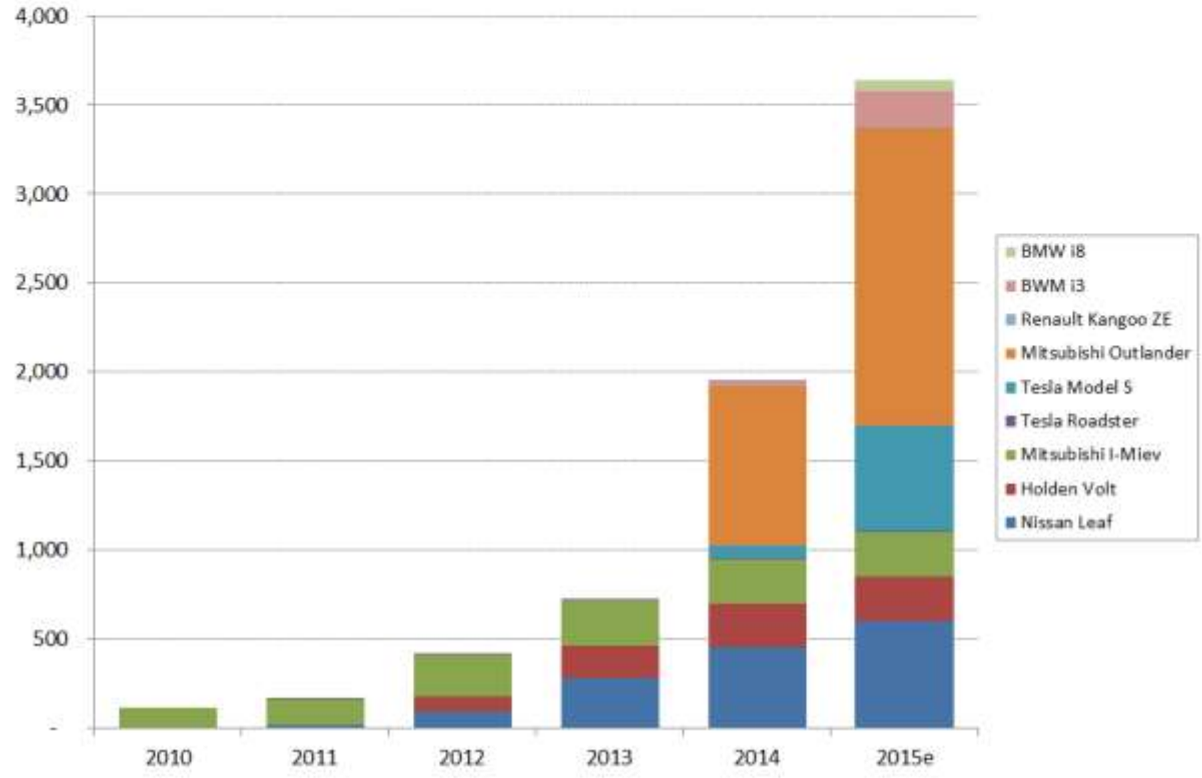
- generous government incentives that reduce the costs of ownership (USA). The USA offers incentives that reduce the cost premium of PEVs, and some states also subsidise private charging infrastructure; and
- concern over air quality, urban pollution and a means to reduce carbon emissions (China, California).

By comparison Australia represents only a very small proportion of on road plug-in electric vehicles. By the end of 2015 there were about 3,600 PEVs sold to date, about half of the sales over 2014 and 2015 were due to the release of the Mitsubishi Outlander PHEV. Total sales for 2014 reached 1,185, and approximately 1,650 for 2015. The sales for the past year represent 0.14 per cent of total vehicles sold within Australia. In 2015 the Mitsubishi Outlander PHEV and the Tesla Model S were the dominant plug-in electric vehicles sold. Many of the Model S vehicles have been sold in Victoria and New South Wales, where Tesla has focused on building the early stages of the supercharger network that connects main highways along the east coast of Australia.

Figure 7.1 summarises the stock of plug-in electric vehicles on Australian roads to the end of 2015. This shows the number of cars on Australian roads doubling from 2013 to 2014, and increasing by about 85 per cent from 2014 to 2015. The Australian market differs from the leading markets by the absence of any substantial government incentive program. However, there are small incentives available in Victoria and the ACT that reduce on road costs. Victorians are eligible for a discount on registration, and PEVs registered in the ACT are exempt from stamp duty and luxury vehicle taxes. Currently there are no incentives that directly reduce the upfront cost of vehicle ownership; or reduce the cost of private charging infrastructure.

[5] http://www.zsw-bw.de/en/support/news/news-detail/mehr-als-740000-autos-weltweit-fahren-mit-strom.html.

Figure 7.1: Australian cumulative sales of plug-in electric vehicles



Note: December quarter, 2015 sales are estimates.
Source: Compiled from various sources.

The on road vehicles are currently comprised of around 60 per cent plug-in hybrid vehicles, and 40 per cent battery electric vehicles.

Table 7.1 summarises the vehicles currently available for purchase in Australia, and the range, energy consumption per kilometre and battery size for each vehicle. The cheapest PEV on the market remains the Nissan Leaf at 36,000 before on-road costs.

Over the past two years first entrants into Australia have started to withdraw models from the market due to low sales. The Mitsubishi i-Miev stopped selling in 2014, and Holden has no plans of offering the next Volt model to Australian customers, with the last Volt sold in early 2015. However, the Nissan Leaf remains relatively popular selling 173 vehicles in 2014, down from a high of 188 in 2013. The withdrawal of these vehicles provides some evidence that the small car market is too expensive for the ordinary consumer (more price elastic/income constraints), with price premiums on a Nissan Leaf to a comparable petrol car of around $15,000 to $20,000.

Following the success of the Tesla Model S and the Mitsubishi Outlander, the majority of the new release vehicles into the Australian market over the next year are also targeting the luxury car market, SUV market or both markets. There is little on offer for small to medium passenger commuters. Table 7.2 summarises the release schedule for new plug-in electric vehicles.

Table 7.1	Summary of plug-in electric vehicles available in Australia					
Make and model	**Type**	**Release year**	**Wh per km**	**Range (km)**	**Battery capacity (kWh)**	**2015 Sale price ($AUD)[2]**
Tesla Roadster	BEV	2010	231	340	53	191,888
Mitsubishi i-Miev	BEV	2010	135	150	16	48,800
Nissan Leaf	BEV	2011	173	175	24	36,000
Holden Volt	PHEV	2012	135	87	16.5	59,990
Porsche Panamera S E-Hybrid	PHEV	2013	162	36	9.4	299,200
Renault Kangoo[1]	BEV	2014	155	170	22	n/a
Tesla Model S	BEV	2014	181	390	60	91,400
Tesla Model S	BEV	2014	181	502	85	103,400 to 119,900
Mitsubishi Outlander	PHEV	2014	134	52	4.5	47,490 to 52,490
BMW i3	BEV	2014	129	190	22	63,900
BMW i3	PHEV	2014	115	170	22	69,900
BMW i8	PHEV	2015	119	37	7.1	299,000

Notes:
1. Renault Kangoo currently in limited trials in Melbourne.
2. If not available for sale in 2015, price is the latest new car price available. Excludes government charges and on-road costs.

Source: Model and technical details from *Green Vehicle Guide*. Sales pricing data compiled from various sources.

Table 7.2	Release schedule for new plug-in electric vehicle models		
Make and Model	**Type**	**Body**	**Timing**
BMW 330e	PHEV	Sedan	May, 2016
BMW X5 xDrive40e	PHEV	SUV	May, 2016
Mercedes-Benz C 350e	PHEV	Sedan	May, 2016
Mercedes-Benz S 500e	PHEV	Limousine	May, 2016
Volvo XC90 T8 and R-Design	PHEV	SUV	Q2, 2016
Tesla Model X	BEV	SUV	September, 2016
Mercedes-Benz GLE 500e	PHEV	SUV	Oct, 2016
Audi Q7 e-tron	PHEV	SUV	2016 Q4
Hyundai Ioniq	BEV/PHEV	Hatch	2017
Porsche Macan S E-Hybrid	PHEV	SUV	TBC

Source: Motoring.com.au, New Car Calendar.

7.3 Public charging infrastructure

Public charging stations are necessary to provide support to a growing market of plug-in electric vehicles. An established network will help to overcome the limitations of the range a PEV can travel under a full battery, this is especially an issue when driving a BEV, as there is no petrol engine to extend the vehicle range.

Public charging stations are available at a range of demand levels. Higher demand stations will be able to charge a vehicle, such as a Tesla supercharger, much more quickly than a standard wall outlet. A Tesla Model S can charge up to 50 per cent of the battery in 20 minutes from a supercharger, while a standard wall outlet will take over 24 hours to fully charge a Model S. Many of the wall outlet chargers are not specifically in place for PEVs, but are available to use at places such as caravan parks in remote holiday destinations.

The availability of public charging stations gives an indication of the demand for plug-in electric vehicles within a given region. NIEIR have tabulated the number of charging stations available in New South Wales by demand, and by distributor region. Commonly, there are multiple charging stations per location.

There are around 67 charging stations in the Ausgrid region, 30 in Endeavour Energy, and 61 in the Essential Energy region. Public charging infrastructure tends to be overrepresented in both the Ausgrid and the Essential Energy regions, and underrepresented in the Endeavour Energy network. Endeavour Energy only contains 12.5 per cent of Level 2 and above public charging stations within New South Wales, while Endeavour Energy's state electricity demand share ranges from 23 to 30 per cent, depending on the measure.

Ausgrid is likely overrepresented because of early electric vehicle trials by the network (such as those included in the *Smart Grid, Smart City* trial). In addition, early adopters of PEVs are likely high income households. The northern suburbs of Sydney and coastal suburbs, which are mostly in the Ausgrid region, generally have higher average wages compared to households south-west of the Parramatta River, which are within the Endeavour Energy region.

Essential Energy is likely overrepresented because of the construction of intra and interstate networks of fast chargers, allowing PEV owners to travel between capital and regional cities.

For this reason the stock and sales of PEVs into the Endeavour region are discounted relative to Endeavours share of New South Wales demand in the short term. Post-2020 it is assumed the market for PEVs in the Sydney region will rebalance, and therefore the PEV market shares will too.

Table 7.3 NSW public charger availability by distributor region, May 2016

Type	Demand	Distributor			New South Wales Total
		Ausgrid	Endeavour Energy	Essential Energy	
Number of public charging stations					
Level 1 (Wall Outlet)	2.4kW	18	17	19	54
Level 2	6.6 kW to 22 kW	39	13	23	75
Fast chargers	50 kW +	10	0	19	29
Total		**67**	**30**	**61**	**158**
Per cent share					
Level 2 and above		47.1%	12.5%	40.4%	100%
All public charging stations		42.4%	19.0%	38.6%	100%

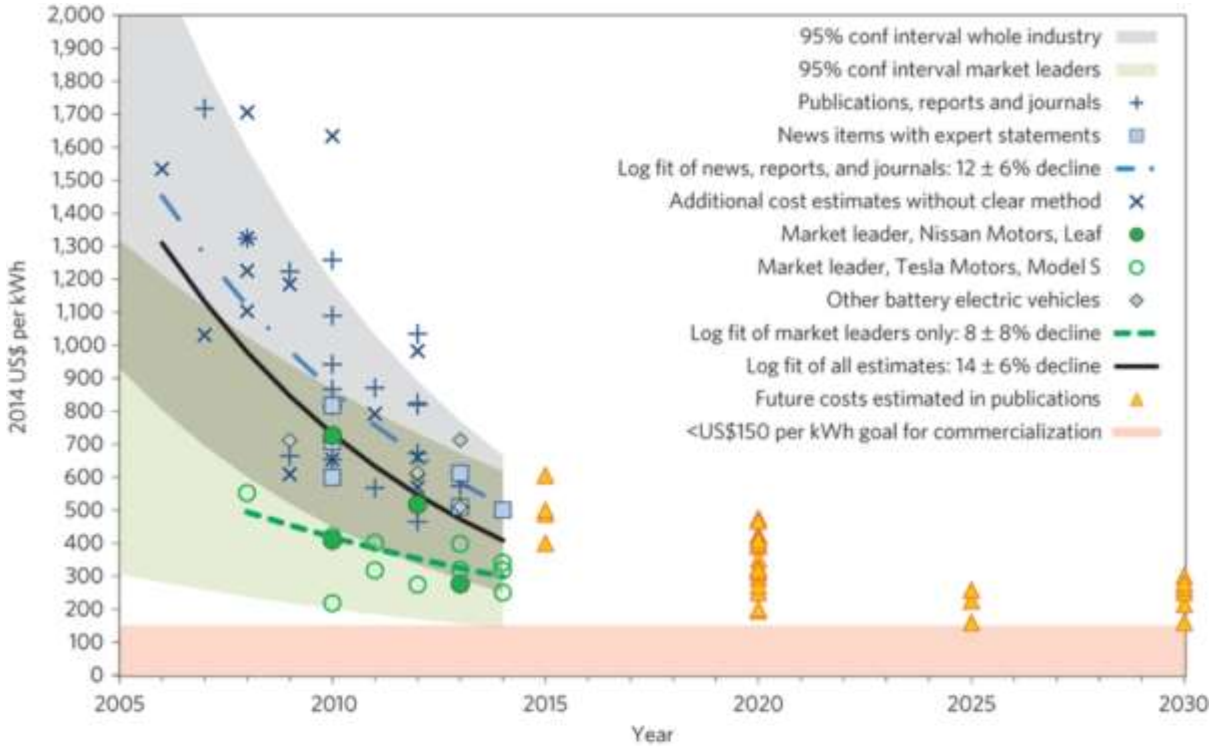
Source: PlugShare.com, accessed 2/05/2016.

7.4 Limits of plug-in electric vehicle ownership

PEV's currently sell at a substantial premium in comparison to similar vehicles with an internal combustion engine. For example, a consumer going to purchase a small car could purchase a Nissan Leaf for $39,990 or a new Nissan Pulsar for around $20,000 to $25,000. This represents a prohibitive purchase premium of $15,000 to $20,000.

A large proportion of the purchase premium is due to the cost of battery storage technology which is expected to fall substantially over the next five years. Battery costs in Figure 7.2 compiled by Nykvist and Nilsson (2015) show an exponential decline in historical costs.[6] With the current cost of storage approximately $450 USD per kWh (based on all estimates) or around $350 USD per kWh based on reported Nissan and Tesla numbers. The market leading Tesla could reduce these costs to $175 USD per kWh through improvements in technology and economics of scale with the completion of companies "Gigafactory". Tesla aims to reach a production capacity of 500,000 units by 2020.[7]

Figure 7.2: Cost of battery storage



Source: Nykvist and Nilsson (2015), "*Rapidly falling costs of battery packs for electric vehicles*", *Nature Climate Change 5 329-332.*

Further cost improvements could be driven by increasing interest in battery storage for stationary applications, for example, coupled with photovoltaic systems in residential or commercial sectors. A separate post-modelling adjustment is estimated to account for displaced exports during the middle of the day to charge the battery, and discharge during peak times.

6 Exponential trend may be overstated due to greater uncertainty of earlier battery costs.

7 http://nextbigfuture.com/2015/07/tesla-gigafactory-on-track-to-begin.html.

The Mitsubishi Outlander has a relatively small purchase premium in part due to the small battery pack of 4.5 kWh. However, the premium is still around $10,000 to $15,000 as the PHEV requires equipment for both electric and petrol engines.

The paybacks of an electric vehicle will also be affected by the price and source of electricity used to charge the battery. Australia has one of the highest grid prices of electricity, which acts as a barrier when compared to other countries. However, many early adopters of PEV's are also likely to have rooftop PV systems. In this case, the operational charging cost of an electric vehicle would be close to zero if it was able to be charged from electricity generated by the sun.

The kilometre range of the PEVs is limited by the expense and effectiveness of current battery technology. Further distances require a larger and more expensive battery. The rated distance for a top of the range Tesla Model S is 502 kilometres, with a massive 85 kWh battery system. While the Nissan Leaf currently can achieve a total 175 kilometres from a 24 kWh battery system, which is more typical of most PEVs. The next generation of PEVs is expected to have an improved range. For example, the Chevorlet Bolt will have a range of about 300 kilometres while being more affordable than a Tesla. At this stage it is uncertain whether Holden will bring the Bolt to the Australian market.

However, the actual distance travelled from a fully charged battery is likely to be much less under real world conditions. Performance is affected by road conditions and climate controls for heating and cooling. Energy requirements used in NIEIR's electric vehicle model encompass actual on road performance.

Other limits and barriers to penetration include:

- length of time to charge the battery;
- relative upfront and operating costs (current low price of oil) of internal combustion engine vehicles;
- availability of public charging infrastructure; and
- cost of installing faster private charging stations at residence.

7.5 Forecast uptake of PEVs in New South Wales

The market penetration model includes exponential uptake over 2016 to 2026 informed by plug-in electric vehicle paybacks, market surveillance, and peer reviews of related studies. The penetrations of plug-in electric vehicles are linked to NIEIR's forecasts of sales of National and State passenger and light commercial vehicles (historic sales and vehicle registrations from ABS). The market model is segmented by electric vehicle fuel type (battery electric vehicles versus plug-in hybrid electric vehicles), and by vehicle type (passenger, light commercial and taxi vehicles).

In the absence of any substantial government incentive, adoption of electric vehicles in Australia is limited by the cost of ownership and the purchasing preferences of Australian consumers. Wide spread adoption could be delayed until PEV's become cost competitive through market forces alone. Accordingly, the PEV market is expected to remain a growing niche of the total car sales market over the next five years. As shown in Table 7.4, by 2020, total PEV sales are expected to account for 1.8 per cent of overall NSW annual vehicle sales.

With the introduction of more mass market PEVs, reduced battery costs and more favourable economics, sales penetration is expected to accelerate over the ten years following 2020. PEV sales will account for around 10.8 per cent of total sales by 2026. In New South Wales, annual sales are expected to increase from around 1,000 in 2016 toward 46,000 per annum by 2026.

The fleet of New South Wales plug-in electric vehicles on road will reach 160,000 by 2026, from a negligible amount on roads in 2015. PEV's are assumed to have an average life of around 10 years.

Over the short term, PHEVs are assumed to be the most popular type of electric vehicle sold. Most new models to be released over 2016, with the exception of Tesla vehicles, are PHEVs. PHEVs may help alleviate consumer concerns about the current limited electric range. As battery technology becomes more competitive, and more mass market BEVs are released, the share of BEV and PHEV will be balanced.

Table 7.5 contains a further segmentation of BEV and PHEV by vehicle class. Due to favourable travel economics there is expected to be increased penetration into light commercial and taxi vehicle types. As these vehicles have higher annual travel kilometres, and the more one travels the greater the realised running cost savings (savings on maintenance and repairs, and fuel cost compared to petrol engines).

Table 7.4 Plug-in electric vehicle market – Sales and stock of battery electric vehicles and plug-in hybrids vehicles, New South Wales

	NSW New vehicle sales	Sales penetration - BEV	Sales penetration - PHEV	Sales penetration - Total PEV	Annual sales - BEV	Annual sales - PHEV	Total PEV sales	Total PEV stock	PEV share of NSW vehicle stock
	number	per cent	per cent	per cent	number	number	number	number	per cent
2016	365,189	0.09	0.18	0.27	329	657	986	2,074	0.04
2017	371,641	0.18	0.33	0.50	650	1,208	1,858	3,932	0.07
2018	378,093	0.28	0.49	0.76	1,040	1,834	2,874	6,803	0.12
2019	384,546	0.43	0.61	1.04	1,634	2,346	3,980	10,778	0.19
2020	390,998	0.90	0.90	1.80	3,519	3,519	7,038	17,801	0.30
2021	397,450	1.15	1.15	2.30	4,571	4,571	9,141	26,910	0.44
2022	403,902	1.50	1.50	3.00	6,059	6,059	12,117	38,965	0.62
2023	410,354	2.00	2.00	4.00	8,207	8,207	16,414	55,260	0.86
2024	416,806	2.60	2.60	5.20	10,837	10,837	21,674	76,713	1.17
2025	423,258	4.50	4.50	9.00	19,047	19,047	38,093	114,275	1.71
2026	429,711	5.90	4.90	10.80	25,353	21,056	46,409	159,734	2.34

Table 7.5	Plug-in electric vehicle market – Stocks of passenger, light commercial and taxi vehicles, New South Wales						
	Passenger (no.)		Light commercial (no.)		Taxis (no.)		
	BEV	PHEV	BEV	PHEV	BEV	PHEV	Total PEV
2016	699	1,180	59	126	2	5	2,071
2017	1,268	2,154	137	343	5	21	3,929
2018	2,177	3,633	262	673	10	45	6,800
2019	3,606	5,523	458	1,095	18	75	10,775
2020	6,680	8,355	880	1,726	36	121	17,798
2021	10,667	12,029	1,427	2,546	59	180	26,907
2022	15,944	16,890	2,150	3,631	89	258	38,962
2023	23,076	23,461	3,129	5,097	130	364	55,257
2024	32,466	32,113	4,416	7,027	183	504	76,710
2025	48,907	47,261	6,671	10,407	277	748	114,272
2026	70,685	63,861	9,658	14,111	402	1,015	159,731

7.6 Plug-in electric vehicle impacts on annual energy consumption

Estimates of annual energy requirements are achieved by applying annual travel kilometres and energy requirements per kilometre to the stock of PEVs.

Annual energy consumption for the PEV fleet depends upon the annual travel characteristics of New South Wales electric vehicle users. New South Wales annual travel characteristics were taken from the ABS (2015) *Survey of Motor Vehicle Use.* Most of the travel is assumed to be around capital cities, rather than interstate and regional. An extensive fast charging network may change this dynamic. Tesla has already begun building an east coast network that contains superchargers along major interstate highways.

PEV's are rated by the *Green Vehicle Guide* in terms of the energy requirement per kilometre. Forecasts of on road energy usage for BEV and PHEV types were developed by applying results from trials and simulations to the tested ranges from the *Green Vehicle Guide*. Forecasts include an efficiency improvement of around 1 per cent per annum (Table 7.7).

Table 7.6 Annual travel characteristics by vehicle class, New South Wales

Vehicle class	Annual travel
Passenger	12,900 km per annum
Light Commercial	17,800 km per annum
Taxis	151,000 km per annum

Source: ABS, *Survey of Motor Vehicle Use, Australia,* 12 months ended 31 October 2014.

Table 7.7 Energy requirements per kilometre of travel for plug-in electric vehicles

Year	BEV kWh per km	PHEV kWh per km
2016	0.20	0.25
2017	0.19	0.24
2018	0.19	0.24
2019	0.19	0.24
2020	0.19	0.24
2021	0.19	0.23
2022	0.18	0.23
2023	0.18	0.23
2024	0.18	0.23
2025	0.18	0.22
2026	0.18	0.22

Source: NIEIR estimates, based on a range of Australian and global studies.

7.6.1 Allocation of energy impacts by tariff class

A more detailed allocation of PEVs into the requested tariff classes was achieved by using the mix of vehicle classes (passenger, light commercial and taxi) and is informed by private individual or private/public firm ownership. These will determine where PEVs are charging, whether it is for example, at a private household, at a workplace or in a car park with many public charging stations. These could be examples of charging taking place at a residential, commercial or industrial tariff customer location respectively.

According to the Ausgrid *Smart Grid, Smart City* trial most PEV owners are currently charging at home. The trial results found that 80.8 per cent charged at home, 17.7 per cent at work and 1.5 per cent roaming (various charge points).

For passenger vehicles, this proportion was adopted in 2016 and the share of households charging at work or at public charging stations is expected to increase as this infrastructure becomes more available. This is also due to increasing use of passenger vehicles by the commercial sector.

For light commercial vehicles, there will be a much greater proportion of vehicles charging on a commercial tariff – either at work or from a public charger. However, there will still be some light commercial vehicles charging on a residential tariff e.g. some utility/vans. Taxis are expected to charge almost exclusively from commercial tariffs, and later industrial tariffs

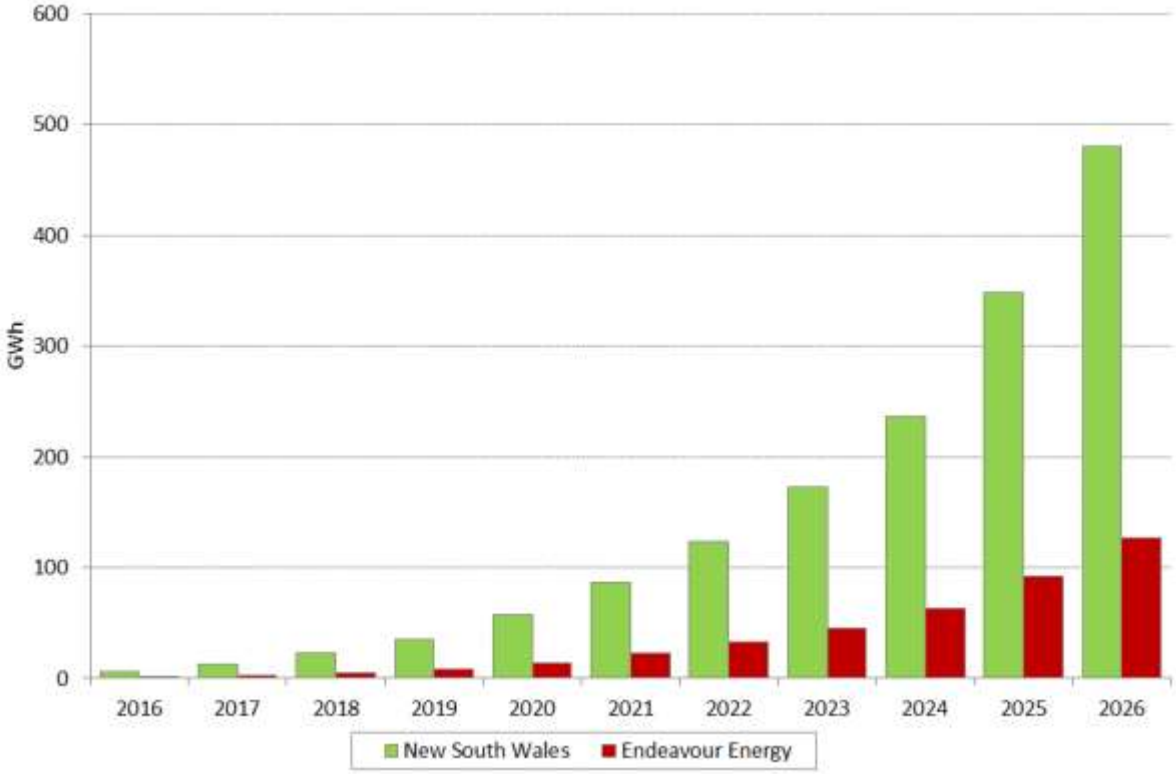
A small proportion may be charging from an industrial tariff, especially if there are many charging stations within a single location (e.g. shopping centre car park, taxi rank). However, large banks of charging stations will require a more developed PEV market.

7.6.2 Forecast of annual energy impacts

Figure 7.3 shows the total forecasts of annual energy post-modelling adjustments for New South Wales and Endeavour Energy.

Over the next five years there is only a minimal impact on annual energy consumption, especially for the Endeavour Energy region with a lower penetration of PEVs. By 2026 PEVs are expected to use 480 GWh in NSW, and 127 GWh in the Endeavour Energy region. This makes up less than 1 per cent of forecast annual NSW electricity consumption.

Figure 7.3: Total PEV annual energy consumption (GWh)



7.7 Plug-in electric vehicle impacts on summer and winter peak demand

Electric vehicles can either charge at a public/workplace location or at a private residence. Public and workplace charging stations have the capability of achieving a much higher demand, and faster charge. Fast chargers of up to 50 kW are available to use. Maximum for a private residence is around 7kW that would require additional charging infrastructure installed in the garage or the side of a house.

Peak demand impacts are estimated by applying a weighted average demand for PEV chargers to the number of electric vehicles charging at summer or winter peak demand. These are informed by current and future charger availability and use. The following assumptions apply to public and private charging stations:

- public weighted average charging: 14.6 kW; and
- private weighted average charging: 4.1 kW.

NIEIR have developed theoretical intra-daily profiles of PEV charging by private or public/workplace locations. These are informed by trial results, and literature on electric vehicles.[8] Robinson et al (2013) found in a trial involving data from 7,704 vehicles that there was minimal charging during off peak hours (time-of-use tariffs were available in region).

Private charging locations are most frequently used during the evening, when commuters return home from work. Public stations are used throughout the day, but there is a late morning/ midday peak when commuters plug into chargers when they arrive at work. Stronger price signalling through tariff structure, and managed smart charging are likely and thus will alter these profiles.

Currently, impacts are assumed to occur at around 4.30pm for summer peak demand and 6.30pm for winter peak demand. NIEIR's model is able to shift the timing of coincident charge according to the daily charging profiles in Figure 7.4.

Electric vehicles are apportioned according to the charging location assumptions developed under the energy impacts. Vehicles can either charge at a residential, commercial or industrial location. The percentage of vehicles charging at summer peak by class is assigned by multiplying the proportion charging at each location, by the proportion at peak demand by private or public locations.

[8] For example, Ausgrid –Smart Grid, Smart City and "*Analysis of electric vehicle driver recharging demand profiles and subsequent impacts on the carbon content of electric vehicle trips*" by Robinson et al (2013).

Figure 7.4: Daily charging profiles for private and public locations

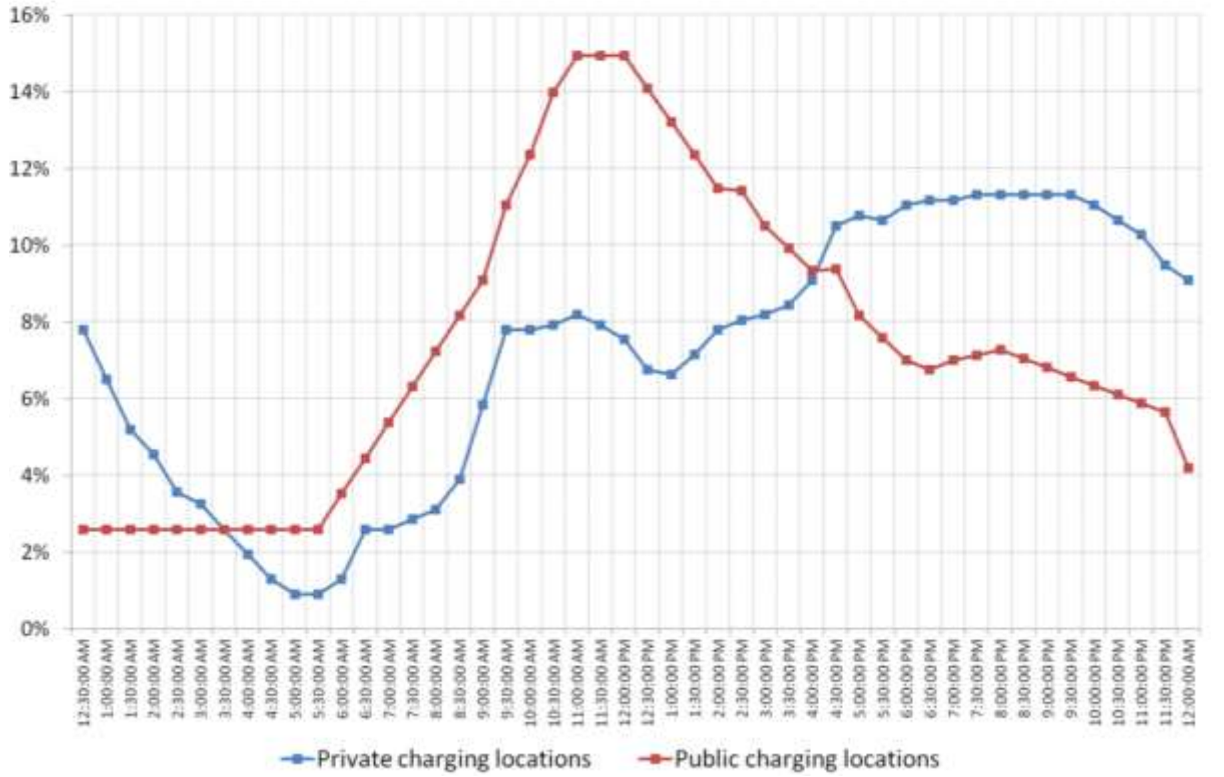


Table 7.8 shows the weighted average per cent share of PEVs charging at peak demand across all electric vehicle types and locations. Approximately 10 per cent of vehicles are charging at summer peak, and 9.5 to 11 per cent at winter peak. Proportions are declining due to the increasing availability of public and workplace charging infrastructure as the market matures, increasing share of commercial vehicles and risk of stronger tariffs and smart charging regimes.

Table 7.8 Average share of PEVs charging at summer and winter peak demand (per cent)

Year	Summer	Winter
2016	10.3	10.9
2017	10.2	10.3
2018	10.2	10.1
2019	10.2	10.0
2020	10.2	10.0
2021	10.1	9.9
2022	10.1	9.7
2023	10.1	9.6
2024	10.1	9.4
2025	10.1	9.5
2026	10.1	9.5

7.7.1 Forecast of summer and winter peak demand

Figure 7.5 and 7.6 show the total demand from electric vehicles at summer and winter peak demand. The impact at summer peak demand is forecast to reach 124 MW in summer and 104 MW in winter by 2026.

Figure 7.5: Total PEV impact on summer peak demand (MW)

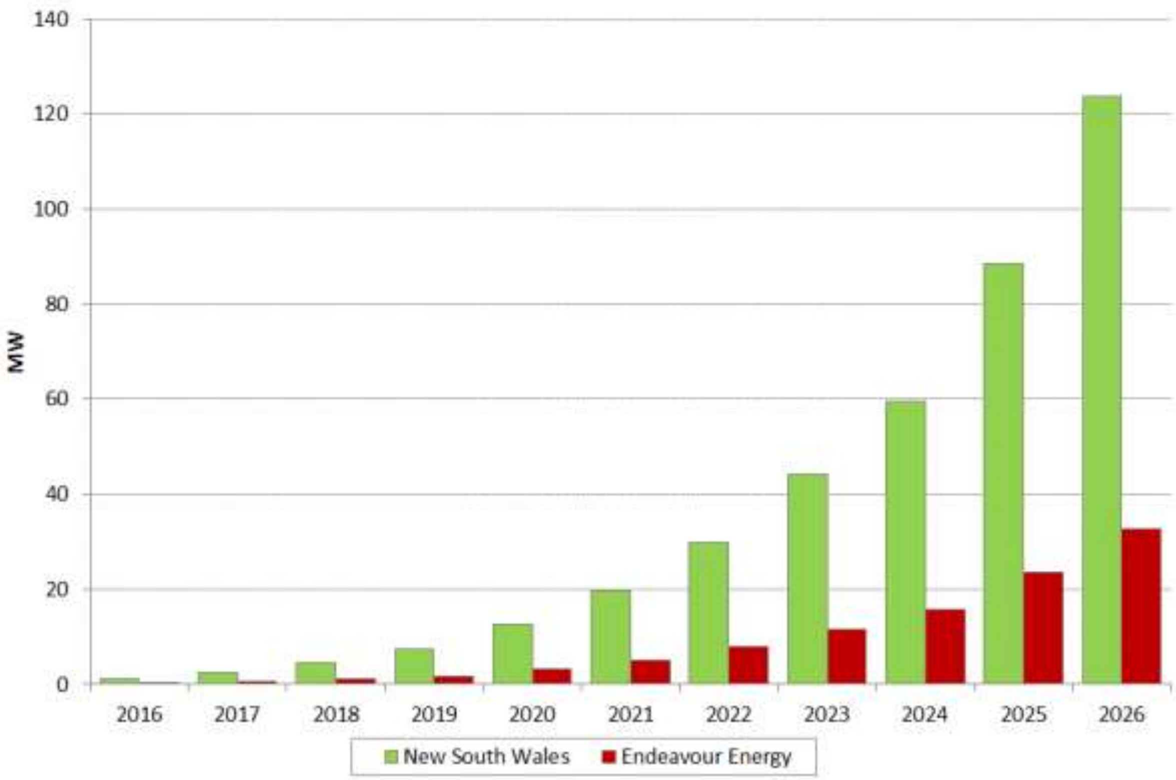
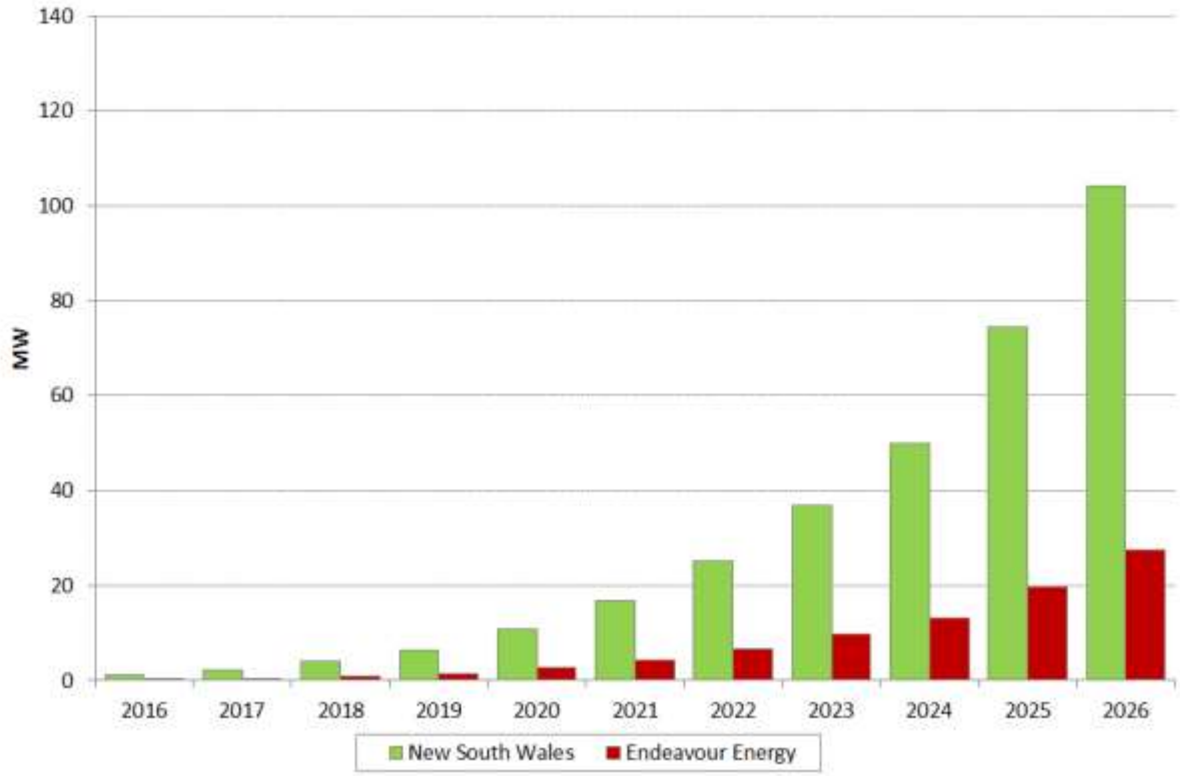


Figure 7.6: Total PEV impact on winter peak demand



8. The NSW Energy Savings Scheme (NSW ESS)

The NSW ESS mandates ESS obligations on electricity and gas (since 2016) retailers for implementation in customer premises in proportion to their energy use applied to annual targets set out to 2025. The obligations are denominated in tCO_2 and are acquitted through Energy Savings Certificates (ESCs) provided through accredited activities (Recognised Energy Savings Activities, RESAs), such as commercial lighting upgrades (dominant activities in recent years). Each accredited activity has a specific ESC level and life (2 to 25 years).

Issues in projecting the energy (electricity, gas) impact of the ESS, and hence the level of any post-modelling adjustment (PMA) for the ESS, are:

- the targets to be set each year out to 2025 and their achievement;
- the split of future activities between electricity and gas;
- the future annual **ESC** levels relative to annual targets from accredited activities and lives (up to 25 years) of these activities;
- the additionality (beyond trend BAU) impact of activities (that is, is a modelling adjustment required, and if so, at what annual level?);
- compliance with ESC creation regulations;
- attribution of activities to ESS and other initiatives; and
- rebound (response of ESS customers to implementation of the ESS activity).

In 2015-16 the NSW ESS market was/is still dominated by commercial lighting upgrades, according to ESS reports. But:

- what precisely are the commercial lighting upgrades (replacement of fluorescent luminaires by Light Emitting Diodes, LEDs, arrays which have slightly higher efficiencies and substantially longer operational lives than fluorescents); and
- what would have been the market penetrations of these commercial lighting upgrades in the absence of the ESS; that is, what is the ESS additionality with respect to these upgrades?

And are the impacts of the ESS commercial lighting upgrades showing up in commercial tariff classes?

Some indication of the ESS additionality can be discerned by examining the penetration of these technologies outside New South Wales. For example, in Western Australia and Queensland where an equivalent of the NSW ESS does not exist. If penetration in these regions is similar to those in New South Wales the ESS additionality is low **unless** it can be shown that the NSW ESS has induced similar penetrations in other regions. The situation and the issues could be examined by discussions with commercial lighting suppliers and/or efficiency consulting/advice firms such as Schneider Electric (a global firm) operating in all Australian regions.

Each year ESCs are created according to accredited methodologies. These ESCs have an impact on reducing electricity demand (MWs, GWhs), the impact depending on characteristics of RESAs from which they are created, the specific ESC methodologies employed and the accredited lives of the RESAs, lives which may extend out 25 years. Accordingly, the impact in any one year of ESC creation is less than the ESCs created in that year.

(**Note:** 1.06 ESCs (tCO_2) = 1 MWh)

For example, in 2014 (from 20 July 2015 Compliance Report) the equivalent of 2,975,715 MWhs of energy savings was created by accredited ESCs; the majority (71 per cent from lighting activities). The estimated impact (IPART) **in 2014** was 1,598,489 MWhs and an impact in future years of 1,377,230 MWhs due to deeming and other forward creation methodologies applied to 2014 RESAs. The **total ESS impact in 2014** estimated by IPART was 1,598,489 MWhs **plus** the impact in 2014 of 2009-13 RESA ESCs in 2014 at 2,781,411 MWhs. That is, an estimated total ESS impact in 2014 of 4,380,300 MWhs; 4,380 GWhs. Further (post-2015) estimated impacts (IPART) from 2009-14 out to 2025 activities are estimated as 6,907,413 MWh (6,907 GWhs). Total New South Wales end-use energy consumption in 2015 was about 60,000 GWhs and **on the above estimation basis** would have been about 64,380 GWhs without the ESS.

By the end of 2014 there was a surplus of ESCs after liability compliance of 3,050,841 ESCs, enough for about a year's compliance acquittal without further ESC creation.

But what is the actual impact of ESS after taking into account additionality, attribution, rebound and compliance? Of the caveats, in the case of the ESS, additionality appears to be the main caveat requiring rigorous analysis.

The ESCs created in commercial lighting over 2013, 2014 and 2015 to some extent appear to be reflected in the network tariff sales data, as reported by Endeavour energy. This is evidenced by the 2.9 per cent average annual decline in commercial energy consumption between 2010 and 2015. However, other programs such as commercial business disclosure (CBD) may also have contributed to the decline.

Endeavour's percentage of New South Wales electricity consumption is estimated to be 26.5 per cent (verified by Endeavour).

As outlined above, ESCs are created from Recognised Energy Saving Activities (RESAs). Each RESA has a specific number of ESCs associated with it. ESC dollar values are determined by the demand and supply of ESCs in the market place. Supply of ESCs depends on the cost of creating specific ESCs, the marketing of RESAs by Accredited Certificate Providers (ACPs) and the response of customers to the offers to implement RESAs by ACPs. The supply of ESCs has exceeded annual target ESC liabilities and by 1 July 2015 the ESC surplus was over 3 million when the 2014 liability was 2,700,000.

The Commercial Lighting Formula for commercial lighting upgrades, encompasses the replacement of inefficient lights with new, more energy efficient lights: thus is a sub-method of the Deemed Energy Saving Method (DESM).

Over time specific RESAs are likely to become a technique/technology which becomes the standard market place technique/technology which is implemented without the need for ESS inclusion/subsidisation. It would then be included in BAU trends revealed by econometric modelling and a PMA would not be necessary. Can the ESS claim credit (spillover effect) for most of this market place trend? (IPART assumes yes and 87 per cent additionality, but we are sceptical.) We believe ESCs for that RESA should decline over time as the additionality of the specific RESA declines over time. Allowing for lower average additionality, attribution to other initiatives (to avoid double counting), rebound (response to improved efficiency) and compliance with RESA regulating the ESS impact could be around 50 per cent on average over the life of RESAs.

ESS revisions, 2015

Extension to gas and to 2025 from 2020.

Legislated target (not adjusted for retained exemptions for Energy Intensive Trade Exposed Industries) from 6 to 7 per cent in 2016, to 7.5 per cent in 2017, 8 per cent in 2018 and 8.5 from 2019.

> OEH estimated 5,100 TJ (1,420 GWhs) gas savings in 2020: **seems high**.
> OEH estimated 378 GWh electricity savings in 2020: **seems low**.

OEH estimated remaining 930 GWhs/year from lighting projects by 2021. (But OEH estimated these lighting projects would provide <11 per cent of ESCs by 2021.)

A 6.5 per cent target over 2016-2020, OEH estimated, would give a cumulative 26,414 GWhs of savings over 2015-2040 and 53 MW of peak demand reduction in 2020.

Extension to 2025 from 2020

OEH estimated the ESS would provide energy savings in 2025 of 2,866 GWhs (1,606 GWhs under current target) and 430 MW peak demand reduction (250 MW under current target).

Expansion to gas

Expanding the ESS 2018 target from 6.5 to 8.0 per cent including gas would result in (OEH):

- a lower ESC price than only electricity; and
- more ESCs in the residential sector and less in the commercial and industrial sector under the combined target.

Electricity retains a conversion factor of 1.06 ESC/MWh and gas converts at 0.39 ESC/MWh (0.11 ESCs/GJ in primary energy terms).

Examples of certificates created over 10 years are provided (p.65). 3-star to 5-star gas heater = 1.9 ESCs ($57 @ $30/ESC); Resistive space heater to 5-star air-to-air heat pump = 11.8 ESCs ($354 @ $30/ESC).

ESS impacts

The 2015 ESS **Review report** estimated ESS to 2015 may have reduced New South Wales GWhs by 1,807 GWhs in 2013-14 and 2 per cent lower by 2021.

Non-additionality recognised as reducing benefits on p.113 of Review report.

LRMCs of New South Wales distribution capacity and capacity charges presented in Tables 25 and 26; avoided gas supply costs in Figure 20.

Avoided carbon costs, p.127; GHGI, p.128:

- seems very conservative at $10/t CO_2.

Avoided health costs, p.130.

Forecasting the ESC market

Energy user paybacks 2.2 to 4.2 years used by OEH/IPART.

Energy efficiency improvement opportunities (EEIOs) become more widely available and recognised in the market as a result of the ESS spillover effect and general market trends (global influences) and consumers choose to implement more EEI measures as a result of these factors.

13 per cent non-additionality, 87 per cent additionality assumed (average?) by IPART/OEH NOT varying over time and by RESA. As commented above this additional impact of the ESS seems to us to be too high.

We recognise however that the ESS could accelerate and extend the impact of RESAs and overall EEI through ESS spillover effects (engendering enhanced EEI culture): **see above comments**.

The OEH/IPART Review estimated an ESS impact of 1,807 GWhs by 2021; 261 MW demand reduction; **cumulative** electricity savings of 48,779 GWhs over 2015 to 2040.

To 2025 Review estimated at a target of 8 per cent of electricity sales, 42.9 x 10^6 ESCs would be surrendered to 2025 at an average ESC price of \$23/t CO_2e.

Options paper claims ESS supported projects to 2014 will save around 11,288 GWhs over their lifetimes and 997,479 MWhs in 2016. **But what is the additional impact?**

Projecting ESS New South Wales electricity impacts, 2016 to 2025

Issues

Targets and their achievement.

Electricity/gas mix.

Additionality (non-inclusion of ESS impact in econometric forecast), attribution (of impacts to other measures, avoidance of double counting), rebound, compliance (with ESS Rule): total of non-inclusion in econometric forecast.

Replacement at end of RESA life with a technology/technique **at least as EE as RESA** assumed by NIEIR. That is, no reversion to initial situation replaced by RESA.

The above discussion indicates that the New South Wales ESS impacts on energy demands (MWs, GWhs) are challenging to determine. Particularly at this point in time because it is difficult to forecast without relevant data the impacts of the 2015 changes to the initiative. Accordingly, we:

(i) have a relatively low degree of confidence in our PMA estimates; and

(ii) recommend careful and detailed monitoring of the initiative's potential and actual impacts.

New South Wales ESS annual, cumulative savings

The **annual reduction** in energy consumption from implementation of a RESA results in reduction in energy use in that implementation year and over the life of the RESAs.

Without the RESA implementation/replacement of the previous technology the energy use would have been higher over the life of the RESA. What would have been the remaining life of the replaced technology? And at its end of life what would it have been replaced with: perhaps the RESA! So for each year the annual and succeeding years of the RESA must be estimated.

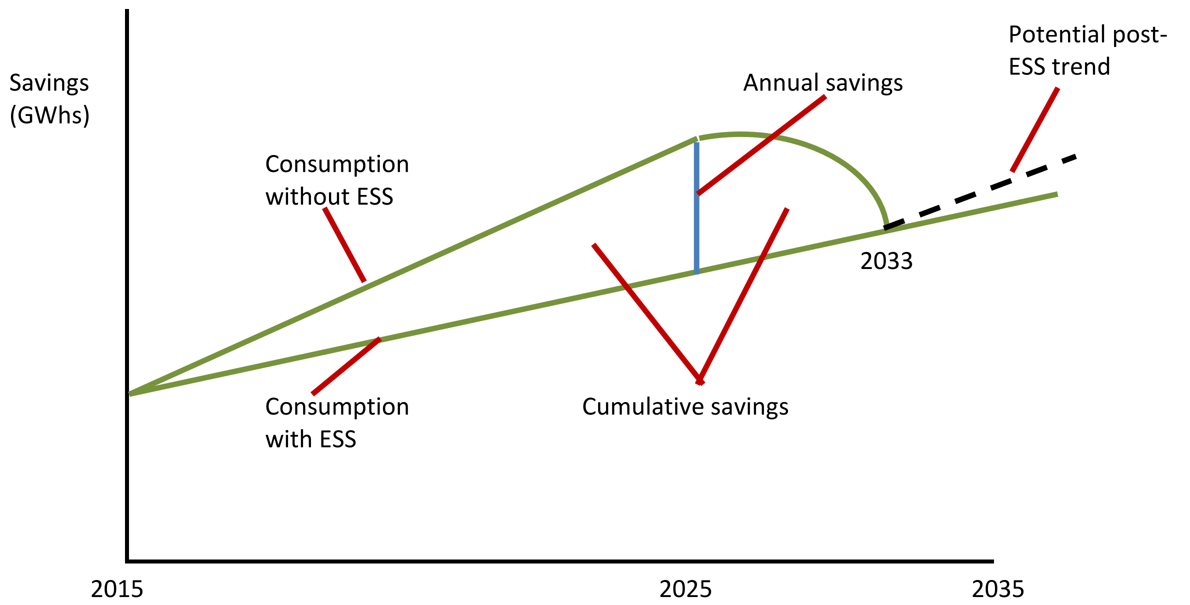
The next year (Year 2) the Year 1 savings are added to (**accumulate**) giving Year 1 and Year 2 savings and so on over the lives of the RESAs. For a 10 year RESA life, we assume Year 1 savings fall to zero in Year 11. That is, each year the RESA becomes more the market place norm so its additional impact reduces and perhaps by Year 10 becomes zero. Diagrammatically the situation is presented below.

Over 10 years (assumed RESA life), **additional RESA savings** would drop to zero under these assumptions. Thus:

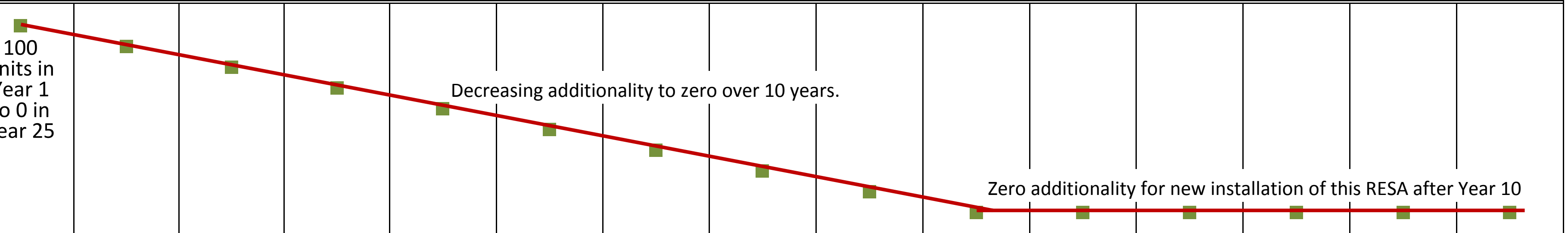
- Year 2 savings from RESAs implemented in Year 2 would be less than from Year 1 implemented RESAs and would reduce to zero in Year 10;
- Year 3 savings from RESAs implemented in Year 3 would be less than from Year 2 implemented RESAs and would reduce to zero in Year 10;
- and so on in Years 4 to 10. In Year 10 the specific RESA would not produce any **additional** savings from an **econometric** viewpoint, but would if a pre-RESA technology were replaced. But this impact is now in the econometric trend;
- savings from the specific RESA accumulate each year BUT the accumulation rate reduces each year till it drops to zero in Year 10 when the RESA is assumed to be the market norm; and
- over Years 1 to 10 the RESA has produced electricity savings by accelerating the introduction of the RESA technology.

OEH/IPART appear to have assumed a constant additionality: we view this as very unlikely. Hence, we discount estimated (OEH, IPART) savings from the New South Wales ESS to arrive at the ESS additional impact.

Figure 8.1: Diagrammatical representation of ESS annual and cumulative savings



In Figure 8.1, **additional** savings from the ESS cease in 2033 but total consumption then follows the trend set by the ESS or increases at a rate influenced by, but not following, the ESS trends.

Table 8.1	New South Wales ESS impacts: example with declining additionality of 10 year life RESA														
	Years (extends out to Year 25)														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15 →**
RESA savings	100 units in Year 1 to 0 in Year 25														
100 per cent additionality in Year 1	100	100	100	100	100	100	100	100	100	100	100	0	0	0	0
		90	90	90	90	90	90	90	90	90	90	0	0	0	0
			80	80	80	80	80	80	80	80	80	80	0	0	0
				70	70	70	70	70	70	70	70	70	70	0	0
					60	60	60	60	60	60	60	60	60	60	0
						50	50	50	50	50	50	50	50	50	50
							40	40	40	40	40	40	40	40	40
								30	30	30	30	30	30	30	30
									20	20	20	20	20	20	20
										10	10	10	10	10	10
Zero additionality in Year 11											0	0	0	0	0
Savings															
Annual	100	190	270	340	400	450	490	520	540	550	450	350	280	210	150
Cumulative	100	290	560	900	1300	1750	2240	2760	3300	3850	4300	4760	5040	5250	5400

Notes: For this RESA a life of 10 years is assumed: this is about average (lives can be up to 25 years).
Annual savings in this example peak in Year 10 and are zero in Year 20. Cumulative savings over the life of this RESA continue to increase until Year 20 but at a decreasing level post-Year 10.

New South Wales ESS targets: basis (quoted in ESS compliance reports)

Target basis is all New South Wales electricity purchases from AEMO plus any unregistered generator sales (including rooftop solar PV) less exempt sales.

The policy intent of the ESS: to capture all electricity purchases to be used or on-sold within New South Wales (p. 21, 2015 Compliance Report).

In New South Wales all rooftop PV was initially exported (gross scheme) to the grid and PV customers imported all their electricity requirements from the grid. The PV exported to the grid was, therefore, included in customer purchases from the grid as this PV was included in grid electricity. But since 2012 **new** PV installations have been on a **net** basis: only exported PV receives a FIT and from 2017 **all** New South Wales PV systems will be on a net basis. PV exported to the grid "backs-off" fossil generators: it does not add to **total** New South Wales generation **nor** to total New South Wales consumption.

Total Liable Acquisitions (Compliance Report, 2013: July 2014) = AEMO's Total Electricity Customer Sales (for NSW only) + Total Unregistered Generator Purchases (includes PV generation, gross in NSW) – Total Exempt Load Deductions.

We have used this as our basis for target estimations.

Table 8.2 ESS targets and NIEIR assumed electricity proportion

	Legislated (per cent of electricity sales)	Effective[(a)]	Electricity[(b)]
2015	5	4.0	3.20
2016	7	5.6	4.48
2017	7.5	6	4.8
2018	8	6.4	5.12
2019	8.5	6.8	5.44
2020	8.5	6.8	5.44
2021	8.5	6.8	5.44
2022	8.5	6.8	5.44
2023	8.5	6.8	5.44
2024	8.5	6.8	5.44
2025	8.5	6.8	5.44
2026	0	0	0

Notes: (a) Constant 20 per cent of exempt sales assumed by NIEIR.
(b) Constant 80 per cent (gas 20 per cent) electricity of effective target: NIEIR's consideration of ESS Review reports, Victorian experience and New South Wales gas use. But over 2016-2026 actual mix could be different.

Estimated NSW ESS electricity targets, 2016-25

Table 8.3	New South Wales electricity consumption: end-use, 2016 to 2035 (NIEIR, August 2015)					
	1 PJ	2 GWhs	3 PV (GWhs)	4 2+3 (GWhs)	5 Electricity "target" (per cent)	6 Target (electricity), GWhs
2016	217.32	60,415	781	61,196	4.5	2,742
2017	218.10	60,632	1,010	61,942	4.8	2,959
2018	220.45	61,285	1,609	62,894	5.1	3,220
2019	223.08	62,016	1,822	63,838	5.4	3,473
2020	225.92	62,806	2,058	64,864	5.4	3,529
2021	228.77	63,598	1,510	65,108	5.4	3,542
2022	232.06	64,513	2,575	67,088	5.4	3,650
2023	234.92	65,308	2,800	68,106	5.4	3,705
2024	237.80	66,108	3,025	69,133	5.4	3,761
2025 (last target year)	241.47	67,128	3,287	70,415	5.4	3,831

Notes: ESS will have some impact out to 2050 with a RESA life of 25 years from some 2025 RESAs.
Column 2: NIEIR projections.
Column 3: Average of NIEIR/AEMO New South Wales PV projections.

Savings from target attainment in each target year will, because of forward certificate (ESC) creation, be spread over a number of years, the ESC levels in each year (1 to 10+) depending on the project mix and the ESC methodologies applied to that project mix. In 2014, from the 20 July 2015 ESS Compliance Report (IPART), the equivalent of 2,975,715 MWhs of energy savings were created by accredited ESCs. The estimated impact (IPRT) in 2014 was 1,598,489 MWhs and the impact from 2014 created ESCs in future years was estimated (IPART) at 1,377,230 MWhs. The future annual impacts of specific target years is very uncertain as the project mix and ESC methodologies which will be applied in the future is uncertain. In this situation we assume the savings schedule will be similar to that presented in Table 6.4 of the 2012 IPART Compliance Report; as follows:

Year 1: 27 per cent Year 2: 14 per cent Year 3: 13 per cent Year 4: 11 per cent
Year 5: 10 per cent Year 6: 10 per cent Year 7: 6 per cent Year 8: 4 per cent
Year 9: 3 per cent Year 10: 0 per cent

Applying this savings schedule to 1,000 GWhs of accredited ESC savings in a specific year would produce the following savings which, following our actual savings methodology, would be reduced according to our "additionality" schedule.

	Year										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Savings schedule	270	140	130	110	100	100	60	40	30	0	0
Savings schedule plus additionality	100 270	90 126	80 104	70 77	60 60	50 50	40 24	30 12	20 6	10 0	0 0

For example, in 2016 with electricity target = 2,742 GWhs, actual savings from 2016 ESC activities.

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
740 (270 x 2.742)	345	285	211	164	137	66	33	16	0

This is then repeated for years 2017 to 2025.

Years prior to 2016 (the commencement of the revised ESS), that is, from 2009 to 2015 (inclusive), will have an impact on New South Wales electricity demands over 2016 to 2025 (at an assumed average RESA life of 10 years. Hence, in projecting ESS PMAs over 2016 to 2035 the impacts from RESA ESCs prior to 2016 must be considered. However, these will already be partly reflected in the historical demand data and are discounted by 50 per cent.

On this basis NIEIR estimates of the PMA adjustments for the New South Wales ESS are presented in Table 8.4. Endeavour PMAs are estimated as 26.5 per cent of that estimated for New South Wales. NOTE, however, that on the basis of demands (GWhs, MWs) to date, these PMAs seem too high. Accordingly, they **could** be discounted by 40 per cent. The situation should be reviewed when credible data becomes available.

Table 8.4	New South Wales additionality (PMA) ESS impacts, GWhs, 2009 to 2035											
			Phase 1 (2009)					Phase 2 (2016)				
	Activity year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Phase 1	2009-14[1] IPART estimate impact to 2015	5,405	997	918	852	802	792	745	550	19	9	0
	NIEIR additionality impact[2]	2,161	349	276	213	161	119	75	28	0	0	0
	2015	648	302	250	185	144	120	86	67	58	0	0
Phase 2	2016		740	345	285	211	164	137	66	33	16	0
	2017			799	373	308	228	178	148	71	36	18
	2018				869	406	335	248	193	161	77	39
	2019					938	438	361	267	208	174	83
	2020						953	445	367	272	212	176
	2021							956	446	368	273	213
	2022								985	460	380	281
	2023									1,000	467	385
	2024										1,015	474
	2025											1,034
	2026	–										
	Annual (includes pre-2016)		**1,391**	**1,670**	**1,925**	**2,167**	**2,356**	**2,486**	**2,567**	**2,632**	**2,649**	**2,703**
	Cumulative (from 2009 to 2016)	**4,969**										
	Cumulative (from 2016)	**–**	**1,391**	**3,061**	**4,986**	**7,153**	**9,509**	**11,995**	**14,562**	**17,194**	**19,843**	**22,546**

Notes: (1) First six years of ESS.
(2) Additionality of pre-2015.
ESCs: 80 per cent in 2015 declining by 20 per cent per year.

Table 8.4	New South Wales additionality (PMA) ESS impacts, GWhs, 2009 to 2035 (continued)										
		Phase 2 (2016)									
	Activity year	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Phase 1	2009-14[(1)] IPART estimate impact to 2015	0	0	0	0	0	0	0	0	0	0
	NIEIR additionality impact[(2)]	0	0	0	0	0	0	0	0	0	0
	2015	0	0	0	0	0	0	0	0	0	0
Phase 2	2016	0	0	0	0	0	0	0	0	0	0
	2017	0	0	0	0	0	0	0	0	0	0
	2018	19	0	0	0	0	0	0	0	0	0
	2019	42	21	0	0	0	0	0	0	0	0
	2020	85	42	21	0	0	0	0	0	0	0
	2021	177	85	43	21	0	0	0	0	0	0
	2022	219	182	88	44	22	0	0	0	0	0
	2023	285	222	185	89	44	22	0	0	0	0
	2024	391	290	226	188	90	45	23	0	0	0
	2025	483	398	295	230	192	92	46	23	0	0
	2026	0	0	0	0	0	0	0	0	0	0
	Annual (includes pre-2016)	**1,701**	**1,241**	**857**	**572**	**348**	**159**	**69**	**23**	**-**	**-**
	Cumulative (from 2009 to 2016)										
	Cumulative (from 2016)	**24,247**	**25,488**	**26,345**	**26,917**	**27,265**	**27,424**	**27,493**	**27,516**	**27,516**	**27,516**

Notes: (1) First six years of ESS.
(2) Additionality of pre-2015.
ESCs: 80 per cent in 2015 declining by 20 per cent per year.

Estimating New South Wales ESS energy impacts by sector

New South Wales energy impacts flowing on from historical and recent years were allocated into residential, commercial and industrial classes according to the historical sectoral proportions in the *Review of the NSW Energy Savings Scheme: Final Statutory Report (June 2015)*. Over 2009 to 2013 compliance years, the 77 per cent of the scheme was related to the commercial sector, 15 per cent was in the industrial sector and only 8 per cent was in the residential sector.

Historically, most of the commercial activities were related to commercial lighting. But the opportunities for replacement lighting in the NSW commercial sector will soon be saturated over the short term. As a result, more of the target is expected to be met by the residential and industrial sectors.

In the Review *of the Energy Savings Scheme: Position Paper (October 2015), NSW Government* the forecast sectoral proportions for certificate creation over 2016 to 2025 are 47 per cent for the residential sector, 33 per cent for the commercial sector and 20 per cent for the industrial sector.

Table 8.5 shows NIEIR's forecasts of the proportion of ESS activity across 2016 to 2026. The historical proportions were applied up to and including 2016, and these were gradually transitioned to the forecast proportions as in the *Position Paper*. These proportions were applied to the deemed savings generated in each year. For example, all of the savings that were due to installations of energy savings equipment during 2016, and the impacts over the next 10 years, were allocated according to the 2016 proportions in Table 8.5.

Table 8.5 New South Wales ESS activity by sector (per cent)

	Residential	Commercial	Industrial
2009-14	8	77	15
2015	8	77	15
2016	8	77	15
2017	15	70	16
2018	21	62	17
2019	28	55	18
2020	34	48	18
2021	41	40	19
2022	47	33	20
2023	47	33	20
2024	47	33	20
2025	47	33	20
2026	47	33	20

Table 8.6 presents the New South Wales total energy impacts by sector from 2016 to 2026. Endeavour Energy impacts are derived at a proportion of 26.5 per cent.

Table 8.6	New South Wales ESS energy impacts by sector (GWh)			
	Residential	Commercial	Industrial	Total
2016	111	1,071	209	1,391
2017	186	1,227	257	1,670
2018	291	1,328	306	1,925
2019	429	1,380	358	2,167
2020	580	1,373	404	2,356
2021	739	1,304	442	2,486
2022	917	1,174	476	2,567
2023	1,037	1,094	501	2,632
2024	1,128	1,006	515	2,649
2025	1,202	970	532	2,703
2026	764	602	336	1,701

New South Wales electricity consumption with and without the ESS

Over the 2016 to 2035 period New South Wales electricity consumption will be driven by:

- overall and sectoral economic growth;
- end-use efficiency improvement (EEI) with and without the New South Wales ESS;
- population which drives demands in the commercial (offices, retail, hospital, hospitality, education, etc.) and residential energy demands;
- household formation the primary driver in the residential sector (each new household adds about 6 MWh/year on average); and
- SMEs in the industrial sector and net change for large industrial firms (some terminating).

Without the ESS there will be EEI but at a slower rate than with the ESS. The ESS will extend and deepen EEI but will essentially accelerate EEI. That is, most, if not all, ESS RESAs would be implemented over a longer time period (2026 to 2035), particularly given the increasing EEI at the global level with international EEI firms such as Schneider Electric entering the Australian EEI market. Thus, as can be seen above, the main ESS impact is in the period 2014 to 2026 when the ESS targets are ramping up.

In the Endeavour Energy region, in the absence of data on ESS activity in the region, we assume 26.5 per cent (Endeavour's share of New South Wales electricity consumption) of the ESS impact estimated above will fall in the Endeavour region.

The main caveats with the consumption results are:

- the additionality, attribution, rebound and compliance of RESA's implemented;
- the future RESA mix;
- the split between gas and electricity ESAs in meeting targets (a higher proportion of gas RESAs will reduce the electricity impact);
- the under or over achievement of targets (so far over achieved); and
- the implementation of RESAs in the Endeavour region (lower proportion of total ESCs created in Endeavour's region the lower the impact on Endeavour region's consumption).

Estimating the demand (MW) impact of the ESS

Estimating the peak demand impacts of the ESS is difficult given the lack of end-use data for New South Wales.

The dominance of lighting, and especially commercial lighting, implies these will dominate the ESS impacts on peak demands for summer and winter.

The approach adopted for ESS impacts on peak demands was broadly as follows:

(i) the sectoral energy savings (residential, commercial and industrial) were calculated for week days across each year, but after netting off weekend savings;

(ii) the average half hourly savings per week day were calculated using the annual operating hours for lighting upgrades by building type (Energy Savings Scheme Rule of 2009, NSW Government Gazette No.26 of 8 April 2016). The average hours of lighting were calculated to be as follows: Commercial 13.7 hours; Industrial 14.3 hours and Residential 6.0 hours; and

(iii) the half hourly MWh savings were adjusted using an assumed load factor which varied for summer and winter MDs and by sector.

The assumed load factor for winter and summer are summarised in Table 8.7. These load factors assume lighting dominates the ESS peak demand impacts.

Table 8.7 Winter and summer load factors for ESS peak demand savings by sector (MDs)

	Winter MD	Summer MD
Residential	0.30	0.10
Commercial	0.25	0.20
Industrial	0.20	0.15

Table 8.8 shows the New South Wales and Endeavour Energy winter peak demand impacts by sector to 2025-26.

Table 8.8	New South Wales peak demand impacts – Summer and winter by sector							
	Winter				Summer			
	Resi-dential	Com-mercial	Industrial	Total	Resi-dential	Com-mercial	Industrial	Total
Total New South Wales								
2016	12.0	52.8	7.9	72.6	4.0	42.2	5.9	52.1
2017	19.9	60.5	9.7	90.1	6.7	48.4	7.3	62.3
2018	31.3	65.4	11.5	108.3	10.5	52.4	8.7	71.5
2019	46.1	68.0	13.5	127.6	15.4	54.4	10.1	79.9
2020	62.3	67.7	15.2	145.2	20.8	54.1	11.4	86.4
2021	79.5	64.3	16.7	160.4	26.5	51.4	12.5	90.5
2022	98.6	57.9	18.0	174.4	32.9	46.3	13.5	92.7
2023	111.4	53.9	18.9	184.3	37.2	43.2	14.2	94.5
2024	121.3	49.6	19.4	190.3	40.5	39.7	14.6	94.7
2025	129.2	47.8	20.0	197.0	43.1	38.2	15.0	96.4
2026	82.1	29.7	12.6	124.4	27.4	23.7	9.5	60.6
Total Endeavour Energy								
2016	3.2	14.0	2.1	19.2	1.1	11.2	1.6	13.8
2017	5.3	16.0	2.6	23.9	1.8	12.8	1.9	16.5
2018	8.3	17.3	3.1	28.7	2.8	13.9	2.3	18.9
2019	12.2	18.0	3.6	33.8	4.1	14.4	2.7	21.2
2020	16.5	17.9	4.0	38.5	5.5	14.3	3.0	22.9
2021	21.1	17.0	4.4	42.5	7.0	13.6	3.3	24.0
2022	26.1	15.3	4.8	46.2	8.7	12.3	3.6	24.6
2023	29.5	14.3	5.0	48.8	9.9	11.4	3.8	25.0
2024	32.1	13.1	5.1	50.4	10.7	10.5	3.9	25.1
2025	34.2	12.7	5.3	52.2	11.4	10.1	4.0	25.5
2026	21.8	7.9	3.4	33.0	7.3	6.3	2.5	16.1

9. Energy Efficiency Opportunities Act (EEOA), the Clean Energy Finance Corporation (CEFC), the Australian Renewable Energy Agency (ARENA), the Clean Energy Innovation Fund (CEIF) and the Emissions Reduction Fund (ERF)

These policy initiatives have the potential to reduce distributor demands (GWhs, MWs) over the projection period. Brief outlines of the initiatives are presented below.

The **Energy Efficiency Opportunities Act (EEOA)**, which was terminated in 2013, required entities using >5 PJ of energy per year to conduct energy audits on their operations and report on EEOs with up to a 3 year payback. Implementation of these opportunities was not, however, mandated.

Monitoring of the EEOA program indicates that it may have accelerated EEO identification and implementation, but the beyond BAU impact of the EEOA is uncertain. That is, EEOA additionality is uncertain as projects reported under EEOA may have been undertaken without the EEOA. The EEOA was terminated in 2013: some EEOA projects may have an impact (no data) post-2015.

Under the CEF Act, the **Clean Energy Finance Corporation (CEFC)** has a $10 billion budget to contribute to investment in renewable energy, low pollution (cogeneration, trigeneration) and energy efficiency technologies. CEFC is expected to provide support through loans, loan guarantees and equity investments.

On 22 March 2016, the Federal Government announced it would reverse the previous intent to terminate the Clean Energy Finance Corporation (CEFC) and the Australian Renewable Energy Agency (ARENA) and establish a $1 billion ($100 million per year over 10 years) Clean Energy Innovation Fund (CEIF).

The CEIF is intended to complement the CEFC and ARENA by targeting projects such as large-scale solar with storage, off-shore energy, biofuels and smart grids. ARENA will be given an expanded focus beyond renewable energy to include energy efficiency and low emissions technology projects and will move from a grant-based role to a predominantly debt and equity basis under the CEIF, which will be funded from the CFFC's $1 billion allocation.

Implications of policy change:

(i) a move away from the Abbot constrained support for positive climate change policies; and

(ii) assured support for longer term clean energy projects.

But no clear plan for a transition away from high greenhouse gas intensive (GHGI) electricity generation.

The **Emissions Reduction Fund** (ERF) is being implemented by the Federal Government. Via a reverse auction (lowest bids win) process greenhouse gas abatement (GHGA) projects are subsidised. In the first two auctions (in 2015) winning bids were dominated by land use change, forestry and farming projects, but over time energy efficiency projects are likely to be funded resulting in lower energy demands (MWs, GWhs).

The third auction took place in late April, 2016 and the mix of projects was similar to the first two auctions. ERF auctions should be monitored to assess their potential impacts on energy demands (MWs, GWhs) in New South Wales distribution regions. The CEFC, ARENA, CEIF and the ERF could potentially attract significant investment in projects (renewables, cogeneration/trigeneration and energy efficiency) which reduce distributor revenues through "behind the fence" supply and demand actions.

Surveys of liable EEOA parties and CEFC, ARENA, CEIF and ERF recipients in each distributor area would be needed to quantify the EEOA and CEFC impacts on electricity demands and then to consider the extent to which these projects were **additional**, that is, beyond BAU trends. **In the absence of such surveys, and because of CEFA policy uncertainty, we do not believe post-modelling adjustments for these programs can be estimated at this time.**

Note that the NSW ESS, through IPART, monitors the ERF to prevent ERF projects from being subsidised under the NSW ESS (thus preventing "double-dipping"). This procedure is also required for CEFC, ARENA and CEIF projects.

10. Commercial mandatory disclosure (CMD)

Commercial mandatory disclosure (CMD) now generally known as Commercial Building Disclosure (CBD), introduced in all States and Territories through CoAG/Ministerial Council on Energy, applies to energy performance certification for all office building space of greater than 2,000 m^2 when it is leased or sold. Liable building owners are required to obtain a Building Energy Efficiency Certificate (BEEC). A BEEC consists of a National Australian Building Environment Rating System (NABERS) rating; information about the energy efficiency of the office lighting, contained in the Tenant Lighting Assessment (TLA); and generic guidance on how the energy efficiency of the office could be improved. NABERS star ratings must also be included in sale or lease advertisements for covered floor spaces.

The BEEC enables potential purchasers or lessees to include consideration of a building's energy efficiency as part of their decision-making processes. In so doing, the CBD program provides the market with information that would, over time, encourage energy efficiency improvements to be made voluntarily. By encouraging the market to appropriately value energy efficiency, rather than forcing the adoption of particular energy efficiency measures, the CBD program is a light-handed form of regulation.

Over 200 assessors are rating office space (leased or sold) of greater than, or equal to, 2,000 m^2. To date over 10 million m^2 have been rated using the NABERS tool.[9] Ratings (star system) have been improving as CBD is implemented. Thus, from a range of press reports surveyed by NIEIR, the following impacts have been reported. Mirvac's building portfolio has an average rating of 4.3 stars. The Dexus Property Group now has an average star rating of 4.3 compared with 3 when it began NABERS rating three years ago: target is 4.5 by December. Investa, now at an average of 4.2, is aiming for an average 4.5 star rating. The Bendigo Bank is aiming for a 5 star rating on all space occupied by the Bank on the basis of positive results from CBD applied and followed up on at Bank HQ.

The evidence is that CBD is having a substantial impact on energy performance in the commercial office sector and over the 2012 to 2022 period will reduce sectoral electricity demands below those previously anticipated. However, at this point in time we are not able to make:

(i) a quantitative assessment of the CBD impact;

(ii) an assessment of the extent, if any, CBD impacts are not included in the New South Wales ESS impacts; and

(iii) the need to make post-modelling adjustments.

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9 Note that the NABERS Energy rating and greenhouse gas emissions reported on a **Building Energy Efficiency (BEEC)** register will not take into account GreenPower purchases. This is because a decision to purchase GreenPower does not reflect the energy efficiency of a building and GreenPower purchases may change over time. GreenPower purchases will, however, be acknowledged on the BEEC. The NABERS Energy rating that must be disclosed in any advertisement and on the Building Energy Efficiency register cannot take into account any GreenPower purchases. Source: http://www.cbd.gov.au/Intro.RateYourBuilding.aspx.

A 2014-15 Review of the CBD (Final Report released in March 2015), indicated the following.

1. The Commercial Building Disclosure program is an appropriate program that complements a suite of related government policies and programs, including the Emissions Reduction Fund (ERF).
2. The CBD program has been effective in inducing positive behaviour change in relation to commercial building energy efficiency in affected buildings, resulting in significant benefits.
3. The CBD program is expected to deliver further benefits in energy reduction and greenhouse gas abatement.
4. CBD remains the principal Commonwealth Government program for driving energy efficiency improvements in the office sector.
5. There are several viable options for the future funding of the CBD program.
6. Future evaluations of energy efficiency programs would benefit from improved data relating to pay-offs of energy efficiency upgrades and workforce productivity improvements.

Recommendations

1. The CBD program should continue.
2. The focus for the CBD program should remain on office buildings.
3. The CBD program should be expanded to include smaller office spaces (down to 1,000 m^2).
4. The CBD program should continue to harness opportunities for further process and administrative efficiency improvements.
5. There are clear opportunities to improve the TLA component of the CBD program.

Summary of Review results

The results from ACIL Allen's analysis of the benefits of the CBD program to date and the benefits going forward are summarised in Table 10.1.

Table 10.1	Summary of benefits of the CBD program: estimated from the program review			
Analysis conducted	**Estimated economic benefit excluding GHG reductions (NPV $m)**	**Estimated economic benefit including GHG reductions (NPV $m)**	**Reduction in end-use energy consumption (cumulative TJ)**	**Reduction in GHG emissions (cumulative ktCO$_2$e)**
Backward looking				
Net benefits to date (2010 to 2014)	$15.4	$44.0	10,020	2,051
Forward looking				
Net benefits of continuing NABERS component of the program (2015 to 2019)	$53.3	$76.0	12,122	2,504
Net benefits of continuing TLA component of the program (2015 to 2019)	-$3.9	$6.9	2,444	612
Total net benefits of continuing program in its present form (2015 to 2019)	**$43.3** (after deducting $6.2m in program administrative costs)	**$76.8** (after deducting $6.2m in program administrative costs)	**14,565**	**3,116**
Additional net benefits from reducing threshold to include office space between 1,000-2,000m^2	$23.9 (additional)	$34.9 (additional)	3,684 (additional)	707 (additional)
Additional net benefits from extending validity period of TLA to 5 years	$2.0 (additional)	Change would not affect energy or GHG emissions reductions	Change would not affect energy or GHG emissions reductions	Change would not affect energy or GHG emissions reductions
Total net benefits of continuing program with reduced threshold and extension of TLA validity period	**$69.2**	**$111.7**	**18,250**	**3,824**
Indicative further net benefits through improved TLA visibility	**$4.2 minus costs of improving visibility (additional)**	**$8.5 minus costs of improving visibility (additional)**	**1,222 (additional)**	**918 (additional)**

Note: The backward looking analysis is based on the period of CBD operation between 2010 and 2014, but includes benefits of the program to 2023 to encompass the ongoing benefits of projects undertaken during 2010-2014. Analysis of forward looking benefits is based on continuing the program from 2015 to 2019, but includes benefits of the program to 2028 to encompass the ongoing benefits of projects.

Source: ACIL Allen.

11. Cogeneration and trigeneration

Cogeneration and trigeneration are, **overall**, favoured by the current policy environment because of financial support (from the CEFC, for example) and as grid electricity prices increase, commercial mandatory disclosure (CMD) ratings and lower greenhouse gas intensity (GHGI) become more important. On the other hand, recent gas price increases are not favourable and neither are network connection constraints, policy uncertainty, stringent investment criteria and air quality issues (emissions, control costs).

A discussion of cogeneration and trigeneration issues was presented in *Cogeneration in NSW: review and analysis of opportunities*, prepared by the Institute for Sustainable Futures, for NSW Department of Planning, March 2008. Although the policy environment has changed to some extent since the report was prepared in 2008, the report provides a useful discussion of cogeneration and trigeneration issues.

Origin Energy, through a wholly owned subsidiary Cogent Energy, announced in April 2012, an agreement with the City of Sydney to invest $100 million over 10 years to build trigeneration precincts across central Sydney. It is planned to commence construction of the plants in 2013 when customers are identified and secured, but actual sites, plant capacities and outputs and scheduling have not yet been decided.

At this time policy and project uncertainty precludes post-modelling adjustments for cogeneration and trigeneration being estimated.

12. Lighting

Lighting efficiency in all sectors, particularly since 2005, has increased significantly as incandescent lighting has been replaced by compact fluorescent lighting (**CFL**), higher efficiency halogens (**HEHs**) and light emitting diodes (**LEDs**). This trend was accelerated by banning of incandescent imports in 2010 and programs in Victoria, New South Wales and South Australia to subsidise the acceleration of incandescent replacement by more efficient lighting.

Also, efficiencies of tube luminaires (fluorescent, LEDs) used in the **commercial and industrial** sectors have been increasing, as have public lighting efficiencies.

Note that under the New South Wales ESS commercial lighting efficiency improvements have been significant and a lighting PMA would involve some degree of double counting.

Offsetting this efficiency improvement trend to some extent has been increased penetration of relatively inefficient Low Voltage (LV) halogens and increases in lighting intensity (lumens/m^2), indoors and outdoors. As virtually all incandescents would have been steadily replaced (before and at end of life) by 2015, econometric modelling is now probably reflecting this technological change and gradually, overall, increasing lighting efficiency. **Hence, for post-2015 projections post modelling adjustments for lighting are probably not necessary and could involve a degree of double counting.**

13. Conclusions of above analysis

After analysis of a range of policies, initiatives and trends, we have concluded that post-modelling adjustments for the 2016 to 2026 period are only necessary at this time for:

(i) photovoltaic (PV) installations;

(ii) electricity storage (behind-the-meter);

(iii) electric vehicle (EV) penetrations; and

(iv) the NSW Electricity Savings Scheme (ESS).

Potential post-modelling adjustments and some suggestions for further work are included in the report.