

Energy Supply Association of Australia

Analysis of initiatives to lower peak demand

Final Report

April 2012



This page left intentionally blank

Contents

Executive summary	1
1 Introduction	14
1.1 Peak demand in Australia	14
1.2 Scope of our work	14
2 Peak demand and energy growth in Australia	16
2.1 Historical trends	16
2.2 Forecast growth	17
2.3 Conclusion	18
3 The value of avoiding peak demand	19
3.1 Network costs	20
3.2 Generation costs	21
3.3 Conclusion – value per kW of demand	22
4 Initiatives to reduce peak demand	24
5 Dynamic pricing	25
5.1 What does it involve?	25
5.2 What is needed to achieve the benefits?	27
5.3 What is the potential impact on peak demand?	28
5.4 Conclusion – value of potential benefits	32
6 Direct load control	33
6.1 What does it involve?	33
6.2 What is needed to achieve the benefits?	35
6.3 What is the potential impact on peak demand?	37
6.4 Conclusion – value of potential benefits	39
7 Vehicle to Grid - Electric and Plug in Hybrid Electric Vehicles	40
7.1 What does it involve?	40
7.2 What is needed to achieve the benefits?	42
7.3 What is the potential impact on peak demand?	44
7.4 Conclusion – value of potential benefits	45
8 Energy efficiency measures	46
8.1 Increases in Minimum Energy Performance Standards for air conditioning	46
8.2 Improvements in building standards	49
9 Distributed generation	54
9.1 Small scale solar	54
9.2 Cogeneration and trigeneration	58
10 Conclusion	60

	10.1 Summary of findings	60
	10.2 Additive nature of benefits	62
11	Bibliography	63

Executive summary

Introduction

Customer demand for electricity in Australia is closely related to weather. At times of extreme heat or cold (such as might occur over a few hours in each year) when a large proportion of people require more electricity to cool or heat their homes and businesses, the electricity supply system can become constrained.

The impact of this 'peak' demand is similar to a busy highway at peak hour. Adding an extra lane on the highway can alleviate congestion at peak times. However, outside of peak hour the additional lane is superfluous. Significant investment is made to upgrade the highway to cater for peak hour traffic, which is not used for most of the time.

Similarly, increasing the supply capacity of the electricity system to cater for extreme peak demand can alleviate supply congestion issues. However, the costs of augmenting the electricity system are significant, and like the additional lane on the highway, the additional capacity is only used for those times of extreme peak demand, which is typically only a few hours or days per year.

With the continued rapid growth in residential air conditioning, the trend of peak demand over the past decade is set to continue, driving increases in the costs of supplying electricity. Accordingly, initiatives to curtail or shift peak load have significant future potential value in terms of reducing growth-related infrastructure and, therefore, constraining rises in electricity prices.

The Energy Supply Association of Australia (ESAA) engaged Deloitte to undertake an analysis of the potential benefits from initiatives to lower peak demand, based on high level estimates of the value of avoiding peak demand and publicly available results from other trials and studies.

Initiatives considered in our study include:

- Dynamic pricing – time of use and critical peak pricing and incentives
- Direct load control of air conditioning and pool pumps
- Vehicle to Grid (V2G) capability of Electric Vehicles (EVs) and Plug-in Hybrid Electric Vehicles (PHEV)
- Energy efficiency measures targeted at reducing the drivers of peak demand, including:
 - Air conditioner appliance efficiency standards
 - Improvements in building standards for retrofitting
- Small scale solar generation.¹

This report presents the results of our analysis. Details on the potential costs to achieve for each modelled initiative are also presented.

¹ We note that our analysis of improvements in building standards are related to savings generated by commercial customers and small scale solar savings will be delivered by both residential and commercial customers.

Results of our analysis

Our analysis has estimated that the economic value of the peak demand reductions potentially achieved by the five core initiatives we have studied ranges between \$1.5 and \$4.6 billion, over 2012-13 to 2021-22. Table 1 summarises the estimated gross benefits for each initiative.

Table 1: Deloitte conclusion – Total estimated value of gross benefits 2012-13 to 2021-22 (NPV, \$m)

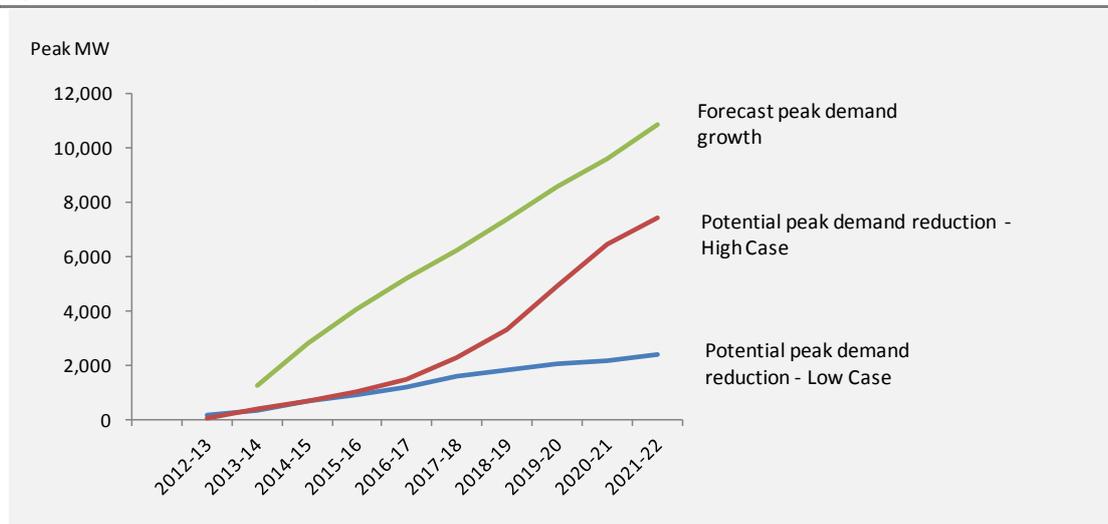
Initiative	Low case benefits (\$m)	High case benefits (\$m)
Time of use pricing	58	193
Critical peak pricing and incentives	385	1,272
Direct load control of air conditioners	200	1,338
Direct load control of pool pumps	188	231
Electric vehicles	60	537
Energy Savings Measures	361	486
Enhanced uptake of Solar PV	300	528
Total gross benefits	1,551	4,585

Source: Deloitte analysis. Note that totals may not sum due to rounding.

The estimated reduction in total demand from these initiatives ranges between 2,382 and 7,410 MW. It is noted that the net benefits actually realised by customers will depend upon the additional cost incurred in achieving these benefits, the regulatory framework and the competitive nature of the wholesale and retail markets. This report presents gross benefits and although costs for each initiative are presented in the body of the report, our analysis has not considered the potential net benefits, which would take into account costs to achieve.

The sum of potential peak demand reductions under the high and low case scenarios, as well as the forecast peak demand for Australia's two main electricity systems are presented in the following graph.

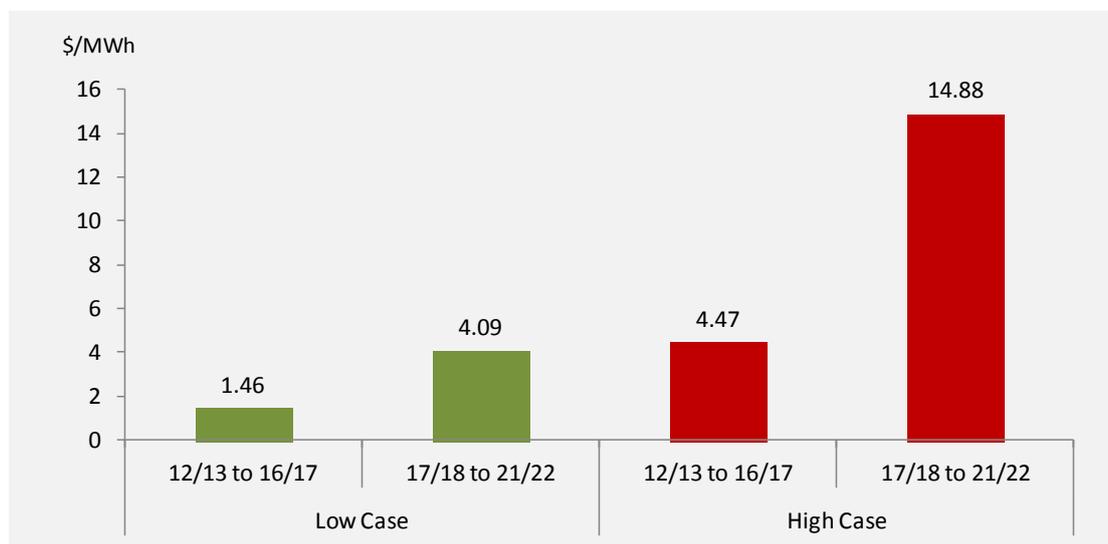
Figure 1: Conclusion –potential peak demand reductions (MW)



Source: Deloitte analysis

To determine the precise impact on electricity tariffs is beyond the scope of this study and depends upon the costs incurred to achieve these benefits. However, we have converted these calculated gross benefits into \$/MWh estimates for the residential market, based on forecast residential electricity consumption.

Figure 2: Domestic gross benefits converted into \$/MWh



Source: Deloitte analysis

The gross benefits translated into a \$/MWh figure for residential customers range from an average of \$1.46/MWh to \$4.09/MWh under the low case scenario and \$4.47/MWh to \$14.88/MWh under the high case scenario.² It is noted that the net benefits actually realised by customers will depend upon the additional cost incurred in achieving these benefits, the regulatory framework and the competitive nature of the wholesale and retail markets.

² In undertaking this calculation, we have assumed that the average residential customer consumes approximately 7 MWh per annum.

Putting aside the benefits associated with improving the energy efficiency of existing commercial buildings, in making this estimate, we have implicitly assumed that all benefits accrue to residential customers.

This report has demonstrated that there are significant potential benefits associated with lowering peak demand in Australia. Accordingly, we recommend that industry, policy makers, regulators and consumer representatives undertake further analysis of these initiatives, including detailed cost benefit analyses incorporating peak demand impacts.

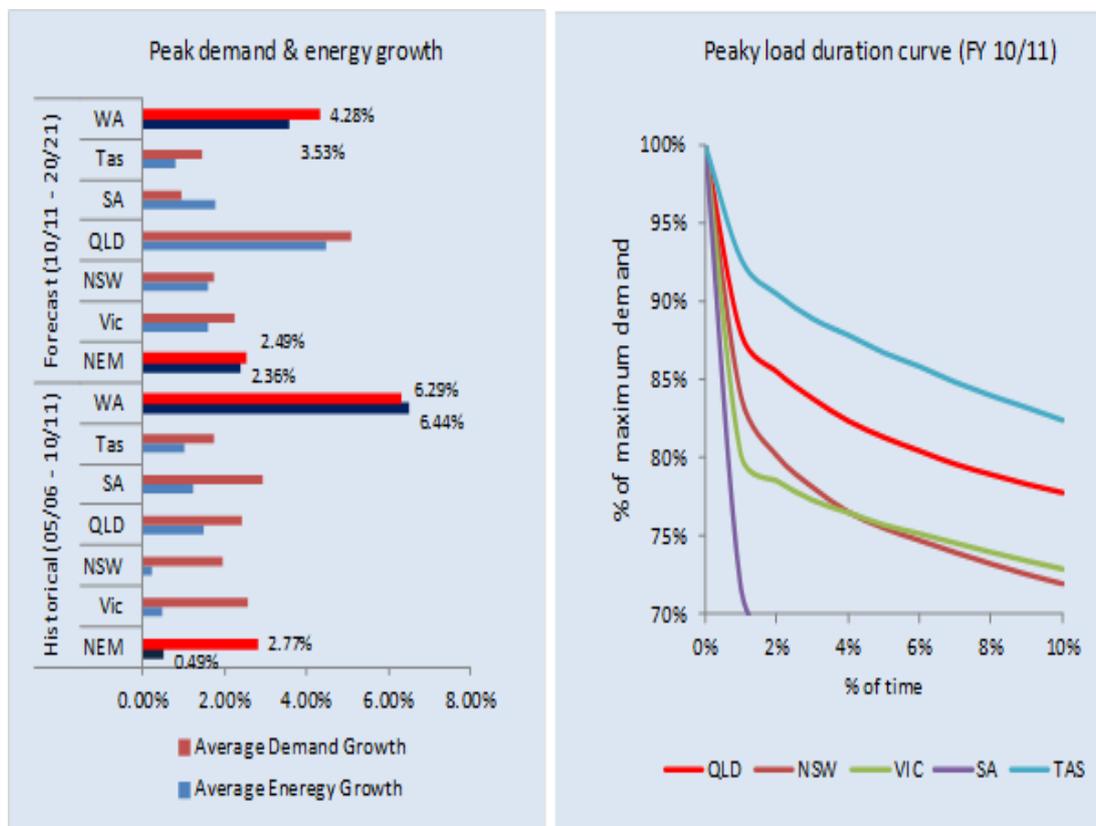
Peak Demand growth

Peak demand growth is a major driver of investment for electricity network and generation businesses. In recent years, peak demand has grown faster than total consumption, resulting in higher average prices for electricity. Slowing average energy consumption has been attributed in various studies to a downturn in economic growth affecting both commercial/industrial and residential energy consumption as well as a general shift away from the more energy intensive manufacturing sector towards the services sector. It is also likely that energy efficiency measures have started to impact consumption. Despite slower energy consumption, peak demand has continued to grow and this relationship is partly responsible for energy prices in many States rising faster than in the recent past.³

The following graph presents historical and forecast energy and peak demand for each state in the NEM and the Western Australian SWIS over 2005-06 to 2020-21. Load duration curves for each NEM state are also presented, which reflect the proportion of time over which peak demand is occurring. The needle-peaks on the load duration curves highlights that the top 20% of maximum demand occurs for less than 2% of time. This implies that investments which are made to meet peak demand are significantly underutilised.

³ Other drivers of electricity price growth include increased reliability standards and rising input costs. Growth in asset replacement expenditure has also contributed to higher energy prices.

Figure 3: Peak demand and energy growth - NEM and SWIS



Sources: AEMO 2011 SOO, IMO 2011 SOO, Deloitte analysis of Net System Load Profile data for the NEM.

Over the period 2011 to 2021, peak demand is forecast to grow at an average of 2.49% in the NEM and 4.28% in the Western Australian SWIS, driving the need for investment in network and generation assets. Therefore, given the peaky nature of the load duration curves, considerable cost savings can be achieved if initiatives to reduce peak demand are implemented.

The value of reducing peak demand

As detailed market modelling was beyond the scope of this project, for the purposes of analysing the potential financial value of initiatives to reduce peak demand, we have selected a high level estimate of \$200 per kW per annum as the value of avoiding an incremental kW of demand.

In selecting this value, we have taken into account the long run marginal cost (LRMC) of electricity network and generation investments, as well as high level estimates used in similar previous studies. We have also taken into account a number of factors relevant to the specific initiatives considered, and accordingly would caution the use of this high level estimate for other purposes.

We note that investment in electricity assets is influenced by load at diverse sections of a network and accordingly, reducing coincident peak demand will not result in avoided investment at every point of constraint on the network. In addition, planning for network and generation augmentation investment is needed several years prior to peak demand exceeding capacity. Reducing peak demand may not result in an immediate deferral of investment, but it should reduce investment in the long term.

In addition, in order to defer investment, network operators, generators and retailers need to be confident on the potential reduction in demand occurring at times of peak, given the commercial implications of not having the capacity or not being contracted to meet peak demand.

Traditionally, demand side participation is valued based on firm contracts between demand side providers (customers) and market participants. Most of the demand reductions associated with the initiatives discussed in this paper (such as Dynamic Pricing) will not be supported by contracts requiring firm demand reductions. Rather, they will be based on incentives to change behaviour. Therefore, for market participants to incorporate anticipated demand reductions into their investment planning, historical data reflecting reliable demand reductions due to the initiatives will be needed. This will only occur over the longer term, reducing the value of avoided investment in the 10 year timeframe of this analysis.

Initiatives to reduce peak demand

Following our research and consultation with the esaa, we have selected five core policy initiatives for the focus of this review, including:

- Dynamic pricing – time of use and critical peak pricing and incentives
- Direct load control of air conditioning and pool pumps
- Vehicle to Grid (V2G) capability of Electric Vehicles (EVs) and Plug-in Hybrid Electric Vehicles (PHEV)
- Energy efficiency measures targeted at reducing the drivers of peak demand, including improvements in building standards for retrofitting and air conditioner appliance efficiency standards
- Small scale solar generation.

In the process of selecting these core policy initiatives, several other initiatives were identified and researched, however, a lack of reliable, recent research prevented quantification of potential benefits.

Dynamic pricing

Economic theory suggests that charging customers prices that reflect the different costs of supplying electricity at different times of the day (sometimes known as flexible pricing) is one of the fundamental ways to reduce peak demand and ensure economically efficient consumption. There are a number of different ways that flexible pricing can be undertaken, which for convenience we have grouped together as Dynamic Pricing.

For the purposes of our analysis, we have defined Dynamic Pricing as:

- Three-rate TOU tariffs (peak, shoulder, off peak), for which rates may vary between seasons (winter, summer) however otherwise remain fixed for the contract period
- Critical peak pricing and/or critical peak incentives, which involve at least one-day ahead notification of a critical peak pricing event. During such a critical peak pricing event, electricity prices would be significantly higher than normal TOU peak prices. Alternatively, during a critical peak pricing event, customers could be paid an incentive for reducing their demand from a determined baseline by an agreed amount.

Trials of Dynamic Pricing are being undertaken in Australia and in many other locations. We have reviewed a sample of trial and research results in estimating the potential value of Dynamic Pricing in reducing peak demand.

The range of Australian time of use studies and trial results we reviewed suggested a 1.1% to 13% reduction in peak load. The results of international trials and studies suggests a range of -4% to 18%. The potential peak load reductions achieved by critical peak pricing trials and studies are significantly greater than those for time of use pricing, ranging between 10.6% and 36% in Australia and 4% to 40% in international studies.

Based on this experience, we have selected the following high and low estimates of customer responses to Dynamic Pricing in calculating the range of possible benefits.

Table 2: Dynamic Pricing – Deloitte peak load reduction assumptions

	Low estimate (% response)	High estimate (% response)
Time of use tariffs	1.5%	5%
Critical peak pricing or incentives	10%	33%

Source: Deloitte analysis

Based on this analysis, and the estimated value of reducing peak demand discussed, we consider that the value of the implementation of Dynamic Pricing in the NEM and SWIS over 2012 to 2022 is in the range set out in table 3 below. These estimates are based on maximum take up rates of 30% of customers being engaged in both time of use and critical peak pricing or incentives from 2017-18, which we consider is a reasonable estimate of achievable engagement over the period of analysis.

Table 3: Dynamic Pricing – estimated value of benefits 2012-13 to 2021-22 (NPV, \$m)

	Low case estimate (\$m)	High case estimate (\$m)
Time of use pricing	58	193
Critical peak pricing / incentives	385	1,272

Source: Deloitte analysis

Direct load control

Direct load control has been used by electricity distributors to control residential electric storage hot water systems across Australia for over 30 years. It is not surprising, therefore, that direct load control of air conditioning and pool pumps – two of the major drivers of peak demand in Australia over the past decade – is now being trialled by distributors.

The best known and most extensive Australian trials of direct load control of air conditioning to date have been conducted by ETSA Utilities and Energex.

Since 2006, ETSA Utilities has conducted several direct load control trials targeting residential and commercial customers' air conditioning. Results of these trials indicated that the potential reductions in peak load range from 19% to 35%.⁴ Energex's Cool Change Trial, which commenced in the summer of 2007 and is still in operation, involves trialling direct load control of over 2,000 customers' air conditioners. On average, participating customers reduced their demand by 13% over the 2009-10 summer peak.⁵

After reviewing the ranges of achievable reductions in published trials, we have adopted the peak load reduction assumptions set out in table 4 below.

⁴ ETSA Utilities, Project EPR 0022 – Response to AEMC Issues Paper – Power of Choice, September 2011.

⁵ Energex, Time for a cool change – Energy Smart Suburbs – Newsletter November 2010.

Table 4: Direct load control – Peak reductions per customer

	Peak reductions per customer - Low case (% per average customer peak load)	Peak reductions per customer - High case (% per average customer peak load)
Direct load control of air conditioners	11.7%	35.0%
Direct load control of pool pumps	27.0%	36.0%

Source: Deloitte analysis

Using a base assumption of average customer contribution to peak of 3 kW, ABS data on air conditioner penetration and pool pump ownership forecasts developed by a consultant for the Department of Environment, Water, Heritage and the Arts, our estimates of the potential NPV benefits of direct load control are presented in table 5.

Table 5: Direct load control – estimated value of benefits 2012-13 to 2021-22 (NPV, \$m)

	Low case estimate (\$m)	High case estimate (\$m)
Direct load control of air conditioners	200	1,338
Direct load control of pool pumps	188	231

Source: Deloitte analysis

Vehicle to Grid – Electric and Plug in Hybrid Vehicles

Recent Australian studies on EVs and PHEVs have optimistically forecast that customer take-up in Victoria will be in the order of 50% of new car sales (more than 100 000 EVs) by 2015 and a similar magnitude in NSW by 2018.⁶

Many research papers on EVs highlight the potential benefits for the electricity market and system that could be generated by the widespread adoption of EVs. In particular, several research papers suggest that EVs present an opportunity to support intermittent renewable generation with baseload storage.⁷ However, to date there has been relatively little research done on the vehicle to grid (V2G) peak load support capability for EVs.

The CSIRO and the Institute for Sustainable Futures are together undertaking a comprehensive assessment of potential EV uptake and use under Australian conditions. The Electric Driveway Project will run over three years and explore the potential synergies between the electricity and transport sectors presented by EVs.

Using the findings reported in a range of studies we have developed a range of potential battery capacity and assumptions regarding availability of cars and battery capacity for V2G supply. Our assumptions are presented in table 6.

⁶ AECOM, Forecast Uptake and Economic Evaluation of Electric Vehicles in Victoria, Final Report, May 2011; AECOM, Economic Viability of Electric Vehicles - Department of Environment and Climate Change (NSW), September 2009.

⁷ Curtin University of Technology, Electric Vehicles and their Renewable Connection – How Australia can take part in the Green Revolution, presentation, June 2009.

Table 6: V2G capability - Deloitte Assumptions

Benefits assumptions	Low case	High case
Maximum capacity per vehicle	10 kWh	24 kWh
% cars available at peak time	40%	60%
% of each car's load available at peak time	40%	50%
Discharge time	8 hours	4 hours

Source: Deloitte analysis

In order to present the potential benefits that initiatives to support the take up of EVs could achieve, we have examined the benefits associated with a take up rate in line with the EV and PHEV forecasts prepared by AECOM for NSW and Victoria, extrapolated for the other States. We consider that the penetration of electric vehicles in Australia over 2012 to 2022 offers benefits in the range set out in the table below.

Table 7: Electric Vehicles – estimated value of benefits 2012-13 to 2021-22 (NPV, \$m)

	Low case estimate (\$m)	High case estimate (\$m)
Electric vehicles (V2G)	60	537

Source: Deloitte analysis

Energy efficiency measures – Implementing improvements in building standards

Improving the energy efficiency of buildings reduces the overall heating and cooling load and also reduces peak demand.

In recognition of the potential savings due to lower peak demand delivered by energy efficiency, and the lack of research into these benefits in 2010 the Department of Climate Change and Energy Efficiency commissioned a national study into the peak demand benefits of various measures to improve the energy efficiency of buildings. The Building Our Savings study was jointly carried out by the Institute for Sustainable Futures and Energetics.⁸ The focus of this study was on the savings generated by retrofitting existing buildings, particularly commercial buildings. Energy savings measures that were modelled as part of this study include:

- Commercial measures: Voluntary Energy Star Program designed to identify and promote energy efficient products; Maintenance and cleaning of filters and coils of air handling, air conditioning, pumping and electrical heating appliances; Fine tuning and maintenance of lighting systems, sensors and controls; Installation of high energy efficiency air conditioning and dynamic lighting systems with controls; installation of more efficient air handling equipment
- Residential measures: Hot water demand reduction; fridge buy-back scheme; draught sealing; installation of new efficient lighting, hot water unit and air conditioners; installation of roof insulation

⁸ Institute for Sustainable Futures and Energetics, Building Our Savings: Reduced Infrastructure Costs from Improving Building Energy Efficiency, Final Report, July 2010.

- Industrial measures: installation of new efficient lighting; green-IT retrofits (affecting servers and power supplies); installation of LED lighting.

The estimates of the impact on summer peak demand are set out in table 8.

Table 8: Building Our Savings study – Reported results – summer peak demand

	Moderate scenario	Accelerated scenario
Maximum seasonal peak demand reduction (MW)	5,283	7,236
% of 2020 summer peak demand eliminated	10%	13%
% of 2010 to 2020 summer peak growth eliminated	43%	58%

Source: Institute for Sustainable Futures and Energetics, Building Our Savings: Reduced Infrastructure Costs from Improving Building Energy Efficiency, Final Report, July 2010.

After reviewing the Building Our Savings study, we consider that the implementation of these measures to improve the energy efficiency of commercial, residential and industrial buildings over 2012 to 2022 offers benefits in the range set out in table 9 below.

We note the potential for further benefits associated with increasing the energy efficiency standards of new buildings, however, more research is needed to determine the peak demand savings from such measures.

Table 9: Energy Savings Measures – estimated value of benefits 2012-13 to 2021-22 (NPV, \$m)

	Low case estimate (\$m)	High case estimate (\$m)
Energy Savings Measures from the Building Our Savings study – potential value of reduced MW	361	486

Source: Deloitte analysis

Distributed generation

There has been a rapid increase in small scale solar generation in Australia over the past decade, driven principally by a reduction in capital cost and government initiatives stemming from the Renewable Energy Target and other direct incentives, such as feed-in-tariffs.

While generation situated close to the point of demand has the potential to reduce the use of network to transport electricity, research suggests that the performance of small scale solar generation at times of peak demand is not close to capacity. This is because times of summer peak demand are not closely correlated with peak sunlight and PV generation. In addition, high temperatures reduce the potential output of PV.

Based on recent studies by Ausgrid, Western Power and the AEMC, we have developed a range for the estimated impact of solar PV on summer maximum demand, per MW of installed PV capacity, as presented in table 10.

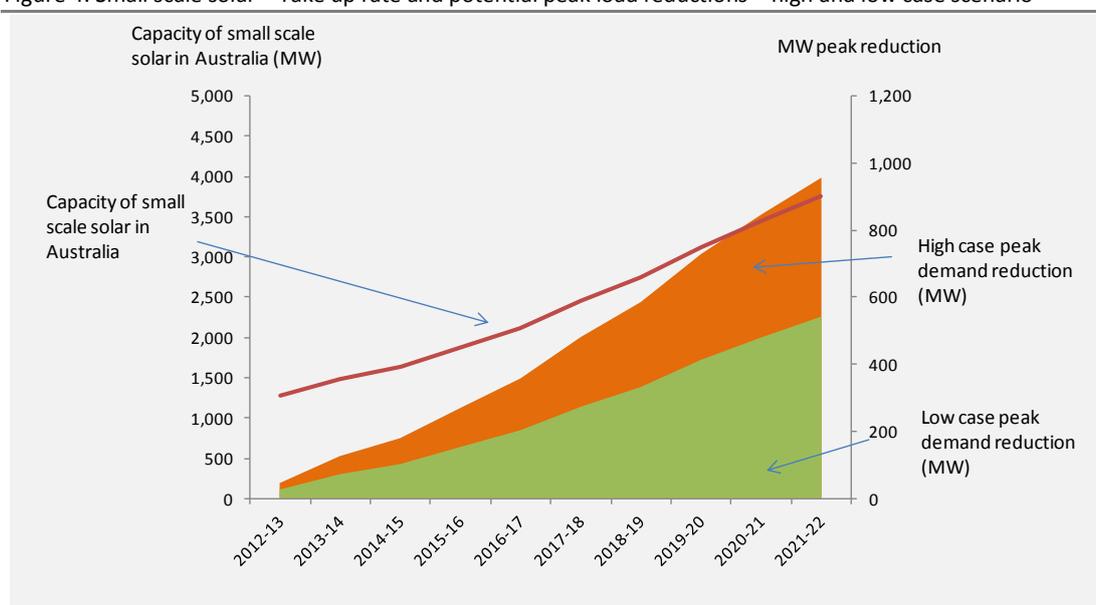
Table 10: Deloitte assumptions – Impact of PV on summer peak demand

	Low case estimate (%)	High case estimate (%)
Reduction at summer peak per MW of installed capacity - NEM	20.9%	34.9%
Reduction at summer peak per MW of installed capacity - SWIS	20.9%	51.6%

Source: Deloitte analysis

Using a publicly available forecast of Solar PV take up, extrapolated out to 2021-22, our assumptions regarding PV take up and the potential peak load reduction are presented in the following graph.

Figure 4: Small scale solar – Take up rate and potential peak load reductions – high and low case scenario



Source: Deloitte analysis

Using these assumptions, we consider that the Enhanced PV Uptake scenario over 2012 to 2022 could result in the range of benefits, as set out in table 11.

Table 11: Enhanced Uptake of solar PV– estimated value of benefits 2012-13 to 2021-22 (NPV, \$m)

	Low case estimate (\$m)	High case estimate (\$m)
Enhanced uptake of Solar PV	300	528

Source: Deloitte analysis

Conclusion

In conclusion, our analysis of the available research and data has yielded a range of gross NPV benefits of between \$1.6 billion and \$4.6 billion over 2012-13 to 2021-22. The results are presented in table 12.

Table 12: Deloitte conclusion – Total estimated value of gross benefits 2012-13 to 2021-22 (NPV, \$m)

Initiative	Low case benefits (\$m)	High case benefits (\$m)
Time of use pricing	58	193
Critical peak pricing and incentives	385	1,272
Direct load control of air conditioners	200	1,338
Direct load control of pool pumps	188	231
Electric vehicles	60	537
Energy Savings Measures	361	486
Enhanced uptake of Solar PV	300	528
Total gross benefits	1,551	4,585

Source: Deloitte analysis

The net benefits realised by customers will depend upon the additional costs incurred to achieve these benefits, the regulatory framework and the competitive nature of the wholesale and retail markets. For each initiative, in the body of this report we have presented an indication of the costs that are likely to be incurred in achieving these benefits.

A significant proportion of the potential benefits are attributable to critical peak pricing incentives and direct load control of air conditioners. Under the high case scenario, we note that the take up rates reach a maximum of 30% for all residential customers for Dynamic Pricing and 16% for direct load control of air conditioning .

Assuming that the peak load reduction benefits of Dynamic Pricing and direct load control are achieved by different residential customers (implying that the maximum benefit can be derived from each initiative as each customer responds to each initiative to highest degree possible) results in 46% of residential customers participating. We consider this is a reasonable assumption, given the current technical, market and policy barriers to these initiatives.

If we assume that each residential customer is only engaged in a single initiative (either Dynamic Pricing, direct load control, V2G or solar PV), the result is a maximum of 59% of residential customers being engaged in 2021-22 under the high case scenario and 49% of customers under the low case scenario.

For building efficiency standards, the benefits we have estimated are to be delivered by retrofitting existing commercial buildings, targeting peak demand savings delivered by commercial customers.

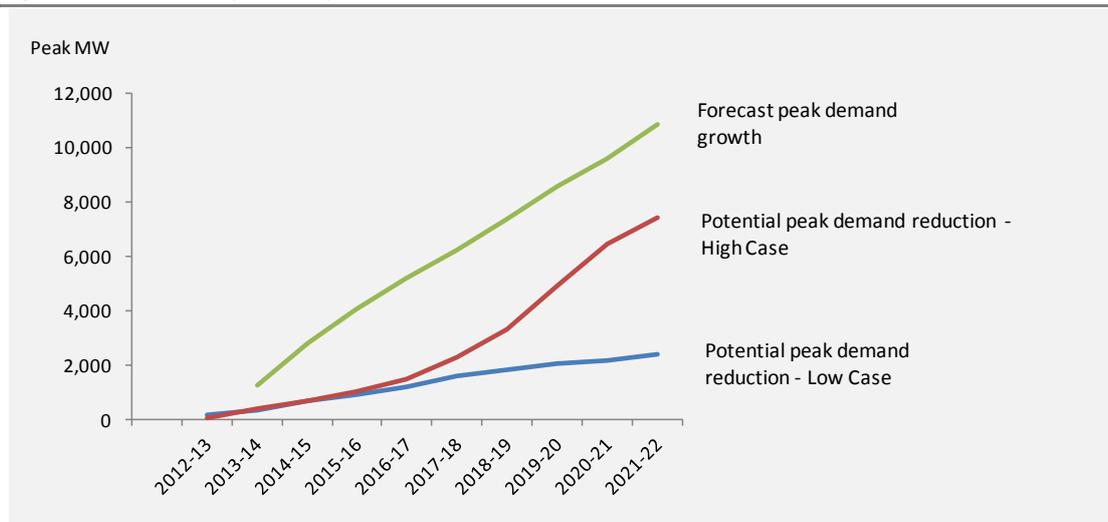
To estimate the impact on electricity tariffs is beyond the scope of this study and depends upon the costs incurred to achieve these benefits. However, we have converted these calculated gross benefits into a \$/MWh estimate for the residential market based on forecast residential electricity consumption.

Putting aside the benefits associated with improving the energy efficiency of existing commercial buildings, in making this calculation, we have implicitly assumed that all benefits accrue to residential customers.

The gross benefits translated into a \$/MWh figure for residential customers range from an average of \$1.46/MWh to \$4.09/MWh under the low case scenario and \$4.47/MWh to \$14.88/MWh under the high case scenario. The actual electricity price impact for residential customers will be lower due to the additional costs incurred in achieving these benefits. The electricity price impact will also depend upon the regulatory framework and the competitive nature of the wholesale and retail markets.

The potential peak demand reductions under the high and low case scenarios, as well as the forecast peak demand for Australia's two largest electricity systems are presented in figure 5.

Figure 55: Conclusion –potential peak demand reductions (MW)



Source: Deloitte analysis

This report demonstrates that there is significant value in initiatives to lower peak demand over the next decade. Under the high case scenario, we estimate that the initiatives considered could reduce peak demand growth by 68% by 2021-22.

1 Introduction

1.1 Peak demand in Australia

Significant, sustained growth in peak demand in Australia over the past decade has been a major driver of rising electricity costs. With the continued rapid growth in residential air conditioners, driven in part by falls in the cost of these appliances, this trend is expected to continue.

Analysis of load duration curves for 2010-11 published by AEMO, which show the proportion of time over which demand has occurred, indicates that for the 'peakiest' NEM regions of South Australia and Victoria, the top 20% of load occurs for less than 2% of the year, or around three days. The conclusion which can be drawn is that a significant amount of electricity network and generation assets which have been built to serve the top 20% of peak demand in these regions, are used for only three days per year. In NSW and Queensland, the top 10% of peak demand is used over less than three days per year.

Accordingly, initiatives to curtail or shift this peak load have great potential to reduce growth-related infrastructure spending and, therefore, constraining rises in electricity prices. Network businesses across Australia have recognised value and in recent years have undertaken a large number of trials and studies on ways to reduce peak demand.

This value has also been recognised by government, in particular the Ministerial Council on Energy (MCE) and the Australian Energy Market Commission (AEMC). Since 2007, the AEMC has been undertaking a detailed investigation into the potential for amendments to electricity regulations to support demand side participation in the NEM.⁹ The Australian Energy Regulator (AER) has also developed a Demand Management Incentive Scheme (DMIS) which is applied to distributors in the NEM to encourage investigation of innovative ways to reduce peak demand.¹⁰

The purpose of this paper is to present, at a high level, the costs of meeting peak demand in Australia, and the potential value of a range of initiatives to lower peak demand. Our analysis is largely based on the findings of a range of Australian trials and studies, as well as international research outcomes that are applicable to the Australian context.

We note that while we have relied on many published trials and studies in developing this analysis, we do not necessarily endorse all of the methods and data used in those studies, nor the individuals and organisations we have referred to in this report. However, we do consider that the research results we have relied upon in generating our estimated peak demand savings are sound, and are among the most relevant and recent available results.

1.2 Scope of our work

As set out in the terms of reference prepared by the ESAA, the scope of work for this analysis involves illustrating, at a high level, the potential financial benefits for Australia of flattening the load profile. This load profile is currently getting peakier, thus exacerbating cost pressures in the industry. This work comprises the following key parts:

- Estimating the financial impact of increasing peakiness over a ten year period

⁹ AEMC, Review of Demand Side Participation in the NEM – Stage 3: Power of Choice. Details available at: <http://www.aemc.gov.au/Market-Reviews/Open/Stage-3-Demand-Side-Participation-Review-Facilitating-consumer-choices-and-energy-efficiency.html> Accessed 28 February 2012.

¹⁰ For example: AER, Demand Management Incentive Scheme - Jemena, CitiPower, Powercor, SP AusNet and United Energy 2011–15, April 2009, available at: <http://www.aer.gov.au/content/item.phtml?itemId=728015&nodeId=7c4f21724ea53a38a35b6a019c65f48d&fn=Final%20Demand%20Management%20Incentive%20Scheme%20for%20Victorian%20DNSPs.pdf> Accessed 28 February 2012.

- Estimating the costs and benefits of a series of plausible tools, including policy reforms and technological innovations which aim to flatten the load profile over the same period, including:
 - Dynamic pricing, including time of use, peak rebates and critical peak pricing
 - Direct load control of appliances
 - Cost effective storage
 - Cost effective energy efficiency measures targeted at peak demand
 - Advanced communication and network monitoring systems which enable operators to manage increases in demand without increasing supply
 - Electric vehicles.

This analysis aims to produce an estimate of the range of total possible cost savings or benefits associated with flattening the load profile.

As requested, the focus of the analysis has been at a national level, however, consideration has been given to whether there are likely to be differential outcomes for networks and generators within the NEM and Western Australian or other electricity markets. Detailed analysis on the location-specific impacts of different technologies was beyond the scope of this engagement.

Our analysis was carried out by desktop research of publicly available trial results and models, based primarily on Australian data.

2 Peak demand and energy growth in Australia

2.1 Historical trends

In identifying growth trends in peak demand and energy consumption across the NEM and the South West Interconnected System (SWIS) over the past decade, we have reviewed data published in the Electricity Statement of Opportunities (SOO) reports produced by the Australian Energy Market Operator (AEMO) and the Western Australian Independent Market Operator (IMO).¹¹ The annual SOO reports provide a reliable, consistent analysis of energy use over time in the NEM and the SWIS.

We acknowledge that whole of system peak demand forecasts can be considered misleading in terms of identifying the drivers of distribution network investment, as the need for new distribution capacity is actually driven by peak demand at particular locations on the network, which may not occur at the same time as system peak. However, we consider that the growth in the system level peak demand is reflective of the general trend across the network driving growth related expenditure.

While historically winter peak demand has driven the need for new investment in electricity infrastructure, caused largely by electric heating and storage water heating loads, the increased penetration of both gas heating and air conditioning has seen a switch to the majority of investment driven by summer coincident peaks. Evidence shows that peak demand is increasingly correlated with high ambient temperatures, which causes additional problems for electricity networks, as equipment performance is also eroded by high temperatures. Given the overarching trend of growth in summer peak demand, our analysis is focussed on reducing summer peaks, however, we note that in Tasmania and in some regional locations in other States, high winter peak demand is also driving network investment. Accordingly, in addition to the initiatives focussed on reducing summer peak demand discussed in this report, winter initiatives such as load control of electric hot water systems remain important tools for management of peak demand going forward.

The AEMO 2011 SOO presents actual energy (sent-out) and maximum demand (POE 50) data for 2005-06 to 2009-10, and estimates for 2010-11. The five year average historical growth rates are:

- Energy – 0.5% per annum
- Summer maximum demand – 2.8% per annum.¹²

The IMO 2011 SOO does not present historical data on energy and maximum demand in the SWIS. Reviewing data published by Western Power reveals the following actual historical growth rates over 2005-06 to 2009-10, and estimates for 2010-11:

- Energy – 6.4% per annum
- Summer maximum demand – 6.3% per annum.¹³

¹¹ AEMO, Electricity Statement of Opportunities for the National Electricity Market, 2011; Independent Market Operator, Statement of Opportunities, June 2011. We note that in March 2012, AEMO released an update to its 2011 SOO, reporting lower energy consumption and peak demand driven by changes in economic conditions and an increased take up of energy efficiency and distributed generation, particularly rooftop solar. While our analysis is based on the 2011 SOO figures, we consider AEMO's changed forecast does not affect our analysis of the benefits of peak demand reduction. As peak demand continues to grow, requiring investment in infrastructure and driving increases in electricity prices, benefits associated with lowering peak demand are increasingly relevant. We also note that the March update provided by AEMO did not contain sufficient information to enable us to amend the ten year energy and maximum demand forecasts for the NEM. AEMO, 2011 Electricity Statement of Opportunities, Update as at 2 March 2012.

¹² AEMO, Electricity Statement of Opportunities for the National Electricity Market, 2011, Chapter 3

This comparison between the NEM and SWIS reveals the significant differences in average economic growth in the Eastern and Western states. Increasing demand from the resource sector, compounded by annual population growth of 2.2% in recent years is driving growth in both energy consumption and peak demand in the SWIS.¹⁴ Western Power's 2011 Annual Planning Report presents an analysis of the deterioration of average system utilisation (being the average proportion of time that the network is fully utilised, or the load factor) on its network falling from 61% to 57% over 2000-01 to 2010-11, demonstrating increasingly sharp peak demand.¹⁵

2.2 Forecast growth

AEMO has forecast that growth in energy and peak demand in the NEM states will converge, as recovery from the economic slowdown builds momentum. AEMO has cited the following specific drivers of growth from 2011:

- Mining activity, LNG developments and flood related construction in Queensland
- Improving economic growth in Victoria, with industrial loads forecast to return to historical levels
- Improving economic growth and mining expansion plans in South Australia
- Increases in agriculture and mining activity and population growth in Tasmania.¹⁶

AEMO's medium scenario growth forecasts for the NEM over the next decade are:

- Energy - 2.4% per annum
- Summer maximum demand - 2.5% per annum (POE 50).

The IMO has forecast maximum demand and energy growth on the SWIS in its 2011 SOO, with growth driven by expected large new loads and strong economic growth. The IMO's energy and maximum demand growth forecasts for the SWIS over 2010-11 to 2021-22 are:

- Energy (expected case) – 3.5% per annum
- Summer maximum demand (expected economic growth) – 4.3% per annum (POE 50).¹⁷

These forecasts show that there is some expectation that energy consumption in the NEM will grow at a similar rate to peak demand going forward, while in the SWIS, energy consumption growth will fall behind peak demand growth.

As outlined in the previous section, both of these long term forecasts run counter to the last five years of growth data reported by AEMO and the IMO, for a variety of different reasons. While it is clearly difficult to project the growth rate differential between energy and peak demand, the clear forecast is that growth in peak demand will continue, driving new investment and increasing the costs of supplying electricity.

The following graph presents historical and forecast energy and peak demand for each state in the NEM and the Western Australian SWIS over 2005-06 to 2020-21. Load duration curves for each NEM state are also presented, which reflect the proportion of time over which peak demand is occurring. The needle-peaks on the load duration curves highlight that the demand driving significant growth-related investment occurs over less than 2% of time.

¹³ Western Power, Access Arrangement Information for 2012-17 - Appendix P - System Demand Forecasting for AA3 and Appendix T – Deloitte Report – Energy and Customer Number forecasts for the AA3 Period; Independent Market Operator, Statement of Opportunities, June 2011, Appendixes 3, 4 and 5.

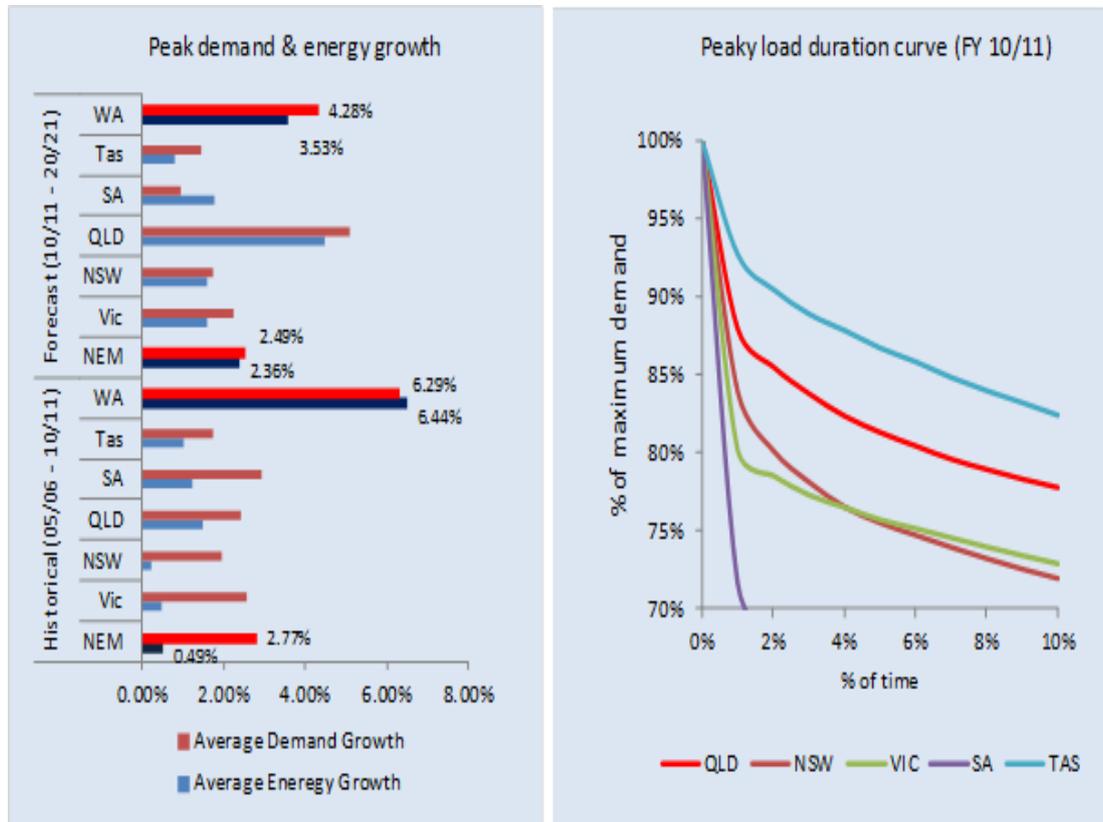
¹⁴ ABS, WA Population Growth – 1367.5 – Western Australian Statistical Indicators 2010.

¹⁵ Western Power, 2011 Annual Planning Report, Chapter 4 – Demand Forecasting.

¹⁶ AEMO, Electricity Statement of Opportunities for the National Electricity Market, 2011, p. 3-1.

¹⁷ Independent Market Operator, Statement of Opportunities, June 2011, Appendixes 3, 4 and 5.

Figure 6: Peak demand and energy growth - NEM and SWIS



Sources: AEMO 2011 SOO, IMO 2011 SOO, Deloitte analysis of Net System Load Profile data for the NEM.

2.3 Conclusion

Summer peak demand in the NEM has grown at an average rate of 2.8% per annum over the past five years and 6.3% per annum in the SWIS. Forecasts for both markets show peak demand growing at a fast rate over the next decade, which will require substantial new investments in network and generation capacity.

The relationship between peak demand and energy consumption has important implications for average energy prices. Increasing growth related network investment, coupled with slowing energy consumption, results in higher average prices for electricity, as network businesses recover the growing costs of their investments over energy sales which are growing at an increasingly slower rate. In recent years, while peak demand has continued to rise significantly in most States, growth in energy consumption has slowed in the NEM. This has been attributed in various analyses to a downturn in economic growth affecting both commercial/industrial and residential energy consumption as well as a general economic shift away from the more energy intensive manufacturing sector towards the services sector in Australia. It is also likely that energy efficiency measures have started to impact energy consumption. This trend is partly responsible for energy prices in many States rising faster than in the recent past.¹⁸

Having established that peak demand is growing and is expected to continue to grow, the following section discusses methodologies for determining the cost of meeting peak demand, and the value of lowering peak demand growth.

¹⁸ Other drivers of electricity price growth include increased reliability standards and rising input costs. Growth in asset replacement expenditure has also contributed to higher energy prices.

3 The value of avoiding peak demand

The actual costs of meeting peak demand will vary according to the nature of demand growth, the existing network infrastructure, any constraints and overall generation capacity and mix. As noted in section 1.2, the aim of this project is to determine, at a high level, the potential value of particular initiatives to reduce peak demand in Australia.

Detailed market modelling is beyond the scope of this project, however, developing a 'rule of thumb' estimate of the cost of an additional MW of demand is an appropriate approach that has been applied in similar analyses of the electricity industry.¹⁹ We note that substantial research on determining a methodology for valuing demand management to avoid network costs is being developed by the Institute for Sustainable Futures as part of the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Intelligent Grid Research Program.²⁰

In order to develop a high level range of estimates of the value of avoided maximum demand, we have reviewed published reports, research and analysis of the costs of serving maximum demand, for both electricity networks and generators.

A number of high level estimates of the cost of meeting peak demand have been published in recent years for a variety of purposes, including by Deloitte in analysing the costs and benefits of the Advanced Metering Infrastructure Program in Victoria.²¹ Some estimates have been developed based on the forecast costs and maximum demand forecasts proposed by network businesses in their regulatory submissions. For example, Energex has estimated that the average investment for each MW of additional capacity is \$3.5 million, comprising of \$2 million for distribution network assets, \$0.7 million for transmission assets and \$0.8 million for generation costs.²² The Institute for Sustainable Futures has previously estimated incremental avoided network costs in NSW to be approximately \$4 million per MW.²³

In developing a high level estimate of the value of avoiding peak demand, the following factors have been taken into account:

- Investment is driven by load at diverse sections of a network, and accordingly, reducing coincident peak demand will not result in avoided investment at every point of constraint on the network
- Investment in network infrastructure is 'lumpy', and planning for investment is needed several years prior to peak demand exceeding capacity. Lowering peak demand may not result in an immediate deferral of investment, rather a long term response.

Some published high level estimates of the value of avoiding peak demand are summarised in the following table.

¹⁹ For example: Ernst & Young, AEMC Power of Choice - Rationale and drivers for DSP in the electricity market - demand and supply of electricity, December 2011.

²⁰ Langham, E. Dunstan, C. and Mohr, S. (2011). Mapping Network Opportunities for Decentralised Energy: The Dynamic Avoidable Network Cost Evaluation (DANCE) Model, iGrid Working Paper 4.4, Prepared by the Institute for Sustainable Futures, University of Technology Sydney as part of the CSIRO Intelligent Grid Research Program.

²¹ Deloitte, Department of Treasury and Finance – Advanced Metering Infrastructure cost benefit analysis – Final Report, August 2011.

²² Department of Employment, Economic Development and Innovation, Queensland Energy Management Plan, May 2011, p. 4.

²³ Institute for Sustainable Futures, Close to Home: Potential Benefits of Decentralised Energy for NSW Electricity Consumers – Prepared for the City of Sydney, November 2010, p. 18.

Table 13: High level estimates of the value of avoiding peak demand

Source	Estimated costs
Deloitte – network and peaking generation	\$200 per kW per annum
Oakley Greenwood – Review of AMI Benefits, July 2010 – network and peaking generation	\$200 per kW per annum
CSIRO – Electric Driveway Project – SP AusNet network value, using the DANCE methodology	\$223 per kVA per annum
CRA 2008 – MCE Cost Benefit Analysis of Smart Meters – network only	\$98 to \$124 per kVA per annum
Ernst & Young – Power of Choice Review – Benchmark range – network only	\$90 to \$300 per kVA per annum

Sources: Deloitte, Department of Treasury and Finance – Advanced Metering Infrastructure Cost Benefit Analysis, August 2011, p. 63; Oakley Greenwood, Review of AMI Benefits – for the Department of Primary Industries Victoria, July 2010; CSIRO Electric Driveway Project, Plugging In: A technical and institutional assessment of Electric Vehicles and the Grid in Australia, Phase 1 Report, June 2011; Institute for Sustainable Futures, Close to Home: Potential benefits of Decentralised Energy for NSW Electricity Consumers, November 2010; Ernst & Young, AEMC Power of Choice - Rationale and drivers for DSP in the electricity market - demand and supply of electricity, December 2011.

The following sections discuss some more detailed estimates of network and generation costs for meeting peak demand.

3.1 Network costs

Electricity network costs represent a high proportion of the costs of meeting peak demand. When developing their network prices for different customer classes, which are to be reviewed and approved by the AER each year, distributors in the NEM are required to take into account the long run marginal cost (LRMC) of providing services.²⁴ Ensuring that tariffs reflect the LRMC of supply helps to send an efficient pricing signal to customers regarding the costs of their demand for electricity.

We consider that LRMC is a good measure of the additional cost a network business would incur to meet growth in peak demand, and by association, a reasonable high level estimate of the value of avoiding peak demand. There are many different methodologies for estimating the LRMC of network electricity supply and many reasons why distribution networks in different regions of the NEM have developed different estimates of LRMC, including design standards and other network characteristics.

However, we have been unable to find published high level network-wide LRMC estimates for transmission networks. We suspect this is due to the large one-off and load-specific nature of transmission investments which makes any high level average estimates of cost inappropriate for our purposes.

Given our aim is to develop a high level estimate of the value of reducing peak demand, we have reviewed a range of publicly available distribution network LRMC estimates developed by distributors for their most recent pricing proposals, without reviewing the methodologies applied in the calculations of these estimates.

The following table presents the LRMC estimates of the distributors.

²⁴ National Electricity Rules, clause 6.18.5 (b)(1).

Table 14: LRMC estimates published by NEM distributors

Distributor	LV (\$/KVA/annum)	HV (\$/KVA/annum)
Ausgrid	138.80	79.60
Endeavour Energy	331.14	83.48
ActewAGL	134.67	113.91
Jemena Electricity Networks*	160.53	44.64
United Energy Distribution*	142.44	64.65
ETSA Utilities	144.00	94.00
Average	175.26	80.05
Average excluding Endeavour Energy	144.09	79.36

Note: *Where LRMC data was presented in c/kWh, we have converted to \$/kVA/annum based on industry standard load factors.

Sources: Ausgrid Network Pricing Proposal - for the FY ending June 2012 - p. 46; Endeavour Energy - Direct Control Services - Annual Pricing Proposal 2011-12, p. 79; Actew AGL, May 2011, p.17; CitiPower, 2011 Pricing Proposal, p. 38; Powercor, 2011 Pricing Proposal, p. 40; JEN, JEN Pricing Proposal 2011 Pricing Proposal, p.26; United Energy, UED Pricing Proposal 2011, table 6.3; ETSA, Pricing Proposal Appendix E.

In making an assessment of the value of deferring peak demand for distribution networks, we have relied primarily on the LV LRMC estimates, as these reflect the cost of supply for small customers. We have considered the estimate published by Endeavour Energy is an outlier, given the recent estimates published by other distributors.

3.2 Generation costs

Peaking generation in Australia is generally supplied by Open Cycle Gas Turbine (OCGT) plants. Accordingly, we have reviewed estimates of the LRMC of OCGT generation in considering the cost of meeting peak demand.

In 2010 and 2011, AEMO published its first National Transmission Network Development Plans (NTNDP) which provides a strategic long term outlook of planning and developments in the NEM. AEMO is currently consulting on the 2012 NTNDP forecasts.

Since 2009, AEMO has contracted a number of consultants to develop LRMC forecasts for different generation technologies, which take into account the relative upfront capital, ongoing maintenance and fuel costs.²⁵ As for network infrastructure, we consider that taking a discounted LRMC of OCGT generation plants is a reasonable proxy for the value of avoided peaking generation capacity.

In 2010, the Department of Energy Resources and Tourism (DRET) commissioned the Electric Power Research Institute (EPRI) to assess the costs of electricity generation for the purposes of developing various energy policies.²⁶ Estimates of LRMC based on cost assumptions produced by ACIL Tasman and Worley Parsons for AEMO and EPRI for DRET are presented in the table below.

²⁵ ACIL Tasman - Fuel Resource, new entry and generation costs in the NEM, April 2009; Worley Parsons, Cost of construction New Generation Technology, January 2012.

²⁶ EPRI, Australian Electricity Generation Technology Costs - Reference Case 2010, February 2010.

Table 15: Estimates of LRMC for OCGT

Source	LRMC OCGT (\$/kW/p.a)
EPRI, 2010	155.9
ACIL for NEMMCO (AEMO) 2009	135.9
Worley Parsons for AEMO 2011	129.2

Note: The \$/kW/p.a. LRMC figures are calculated by Deloitte based on the published capital cost, fixed and variable O&M, fuel and heat rate estimates.

Sources: EPRI, Australian Electricity Generation Technology Costs - Reference Case 2010, February 2010; ACIL Tasman - Fuel Resource, new entry and generation costs in the NEM, April 2009; Worley Parsons, Cost of construction New Generation Technology, January 2012.

3.3 Conclusion – value per kW of demand

After reviewing the range of high level and detailed LRMC cost estimates discussed above, and the underlying assumptions and input data relied on in these sources, we have developed an estimate of the average cost to provide an incremental kW of peak demand in Australia, in terms of network and generation costs. We consider our estimate is a reasonable proxy for the value of avoided costs for the purposes of this high level analysis, which takes into account a number of factors relevant to the initiatives under analysis.

While we have reviewed LRMC cost estimates in forming our view on this estimate, the value of avoiding peak demand will be lower than the cost to serve peak demand, due to diversity on the network, investment profiles and the variable supply demand balance. In addition, in order to defer investment, network operators, generators and retailers need to be willing to rely on the demand reduction occurring at times of peak, considering the implications of not having the capacity or not being contracted to meet peak demand.

Traditionally, demand side participation is valued based on firm contracts between demand side providers (typically large customers) and market participants. However, most of the demand reductions associated with initiatives discussed in this paper (such as Dynamic Pricing) will not be underpinned by contracts requiring firm demand reductions. Rather, they will be based on incentives for residential customers to change their behaviour at times of peak demand. Given this relies on assumptions about the elasticity of demand for electricity, for market participants to incorporate demand reductions into their investment planning, it is accepted that historical data reflecting reliable demand reductions due to the initiatives will be needed. This will only occur over the longer term, reducing the value of avoided investment in the 10 year timeframe for this analysis.

In addition, network diversity means that while benefits may accrue to distributors due to reduced demand within an area supplied by a single zone substation (for example, a suburb where a residential peak reduction initiative is focussed), the same benefits will be dispersed and therefore lower at transmission connection points which supply a wider area. Similarly, the time of peak demand in the wholesale electricity market does not necessarily coincide with times of network peak, meaning that benefits may not accrue to all sections of the supply chain at once.

To capture all of these factors in detail, a comprehensive model of network and generation demand, supply and diversity factors would be needed, which is beyond the scope of this engagement.

Therefore, taking into consideration the stand-alone distribution network costs (between \$135 and \$161 per kW per annum) and generation costs (\$129 to \$156 per kW per annum) and the published high level ranges outlined above, we consider that an estimate of \$200 per kW per annum is

reasonable for the purposes of our analysis. We note that this estimate is approximately 30% below the sum of the distribution network and generation LRMC estimates, which theoretically should represent the maximum cost of supplying an additional kW of peak demand.

We note that our selected value per kW of peak demand reduction is considered appropriate for the purposes of this high level analysis, however, we would caution the use of this figure for other purposes. As we have discussed above, detailed market modelling was beyond the scope of this engagement.

Table 16: Deloitte estimate: Value of avoided peak demand

	Estimated value of peak demand (\$/kW/annum)
Deloitte estimate	200

We have used this estimate in determining the potential value of the initiatives discussed in the following sections.

4 Initiatives to reduce peak demand

In recent years, supporting and encouraging measures to reduce peak demand have been a significant focus of industry and government, driven by rising investment in electricity assets to support increasing peak demand..

Household energy consumption is increasingly the major contributor to peak demand growth, as industrial and commercial loads tend to be less weather-dependent and fluctuate to a lesser extent. Accordingly, our analysis of initiatives is mostly focused on ways to reduce household summer peak demand.

Following research and consultation with the ESAA, we have selected five core initiatives for the focus of this review, including:

- Dynamic pricing – time of use and critical peak pricing and incentives
- Direct load control of air conditioning and pool pumps
- Vehicle to Grid (V2G) capability of Electric Vehicles (EVs) and Plug-in Hybrid Electric Vehicles (PHEV)
- Energy efficiency measures targeted at reducing the drivers of peak demand, including:
 - Air conditioner appliance efficiency standards
 - Improvements in building standards for retrofitting
- Small scale solar generation.²⁷

Other initiatives that were researched, considered but then not evaluated include:

- Peak demand limiting, which is currently in very early trial stage in the NEM and would target a similar range of benefits as direct load control
- Residential insulation, which is captured by the improvements in building standards
- Power factor correction, which is only economic for large industrial and commercial customers and which has already been implemented to a large extent by distributors
- In home displays, for which the impact on peak demand is likely to be tied to time of use pricing and critical peak incentives. This is discussed in the section on Dynamic Pricing below
- General incentive schemes, such as the Victorian Energy Efficiency Target (VEET), for which the benefits are largely captured by energy efficiency measures
- Battery storage, which is currently uneconomic due to very high capital costs and is at early trial stage in the NEM.

The following chapters present the findings of our research and analysis on each initiative.

²⁷ We note that our analysis of improvements in building standards are related to savings generated by commercial customers and small scale solar savings will be delivered by both residential and commercial customers.

5 Dynamic pricing

5.1 What does it involve?

Economic theory suggests that charging customers prices that reflect the different costs of supplying electricity at different times of the day is one of the fundamental ways to reduce peak demand and ensure economically efficient consumption behaviour. Assuming consumers can receive, understand and have the freedom and ability to respond to clear, consistent price signals, and assuming that peak energy is a normal good (where demand falls as price rises), enabling flexible time of use (TOU) pricing is a very reasonable approach to managing peak demand. Where these criteria do not hold, for example, people that cannot reduce their energy use at peak times due to work requirements, the economic case for such variable pricing becomes less clear.

There are a number of different ways that flexible pricing can be undertaken, which for convenience we have grouped together as Dynamic Pricing.

For the purposes of our analysis, we have defined Dynamic Pricing as constituting the following:

- Three-rate TOU tariffs (peak, shoulder, off peak), for which rates may vary between seasons (Winter, Summer) however otherwise remain fixed for the contract period
- Critical peak pricing (CPP) and/or critical peak incentives, which involve at least one-day ahead notifications being sent to customers to advise them of a critical peak pricing event. During a critical peak pricing event, electricity prices would be significantly higher than normal TOU peak prices. Alternatively, during a critical peak pricing event, customers could earn an incentive payment by reducing their demand from a determined baseline by an agreed amount.

In most Australian states, large commercial and industrial customers have been subject to TOU pricing for some time, however, TOU pricing has not been widely available to residential customers, due to the fact that the current stock of electricity meters are not able to record consumption over different periods of the day. We note that in some jurisdictions, for approximately ten years, distributors have been installing, on a new and replacement basis, meters with multiple registers that can record consumption in peak, shoulder and off-peak periods. However, the time periods for these meters are generally predetermined at the manufacturing stage and daily consumption within periods is not recorded. Interval metering, which records consumption on a half hourly basis, is required to facilitate Dynamic Pricing.

The degree to which customers will respond to peak prices over the long term is the subject of significant research and debate, both in Australia and internationally.

Trials of Dynamic Pricing are being undertaken by distributors and retailers in Australia and in many locations worldwide. We have reviewed a sample of trial and research results in determining the potential value of Dynamic Pricing in reducing peak demand. The following table lists the trials whose results we have considered in our analysis.

Table 17: Dynamic Pricing – Australian and international trials and research

Organisation	Jurisdiction	Basis of findings / assumptions
Ausgrid – various trials since 2005	NSW	Ausgrid has been carrying out trials of Dynamic Pricing with residential customers for some years, under various programs, most recently the Smart Grid Smart City trial. Ausgrid’s main published trial results are based on data collected over 2006 involving 3000 customers on TOU tariffs. ²⁸
Essential Energy – Home Energy Efficiency Trial (2004)	NSW	This trial involved 150 customers participating in critical peak pricing events.
Endeavour Energy – Western Sydney Pricing Trial	NSW	This involved 900 customers across a range of TOU and critical peak pricing, as well as a web interface.
CRA International – California Statewide Pricing Pilot 2005	California	Results from various Dynamic Pricing trials involving 2500 customers over 18 months in 2003-04.
Newsham and Bowker –2010	North America	This is a research paper titled <i>The effect of utility time-varying pricing and load control strategies on residential summer peak electricity use: a review</i> . The analysis stems from the results of 16 studies on Dynamic Pricing carried out by utilities across North America.
The Brattle Group – various studies, reports and presentations	USA	Based on rate designs in the US and trial results.
Deloitte – Cost benefit analysis of the Victorian Advanced Metering Infrastructure Program, August 2011	Victoria	Assumptions and analysis based on a range of international trial results on TOU and Critical Peak pricing incentives.
MCE – Cost benefit analysis of smart meters and direct load control, 2008	Australian states	Assumptions and analysis on customer response to TOU and critical peak pricing was based on the findings from the California Statewide Pricing Pilot.
OTTER – Cost benefit analysis of the rollout of interval meters in Tasmania, 2006	Tasmania	Assumptions based on a range of Australian and international trial results on TOU pricing.

Sources: Futura Consulting, Power of choice – giving consumers options in the way they use electricity - Investigation of existing and plausible future demand side participation in the electricity market, Final Report, December 2011 (reporting results of Ausgrid, Endeavour Energy and Essential Energy); CRA International, Impact Evaluation of the California Statewide Pricing Pilot, March 2005; Newsham and Bowker, The effect of utility time-varying pricing and load control strategies on residential summer peak electricity use: A review, June 2010; Faruqi, Dynamic Pricing: The top 10 Myths - ENA Smart Networks Summit, Sydney May 2011; Deloitte, Department of Treasury and Finance - Advanced metering infrastructure Cost benefit analysis, August 2011; NERA et al for the MCE, Cost Benefit Analysis of Smart Metering and Direct Load Control - Overview Report for Consultation, February 2008; OTTER, Costs and Benefits of the Rollout of Interval Meters in Tasmania - Final Report, October 2006.

²⁸ Futura Consulting, Power of choice – giving consumers options in the way they use electricity - Investigation of existing and plausible future demand side participation in the electricity market, Final Report, December 2011;

5.2 What is needed to achieve the benefits?

As discussed above, the primary piece of infrastructure required to implement Dynamic Pricing is interval meters which are capable of recording electricity consumption in short intervals, most commonly half hourly periods.

In some States, interval meters are being rolled out with significant communications infrastructure ('smart meters') to enable them to transmit consumption and connection point data to the distributor every half hour. The ability to remotely communicate with meters presents a large number of potential benefits for distributors and customers, in particular more efficient network management. Accordingly, the economic case for installing smart meters typically relies on a multitude of benefits that include many which are unrelated to Dynamic Pricing.

We recognise that some aspects of Dynamic Pricing can be implemented without remote communications to the meter. However, based on our research, it is clear that the benefits of TOU pricing and critical peak pricing or incentives are closely tied to providing enhanced information on energy consumption to customers. Real time (or close to real time) feedback on energy use is seen as an important driver of customer behaviour, as being able to review and understand what is behind electricity bills within short intervals (not necessarily instantly, however much more frequent than the common quarterly bill cycle) will significantly enhance customer willingness and ability to respond to Dynamic Pricing.

In our view, experience in Victoria and other international jurisdictions suggests that it is unlikely that TOU pricing will be rolled out on a mandatory basis. In order to attract a critical mass of customers to Dynamic Pricing, information and feedback on energy use will be needed to ensure that customers are best placed to benefit and therefore commit to Dynamic Pricing on a large scale.

In order to develop an understanding of the range of costs involved in implementing Dynamic Pricing, we have reviewed the costs per customer incurred or expected to be incurred in smart meter rollouts in Australia and internationally. As to be expected, rollout costs vary substantially, driven by economies of scale and quantity discounting as well as vast functionality and technology differences. With rollouts in the range of 280,000 to 35 million meters, reported costs per customer range from \$170 to over \$900.²⁹

We have also reviewed estimates of costs developed by EMCa for the MCE in 2008 as part of the National Cost Benefit Analysis of Smart Metering and Direct Load Control.³⁰ This is the only comprehensive Australia-wide study on the expected costs of a mandatory rollout of smart metering that has been conducted to date. The range of costs per customer in each state was estimated by EMCa at \$341 to \$475, or \$377 per customer, as an Australia-wide average.

Noting the variance between actual rollout costs and estimates discussed above, we acknowledge that there are a large number of variations that prevent an accurate comparison between international and Australian smart meter rollouts, including:

- Numbers of meters installed
- Type of meter installed
- When and how the meter is installed (on a voluntary (customer request) basis, new and replacement, or a mass rollout)
- Communications infrastructure that is suitable for the region

²⁹ Rollouts considered were in Victoria, France and Western Australia. See: Deloitte, Department of Treasury and Finance - Advanced metering infrastructure Cost benefit analysis, August 2011; eMeter Smart Grid Watch article – French Government Announces Smart Meter Rollout Schedule, September 29 2011 – Accessed at: <http://www.emeter.com/smart-grid-watch/2011/french-government-announces-smart-meter-rollout-schedule/> Accessed on 29 February 2012; Western Power, Smart Grid Proposal, October 2011.

³⁰ EMCa, Cost Benefit Analysis of Smart Metering and Direct Load Control - Workstream 6: Transitional Implementation Costs: Phase 2 Consultation Report, February 2008.

- Associated back office and IT costs, for both distributors and retailers.

5.3 What is the potential impact on peak demand?

5.3.1 Potential customer response to TOU and CPP at peak times

The results of trials and research discussed above and listed in table 17 are presented in the following tables.

Table 18: TOU Pricing –Results of studies and trials

Source	Peak demand reduction achieved (% per customer peak demand)
Ausgrid – AMI Trial 2006 and Strategic Pricing Study 2005	4% to 13%
Endeavour Energy – Western Sydney Pricing Trial	No quantifiable result
CRA International – California Statewide Pricing Pilot 2005	0.6% to 5.9%
Newsham and Bowker, various North American trials and studies, 2010	-4% to +5%*
The Brattle Group – various papers and presentations	14% to 18% (median)
Deloitte 2011 – Cost Benefit Analysis of AMI	1.5%
MCE – Cost benefit analysis of Smart Metering and Direct Load Control (estimates for all states)	1.1% to 5.8%
OTTER 2006 – Accelerated smart meter rollout (Scenario 9)	10%

* Note: Newsham and Bowker reported much higher peak demand reductions achieved in some of the TOU studies they reviewed (up to 30%), however the higher results were generally from studies involving other enabling technologies (such as direct load control) in addition to simple TOU pricing. The negative low end result represents an increase in peak time usage reported as a result from a 2006 Idaho trial. Newsham and Bowker stated that a simple TOU program can only expect to realise on-peak reductions of 5%. See: Newsham and Bowker, The effect of utility time-varying pricing and load control strategies on residential summer peak electricity use: A review, June 2010.

Table 19: CPP Incentives– Results of studies and trials

Source	Peak demand reduction achieved (% per customer peak demand)
Ausgrid –Strategic Pricing Study 2005	36%
Endeavour Energy – Western Sydney Pricing Trial	35%
Essential Energy – Home Energy Efficiency Trial	25%
CRA International – California Statewide Pricing Pilot 2005	13.1% to 27.2%
Newsham and Bowker, 2010	4% to 40% - CPP 0 to 18% - Peak time rebate
The Brattle Group – various studies, reports & presentations	34% to 38% (median)
Deloitte 2011 – Cost Benefit Analysis of AMI	15%
MCE – Cost benefit analysis of Smart Metering and DLC	10.6% to 21.5%

The range of Australian time of use studies and trial results in table 19 spans from 1.1% to 13% peak load reduction, while the range of results of international trials and studies spans from -4% to 18%. There is considerable debate about the potential load reductions that can be achieved by time of use pricing in Australia. Results are undoubtedly affected by the sample or trial size, the price differential between peak and off peak periods and the time period over which the tariffs are in place.

The potential peak load reductions achieved by critical peak pricing trials and studies are significantly greater than those for time of use pricing, ranging between 10.6% and 36% in Australia and 4 to 40% internationally. Results will vary depending on the price differential and how many times per year critical peak events are notified.

The impact of fatigue over time as customers adjust to new pricing regimes is not yet fully understood. In addition, we note that in order to avoid network costs, peak load reductions need to be firm and sustainable such that distributors can justifiably rely on them in risking adverse service standards outcomes. In practice, this is likely to occur only over the long term as a reliable data set on customer response to Dynamic Pricing is obtained.

Accordingly, in estimating the peak load reductions that could be achieved and relied upon by networks and generators over the next decade, a conservative lens needs to be applied to the results listed above.

Based on our experience and research, we have selected the following high and low estimates of customer responses to Dynamic Pricing in calculating the range of possible benefits.

Table 20: Dynamic Pricing – Deloitte peak load reduction assumptions

Dynamic pricing	Low estimate (% response)	High estimate (% response)
Time of use tariffs	1.5%	5%
Critical peak pricing or incentives	10%	33%

We acknowledge that there are differences in the assumptions and circumstances surrounding the research and trials we have reviewed which would affect the potential reductions in peak demand that can be achieved. For example, trials which involve incentive payments to participants are recognised to suffer from selection bias, whereby the trial may produce outcomes that are more favourable than would be the case should the tariffs be implemented on a business as usual basis.

However, given the objective of our review is to develop a plausible range of benefits, we consider the application of this high level analysis of results is appropriate.

In developing these estimates of high and low benefits from Dynamic Pricing, we have not determined an average TOU price nor the differential between the three time periods, noting that this in itself would require a significant number of assumptions about likely DNSP and retailer pricing. Instead, we have reviewed the literature and considered the average impact of TOU pricing on peak demand.

Rather than specifying a particular design or pricing structure for critical peak pricing and incentives, we have reviewed the literature and considered the potential peak load reduction that a variety of critical peak prices and incentive payments could deliver.

We have also assumed that in order to achieve the benefits of TOU pricing, some information is provided to customers to support their response to the new tariffs, including in home displays (IHDs) or enhanced billing. We note that there is significant literature in support of the energy efficiency benefits associated with IHDs and enhanced billing, however, it is difficult to isolate the impact of these on peak demand from Dynamic Pricing.

5.3.2 Potential reductions in peak demand – other assumptions

Taking the range of estimates of customer response to Dynamic Pricing discussed in the previous section, we have then made the following assumptions to determine the potential value of this initiative:

- Take up rates – In order to estimate a benefit, we have assumed that a maximum of 15% of customers elect to partake in TOU tariffs, gradually increasing from 2012 to 2018. This assumption recognises that even with a strong Government led mandate for this initiative, smart meter installations are likely to be at various stages across the NEM over the next decade. Our conservative assumption reflects a reasonably achievable benefit in the medium term.
- Average peak load per customer – we have used an average customer peak load of 3kW in estimating the potential peak load reductions achievable.

The engagement of customers in Dynamic Pricing is key to achieving the take up rates that are assumed in this study. International evidence of the value of engaging customers early in any smart meter rollout and pricing program, and building their trust through educational materials and information on time of use pricing, is mounting.

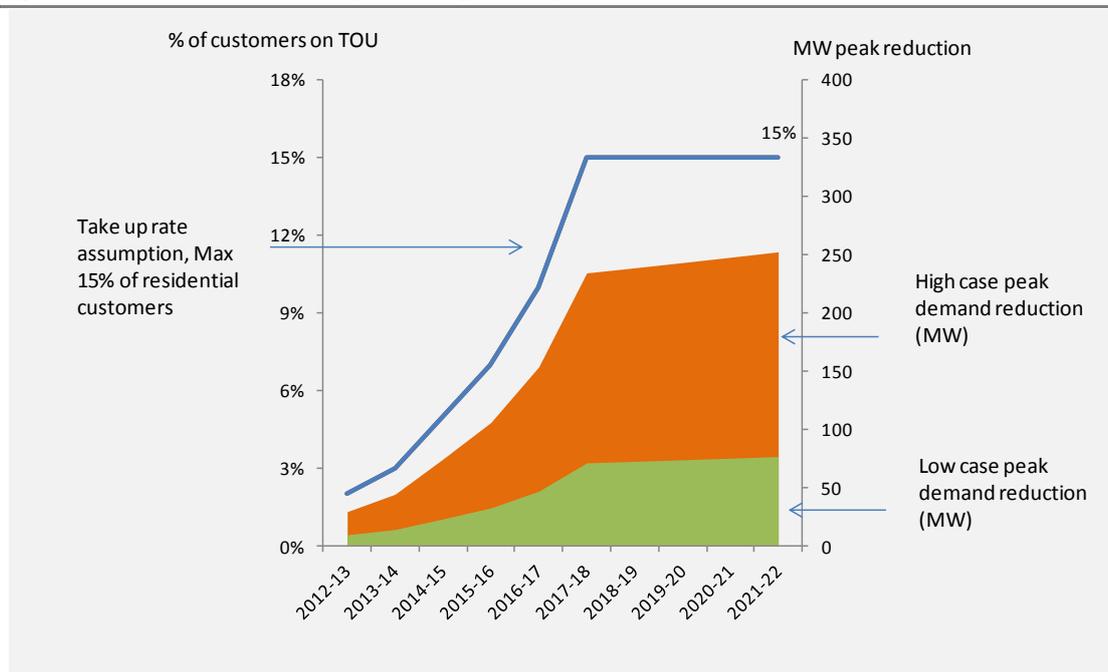
Canadian utility HydroOne undertook an extensive customer engagement program throughout its smart meter installation program over 2004 to 2011, with each customer receiving 3 to 5 individual communications regarding the objectives, benefits and implications of time of use pricing and smart metering. HydroOne is now in the final phases of switching all of its 1.2 million residential and small business customers to time of use pricing. With a 100% take up rate and relatively little customer opposition to the new tariff structures, HydroOne and its customers are set to achieve significant peak load reduction benefits due to Dynamic Pricing initiatives.³¹

In order to achieve the benefits associated with Dynamic Pricing discussed in this report, clear, consistent and sustained communications from industry and Government on the implications, costs and benefits of Dynamic Pricing is crucial.

The following graphs represent our assumptions regarding take up rates and potential peak load reduction (MW – high and low case scenarios) for time of use tariffs and critical peak pricing and incentives.

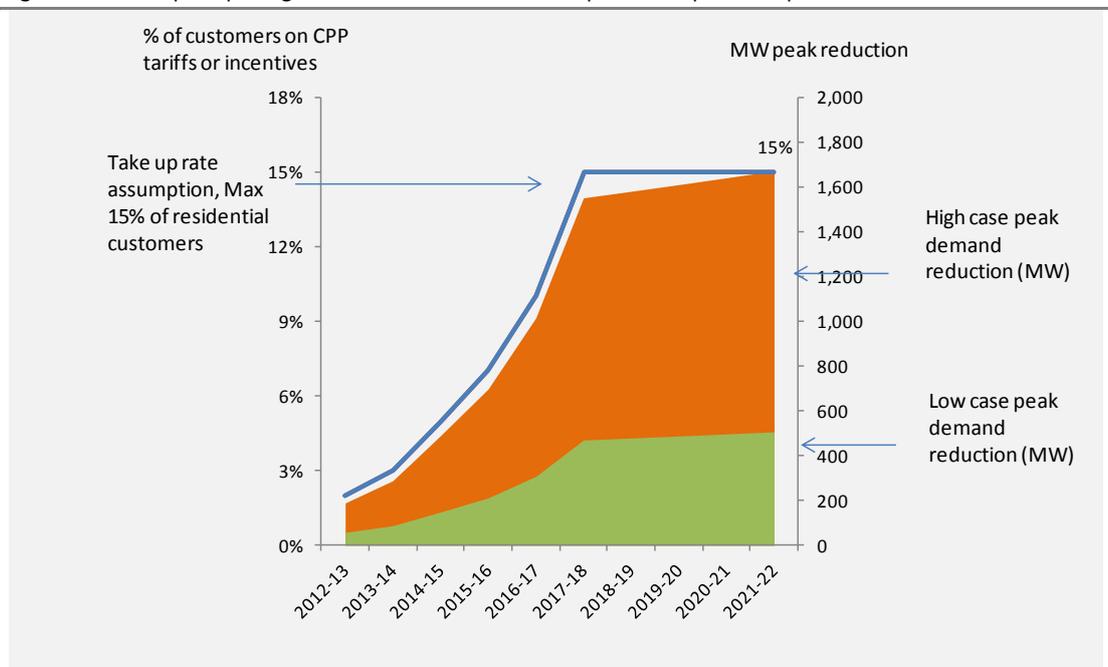
³¹ Deloitte, Department of Treasury and Finance - Advanced metering infrastructure Cost benefit analysis, August 2011, pp. 37-38 and HydroOne website, available at: <http://www.hydroone.com/TOU/Pages/Default.aspx> Accessed 2 March 2012.

Figure 7: Time of use tariffs – take up rate and potential peak load reduction



Source: Deloitte analysis

Figure 8: Critical peak pricing tariffs and incentives – take up rate and potential peak load reduction



Source: Deloitte analysis

5.4 Conclusion – value of potential benefits

In conclusion, we consider that the implementation of Dynamic Pricing across the NEM and SWIS over 2012 to 2022 offers benefits in the range set out in the table below.

Table 21: Dynamic Pricing – estimated value of benefits 2012-13 to 2021-22 (NPV, \$m)

	Low case estimate (\$m)	High case estimate (\$m)
Time of use pricing	58	193
Critical peak pricing / incentives	385	1,272

Source: Deloitte analysis

6 Direct load control

6.1 What does it involve?

Direct load control has been used by electricity distributors to control residential electric storage hot water systems across Australia for over 30 years. Load control devices (or time clocks) enable distributors to stagger hot water load throughout neighbourhoods to prevent it from contributing to peak demand. Prior to this technology, hot water demand was one of the major drivers of peak demand, which as discussed above, historically occurred during the winter in most parts of Australia. The savings generated by direct load control of hot water systems are substantial – Energex alone estimates that it has saved 450 MW of winter peak demand.³² In analysis conducted for the AEMC in December 2011, Futura estimated that 1,750 MW of summer peak demand has been shifted to off-peak periods Australia-wide through the use of direct load control of hot water systems.³³

It is not surprising, therefore, that direct load control of air conditioning and pool pumps – two of the major drivers of peak demand in Australia over the past decade – is now being trialled by distributors across the country. Direct load control devices installed in air conditioning enable distributors to remotely cycle compressors over short intervals to manage the collective load on the network and reduce peak demand. A well-managed direct load control program means that participating customers are unaware of the impact of the load control on their cooling.

Internationally, direct load control has extended beyond air conditioning and pool pumps to other appliances. Californian distributor, Florida Power & Light, operates a program called *On-Call* which is viewed as one of the most successful load control programs in the US. Controls are fitted to five or more appliances in each eligible customer's home in return for a fixed annual rebate of up to US\$137 per year.³⁴ At times of peak demand, Florida Power & Light selectively controls appliances such that customers are unaware of the impact. This direct load control program has provided Florida Power & Light with control over 10% of its peak load (2,500 MW).³⁵

The best-known and most extensive Australian trials of direct load control of air conditioning to date have been conducted by ETSA Utilities and Energex.

Since 2006, ETSA Utilities has conducted several direct load control trials targeting residential and commercial volunteer customers' air conditioning. Results of these trials indicated that the potential reduction in each customer's peak load ranges from 19% to 35%.³⁶

However, findings from ETSA's trials indicate that only particular types of air conditioners are able and worthwhile to be controlled. Based on the results of its trials, ETSA carried out a cost benefit analysis of a larger scale rollout of direct load control of air conditioning. Based on an assumption of 10% customer take up, ETSA found that a large scale rollout of direct load control in its territory would not result in net benefits. However, results of a cost benefit analysis of an enhanced load control device (known as Peakbreaker+), which is fitted with two-way communications and provides enhanced network optimisation, concluded with positive net benefits.³⁷

³² Energex, Response to the Prime Minister's Task Force on Energy Efficiency, April 2010. We note that there are still further potential savings to be delivered by increased penetration of direct load control of hot water systems, particularly in jurisdictions which currently have a lower take up. However, we have not attempted to measure the further potential for peak demand savings from controlling hot water, focussing instead on new initiatives to lower peak demand.

³³ Futura Consulting, Power of choice – giving consumers options in the way they use electricity - Investigation of existing and plausible future demand side participation in the electricity market, Final Report, December 2011.

³⁴ Florida Power & Light, website link: <http://www.fpl.com/residential/savings/onrecall.shtml>, Accessed 23/2/12, 2:30pm.

³⁵ Deloitte, Department of Treasury and Finance – Advanced Metering Infrastructure cost benefit analysis – Final Report, August 2011.

³⁶ ETSA Utilities, Project EPR 0022 – Response to AEMC Issues Paper – Power of Choice, September 2011.

³⁷ ETSA Utilities, Demand Management Program Interim Report No. 3, June 2010.

Energex's Cool Change Trial, which commenced in the summer of 2007 and is still in operation, involves trialling direct load control of over 2,000 customers' air conditioners. On average, customers involved reduced their demand by 13% over the 2009-10 summer peak.³⁸

Other trials of direct load control are being carried out as part of the Australian Government's Solar Cities Program, in particular in Perth and Blacktown. The Blacktown Solar Cities air conditioner trial, which involved distributor Endeavour Energy cycling 529 customers' air conditioners, achieved a 27% reduction in their peak load.³⁹ In its first year, the Perth Solar Cities air conditioner trial achieved an average reduction of up to 20% of the peak demand of 211 participant households.⁴⁰

Trials of direct load control of pool pumps have also been carried out in Australia, and even implemented as business-as-usual tariffs in Queensland by Energex and Ergon Energy and in NSW by Endeavour Energy. Two trials of pool pumps implemented by Energex achieved average peak load reductions of 0.8 kW per appliance (or 27% of average customer peak load of 3 kW).

Energex is currently offering customers a \$250 gift card in exchange for connecting their pool pumps to an off-peak controlled load circuit (tariff 33 or tariff 31), which offers a lower c/kWh rate in exchange for periods of no supply during peak.⁴¹ Futura has estimated that 110 MW of pool pump load has already been shifted away from the peak period in South East Queensland.⁴²

In 2009, as part of the Blacktown Solar Cities program, Endeavour Energy implemented a pool pump direct load control trial which it subsequently expanded to offer its customers on a commercial basis. Endeavour Energy's pool pump load control trial achieved average reductions of up to 36% of peak demand per customer.⁴³ The quantity of pool pump peak load that has already been shifted in Endeavour Energy's region as a result of new direct load control tariffs is not reported.

The following tables outline the results of our research on the potential impact of direct load control of air conditioning and pool pumps.

Table 22: Direct load control of air conditioners – research and trials

Organisation	Jurisdiction	Peak load reduction per customer (%)	Basis of findings / assumptions
ETSA Utilities	South Australia	19 to 35%	Various trials since 2006 – air conditioning
Energex	SE Queensland	13%	Trials
Blacktown Solar Cities	Western Sydney	27%	Trials
Perth Solar Cities	Perth	20%	Trial in 2010-11, 211 customers
Deloitte – Cost benefit analysis of the Victorian AMI Program, August 2011	Victoria	15%	Assumptions & analysis based on a range of international trial results on direct load control
MCE – Cost benefit analysis of Smart Metering and DLC	Australia	11.7% to 13.9%	Assumptions and analysis based on a range of trial results

³⁸ Energex, Time for a cool change – Energy Smart Suburbs – Newsletter November 2010.

³⁹ Futura Consulting, Power of choice – giving consumers options in the way they use electricity - Investigation of existing and plausible future demand side participation in the electricity market, Final Report, December 2011, p. 60.

⁴⁰ Perth Solar City Annual Report 2010-11.

⁴¹ Energex website, <http://www.energex.com.au/sustainability/energy-conservation-and-demand-management/residential-targeted-initiatives/pool-rewards-program>, Accessed 24 February 2012.

⁴² Futura Consulting, Power of choice – giving consumers options in the way they use electricity - Investigation of existing and plausible future demand side participation in the electricity market, Final Report, December 2011.

⁴³ Futura Consulting, Power of choice – giving consumers options in the way they use electricity - Investigation of existing and plausible future demand side participation in the electricity market, Final Report, December 2011, p. 65.

Table 23: Direct load control of Pool pumps – research and trials

Organisation	Jurisdiction	Peak load reduction per customer (%)	Basis of findings / assumptions
Energex	SE Queensland	27%	Trials
Endeavour Energy - Blacktown Solar Cities	Western Sydney	36%	Trials

6.2 What is needed to achieve the benefits?

A range of load control devices have been used in Australian trials, which vary according to the type of air conditioner on which it is installed. Where customers do not have a smart meter, load is typically either controlled via a ripple control system or FM radio signals between the distributor and air conditioner. Ripple control systems are relatively widespread in NSW and Queensland, however are less prevalent in the other states.⁴⁴

Customers with a smart meter still require a device to be fitted to their air conditioner, however, load is controlled via a Home Area Network or equivalent, through the smart meter.

A significant amount of work has been undertaken by the Equipment Energy Efficiency Committee and the National Smart Metering Program in developing standards for load control features within priority appliances, including developing minimum demand control functionality and standards for connection to load control interfaces. Local manufacturers have begun to incorporate Australian Standard AS4755 interface into their air conditioners, which provides standards for a simple interface that enables load control. Similar standards are being developed for pool pumps.⁴⁵ Smart air conditioners, which are pre-fitted with Peak Smart technology at the time of manufacture, are already appearing on the Australian market, for example, various models are produced by Kelvinator.⁴⁶

The costs of installing a load control device in an existing air conditioner, including the device itself and the time taken to install it, vary according to the type of air conditioner and control system. As part of the MCE's 2008 Cost Benefit Analysis of Smart Metering and Direct Load Control, EMCa reviewed the costs of suitable direct load control devices available on the market.⁴⁷ Costs of retrofitting old air conditioners were estimated to range between \$160 to \$280 (total installation cost), while costs of fitting devices in new air conditioners at the same time as they are installed was estimated to range between \$120 to \$190.⁴⁸

We have reviewed the cost estimates used by EMCa in light of more recent developments and trials, to develop an average range of likely costs incurred in direct load control of air conditioners and pool pumps. We note that the costs of implementing device trials are generally higher than would be expected on a business as usual basis, and accordingly there is limited information available on the likely costs of a commercial scale rollout.

⁴⁴ EMCa, Cost Benefit Analysis of Smart Metering and Direct Load Control - Workstream 6: Transitional Implementation Costs: Phase 2 Consultation Report, February 2008.

⁴⁵ National Smart Metering Program Business Requirements Working Group, The National Smart Metering Program and the AS4755 Appliance Interface: Establishing a Direct Connection.

⁴⁶ Current.com.au, Kelvinator brings Peak Smart air con technology to the community, 16 January 2012, accessed at: <http://www.current.com.au/2012/01/16/article/Kelvinator-brings-Peak-Smart-air-con-technology-to-the-community/PDWKYTBPWM.html> . Accessed on 24 February 2012.

⁴⁷ EMCa, Cost Benefit Analysis of Smart Metering and Direct Load Control - Workstream 6: Transitional Implementation Costs: Phase 2 Consultation Report, February 2008.

⁴⁸ NERA et al, Cost Benefit Analysis of Smart Metering and Direct Load Control - Overview Report for Consultation, February 2008, p. 41 to 42.

We reviewed a presentation on low cost direct load control made by David Crossley of Energy Futures Australia at a Metering and Billing conference in Brisbane, November 2006.⁴⁹ Crossley reported on a range of potential devices and associated communications equipment that would allow air conditioner or other appliance cycling. Costs vary significantly depending on the method of communication (wired or wireless, one way or two way to allow load measurement), whether there is an information display for reporting to customers and whether interval measurement of load is required. Costs were reported by Crossley to be as low as \$26 per installed device (for example, for a plug in device that enables remote control of appliances through power line signalling) up to \$600 for a fully integrated load control system.⁵⁰

Our range of total costs per customer estimates reflect the costs incurred in international trials and actual market offerings, allowing a conservative maximum cost to cover potential complications in the installation of the device.⁵¹ We have presumed that the devices to be installed are not associated with a time of use load control plan, and for simplicity, that the range also covers the costs of installing devices where there is a smart meter installed.

The following table presents our estimates of the range of costs per device.

Table 24: Direct load control – ranges of costs (\$2012)

Device	Total cost per customer – Low case	Total cost per customer – High case
Retrofitting existing AC	150	280
New AC, installed at time of AC installation	100	190
Pool pump DLC device	120	235

Source: Deloitte analysis

Our estimate of total costs associated with implementing direct load control of air conditioning and pool pumps, based on the take up rates discussed below, is presented in the following table.

Table 25: Direct load control – total costs

	Costs – Low case (\$m)	Costs – High case (\$m)
Direct load control of air conditioners	55	262
Direct load control of pool pumps	23	51

Source: Deloitte analysis

⁴⁹ Crossley, Energy Futures Australia Pty Ltd - Presentation to Metering & Billing/CRM Conference: Low Cost Load Control Technology, November 2006

⁵⁰ Crossley, Energy Futures Australia Pty Ltd - Presentation to Metering & Billing/CRM Conference: Low Cost Load Control Technology, November 2006, p. 29.

⁵¹ Deloitte, Department of Treasury and Finance – Advanced Metering Infrastructure cost benefit analysis – Final Report, August 2011

6.3 What is the potential impact on peak demand?

Table 22 above outlines the range of peak load reductions that have been achieved in various Australian trials, as well as the assumed peak load reductions derived in two cost benefit analysis studies of direct load control. After reviewing the ranges of achievable reductions in published trials, we have applied the peak load reduction assumptions as set out in the table below.

Table 26: Direct load control – Peak reductions per customer

	Peak reductions per customer - Low case (% per average customer peak load)	Peak reductions per customer - High case (% per average customer peak load)
Direct load control of air conditioners	11.7%	35.0%
Direct load control of pool pumps	27.0%	36.0%

Both the size of a customer's peak load and the contribution of an air conditioner to that customer's peak load can vary significantly, depending on house size, type of air conditioner and the number and type of other appliances that are installed at the house. We recognise that more detailed modelling of average customer loads in different States and regions would produce a more accurate estimate of the potential impact of direct load control on total summer peak demand. However, such detailed modelling is beyond the scope of this analysis. For the purposes of estimating the value of load control, we have used a base assumption of average customer contribution to peak of 3 kW, to which we've applied the range of trial results discussed above.

In order to estimate a take up rate of direct load control to determine the potential value in terms of avoided infrastructure investment, we have considered the approach taken in the MCE's National Cost Benefit Analysis of Smart Metering and Direct Load Control, as well as the take up rates assumed in Deloitte's Cost Benefit Analysis of the Victorian AMI Program.

Estimates of air conditioner penetration and pool pump ownership are presented in table 26. We note that air conditioner penetration rates are presented as those net of evaporative coolers (as these are not suitable for direct load control), with data sourced from the ABS and a report prepared for the National Appliance and Equipment Energy Efficiency Committee in 2006.⁵²

Our forecast of pool pumps was derived from a report by Dr George Wilkenfeld for the Department of Environment, Water, Heritage and the Arts in July 2009.⁵³ Based on Energen's estimates of pool pumps that are already controlled under its Tariff 33 and Tariff 31 programs, extrapolated by Futura in its report to the AEMC Power of Choice Review, we have estimated the number of uncontrolled pool pumps from which peak load savings are available.⁵⁴

⁵² ABS, 4602.0.55.001 - Environmental Issues: Energy Use and Conservation, Mar 2011; Energy Efficient Strategies, Status of Air Conditioners in Australia, January 2006.

⁵³ Wilkenfeld, Dr George, Swimming Pools: Energy use and impact on peak load, July 2009

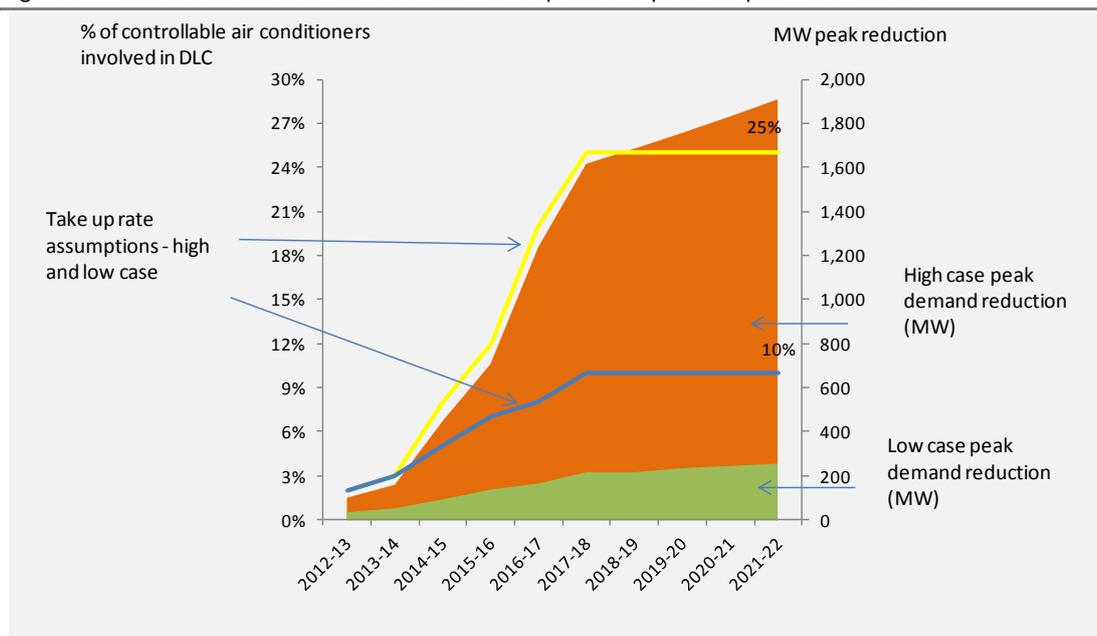
⁵⁴ We estimate that there are currently 140,000 pool pumps already involved in direct load control programs in Australia (being 10% of the current pool pump load).

Table 27: Direct load control – assumptions (Australia-wide)

Year	Air conditioner penetration – non evaporative coolers only	Uncontrolled pool pump forecast
2012-13	59.0%	1,110,000
2013-14	60.5%	1,160,000
2014-15	62.1%	1,170,000
2015-16	63.7%	1,210,000
2016-17	65.4%	1,235,000
2017-18	66.9%	1,260,000
2018-19	68.2%	1,310,000
2019-20	69.5%	1,335,000
2020-21	70.9%	1,372,281
2021-22	72.3%	1,410,504

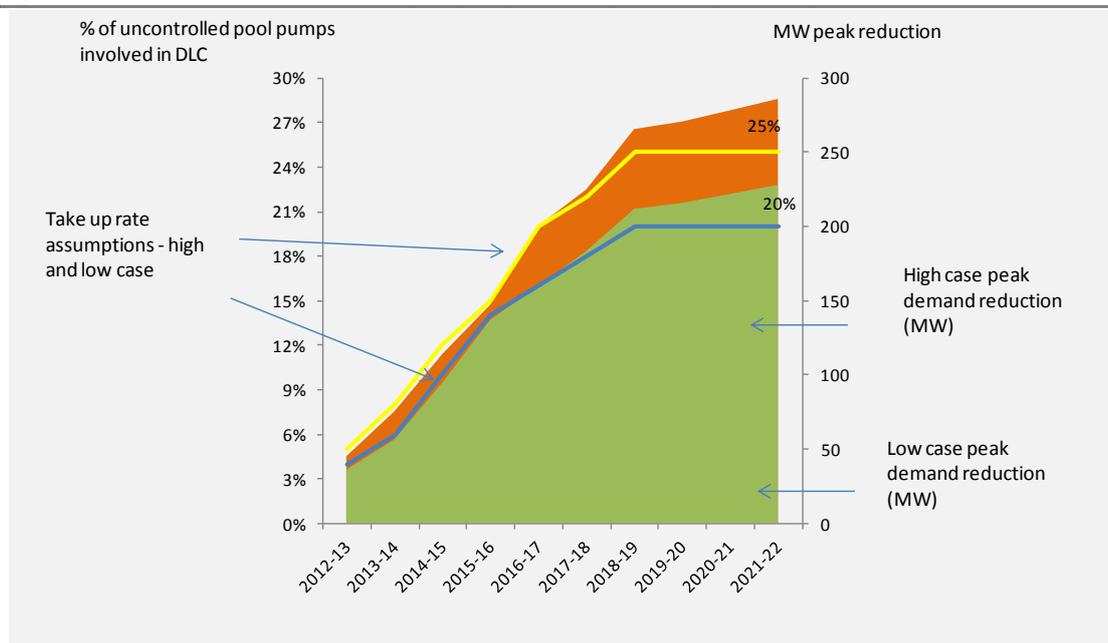
Our estimated national take up rates of direct load control, reported as a percentage of all customers, not just those with air conditioning or pool pumps, are presented below in graphs, along with our estimates of the potential peak load reductions (MW) for the high and low case scenarios.

Figure 9: Direct load control of air conditioners – take up rate and potential peak load reduction



Source: Deloitte analysis

Figure 60: Direct load control of pool pumps – take up rate and potential peak load reduction



Source: Deloitte analysis

6.4 Conclusion – value of potential benefits

In conclusion, we consider that the implementation of direct load control of air conditioning across the NEM and SWIS over 2012 to 2022 offers benefits in the range set out in the table below.

Table 28: Direct load control – estimated value of benefits 2012-13 to 2021-22 (NPV, \$m)

	Low case estimate (\$m)	High case estimate (\$m)
Direct load control of air conditioners	200	1,338
Direct load control of pool pumps	188	231

Source: Deloitte analysis

7 Vehicle to Grid - Electric and Plug in Hybrid Electric Vehicles

7.1 What does it involve?

With concerns about climate change, fuel price rises, declines in the cost of electric vehicles (EVs) and improvements in EV travel distances, it is reasonable to expect an increase in the take up of EVs will occur in the near future. Recent Australian studies on EVs have optimistically forecast that customer take-up in Victoria will be in the order of 50% of new car sales (more than 100 000 EVs) by 2015, and a similar magnitude in NSW by 2018.⁵⁵

While initial EV take-up involves Hybrid Electric Vehicles (HEVs), as the momentum behind EVs builds and manufacturers respond, Plug-in Hybrid Electric Vehicles (PHEVs) and Battery EVs (BEVs) will become more prevalent. These vehicles pose serious issues, but also opportunities, for electricity markets and networks which are already facing rising peak demand.

Significant uncontrolled charging of EVs would have large adverse consequences for the electricity system, in terms of increasing peak demand, as well as creating system instability. Therefore, we consider it is most likely that regulated or controlled charging of EVs will be implemented before a significant number of the vehicles are sold in Australia.

Californian utility, Pacific Gas & Electric (PG&E), has led the way encouraging its customers to adopt EVs by offering specialised EV tariffs, depending on vehicle types and charging behaviour. While PG&E has recognised the potential for Vehicle to Grid (V2G) technology and tariffs, it is not currently available to customers.⁵⁶

Better Place Australia, a subsidiary of US firm Better Place LLC, is a high profile company that is supporting the take up of EVs in Australia through promoting its innovative battery-swap charging business model. The Better Place model enables its member EV drivers to switch a depleted battery for a fully charged one in under five minutes at a Battery Switch Station. Better Place contracts with electricity suppliers to ensure batteries are recharged using renewable energy.⁵⁷

Many research papers on EVs highlight the potential benefits for the electricity market and system that could be generated by the widespread adoption of EVs with controlled charging. For example, the Centre for Energy and Environmental Markets at the University of NSW published a paper in 2010 on the potential for coordinated charging to improve the utilisation of network infrastructure.⁵⁸ Several other research papers suggest that EVs present an opportunity to support intermittent renewable generation with baseload storage.⁵⁹ However, to date there has been relatively little research on the V2G peak load support capability for EVs internationally, let alone in Australia.

⁵⁵ AECOM, Forecast Uptake and Economic Evaluation of Electric Vehicles in Victoria, Final Report, May 2011; AECOM, Economic Viability of Electric Vehicles - Department of Environment and Climate Change (NSW), September 2009.

⁵⁶ Pacific Gas & Electric Website,

<http://www.pge.com/myhome/environment/whatyoucando/electricdrivevehicles/rateoptions/> Accessed 24/2/12.

⁵⁷ Better Place website: <http://www.betterplace.com.au/about-us/our-solution.html> Accessed 24/12/12.

⁵⁸ Cain, MacGill and Bruce, School of Photovoltaic and Renewable Energy Engineering – Centre for Energy and Environmental Markets, Assessing the Potential Impacts of Electric Vehicles on the Electricity Distribution Network, 2010.

⁵⁹ Curtin University of Technology, Electric Vehicles and their Renewable Connection – How Australia can take part in the Green Revolution, presentation, June 2009.

A US research paper published in 2006 estimated the potential for controlled charging of PHEVs to provide peaking capacity.⁶⁰ Denholm and Short, working for the US Department of Energy, investigated the potential for PHEVs to provide support during periods of extreme peak demand or emergencies, evaluating the potential driving and charging behaviour over six geographic regions in the US. The paper presents a range of potential dependable capacity based on a number of scenarios, as outlined in the following table.

Table 29: Denholm and Short – PHEV charging capacity

Vehicle use	Effective capacity – range
% reliably plugged in at planning peak	40 – 60%
Average battery state of charge at planning peak (%)	40 – 50%
Discharge time required for dependable capacity (hours)	4 – 8 hours
Base dependable capacity (kW per PHEV)	0.2 to 0.77 kW

Source: Denholm and Short, An Evaluation of Utility System Impacts and Benefits of Optimally Dispatched Plug-In Hybrid Electric Vehicles, October 2006, p. 20.

Denholm and Short reported these findings as conservative, having attempted to capture the uncertainty that utilities may apply to generators they do not own. The paper notes that as PHEVs penetrate the vehicle market, this uncertainty should fall away.

The CSIRO and the Institute for Sustainable Futures are together undertaking a comprehensive assessment of potential EV uptake and use under Australian conditions. The Electric Driveway Project will run over three years and explore the potential synergies between the electricity and transport sectors presented by EVs. A Phase 1 Report was released in March 2011, which included an assessment of international EV developments and the potential vehicles for the Australian market. Forecasts of EVs were drawn from AECOM's studies on take up in Victoria and NSW.⁶¹

Using analysis of Victorian Net System Load Profile data and SP AusNet's planned growth-related network investment, the Phase 1 Report presents a case that even a small number of EVs could defer the need for investment at the zone substation level for several years. The CSIRO's analysis has demonstrated that the economics of using EVs as peaking capacity is closely tied to the size of the battery, and the feed-in tariff rate that customers would expect to receive in return for providing grid support.

To date, aside from the CSIRO's Electric Driveway Project, limited research has been published regarding the potential benefits of EV batteries in providing network support during critical peak demand periods in Australia. There has been some suggestion that given critical peak demand represents such a small, undefined proportion of the year, the economic value of providing critical peak demand support may not justify the expense of both physical and regulatory requirements to ensure restricted charging and availability of batteries to the grid. The potential for EV batteries to supply ancillary services (including regulation of frequency and spinning reserves) is likely to present a greater economic case than peak capacity.⁶² However, several researchers have pointed out that

⁶⁰ Denholm and Short, An Evaluation of Utility System Impacts and Benefits of Optimally Dispatched Plug-In Hybrid Electric Vehicles, October 2006

⁶¹ CSIRO Electric Driveway Project, Plugging In: A technical and institutional assessment of Electric Vehicles and the Grid in Australia, Phase 1 Report, March 2011.

⁶² Letendre and Deholm, 'Electric & Hybrid Cars -New Load, or new Resource' in Public Utilities Fortnightly, December 2006; CSIRO p 63

the market for ancillary services is small and would likely achieve saturation with only a small number of participating customers.⁶³

Limited battery capacity and the effect of grid support on battery life are currently some of the more challenging technical barriers to the use of EVs as peaking capacity. A 2009 US study on the economics of using EV batteries for energy arbitrage concluded that, even assuming perfect market information and that using EV batteries for grid support resulted in no battery degradation, the economic profit is likely to be between US\$142 and \$249, which is probably too low to provide much of an incentive for EV take up.⁶⁴

In our view, there is a potential benefit associated with EV battery storage in managing peak demand, however, a comprehensive cost benefit analysis of using EV batteries as network support in Australia during peak times needs to be conducted to determine whether the costs of infrastructure and supporting regulatory frameworks would outweigh the benefits of reduced peak demand. We note that for EVs to provide peak demand support services through V2G, at a minimum the following conditions would need to be in place to enable this to occur:

- Utility controlled smart-charging, combined with suitable tariffs to provide incentives for customers to partake
- Subsidisation for customer's EV batteries – there is some evidence that using the EV batteries as grid support is likely to wear down the battery life. As such, appropriate arrangements would need to be in place to ensure customers are left no worse off in the long term costs of running their EV.

We note that the widespread adoption of EVs in Australia would also increase the potential benefits from time of use pricing, in turn increasing the likelihood that such tariffs would be mandated or rolled out on a large scale.

7.2 What is needed to achieve the benefits?

As for smart meters, the economic case for EVs does not rely on the potential reduction in peak demand and associated infrastructure. Benefits generated by lowering fuel consumption and greenhouse gas emissions represent the majority of the value associated with EVs, and are forecast to offset the associated costs of implementation.

AECOM and the Electric Driveway Project have published data on the likely cost of EVs and charging infrastructure in Australia over the next decade.⁶⁵ After reviewing this research, we have developed a range of high and low estimates of the forecast average EV price premium above ordinary vehicles over the next 10 years. These are presented in the following table.

⁶³ Peterson, Whitacre and Apt, The Economics of using plug-in hybrid electric vehicle battery packs for grid storage, in the Journal of Power Sources, September 2009

⁶⁴ Peterson, Whitacre and Apt, The Economics of using plug-in hybrid electric vehicle battery packs for grid storage, in the Journal of Power Sources, September 2009.

⁶⁵ AECOM, Forecast Uptake and Economic Evaluation of Electric Vehicles in Victoria, Final Report, May 2011; AECOM, Economic Viability of Electric Vehicles - Department of Environment and Climate Change (NSW), September 2009; CSIRO Electric Driveway Project, Plugging In: A technical and institutional assessment of Electric Vehicles and the Grid in Australia, Phase 1 Report, March 2011.

Table 30: EV price premium – Deloitte forecast based on AECOM and CSIRO/ISF

Year	Low case – EV price premium forecast	High case – EV price premium forecast
2012-13	\$16,250.00	\$40,000.00
2013-14	\$15,000.00	\$36,666.67
2014-15	\$13,750.00	\$33,333.33
2015-16	\$12,500.00	\$30,000.00
2016-17	\$11,250.00	\$26,666.67
2017-18	\$10,000.00	\$23,333.33
2018-19	\$8,750.00	\$20,000.00
2019-20	\$7,500.00	\$16,666.67
2020-21	\$6,250.00	\$13,333.33
2021-22	\$5,000.00	\$10,000.00

Costs of commercial (workplace, public or battery swap stations) charging infrastructure vary significantly, from small scale public stations at \$3,000 each, to \$500,000 for a large commercial operation. Without a more detailed analysis of the forecast scenario, it is not possible to determine with any accuracy the likely future costs associated with charging stations. However, it is acknowledged that the costs of vehicles alone are not the only costs to implement EVs on a wide scale.

The following table presents the potential costs associated with our EV take up scenario to 2021-22 based on AECOM's forecasts for NSW and Victoria, discussed below.

Table 31: EVs – Cost estimates

	Low case – cost forecast (\$m)	High case – cost forecast (\$m)
AECOM forecasts – cars only	4,240	9,401

We note that our analysis does not incorporate the costs and benefits of customers using energy bought at off peak times to sell back into the grid at peak times, as we note that the implications of this would depend upon the retail market offerings that support V2G services.

7.3 What is the potential impact on peak demand?

Using the findings reported in a range of studies, discussed above, we have developed a range of potential battery capacity and assumptions regarding availability of cars and battery capacity for V2G supply.⁶⁶ Our assumptions are presented in the following table.

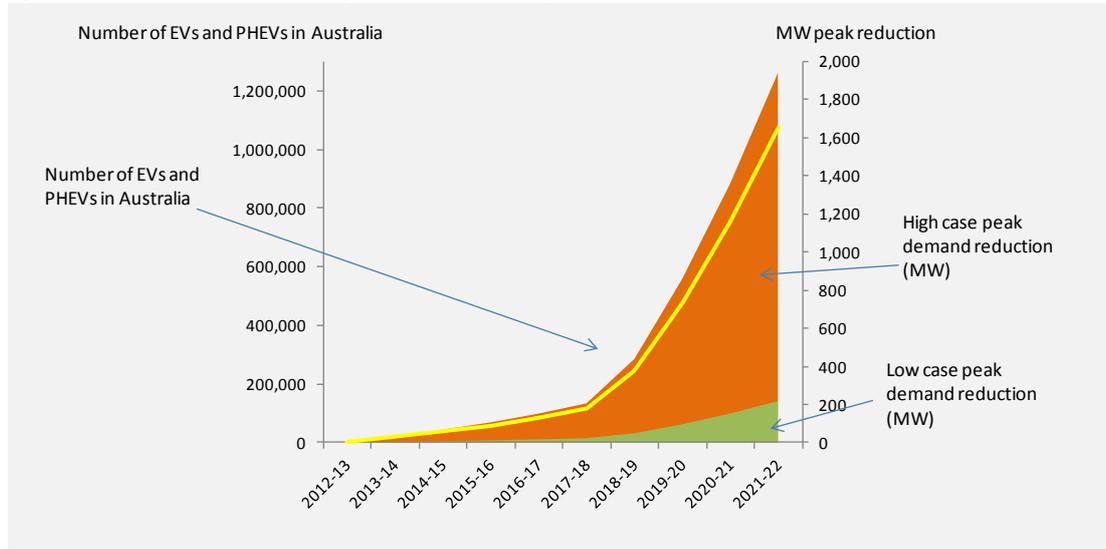
Table 32: V2G capability - Deloitte Assumptions

Benefits assumptions	Low case	High case
Maximum capacity per vehicle	10 kWh	24 kWh
% cars available at peak time	40%	60%
% of each car's load available at peak time	40%	50%
Discharge time	8 hours	4 hours

In order to present the potential benefits that initiatives to support the take up of EVs could hold for Australia, we have examined the benefits associated with a take up rate in line with the EV and PHEV forecasts prepared by AECOM for NSW and Victoria, extrapolated out to other states. Our forecast take up rates are presented in the following graph, along with our estimated peak load reductions under the high and low case scenarios.

⁶⁶ We note that, in assuming that EVs will be able to deliver energy to the grid at peak times from wherever they are parked and plugged in, we have not differentiated between the benefits and costs associated with V2G and Vehicle to Home capabilities of EVs in our analysis. We have essentially assumed that EVs plugged in at a customer's home during peak times will work by offsetting that customer's peak load, however we acknowledge that there are implications for this in relation to the import/export capabilities of inverters. A more detailed analysis of the different requirements and implications is needed to more accurately forecast the potential costs and benefits, which is beyond the scope of this engagement.

Figure 7: Electric Vehicles – take up rates and estimate peak load reduction scenarios (MW)



Note: This AECOM forecast has been estimated on the basis of extrapolation from graphical forecasts of EV and PHEV take up for Victoria and NSW, presented in AECOM’s public reports.

7.4 Conclusion – value of potential benefits

In conclusion, we consider that the penetration of electric vehicles in Australia over 2012 to 2022 offers benefits in the range set out in the table below.

Table 33: Electric Vehicles – estimated value of benefits 2012-13 to 2021-22 (NPV, \$m)

	Low case estimate (\$m)	High case estimate (\$m)
Electric vehicles (V2G)	60	537

Source: Deloitte analysis

8 Energy efficiency measures

Typically, measures to improve energy efficiency are aimed at lowering the volume of energy used over time (MWh) rather than demand specifically at peak times. However, some measures which are aimed at the drivers of summer peak demand (such as air conditioning) will also have an impact on peak demand. Two energy efficiency measures which could reduce peak demand are discussed in this section.

8.1 Increases in Minimum Energy Performance Standards for air conditioning

8.1.1 What does it involve?

Air conditioning has been a major driver of peak demand in Australia over the past decade, with penetration rates now reaching over 90% of households in South Australia and 70% of households in Victoria.⁶⁷

Minimum Energy Performance Standards (MEPS) is a mandated program operating throughout Australia and in New Zealand which determines the general regulatory requirements for appliances in terms of energy efficiency. Suppliers of products covered by MEPS must register their products with the Equipment Energy Efficiency Program E3 Regulators before they can be legally sold to Australian and New Zealand customers. MEPS are enforced by State Government legislation, with offences and penalties if parties fail to comply with the requirements, which are set out in Australian Standards (for example A/NZS 3823.2). Household appliances covered by MEPS include refrigerators and freezers, electric storage hot water systems, air conditioners, light globes and lamps, televisions and set top boxes.

Air conditioning is the single biggest appliance contributing to peak demand in Australia. Accordingly, improving the efficiency of air conditioners offers benefits in terms of lowering peak demand, as well as benefits associated with lowering overall energy use. However, limited research has been carried out to date on the peak load reduction benefits of improving air conditioner efficiency, due to a general focus on reducing overall energy use.

The National MEPS for air conditioning were introduced in 2001 and have been subsequently increased several times. In 2010 the Department of Climate Change and Energy Efficiency commissioned EnergyConsult to undertake an evaluation of the impacts of regulation of air conditioning in Australia since MEPS was introduced.⁶⁸ The final report, published in November 2010, found that the impact of MEPS on product efficiency and therefore energy consumption was considerable:

The annual rate of improvement (of product efficiency and energy consumption) before MEPS was around 0.5%, but grew to around 3% after the 2004 MEPS and to around 4% after the 2006/07 MEPS.⁶⁹

⁶⁷ ABS, 4602.0.55.001 - Environmental Issues: Energy Use and Conservation, March 2011.

⁶⁸ EnergyConsult Pty Ltd for the Department of Climate Change and Energy Efficiency, Evaluation of Energy Efficiency, Equipment Energy Efficiency Program: Policy Measures for Household Air Conditioners in Australia, November 2010.

⁶⁹ EnergyConsult Pty Ltd for the Department of Climate Change and Energy Efficiency, Evaluation of Energy Efficiency, Equipment Energy Efficiency Program: Policy Measures for Household Air Conditioners in Australia, November 2010, p. 1.

The cumulative energy savings over 2004 to 2020, based on estimated achievements to date, was forecast at 6,533 GWh.⁷⁰ No estimate of the impact on summer peak demand was provided in the evaluation report.

Most recently, MEPS for air conditioning were increased in October 2011, following a July 2009 request by COAG to examine the feasibility of a MEPS increase of 10% above April 2010 levels. Analysis of various options was carried out by the Equipment Energy Efficiency Committee, including options for amending the standards to introduce consistency across different sizes and types of air conditioners.⁷¹ The cost benefit analysis included benefits associated with lowering peak demand, however, details on the actual assumed peak MW reduction for each option were not published and are not discernible from the published data. We note that the Regulatory Impact Statement did not take into account the impact of direct load control of air conditioners. The GWh savings anticipated under each of five scenarios are presented in the following table.

Table 34: MEPS for AC – Regulatory Impact Statement 2011 – forecast GWh per annum impacts

Scenario	2015	2020	2025
MEPS2010+10%: April 2010 +10% across the board	278	605	769
Proposal A: 10% above 2010 level, excluding non-ducted split systems	342	743	942
Proposal A1: Similar to A, but non ducted split systems would have an increased MEPS (Implemented in October 2011)	273	594	756
Proposal B: Greater than 10% above 2010 levels for most AC	324	860	1,158
Proposal C: 25% more efficient than 2010	591	1,839	2,652

Source: EnergyConsult Pty Ltd for the Equipment Energy Efficiency Committee under the auspices of the MCE, Decision Regulatory Impact Statement: Minimum Energy Performance Standards for Air Conditioners: 2011, December 2010.

Forecasts of peak demand typically take into account policies that are anticipated to have an incremental impact on system peak. In reviewing peak demand forecasts submitted by Victorian distributors in 2009, the AER considered the impact that the planned improvements in MEPS for air conditioning would have on the distributors' peak demand and therefore growth related infrastructure programs.⁷² Distributors' peak demand forecasts were prepared by the National Institute of Industry and Economic Research (NIEIR), however, their methodology for assessing the impact of MEPS for air conditioning on peak demand was not publicly disclosed. The total estimated impact in terms of Victorian MW reduction was published, which provides a useful baseline for analysis of the expected impact of the increase in MEPS on network peak demand. The estimated impact of MEPS is presented in the following table, in MW and % of maximum demand.

Table 35: MEPS for Air conditioning – Forecast impact on peak demand in Victoria

	2011	2012	2013	2014	2015
AER - MEPS impact on 50 POE peak demand in VIC - As forecast by NIEIR	-9.4	-19.8	-31.4	-41.5	-50.9
% impact of MEPS on 50 POE peak demand in VIC	-0.1%	-0.2%	-0.3%	-0.4%	-0.5%

Source: ACIL Tasman, Victorian Electricity Distribution Price Review - Review of maximum demand forecasts - Final report, April 2010.

⁷⁰ EnergyConsult Pty Ltd for the Department of Climate Change and Energy Efficiency, Evaluation of Energy Efficiency, Equipment Energy Efficiency Program: Policy Measures for Household Air Conditioners in Australia, November 2010, p. 1.

⁷¹ EnergyConsult Pty Ltd for the Equipment Energy Efficiency Committee under the auspices of the MCE, Decision Regulatory Impact Statement: Minimum Energy Performance Standards for Air Conditioners: 2011, December 2010.

⁷² AER, Final Decision - Victorian Electricity Distribution Network Service Providers, Distribution Determination 2011-15, p. 95.

8.1.2 What is needed to achieve the benefits?

As for smart metering and EVs, the economic case for improving the energy efficiency of air conditioning does not rest on peak demand reduction benefits, rather relies on the energy consumption savings that such policies generate. Costs involved relate mainly to the requirement for air conditioning retailers and wholesalers to sell compliant goods after the legislation is passed in each State.

The MEPS for Air conditioning Regulatory Impact Statement Decision includes a detailed analysis of the costs of implementing each proposed scenario, including costs to manufacturers, suppliers and end customers. Costs of each scenario were presented on an NPV basis, reproduced in the table below.

Table 36: MEPS for Air conditioning – 2011 RIS – Total costs

	Total costs (NPV to 2020, 7% discount rate, \$m)
MEPS2010+10%: April 2010 +10% across the board	968
Proposal A: 10% above 2010 level, excluding non-ducted split systems	1,395
Proposal A1: Similar to A, but non ducted split systems would have an increased MEPS (Implemented in October 2011)	1,015
Proposal B: Greater than 10% above 2010 levels for most AC	2,344
Proposal C: 25% more efficient than 2010	4,557

Source: EnergyConsult Pty Ltd for the Equipment Energy Efficiency Committee under the auspices of the MCE, Decision Regulatory Impact Statement: Minimum Energy Performance Standards for Air Conditioners: 2011, December 2010, p. 45.

8.1.3 What is the potential impact on peak demand?

Since its introduction in 2001, MEPS for air conditioning has achieved considerable reductions in summer peak demand, such that electricity distributors are now incorporating the impact of increases in MEPS into their five yearly peak demand forecasts.

However, there are some reports that suggest the potential to further increase the efficiency of new air conditioners may be limited. A 2010 Japanese study, as quoted in a presentation by Carbon Market Economics in September 2010, concluded that cost effective improvements in energy efficiency of air conditioners is virtually exhausted, based on the following factors:

- The motor efficiency of compression has reached 95%
- Heating insulation efficiency has reached 80%
- Improvement in recent years has been achieved by expanding the size of heat exchanges. Space restraints are likely to prevent significant increases in the future.⁷³

⁷³ Jolly, R of Carbon Market Economics, Policy Roadmap for Energy Efficient Air conditioners, Presented at Energy Efficiency, Climate and China's Development Strategy, Beijing, 9 September 2010.

Carbon Market Economics reported that future efficiency savings in air conditioning are likely to be driven by improvements in the quality of ducting and ducting insulation for central air conditioners.

As noted above, there is very little published research to date on the impact of air conditioner efficiency on summer peak demand. While we considered that Proposal scenario C analysed in the 2011 MEPS Regulatory Impact Statement was a possible indicator of further future efficiencies in air conditioning, the significant costs and low cost benefit ratio estimated for this scenario suggests that it is not a viable, achievable initiative at this point in time.

Accordingly, while we consider there is definitely value in improving air conditioner efficiency in terms of peak demand reductions, we have not estimated a value for the purposes of this high level analysis. We note that the study on improvements in building standards incorporates savings resulting from retrofitting commercial buildings with more efficient cooling systems.

8.2 Improvements in building standards

8.2.1 What does it involve?

Improving the energy efficiency of buildings reduces their overall heating and cooling load, also lowering peak demand.

As part of the Australian Government's National Strategy on Energy Efficiency, investigations into the value of making changes to building regulations to improve and increase energy efficiency standards are currently being undertaken by the Department of Climate Change and Energy Efficiency. Several energy efficiency measures related to the construction industry were endorsed by the Council of Australian Governments (COAG) in 2009, including increasing energy efficiency standards in the National Construction Code, which incorporates the Building Code of Australia (BCA), and working to improve consistency in construction standards across jurisdictions.

Changes to the BCA to implement the National Strategy on Energy Efficiency were enacted in May 2010. Standards for new residential dwellings were increased, requiring 6 stars or equivalent, and commercial building standards were also increased. The new standards affected the following building features:

- performance of the building fabric;
- external glazing and shading;
- sealing of the building;
- effects of air movement; and
- performance of the building's domestic services, including hot water supply, insulation and sealing of ductwork and central heating water piping, space heating, artificial lighting, and the heating and pumping of swimming pools and spas.⁷⁴

The Regulatory Impact Statement for these changes to the BCA did not attempt to model the benefits associated with avoided peak demand, although noted the potential value.⁷⁵ As discussed above, the focus of strategies to improve energy efficiency has traditionally been on the impact on energy consumption over time, rather than at peak times. As such, to date there has been limited research carried out on the impact of improving the energy efficiency of buildings on peak demand.

⁷⁴ Australian Building Codes Board website, available at: <http://www.abcb.gov.au/major-initiatives/energy-efficiency/residential-housing> Accessed 26 February 2012.

⁷⁵ Australian Building Codes Board (prepared by the Centre for International Economics), Proposal to Revise the Energy Efficiency Requirements of the Building Code of Australia for Residential Buildings — Classes 1, 2, 4 and 10, December 2009, Appendix F, p 226.

In 2003, the former NSW Minister for Planning commissioned a five year study into demand management which considered the costs and potential benefits of a range of demand management techniques and practices in terms of lowering the costs of serving peak demand, including energy efficiency measures.⁷⁶ The focus of the study was on 764 business customers within the NSW distribution network area of Ausgrid (formerly EnergyAustralia). In relation to energy efficiency, the study reported that between 17 and 88 MVA of savings could be generated by energy efficiency measures across the trial area, depending on the costs of the measures.⁷⁷ After reviewing the study, while useful in detailing the potential for energy efficiency to lower peak demand on specific customer sites, we noted that the presentation of results does not enable extrapolation across Australia to identify the potential savings delivered by energy efficiency, without a significant number of assumptions that we consider would undermine the analysis.

In recognition of the potential for energy infrastructure savings due to lower peak demand delivered by energy efficiency, and the lack of investigation or research into these benefits to date, in 2010 the Department of Climate Change and Energy Efficiency commissioned a national study into the peak demand benefits of various measures to improve the energy efficiency of buildings. The Building Our Savings study was jointly carried out by the Institute for Sustainable Futures and Energetics.⁷⁸ The focus of this study was on the savings generated by retrofitting existing buildings, particularly commercial buildings. The final report noted that changes to the BCA for new buildings would be expected to deliver savings in the medium to long term, beyond the 2020 timeframe for the study, however, also noted that changes to regulations for the retrofitting of commercial buildings could have a much shorter benefit delivery timeframe.⁷⁹

Using a range of available data on energy efficiency and building on previously published work⁸⁰ on Conservation Load Factors (CLF) to indicate the contribution of features of residential, commercial and industrial buildings to both gas and electricity peak demand, the Building Our Savings study considered a range of energy efficiency measures under two scenarios:

- Moderate scenario – in which building performance improvements are carried out largely at the end of an investment's (for example, an appliance's) useful life. Under this scenario, replacement of investments by more efficient models will only impact 20% of the energy used in 2020
- Accelerated scenario – in which significant replacement of less efficient infrastructure is carried out before the end of its useful life, such that only 20% of end users will wait to the end of an investment's useful life to replace it with a more efficient model.

The following diagram, reproduced from the Building Our Savings report, illustrates these scenarios.

⁷⁶ Demand Management and Planning Project, completed in June 2008. Details available on TransGrid's website: <http://www.transgrid.com.au/network/nsdm/Pages/default.aspx> Accessed 27 February 2012.

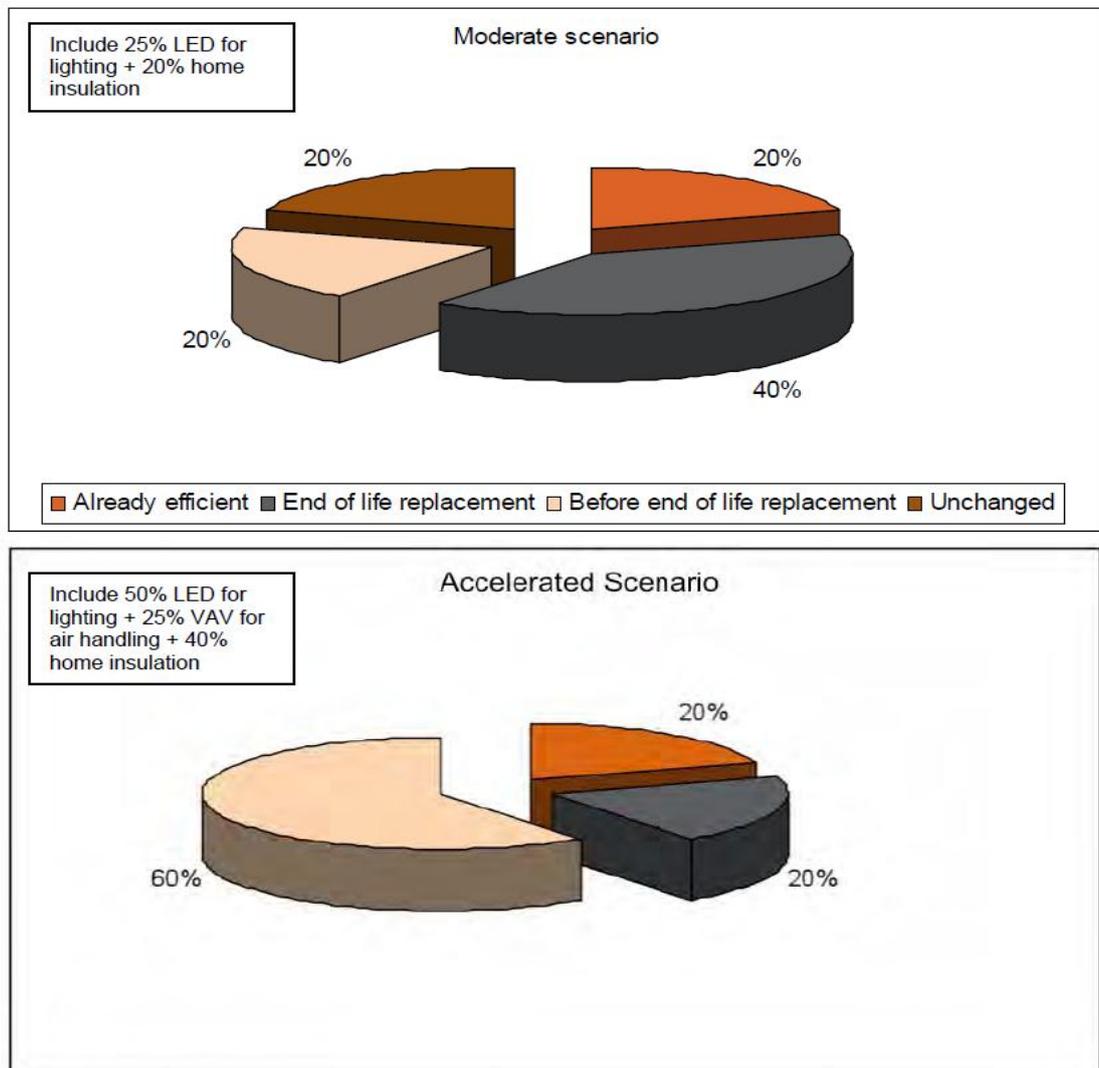
⁷⁷ NSW Department of Planning, EnergyAustralia and TransGrid - Demand Management and Planning Program – Final Report, June 2008

⁷⁸ Institute for Sustainable Futures and Energetics, Building Our Savings: Reduced Infrastructure Costs from Improving Building Energy Efficiency, Final Report, July 2010.

⁷⁹ Institute for Sustainable Futures and Energetics, Building Our Savings: Reduced Infrastructure Costs from Improving Building Energy Efficiency, Final Report, July 2010, p. 102.

⁸⁰ Including the Demand Management and Planning Program and a 2002 study by the Sustainable Energy Development Authority (SEDA) submitted to IPART's enquiry into the role of demand management (SEDA, Distributed Energy Solutions-Cost & Capacity Estimates for Decentralised Options for Meeting Electricity Demand in NSW, February 2002). The SEDA report published the potential MW savings from various energy efficiency measures, however, given the more recent Building Our Savings study drew on SEDA's earlier results, we considered it appropriate to rely on the more recent study results.

Figure 8: Building Our Savings report - Scenarios



The Building Our Savings study also considered the potential for cogeneration, standby generation, and time of use pricing to reduce peak demand, however, these benefits were not modelled.⁸¹

Energy savings measures that were modelled as part of this study include:

- Commercial measures: Voluntary Energy Star Program designed to identify and promote energy efficient products; Maintenance and cleaning of filters and coils of air handling, air conditioning, pumping and electrical heating appliances; Fine tuning and maintenance of lighting systems, sensors and controls; Installation of high energy efficiency air conditioning and dynamic lighting systems with controls; installation of more efficient air handling equipment
- Residential measures: Hot water demand reduction; Fridge buy-back scheme; Draught sealing; installation of new efficient lighting, hot water unit and air conditioners; installation of roof insulation

⁸¹ Institute for Sustainable Futures and Energetics, Building Our Savings: Reduced Infrastructure Costs from Improving Building Energy Efficiency, Final Report, July 2010.

- Industrial measures: installation of new efficient lighting; Green-IT retrofits (affecting servers and power supplies); installation of LED lighting.

The study's estimates of the impact on summer peak demand are reproduced in the following table.

Table 37: Building Our Savings study – Reported results – summer peak demand

	Moderate scenario	Accelerated scenario
Maximum seasonal peak demand reduction (MW)	5,283	7,236
% of 2020 summer peak demand eliminated	10%	13%
% of 2010 to 2020 peak growth eliminated (Summer)	43%	58%

Source: Institute for Sustainable Futures and Energetics, Building Our Savings: Reduced Infrastructure Costs from Improving Building Energy Efficiency, Final Report, July 2010.

8.2.2 What is needed to achieve the benefits?

As for smart metering, MEPS for air conditioning and EVs discussed above, the business case for improving energy efficiency of buildings does not rely on peak demand reduction benefits alone. The costs of implementing improvements to the energy efficiency of existing buildings are substantial. Estimates of the total costs of implementing the changes modelled in the Building Our Savings study to 2020 are reproduced here for completeness.

Table 38: Building Our Savings study – Estimated total costs of implementing energy savings measures to 2020 (\$m)

	Moderate scenario	Accelerated scenario
Cost of implementation – total costs to 2020	12,341	29,416

Source: Institute for Sustainable Futures and Energetics, Building Our Savings: Reduced Infrastructure Costs from Improving Building Energy Efficiency, Final Report, July 2010, Table 50, p. 96.

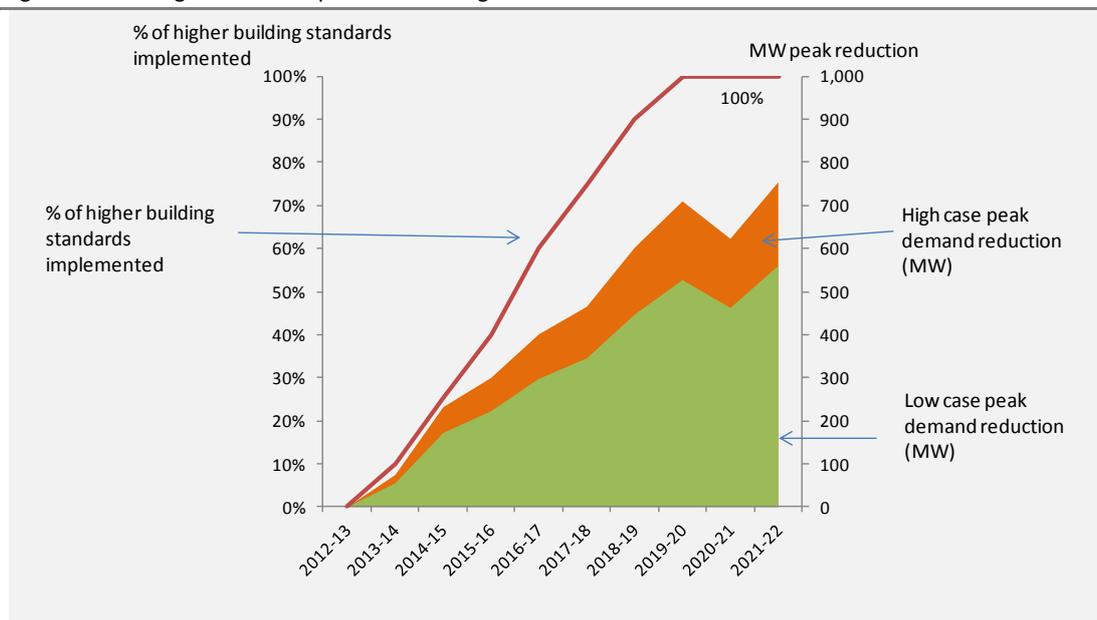
8.2.3 What is the potential impact on peak demand?

The Building Our Savings study reported a total potential reduction in growth in summer peak demand of 43% to 58% for the moderate and accelerated scenarios, respectively.⁸²

A trajectory of potential take up of the energy savings measures has been estimated in the modelling of benefits, based on our expectations of an aggressive promotion of energy efficiency by Government. Take up rates and our estimates of potential peak demand reductions for the high and low case scenarios are presented in the following graph.

⁸² We note that our analysis of peak demand savings has not relied upon the cost saving estimates presented in the Building Our Savings study.

Figure 93: Building standards improvements – high and low scenarios



Source: Deloitte analysis

We note that these benefits are attributed to the estimated impact of retrofitting commercial buildings with more energy efficient appliances, fittings and fixtures, as discussed in section 8.2.1. We acknowledge the potential for further benefits to be generated by increasing energy efficiency standards for new residential and commercial buildings (for example, seven star ratings), however, as discussed above, we were unable to find a reliable estimate of the potential impact of these measures on peak demand.

8.2.4 Conclusion – value of potential benefits

In conclusion, we consider that the implementation of certain measures to improve the energy efficiency of commercial, residential and industrial buildings over 2012 to 2022 offers benefits in the range set out in the table below.

Table 39: Energy Savings Measures – Building Our Savings study – estimated value of benefits 2012-13 to 2021-22 (NPV, \$m)

	Low case estimate (\$m)	High case estimate (\$m)
Energy Savings Measures from the Building Our Savings study – potential value of reduced MW	361	486

9 Distributed generation

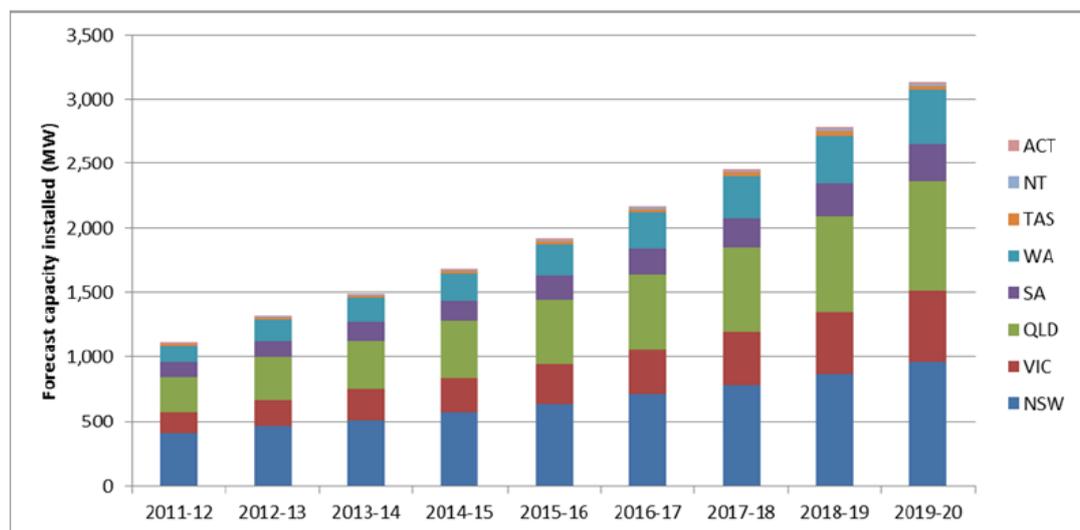
9.1 Small scale solar

9.1.1 What does it involve?

There has been a rapid increase in small scale solar generation in Australia over the past decade, driven principally by a reduction in the upfront capital costs and government initiatives stemming from the Renewable Energy Target and other direct incentives, such as feed-in-tariffs. Using data from the Office of the Renewable Energy Regulator, Futura estimated that the total installed capacity of rooftop solar systems in Australia in late 2011 was 630 MW.⁸³ AEMO has estimated that total solar PV generation capacity at the end of September 2011 was approximately 1000 MW.⁸⁴

A recent Australia-wide forecast of small scale solar take up was carried out by ACIL Tasman for the Australian Energy Markets Commission (AEMC), submitted as advice to the MCE on the impact of the Renewable Energy Target.⁸⁵ A range of scenarios were modelled, from 'Core Scenario' based on current policy settings, to 'Elevated Uptake Scenario', incorporating various policy settings and a carbon price. The modelling incorporated variable inputs on up front subsidies and on-going assistance, retail electricity prices faced by households and small businesses and solar PV system costs over time.⁸⁶ ACIL Tasman's PV forecast is reproduced in the following figure.

Figure 104: ACIL Tasman forecast of solar PV installations by jurisdiction – under a carbon emissions price



Source: AEMC, Final Report – Impact of the Enhanced Renewable Energy Target on energy markets, 25 November 2011, p. 13.

⁸³ Futura Consulting, Power of choice – giving consumers options in the way they use electricity - Investigation of existing and plausible future demand side participation in the electricity market, Final Report, December 2011, p. 53.

⁸⁴ AEMO, National Transmission Network Development Plan 2011, p 9-2.

⁸⁵ AEMC, Final Report – Impact of the Enhanced Renewable Energy Target on energy markets, 25 November 2011; ACIL Tasman, Analysis of the Impact of the Small-scale Renewable Energy Scheme – Projection of retail electricity price impacts and abatement to 2020, November 2011, p. 42.

⁸⁶ ACIL Tasman, Analysis of the Impact of the Small-scale Renewable Energy Scheme – Projection of retail electricity price impacts and abatement to 2020, November 2011, p. viii.

The AEMC and ACIL Tasman reports did not publish the annual forecast figures for small scale solar, however stated that the forecast for 2019-20 under the Elevated Uptake Scenario (including a carbon price) was 3,136 MW.⁸⁷

While generation situated close to the point of demand has the potential to avoid the use of network to transport electricity, research suggests that the performance of small scale solar generation at times of peak demand is not close to capacity. This is because times of summer peak demand are not always closely correlated with peak sunlight and PV generation. In addition, high temperatures reduce the potential output of PV.

A recent research paper published by Ausgrid indicated that the impact of rooftop solar on its summer peak demand has been small to date, despite the substantial take up in NSW. Using interval data from 26,744 installed solar systems over its peak demand period in early February 2011, Ausgrid noted that system peak time differed from the solar peak time, with the estimated output of the sample solar PV contributing only 32% of the total installed capacity of PV during the peak period. Ausgrid indicated that there has been no network investment deferral as a result of installed PV on its network. The most optimistic location on Ausgrid's network for PV to defer network investment was cited as Charmhave Zone Substation, however, Ausgrid noted that:

*If the uptake of solar connections on this substation was about three times higher, then there could be enough peak reduction to defer a transformer upgrade for one year.*⁸⁸

Ausgrid reported that, of the 51.6 MW of installed solar capacity studied, between 18 and 23.9 MW of peak demand was avoided over five summer peak days, representing between 0.30% and 0.43% of total summer peak demand on those days.⁸⁹

Western Power's 2011 Annual Planning Report discussed the impact that PV is having on peak demand on its network. Western Power's 2011 annual demand forecast incorporates the expected impact of PV at times of peak. Western Power noted that:

*The output of the PV systems is at a maximum in the middle of the day and early afternoon when the amount of direct incident sunlight is usually the highest (when) there is usually the least amount of shading of the solar panels to the sunlight. Historically the summer system peak occurs after 4:00pm when the solar activity is significantly less than in the middle of the day hence PV contribution to supplying electricity is also significantly reduced.*⁹⁰

Western Power incorporated an anticipated reduction in maximum demand of 74 MW in 2012 rising to 133 MW by 2017 in its 2011 peak demand forecast.⁹¹ Western Power published a report outlining its methodology for estimating the impact of PV on its network peak demand, based on assumed PV generation profiles.⁹² The forecast PV impact was estimated based on an assumption that the maximum achievable load at peak times was 51.6% of total generation capacity. That is, for the forecast 148 MW of installed capacity in 2012, 76.3 MW was expected to be generating at peak times.⁹³

As part of the 2011 National Transmission Network Development Plan (NTNDP) for the NEM, AEMO presented analysis of the potential impact on demand from widespread adoption of plug-in electric vehicles (not including V2G analysis) and increasing penetration of rooftop solar photovoltaic (PV) generation.⁹⁴ The solar analysis was based on a simulated PV generation system located in Sydney,

⁸⁷ ACIL Tasman, Analysis of the Impact of the Small-scale Renewable Energy Scheme – Projection of retail electricity price impacts and abatement to 2020, November 2011, p. 43.

⁸⁸ Ausgrid, Research paper - Effect of small solar Photovoltaic (PV) systems on network peak demand, October 2011.

⁸⁹ Ausgrid, Research paper - Effect of small solar Photovoltaic (PV) systems on network peak demand, October 2011, p. 4.

⁹⁰ Western Power, 2011 Annual Planning Report, p. 46.

⁹¹ Western Power, 2011 Annual Planning Report, p. 56.

⁹² Western Power, Photovoltaic (PV) Forecast, 28 March 2011.

⁹³ Western Power, Photovoltaic (PV) Forecast, 28 March 2011, p. 20.

⁹⁴ AEMO, National Transmission Network Development Plan 2011, Chapter 9.

with climate simulation including ambient temperature and solar radiation at hourly intervals over a year, assuming a north-facing system with no shading at 30 degree tilt angle. AEMO also accounted for losses from system components.

The analysis on PV impact assumed a baseline of PV generation capacity of 2,000 MW. AEMO noted that this capacity figure was selected in order to explore the impact of generation capacity that is high enough to have a clear impact on the regional load profile, but that is still considered a reasonable projection given recent estimates of PV capacity in Australia. AEMO indicated that the output profiles could be scaled up or down directly to represent higher or lower capacities.⁹⁵

Two scenarios were modelled:

- PV1 – with high output during summer, assuming a sunny summer day with little to no cloud. Under this scenario, the generation reaches its maximum of 1,633 MW at 11am, decreasing from then onwards, sharply decreasing after 5:30pm when the sun is lower in the sky
- PV2 – with low output during summer, assuming a hot and cloudy day. Generation reaches a maximum of only 60% of the PV1 scenario at 11am.

The results of AEMO’s research are presented in the following table.

Table 40: AEMO Research on PV impact on peak demand - Results

Scenario	MW output at peak	Percentage of maximum potential solar PV generation output	Summer peak demand impact
PV1	418	26%	A 1.8% reduction in peak demand, shifted from 5:30pm to 6pm
PV2	373	23%	A 1.6% reduction in peak

Source: AEMO, National Transmission Network Development Plan 2011, p. 9-16.

9.1.2 What is needed to achieve the benefits?

Once again, the economic case for installing rooftop solar does not rest upon the value of peak demand savings it can generate alone, rather, most benefits are related to the reduced consumption of energy produced by emissions-intensive generation. However, we acknowledge that in order to achieve benefits, there are substantial costs, in particular upfront capital and installation costs.

Based on a literature review of PV system cost components, ACIL Tasman reported 2011 estimates of the total cost of PV installations per kW of installed capacity (before any subsidy), ranging between \$5,000 and \$6,400.⁹⁶ In forecasting system cost out to 2020, ACIL Tasman’s analysis presented a decline in real costs.

To inform our estimate of the incremental costs associated with the Enhanced PV forecast, we reviewed ACIL Tasman’s cost estimates and current market costs for small scale solar, and have assumed a real cost of \$5000 per kW of installed capacity of PV in 2012, declining to \$4000 per kW in 2021-22. Total costs of the Enhanced PV forecast scenario are presented in the following table.

⁹⁵ AEMO, National Transmission Network Development Plan 2011, p. 9-10, footnote 18.

⁹⁶ ACIL Tasman, Analysis of the Impact of the Small-scale Renewable Energy Scheme – Projection of retail electricity price impacts and abatement to 2020, November 2011, p. 24.

Table 41: Enhanced uptake of Solar PV – total system costs

	Total costs 2012-13 to 2021-22 (\$m, NPV)
Enhanced uptake of Solar PV – total system costs	7,382

We also consider it is important to note the potential network costs associated with an increased penetration of solar PV, due to the impact of intermittent generation on system stability, including increases in harmonic levels, deterioration in power factor and voltage rise. Solar PV is also associated with interference with network protection operations, potentially causing network protection devices to fail to detect fault currents. A high penetration of solar PV that fluctuates over the day with sunlight is also likely to result in large power swings, requiring other forms of generation to step in and supply load, increasing the potential for network instability and outages.⁹⁷ We have not attempted to quantify the impact of these offsetting costs in our analysis, however acknowledge that they need to be taken into account in any detailed cost benefit analysis of significant take up of solar PV.

9.1.3 What is the potential impact on peak demand?

Based on the analysis of research papers discussed above, we have developed a range for the estimated impact of solar PV on summer maximum demand, per MW of installed PV capacity. For the NEM, the upper bound of the range reflects average findings from Ausgrid's 2011 research, while the lower bound represents AEMO's high case findings, published within the 2011 NTNDP.

For the SWIS, the high case estimate is based on Western Power's analysis of PV impact on peak demand, while the low case estimate is based on AEMO's study.

Table 42: Deloitte assumptions – Impact of PV on summer peak demand

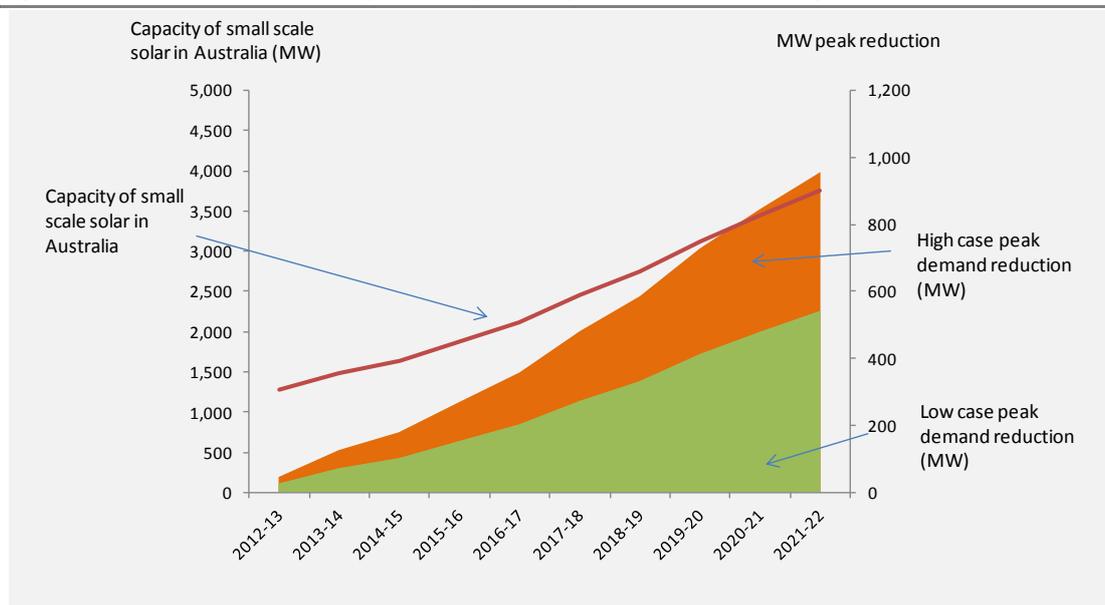
	Low case estimate (%)	High case estimate (%)
Reduction at summer peak per MW of installed capacity - NEM	20.9%	34.9%
Reduction at summer peak per MW of installed capacity - SWIS	20.9%	51.6%

Given Tasmania's winter peaking system, we have excluded benefits associated with the installation of solar PV in Tasmania from our analysis. Peak demand savings are weighted between the NEM and SWIS according to their relative summer peak demand data.

The following graph illustrates our assumptions regarding the take up of small scale solar and the potential peak load reductions under the high and low case scenarios.

⁹⁷ Endeavour Energy Power Quality and Reliability Centre, Small Scale Domestic Rooftop Solar Photovoltaic Systems, Technical Note 10, October 2011.

Figure 115: Small scale solar – Take up rate and potential peak load reductions – high and low case scenario



Source: Deloitte analysis

9.1.4 Conclusion – value of potential benefits

In conclusion, based on available research on the impact of solar PV on summer peak demand, we consider that the Enhanced Uptake scenario forecast by ACIL Tasman extrapolated over 2012 to 2022 could result in the range of benefits, as set out in the table below.

Table 43: Enhanced Uptake of solar PV– estimated value of benefits 2012-13 to 2021-22 (NPV, \$m)

	Low case estimate (\$m)	High case estimate (\$m)
Enhanced uptake of Solar PV – value of potential reduction in peak demand	300	528

9.2 Cogeneration and trigeneration

Cogeneration (co-gen) is output from a small power plant located close to or inside a commercial or residential building, which uses fuel or solar energy to produce both energy and useful heat output that would otherwise be wasted. The heat output is generally used to provide thermal energy for heating the building. Trigeneration (tri-gen) takes this efficiency one step further, also producing energy that is used for cooling.

Co-gen and Tri-gen are highly regarded for their potential to lower overall energy use, and particularly for potential to lower greenhouse gas emissions. Co-gen and Tri-gen sites are emerging in all states of Australia, as financial incentives and emissions reduction targets encourage the use of renewable energy.

One of the best known distributed generation projects in Australia is the City of Sydney's *Sustainable Sydney 2030* plan. This project has a target for 360 MW of tri-gen to be operational by 2030, which if implemented, would reduce the city's summer peak demand by up to one third.⁹⁸

To date, there have been no comprehensive national studies on the potential quantity of co-gen and tri-gen. At various times over the past decade, State governments have carried out research on the potential for co-gen and tri-gen in their jurisdictions, including some cost benefit studies. The Institute for Sustainable Futures conducted some high level analysis of the potential capacity of co-gen and tri-gen in Australia, based on previous studies on Victoria, Queensland, NSW, Tasmania and Western Australia. The Institute for Sustainable Futures reported that total potential capacity of co-gen and tri-gen is in the vicinity of 2,500 MW.⁹⁹

To predict the impact of co-gen and tri-gen on peak demand would require a forecast of the potential capacity, as well as detailed studies on the contribution of various types of systems at times of peak demand. We consider that while the implementation of co-gen and tri-gen will undoubtedly result in lower peak demand in the NEM and SWIS over the next decade, it is not possible to develop a high level estimate of the potential value of these initiatives without a comprehensive national or recent state based forecast to draw upon.

⁹⁸ City of Sydney, *Decentralised Energy Master Plan – Trigeneration 2010-2030*; Futura Consulting, *Power of choice – giving consumers options in the way they use electricity - Investigation of existing and plausible future demand side participation in the electricity market*, Final Report, December 2011, p. 17;

⁹⁹ Institute for Sustainable Futures and Energetics, *Building Our Savings: Reduced Infrastructure Costs from Improving Building Energy Efficiency*, Final Report, July 2010, p. 40.

10 Conclusion

10.1 Summary of findings

In conclusion, our analysis of the available research and data relating to seven initiatives has yielded a total range of NPV benefits of between \$1.6 billion and \$4.6 billion over 2012-13 to 2021-22. The results are presented in the table below.

Table 44: Deloitte conclusion – Total estimated value of gross benefits 2012-13 to 2021-22 (NPV, \$m)

Initiative	Low case benefits (\$m)	High case benefits (\$m)
Time of use pricing	58	193
Critical peak pricing and incentives	385	1,272
Direct load control of air conditioners	200	1,338
Direct load control of pool pumps	188	231
Electric vehicles	60	537
Energy Savings Measures	361	486
Enhanced uptake of Solar PV	300	528
Total gross benefits	1,551	4,585

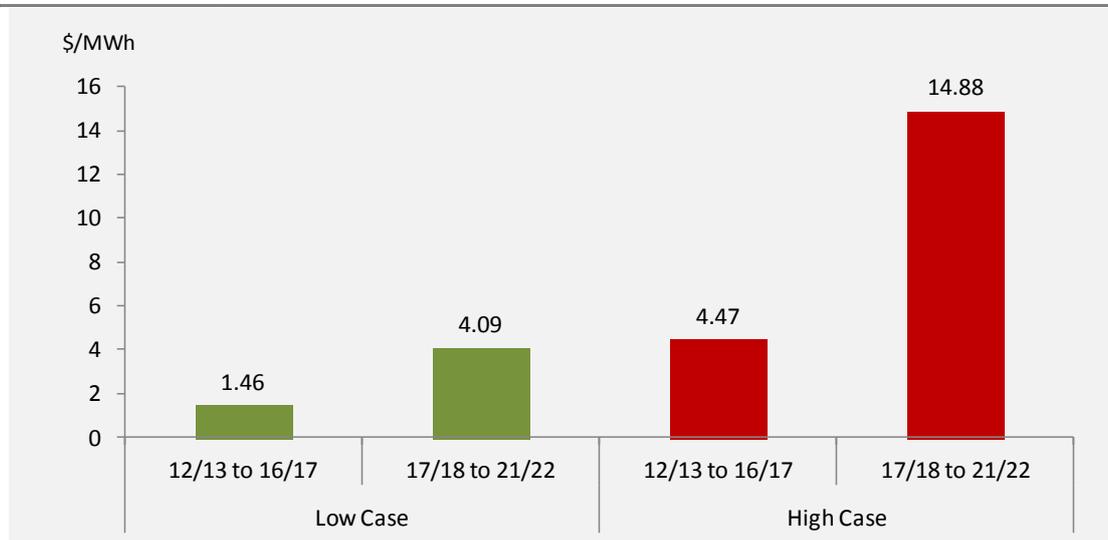
Source: Deloitte analysis. Note totals may not sum due to rounding.

The net benefits realised by customers will depend upon the additional costs incurred to achieve these benefits, the regulatory framework and the competitive nature of the wholesale and retail markets.

To determine the precise impact on electricity tariffs is beyond the scope of this study and will depend upon the costs incurred to achieve the benefits. However, we have converted the calculated gross benefits into a \$/MWh figure for residential customers, based on forecast residential electricity consumption. The results are presented in the figure below.

Putting aside the benefits associated with improving the energy efficiency of existing commercial buildings, in making this calculation, we have implicitly assumed that all benefits accrue to residential customers.

Figure 128: Domestic gross benefits translated into \$/MWh



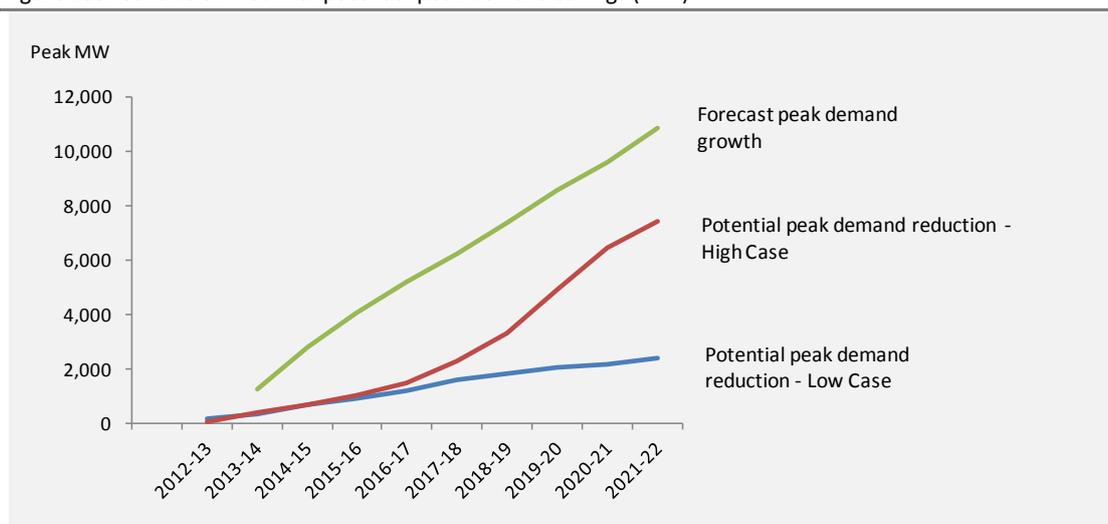
Source: Deloitte analysis

The gross benefits translated into a \$/MWh figure for residential customers range from an average of \$1.46/MWh to \$4.09/MWh under the low case scenario and \$4.47/MWh to \$14.88/MWh under the high case scenario.

The actual electricity price impact for residential customers will be lower due to the additional cost incurred in achieving these benefits. The electricity price impact will also depend upon the regulatory framework and the competitive nature of the wholesale and retail markets.

The sum of potential peak demand reductions under the high and low case scenarios, as well as the forecast peak demand for the NEM and the SWIS are presented in the following graph.

Figure 139: Conclusion – Sum of potential peak demand savings (MW)



Source: Deloitte analysis

10.2 Additive nature of benefits

We consider that it is unlikely that all eligible and responsive customers will elect to be engaged in only one peak demand saving initiative each, should more be offered to them by electricity retailers or via marketing. However, we also acknowledge that when a customer is involved in more than one initiative, the potential savings from each initiative are reduced, as there is a finite amount of peak savings that can be delivered by a single customer. To account for this, we have moderated our take up rate assumptions at a global level.

As is presented in table 44, the majority of the quantified benefits are attributable to critical peak pricing incentives and direct load control of air conditioners. For these initiatives, we consider that customers curtailing their discretionary peak load, either through pricing incentives or load control, will deliver the majority of their benefits.

Given they are stemming from changes in the use of a small set of discretionary appliances, the additive nature of benefits from these particular initiatives needs to be considered. We have taken this into account in our assumptions regarding the scenarios on customer take rates. Under the high case scenario, we note that the take up rates reach a maximum of 30% for all residential customers for Dynamic Pricing and 16% for direct load control of air conditioning .

In short, assuming that the peak load reduction benefits of Dynamic Pricing and direct load control are delivered by different residential customers (implying that the maximum benefit can be derived from each initiative as each customer responds to each initiative to highest degree possible) results in 46% of residential customers being engaged. We consider this is a reasonable assumption, given the current technical, market and policy barriers to these initiatives.

The addition of the benefits of all quantified initiatives has also been considered at the global level, and taken into account in the individual take up rates for each initiative.

If we assume that each residential customer is only engaged in a single initiative (either Dynamic Pricing, direct load control, V2G or solar PV), the result is a maximum of 59% of residential customers being engaged in 2021-22 under the high case scenario. This assumption results in a maximum of 49% of customers under the low case scenario.

For building efficiency standards, the benefits we have estimated are to be delivered by retrofitting existing commercial buildings, targeting peak demand savings delivered by commercial customers. Accordingly, we consider it is reasonable to add savings from building efficiency standards to the potential savings from residential customers.

11 Bibliography

Resources

ABS, 4602.0.55.001 - Environmental Issues: Energy Use and Conservation, Mar 2011

ABS, 4602.0.55.001 - Environmental Issues: Energy Use and Conservation, Mar 2011

ABS, WA Population Growth – 1367.5 – Western Australian Statistical Indicators 2010

ACIL Tasman, Analysis of the Impact of the Small-scale Renewable Energy Scheme – Projection of retail electricity price impacts and abatement to 2020, November 2011

ACIL Tasman - Fuel Resource, new entry and generation costs in the NEM, April 2009

Actew AGL, Pricing proposal, May 2011

AECOM, Forecast Uptake and Economic Evaluation of Electric Vehicles in Victoria, Final Report, May 2011

AECOM, Economic Viability of Electric Vehicles - Department of Environment and Climate Change (NSW), September 2009

AEMC, Final Report – Impact of the Enhanced Renewable Energy Target on energy markets, 25 November 2011

AEMO, Electricity Statement of Opportunities for the National Electricity Market, 2011

AEMO, 2011 Electricity Statement of Opportunities, Update as at 2 March 2012

AEMO, National Transmission Network Development Plan 2011

AER, Demand Management Incentive Scheme - Jemena, CitiPower, Powercor, SP AusNet and United Energy 2011–15, April 2009

Ausgrid Network Pricing Proposal - for the FY ending June 2012

Ausgrid, Research paper - Effect of small solar Photovoltaic (PV) systems on network peak demand, October 2011.c

Australian Building Codes Board (prepared by the Centre for International Economics), Proposal to Revise the Energy Efficiency Requirements of the Building Code of Australia for Residential Buildings — Classes 1, 2, 4 and 10, December 2009

Cain, MacGill and Bruce, School of Photovoltaic and Renewable Energy Engineering – Centre for Energy and Environmental Markets, Assessing the Potential Impacts of Electric Vehicles on the Electricity Distribution Network, 2010.

City of Sydney, Decentralised Energy Master Plan – Trigeneration 2010-2030; Futura Consulting, Power of choice – giving consumers options in the way they use electricity - Investigation of existing and plausible future demand side participation in the electricity market, Final Report, December 2011

CitiPower, 2011 Pricing Proposal

CSIRO Electric Driveway Project, Plugging In: A technical and institutional assessment of Electric Vehicles and the Grid in Australia, Phase 1 Report, March 2011.

Curtin University of Technology, Electric Vehicles and their Renewable Connection – How Australia can take part in the Green Revolution, presentation, June 2009

Resources

Crossley, Energy Futures Australia Pty Ltd - Presentation to Metering & Billing/CRM Conference: Low Cost Load Control Technology, November 2006

Deloitte, Department of Treasury and Finance – Advanced Metering Infrastructure cost benefit analysis – Final Report, August 2011

Denholm and Short, An Evaluation of Utility System Impacts and Benefits of Optimally Dispatched Plug-In Hybrid Electric Vehicles, October 2006

Endeavour Energy - Direct Control Services - Annual Pricing Proposal 2011-12

Endeavour Energy Power Quality and Reliability Centre, Small Scale Domestic Rooftop Solar Photovoltaic Systems, Technical Note 10, October 2011

EnergyConsult Pty Ltd for the Equipment Energy Efficiency Committee under the auspices of the MCE, Decision Regulatory Impact Statement: Minimum Energy Performance Standards for Air Conditioners: 2011, December 2010

Energy Efficient Strategies, Status of Air Conditioners in Australia, January 2006.

Energex, Time for a cool change – Energy Smart Suburbs – Newsletter November 2010

Energex, Response to the Prime Minister’s Task Force on Energy Efficiency, April 2010

EnergyConsult Pty Ltd for the Department of Climate Change and Energy Efficiency, Evaluation of Energy Efficiency, Equipment Energy Efficiency Program: Policy Measures for Household Air Conditioners in Australia, November 2010

EMCa, Cost Benefit Analysis of Smart Metering and Direct Load Control - Workstream 6: Transitional Implementation Costs: Phase 2 Consultation Report, February 2008.

eMeter Smart Grid Watch article – French Government Announces Smart Meter Rollout Schedule, September 29 2011

EPRI, Australian Electricity Generation Technology Costs - Reference Case 2010, February 2010

Ernst & Young, AEMC Power of Choice - Rationale and drivers for DSP in the electricity market - demand and supply of electricity, December 2011.

ETSA Utilities, Demand Management Program Interim Report No. 3, June 2010

ETSA Utilities, Project EPR 0022 – Response to AEMC Issues Paper – Power of Choice, September 2011

Futura Consulting, Power of choice – giving consumers options in the way they use electricity - Investigation of existing and plausible future demand side participation in the electricity market, Final Report, December 2011

Independent Market Operator, Statement of Opportunities, June 2011, Appendixes 3, 4 and 5.

Institute for Sustainable Futures, Close to Home: Potential benefits of Decentralised Energy for NSW Electricity Consumers

Institute for Sustainable Futures and Energetics, Building Our Savings: Reduced Infrastructure Costs from Improving Building Energy Efficiency, Final Report, July 2010

Jolly, R of Carbon Market Economics, Policy Roadmap for Energy Efficient Air conditioners, Presented at Energy Efficiency, Climate and China’s Development Strategy, Beijing, 9 September 2010.

Jemena Electricity Networks (JEN), JEN Pricing Proposal 2011 Pricing Proposal

Resources

Langham, E. Dunstan, C. and Mohr, S. (2011). Mapping Network Opportunities for Decentralised Energy: The Dynamic Avoidable Network Cost Evaluation (DANCE) Model, iGrid Working Paper 4.4, Prepared by the Institute for Sustainable Futures, University of Technology Sydney as part of the CSIRO Intelligent Grid Research Program.

Letendre and Dehholm, 'Electric & Hybrid Cars -New Load, or new Resource' in Public Utilities Fortnightly, December 2006

National Smart Metering Program Business Requirements Working Group, The National Smart Metering Program and the AS4755 Appliance Interface: Establishing a Direct Connection

NERA et al, Cost Benefit Analysis of Smart Metering and Direct Load Control - Overview Report for Consultation, February 2008

Newsham and Bowker, The effect of utility time-varying pricing and load control strategies on residential summer peak electricity use: A review, June 2010.

NSW Department of Planning, EnergyAustralia and TransGrid - Demand Management and Planning Program – Final Report, June 2008

Oakley Greenwood, Review of AMI Benefits – for the Department of Primary Industries Victoria, July 2010

Perth Solar City Annual Report 2010-11

Peterson, Whitacre and Apt, The Economics of using plug-in hybrid electric vehicle battery packs for grid storage, in the Journal of Power Sources, September 2009.

Powercor, 2011 Pricing Proposal

Department of Employment, Economic Development and Innovation, Queensland Energy Management Plan, May 2011

United Energy, UED Pricing Proposal 2011

Western Power, 2011 Annual Planning Report

Western Power, Access Arrangement Information for 2012-17 - Appendix P - System Demand Forecasting for AA3 and Appendix T – Deloitte Report – Energy and Customer Number forecasts for the AA3 Period

Western Power, Smart Grid Proposal, October 2011.

Wilkenfeld, Dr George, Swimming Pools: Energy use and impact on peak load, July 2009

Worley Parsons, Cost of construction New Generation Technology, January 2012

Statement of responsibility

This report is prepared solely for the internal use of the ESAA. This report is not intended to and should not be used or relied upon by anyone else and we accept no duty of care to any other person or entity. The report has been prepared for the purpose set out in our proposal. You should not refer to or use our name or the advice for any other purpose.

About Deloitte

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited, a UK private company limited by guarantee, and its network of member firms, each of which is a legally separate and independent entity. Please see www.deloitte.com/au/about for a detailed description of the legal structure of Deloitte Touche Tohmatsu Limited and its member firms.

Deloitte provides audit, tax, consulting, and financial advisory services to public and private clients spanning multiple industries. With a globally connected network of member firms in more than 150 countries, Deloitte brings world-class capabilities and deep local expertise to help clients succeed wherever they operate. Deloitte's approximately 170,000 professionals are committed to becoming the standard of excellence

About Deloitte Australia

In Australia, the member firm is the Australian partnership of Deloitte Touche Tohmatsu. As one of Australia's leading professional services firms, Deloitte Touche Tohmatsu and its affiliates provide audit, tax, consulting, and financial advisory services through approximately 5,400 people across the country. Focused on the creation of value and growth, and known as an employer of choice for innovative human resources programs, we are dedicated to helping our clients and our people excel. For more information, please visit our web site at www.deloitte.com.au.

Liability limited by a scheme approved under Professional Standards Legislation.

Member of Deloitte Touche Tohmatsu Limited

This document and the information contained in it are confidential and should not be used or disclosed in any way without our prior consent.

© 2012 Deloitte Touche Tohmatsu