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CONSULTATION REGULATION IMPACT STATEMENT

Mandating ‘Smart Appliance’ Interfaces for Air Conditioners, Water Heaters and other Appliances

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# Overview

Peak demand prompted by extreme weather events results in major spikes in electricity usage. These peak events create a problem as they require expensive investment to increase network capacity.

There are a variety of ways to respond to this problem and manage electricity demand. This Regulation Impact Statement (RIS) focuses on demand response through direct load control, which would allow certain household appliances to be remotely controlled and reduce the demand for electricity at peak times. The approach would be facilitated by mandating that key appliances must be equipped with a demand response interface. This interface would allow the establishment of communication links between appliances and the electricity network.

There are different possible technologies which can allow an appliance to be remotely controlled, and currently many appliance manufacturers are unwilling to risk investing in a particular communications approach unless they know it will be used by other market participants. Mandating compliance with the Australian Standard for demand response interfaces would overcome this and allow sufficient market aggregation to occur.

## The Problem

The problem of peak demand is outlined by the Productivity Commission[[1]](#footnote-1):

“Heat waves, cold snaps and other often short-lived and infrequent events can create major spikes in electricity usage, known as ‘peak’ or ‘critical peak’ demand.

Demand for electricity is inherently variable and can fluctuate from hour-to-hour, day-to-day, season-to-season and year-to-year. As well as the common fluctuations in electricity usage seen through each day and across the year, sometimes there can be major spikes in usage, for example during unusually hot days.

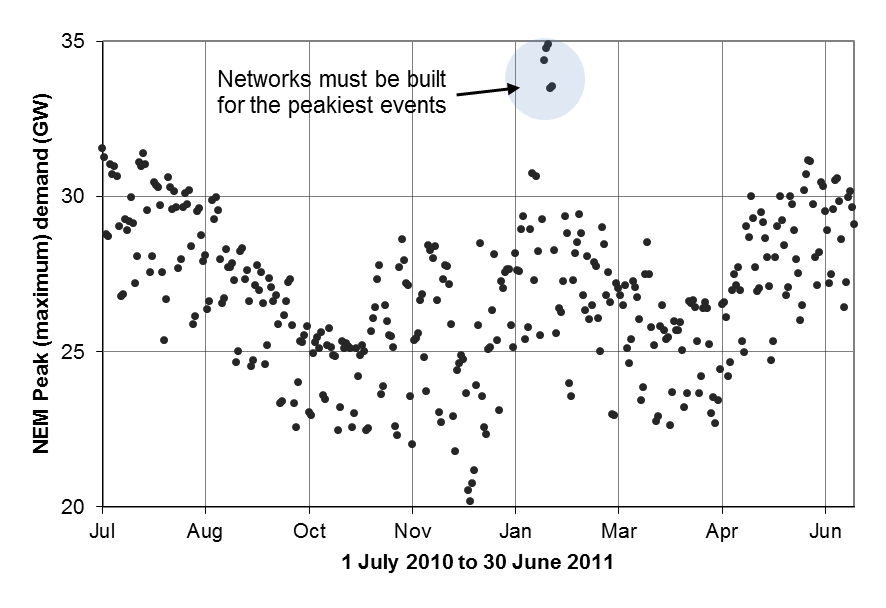
In contrast to the variable nature of electricity demand, network capacity (which is determined by the technical design limits of individual network elements) cannot be increased in the short-run. As network usage approaches or exceeds capacity limits, there may be damage to equipment and loss of network performance, which may even lead to a partial or full system shutdown.[[2]](#footnote-2)

As it is not economic to store electricity at its point of use, avoiding supply failures requires networks to be built to reliably exceed peak demand. That is, they must be able to accommodate the highest draw of power from end users in any instant.

This means that infrequent and short periods of high electricity consumption can require a disproportionate share of generation and network investment, which in turn drive up the cost of electricity generally. This is the problem of ‘peak’ demand (or ‘critical peak’ demand, as the problem of major spikes is sometimes called).”

The following chart shows the daily peak demand in the National Electricity Market (NEM) for the year to June 2011.

**Figure EX1: Electricity networks must be built for the ‘peakiest’ events[[3]](#footnote-3)**



The chart shows peak or maximum demand varies considerably, generally ranging from 20 to 30 gigawatts (GW). The periods with higher maximum demand tend to be in summer and winter. The chart also shows the limited number of ‘critical’ peaks in demand (up to 35 GW), which occurred in the January/February period.

Electricity generation, transmission and distribution systems must be designed to provide high levels of reliability at all times, including during periods of peak demand. As the extreme peaks in demand are of relatively brief duration (hours at most, occurring on only a few days each year), the full capacity of the electricity system is under-utilised for most of the time.

However, this is not in itself an indication that peak, or critical peak, electricity demand is a problem. It is to be expected that people will use more electricity to heat or cool their home when the weather is very hot or cold, and that people will value this comfort. The Productivity Commission suggests that “growth in peak demand therefore need not indicate an economic problem, at least not on its own. Rather, the issue is whether the rate of peak demand is economically efficient, given the benefits and costs entailed. This depends on whether the amenity and other benefits consumers gain from all of their peak electricity consumption are at least commensurate in value with the high cost of supplying it.”[[4]](#footnote-4)

However, most electricity consumers currently pay a single or flat electricity tariff for their usage. As they do not have an incentive to reduce their usage when demand is high and electricity used at peak times is much higher than it would be if consumers were paying the true cost.

The Productivity Commission concludes “growth in peak electricity demand is likely to be inducing (or bringing forward) a sizable stream of otherwise unnecessary investment, for which consumers ultimately pay. And the widening gap between peak and average demand is contributing to reduced productivity in the electricity sector.”[[5]](#footnote-5)

### Regulatory and market failures

#### Lack of price signals in the electricity market

This RIS seeks to address two failures in the electricity market. As indicated above, a failure of current regulation of the electricity market is the use of single (or flat) prices for electricity. In contrast to most markets in which consumers bear the costs of their consumption, the lack of cost reflective price signals to consumers means that most residential consumers do not receive a signal about the cost of consuming electricity at peak times.

For example, the great majority of air conditioner owners only pay the cost of purchasing the appliance and a flat tariff for their electricity. This generally only covers part of the actual costs of running an air conditioner because the tariff does not reflect the costs of providing sufficient network capacity to deal with demand peaks. The cost of this additional network capacity is spread across all consumers, regardless of whether or not they have an air conditioner or are using it during peak periods.

This situation is a major contributor to the peak demand problem, as it encourages over-consumption at peak times and inefficient supply-side investment. The current smoothing of prices may also create inequities, with low income consumers cross-subsiding the better off. This is because low income households are less likely to own energy intensive appliances such as air conditioners or swimming pool pumps.[[6]](#footnote-6)

#### Network Externality

A ‘network externality’ (which is also referred to as “demand side economies of scale”) is a form of market failure where the benefit that an individual can derive from a product depends on the number of other users of that product.[[7]](#footnote-7) A classic example is the telephone. Similarly, for an individual consumer to benefit from having a smart appliance with a particular type of interface it is also necessary for other consumers to have smart appliances with the same interface. This enables service providers to achieve economies of scale, making it feasible for them to offer a demand response scheme for appliances to many or all consumers. Currently there are competing technologies and a lack of standardisation, and neither appliance manufacturers nor energy utilities will risk committing to a single approach for communicating with smart appliances.

The Australian Standard proposed for adoption is an open rather than a proprietary standard, and specifies minimum physical, functional and electrical requirements for an interface. It is analogous to the Universal Serial Bus (USB) standard, which establishes communications between personal computers and the devices they control.

### Scale of the problem

Rising peak demand is a key driver of investment in generation and network capacity, the costs of which are ultimately borne by all electricity users. Capital expenditure to accommodate peak load growth in the NEM jurisdictions accounts for around 45 per cent of approved total network investment and slightly more than half of transmission spending.[[8]](#footnote-8) This equates to:

* $11 billion in system (network and generation) capacity that is used for only 100 hours per year;
* $2,900 in investment per marginal peak load kilowatt (kW); and
* $1,200 per customer over the lifetime of the latest 5 year electricity price determinations.

The increasing cost of peak energy has been a major contributor to the overall increase in electricity prices, which have increased substantially since the mid-2000s, with retail electricity prices increasing by around 50 per cent in real terms from June 2007 to June 2012. This increase is demonstrated in the chart below.[[9]](#footnote-9)

**Figure EX2: Electricity prices – September 1980 to June 2012**

|  |  |
| --- | --- |
| Business and household electricty prices**a** | Real household electricity prices**b** |
| Description: There are two charts on electricity prices. This first chart shows the change from September 1980 to June 2012 in electricity prices for businesses and households, compared with the general rate of inflation.Description: This second chart is a measure of the relative price of electricity (the retail price divided by the consumer price index). The relative price fell after the mid-1980s to the 2000s, but has soared from around 2006. | |

a Data are from September 1980 to June 2012, rebased so that June 1990=100. The data relate to all Australian electricity prices, not just those in the National Electricity Market, but the trends will be similar.

b’Real’ prices are household prices divided by the CPI average for capital cities. The index shows how much electricity prices have increased above inflation.

Data sources: ABS (2012c), Consumer Price Index, Australia, June 2011, Cat. No. 6401.0 and ABS (2012d), Producer Price Indexes, Australia, June 2012, Cat. No. 6427.0.

Increasing network costs are the biggest factor driving up the cost of electricity. In 2012-13 51 per cent of an average Australian household electricity bill is made up mainly of network charges (wholesale generation costs and renewable energy/energy efficiency scheme costs each represent around 20 per cent).[[10]](#footnote-10)

The investment needed in the National Electricity Network (NEM) is forecast to exceed $7 billion for transmission and $35 billion for distribution over the current 5 year regulatory period. This is a rise in investment from the previous periods of 82 and 62 per cent (in real terms) in transmission and distribution networks, respectively.[[11]](#footnote-11)

Peak electricity demand growth has been a key driver of these network costs, as the capacity of the network is based on meeting peak demand. Peak demand events occurring for less than 40 hours per year (or less than one per cent of the time) account for 25 per cent of retail electricity costs.[[12]](#footnote-12)

#### Jurisdictional analysis

The table below shows projections of variables that will affect the growth in peak demand across the States and Territories.

**Table EX1: Summary by jurisdiction[[13]](#footnote-13)**

|  | | NSW/ ACT | Vic | Qld | WA | SA | Tas | NT | Australia/ NEM |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Estimated investment required per marginal peak load kW | | $3,100 NSW  $1,500 ACT | $800 | $3,500 | $3,200 | $2,400 | $500 | $3,500 | Australia  $2,900 |
| Population growth rate  2010-2020 (a) | | 1.1 % | 1.3% | 2.0% | 1.9% | 0.9% | 0.6% | 1.5% | Australia 1.4%  NEM 1.3% |
| Energy use increase rate 2012-22 (a) | | 1.1% | 1.8% | 2.2% | 2.9% | 0.7% | 1.1% | 1.7% | 1.3% NEM |
| Peak load increase rate 2011-22  Summer Maximum Demand (SMD)  Winter Maximum Demand (WMD) | | 1.2%/  1.2% | 1.6%/  1.6% | 2.5%/  2.9% | 3.8%/  2.9% | 1.0%/  1.2% | 1.1% /  1.1% | NA | 1.6%/1.6% NEM |
| SMD increase rate compared with energy | | +0.1% | -0.2% | +0.3% | +1.1% | +0.3% | +0.0% | NA | +0.3% NEM |
| Projected Maximum Demand, MW | Summer 2012-13 | 13,399 | 9,690 | 9,007 | 4,181 | 2,778 | 1,371  (1,770 WMD) | NA | NEM  33,345 |
| Summer  2021-22 | 14,860 | 11,147 | 11,245 | 6,038 | 3,016 | 1,516  (1,955 WMD) | NA | NEM  38,440 |

(a) Medium growth rates in ‘mass-market’ energy use (i.e. excluding large industrial or commercial customers). Mass market users contribute most to short-duration peak loads and are not exposed to peak-related pricing. Peak reductions from contracts with large industrial or commercial customers are factored into maximum demand projections.

The table shows the extent of the peak demand problem varies considerably across jurisdictions. Queensland and Western Australia (WA) have high marginal costs per peak kW ($3,500 and $3,200 respectively), and deteriorating load factors (i.e. peak demand growth faster than energy growth). In comparison, the estimated investment required per marginal peak load kW for Tasmania is much lower ($500/kW) and peak load is projected to increase no faster than energy.

The investment per marginal peak load kW varies for the remaining jurisdictions, with $3,100 required for New South Wales (NSW), $800 for Victoria, $2,400 for South Australia (SA), $1,500 for the Australian Capital Territory(ACT) and $2,900 for the Northern Territory (NT). This gives a weighted national average for Australia of $2,900 in investment required per marginal peak load kW, and peak load growing faster than energy use by 0.3 per cent per annum. This means that the investment in peak load per kWh of energy sold will increase, so average prices per kWh will be driven up, all else being equal.

#### Appliances which can effectively contribute to reducing peak demand

Generally, products which are likely to be good candidates for a smart appliance scheme are those which are large contributors (or large future contributors) to peak demand, and where the contribution to peak demand can be reduced at minimal cost to consumers and the community.

Products which do not have to operate at specific times provide an opportunity to reduce peak demand cost effectively. Specifically, shifting the operation of electric hot water systems, swimming pool pumps and electric vehicle chargers outside peak times for no more than about 40 hours per year will have negligible impact on consumer utility. In contrast, consumers will not tolerate automatic curtailment of activities with high value to them and which cannot be rescheduled or substituted – for example adequate light, television and cooking.

In the case of air conditioners, which are clearly the largest contributor to peak demand, some consumers can choose to accept a reduces level of service at times of high demand (although possibly at a cost of some discomfort) in response to electricity bill savings or other monetary incentives. Trials have shown that most consumers will tolerate interruptions to air conditioner operations and that reduced levels of service cause only limited discomfort, with the majority of users in trials not even aware when a demand response event has occurred.[[14]](#footnote-14)

##### Air conditioners

A major factor in the growth in peak demand has been the increasing household penetration of air conditioning. The proportion of Australian households with at least one refrigerative air conditioner was fairly steady at around 25 per cent through the 1990s, but had reached 56 per cent in 2012 and is projected to exceed 70 per cent by 2020. At the same time, the average capacity and electrical power of air conditioners installed is increasing.[[15]](#footnote-15) This means that the associated use of electricity is projected to be five times greater than it was in 1990.[[16]](#footnote-16) Rising incomes and the declining cost of air conditioners are key causes of this trend, along with the increasing size of new homes.[[17]](#footnote-17)

Household air conditioners have contributed to emergency load shedding and blackouts in several Australian States since February 2004, when heavy air conditioner use during heat waves caused blackouts in Perth and parts of Melbourne.[[18]](#footnote-18) The most recent such events were in January and February 2009, during the period of record high summer temperatures in SA and Victoria, leading up to the Victorian bushfires.[[19]](#footnote-19)

Over 1 million refrigerative air conditioners are sold each year, with Queensland accounting for 32 per cent of sales and NSW/ACT accounting for 25 per cent, and high growth in sales expected to continue particularly in Queensland and WA. There are about 100 suppliers in Australia, with 10 to 15 supplying approximately 80 per cent of units sold.[[20]](#footnote-20) The vast majority of air conditioners are imported, mainly from China, Thailand, Korea and Malaysia.[[21]](#footnote-21) There are also some small local assemblers. Some imported units already have latent demand response capabilities but these cannot be easily accessed without a standard interface.

##### Water heaters

A demand response capability for electric, heat pump and solar-electric water heaters would contribute to reducing winter peak demand more than summer peak demand. Demand response could also provide a mode of load control that is technically superior to existing off-peak tariffs, especially for solar-electric and heat pump water heaters, which typically need to keep pumps and control electronics energised.

Total sales of the types of water heater that would benefit from demand response was estimated at 370,000 units in 2011: 270,000 electric, 80,000 solar-electric and 20,000 heat pump units.[[22]](#footnote-22) Most electric storage water heaters are made in Australia and other types are assembled from a mixture of imported and assembled components.

##### Swimming pool pumps

A demand response capability for pool pumps would contribute to reducing network summer maximum demand, because it is estimated that around 50 per cent of pumps operate during air conditioner-induced peak events.[[23]](#footnote-23) There are about 1 million residential pools in Australia: 33% of these are in NSW, 31% in Queensland, 14% in Victoria and 13% in WA. [[24]](#footnote-24) Between 70,000 and 100,000 pool pump-units are sold each year.[[25]](#footnote-25) The demand response interface would be located in the pool controller rather the pump itself. Most pool controllers sold in Australia are locally made.

##### Electric vehicle charge suppliers

There is growing interest in the possibilities of electric vehicles (EVs). Demand response capabilities could forestall the development of future peak load problems due to EV chargers. EV chargers are an undeveloped market at present. Some vehicle manufacturers are importing small number of vehicles to test the market and it is expected that these would have to be sold (or leased) with home rechargers, which are also likely to be imported.

#### The problem – conclusion

On a small number of very hot days, the demand for electricity is significantly higher than it is for the rest of the year. These peaks in demand have been increasing over the past decade, primarily due to the increased penetration of household air conditioners. A lack of cost reflective price signals means that the market cannot efficiently respond to these peaks. The current pricing structure of a single rate for electricity encourages over consumption at peak times and excess investment in the supply of electricity.

Critical peak events require a large amount of investment in the electricity network – around 25 per cent of retail electricity bills reflect the cost of system capacity that is used for under one per cent of the time. The scale of the problem varies across jurisdictions. The ability to respond to peak periods through demand response is currently inhibited by the lack of a standard communications interface for energy intensive appliances, such as air conditioners. A standard interface would allow demand side economies of scale to develop, making it feasible for energy providers to offer a demand response scheme for many or all consumers.

## Other Developments regarding Peak Demand

### Electricity market reform package

The predecessor of the Council of Australian Governments’ (COAG) Standing Council on Energy and Resources (SCER), the Ministerial Council on Energy (MCE), first recognised the potential for demand side participation (DSP) to improve the efficiency of the NEM in 2007 (Appendix 5). DSP refers to the ability of energy consumers to make decisions regarding the quantity and timing of their energy consumption, which reflects the value to them of the supply and delivery of electricity.

Building on the work of MCE, SCER initiated a range of demand–side activities with the objective ‘to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity through an optimal level of demand side participation.’ The Select Council on Climate Change (SCCC) also has carriage of some of the work of the former MCE.

In December 2012 COAG endorsed a package of reforms that were agreed by SCER ‘Electricity market reform – putting consumers first’. The SCER package contains measures to strengthen regulation, empower consumers, enhance competition and innovation, and ensure competition and innovation. Key measures in the announcement that affect this RIS include:

* SCER agreed to develop arrangements necessary to encourage the market-driven (business-led) competitive roll-out of smart meters and other advanced metering.
* SCER agreed to provide for the phase-in of cost-reflective retail pricing structures through the use of time varying network tariffs that small consumers can choose to opt into.

The COAG Energy Market Reform Implementation Plan also includes a key recommendation for ‘balanced incentives for distribution businesses to implement efficient demand side options and to pursue innovative demand side solutions’.[[26]](#footnote-26)

### Demand management

Demand management offers a potential solution to the problem of peak demand, by providing incentives for consumers to reduce their electricity use at peak times and shift some of their electricity use to non-peak times. It can delay the significant investment required to expand supply side capacity and to improve the efficiency of network infrastructure. A summary of demand management approaches is listed in the table below:[[27]](#footnote-27)

**Table EX2: Summary of demand management approaches**

| Approach | How it works |
| --- | --- |
| Cost-reflective pricing | Charging customers different amounts for their consumption at different times of the day or year, reflecting the varying costs of delivering electricity at different times of year. These price signals could shift consumption away from the peak. |
| Residential direct load control programs | Networks, retailers (with the agreement of customers) or customers automating the response of household appliances such as air conditioners during network or wholesale ‘peak’ events. |
| Industrial and commercial load management contracts | During ‘peak events’ and subject to pre-agreed terms, industrial or commercial equipment is turned down or off by a network or retailer, or an aggregator working on their behalf. Usually the user can opt out at some cost (based on pre-agreed terms). |
| Distributed generation | The production of electricity close to its point of consumption, such that it does not need to pass through all or any of the network. A variant on this is ‘fuel substitution’, in which customers are switched from electric to gas appliances. |
| Energy efficiency | Lowering the electricity demands of appliances, including during peak events. |

Cost reflective pricing and direct load control both provide direct ways to address the costs of peak demand.

## Focus of the Regulation Impact Statement – smart appliances

This RIS only examines the case for including a demand response capability in selected appliances. (Appliances with such capability are sometimes called ‘smart appliances’ because they are compatible with ‘smart grid’ operation). This capability would allow appliance owners who wish to do so to participate in demand side management either through direct load control or by programming their smart appliances to respond to cost-reflective pricing.

Pricing responses to peak demand are being addressed through SCER, whereas this RIS is being undertaken for the SCCC. Consequently, this RIS only addresses the issue of mandating a smart appliance interface for key appliances. On their own, smart appliances may not fully address the issue of peak demand, but can support and complement other approaches.

### Australian and New Zealand Standard AS/NZS 4755

Work on a voluntary Australian Standard for smart appliances commenced in 2005. Standards Australia has now developed a standard for a demand response interface for appliances which does not require committing a product to a single mode of communication. This overcomes the problem that different utilities use different communications platforms. Leaving the mode of communication flexible lowers commercial risk for all stakeholders, including appliance manufacturers and energy utilities: any utility can connect to any appliance with the standard interface, and appliance manufacturers can realise the commercial value of the interface in any utility area.

An appliance complying with AS/NZS 4755 ‘Demand response capabilities and supporting technologies for electrical products’ (‘AS/NZS 4755’ or ‘the Standard’) must be capable of entering a limited set of ‘demand response modes’ (DRMs). The DRMs in AS/NZS 4755 include the ability (on receipt of a load control signal) to turn off/change to minimum load settings, limit load to 50 or 75 per cent, and shift load or store energy. If these capabilities are present and connected to a communications pathway via a demand response controller (‘the controller’) or a smart meter, the utility can instruct the appliance to reduce load during peak load events. Alternatively, the consumer can program the controller to enter a DRM when pre-set electricity price or other criteria are met (this behaviour is known as ‘price responsive’ demand response).

### Cost reflective pricing and direct load control

Studies such as those undertaken by the Productivity Commission on electricity network regulation[[28]](#footnote-28) indicate that direct load control of appliances and cost reflective pricing (either through time of use or critical peak pricing) are mutually reinforcing. These studies found that the availability of technology to automatically turn off, turn down or cycle appliances, or notify homeowners of critical peaks and other price information, increases the average response of consumers to cost reflective pricing.

The ability for consumers to participate in direct load control of appliances could also mean that lapses in their monitoring of prices or appliance usage would not expose them to unexpectedly high bills. This suggests that the availability of smart appliances is likely to increase the acceptance of cost reflective pricing. However, direct load control can also be successfully implemented without cost-reflective pricing.

Although this RIS does not assess options for cost reflective pricing, and the impact of the measure does not rely on cost reflective pricing, the RIS assesses how flexible pricing affects different smart appliance options.

## Objective

The objective of the proposal in this RIS is to contribute to reducing the future investment requirements for electricity network, generation and transmission infrastructure due to inefficient growth in peak electricity demand.

## Options

This RIS assesses the following options:

1. Take no further action, and rely on existing programs and policies;
2. Encourage the voluntary adoption of smart appliances through energy labelling and other incentives; or
3. Mandate the presence of demand response capabilities in the products which contribute (or are likely to contribute) most to peak demand.

### No further action – utilise existing policies

Under this scenario, compliance with AS/NZS 4755 for air conditioners and other appliances will not be mandated. Although there may be some one-off demand response initiatives, it is likely that any reduction on peak electricity demand will rely mostly on cost reflective pricing alone.

COAG’s endorsement of the SCER recommendation in December 2012 to phase in cost reflective electricity pricing may contribute significantly to addressing the peak demand problem. However, without mandated compliance with AS/NZS 4755 consumers would need to respond manually because automated demand response in major appliances is not likely to be available.

There may also be some benefits for peak demand from E3 energy efficiency measures for the products in question. However, programs to reduce the take-up of greenhouse intensive water heaters could increase peak load by shifting water heating load from off-peak to uncontrolled tariffs.

### Voluntary adoption through energy labelling and other incentives

In 2010 the E3 program changed the air conditioner star rating energy label to enable suppliers to indicate whether the model has a demand response interface that complies with AS/NZS 4755. Since then it has been open to air conditioner suppliers to voluntarily introduce compliant products and offer them to customers.

Cash incentive payments provide another means of encouraging buyers to voluntarily purchase an AS/NZS 4755 compliant products. At least one utility, Energex, is trialling up-front incentives for customers in designated areas who purchase smart air conditioners and have them activated on installation.[[29]](#footnote-29) Energex publishes a list of AS/NZS 4755-compliant air conditioners and retailers who can supply them.

### Mandate the presence of demand response capability

Under this option all air conditioners, electric and electric-boosted water heaters, pool pump controllers and electrical vehicle charge/discharge controllers intended for household use in Australia must comply with AS/NZS 4755. All of these appliances will therefore have to be sold with a built-in standardised interface, which will allow them to connect to a communications system and participate in demand response schemes. The interface is estimated to add about $10 to the retail price of these products.

## Impact Analysis

### Business as usual

#### AS/NZS 4755 not mandated

Under business as usual, an AS/NZS 4755-compliant interface will not be mandated. There would be no increase in the price of these appliances due to the costs of complying with the Standard, unless manufacturers voluntarily chose to include a compliant interface. However to date voluntary compliance has been minimal. Therefore, it is unlikely that there will be a sufficient number of appliances with a compliant interface to make it cost-effective for utilities to offer customers demand response through direct load control.

*Electricity pricing*

The December 2012 COAG decision to phase in cost reflective pricing could have a significant impact on peak demand. It is difficult to predict the extent of the impact, as small electricity consumers will be able to choose whether to opt in to time-based tariffs.

Over seven Australian trials of different pricing arrangements the average reductions in peak demand were between 13 and 40 per cent. When prices are considerably higher (through ‘critical peak’ pricing) during a declared peak event, the reduction in peak consumption is generally more than four times that under flatter ‘time of use’ tariffs.[[30]](#footnote-30) One disincentive for customers to opt in to critical peak pricing would be the risk that they may not have sufficient control over their energy use to ensure they are not liable to the higher energy costs at times of peak demand. Pricing on its own may not be enough to support an efficient consumption response. SCER states “many consumers have limited knowledge of and engagement with their electricity consumption and may not understand the new pricing structures sufficiently well to take advantage of new opportunities.”[[31]](#footnote-31)

#### E3 program measures

The E3 program has a number of policy measures in place that are aimed at improving the energy efficiency of air conditioners, water heaters and pool pumps. Electric vehicle chargers are an emerging area that is not currently regulated by the E3 program, but they may have a significant impact on peak demand in coming years.

#### Air conditioner energy efficiency

The E3 program has measures in place that are intended to increase the average energy efficiency of new air conditioners. These include energy labelling and minimum energy performance standards (MEPS), which last increased in October 2011.[[32]](#footnote-32) The rapid increase in the average energy efficiency of air conditioners in the past few years may have contributed to slowing growth in household energy, but has had no noticeable impact on the growth in peak demand from air conditioner load.

This is due to the increase in the proportion of Australian households which have installed air conditioners and the usage patterns of household air conditioners. Maximum demand occurs on the hottest days when most air conditioners are operating at the full extent of their capacity, irrespective of their efficiency.

#### Energy efficiency of pool pumps

The E3 program is investigating the implementation of energy labelling and MEPS for swimming pool pump-units. A transitional voluntary labelling program is in place, and a Consultation RIS on mandatory labelling and MEPS is in preparation.[[33]](#footnote-33) If these measures were implemented it could have some benefits for reducing peak demand, especially in summer.

#### Electric vehicle development

There is growing interest in the possibilities of electric vehicles in Australia and other countries. Their widespread adoption would almost certainly exacerbate electricity network constraints and peak demand problems. A home charger will have a peak demand of 6 to 10 kW, making it the highest energy consuming device in most homes. Without incentives to do otherwise, it is likely that users would initiate charging on their return from work, coinciding with the evening peak.

### Encourage voluntary adoption through energy labelling and other incentives

Encouraging the voluntary adoption of smart appliances has advantages. A voluntary scheme by nature is more flexible than a mandatory scheme. It is inexpensive as it doesn’t impose additional mandatory requirements or costs on suppliers. A voluntary scheme means that the inclusion of demand response capability in appliances can be market led rather than determined by government. Mandating a demand response capability in air conditioners and other appliances would represent a significant market transformation, given that currently there are a very small proportion of appliances with this feature.

The test for a voluntary scheme is whether it is effective. As the option of voluntary compliance with smart appliance standards has now been available for almost three years, it is possible to gauge the level of supplier response. The table below indicates that in November 2010 0.2 per cent of household size air conditioner models had the capability built in, and the rate had reached only 1.2 per cent by August 2011. If models which can be made capable with a separate part are included, the compliance rates were 11.4 per cent and 12.8 per cent respectively.

There was some increase in compliance in early 2012 due to suppliers wishing to take advantage of the rebate offer from Energex in Queensland, but the share of models with the capability built in is still less than 5 per cent. This indicates that voluntary compliance rates are very low.

**Table EX3: Air conditioners – rates of voluntary compliance with AS/NZS 4755.3.1**

| Demand Response Capability (all models <= 30 kW cooling) | November 2010 | | August 2011 | | August 2012(b) | |
| --- | --- | --- | --- | --- | --- | --- |
| Models | Brands(a) | Models | Brands(a) | Models | Brands |
| No Capability | 1,136 | 65 | 1,337 | 72 | NA | NA |
| Capability built in and ready to use | 3 | 1 | 19 | 2 | 53 | 3 |
| With addition of separate part | 143 | 5 | 178 | 6 | 178 | 6 |
| Total | 1,282 | 68 | 1,534 | 78 | 1,160 | NA |

Source: Extracted by Energy Strategies from E3 registration database, November 2010 and August 2011.

(a) Some brands offer models with different capabilities, so adds to more than total number of brands   
(b) Based on list of Energex rebate models at [www.energex.com.au/residential-and-business/rewards-for-air-conditioning-pools-and-hot-water/households/current-peaksmart-air-conditioner-models](http://www.energex.com.au/residential-and-business/rewards-for-air-conditioning-pools-and-hot-water/households/current-peaksmart-air-conditioner-models).

### Mandate the presence of demand response capabilities

Mandating a demand response capability in air conditioners and other appliances would mean that the majority of models would need to be redesigned, or packaged and supplied with additional components, to comply with the proposed regulation. Experience with changes to MEPS levels shows that when given sufficient notice, suppliers have been able to ensure that their new models meet more stringent MEPS requirements by the time the regulation takes effect.

Mandating the presence of AS/NZS 4755 interfaces on the identified appliances would ensure that the stock of smart appliances builds up to the critical mass needed to support utility demand response programs. Mandating compliance with the Standard would result in a much more rapid build-up of AS/NZS 4755 devices, so the cost-effectiveness threshold for the installation of communications infrastructure and the marketing of commercial offerings to consumers is reached more quickly.

A significant advantage of demand response through direct load control is that it can provide a fixed level of reduction in electricity demand. This ability to provide certain load reductions is also valuable when planning future expansion of the electricity supply network. With cost reflective pricing only, the reduction in demand at peak periods is less certain, so a risk of excess demand causing network outages remains.

#### Air conditioners

The regulation proposed under this option would require that all air conditioner models up to 30 kW cooling capacity, imported or manufactured after mid-2014, must either:

* have an AS/NZS 4755.3.1 interface built in and ready to use; or
* be capable of achieving AS/NZS 4755.3.1 compliance with the addition of a standard part, and the necessary separate part must be supplied with every model and the installation instructions must specify that the part must be installed.

About 230 of the air conditioner models registered at August 2012 (approximately 20 per cent of the total) are known to be capable of meeting the proposed regulation now.

The technical changes required to make an air conditioner model minimally compliant with the Standard are relatively minor. Given sufficient lead time, there is no technical reason why suppliers of air conditioners to the Australian market cannot make these changes. It has been estimated that the changes would increase prices by about $10 per unit. This represents less than 1 per cent of the $1,053 average retail price of household size models sold in 2009 (which averaged 5.7 kW cooling capacity).

Some air conditioners with AS/NZS 4755.3.1 interfaces will inevitably end up in aged care or commercial applications, where interruption of operation would be unacceptable. If so, the installer need not activate the interface. However the owner would still need to pay the additional cost, because every unit would be sold with an interface.

#### Swimming pool equipment suppliers

For pool pump-unit controllers (PPCs), most of the design and manufacture is done in Australia. Importers as well as local manufacturers were represented in the standards process that led to the publication of AS/NZS 4755.3.2, as were the pool industry associations. Given sufficient lead time it is expected that the industry will be able to adjust.

Nearly all pools have a main filtration pump. Some of these also operate additional functions, such as pumping water through rooftop solar heating panels. Where a single pump does filtration only, or filtration plus other duties, interruption during a DR event will cease all functions. This means that the cost of a single activated PPC will be set against the benefit of reducing not just the filtration load, but possibly other loads as well.

Some pools have multiple pumps, each serving a different load. In these cases the value of establishing demand response for pumps other than the filtration pump would be much lower. Therefore it may be cost-effective to exempt pumps that cannot be used for filtration from the requirement to have an integral AS/NZS 4755 interface.

Although the Standard is intended to apply to products generally used in the residential pool market, some may end up in commercial applications, where strict requirements on filtration and sanitisation make interruption of operation unacceptable. If so, the installer need not activate the interface. However the commercial operator would still need to pay the additional cost, because every unit would be sold with an interface.

#### Water heater suppliers

The Standard covering demand response requirements for electric and electric-boosted water heaters has yet to be published, although an advanced draft has been prepared. Publication of the draft standard is expected in early 2013. It will cover three main technology types: electric storage water heaters, solar-electric water heaters and heat pump water heaters.

Whether or not greenhouse intensive electric storage water heaters are phased out, smaller electric storage water heaters would remain on the market for apartment and commercial use. It is these smaller units, which are not suitable for off-peak tariffs due to their limited heat storage capacity, which will benefit most from direct load control using the Standard. The circuit between the appliance interface and the demand response controller requires voltages levels of no greater than 34.5 volts (V). Very few electric water heaters use voltages below 230 V at present but given sufficient lead time, there is no technical reason why the suppliers of electric, solar-electric and heat pump water heaters to the Australian market cannot make the necessary design changes.

#### Electric vehicle charger suppliers

This is an undeveloped market at present. A few vehicle manufacturers are importing small numbers of vehicles to test the market, and it is expected that these would have to be sold (or leased) with home rechargers, which are also likely to be imported.

There is considerable work still to be done to standardise plugs and other aspects of chargers. This provides a window of opportunity to incorporate AS/NZS 4755 requirements into the emerging standards framework. A working group has drafted the relevant part of the Standard, and publication of the standard is expected in early 2013. The working group includes several suppliers of electric vehicle charging services.

#### Electricity suppliers

The proposal would directly impact on the businesses of the distribution and transmission network service providers. These businesses are responsible for the infrastructure investment needed to accommodate growth in electricity demand and to maintain security and quality of supply.

There are a range of possible distributor responses to the build-up of AS/NZS 4755-compliant appliances in their supply areas, from ignoring them to providing cash incentives to customers to participate. The close involvement of several distributors and the Energy Network Association in the development of the Standard strongly suggests that many will support the purchase of appliances not just with minimal demand response capabilities but with higher capabilities. They may offer incentives to consumers for participation in direct load control programs, whether in the form of rebates for appliances, regular cash payments or access to more attractive tariffs. However the distributors would only take part in demand response programs if they can obtain a benefit, which would partly depend on the treatment of such schemes by regulators.

#### Electricity retailers

Electricity retailers do not directly bear the costs of network investment, but they do have to pay the distributors for use of the network. The other major part of their cost is wholesale energy. It may suit them to call demand response events at times when there is no network stress, but wholesale energy prices are high. At summer peaks, both conditions tend to be present.

While electricity retailers can also derive cost savings and business benefits from demand response, they will most likely have to negotiate with the network operators on operational issues and the sharing of costs and benefits. For example, it is possible that the retailers rather than the distributors will have to handle communications with customers regarding enrolment and ongoing participation in demand response programs.

#### Generators and system managers

Generators will be less directly impacted than distributors, transmission providers or retailers. However as demand response programs mature it is possible that energy retailers or demand response aggregators could bid load reductions into the electricity market in direct competition with generation.

The development of ‘smart grids’ and capabilities such as direct load control and ‘price responsive’ demand response (where the response depends on user behaviour at the time rather than demand response contracts) will require new approaches to system management. This means the cost of developing the new approaches will need to be incurred anyway. Mandating AS/NZS 4755 interfaces for appliances will not add to these costs, but growth in demand response participation will almost certainly influence the direction of system management.

#### Consumers

Incorporating AS/NZS 4755 interfaces would add less than 1 per cent of the price for air conditioners, electric and electric-boosted water heaters, and perhaps 2 to 3 per cent for swimming pool pumps and controllers. In contrast, retrofitting of an air conditioner to enable direct load control requires electrical re-wiring and could cost around $1,500.[[34]](#footnote-34)

The activation costs would be in the order of $50 to $180, but these are likely to be met by the electricity distributor or retailer in return for an agreement to participate in a demand response program. Participation will be voluntary, so households who choose not to do so will pay no activation costs and derive no direct monetary benefits. However, even non-participating consumers will benefit indirectly because network costs to all electricity users are expected to be lower than otherwise, assuming that a sufficient proportion of other consumers do participate. Consumer participation in demand response programs will be enhanced by the move to cost reflective pricing structures, which has been endorsed by COAG. Demand response can reduce the exposure of consumers to high electricity prices in peak periods.

Consumers who choose to participate in demand response programs could experience one or more events each year (most likely during summer peak days) when the appliances they have agreed to allow the utility to control will modify their operation. Trials show that householders are unlikely to notice operating changes at all during demand response events. If they do notice a change and wish to continue the appliance operation, the Standard provides for optional manual over-rides on products other than air conditioners.

### Cost benefit analysis

Costs and benefits have been projected for mandating compliance with the Standard for all products sold after a given date, and compared with the business as usual (BAU) case. For the purposes of cost-benefit modelling the implementation date is assumed to be June 2014.

The cost of adding smart appliance interfaces will be passed on to every buyer of that class of product. The economic benefit that would be created by the proposal comes from a reduction in the costs of the physical infrastructure needed to meet peak demand, compared to BAU. The quantum of net benefit is the difference between the value of infrastructure cost avoided and the cost of establishing and operating the direct load control system. An important benefit not quantified in this RIS (due to the need for extensive modelling of the electricity system) is the potential for direct load control capability to reduce wholesale electricity prices.

The tables below show the costs and benefits for three coverage scenarios:

1. A scenario where only existing electricity network communication platforms are utilised to support the roll-out of direct load control programs that utilise smart appliances. Coverage includes NSW, Queensland and Victoria only as these are the States known to already have communications platforms in place;
2. An intermediate or ‘constrained’ scenario – the States known to have existing communications platforms plus coverage of 50 per cent of WA and SA households over the projection period; and
3. Universal coverage throughout Australia. The December 2012 COAG agreement to encourage the market-driven competitive roll-out of smart meters and other advanced metering could result in extensive coverage over the projection period.

These three scenarios have been constructed purely to explore the range of possible costs and benefits. They do not, however, necessarily reflect the main drivers to the establishment and roll-out of direct load control programs. For example, uptake in Scenario A is assumed to be driven by the presence of an existing communication platform despite the fact that, as noted in section 5.3, the marginal costs of establishing a communications platform is very low. As such, it is very unlikely that a roll-out, even in worst-case scenarios, will be only confined to those states with existing communication platforms.

The best case table shows costs and benefits where the option to participate in direct load control is available from 2014, consumer participation is high and activation costs are low. Conversely, the worst case table shows where the option to participate in direct load control does not commence until 2018, consumer participation is low and activation costs are high.

**Table EX4: Costs and benefits of universal and constrained coverage – best case ($m)**

| Group | A. Existing coverage only | | | B. Constrained coverage | | | C. Universal coverage | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Costs | Benefits | Net | Costs | Benefits | Net | Costs | Benefits | Net |
| NSW, Vic, Qld | $765 | $9,144 | $8,379 | $765 | $9,144 | $8,379 | $765 | $9,144 | $8,379 |
| SA, WA | $21 | $0 | -$21 | $62 | $640 | $578 | $125 | $1,280 | $1,155 |
| Tas, ACT, NT | $6 | $0 | -$6 | $6 | $0 | -$6 | $47 | $367 | $320 |
|  | $792 | $9,144 | $8,352 | $834 | $9,784 | $8,951 | $937 | $10,791 | $9,854 |

**Table EX5: Costs and benefits of universal and constrained coverage – worst case ($m)**

| Group | A. Existing coverage only | | | B. Constrained coverage | | | C. Universal coverage | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Costs | Benefits | Net | Costs | Benefits | Net | Costs | Benefits | Net |
| NSW, Vic, Qld | $575 | $4,113 | $3,539 | $575 | $4,113 | $3,539 | $575 | $4,113 | $3,539 |
| SA, WA | $21 | $0 | -$21 | $56 | $334 | $279 | $111 | $669 | $557 |
| Tas, ACT, NT | $6 | $0 | -$6 | $6 | $0 | -$6 | $40 | $178 | $138 |
|  | $601 | $4,113 | $3,512 | $636 | $4,448 | $3,811 | $726 | $4,960 | $4,234 |

In the best case scenario with universal coverage, net benefits are estimated to be $9,854 million. The net benefit decreases to $8,951 million with constrained coverage, and $8,352 million when only the States that have been identified as having existing network communication platforms are covered. For the best case scenarios, benefit/cost ratios range from 11.5 to 11.7. In the worst case, the net benefit with universal coverage is $4,234 million. This decreases to $3,811 with constrained coverage and $3,512 million with coverage of the States that have been identified as having existing network communication platforms only. For the worst case scenarios, benefit/cost ratios are in the range of 6.8 to 7.0.

Because the States where communication platforms are already in place account for between 83 and 85 per cent of the total available benefits nationwide, the proposal would remain highly cost-effective even if there was no further development of communications platforms in any jurisdiction. Note that the minimum participation rate required to achieve a cost/benefit ratio of 1.0 in Australia is 2.5 per cent of air-conditioner-owning households by 2028. This means that net benefits can be obtained even with only a very modest roll-out of direct load control programs. The estimates are also consistent with the savings projections recently published in the Australian Energy Market Commission’s (AEMC) Power of Choice report.

However, in jurisdictions where direct load control programs are not established households would bear the small cost of the appliance interface but would not receive the benefits flowing through from deferred network investment. The net present value of these costs would be about $27 million in the ‘existing coverage only’ scenario, and $6 million in the ‘constrained’ scenario. These stranded costs are equivalent to between 0.1 and 0.6 per cent of the net national benefit.

#### Direct load control and flexible pricing

The cost-benefit analysis assumes that the adoption of time of use (TOU) tariffs and other forms of time-variable pricing remains low. Such tariffs are likely to become much more widespread following the December 2012 COAG announcement that provides for the phase in of cost-reflective retail pricing structures. If so, there is likely to be even greater acceptance of direct load control because customers could see the direct benefits of having their load managed. Further, electricity suppliers would have less need to persuade customers with incentives. Therefore assuming the present pattern of tariffs builds a conservative bias into the modelling.

By 2028, it is projected that the routine load reduction at summer maximum demand per NEM household (averaged over all households, including those not participating in demand response) will be between 0.26 and 0.48 kW. Utility trials have found that the expected reduction in peak load per household under TOU pricing alone is around 0.11 kW. Therefore the proposal would achieve 2½ to 4½ times the load reduction available from introducing universal TOU pricing for all NEM households. If the measures coexisted the impacts would not be additive, but TOU pricing would drive more customers to accept direct load control where available.

For network planning purposes, direct load control can ensure that the projected load reduction can be called when required. With TOU or critical peak pricing alone, there is no assurance that any given level of load reduction would be available during critical peak periods or in emergencies, so a level of risk remains.

*Impact on competition*

The development of the Standard has been broad-based and competitively neutral, in that most (in some cases all) of the manufacturers and importers of the affected products have participated directly. Many other companies have been represented via their industry associations. There is nothing in the standards that technically favours local manufacturers over importers, or vice versa. However, it can be costly for importers to develop products specifically for a small market like Australia.

It is possible that suppliers with longer product development lead times or longer overseas supply chains could have more difficulty in ensuring that all their models comply by the target implementation date. However, this should be addressed by ensuring suppliers have adequate time to implement the necessary changes.

Some suppliers may choose to withdraw from the market. If so, the number of models available on the Australian market could decline temporarily. This has been expected to occur whenever higher MEPS levels have been implemented for air conditioners, refrigerators and freezers in the past. However, post-implementation market analyses have found that changes of this kind have not produced lasting reductions in model range or consumer choice.

## Consultation

### Consultation so far

The level of awareness and preparedness of the appliance industry with respect to the proposal is comparable to that at the Consultation RIS stage of previous regulatory proposals for the implementation of MEPS for other products. Representatives of the electricity supply and air conditioner industries began meeting to discuss the problem of peak demand in February 2004. This informal grouping, which came to be known as the Australian Demand Management Forum (ADMF), included government agencies and air conditioner and electricity suppliers.

The ADMF group formed the nucleus of Standards Committee EL-054. The E3 program has participated in ADMF and in EL-054 from the beginning. The E3 Committee first alerted the air conditioning industry to the possibility that compliance with the Standard could be mandated in September 2005. Since then E3 representatives have held at least annual briefings in relation to progress on demand response. The industry associations and the six global brands represented on the Standards working group account for over 90 per cent of the retail market for household air conditioners in Australia.[[35]](#footnote-35) The possibility of demand response for swimming pool equipment was first raised by E3 representatives at a swimming pool industry forum in Melbourne in March 2005 and at a number of industry forums since then.

#### International engagement

As AS/NZS 4755 is the only standard of its type in the world, the E3 program is participating in International Electrotechnical Committee smart appliance processes with the aim of having AS/NZS 4755 adopted as an international standard. The Standard is already being used by a number of global air conditioner manufacturers, some of whom (Daikin and Electrolux) have publicly called for its adoption as an international standard.

The E3 program sponsored an APEC workshop on Smart Appliance Standards for Air Conditioners and other appliances, in Seoul in November 2011. This was attended by several global air conditioner manufacturers and several policy-makers from other countries. Further, Chinese electricity utilities have approached Standards Australia and E3 representatives to seek further information on the Standard, with a view to its possible adoption in China.

#### Consultation to occur

Consultation with major stakeholders on this RIS is planned for the first half of 2013. Consultation sessions are planned for both Australia and New Zealand.

#### Questions for stakeholders

The major questions to be asked in consultation include:

* Do you support the proposal to mandate compliance with AS/NZS 4755 for the nominated priority appliances?
* Do you agree with the scope of the proposal (air conditioners to 30 kW, pool pump-unit controllers, electric, solar-electric and heat pump water heaters, and charge/discharge controllers for electric vehicles)? If not, what products would you propose be included or excluded, and why?
* What is your estimate of how much the cost of compliance will increase the price of each product?
* Do you agree with the estimates of the dollar values of the benefit of deferring capital expenditure by reducing peak demand? Do you have any other estimates (if so, please provide the source)? What proportion of future network expenditures are expected to be attributable to peak demand, as distinct from asset replacement and other causes?
* Do you think the estimated pathways cost is reasonable, or do you have other estimates?
* Do you think the proposal would reduce competition among product suppliers, reduce consumer choice or lead to an increase in product prices (beyond what is expected to occur due to the cost of the interface)?
* In regard to the regional aspects of the scheme do you consider that the proposal will provide significantly more benefits to certain regions? If so, which ones? Will any regions be largely unaffected by the proposal? If so, which ones? What causes these differences in impacts between regions?

## Implementation

Implementation involves mandating that all air conditioners, electric and electric-boosted water heaters, pool pump controllers and electrical vehicle charge/discharge controllers intended for household use must comply with AS/NZS 4755. It would not be necessary to mandate compliance with the full range of demand response capabilities of the Standard – only that appliances must all be sold with a standard physical interface and must be capable of demand response to switch off load when instructed to do so.

Mandating the presence of the AS/NZS 4755 interface on appliances does not mean that owners of those appliances would be obliged to make use of those capabilities. It would be up to appliance owners to decide whether to enter demand response and load control arrangements with their electricity suppliers or with other commercial intermediaries.

The activation of the AS/NZS 4755 capabilities of an appliance requires the presence of a communications platform, a controller or a smart meter, and the necessary connections (wireless or cable) to complete the communications pathway to the interface of the smart appliance.

The interface on the appliance would accept a range of pathways. Appliances already compliant with AS/NZS 4755 would not need to be changed, and when an appliance reaches the end of its service life its replacement can be connected to the existing receivers or cables. The cost of connecting compliant appliances to an activation pathway would be predictable and low, as distinct from unpredictable and high, as is the case at present.

## Conclusion

The analysis in the RIS indicates that by itself demand response provides net economic benefits. The modelling projects that demand response could permanently offset 3 to 5 years of peak demand growth. If the benefits were passed on to all householders, it could support a reduction in electricity bills of $60 to $120 per household per year, from 2014 to 2028.

A key advantage of demand response is that it can provide fixed reductions in electricity demand as required. With dynamic pricing alone, the amount of demand reduction that will occur in peak periods is less certain. However, an approach that includes both dynamic pricing and demand response is likely to be most effective. This approach would provide the greatest net benefits, as direct load control and flexible pricing are mutually reinforcing. Cost reflective pricing, for example, would provide additional incentives for households to actively participate in a smart appliance scheme. The December 2012 announcement by COAG to phase in efficient and cost-reflective retail energy prices by July 2014 therefore provides further impetus to the proposal.

Thus the RIS recommends that the preferred option of mandating compliance with Australian Standard AS/NZS 4755 be adopted.

## Recommendations

In light of the analysis in the RIS it is recommended that:

* 1. All air conditioners (up to 30 kW cooling capacity), electric, solar-electric and heat pump water heaters, pool pump-unit controllers and electric vehicle chargers manufactured in or imported to Australia after June 2014 should be equipped with AS/NZS 4755 smart appliance interfaces.
  2. For air conditioners, the measure should be implemented by mandating compliance with the AS/NZS 4775.3.1:2012 Interaction of demand response enabling devices and electrical products—Operational instructions and connections for air conditioners.
  3. From the implementation date, all air conditioners within the scope of AS/NZS 4755.3.1 should be ‘demand response capable’ within the meaning of AS/NZS 3823.2:2009 Performance of electrical appliances—Air conditioners and heat pumps; i.e. fully compliant with AS/NZS 4755.3.1 without the need to purchase further parts or components.
  4. For pool pump-unit controllers, the measure should be implemented by mandating compliance with AS/NZS 4755.3.2:2012: Interaction of demand response enabling devices and electrical products—Operational instructions and connections for swimming pool pump-unit controllers.
  5. For electric and electric-boosted water heaters, the measure should be implemented by mandating compliance with AS/NZS 4755.3.3 Interaction of demand response enabling devices and electrical products—Operational instructions and connections for electric and electric-boosted water heaters (forthcoming).
  6. For electric vehicle chargers, the measure should be implemented by mandating compliance with AS/NZS 4755.3.4 Interaction of demand response enabling devices and electrical products—Operational instructions and connections for charge/discharge controllers for electric vehicles (forthcoming).
  7. To maximise the probability that AS/NZS 4755-compliant appliances will be activated effectively and rapidly, governments should ensure that AS/NZS 4755 standards for demand response enabling devices are finalised as soon as possible.
  8. Governments should work with the electricity supply industry to promote to appliance buyers the value of higher levels of demand response in appliances (above DRM1, the minimum mandatory level).
  9. To support the above, governments should implement the mandatory disclosure of demand response capability levels in point of sale information (on energy labels or by other means).
  10. Governments should commence a review of progress on large scale residential sector demand response and direct load control programs, not more than 3 years after implementation of the proposed measure.

Attached is a supplementary report providing a much more detailed and thorough analysis of the problem and the impacts of options to address the problem.

## Submissions on this Consultation RIS

Submissions are invited on any of the material in this RIS and the Supplementary Information, but particularly the following questions

1. Do you support the proposal to mandate compliance with AS/NZS 4755 for the nominated priority appliances? Please give reasons.
2. Do you agree with the scope of the proposal (air conditioners to 30 kW, pool pump-unit controllers, electric, solar-electric and heat pump water heaters, and charge/discharge controllers for electric vehicles and other storage devices)? If not, what products would you propose be included or excluded, and why?
3. What is your estimate of how much complying with the Standard will increase the price of each product?
4. Do you agree to the estimate of the dollar value of benefit from deferring capital expenditure by reducing peak demand? Do you have other estimates (if so please provide source)? What proportion of future network expenditures are expected to be attributable to peak demand, as distinct from asset replacement and other causes?
5. Do you think the estimated pathways cost is reasonable, or do you have other estimates?
6. The RIS considers that the communications infrastructure needed by electricity utilities to be able to offer demand response and direct load control service to customers will be either zero (using either existing ripple control systems or smart meters to be installed in any case) or low (e.g. FM radio control). Do you agree? If not, can you provide estimates of the costs?
7. What implications (positive or negative) would the proposals have for your industry, in terms of activity, profitability and employment?
8. What can appliance suppliers, installers and energy utilities do to facilitate customer enrolment in direct load control or demand response programs?
9. Do you think the proposal would reduce competition among product suppliers, reduce consumer choice or lead to an increase in product prices (beyond what is expected to occur due to the cost of the interface)?
10. If the measure is implemented, which of the target implementation dates (mid 2013, mid 2014 or other options) do you prefer, and why?
11. Do you consider that there are any major technical or functional issues related to the proposal? If so, how should these be addressed?
12. How will the proposal impact on electricity prices and energy network costs and investment requirements?
13. Do you think that the effectiveness of the proposal depends on the implementation of more cost-reflective pricing, e.g. time of use (TOU) tariffs?
14. Do you agree with the specific recommendations in the RIS? If not, please address comments by the numbered recommendation?
15. In regard to the regional aspects of the scheme do you consider that the proposal will provide significantly more benefits to certain regions? If so which ones? Will any regions be largely unaffected by the proposal? If so which ones? What causes these differences in impacts between regions?
16. (To electricity network service providers and electricity retail companies specifically). Is it your company’s intention to offer tariff or other incentives for customers to have demand response interfaces on the appliances in question, activated and to participate in demand response programs? Are there any specific barriers (or lack of incentives) that would prevent your company from offering and promoting such programs?
17. (To energy utilities and all respondents). In your opinion, what proportion of householders with AS4755-compliant appliances will have the demand response interfaces on the appliances activated and will participate in demand response programs? Do you have survey or other evidence to support your view?
18. (To consumer and welfare organisations). In your opinion, what measures should be taken to ensure that consumers are adequately informed of the potential costs, as well as the benefits, of entering contracts that enable the demand response capabilities on their appliances to be activated?
19. (To electricity price regulators). Do you consider that the regulatory arrangements provide utilities with an incentive to participate in a smart appliance scheme rather than invest in additional infrastructure in response to peak demand?

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**Making a submission**

Written submissions should state ‘Mandating Smart Appliance Interfaces’ in the subject heading and should be sent to [energyrating@climatechange.gov.au](mailto:energyrating@climatechange.gov.au) by close of business Friday 3 May 2013.

[](http://www.energyrating.gov.au/)

SUPPLEMENTARY INFORMATION

CONSULTATION REGULATORY IMPACT STATEMENT:

Mandating ‘Smart Appliance’ Interfaces for Air Conditioners, Water Heaters and other Appliances

This report has been prepared to supplement the Consultation Regulatory Impact Statement by providing detailed analysis of the benefits and costs of the proposal.

## Glossary

| Term | Description |
| --- | --- |
| AC | Air conditioner |
| Activated load | The total electricity demand of smart appliances in which the interface is physically connected to the communications system of a remote agent |
| AEMC | Australian Energy Market Commission |
| AEMO | Australian Energy Market Operator |
| AER | Australian Energy Regulator |
| AIG | Australian Industry Group |
| AIRAH | Australian Institute of Refrigeration, Air conditioning and Heating |
| AMI | Advanced metering infrastructure |
| AREMA | Air conditioning and Refrigeration Equipment Manufacturers Association of Australia |
| AS | Australian Standard |
| Available load | The maximum electricity load of participating appliances that are likely to be on, or otherwise available for modified operation, during a DR event, given that some appliances will be off, or not capable of all DRMs |
| capex | Capital expenditure |
| CESA | Consumer Electronics Suppliers Association |
| CLC | Controlled load contactor (on SMs, as defined in SMIFS): high power relay intended to enable SM to manage for legacy off-peak load. |
| CLC/R | Controlled load contactor/Relay (on SMs, as defined in SMIFS): Functions to manage either CLC or CLR. |
| CLR | Controlled load relay (on SMs, as defined in SMIFS): voltage-free relay intended to link SM directly to an AS/NZS 4755 compliant appliance |
| Controllable load | The total electricity load from participating appliances which can be altered during a DR event (e.g. typically 50% of the actual load for air conditioners, if they are cycled on and off for equal time periods). |
| CPP | Critical Peak Price (electricity price) |
| DCCEE | Department of Climate Change and Energy Efficiency, |
| DEWHA | Department of the Environment, Water, Heritage and the Arts |
| DLC | Direct Load Control. An arrangement under which an appliance user authorises an electricity utility or other entity to modify the operation of the user’s appliances, within the context of a DR Program |
| DNSP | Distribution Network Service Provider |
| DR | Demand Response. The automated alteration of an electrical product’s normal mode of operation in response to an initiating signal originating from or defined by a remote agent. usually with the objective of reducing the product’s power demand (as defined in AS4755) |
| DR Program | An arrangement in which remote agents offer, and appliance owners/users may accept, contracts for remote agents (or users) to modify the operation of the appliance under agreed conditions for agreed recompense (monetary–e.g. lump sum payment or lower tariffs–or other) |
| DRM | Demand Response Mode (as defined in AS/NZS 4755) |
| DRED | Demand response enabling device |
| DSP | Demand side participation. The ability of consumers to make informed decisions about the quantity and timing of their electricity use |
| E3 | Equipment Energy Efficiency (Program or Committee) |
| EA | Energy Australia |
| EECA | Energy Efficiency and Conservation Authority (of New Zealand) |
| EER | Energy Efficiency Ratio (a measure the energy efficiency of air conditioners in their cooling mode) |
| ENA | Energy Networks Association |
| ESWH | Electric storage water heaters |
| EV | Electric Vehicle |
| FY | Financial year (FY 2014 is July 2013 to June 2014) |
| GPO | General purpose outlet (i.e. standard 10 amp power-point) |
| GSM | Global System for Mobile communications (mobile telephony standards) |
| HAN | Home area network |
| HH | Household |
| HPWH | Heat pump water heater |
| IHD | In-Home Display |
| kW | kilowatts |
| MD | Maximum Demand |
| MW | Megawatts (kW x 1,000) |
| NEM | National Electricity Market |
| NEMMCO | National Electricity Market Management Company |
| NSSC | National Stakeholder Steering Committee (for Smart Metering) |
| NZEECS | New Zealand Energy Efficiency and Conservation Strategy |
| NZES | New Zealand Energy Strategy |
| OEM | Original Equipment Manufacturer |
| OP | Off Peak (electricity price) |
| opex | Operating expenditure |
| Participating load | The total electricity demand of appliances that are activated and where the owner/user has agreed to participate in a DR program |
| PPC | Pool pump controller |
| Remote agent | An electricity utility or other entity authorised by a user to modify the operation of the user’s appliances, within the context of a DR Program |
| SAI | Smart Appliance Interface – demand response interface as defined in AS/NZS 4755 |
| SCCC | Select Council on Climate Change |
| SCER | Standing Council on Energy and Resources |
| SELV | Separated Extra Low Voltage: An extra-low voltage system that is electrically separated from earth and from other systems in such a way that a single fault cannot give rise to the risk of electric shock. |
| SEWH | Solar-electric water heater |
| SG | Smart grid |
| SH | Space heater |
| SM | Smart meter (also known as AMI – Advanced Metering Infrastructure) |
| SMD | Summer maximum demand |
| SMIFS | Smart Meter Infrastructure Functionality Specification |
| TNSP | Transmission Network Service Provider |
| TOU | Time-of-use (electricity price) |
| TTMRA | Trans-Tasman Mutual Recognition Arrangement (or Agreement, or Act) |
| WH | Water heater |
| WMD | Winter maximum demand |

# 1. Background

The contribution of network charges to rising electricity prices, and the need to manage demand as well as supply, are major issues for both electricity market regulators and policy makers. This regulation impact statement deals with the technology of demand response, which provides a partial alternative to meeting the growth in peak demand.

The consumption of electricity in Australia is projected to grow strongly over the coming decades, driven by both economic and population growth. National electricity consumption is projected to increase at about 1.4% per annum (Table 1). The great majority of Australian electricity users are served by the National Electricity Market (NEM), which covers Queensland, NSW, ACT, Victoria, SA and Tasmania. WA and the NT have separate systems. The NEM comprises a wholesale market for electricity generation, regulated transmission and distribution networks (often called the ‘poles and wires’) and electricity retailers.

Under the intergovernmental Australian Energy Market Agreement, three institutions have responsibility for electricity market regulation and operation:

* The Australian Energy Market Operator (AEMO) is responsible for the day-to-day operation and administration of the electricity wholesale market in the NEM jurisdictions;
* The Australian Energy Market Commission (AEMC) is responsible for rule-making and market development in the NEM, reviewing the energy market framework and providing advice to the Standing Council on Energy and Resources (SCER);
* The Australian Energy Regulator (AER) is responsible for regulating the wholesale electricity market and for the economic regulation of the electricity transmission and distribution networks in the NEM. WA and the NT have their own regulators.

State and territory governments are responsible for regulating retail energy markets, and retail price cap regulation continues to apply in several jurisdictions. Several non-price regulatory functions have been transferred to a National Energy Customer Framework, administered by the AEMC and the AER, which commenced in July 2012.

Electricity prices were relatively stable until 2007, when prices began to rise substantially. The index of capital city household electricity prices rose from 94 in 2007 to 143 in 2011, standardised to 1990 prices (AER 2011). The AER attributes this mainly to rising network charges, driven by a mix of factors including continued growth in peak energy demand, stricter reliability and safety standards imposed by jurisdictional agencies, growth in customer numbers, the need to replace ageing equipment, and higher debt costs. In 2011 network charges accounted for between 41% and 51% of electricity prices in the NEM, wholesale generation costs for 32% to 42%, environmental and energy efficiency programs for 4% to 8% and retail costs for about 10% (AER 2011).

The *Draft Energy White Paper* published in late 2011 identified network charges as a major contributor to rising energy costs, and air conditioners as drivers of network charges:

‘Rising energy costs due to a range of factors is now a critical concern for households and businesses alike. Consumer use of energy-intensive appliances has increased sharply – for example, the number of air conditioners installed in the last five years has grown by 1.7 million or around 36 per cent – and has led to rising peak demand, which is contributing to the increasing cost of electricity’ (DRET 2011a).

The final *Energy White Paper* notes:

‘For example, while it may cost around $1,500 to buy and install a 2‑kilowatt (electrical) reverse-cycle air conditioner, such a unit could impose capital costs on the energy system as a whole of $7,000 when adding to peak demand’ (DRET 2012).

In its latest round of 5-year determinations, the AER approved total revenue of $46,550 million for distribution network service providers in the NEM (Table 1). This is equivalent to $914 per annum per customer (noting that about 88% of NEM customers are residential). The revenue is intended to cover operating expenditure, capital expenditure and return on assets.

## 1.1 SCER Work on Demand Side Participation

The Standing Council on Energy and Resources (SCER) has instigated a range of activities to address the issue of demand for energy.[[36]](#footnote-36) The objective is: ‘*To promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity through an optimal level of demand side participation.*’

As part of this package of activities, it is investigating:

* improving pricing and incentives – prices that reflect the cost of electricity and provide clear signals that encourage consumers to manage their demand; and networks that allow for and exhibit efficient levels of distributed generation and demand side response. These include smart meter and smart grid work programs to test, analyse and establish enabling technologies to support granular price signals.
* informing choice – to enable consumers to easily assess the costs and benefits of electricity consumption decision and access information about options to change consumption; and
* enabling technologies – technologies, skills and supporting frameworks to minimise the transaction costs of demand side responses and facilitate development of innovative services, including by non-traditional providers. These include direct load controls for air conditioners and other products that will support deployment of demand response enabled appliances.

Work already under way includes:

* *Power of Choice* review by the AEMC. The review considered all market and regulatory arrangements that impact on the electricity market including the National Electricity Rules, other national and jurisdictional regulations, commercial arrangements and market behaviours. It made recommendations for changes to the NEM to help consumers better manage their energy consumption and help consumers make informed choices about the way they use electricity and manage their bills. The final report was published in November 2012 (AEMC 2011c).
* *Inquiry into Electricity Network Regulation* by the Productivity Commission (PC 2012). The draft report was published in published in October 2012 (PC 2012).

The relevant findings in the final *Power of Choice* report of the AEMC and the draft report of the Productivity Commission are reported in Chapter 6 of this RIS.

## 1.2 Demand Side Interests of NEM Participants

The NEM and the WA electricity market comprise a range of agents with distinct market roles and with different opportunities and risks in relation to electricity demand. Generators with rapid-response plant (e.g. natural gas or hydro) can profit from system peaks because wholesale prices spike at those times. Retailers, on the other hand, bear the price risk at those times, at least from customers who are on flat tariffs (the vast majority of residential customers) or on time-of-use tariffs which are less than fully reflective of actual wholesale price variations. For this reason, most retailers hedge their risk exposure through long-term contracts with generators or by directly owning quick-response generation plant.

Transmission and network service providers face different risks. They have an obligation to maintain services at high levels of reliability, which effectively means providing sufficient infrastructure to meet the foreseeable peak demand on their network, unless they have a means of mitigating, off-setting or controlling that demand. Bringing on additional generation at times when the network capacity is at its limit is not an option. Indeed, many network constraints are local rather than system-wide, and occur at times when there is more than enough total generation available.

Therefore meeting local and system-wide peak loads is a more critical issue for distribution network service providers than for retailers. However, if network operators put in place the technical means to mitigate demand during peak load periods, there is nothing to prevent retailers from accessing that capability at other times under normal commercial arrangements, providing that this does not conflict with any contractual undertakings to customers (e.g. regarding the maximum number of occasions or hours that load many be controlled in any one year). Conversely, if the retailer invests in such a system, the network operator could contract to make use of it.

The AEMC *Power of Choice* inquiry recognises that the interests of NEM participants need to align if barriers to demand side technology (meters and controls) are to be overcome:

‘For example, evidence to date suggests that no single party has sufficient incentive to invest the upfront costs in installing smart meters. The benefits in terms of costs savings are likely to accrue across all parties, but should ultimately flow to the consumer. However, consumers do not have sufficient information to assess the costs and benefits, retailers do not have any certainty that they will retain a consumer long enough to recoup the costs of the meter, and distribution network service providers do not have the certainty that they would recover their investment through the price determination process. Some form of contract or agreement may be required so that costs and benefits can be apportioned across the parties’ (AEMC Fact Sheet 6).

# 2. The Problem: Electricity Peak Demand Growth

Electricity generation, transmission and distribution systems must be designed to provide high levels of reliability at all times including peak load periods, which in Australia generally coincide with the coldest and the hottest days of the year. As the extreme peaks are of relatively brief duration (hours at most, occurring on only a few days each year) the full capacity of the system is under-utilised for most of the time.

Table 1 is a typical ‘load duration curve’ for a network with a high concentration of domestic air conditioners, in this case the South West Interconnected System (SWIS) centred on Perth. The last 20% of capacity is used for less than 2.5% of the time, and the last 10% of capacity is used for less than 0.5% of the time, or about 40 hours per year.

This is not a short-term problem that will be resolved through normal growth in electricity consumption, or indeed through a slowing in the rate of growth in electrical energy use, as has occurred in recent years (AEMO 2012). The AEMO projects that in most regions of the NEM, both summer maximum demand (SMD) and winter maximum demand (WMD) will increase at a greater rate than ‘mass-market’ energy use (i.e. all energy use other than large industrial). It is the high variability of the mass-market load which causes peak load to exceed average load by such a wide margin.

This means that the load factor of the system (the ratio of average load to peak load: a key indicator of the economic utilisation of electricity infrastructure) will continue to fall in most NEM regions as well as in WA (Table 1). A fall in energy consumption below projected levels can exacerbate the problem, as under present regulatory settings and pricing structures the cost of meeting the peak would have to be recovered from lower sales. The introduction in mid 2012 of a price component related to the greenhouse gas-intensity of electricity supplied is likely to have a greater impact on the total amount of electricity used than on peak demand, so it may place further downward pressure on load factor.

Table 1. Projected annual rates of change: population, electrical energy use and peak demand

|  | A. Population growth rate  2011-2021 (a) | B. Energy annual increase rate 2012-22(b) | C. SMD annual increase rate 2012-22(b) | D. WMD annual increase rate  2011-22(b) | (C-B) SMD increase rate compared  with energy | $m 5 year distributor revenues approved by AER (e) |
| --- | --- | --- | --- | --- | --- | --- |
| NSW+ACT | 1.1 % | 1.1% | 1.2% | 1.2% | +0.1% | 18,779 |
| Victoria | 1.3% | 1.8% | 1.6% | 1.6% | -0.2% | 7,832 |
| Queensland | 2.0% | 2.2% | 2.5% | 2.9% | +0.3% | 14,821 |
| SA | 0.9% | 0.7% | 1.0% | 1.2% | +0.3% | 3,524 |
| WA | 1.9% | 2.9% (c) | 3.8% (c) | 2.9% (c) | +1.1% | NA |
| Tasmania | 0.6% | 1.1% | 1.1% | 1.1% | 0% | 1,594 |
| NT | 1.5% | 1.7% (d) | NA | NA | NA | NA |
| **Australia** | **1.4%** | **1.4%** | **NA** | **NA** | **NA** | **NA** |
| NEM Region | 1.3% | 1.3% | 1.6%(f) | 1.6%(h) | +0.3% | 46,550 |

(a) ABS 3236.0 Household and Family Projections, Australia, 2006 to 2031 (b) AEMO (2012a) medium growth rates in ‘mass-market’ energy use, unless otherwise indicated. (c) IMO (2011) (d) ABARE 2009 (e) Sum of current 5-year determinations; in 2009/10 dollars. See Appendix 1. (f) Calculated as 92% of sum of regional SMDs. (h) Calculated as 98% of sum of regional MWDs.

As part of the revenue determination process, the AER requests distribution network service providers (DNSPs) to indicate revenue requirements in standard categories, including return on capital, operating expenditure (‘opex’) and capital expenditure (‘capex’). Capex is further disaggregated into the investment required to connect new consumers, to replace assets at the end of their lives, to maintain power quality and reliability and to meet projected growth in peak demand. These estimates (summarised in Appendix 1) provide the best information publicly available of the investment in distribution infrastructure required solely or primarily to meet rising peak demand. It is estimated that capex to meet peak demand growth accounts for about $2,500 million per year, or 27% of the total DNSP revenue requirement in the NEM. This excludes WA and NT.

Comparison of the expenditure with the DNSPs’ own projections of growth in maximum demand over the same period indicates an average investment cost of about $2,845 per kW of increase in peak load across the NEM, or about $280 per electricity customer per year. The cost varies significantly by state, from about $3,500/peak kW in Queensland to $500/peak kW in Tasmania (Table 9).

In WA, NT and in all NEM regions other than Tasmania, SMD is significantly higher than WMD, indicating that cooling rather than heating is the main contributor to system peak load. Summer peak loads tend to occur on the days when the use of household air conditioning is at its highest. This is illustrated by the significant difference in load between summer days of relatively moderate temperatures and days of high temperature (Figure 2). While the shapes of the load curves and the difference between moderate and peak days vary, the same patterns are apparent in all the summer-peaking parts of the NEM (DRET 2011a).

A study commissioned by the AEMC to review the drivers for peak demand growth in the NEM concluded: ‘In summary, the experience of DNSPs appears to support a hypothesis that the network peak is driven by residential peak demand factors, specifically the increasing use and penetration of air conditioners. The rapid uptake of air conditioners in residential dwellings is noted as a principle driver of peak demand growth across networks in the NEM and a major driver of capital expenditure’ (E&Y 2011).

The proportion of Australian households with at least one refrigerative air conditioner was fairly steady at around 25% through the 1990s, and then surged to 43% between 1999 and 2004 (EES 3008). It reached 56% in 2010 and is projected to exceed 70% by 2020. At the same time, the average capacity and electrical power of air conditioners installed is increasing.[[37]](#footnote-37) Each additional air conditioner contributes to the continuing rise in peak demand, even allowing for the fact that 30% (Swift 2005) to 35% (CRA 2006) of units are off during peak load events. The average investment in network infrastructure required for each new air conditioner on the NEM is about (2.1 x 70% x $2,845 = $4,180), where 2.1 kW is the average peak electrical capacity of split unit air conditioners installed in existing homes (Table 10), and 70% is the probability of operation during extreme peak periods. Present electricity pricing structures are not able to reflect this, as explained in the next section. The lack of energy price signals has been one of the reasons for the phenomenal growth in air-conditioner driven peak demand.

Even though household air conditioners are responsible for a large proportion of peak load on very hot days, it is often possible to reduce other loads during those periods so that the overall peak is somewhat reduced. Every kW reduction in load at those times is of equal value. Most utilities have standing arrangements with large industrial or commercial customers, on whom they can call in advance to curtail load when peaks are expected. The AEMC has factored load reductions from these sources into its projections (Table 1), and it is expected that they would continue irrespective of how the residential load develops.

Figure 1. Typical load duration curve, indicating network capacity utilised over a year

Description: Percentage of the load carrying capacity of a typical electricity network that is utilised over the number of hours in year. At no time is less than 38 percent of the capacity used.  Capacity utiliisation exceed 80% for only 2.5% of the year (220 hours) and 90% for only 1% of the year (88 hours).  

Description: The electricity load in Megawatts (millions of watts) for 24 hours for the town of Victor Harbour in South Australia. The load curves for two separate days in January 2009 are superimposed. The load for the 'normal day' peaks at 12.30 am at 15 Megawatts and does not exceed 9 Megawatts for the rest of the day. The load for the 'peak day' also has a peak at 12.30 am then dips and rises gains froms 6 am, peaking at 24 Megawatts at about 6 pm.  Figure 2. Typical impact of air conditioning load on summer maximum load

Source: Wessex Consulting 2011

## 2.1 Approaches to addressing the problem

There is a range of possible approaches to dealing with the issue of projected increases in peak demand, and in particular the contribution of household air conditioning to those increases. These approaches involve a range of inter-related pricing, regulatory and technology initiatives, summarised in Appendix 2. One of their main objectives is **to contribute to reducing the future investment requirements for electricity network, generation and transmission infrastructure caused by growing peak demand, and so contribute to containing the total cost of electricity supply to consumers.**

With regard to residential and small business consumers, four of the approaches available for government consideration are:

1. Continue with current electricity pricing approaches and raise sufficient revenue to meet projected peak load increases by supply investments alone (i.e. continue Business as Usual);
2. Introduce more cost-reflective pricing and raise sufficient revenue to meet projected peak load increases by supply investments alone. The implementation of pricing changes is in the hands of governments and regulators, and would most likely be implemented in different ways and different time scales in each State and Territory. It is beyond the scope of this RIS to assess the cost and benefits of such pricing changes, although it is important to consider the effects, should they be implemented;
3. Continue with current electricity pricing approaches, but also encourage the take-up of demand response technologies which could reduce peak loads. The present RIS covers a key measure that would facilitate the take-up of demand response technologies, and which could be implemented using existing appliance legislation; and
4. Introduce more cost-reflective pricing *and also* encourage the take-up of demand response technologies.

These approaches address two forms of market failure, one negative and one positive:

1. The lack of price signals creates a negative externality, in that individuals do not pay the full cost of their decision to use an air conditioner. Specifically, air conditioner users only pay for the appliance and a flat tariff that which covers only a small part of the actual costs of its energy supply. Given that the appliances are used for short periods at high intensity, the cost of the additional generation, transmission and distribution capacity, which lies unutilised for most of the year, is paid by all consumers regardless of whether or not they have an air conditioner or whether they are careful to use their air conditioner out of peak times.
2. Even if the market failures above are addressed, and consumers were able to gain a price benefit from having smart appliances, they could not access this benefit unless a critical mass of consumers undertook the same behaviour. That is, for an individual consumer to benefit from having a smart appliance it is necessary for other consumers to also purchase smart appliances in sufficient quantities to make it feasible for energy providers to offer the scheme to all consumers. This may be described as a ‘network externality’ (a category of ‘positive externality’) where the utility an individual user derives from a product increases with the number of other users of that product.[[38]](#footnote-38)

These approaches form the context for the options which will be considered in the RIS.

### Business as Usual

Electrical energy use and peak demand are both potentially sensitive to prices, provided that these can be communicated to customers clearly and customers are able to respond. Larger consumers can choose maximum demand tariffs, which reflect their use of the network, as well as time-variable energy charges. In the household sector, which contributes most to the growth in SMD, pricing strategies have historically been simpler, partly due to metering limitations and partly due to the tendency of governments to shield householders from the full effects of geographical and time of use (TOU) variation in the costs of supply.

A standard ‘accumulation’ electricity meter can only record the total energy used since it was installed or reset, but not the TOU. Pricing must therefore be based on a single value: the kWh consumed between readings (although it is common to apply algorithms to this value so that tranches of consumption can be priced at different rates).

Simple metering technology can also be used to segregate certain loads by time, and remove them from the peak period. Most electricity suppliers offer ‘off-peak’ (OP) tariffs which utilise a second accumulation meter for the OP load – typically a water heater, but in some states also electric storage space heating or swimming pool pumps. In return for a lower tariff, the customer accepts the right of the electricity supplier to exercise direct load control (DLC) to restrict that appliance’s use of electricity to certain hours of the day.

The OP approach has been effective for loads where energy can be stored (e.g. in hot water or in a concrete slab) or for tasks which are not time-critical (e.g. pool filtration). However, current OP tariffs and metering cannot offer a moderated or reduced service during flexible control periods – only on or off on a regular daily schedule. This makes OP ineffective for air conditioners, because consumers are not willing to accept that their air conditioners could not be used at all between certain hours of every day.

The growth in air conditioner contribution to peak demand has taken place under existing pricing regimes, and without changes to those regimes or other interventions, there is no reason to expect that the growth will slow.

### More Cost-Reflective Electricity Pricing

In recent years some energy suppliers have introduced TOU, or ‘interval’ meters, which allow customers to use electricity whenever they want, but charge according to whether the energy is used during ‘peak’, ‘shoulder’ or ‘off-peak’ periods.[[39]](#footnote-39) While these are more reflective of costs than traditional flat tariffs, the peak rates are still only a fraction of the actual marginal costs of supplying energy during the most congested periods of the year, when wholesale generation costs alone can spike to $12.50/kWh[[40]](#footnote-40) and marginal distribution network costs are several thousand dollars per kW. Pricing at the full marginal rate, even if technically possible, would carry unacceptable risks for both customers and suppliers, because small miscalculations in pricing and in energy use during peak price periods could led to very large losses or gains to either party.

Some utilities have also experimented with ‘critical peak’ (CP) pricing where customers are given up to 24 hour notice (by telephone, mobile phone text message and/or email) of impending CP periods, typically on the eve of hot days when SMD events are expected. The energy rate during those periods can be $2/kWh or higher (EA & TG 2009).

Not all TOU meters are necessarily ‘smart’ meters, although all smart meters have TOU metering capability, as well as remote reading and communications capabilities. For Australia, these capabilities have been standardised in the *Smart Meter Infrastructure Minimum Functionality Specification* (SMIFS), which was endorsed by the Standing Council on Energy and Resources in December 2011 (SCER 2011).

This ministerial endorsement does not oblige any jurisdiction to introduce smart meters, but if they are introduced they must meet the SMIFS. Nor does the presence of a smart meter necessarily mean TOU electricity pricing. The data from smart meters can be used in the same way as if they were old-style accumulation meters. The Government of Victoria, the only jurisdiction so far to have mandated the introduction of smart meters, has reached an agreement with electricity distributors to delay the widespread introduction of flexible pricing rates until 2013, and even then customers will be able to choose to remain on a flat rate.[[41]](#footnote-41)

The extent to which TOU and CP prices actually impact on electricity use and peak demand depends on a number of factors:

* The willingness of consumers to adopt dynamic price tariffs, irrespective of the type of metering. If they cannot understand the tariffs because the structure is too complex, or consider that the risk of paying more during high-price periods exceeds the benefit of saving money during lower price periods (or the value of some other form of incentive), they are not likely to participate. In this respect TOU prices are much riskier for consumers than OP prices, which guarantee a lower tariff for certain end uses, and then require no further action (i.e. the supplier becomes responsible for control of that load). With TOU prices, there is no guarantee that the consumer’s average price will not rise, and consumers must take responsibility for their own load in order to gain any advantage.
* The ability of consumers to monitor energy use and prices. This is the main justification for ‘In Home Displays’ (IHDs). To take advantage of TOU tariffs consumers must be aware of when peak, shoulder and OP periods apply. For existing TOU tariffs the hours are generally fixed, although they still vary according to ‘work days’ and ‘non-work’ days. CP periods are not fixed, so response depends on knowing when CP periods are called. For fully dynamic prices – which change with wholesale generation prices and the state of the network – consumers would need a continuous indication of the price.
* The ability and willingness of consumers to respond to price signals.

The reductions in peak load observed from switching customers to TOU tariffs are fairly modest. An analysis by the DNSP Ausgrid showed an average reduction of about 4% in the maximum demand at time of peak for customers who were transferred from a standard flat rate domestic tariff to a TOU tariff (Futura 2011). This would represent a reduction of about 0.1 kW per customer at time of peak. The trial also showed some degradation of load reduction over time for the customers that transferred to the TOU tariff. Recent TOU tariff trials by Western Power also indicate a reduction of about 0.1 kW per customer at time of peak (Appendix 3).

The amplification of the TOU price signal through means such as in-home displays increases the effectiveness somewhat, although not necessarily by enough to offset the cost of the IHDs (ACEEE 2012). Recent trials of real-time pricing feedback in the USA, the UK and Ireland indicate customer reductions in peak load of between 5% and 7% (Appendix 3, Table 47). However, the percentage load reductions achieved on weekdays are about half that achieved by the same group on weekends, indicating that if people are not home they cannot respond. Eventually, even customers who are at home and potentially aware of price signals may tire of manual response, so the availability of automated response is a factor.

In a recent investigation for the AEMC of the efficient operation of price signals in the NEM, PricewaterhouseCoopers (PWC) concluded:

‘Technology has a significant role in enabling businesses to set efficient tariffs and for consumers to be able to respond efficiently to those tariffs... Technology may also assist consumers when they have time of use metering in overcoming some of the transaction costs involved in making efficient consumption decisions. This can occur where consumption decisions can be automated through, for instance, smart appliances’ (PWC 2011).

Overall, the introduction of cost-reflective pricing can change consumer behaviour, and partly help to avoid continuing growth in peak demand, although by itself it is unlikely to fully address the problem of peak demand. It provides less certainty to utilities than a scheme where demand response is automated.

### BAU Pricing with Demand Responsive Appliances

Demand response can mitigate the risk to consumers of accepting TOU pricing. A ‘demand responsive’ or ‘smart’ appliance is one which can automatically change its mode of operation in response to changes in electricity price, network congestion or emergency load-shedding signals. Consumers can either program demand response (DR) to activate when price or other pre-set criteria are met (‘price-sensitive DR’), or assign the control to an ‘external agent’ authorised by the consumer (‘Direct Load Control’, or DLC). The external agent may be the electricity distributor, the electricity retailer or some other service provider.

DLC delivers a much higher probability of load reduction than price-driven DR. If the load is under the control of the utility, this control can be factored into long term peak demand planning. While consumers can withdraw from either arrangement, or alternate between them, it is easier for them to modify or terminate price responsive DR than to withdraw from DLC. Furthermore, utilities have no way of directly knowing how many customers are practising price-driven DR, whereas they have a record of those who have signed up for DLC.

Developing a large scale DR capability can be an economically attractive way for DNSPs to address projected growth in peak demand, provided the marginal cost per peak kW avoided is lower than the marginal cost of building infrastructure to serve each additional kW of peak load. There is considerable scope for this as the marginal cost per peak kW supplied is so high (see previous section). Therefore, if DR can offer a lower cost option for meeting peak load, the network charges that all consumers must meet can be significantly lower.

At present the only mass-market DR options available to Australian utilities (beyond the already well developed OP water heating tariff) are effective, but too expensive to implement. Several utilities have undertaken DR trials for air conditioners in which the units are ‘cycled,’ or operated at a reduced level of service, during peak load events (Appendix 3). These trials have been technically successful, in that summer peak was significantly reduced and consumers found the cycling acceptable. The average load reductions achieved were in the order of 0.5 to 1.0 kW per participating household, compared with about 0.1 kW from TOU pricing alone.

The two main costs of implementing DR are the communications and control platform and the connection to the appliance. Some utilities were able to use relatively inexpensive platforms, such as pre-existing ripple control or FM radio network. However the costs of connection for existing air conditioners was very high, because of the great diversity in ages and types. In the trials, technicians had to carry a large number of components and parts, often had to break into the control circuits in a way that voided the manufacturer’s warranty (so transferring that risk to the utility), and found they could not access many units at all, so wasting many visits and further increasing the cost per effective connection.

Trials in Australia have also established that a high proportion of consumers can be motivated to participate in air conditioner DR programs in return for moderate one-off cash incentives, even if they are on flat tariffs and so would see no *tariff* advantage from participating.[[42]](#footnote-42)

Purchasing, connecting and activating demand–responsive appliances is a convenient way for customers to ensure that preferences are automatically carried out, just as purchasing energy-efficient appliances locks in energy savings without needing to change or be aware of behaviour every time a product is used.

Therefore, a combination of existing tariff structures and incentive payments for participation could potentially build up a stock of demand-responsive air conditioners which could be used to manage peak demand, as a (partial) alternative to investment in supply infrastructure. The barrier to this approach is that the technical DR options available at present are too expensive to make this course of action economic.

### Cost Reflective Pricing with Demand Responsive Appliances

If participation in DR programs can be made attractive to customers with flat electricity tariffs – as appears to be the case – then it should be even more attractive to customers on TOU and CP tariffs. There will be a direct monetary benefit to the consumer through the reduction of load in high price periods, so the need for separate monetary incentives should be much reduced, or perhaps avoided altogether.

Indeed, the availability of DR appliances is likely to increase the rate of acceptance of TOU tariffs, because the consumer’s risk of exposure to high-price periods can be limited. The consumer would no longer have to be home and/or constantly monitoring price changes on an IHD or perhaps a smart phone, and would not need to maintain the discipline of manually adjusting or switching off appliances, or of programming them to avoid peak-price periods.

If a TOU pricing regime is implemented using smart meters, these could act as the communications platform, so the only additional cost to the utility or the householder would be for connection of the appliances. However, if TOU pricing were implemented with non-communicating interval meters only, there would still be a need for a communications platform.

While the availability of TOU pricing would increase consumer interest in demand response, and if smart meters were rolled out this could reduce the costs of communications, the cost per physical appliance connection would still be too high. This makes it too expensive for most utilities to offer demand response options using current technology.

## 2.2 Discussion of approaches

The main approaches to addressing air conditioner peak demand are summarised in Table 2. These approaches form the context for the options which will be considered in the RIS

Under BAU there is currently no incentive for consumers to change their air conditioner use although such incentives may develop if more cost reflective approaches to pricing are implemented. The other approaches assist, in different ways and to varying degrees, towards the objective of ‘contributing to reducing the future investment requirements for electricity network, generation and transmission infrastructure caused by growing peak demand, and so contribute to containing the total cost of electricity supply to consumers.’

Table 2. Approaches to address air conditioner peak demand

| Approach | Tariffs | Demand responsive air conditioners available? | Potential effectiveness in reducing peak demand |
| --- | --- | --- | --- |
| 1 | Flat tariffs (BAU) | None | No broad demand response scheme, but some other approaches may have some effect. |
| 2 | Cost-reflective TOU/CP tariffs | None | Medium effectiveness |
| 3 | Flat tariffs | Yes – High cost only | Low effectiveness |
| Flat tariffs | Yes – Low cost | High effectiveness |
| 4 | Cost-reflective TOU/CP tariffs | Yes – High cost only | Medium effectiveness |
| Cost-reflective TOU/CP tariffs | Yes – Low cost | High effectiveness |

The introduction of cost-reflective prices would mean that the cost of using electricity on peak days would be more clearly signalled to those air conditioner users who opted to take (or were forced to take) them. If they modified their behaviour there would be some reduction in peak load, so to that extent a pricing strategy would contribute to meeting the objective. Equity would be increased because if consumers on TOU or CP tariffs did not modify behaviour, more of the cost which that behaviour imposes on the network would be borne by those who caused it rather than spread across all users. However, the extent to which even willing consumers could sustain changes in behaviour without automated demand response is limited.

Peak demand could be reduced even under present tariff structures if energy utilities were willing and able to recruit consumers to demand response programs. Trials have demonstrated that such programs are acceptable to consumers and can achieve durable reductions in peak load, but utilities are not willing to offer them beyond the trial stage because the costs are too high. If there were a low cost means of direct load control this would contribute significantly to meeting the objective of reducing peak demand.

Recruitment should be easier with TOU and CP tariffs, because there would be a clear monetary benefit in avoiding or reducing load during high-price periods. However, utilities face the same barrier – the costs of connecting customers to direct load control using current technology are too high.

The proposal in this RIS is aimed at reducing the costs of demand response and direct load control technology in air conditioners and other appliances. Other approaches to containing peak load – such as cost-reflective pricing – are outside the scope of the RIS.

In summary:

* The availability of low-cost demand responsive air conditioners would contribute significantly to reducing peak load under both current pricing regimes and with TOU and CP prices; and
* The availability of TOU and CP pricing is not a necessary precondition for the effectiveness of direct load control approaches, although the two are likely to be mutually reinforcing.

# 3. The Objectives of Government Action

The objective of the proposal can be restated as **‘to contribute to reducing the future investment requirements for electricity network, generation and transmission infrastructure due to inefficient growth in peak electricity demand.’**

The objective is a comparative rather than an absolute one. It is unlikely that any single approach could achieve it, and it is unlikely that that any single approach would be adopted by all utilities and stakeholders.

Increasing the availability of low-cost demand response technology – the subject of this RIS – would contribute to reducing peak demand and containing infrastructure costs, under either current tariff structures or under time-of-use prices. The introduction of TOU and CP prices is a separate matter, beyond the scope of this RIS but forms part of the context against which the achievement of the objective is assessed.

# 4. Options for supporting demand response

## 4.1 Barriers to adoption of demand responsive appliances

Supporting the development of low-cost demand response in air conditioners requires identifying and addressing a number of inter-related barriers to the development and wide availability to consumers of demand responsive (or ‘smart’) air conditioners:

* the availability of common technical standards;
* the willingness of appliance manufacturers to offer products meeting those standards; and
* the willingness of electricity network and other stakeholders to develop communications platforms to support those products.

Connection of a smart appliance to a communications-enabled electricity network requires a reliable pathway to transfer information. There are many possible pathways and all have their advantages, disadvantages and advocates. There is no single globally adopted system or standard for communicating with smart appliances, or even any single national system, and no evidence that any are emerging (see Appendix 4).

For appliance manufacturers to adopt a single means of communication and build it into all their products they would have to be confident that the product will have commercial value wherever it is sold. As long as there are competing technologies and a lack of standardisation, neither appliance neither manufacturers nor energy utilities can risk committing to a single approach.

The Commonwealth’s *Smart Grid, Smart City* report identifies lack of standardisation as a major barrier to the development of smart grid capabilities in Australia (DEWHA 2009), as did the Ministerial Council on Energy (predecessor of SCER) when it set up the National Stakeholder Steering Committee (NSSC) to develop smart meter standards:

‘MCE requests advice from the NSSC on recommendations to integrate this capability [demand response] into priority appliances. This analysis should be undertaken in conjunction with the existing appliance energy standards work currently being conducted by both the Equipment Energy Efficiency (E3) Committee of the National Framework for Energy Efficiency and Standards Australia.’ (MCE, 13 June 2008 Communiqué; see Appendix 5).

### Technical Standards and Related Issues

#### Australian and New Zealand Standard AS/NZS 4755

In order to overcome the barrier of multiple communications platforms Standards Australia has developed a demand response (or ‘smart appliance’) interface which does not commit a product to a single mode of communication. Leaving the mode of communication flexible lowers commercial risk for all stakeholders, including appliance manufacturers and energy utilities: any utility can connect to any appliance with the standard interface, and appliance manufacturers can realise the commercial value of the interface in any utility area.

An appliance complying with AS/NZS 4755 *Demand response capabilities and supporting technologies for electrical products* must be capable of entering a limited set of ‘demand response modes’ (DRMs). If these capabilities are present and connected to a communications pathway such as a demand response enabling device (DRED) or a smart meter, the utility can instruct the appliance to initiate demand response during peak load events (‘direct load control’). Alternatively, the consumer can program the DRED to enter a DRM when pre-set electricity price or other criteria are met (‘price responsive’ demand response).

The products covered and their DRMs are summarised in Table 3. While air conditioners are the most significant contributors to peak demand, Commonwealth, State and Territory government energy agencies and energy utilities requested that the standard also cover other products for which:

* DR could contribute to reducing network summer peak demand – i.e. swimming pool pumps, many of which operate during air conditioner-induced SMD events;
* DR could contribute to reducing winter peak demand, which is still the limiting factor in a significant proportion of local substations (see Appendix 1) – i.e. electric water heaters;
* DR would provide a mode of load control that is technically superior to the existing off-peak tariff. This applies to solar-electric and heat pump water heaters; and
* DR capabilities would forestall the development of future peak load problems – i.e. electric vehicle (EV) chargers.

The minimum capability required to comply with AS/NZS 4755 is DRM1, which is to turn off (or to change to minimum load settings) on receipt of a load control signal. This alone would enable a product to be ‘cycled’ by external control of the ‘on’ and ‘off’ periods. The ability to respond to other modes (DRM 2 to 8) is optional, and manufacturers would be free to make a commercial decision whether to provide them or not. DRM 2 and 3 are alternative ways to achieve load reduction that better suit certain types of product, so offer greater flexibility but no greater load reduction benefits than DRM1. The benefits that would accrue from widespread use of the other DRMs are identified but not quantified (Table 7).

AS/NZS 4755 is unique in that it is the first standard of this kind published, and is already being used by some air conditioner manufacturers in Australia. There are no comparable smart appliance interface standards available anywhere else in the world at present, so there is no possibility of conflict. Indeed, some global appliance manufacturers have publicly called for adoption of AS/NZS 4755 as an international standard, and Standards Australia has commenced action to this end.

Table 3. Demand response modes in AS/NZS 4755

| Product |  | Demand Response Modes (DRMs) | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| AS/NZS 4755 part | | Minimum load/off | Reduce load(c) | Load shift/ store energy | Discharge Energy | Do not discharge energy |
| Air conditioners | 3.1 (a) | | DRM 1 | DRM 2,3 | NA | NA | NA |
| Pool pump controllers | 3.2 (a) | | DRM 1 | DRM 2 | DRM 4 | NA | NA |
| Electric storage water heaters | 3.3 (b) | | DRM 1 | DRM 2 | DRM 4 | NA | NA |
| Solar-electric water heaters | 3.3 (b) | | DRM 1 | DRM 2 | DRM 4 | NA | NA |
| Heat pump water heaters | 3.3 (b) | | DRM 1 | DRM 2 | DRM 4 | NA | NA |
| Electric Vehicle chargers | 3.4 (b) | | DRM 1 | DRM 2 | DRM 4 | DRM 8(d) | DRM 5(e) |

(a) Published part. (b) Draft in preparation. (c) DRM6=limit load to 50%. DRM7=limit load to 75%. (d) Also DRMs 6 and 7 to constrain the rate of discharge. (e) Mandatory mode for products capable of discharge to grid.

#### Electricity Utility Intentions

The full potential benefit of smart appliances with AS/NZS 4755 capabilities will only be realised if electricity utilities or other commercial organisations connect the appliances and make use of their capabilities. The Energy Networks Association (ENA), and several of its members individually – Energex, ETSA, Ausgrid (formerly EnergyAustralia), Integral Energy, SP AusNet and Western Power – participated in the development of AS/NZS 4755. Some have indicated to the E3 Committee that the AS/NZS 4755 appliance interface will greatly facilitate their demand response activities.[[43]](#footnote-43) They also indicated this in their submissions to the AEMC inquiry on Demand Side Participation in the NEM.[[44]](#footnote-44)

In some states utilities are required to consider demand response strategies as part of their five-yearly price determinations. Energex and Ergon Energy, for example, are required by the Queensland Electricity Regulation 2006 (Qld) Section 127c, to submit a Demand Management Plan to the jurisdictional regulator (now the AER). As part of its 2010-2015 prices determination Energex has approval from the AER to undertake a number of demand management programs, in order to achieve up to 67 MW of peak load reduction from the residential sector by direct load control.

However, the effectiveness of a policy of supporting low-cost demand response in air conditioners is reliant on achieving minimum levels of implementation and participation, so the risks of not achieving those levels are covered in a later section

## 4.2 Smart appliance policy options

The first barrier to the availability of demand responsive air conditioners – the lack of a technical standard – has been addressed. The further policy options for government are:

1. Take no further action, and rely on existing programs and policies;
2. Encourage the voluntary adoption of smart appliances through energy labelling and other incentives; or
3. Mandate the presence of demand response capabilities in the products which contribute (or are likely to contribute) most to peak demand.

### No further action

In the absence of further action to promote demand-responsive products there would still be a number of programs under way which influence the peak load impact of air conditioners and other appliances. Some of these could help reduce peak load, even in the absence of further action, while others have a high risk of increasing peak load.

#### Air Conditioner Energy Efficiency

The E3 Program contains a number of measures intended to increase the average energy efficiency of new air conditioners, including energy labelling and minimum energy performance standards (MEPS), which last increased in October 2011.[[45]](#footnote-45) The rapid increase in the average energy efficiency of air conditioners in the past few years may have contributed to slowing growth in household energy, but has had little impact on the growth in peak demand from air conditioner load.

This is due to the patterns of use of household air conditioning in Australia (Appendix 6). Maximum demand occurs on the hottest days, when most air conditioners are operating at the full extent of their capacity, irrespective of their efficiency. While raising the energy efficiency of air conditioners even more rapidly (should that be possible) could lead to some reduction in summer peak demand below the BAU trend, it would be minor compared with that obtainable through demand response.

#### Phase-out of Greenhouse Intensive Water Heaters

State and Territory governments are working with the Commonwealth to phase out greenhouse gas-intensive water heaters.[[46]](#footnote-46) This would lead to a reduction in the stock of load-controlled electric off peak (OP) storage water heaters, and an increase in solar-electric and heat pump water heater numbers. If no specific action is taken to address peak load, this could add to peak loads, especially in winter.

#### Energy Efficiency of Pool Pumps

The E3 program is investigating the implementation of energy labelling and MEPS for swimming pool pump-units. A transitional voluntary labelling program is in place, and a Consultation RIS on mandatory labelling and MEPS is in preparation.[[47]](#footnote-47) If these measures were implemented it could have some benefits for reducing peak demand, especially in summer, but significantly less than obtainable through a direct load control strategy.

#### Electric Vehicle Development

There is growing interest in the possibilities of electric vehicles (EVs), in Australia and in other countries. Their widespread adoption would certainly exacerbate electricity network constraints and peak demand problems. A home EV charger will have a peak demand of 6 to 10 kW, making it the highest-power device in most homes. Without incentives to do otherwise, it is likely that EV users would initiate charging on their return from work, coinciding with the evening peak.

A strategy to manage electricity demand will be critical to the development of an EV industry in Australia. If not, there is a high risk that peak load constraints will inhibit the adoption of home-charged EVs (Standards Australia 2009). A recent study for the AEMC of the energy market impact of EVs reports:

‘…in the central take up scenario, unmanaged charging of EVs starts to have a significant impact on peak demand around 2020. This should allow sufficient time for the electricity market to plan and manage the additional increase in peak load that may be required. However, it is possible that take up could be much quicker…in which case the impact of EVs on peak demand, if unmanaged, could be felt as early as 2015…

If electric vehicle drivers can be encouraged to charge their vehicles in off-peak periods, either through incentivising customers to charge at off-peak times through time of use charging or smart metering, or enforcing off-peak charging through ripple control or regulation, the impacts fall significantly’ (AECOM 2012).

The study also estimates the that: ‘if charging is unmanaged and around 50 per cent of EV users come home and charge at peak periods, under the central take up scenario the cost of increased capacity in the NEM could be around $1.8 billion by 2020 and $4.6 billion by 2030. This equates to around $10,000 per EV, although the actual amount will vary by location and use profile.’

AS/NZS 4755 provides the only technical means currently available in Australia for managing the peak load impacts of electric vehicle charging, that is potentially effective in any utility area, with any metering system and any tariff arrangements.

### Encourage voluntary Compliance with Standards

#### Support voluntary compliance with energy labelling

The part of AS/NZS 4755 which covers air conditioners was originally published in 2008. Since then it has been open to air conditioner suppliers to voluntarily introduce compliant products and offer them to customers. Two levels of compliance are possible:

* Full compliance, without the need for purchase of additional parts or components; and
* ‘Potential’ compliance, where a product could be made to comply with the addition of a nominated standard part, which is not otherwise supplied with every unit.

To assist suppliers to market smart air conditioners, the E3 Program changed the air conditioner star rating energy label to enable suppliers to indicate whether the model complies with AS/NZS 4755 (Figure 14).

It may be possible to extend this strategy of voluntary compliance supported by mandatory energy labelling to some other products. A standard for the testing and energy labelling of swimming pool pump-units was published in 2008 (AS 5012). It would be possible to revise the pump-unit energy label to allow indication of whether that model complies with AS/NZS 4755, as is the case with the air conditioner label.

There is however, no present possibility of indicating the demand response status of the following products on an energy label:

* Pump-unit controllers not integrated into the pump-unit itself, which is likely to be the majority of smart controllers. At present there is no standard for labelling these products;
* Electric, solar-electric or heat pump water heaters. Although there are standards for energy performance testing products, and MEPS for electric storage water heaters, at present there are no standards for the energy labelling of these products; and
* EV chargers. There are no performance standards or other standards for these products at present.

While the absence of labelling could be addressed over time, there are other significant barriers to relying on energy labelling as the primary option for promoting smart appliances. Energy labelling is effective because any appliance buyer can readily calculate the monetary benefit of preferring one product to another, by multiplying the difference in annual kWh on the energy labels by the electricity price. If the buyer prefers the more efficient model the benefit starts to be realised as soon as the appliance is plugged in and used.

These conditions do not apply to labelling ‘smart’ appliance status. The benefit of preferring an appliance with this capability will only be realised if and when the capability becomes useful in lowering the customer’s energy costs. This will depend on a combination of both physical and contractual circumstances, which are not clear at the time of purchase, and which the buyer cannot be sure will ever eventuate. It will always be more difficult for a buyer to come to an understanding of the direct benefits of an isolated smart appliance purchase than the benefits of an isolated energy-efficient appliance purchase. Therefore energy labelling alone is not likely to create a significant purchaser-led demand for smart appliances.

The option of two levels of compliance for air conditioners adds a further level of uncertainty, both for buyers and for electricity distributors, who would be relying on the market reaching a critical mass of products to make demand response programs cost-effective for them. It would be difficult to know what proportion of air conditioners complied under which option – ‘demand response capable’ or ‘potentially demand response capable’. Large scale rollouts of demand response programs would still carry the risk that making new air conditioners fully ‘smart’ might require a second technician visit after the required part is obtained.

#### Energy labelling supported by incentive payments

Buyers are more likely to purchase an AS/NZS 4755 compliant air conditioner or other appliance if they are offered an incentive payment to do so. The logical source of the incentive payment is the utility which stands to reduce its future investment requirements as a result of controlling that customer’s load during peak periods. Provided the value to the utility exceeds the value of the payment (including the administrative costs) it is of benefit to all the utility’s customers, not just the recipient.

At least one utility, Energex, is trialling up-front incentives for customers in designated areas who purchase smart air conditioners and have them activated on installation.[[48]](#footnote-48) It publishes a list of AS/NZS 4755-compliant air conditioners and retailers who can supply them. The administrative costs of the program, and hence the effective costs per demand-responsive air conditioner connection, are not known. Whether the program will be cost-effective beyond the expenditure of funds already approved for demand management by the regulator is not known, but its continuation and extension to other areas is likely to depend on all new air conditioners eventually being equipped with AS/NZS 4755 interfaces so that it will no longer be necessary to offer incentives for customers to seek them out.[[49]](#footnote-49)

While local utility incentive programs should increase the take-up of smart appliances in the areas where they are offered, and for the duration of the offers, they are unlikely to create a permanent market shift to towards demand-responsive appliances throughout Australia. A sustained and near-universal incentive program may well have this outcome, but it is beyond the scope of the present proposal to require all utilities to develop such programs. However, greater availability of AS/NZS 4755 appliances would certainly improve the cost-effectiveness of such programs for utilities and so would increase the chance that more of them would offer incentives.

#### Impact of voluntary compliance to date

As the option of voluntary compliance with smart appliance standards has now been available for over three years, it is possible to gauge the level of supplier response. Table 4 indicates that in November 2010 barely 0.2% of household size air conditioner models had the capability built in, and the rate had reached only 1.2% by August 2011. If models which can be made capable with a separate part are included, the compliance rates were 11.4% and 12.8% respectively.

There was some increase in compliance in early 2012 by suppliers wishing to take advantage of the Energex rebate offer, but the share of models with the capability built in is still less than 5%. This indicates that voluntary compliance rates are low, and growing far too slowly to support utility peak load strategies based on demand response activations and contracts.

Table 4. Air conditioners: Rates of voluntary compliance with AS /NZS 4755.3.1

| Demand Response Capability (all models <= 30 kW cooling) | November 2010(a) | | August 2011(a) | | August 2012(b) | |
| --- | --- | --- | --- | --- | --- | --- |
| Models | Brands(b) | Models | Brands(b) | Models | Brands |
| No Capability | 1,136 | 65 | 1,337 | 72 | 929 | NA |
| Capability built in and ready to use | 3 | 1 | 19 | 2 | 53 | 3 |
| With addition of separate part | 143 | 5 | 178 | 6 | 178 | 6 |
| Total | 1,282 | 68 | 1,534 | 78 | 1,160 | NA |

Source: Extracted by Energy Strategies from registration database, November 2010 and August 2011.

1. Some brands offer models with different capabilities, so adds to more than total number of brands
2. Based on list of Energex rebate models at [www.energex.com.au/residential-and-business/rewards-for-air-conditioning-pools-and-hot-water/households/current-peaksmart-air-conditioner-models](http://www.energex.com.au/residential-and-business/rewards-for-air-conditioning-pools-and-hot-water/households/current-peaksmart-air-conditioner-models).

### Mandate Compliance with Standards

It would be feasible to mandate that all air conditioners, electric and electric-boosted water heaters, pool pump controllers and electrical vehicle charge/discharge controllers intended for household use must comply with AS/NZS 4755, so that their load could be controlled. It would not be necessary to target products intended for commercial use, because these tend to be purchased by more informed and energy price-sensitive buyers, have more sophisticated control systems and often interface with building energy management systems with a wider range of demand response capabilities than the AS/NZS 4755 interface.[[50]](#footnote-50)

It would not be necessary to mandate compliance with the full range of demand response capabilities of AS/NZS 4755 – only that appliances must all be sold with a standard physical interface and must be capable of demand response mode 1 (DRM1) – to switch off load when instructed to do so. DRM 1 can be used by a remote agent to ‘cycle’ an air conditioner (i.e. to alternate periods off and on, so that it continues to cool, but limiting its demand over the cycling period) or to switch it off entirely for the duration of an emergency.

Mandating the presence of the AS/NZS 4755 interface on appliances does not mean that owners of those appliances would be obliged to make use of those capabilities. It would be up to them to decide whether to enter demand response and load control arrangements with their electricity suppliers or with other commercial intermediaries.

The interface on the appliance needs to be connected to a communication system, or ‘platform’ before the appliance can receive external instructions and act on them (see Appendix 4). There are several pathways for this to occur (see Appendix 3). The electricity utility may use:

* a demand response enabling device (DRED) that connects directly to the interface;
* a Controlled Load Relay (CLR) on a smart meter, that connects directly to the interface; or
* a utility-controlled home area network (HAN), accessed through a smart meter.

The interface would accept all of these pathways. It would be possible to switch between pathways at a customer site in any sequence, according to the occupant’s preferences and whether/when a DRED or smart meter may be installed. The AS/NZS 4755-compliant appliances already there would not need to be changed, and when an appliance reaches the end of its service life its replacement can be connected to the existing receivers or cables. The cost of connecting appliances to an activation pathway would be predictable and low, as distinct from unpredictable and high, as is the case at present.

Supporting demand response for air conditioners represents the primary objective of the proposal. However, there would be significant additional benefit obtainable, at little additional cost, from mandating compliance with AS/NZS 4755 for the other products covered by the standard as well (Table 3). The potential benefits are:

* A much more rapid build-up of AS/NZS 4755 devices, so the cost-effectiveness threshold for the installation of communications infrastructure and the marketing of commercial offerings to consumers is reached more quickly in each utility area;
* The additional value of the DR and peak load reduction capability of those appliances (especially pool pumps and electric water heaters that are too small for OP tariffs);
* In the case of larger electric water heaters, a potential low-cost replacement to the traditional modes of OP tariff control such as ripple control, which are nearing the end of their useful lives in some areas;
* For solar-electric and heat pump water heaters, a more technically suitable form of control than simple OP (which completely de-energises the water heater, its pumps and its control electronics). This will increase in importance as the market share of these types increases;
* For EV chargers, insurance against the risk of rapid development of a peak load problem;
* Development of markets for the other demand response services supported by AS/NZS 4755: on-demand load shifting and discharge of stored energy.

Mandating the presence of AS/NZS 4755 interfaces on a wider range of appliances would ensure that the stock of smart appliances builds up to the critical mass needed to support utility demand response programs. On the basis of this assurance, the AER could not only assume that network operators would make use of AS/NZS 4755 capabilities, but could require them to do so where large scale demand programs represented a lower-cost means of addressing growth in maximum demand than the alternatives.

In 2010 MCE agreed to phase out greenhouse-intensive electric resistance water heaters from existing houses. Much of the market would shift to natural gas, but where gas is not available the use of solar-electric and heat pump water heaters would increase. As these types are less suited to OP operation than electric resistance water heaters, this change could add to peak demand, especially in winter, when solar-electrics often rely on their resistance elements.

The most effective strategy to avoid this would be to introduce smart solar-electric and heat pump water heaters. These could have access to electricity supply at all times except high-price or high-congestion periods, so would not need to be oversized to ensure that hot water can be supplied despite long periods of de-energisation. Under this strategy, the average size, cost and heat loss of water heaters could also be reduced compared with models designed for traditional OP tariffs. Smart appliance interfaces would also be valuable for the many small electric water heaters installed in Class 2 (apartment) dwellings, which are too small to use OP and cannot be phased out for the foreseeable future due to space and other constraints.

The proposed introduction of energy labelling and MEPS will mean that pool pump-unit manufacturers will need to change their model range. This gives an opportunity to lower the marginal costs of making other design changes at the same time, such as introducing smart capabilities for pumps with integral controllers.

The presence of an AS/NZS 4755 interface in all EV charge/discharge controllers would facilitate the development of the EV market. It would enable charging to take place at any time, and only be interrupted if there were a critical peak, an emergency or a high-price event. The alternative would be a much more restrictive charging and tariff regime. EV chargers (and other distributed electricity storage or generation devices) could also have a DRM8 mode, which enables the system operator to initiate discharge of stored energy back to the grid – once again, subject to the owner/user’s prior agreement to allow this mode to be activated. (Electric vehicle charging is further discussed in Appendix 6).

## 4.3 Evaluation of options

### Evaluation Criteria and Assessment

The policy options considered are:

1. Business as usual (BAU): no action beyond publication of a demand response standard;

2. Encourage the voluntary adoption of smart appliances through energy labelling, with the possibility of further support by incentive payments;

3. Mandate the presence of demand response capabilities in appliances.

The main evaluation criterion is whether the option would contribute to reducing the future investment requirements for electricity network, generation and transmission infrastructure, and so help to contain the total cost of electricity supply to consumers, by supporting the development of low-cost demand response technology.

A further criterion is whether the option would support or inhibit the achievement of other energy policy objectives, such as greenhouse gas reduction, facilitating electric vehicle development and maximising the benefits of public investment in smart grids and smart meters.

If no specific government action is taken, few smart appliances are likely to appear on the market. The voluntary adoption of smart appliance interfaces for air conditioners has been encouraged via mandatory energy labelling since 2008. It has not been successful in achieving its objectives. One reason is that buyers cannot be sure of the benefit of selecting a product with smart capabilities, unless and until a third party offers the required activation services and incentives to use them. Therefore this strategy will not meet the objectives

There is no reason to expect that indicating the presence of AS/NZS 4755 capabilities on energy labels for pool pump controllers, solar-electric and heat pump water heaters, and EV chargers would be more effective than it has been for air conditioners. Therefore the impact of the ‘voluntary implementation’ option is expected to be indistinguishable from BAU.

Offering incentive payments to customers to seek out and purchase AS/NZS 4755 air conditioners (from the relatively small model range now available) should increase the take-up of those appliances in the areas where incentives are offered, and for the duration of the offers, but they are unlikely to create a permanent market shift to towards demand-responsive appliances throughout Australia.

Mandatory compliance is likely to be the only option which would deliver a smart appliance capability in all products from a given date. It appears to be the only option which can change the economic and risk profile of utility demand response programs to the extent that large scale demand response become a realistic alternative to expanding infrastructure (Table 5).

Table 5. Likely take-up of appliances with smart interfaces under various options

|  | No specific action ( BAU) | Voluntary: Label smart capability | Mandatory: require compliance |
| --- | --- | --- | --- |
| Air conditioners | Negligible | Low | High |
| Electric water heaters | Negligible | Negligible (a) | High |
| Solar-electric water heaters | Negligible | Negligible (a) | High |
| Heat pump water heaters | Negligible | Negligible (a) | High |
| Pool pump-unit controllers | Negligible | Low (a) | High |
| Electric vehicle chargers | Negligible | Negligible (a) | High |

(a) Assuming that new Energy Labels or Smart Appliance labels can be introduced for these appliances

Table 6 summarises the impact of smart appliance capability on the realisation of greenhouse and energy efficiency objectives relevant to the appliances in question, as well as on the more general objectives of facilitating electric vehicle development and maximising the benefits of public investment in smart grids and smart meters.

Table 6. Impact of smart appliances on other energy policy objectives

| Energy Policy Objectives | Without smart appliances | | | With smart appliances | | |
| --- | --- | --- | --- | --- | --- | --- |
| Max demand benefits | Max demand risks | Energy storage benefits | Max demand benefits | Max demand risks | Energy storage benefits |
| Reducing emissions by increasing air conditioner energy efficiency | Some | None | None | More | None | None |
| Reducing emissions by phasing out emissions--intensive water heaters | No | High | Reduced | Yes | None | Maintained |
| Reducing emissions by increasing pool pump energy efficiency | Some | None | None | More | None | Some |
| Facilitation of electric vehicle development | No | High | Low | Yes | None | High |
| Realisation of benefits of public investment in smart grids, smart meters & TOU pricing regimes | Low | | | High | | |

Green cells indicate policy is assisted by smart appliance interfaces; yellow indicates neutral impact.

Table 6 shows that the presence of smart appliance capabilities:

* Increases the benefit in terms of the ability to control and limit peak electricity demand;
* Reduces the risk of inadvertently increasing peak electricity demand; and/or
* Increases the potential for energy storage at times of low electricity price or high availability of renewable electricity generation. The presence of an energy storage capability is not a central requirement of AS/NZS 4755, but would be left to the market. However, for a product that already has the required physical interface and DRM 1 capabilities, the marginal cost of adding other demand response capabilities is low.

The green cells in Table 6 indicate that smart appliances have a positive impact on that policy objective, and the yellow cells indicate a neutral impact. The presence of smart appliance capabilities has a positive impact in ten areas, is neutral in three areas and there are no areas where it impacts negatively. Therefore increasing the number of smart appliances supports these energy policy objectives.

### Options Modelled

The smart appliance options modelled should be considered in the context of the approaches discussed in Chapter 2, i.e. encouraging the take-up of demand response technologies under both current pricing structures and under time-variable pricing.

It is assumed that under Option 1 (BAU), the rate of adoption of smart appliances would be negligible, and may never reach the threshold levels (or ‘critical mass’) that utilities require to commit to rolling out demand response communications systems and offering direct load control contracts to consumers.

Option 2 (voluntary adoption) has already been tried with regard to air conditioners. While there has been a small voluntary take-up of AS/NZS 4755 smart appliance interfaces by some air conditioner suppliers, the concentration of products is only likely to reach threshold levels in areas where utilities offer relatively high incentive payments, only as long as those incentives are available, and only among buyers willing to purchase those few models and brands that are currently equipped with interfaces. There is no reason to expect that extending Option 2 to the other products under consideration would be more effective. Therefore the impacts of Option 2 are effectively indistinguishable from BAU.

The only Option guaranteed to lead to the installation of a critical mass of smart appliances within a predictable time period is Option 3 – requiring mandatory compliance with AS/NZS 4755 for all products sold after a given date. Therefore this is the only option for which costs and benefits can be projected, and compared with the BAU case. For the purposes of cost-benefit modelling the implementation date is assumed to be June 2014. Given the need for Governments to agree on adopting the proposal, and then giving a reasonable lead time for industry to comply, mid 2014 is probably the earliest feasible date.

# 5. Costs and Benefits

## 5.1 Overview of costs and benefits

Adding smart appliance interfaces to products will impose additional manufacturing costs, which will be passed on to every buyer of that class of product. Whenever an interface is ‘activated’ – connected to a communications system – its load becomes potentially controllable. It does not become actually controllable until customers connect the appliance to their own home energy management systems or consent to participate in a direct load control (DLC) program. In the latter case the appliance then remains controllable for the duration of the customer’s agreement. Estimating the number of customers participating at any given time is a key factor in projecting the total benefit (Appendix 7).

There are economic costs in establishing the physical pathways and in maintaining customer participation in DLC programs, even if DLC events are never called. Some of these costs are fixed, while others vary with the number of activations and participants. Conversely, there are economic benefits to the electricity supply system, some of which accrue even if a DLC event is never called. Every participating air conditioner represents a quantum of demand that can be reduced during a peak event, or shut off completely in an emergency. For network planning purposes this makes the development of smart appliance capability an alternative (or partial alternative) to the construction of supply infrastructure.

Some of these costs and benefits are quantified in this RIS, while others are described qualitatively (Table 7). Further details on quantitative costs and benefits are in Appendix 7.

The proposal would establish the basic technical conditions for demand response programs everywhere in Australia, once the growth in the stock of interface-equipped appliances becomes predictable, and these conditions would persist indefinitely into the future. There is no time limit on when local demand response programs could be initiated.

The rate and timing of activation of appliance demand response capability will depend on electricity suppliers or DR aggregators, and will vary from place to place according to local load profiles and network conditions. As the concentration of smart appliances rises and the costs of local connection programs falls, the rate of offerings and take-ups would be expected to increase.

Only DRM1 (which enables cycling on and off) will be mandatory for all appliances. Many products will also be capable of self-regulated part-load operation (DRMs 2 and 3 in Table 3). The strategy which electricity suppliers follow when exercising DLC will depend on the granularity of their control systems, i.e. whether they broadcast the same DLC signals throughout the network or whether they can call different groups of appliances in different areas. The simplest strategy during a peak event would be to call DRM 3 first, then DRM 2, then cycle DRM 1 (starting with, say, 20 mins off and 40 mins on and then increasing off-times until the load reduction required has been reached).

The more air conditioners that are equipped with DRMs 2 and 3, the more load reduction that can be utilised before needing DRM 1. Thus the presence of DRMs 2 and 3 increases the flexibility of response available, and may increase participation rates because consumers may be more inclined to enter a DLC contract if there is assurance of partial service during peak events. However, even if appliance makers do not provide DRMs 2 and 3 at all, modulated load reduction can still be obtained by varying the cycling periods using DRM 1.

The proportion of pool pumps, water heaters or EV charging devices that would be capable of DRM 4, which would enable them to use energy that may otherwise be wasted during times of high renewable energy availability, will also be up to the market. Therefore the value of energy storage or time-shift services cannot be quantified. The number of EVs or other energy storage devices that would be capable of DRM 8 and so provide grid support is also unknown, so the value cannot be quantified.

The green cells in Table 7 indicate the classes of benefit quantified in the present analysis. The yellow cells indicate additional benefits realisable at no additional cost, once the measure is implemented and the activation pathways and supporting systems are established. If the cost-benefit analysis indicates that the measure is cost-effective based on the quantified benefits alone (as appears to be the case) it is not necessary to quantify the additional benefits.

Table 7. Demand response costs and benefits quantified in this RIS

| Electrical Products | Costs | | Benefits | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Interface costs | Connection & activat-ion costs | Reduce wholesale price | Displace spinning reserve(a) | Reduce summer peak | Reduce winter peak (b) | Reduce peak period energy | Energy storage & time-shift | Return energy to grid |
| Air conditioners | Quantified | Quantified | Not quantified | Not quantified | Quantified | Additional value not quantified | Not quantified | NA | NA |
| Pool pump controllers | Quantified | Quantified | Not quantified | Not quantified | Quantified | Additional value not quantified | Not quantified | Not quantified | NA |
| Electric storage water heaters | Quantified | Quantified | Not quantified | Not quantified | Quantified | Quantified | Not quantified | Not quantified | NA |
| Solar-electric water heaters | Quantified | Quantified | Not quantified | Not quantified | Quantified | Quantified (b) | Not quantified | Not quantified | NA |
| Heat pump water heaters | Quantified | Quantified | Not quantified | Not quantified | Quantified | Quantified | Not quantified | Not quantified | NA |
| Electric Vehicle charge/discharge | Not quantified | Not quantified | Not quantified | Not quantified | Not quantified | Not quantified | Not quantified | Not quantified | Not quantified |
| Relevant DRMs |  |  | All DRMs | All DRMs | DRM 1,2,3 | DRM 1,2,3,4(c) | DRM 1,2,3 | DRM 4 | DRM 6,7,8 |

Green cells indicate quantified benefit. Orange cells indicate possible additional benefit.

(a) Spinning reserve is the practice of having enough turbine capacity spinning but not generating at all times, so that if the largest single generating unit on the grid at any time fails the spinning reserve can be engaged fast enough to avoid load shedding. The fuel needed to keep turbines spinning unloaded is much less than required to generate, but still significant (and reduces options for plant maintenance). If load is available for rapid reduction

via SAI-equipped appliances, spinning reserve can be reduced.

(b) For New Zealand, impact of DRM 1 on AC winter peak is quantified, but additional value for summer peak is not quantified.

(c) DRM 4 can be used to pre-boost solar water heaters, so avoiding winter peak-period boosting.

### Timing and Allocation of Costs and Benefits

#### Timing

The small additional cost added to the appliance price by the interface will be incurred by each appliance buyer at the time of purchase. The utility or DR aggregator will have to meet the cost of establishing a communications platform if one does not already exist. The great majority of the costs of the proposal will be incurred at the time appliances are ‘activated’, or connected to the communications platform. The timing, design and magnitude of participation incentives will be up to the activating agent. Where exposure to a TOU tariff provides sufficient participation incentive, the activating agent may or may not seek upfront capital contributions toward the cost of activation.

Whether smart appliances can be connected and controlled as soon as they are installed, or whether the benefits can only be realised once some threshold is reached, depends on a wide range of factors. If there is an existing communications platform such as the ripple control system in Queensland and NSW, smart appliances can be activated and controlled immediately. The Queensland distributor Energex is currently using some of its 118 available ripple control channels to successfully control AS/NZS 4755-equipped appliances in a Brisbane trial. Energex offers a $250 incentive for customers in the trial area for the purchase of AS/NZS 4755 air conditioners, and mails out a ripple-enabled DRED for the installer to fit at the time of installation. This responds to ripple signals immediately, so the benefit of each additional controllable load accrues to the utility progressively, as each product is installed.

If the interface becomes mandatory, it may be cost-effective for the utility to pay to install a DRED with every new air conditioner (especially if DRED costs fall, as Energex expects). The utility or an aggregator can then approach customers later for agreement to participate. There may still be advantage in targeting invitations to households served by problem substations, or in new housing areas where substation investments can be reduced if sufficient controllable load is acquired. Targeting allows the value of incentive payments to be maximised – otherwise customers around non-problem substations would also accept offers.

In areas without a pre-existing communications platform, it may not be cost-effective for the utility to set one up until it is confident that a threshold level of households will have at least one appliance with an AS/NZS 4755 interface. At the projected rate of air conditioner and water heater sales, it is expected that between a third and a half of all Australian households will have at least one product with an AS/NZS 4755 interface within 4 years of the interface being made mandatory.

The benefit stream has therefore been calculated in two ways for this RIS:

* with benefits realised ‘progressively’ from the first year of smart appliances availability (FY 2015), as appliances are installed and a proportion activated each year; and
* with benefits ‘deferred’ so that they only start to accrue from year 4 (FY 2018).

The benefits in the states with existing ripple systems are likely to be progressive (although the effects of deferment have also been calculated) but in other States they could be either progressive or deferred. Where smart meters provide the activation route, the most likely scenario is that utilities will offer DLC contracts district by district once two conditions are met: smart meters have been rolled out and there is a sufficient concentration of smart appliances to make a DLC contract offering in that area cost-effective. In Victoria, all homes are expected to have a smart meter by 2014, so if the interface is made mandatory, the second condition is likely to be met everywhere in that State after about 4 years.

The range of activation pathways available and the methods preferred by each distributor will vary. Each pathway has a distinctive cost profile, and costs also depend on whether the installation occurs at the time of building construction or in an existing dwelling (Table 12).

#### Allocation of Net Benefit

The economic benefit that would be created by the proposal comes from a reduction in the real costs of the physical infrastructure needed to meet peak demand, compared to BAU. The quantum of net benefit is the difference between the value of infrastructure cost avoided and the cost of establishing and operating the DLC system.

The timing and allocation of net benefits among customers is up to electricity distributors and their agents. The full net benefits could be passed on to all electricity consumers equally in the form of tariff reductions. Alternatively, a share of the benefits could be distributed in the form of cash incentives for demand response contract participants, so reducing the pool available for tariff or bill reductions.

Contracts would have to be designed so that the favourable tariffs or other incentives offered would be sufficient to motivate householders to participate. It is up to the distribution network service providers and their agents to devise the right balance of incentives to achieve the necessary participation rates. An example is given in Box 1.

The timing of costs and benefits is modelled as follows:

* The additional costs which the interface adds to the price of appliances is borne by consumers in the year in which those appliances are purchased;
* The costs of activating interfaces are incurred in the year the interface is activated (which may be at the time of appliance purchase or later);
* The benefit (in terms of avoiding the investment in peak load supply infrastructure that would be required to meet an uncontrolled load of that magnitude, after diversity) accrues in the year that the appliance is activated – whether that occurs in the year of installation (‘progressive’) or after a threshold of smart appliance concentration has been reached (‘deferred’). This is expressed as $/controllable kW.

In assessing the timing of benefits, it should be noted that AER determinations are forward‑looking assessments of the revenue required by the regulated distribution network service provider (DNSP) over the coming 5-year period. Part of the DNSP’s calculation is the projected CAPEX required to meet projected net increments in peak load in each year of the 5 year period. The DNSP will need to make an assessment of the quantum of load added each year (or each month) and the shape (whether constant or varying by time of day/season) less the quantum and shape of load retired. For domestic customers this may be modelled at the population or household level or at the specific appliance stock level (as in this RIS; for air conditioning load most DNSPs seem to do detailed stock modelling).

The modelling in the RIS mimics the capital requirement calculation that a DNSP would need to go through. If ministers adopt the proposal in, say, mid 2013 then all DNSPs preparing their capital cost projections after that time would be able to project with certainty the rate of accumulation of SAI-equipped appliances in their area during the next determination period, and so compare the (much reduced) costs of meeting peak load via a (partial) load control strategy as against a pure infrastructure build strategy. In fact recent changes to regulatory regime empower the AER (who would also be aware of the Minister’s decision) to require DNSPs to make those calculations annually, even during the determination period (see extract, below).

To the extent that the load control strategy led to a lower capital requirement, the total forward-looking revenue determination would be lower.

Before the Rule changes there would have been little scope for cost savings during already-existing 5-year determinations expiring after mid-2013, because the money will have been spent. This had little impact on the cost-benefit analysis in the RIS, which assumed that the projected availability of SAI-equipped appliances would be known to both DNSPs and the AER before the next regulatory periods, which are due to commence as follows: NSW and ACT (early 2014), SA (early 2015) Queensland (mid 2015), Victoria (late 2015) Tasmania (early 2017). However the Rule changes mean that the scrutiny is annual, funds not spent or spent imprudently can be clawed back, and there is now an obligation for DNSPs to consider demand side solutions.

The net present value (at mid-2012) of the stream of future costs and benefits is calculated using a range of discount rates: 7%, 3% and 11%.

Some studies treat the value of avoided investment in infrastructure as an annual benefit (e.g. Deloitte 2012), but the two approaches are essentially equivalent, once allowance is made for discount rates and the duration of the impact of the investment-avoiding measure. It is necessary to assume that the effect of the demand-side investment-avoiding strategy is accurately projected and that it is implemented as planned – just as it is necessary to assume the same for supply-side infrastructure investments.

Table 8. Examples of utility demand response program options

|  | Option A: No air conditioners have  AS/NZS 4755 DR interfaces | | | | Option B: All air conditioners have  AS/NZS 4755 DR interfaces | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Unit cost | % | Number | Total cost | Unit cost | % | Number | Total cost |
| Customers |  |  | 1000 |  |  |  | 1000 |  |
| Contact to ask if there is AC, and willing to participate | $10 | 100% | 1000 | $10,000 | $10 | 100% | 1000 | $10,000 |
| Number of air conditioner owners |  | 70% | 700 |  |  | 70% | 700 |  |
| AC owners giving positive response |  | 50% | 350 |  |  | 70% | 490 |  |
| Visit customer site | $25 | 100% | 350 | $8,750 | $25 | 100% | 490 | $12,250 |
| Check suitability for activation | $25 | 100% | 350 | $8,750 |  |  |  |  |
| Number suitable |  | 50% | 175 |  |  |  |  |  |
| Connect if suitable (includes hardware) | $250 |  | 175 | $43,750 | $150 | 100% | 490 | $73,500 |
| Total costs and participants |  |  | 175 | $71,250 |  |  | 490 | $95,750 |
| Total cost to utility per participant |  |  |  | $407 |  |  |  | $195 |
| kW controllable load gained (1 kW/unit at 50% cycling) |  |  | 175 | 0 |  |  | 490 | 0 |
| Value of infrastructure avoided (at $2,900/peak kW) |  |  |  | $507,500 |  |  |  | $1,421,000 |
| Net economic benefit of DR program to utility |  |  |  | $436,250 |  |  |  | $1,325,250 |
| Net economic benefit per participant |  |  |  | $2,493 |  |  |  | $2,705 |
| Net economic benefit per customer (participant or not) |  |  |  | $436 |  |  |  | $1,325 |
| Monetary incentive paid to each participant |  |  |  | $1,000 |  |  |  | $1,000 |
| Total incentives paid to participants |  |  |  | $175,000 |  |  |  | $490,000 |
| Balance of economic benefit |  |  |  | $261,250 |  |  |  | $835,250 |
| Appliance interface costs (borne by customers) |  |  |  | $0 |  |  |  | $7,000 |
| Net financial benefit per customer (participant or not) |  |  |  | $261 |  |  |  | $835 |
| Net financial benefit accruing to each participant |  |  |  | $1,261 |  |  |  | $1,835 |
| Net financial benefit accruing to each non-participant |  |  |  | $261 |  |  |  | $835 |

## 5.2 Quantified benefits

### Capital Costs Avoided

Whenever an air conditioner or any other appliance is connected to the network, there must be sufficient capital investment in both network and generation capacity to supply its projected contribution to peak demand, if the required security of supply criteria are to be maintained. This cost is not borne directly by the appliance purchaser at the time of purchases, but is anticipated by the network operator (as part of its capital and infrastructure planning process) and the costs are either recovered from all consumers without differentiation or, if there are price-reflective tariffs, there is a greater contribution from those actually imposing the costs.

The marginal cost of meeting an expected 1 kW increase in peak demand on a given electricity network has been estimated from a range of sources. As part of the AER determination process, the AER requests distribution network service providers (DNSPs) to indicate revenue requirements in standard categories, including return on capital, operating expenditure (‘opex’) and capital expenditure (‘capex’). Capex is further disaggregated into the investment required to connect new consumers, to replace assets at the end of their lives, to maintain prescribed reliability standards and to meet projected growth in peak demand.

The data presented by DNSPs for the current round of AER distributor price determinations is analysed in Appendix 1. Comparison of projected peak load-related capex with the projected growth in maximum demand over the same period gives an average cost per MW of increased peak load of $2,061 per kW across the NEM, or $239 per electricity customer per year over the lifetime of the latest 5-year price determinations. The cost per kW varies significantly by region and state, from about $3,020/kW in Queensland to $438/kW in Tasmania.

Generation and transmission investment adds about 15% to the marginal cost per peak kW (DEEDI 2011, AER 2009a). Table 9 summarises the values used in this RIS for calculating the one-time benefits of avoiding peak load growth in each State. This therefore becomes the cost that is avoidable if reliable means of controlling the load are installed at the same time as the load itself.

Table 9. Estimated investment required per marginal peak load kW

|  | MW load growth (a) | Distribution $/kW (a) | Other (b) $/kW | Total $/kW | Rounded $/kW |
| --- | --- | --- | --- | --- | --- |
| NSW | 2589 | 2589 | 487(b) | 3076 | 3100 |
| Vic | 678 | 678 | 109 | 787 | 800 |
| Qld | 3020 | 3020 | 483 | 3503 | 3500 |
| SA | 2061 | 2061 | 330 | 2391 | 2400 |
| WA | 1370 | 2727 | 436 | 3163 | 3200 |
| Tas | 105 | 438 | 70 | 508 | 500 |
| ACT | 68 | 1019 | 487 | 1506 | 1500 |
| NT | 105 | 3020 | 483 | 3503 | 3500 |
| NEM – weighted | 8521 | 2423 | 412 | 2835 | 2845 |
| National – weighted | 9995 | 2471 | 416 | 2887 | 2900 |

(a) Extracted from DNSP submissions to current AER price determinations – See Appendix 1. (b) 15% allowance over distribution cost for transmission and generation investment.

Table 10 indicates the load reduction available from each individual appliance participating in a DR program, and the capital cost that needs to be invested in the electricity supply network to meet the contribution to summer peak demand of each appliance. This ranges from about $17,350 for a ducted air conditioner in a newly constructed house, to about $570 per solar-electric or heat pump water heater.

Table 10. Load reduction available from participating appliances

|  | Typical peak kW (electric) | % operating at  at time of MD | Average curtailable kW/ activated unit available in 2028 | Capital investment to accommodate peak load, per unit(a) | Average controllable kW/ activated unit available in 2028 |
| --- | --- | --- | --- | --- | --- |
| Ducted AC Pre-2013 houses | 6.0 | 70% at 2014 SMD 80% at 2028 SMD | SMD 4.8 | $13,660 | SMD 2.4 (b) |
| Ducted AC Post-2012 houses | 7.6 | 70% at 2014 SMD 80% at 2028 SMD | SMD 6.1 | $17,350 | SMD 3.0 (b) |
| Non-ducted AC Pre-2013 houses | 2.1 | 70% at 2014 SMD 80% at 2028 SMD | SMD 1.7 | $4,840 | SMD 0.8 (b) |
| Non-ducted AC Post-2012 houses | 2.6 | 70% at 2014 SMD 80% at 2028 SMD | SMD 2.1 | $5,970 | SMD 1.0 (b) |
| All air conds (weighted average of above categories) | 2.6 | 70% at 2014 SMD 80% at 2028 SMD | SMD 2.1 | $5,970 | SMD 1.0 (b) |
| Pool pump | 0.9 | 50% | SMD 0.45 | $1,280 | SMD 0.8 (d) |
| Electric storage water heaters – houses (c) | 3.6 | 100% | SMD 0.4 WMD 0.6 | $1,140 | SMD 0.4 (d) WMD 0.6 (d) |
| Electric storage water heaters – apartments (c) | 3.6 | 100% | SMD 0.5 WMD 0.7 | $1,140 | SMD 0.5 (d) WMD 0.7 (d) |
| Solar-electric water heaters (c) | 3.6 | 100% | SMD 0.2 WMD 0.4 | $570 | SMD 0.2 (d) WMD 0.4 (d) |
| Heat pump water heaters (c) | 0.9 | 100% | SMD 0.2 WMD 0.4 | $570 | SMD 0.2 (d) WMD 0.4 (d) |

See Appendix 6. (a) Capital investment per peak kW in NEM region (Table 9) multiplied by peak kW at SMD. (b) 50% cycling – i.e. equal periods on and off during peak load events. (c) Only water heaters on uncontrolled tariffs are included in the analysis. (d) Full curtailment during peak.

## 5.3 Quantified costs

### Appliance Interfaces

It is estimated that an AS/NZS 4755 interface, plus supporting hardware and software, would add about $5 to manufacturing costs per appliance, or $10 to the retail price.[[51]](#footnote-51) The manufacturer of each model of the affected product types will have to re-engineer it to make it AS/NZS 4755-compliant. Some air conditioner models are already offered with AS/NZS 4755 interfaces, and some models have the software capabilities but not the physical interface. The design changes required are discussed in Appendix 4. At the time of writing there are no water heaters, pool pump controllers or EV chargers with the interface.

### Demand Response Enabling Devices (DREDs) and Connections

The activation of the AS/NZS 4755 capabilities of an appliance requires the presence of a communications platform, a demand response enabling device (DRED) or a smart meter (SM), and the necessary connections (wireless or cable) to complete the communications pathway to the Smart Appliance Interface (SAI). Three pathway options are modelled:

* A DRED that is independent of the electricity meter – e.g. one which receives signals by ripple control, mesh radio or internet;
* A Home Area Network (HAN) interface built into a SM; and
* A Controlled Load Relay (CLR) built into a SM.

The communications platforms available in each state are covered in the next section.

#### Utility Communications Platforms

In jurisdictions where SMs are being rolled out irrespective (Victoria), it is assumed that they will provide the communications infrastructure to support the SAI, at no additional cost. [[52]](#footnote-52) In jurisdictions where there is an existing ripple control system (Qld, NSW), it is assumed that this can provide the communications infrastructure, at no additional cost. (This is already being used in trials in Qld).

SM trials or partial rollouts are under way in ACT, NSW, SA, WA and Tasmania (see Table 11). If the trials lead to a decision for a mass SM roll-out, the decision will be taken mainly for reasons *other than* to provide a means of accessing the SAI (although it is known that the potential value of accessing AS/NZS 4755 DR capability is being assessed by several utilities, and is likely to become a factor in subsequent SM decisions).

It is assumed that if SM rollouts proceed, SMs will provide the communications infrastructure to support the SAI, at no additional cost, and if SM rollouts do not proceed there will be other, low-cost options to access the SAIs: for example FM radio, which was successfully used in an Adelaide trial, at an infrastructure set-up cost of tens of thousands of dollars.[[53]](#footnote-53) Such low-cost options are available in most cities and towns (albeit some may have less than complete coverage). A non-SM, non-ripple option would be the only option in the NT.

Table 11. Communications platform in each state and territory

|  | Electricity Distributor Communications infrastructure | Infrastructure needed at customer premises for DR activation |
| --- | --- | --- |
| Qld (a) | Existing Ripple Control Network | Ripple receiver DRED to SAI |
| NSW (a) | Existing Ripple Control Network | Ripple receiver DRED to SAI |
| Smart meter trials under way | Wireless link from SM to SAI or  Cable link from SM to SAI |
| Victoria (a) | New smart meters (being rolled out irrespective) | Wireless link from SM to SAI (no provision for cable link in Victorian pre-SMIFS SMI standards) |
| ACT | Smart meter trials under way | Depends on infrastructure adopted |
| SA(a) | New smart meter trials; includes 3G and 4G WiMAX communications | Wireless link from SM to SAI  Powerline link SM to SAI  Cable link from SM to SAI |
| WA (a) | Smart meter trials under way | Wireless link from SM to SAI or  Cable link from SM to SAI |
| Tasmania | SMs installed on PV installations  Additional SM rollouts planned | Depends on infrastructure adopted |
| NT | None existing or planned (b) | Depends on infrastructure adopted –may be non-communicating DRED |

Note: Green indicates that communications platform already exists or is being rolled out. Orange indicates options under consideration. Red indicates that no communications platform is currently under consideration. (a) Confirmed to E3 Committee, personal communications, November 2012. (b) For modelling purposes a platform establishment cost of $0.05 m is assumed. It is understood there are trials of a non-communicating DRED which senses changes in the voltage and frequency of the grid and implements DRMs accordingly are under way.

The marginal cost of establishing a communications platform to support the SAI are either:

* Zero; where SMs are being or will be rolled out, or where there are existing ripple control systems (i.e. in Victoria, NSW and Qld); or
* Very low; where SMs are not rolled out; and it becomes necessary to establish a new communications system solely to support the SAI. A reasonable estimate of maximum initial set-up costs would therefore be of the order of $1 per household covered.

The cost allowed for on-site equipment installation for households choosing to participate in DR is up to $180 (Table 12), plus $20/yr for duration of participation. This swamps the estimated $1 per household set-up costs to make the system operational – although the set-up cost is fixed and incurred at the start, while activation and participation costs are variable and are incurred progressively as consumers enrol.

In all likelihood, there will be several co-existing or successive activation pathways and business models. For example, a third party DR aggregator may wish to set up an FM radio system, enrol customers, supply and install a radio-receiver DRED that attaches to the SAI, and sell the DR benefits to the customer’s network and/or retailer. If the SM rollout reaches that part the network and the customer subsequently makes a DR contract with the distributor, the change can be affected simply by exchanging the DRED for a wireless receiver that communicates with the SM. The aggregator can then retrieve its DRED and use it elsewhere.

It is possible that the least costly infrastructure (e.g. FM radio) could only manage basic DR functions (DRM 1, 2 or 3): e.g. instruct the appliance to turn off or perform at reduced load for the duration of a peak event. Accessing the more complex energy storage and discharge functions that may be present in some SAI-equipped appliances (DRM 4 to 8) may require more sophisticated control. However the only economic benefit included in the cost-benefit analysis is for DRM1, because that would be the only mandatory requirement. If a utility or third party aggregator wished to install a more capable and/or more costly communications infrastructure, it would presumably do so on the basis of a favourable business case.

#### On-site components

Electronic component suppliers have already produced DREDs or receivers that link the SAI to any of the above communications infrastructures. Table 12 summarises the upper and lower range of estimated costs for establishing each pathway between the platform and the first AS/NZS 4755-capable appliance in a home. The assumptions made to arrive at these costs can be found in Appendix 7. It is assumed that the activation costs for the second and third appliance in a dwelling are 80% and 70%, respectively, of the activation costs of the first, because of the possibility of using components and cabling already installed. The sensitivity of the costs and benefits to higher cost assumptions is tested later. These cost estimates are comparable with those in Deloitte (2012).

Table 12. Estimated pathway costs for accessing first AS/NZS 4755 appliance at a site – high cost

|  | Activ-ation  pathway | SM Cost | DRED (installed) | | Receiver | Cabling (a) | | Total cost | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | All dwellings | New build | Existing | All dwellings | New build | Existing dwelling | New building | Existing building |
| High cost | DRED | NA | $150 | $180 | NA | NA | NA | $150 | $180 |
| SM/HAN | NA | NA | NA | $100 | NA | NA | $100 | $100 |
| SM/CLR | $3 | NA | NA | NA | $70 | $140 | $73 | $143 |
| Low cost | DRED | NA | $100 | $130 | NA | NA | NA | $100 | $130 |
| SM/HAN | NA | NA | NA | $75 | NA | NA | $75 | $75 |
| SM/CLR | $3 | NA | NA | NA | $45 | $115 | $48 | $118 |

(a) 25 m point to point

### Participation Costs

There will be on-going administrative costs associated with maintaining records of activated appliances, communicating with participants and answering inquiries (i.e. printing, postage and call centre costs). These are estimated at $20 per year for the first participating appliance in a dwelling, and $10 per year for each additional appliance.

## 5.4 Cost-benefit analysis

### Connection and Take-up Scenarios

Three conditions must be satisfied for a product to be part of a utility demand response program: it must have an AS/NZS 4755 interface, the interface must be activated and the householder must agree to participate by accepting a demand response contract. The mathematical combination of these three factors – interface compliance rates, activation rates and participation rates – will give the share of appliances which participate in DR programs.

The net present values of projected costs and benefits are modelled over a 15 year horizon, on the assumption that a decision to implement the proposal would be taken in about mid-2013:

* As the lead time between decision and implementation is typically one year, no appliance costs or demand avoidance benefits are incurred in the financial year (FY) 2014 (mid 2013 to mid 2014). The cost of establishing a communications platform is only incurred in jurisdictions without existing platforms or without the possibility of using smart meters in effect, only the NT (see Table 11);
* If the interface is made mandatory for products sold after mid 2014, then all units sold after then would comply. The first year in which benefits and *significant* costs are incurred (for on-site activation/connection of a proportion of SAIs) FY 2015;
* The 14th year in which benefits and costs are incurred is FY 2028.

Products with SAIs could be activated at installation or any time after. Activations may become common when appliances are installed at the time of dwelling construction, because the costs are lower: there are electricians on site and the cost of running additional control cables to the meter box or installing DREDs is minimal. Utilities could engage with builders and electricians to cover the additional costs, on the expectation that occupants will be more likely to consent to participate if there is no requirement for a subsequent technician visit.

High and Low activation/participation scenarios are modelled. In each scenario, the share of new air conditioners, pool pumps and water heaters that is activated in each state is estimated, for each year from 2014 to 2028. The allocation of activations between the three pathways is also considered, because the costs are different (Table 12). Not all pathways are available in each state.

The proportion of activated appliances where the customer chooses to participate is separately estimated. In practice, participation rates for activated appliances will always be below 100%. Some ‘speculative’ activations will remain unrewarded, and there will be some churn when a participating customer moves and the next occupant does not wish to participate. It is estimated that participation rates will be higher for separate DREDs, because the installation of the equipment by the utility is more likely to follow the prior consent of the customer. Participation rates may be lower for SM activations at first, because those activations are more likely to be done prior to dwelling occupation so a higher proportion will be speculative. However, activation rates for all modes the rate is projected to increase over time.

The overall participation rates for the Low scenario in NSW are indicated in Table 13. The share of air conditioner installations in new homes where the interface is activated at the time of appliance installation is estimated at 23% in 2014, rising to 49% in 2028. The activation rates are lower where air conditioners are installed in established dwellings (19% rising to 26%). The corresponding assumptions for pool pumps and non-off-peak electric water heaters of all types are shown in Table 13, for NSW. Assumptions vary by jurisdiction (Appendix 7).

The overall national participation rates in the High and Low scenarios are illustrated in Figure 3. Projected participation rates in 2028 are summarised in Table 14. The participation rates projected via smart meters are consistent with previous studies of smart metering and direct load control (NERA 2008 – see Appendix 6).

Table 13. Projected SAI activation and participation rates, NSW (low)

| Appliance |  | Activation pathway | **2014** | **2028** | **2014** | **2028** |
| --- | --- | --- | --- | --- | --- | --- |
| At time of construction | | Post-construction | |
| Air conditioner | **Activation rate:** Proportion of products with SAI which are activated at installation | Via SM/Relay | 7.5% | 19% | 3.8% | 3.8% |
| Via SM/HAN | 7.5% | 11% | 7.5% | 11.3% |
| Via separate DRED | 7.5% | 19% | 7.5% | 11.3% |
| Total, all pathways | 23% | 49% | 19% | 26% |
| **Participation rate:** proportion of products activated this way where householder participates | SM/Relay | 15% | 38% | 15% | 38% |
| SM/HAN | 23% | 45% | 23% | 45% |
| Separate DRED | 60% | 64% | 60% | 64% |
| Pool Pump |  |  | New pool | | Replacement pump | |
| Activation rate | Total, all pathways | 7.5% | 60% | 7.5% | 60% |
| **Participation rate** | Total, all pathways | 40% | 90% | 40% | 90% |
| Water heater |  |  | At time of construction | | Post-construction | |
| Activation rate | Total, all pathways | 7.5% | 60% | 7.5% | 60% |
| **Participation rate** | Total, all pathways | 20% | 60% | 20% | 60% |

Description: The shares of appliance-owning households that are pojected to particiipate in demand response schemes in each yer between 2014 and 2028. All lines start rising in 2015. The value which each line reaches in 2028 is in Table 14. Figure 3. Projected participation rates by appliance, national weighted averages

Table 14. Projected participation rates in 2028 (universal coverage)

| Electrical appliance  (All sold with SAIs after mid 2014) | Share of appliances of this type participating in demand response programs by 2028 (a) | | |
| --- | --- | --- | --- |
|  | Low | High | Theoretical Maximum |
| Air Conditioners | 28% | 49% | 93% |
| Pool pumps | 54% | 72% | 72% |
| Water Heaters (inc. heat pump, solar-electric) | 33% | 44% | 44% |

(a) National averages; residential sector only. Values are combinations of factors in Table 13 for each jurisdiction, weighted by rates of new construction and of product replacements in dwellings post-construction.

As Table 11 indicates, Queensland, NSW and Victoria already have communications platforms in place and the other jurisdictions are considering smart meters (except for the NT). Three ‘platform coverage scenarios’ have been modelled: universal coverage throughout Australia, coverage only where communication platforms are known to exist (Qld, NSW and Vic), and an intermediate or ‘constrained’ scenario which includes existing coverage plus coverage in over half of WA and SA households over the projection period.

These three scenarios have been constructed to explore the full range of possible costs and benefits. They do not necessarily reflect the main drivers to the establishment and roll-out of direct load control programs. For example, uptake where communication platforms currently operate is assumed to be driven by the existence of those communication platforms despite the fact that, as noted in section 5.3, the marginal costs of establishing a communications platform is very low. As such, it is very unlikely that a roll-out, even in worst-case scenarios, will be confined to those states with existing communication platforms.

As all households would pay the extra costs of purchasing SAI-equipped appliances whether they had access to a communications platform or not, then in the absence of universal communications coverage some households would incur costs without the option of gaining benefits. This situation is summarised in Table 15.

Table 15. Platform coverage scenarios

| Group | A. Existing coverage only | | B. Constrained coverage | | C Universal coverage | |
| --- | --- | --- | --- | --- | --- | --- |
| Costs | Benefits | Costs | Benefits | Costs | Benefits |
| NSW, Vic, QLD | All cost categories | All benefits | All cost categories | All benefits | All cost categories | All benefits |
| SA,WA | Interface costs only | No benefits | All interface costs; ½ of other costs | ½ of modelled benefits | All cost categories | All benefits |
| Tas, ACT, NT | Interface costs only | No benefits | Interface costs only | No benefits | All cost categories | All benefits |

Apart from the High and Low participation scenarios, there is an additional ‘theoretical maximum’ scenario in which every household purchasing a new air conditioner participates. As this could only be achieved my making participation in DLC obligatory, it is inconsistent with the basic assumption in this RIS: that only the presence of the interface would be mandatory, and activation and participation would be left to the market. Nevertheless the calculation provides a useful perspective on the modelling, by illustrating the extent to which even the High participation assumptions are well short of the theoretical maximum.

The number of annual air conditioner activations required to achieve the participation rates in Figure 3 are illustrated in Figure 4. The top line indicates the theoretical maximum number of activations achievable if DLC communications platforms are rolled out progressively and every air conditioner sold from 2014 is activated on installation. The line rising steeply after 2017 illustrates the effect of deferring activations until the fourth year, on the assumption that it is not cost-effective to offer activations until SAI-equipped appliances reach a critical mass. The lower pairs of lines indicate the High and Low participation rates assumed for modelling purposes. The near-horizontal line at the bottom indicates the annual construction of new dwellings. To achieve the projected participation rates, the majority of activations each year will need to occur when air conditioners are replaced in existing homes, because the opportunities for activations in new dwellings is limited by the construction rate.

Figure 4. Projected annual air conditioner activations

Description: The number of air conditioners that are 'activated' in each year from 2014 to 2028. 'Air conditioner activations - mandatory' rises rapidly from zero in 2014 to nearly 800,000 in 2019, then rises more gradually to 1 million in 2028. The 'higher particapition' trend lines reach about 440,000 in 2028. The 'lower participation' trend lines reach about 320,000 in 2028. The number of new dwellings rises from about 130,000 in 2014 to 180,000 in 2028. 

### Projected Demand Reductions

The projected reductions at the time of summer and winter maximum demand available from DLC programs in each jurisdiction in 2028 are illustrated in Figure 5 and Figure 6 (and analysed in detail in Appendix 7). The projected impacts are based on 50% output (equal periods on and off) for participating air conditioners operating at the time of summer peak, and complete turn off for participating pool pumps and water heaters. Utility trials indicate that these operating conditions would be acceptable to nearly all householders (Appendix 3).

Figure 7 and Figure 8 illustrate the progressive growth of total controllable load between 2014 and 2028 in the NEM region (i.e. all jurisdictions other than WA and NT). The upper green and blue lines indicate the increase in projected SMD and WMD respectively, based on the latest projections (AEMO 2012). The solid red line indicates the total power in megawatts (MW) of participating air conditioners likely to be operating at summer peak, and the solid orange line adds the MW of participating pool pumps and water heaters.

The total MW of appliance load available for curtailment during a summer emergency peak load event in the NEM region is projected at 3,228 to 6,517 MW by 2028 (leaving aside the theoretical maximum case). This would be equivalent to between 37% and 75% of the total projected growth in NEM summer peak demand (Table 16). In a non-emergency (or ‘routine’) summer peak load event, with participating air conditioners reduced to 50% load and pool pumps and water heaters switched off completely, the SMD reduction available in the NEM region would be 1,913 to 3,605 MW, equivalent to 22% to 41% of the total projected growth in summer peak demand (Figure 7, Figure 8). As SMD on the NEM is projected to increase at about 680 MW per year by the mid 2020s, direct load control of these appliances could defer SMD growth by 3 to 5 years.

Table 16. Projected impacts on peak load in the NEM region, 2028 (universal coverage)

| Effective | Participation | | Total MW reduction | | kW/HH reduction(a) | | Load growth | MW reduction/growth | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Emergency | Routine | Emergency | Routine | MW 2012-26 | Emergency | Routine |
| Progressive | Low | Summer | 3,878 | 2,238 | 0.52 | 0.30 | 8,737 | 44% | 26% |
|  |  | Winter | 2,055 | 1,250 | 0.28 | 0.17 | 8,475 | 24% | 15% |
|  | High | Summer | 6,517 | 3,605 | 0.87 | 0.48 | 8,737 | 75% | 41% |
|  |  | Winter | 3,364 | 1,933 | 0.45 | 0.26 | 8,475 | 40% | 23% |
|  | Max | Summer | 22,269 | 11,480 | 2.98 | 1.54 | 8,737 | 255% | 131% |
|  |  | Winter | 8,808 | 4,655 | 1.18 | 0.62 | 8,475 | 104% | 55% |
| Deferred | Low | Summer | 3,228 | 1,913 | 0.43 | 0.26 | 8,737 | 37% | 22% |
|  |  | Winter | 1,737 | 1,090 | 0.23 | 0.15 | 8,475 | 20% | 13% |
|  | High | Summer | 5,367 | 3,030 | 0.72 | 0.41 | 8,737 | 61% | 35% |
|  |  | Winter | 2,801 | 1,651 | 0.37 | 0.22 | 8,475 | 33% | 19% |
|  | Max | Summer | 18,222 | 9,457 | 2.44 | 1.27 | 8,737 | 209% | 108% |
|  |  | Winter | 7,278 | 3,890 | 0.97 | 0.52 | 8,475 | 86% | 46% |

Best and worst cases highlighted. (a) Based on projected number of household electricity users in NEM in 2028

By 2028, it is projected that the routine load reduction at SMD per NEM household (averaged over all households, including those not participating in DLC) will be between 0.26 and 0.48 kW. Utility trials have found that the expected reduction in peak load per household under TOU pricing alone is around 0.11 kW (Appendix 3). Therefore the proposal would achieve 2½ to 4½ times the load reduction available from introducing universal TOU pricing for all NEM households. If the measures coexisted the impacts would not be additive, but TOU pricing would drive more customers to accept DLC where available. For network planning purposes, only DLC can ensure that the projected load reduction can be called when required. With TOU or CP pricing alone, there is no assurance that any given level of load reduction would be available during SMD or in emergencies, so a level of risk remains.

Deferring the commencement of the DLC programs to the 4th year delays the build-up of the controllable load in each case, so that it is about 13% to 18% lower in 2028 than without deferral. For example, in the High participation cases, deferral drops the load available during routine SMD events in 2028 from 3,605 MW to 3,030 MW.

The effects of achieving the theoretical maximum rate of air conditioner activations are also indicated in Table 16. If all new air conditioners installed after 2014 were to participate in DLC from the time of installation, the total controllable load available would significantly exceed the total increase in peak demand expected on the NEM. The large estimated benefit from the Theoretical Maximum, although purely a theoretical concept partly reflects that the large majority of connections could, depending how energy is used in each household, potentially be cost effective. Although infeasible, the Theoretical Maximum option provides some supporting evidence that there may be a large potential up-side to the benefits which can be achieved.

While the High and Low cases assume that the share of air conditioners activated at time of installation will rise over time – due to market forces and greater consumer familiarity with DLC – at the rates projected in Appendix 7, it will never reach 100% for the following reasons:

* Even though every air conditioner sold after mid 2014 will have an interface (if compliance is complete), 100% activation can only be achieved if it becomes mandatory for installers to fit a DRED or complete the connection (via cable or wireless link) to a smart meter, if present. This could only be mandated through changes in the wiring rules, which are beyond the scope of this RIS and are not contemplated at present.
* Many air conditioners with interfaces will be activated some time *after* installation (e.g. when a smart meter is subsequently installed, or the utility makes a local offering to install DREDs in a target area). Any time lags between activation and installation will reduce the rate of controllable load build-up to below the theoretical maximum.
* Some utilities may not deploy a communication platform in an area until a critical mass of installations is reached. This too will reduce the rate of controllable load build-up to below the theoretical maximum.
* Achieving a 100% participation rate would mean that every consumer would have to join and remain in DLC from the time they purchase a new air conditioner. This would conflict with a major principle of DLC contracts – that consumers can decide if and when to participate, and when to leave (subject to any pre-agreed conditions, and subject to the cessation of any incentives to participate). This freedom allows all consumers to make their own decisions about the value of participation. It is assumed that even in the High case about half of all consumers will value the freedom to use air conditioning without constraint so highly that they will still decline to participate in DLC by 2028, and so choose to forego incentives or to pay more for electricity than otherwise – as is their right.
* Obliging all customers to take part in DLC would also reduce the marginal cost-effectiveness of each additional participant, because customers who rarely use their air conditioner during peak periods would also be forced to participate. The connection cost would be the same, but the average quantum of controllable load available during peaks would be much lower than for participants who self-selected on the basis of being high air conditioner users.

Therefore achieving the ‘theoretical maximum’ level of load reduction would require mandatory participation in DLC, which no utility has suggested and which would be almost certainly unacceptable to governments and to consumers.

The Megawatts (millions of watts) of controllable reduction in peak demand available in each jurisdiction during both summer maximum demand (SMD) and winter maximum demand (WMD) events, shown as vertical bars. Each bar shows how much of the load reduction comes from air conditioners, pool pumps and water heaters. The highest bar is Queensland SMD (about 1,450 Megawatts).   Figure 5. Projected reductions in SMD and WMD by jurisdiction, 2028  
(universal coverage, high participation rates)

Description: The Megawatts (millions of watts) of controllable load reduction in peak demand available in each jurosdiction during both summer maximum demand (SMD) and winter maximum demand (WMD) events, shown as vertical bars. Each bar shows how much of the load reduction comes from air conditioners, pool pumps and water heaters. The highest bar is Queensland SMD (about 850 Megawatts). Figure 6. Projected reductions in SMD and WMD by jurisdiction, 2028  
(universal coverage, low participation rates)

Description: Increase in Megawatts (millions of watts) compared with 2013 in each year to 2028, in the National Electricity Market region. Summer maximum demand and winter maximum demand each rise by about 8,500 Megawatts by 2028. The controllable load available during demand repsonse events rises to between 5,800 and 6,400 Megawatts by 2028. The load avoided by appliance 'cycling' rises to between 3,000 and 3,600 Megawatts by 2028.    Figure 7. Projected controllable load during summer maximum demand, NEM region (universal coverage, high participation rates)

Description: Increase in Megawatts (millions of watts) compared with 2013 in each year to 2028 in the National Electricity Market region. Summer and winter maximum demand both rise by about 8,500 Megawatts by 2028. The controllable load available during demand response events rises to between 3,200 and 3,800 Megawatts by 2028. The load avoided by appliance 'cyling' rises to between 1,600 and 2,100 Megawatts.Figure 8. Projected controllable load during summer maximum demand, NEM region (universal coverage, low participation rates)

### Total Monetary Costs and Benefits

Table 17 summarises the NPV of the costs and benefits of the proposal from mid 2013 (the earliest time when a decision on implementation might be made, give the RIA process). At the 7% discount rate used in this cost-benefit analysis, extending the modelling horizon beyond 2028 further adds little information of value to decision-makers. It is also possible that at some time in the future there may be a global standard for appliance interactions with smart grids, which could make the AS/NZS 4755 interface obsolete. Even so, the peak load reductions gained up to that time could be retained as long as utilities and DR aggregators continued to operate the communications platforms supporting AS/NZS 4755-compliant appliances. Furthermore, it is likely that smart appliances meeting any new standard (if there is one) will also be compatible with AS/NZS 4755 communications infrastructure, because utilities and regulators will be keen to preserve the value of that infrastructure.

The great majority of the capital costs of the proposal are incurred at the time the DRED, SM or other hardware needed to activate the first SAI-equipped appliance in each home is installed. When that appliance reaches the end of its service life, replacing it with another SAI-equipped appliance incurs no marginal cost – installers simply connect the replacement appliance to the existing DRED or SM at the same time as they connect it to the existing power supply. By the same token the quantum of demand available for control would not change, unless the new appliance had a significantly higher or lower peak power requirement than the one it replaces. In general, replacement would incur neither additional cost nor create additional benefit, but would ensure retention of the benefit gained up to that point.

The cost and benefits in Table 17 correspond to the ‘routine reduction in SMD’ on the NEM in Table 16, plus the cost and benefits for WA and NT. Two cost alternatives are modelled for each case, based on the High and Low pathway costs in Table 12. The demand reduction and hence the value of projected savings in each pair of cases is identical, but the difference in pathway cost assumptions leads to different net benefits and benefit/cost ratios. Excluding the theoretical maximum cases, the estimated net national benefits range from $4,234 million to $9,854 million, and the benefit/cost ratios from 6.8 to 11.5 (at 7% discount rate).

Table 17. Projected costs and benefits, universal coverage

| Effective | Particip-ation level | Activation  cost, Case | SMD  saved MW | $m NPV Costs(b) | $m NPV Benefits(b) | $m NPV Net benefits | B/C  at 7% | B/C at 3% (c) | B/C 11% (d) | Deferral cost (e) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Progressive | Low (a) | 1.Low | 2431 | $705 | $6,333 | $5,628 | 9.0 | 9.2 | 8.8 | NA |
|  |  | 2. High | 2431 | $877 | $6,333 | $5,456 | 7.2 | 7.4 | 7.0 | NA |
|  | High (a) | 3. Low | 4020 | $937 | $10,791 | $9,854 | 11.5 | 11.8 | 11.3 | NA |
|  |  | 4. High | 4020 | $1,162 | $10,791 | $9,629 | 9.3 | 9.5 | 9.1 | NA |
|  | Max (a) | 5. Low | 13181 | $2,241 | $35,135 | $32,894 | 15.7 | 15.6 | 15.7 | NA |
|  |  | 6. High | 13181 | $2,734 | $35,135 | $32,401 | 12.9 | 12.9 | 12.9 | NA |
| Deferred | Low (a) | 7. Low | 2081 | $587 | $4,960 | $4,373 | 8.5 | 8.8 | 8.1 | -22% |
|  |  | 8. High | 2081 | $726 | $4,960 | $4,234 | 6.8 | 7.1 | 6.5 | -22% |
|  | High (a) | 9. Low | 3401 | $757 | $8,367 | $7,610 | 11.1 | 11.5 | 10.6 | -22% |
|  |  | 10. High | 3401 | $937 | $8,367 | $7,430 | 8.9 | 9.3 | 8.6 | -22% |
|  | Max (a) | 11. Low | 10934 | $1,650 | $26,771 | $25,121 | 16.2 | 16.4 | 16.1 | -24% |
|  |  | 12. High | 10934 | $2,035 | $26,771 | $24,736 | 13.2 | 13.3 | 13.0 | -24% |

Best and worst cases highlighted. (a) Corresponds to SMD Cases Table 16 for NEM plus load reductions in WA and NT (b) NPV at 7% discount rate for costs and benefits incurred 2014-2028 (c) 3% discount rate (d) 11% discount rate (e) Reduction in NPV of net benefits compared with corresponding ‘progressive’ case.

These estimates are consistent with the savings projections recently published in the AEMC’s *Power of Choice* report, which states:

‘Frontier Economics estimated that economic cost savings of peak demand reduction in the NEM is likely to be between $4.3 billion to $11.8 billion over the next ten years (net present value, 2013/14 to 2022/23) which equates to between 3 per cent to 9 per cent of total forecast expenditure on the supply side. The majority of these savings occur in the network sector given the current over supply of wholesale generation and relatively conservative view of baseline demand growth. This is based upon an assumption that network expenditure continues at the current rate’ (AEMC 2012c).

#### Effect of Partial Coverage of Communications Platforms

Table 18 and Table 19 summarise the cost and benefits if access to communications platforms is limited rather than universal. The peak load reductions and net benefits would fall, but the B/C ratios would remain virtually unchanged. The states where platforms are already in place account for between 83% and 85% of the total available benefits nationally, so even if there was no further development of communications platforms in any jurisdiction the proposal would still be highly cost-effective. In fact, the minimum participation rate required to achieve a cost/benefit ratio of 1.0 in Australia is 2.5% of air-conditioner-owning households by 2028. This means that net benefits can be obtained even with only a very modest roll-out of direct load control programs.

Table 18. Projected costs and benefits, Existing coverage only

| Effective | Particip-ation level | Activation  cost, Case | SMD  saved MW | $m NPV Costs(b) | $m NPV Benefits(b) | $m NPV Net benefits | B/C  at 7% | Deferral cost (c) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Progressive | Low (a) | 1.Low | 1977 | $597 | $5,325 | $4,728 | 8.9 | NA |
|  |  | 2. High | 1977 | $736 | $5,325 | $4,589 | 7.2 | NA |
|  | High (a) | 3. Low | 3305 | $792 | $9,144 | $8,352 | 11.5 | NA |
|  |  | 4. High | 3305 | $974 | $9,144 | $8,170 | 9.4 | NA |
|  | Max (a) | 5. Low | 9811 | $1,761 | $25,538 | $23,777 | 14.5 | NA |
|  |  | 6. High | 9811 | $2,149 | $25,538 | $23,389 | 11.9 | NA |
| Deferred | Low (a) | 7. Low | 1673 | $491 | $4,113 | $3,622 | 8.4 | -23% |
|  |  | 8. High | 1673 | $601 | $4,113 | $3,512 | 6.8 | -23% |
|  | High (a) | 9. Low | 2767 | $631 | $6,999 | $6,368 | 11.1 | -24% |
|  |  | 10. High | 2767 | $774 | $6,999 | $6,224 | 9.0 | -24% |
|  | Max (a) | 11. Low | 8132 | $1,289 | $19,477 | $18,189 | 15.1 | -24% |
|  |  | 12. High | 8132 | $1,584 | $19,477 | $17,893 | 12.3 | -23% |

Best and worst cases highlighted. (a) Corresponds to SMD Cases Table 16 for NSW, Vic and Qld only. (b) NPV at 7% discount rate for costs and benefits incurred 2014-2028 (c) Reduction in net benefits compared with corresponding ‘progressive’ case.

Table 19. Projected costs and benefits, constrained coverage

| Effective | Particip-ation level | Activation  cost, Case | SMD  saved MW | $m NPV Costs(b) | $m NPV Benefits(b) | $m NPV Net benefits | B/C  at 7% | Deferral cost (c) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Progressive | Low (a) | 1.Low | 2142 | $625 | $5,718 | $5,092 | 9.1 | NA |
|  |  | 2. High | 2142 | $777 | $5,718 | $4,941 | 7.4 | NA |
|  | High (a) | 3. Low | 3567 | $834 | $9,784 | $8,951 | 11.7 | NA |
|  |  | 4. High | 3567 | $1,032 | $9,784 | $8,752 | 9.5 | NA |
|  | Max (a) | 5. Low | 11281 | $1,957 | $29,937 | $27,980 | 15.3 | NA |
|  |  | 6. High | 11281 | $2,390 | $29,937 | $27,546 | 12.5 | NA |
| Deferred | Low (a) | 7. Low | 1822 | $515 | $4,448 | $3,933 | 8.6 | -23% |
|  |  | 8. High | 1822 | $636 | $4,448 | $3,811 | 7.0 | -23% |
|  | High (a) | 9. Low | 3000 | $665 | $7,538 | $6,873 | 11.3 | -23% |
|  |  | 10. High | 3000 | $823 | $7,538 | $6,715 | 9.2 | -23% |
|  | Max (a) | 11. Low | 9343 | $1,425 | $22,814 | $21,389 | 16.0 | -24% |
|  |  | 12. High | 9343 | $1,755 | $22,814 | $21,059 | 13.0 | -24% |

Best and worst cases highlighted. (a) Corresponds to SMD Cases in Table 16 for NSW, Vic and Qld and half of activation costs and benefits for SA and WA. (b) NPV at 7% discount rate for costs and benefits incurred 2014-2028 (c) Reduction in net benefits compared with corresponding ‘progressive’ case.

However, in jurisdictions where direct load control programs are not established householders would still bear the costs of appliance interfaces but would not receive the benefits of deferred network investment. The NPV of these costs would be about $M 27 in the ‘existing coverage only’ scenario, and $M 6 in the ‘constrained’ scenario (Table 20 and Table 21). These ‘stranded costs’ are equivalent to between 0.1% and 0.6% of the net national benefit. In other words, if householders in jurisdictions without communications platforms were to be compensated the cost would amount to a negligible share of total benefits.

Table 20. Costs and benefits of universal and constrained coverage – best case

| Group | A. Existing coverage only | | | B. Constrained coverage | | | C. Universal coverage | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Costs | Benefits | Net | Costs | Benefits | Net | Costs | Benefits | Net |
| NSW, Vic, Qld | $765 | $9,144 | $8,379 | $765 | $9,144 | $8,379 | $765 | $9,144 | $8,379 |
| SA, WA | $21 | $0 | -$21 | $62 | $640 | $578 | $125 | $1,280 | $1,155 |
| Tas, ACT, NT | $6 | $0 | -$6 | $6 | $0 | -$6 | $47 | $367 | $320 |
|  | $792 | $9,144 | $8,352 | $834 | $9,784 | $8,951 | $937 | $10,791 | $9,854 |

Best Case corresponds to Case 3 in Table 17, Table 18 and Figure 19. All values $m NPV (7% discount rate)

Table 21. Costs and benefits of universal and constrained coverage – worst case

| Group | A. Existing coverage only | | | B. Constrained coverage | | | C. Universal coverage | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Costs | Benefits | Net | Costs | Benefits | Net | Costs | Benefits | Net |
| NSW, Vic, Qld | $575 | $4,113 | $3,539 | $575 | $4,113 | $3,539 | $575 | $4,113 | $3,539 |
| SA, WA | $21 | $0 | -$21 | $56 | $334 | $279 | $111 | $669 | $557 |
| Tas, ACT, NT | $6 | $0 | -$6 | $6 | $0 | -$6 | $40 | $178 | $138 |
|  | $601 | $4,113 | $3,512 | $636 | $4,448 | $3,811 | $726 | $4,960 | $4,234 |

Worst Case corresponds to Case 8 in Table 17, Table 18 and Table 19. All values $m NPV (7% discount rate)

#### Effect of TOU and Time-variable tariffs

The context of the cost-benefit analysis it that the adoption of TOU tariffs and other forms of time-variable pricing remains low. If such tariffs do become widespread there would most likely be even greater acceptance of DLC options, because customers could see the direct benefits of having their load managed, and electricity suppliers would have less need to persuade them with incentives. Therefore assuming the present pattern of tariffs builds in a conservative bias.

A prior introduction of universal TOU pricing would almost certainly affect the costs and benefits of the proposal, but it is very difficult to quantify the impacts, costs and benefits. For example, it is not known what proportion of TOU accounts would use simple interval meters (so needing additional hardware to activate the DR interface) and what proportion would use communicating smart meters, so making costs of activation very low. Under a TOU tariff regime, activation costs could be lower *or* higher.

The evidence suggests that TOU pricing would contribute to reductions in peak demand, but at best it would only partly address the problem. Trials have shown that the magnitude of peak load reduction obtainable from TOU prices alone are much less than those available from DLC alone (Appendix 3).

In any case, both cost reflective pricing and DLC could only partly address the problem. The schemes, however, are mutually reinforcing. Cost reflective pricing, for example, could provide considerable incentives for a household to participate in DLC as a DLC scheme provides an automated way to respond to higher prices. Conversely, a household with DLC would also be keener to participate in a TOU scheme, as TOU provides additional benefits from participating in a DLC scheme than from the DLC arrangement with the utility.

An additional perspective on the relative effectiveness of peak load reduction approaches is provided in a recent report by Deloitte (2012), which estimates the gross benefits from a range of pricing and DLC initiatives (Table 22). The study reports gross benefits only over a 10 year period, i.e. without estimating the cost of implementing the initiative. (The RIS estimates costs and net benefits, as well as gross benefits, over a 15 year period).

Table 22. Total estimated net present value of gross benefits 2013-2022, Deloitte (2012)

| Initiative (a) | Low case gross benefit ($m)(a) | High case gross benefit ($m)(a) | Relationship to DLC technology proposals in this RIS (b) |
| --- | --- | --- | --- |
| TOU pricing | 58 | 193 | DLC may help realise benefit |
| CPP and incentives | 385 | 1,272 | DLC may help realise benefit |
| DLC for air conditioners | 200 | 1,338 | Depends on DLC technology |
| DLC for pool pumps | 188 | 231 | Depends on DLC technology |
| Grid support from EVs | 60 | 537 | Depends on DLC technology |
| Energy efficiency measures | 361 | 486 | No direct relationship |
| Enhanced uptake of Solar PV | 300 | 528 | No direct relationship |
| **Total gross benefits** | **1,551** | **4,585** |  |
| Sum of benefits depending on pricing | 443 (29% of Total) | 1,465 (32% of Total) |  |
| Sum of benefits depending on DLC technology (b) | 448 (29% of Total) | 2,106 (46% of Total) |  |
| Potential peak demand reduction, 2022 | 2,400 MW(c) | 7,500 MW(c) |  |

(a) Deloitte (2012) Table 12 (b) GWA summary of Deloitte data (c) Deloitte (2012) Figure 1.

Deloitte concludes that

‘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 ’ (Deloitte 2012)

These DLC take-up rate projections for air conditioners in 2022 are comparable to those in the present RIS, which are 14% in the Low case and about 24% in the High case (Figure 3). Deloitte projects peak load reductions of 2,400-7,500 MW in 2022 from all measures in Table 22, whereas this RIS projects load reductions of 1,080-2,700 MW in 2022 from DLC measures from air conditioners, pool pumps and water heaters. This suggests that the addition of pricing measures would increase the extent of load reductions.

In their ‘Low Case’, Deloitte estimate the gross benefits from DLC measures for the products covered by the present RIS (air conditioners, pool pumps and EVs) and from pricing measures are similar. In the ‘High Case’ the gross benefits of DLC measures are significantly greater than the benefits available from pricing measures.

However, treating dynamic pricing and DLC measures separately misses the potential for them to interact with and reinforce one another. Customers who choose to take CPP contracts will be directly advised of and pay close attention to impending peak load periods, and will initially take the trouble to reduce load manually. Over time however, and if they experience costly failures to respond to CPP notifications, it is possible that they will either withdraw from CPP or seek DLC arrangements to minimise their price exposure.

TOU tariffs have much higher predictability for consumers in that there is less difference between peak, shoulder and low prices, and the applicable time periods are fairly constant. Householders who accept TOU tariffs are likely to be more risk averse and less confident in their ability to respond to peaks than those choosing CPP. TOU customers may be receptive to entering a DLC arrangement at the same time as going on the new tariff. It will be up to electricity utilities (distributors, retailers or acting jointly) to develop the most effective marketing strategies and combinations of tariff and DLC offerings. Most trials so far involve conventional tariffs, with participants recruited by cash or other incentives.

#### Effect of time profile of investment

In each scenario, costs and benefits are accumulated over the same 15-year time horizon (2014-2028) and the discounted NPV of all cost and benefit streams are calculated from mid 2013. Extending the projection horizon further has negligible impact on NPVs. As the typical service life air conditioner is about 14-15 years, after 2028 a second generation of SAI‑equipped products begins to replace the first generation. This does not involve additional activation costs, because the original DREDs and smart meters can be reused for at least another appliance lifetime, but nor does the replacement increase the amount of controllable load – it only maintains it. Air conditioner ownership will also have reached saturation by the mid 2020s. Therefore the rate of further gain in impacts, costs and benefits after 15 years or so drops to the rate of population growth.

In the ‘Progressive’ scenario the utility’s communications platform is in place from 2014, so any SAI-equipped appliances installed in 2014 or later can be activated immediately. Therefore the benefit of each quantum of controllable load can be realised as soon as the appliance is installed and the consumer decides to participate in a DLC contract. This pattern is typical where pre-existing ripple control systems are used to communicate with DREDs.

In the ‘Deferred’ scenario the utilities only establish a communications platform and begin to offer DLC when there is a critical mass of SAI-equipped appliances in the community, assumed to be in 2018. The utilities hold off investing in on-site activation equipment until 2018, but with effective marketing the activation rates catch up with those in the ‘Progressive’ scenario within two years (Figure 4). Deferring the commencement of benefits reduces the NPV of benefits by more than the NPV of costs, so it reduces net benefits by about 22%. This is the most rational capital investment profile where platform implementation is deferred.

If however utilities roll out the most expensive part of the demand response infrastructure – the activation hardware at the customer site – before the communications platform is in place, then that capital is unproductive until 2018 (Table 23). The NPV of the costs would be similar to the ‘Progressive’ case but the NPV of the benefits would be the lower value in the corresponding ‘Deferred’ case. The net benefits would therefore be even lower than in the ‘Deferred’ case – about 24% below the ‘Progressive’ case (Table 24).

Table 23. Alternative time profiles for costs and benefits

| Investment and effectiveness | Communication Platform becomes operational | On-site activation equipment installed (DREDs or meters) | Participations begin |
| --- | --- | --- | --- |
| Progressive (Table 17) | 2014 (Year 1) | As appliances are installed,  from 2014 | 2014 |
| Deferred (Table 17) | 2018 (Year 4) | As appliances are installed, from 2018 | 2018 |
| Deferred with early  investment of capital (Table 24) | 2018 (Year 4) | As appliances are installed, from 2014 | 2018 |

Table 24. Projected costs and benefits, SMD impact – sub-optimal investment profile

| Effective | Particip-ation level | Activation  cost, Case | $m NPV Costs(b) | $m NPV Benefits(b) | $m NPV Net benefits | B/C  at 7% | B/C at  3%(b) | B/C at 11%(c) | Deferral cost (e) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Deferred – with early investment of capital | Low (a) | 1.Low | $705 | $5,702 | $4,960 | $4,255 | 7.0 | 7.5 | -24% |
|  | 2. High | $877 | $5,702 | $4,960 | $4,083 | 5.7 | 6.0 | -25% |
| High (a) | 3. Low | $937 | $9,657 | $8,367 | $7,429 | 8.9 | 9.5 | -25% |
|  | 4. High | $1,162 | $9,657 | $8,367 | $7,205 | 7.2 | 7.7 | -25% |
| Max (a) | 5. Low | $2,241 | $30,301 | $26,771 | $24,530 | 11.9 | 12.5 | -25% |
|  | 6. High | $2,734 | $30,301 | $26,771 | $24,037 | 9.8 | 10.3 | -26% |

(a) Corresponds to SMD Cases Table 16 (b) NPV at 7% discount rate for costs and benefits incurred 2013-2026 (c) 3% discount rate (d) 11% discount rate (e) Reduction in NPV of net benefits compared with corresponding ‘progressive’ case.

#### Effect of discount rates

Changing the discount rate from 7% to 3% or 11% has negligible effect on the B/C ratios (Table 17), although it does affect the NPV of the projected stream of net benefits. At the 3% discount rate, these are about a third higher than at the 7% discount rate, and at the 11% discount rate they are about a quarter lower. The relative insensitivity of the outcomes to discount rate is due to the fact that both costs and benefits are dominated by capital costs incurred or avoided in specific years, and not by streams of energy expenditures or savings, as would be the case with an energy efficiency measure.

#### Cost and benefits by appliance type

Table 25 and Table 26 analyse the costs and benefits by appliance type, for the cases with the lowest and the highest B/C ratios in Table 17 (excluding the theoretical maximum cases). In the low case, air conditioners account for about 61% of total costs but 81% of total benefits. In the high case air conditioners account for about 67% of total costs but 88% of total benefits.

The program is also cost-effective for pool pump controllers and for water heaters – more so when the effect of water heaters on winter maximum demand is taken into account. Costs and benefits for electric vehicle chargers cannot yet be quantified because there is no information on which to base market projections.

Table 25. Costs and benefits by appliance type, Australia, worst case

|  | NEM SMD  Reduction in 2028, MW | Aust SMD  Reduction in 2028, MW | NPV Cost $m(a) | NPV Benefit $m(a) | NPV Net benefit $m(a) | B/C ratio  7% (a) |
| --- | --- | --- | --- | --- | --- | --- |
| Air Conditioners (SMD) | 1315 | 1428 | $414 | $3,947 | $3,533 | 9.5 |
| Pool pumps | 282 | 352 | $114 | $601 | $488 | 5.3 |
| WH (SMD) | 244 | 301 | $199 | $412 | $213 | 2.1 |
| Total (SMD) | 1840 | 2081 | $726 | $4,960 | $4,234 | 6.8 |
| WH (WMD) | 381 | 472 | $199 | $631 | $432 | 3.2 |
| WH (weighted) |  |  | $199 | $440(b) | $241 | 2.2 |

Corresponds to Case 8 in Table 17. (a) NPV at 7% discount rate for costs and benefits incurred over period 2014-2028 (b) Assuming 13% of the value of further capital investment per peak MW for water heating (412 + (631 – 412) x 0.13) = 440 is related to winter-peaking transformers and lines (see Appendix 1)

Table 26. Costs and benefits by appliance type, Australia, best case

|  | NEM SMD  Reduction in 2028, MW | Aust SMD  Reduction in 2028, MW | NPV Cost $m(a) | NPV Benefit $m(a) | NPV Net benefit $m(a) | B/C ratio  7% (a) |
| --- | --- | --- | --- | --- | --- | --- |
| Air Conditioners (SMD) | 2912 | 3157 | $616 | $9,440 | $8,824 | 15.3 |
| Pool pumps | 375 | 469 | $121 | $802 | $681 | 6.6 |
| WH (SMD) | 317 | 393 | $200 | $549 | $349 | 2.7 |
| Total | 3605 | 4020 | $937 | $10,791 | $9,854 | 11.5 |
| WH (WMD) | 492 | 613 | $200 | $841 | $642 | 4.2 |
| WH (weighted) |  |  | $200 | $587(b) | $387 | 2.9 |

Corresponds to Case 3 in Table 17. (a) NPV at 7% discount rate for costs and benefits incurred over period 2013-2026 (b) Assuming 13% of the value of further capital investment per peak MW for water heating (549 + (841 – 549) x 0.13) = 587 is related to winter-peaking transformers and lines (see Appendix 1)

#### Phase-out of greenhouse-intensive water heaters

All analyses to this point have been undertaken on the basis that the phase-out of greenhouse gas-intensive water heaters agreed by MCE in December 2010 will not proceed, beyond the States that have already implemented in (SA and Qld). If it does proceed then:

* among electric water heaters, off-peak water heaters (which are already load-controlled and therefore not contributors to peak load) would be progressively replaced by solar-electric and heat pump water heaters, of which a far greater proportion would be unsuitable for OP operation, and so would benefit from load control via the SAI;
* however, while the number of water heaters benefiting from load control would increase, the, the quantum of load reduction available from each solar-electric and heat pump water heater at SMD and WMD is lower. As the connection and activation costs per water heater are the same for al electric types, the B/C ratio would fall.

This is borne out by comparing Table 27 with Table 25 and Table 28 with Table 26. The MW reduction available from water heaters is lower but the costs are higher. In the low net benefit cases, the B/C ratio for water heaters falls from 2.4 to 0.9 (with WMD benefits included) and in the high net benefit cases the B/C ratio for water heaters falls from 2.9 to 0.9. However this RIS does not quantity the benefits to the grid of the rapid-response heat sink capacity that water heaters capable of DRM4 would be able to provide. Therefore inclusion of water heaters in the proposal is almost certain to be cost-effective even if the phase-out proceeds.

Table 27. Costs and benefits by appliance type, Australia, worst case –  
with phase-out of greenhouse-intensive water heaters

|  | NEM SMD  Reduction in 2028, MW | Aust SMD  Reduction in 2028, MW | NPV Cost $m(a) | NPV Benefit $m(a) | NPV Net benefit $m(a) | B/C ratio  7% (a) |
| --- | --- | --- | --- | --- | --- | --- |
| Air Conditioners (SMD) | 1315 | 1428 | $414 | $3,947 | $3,533 | 9.5 |
| Pool pumps | 282 | 352 | $114 | $601 | $488 | 5.3 |
| WH (SMD) | 168 | 196 | $283 | $220 | -$63 | 0.8 |
| Total (SMD) | 1765 | 1977 | $811 | $4,769 | $3,958 | 5.9 |
| WH (WMD) | 321 | 375 | $283 | $412 | $129 | 1.5 |
| WH (weighted) |  |  | $283 | $245(b) | -$38 | 0.9 |

Corresponds to Case 8 in Table 17. (a) NPV at 7% discount rate for costs and benefits incurred over period 2014-2028 (b) Assuming 13% of the value of further capital investment per peak MW for water heating (220 + (412 – 220) x 0.13) = 245 is related to winter-peaking transformers and lines (see Appendix 1)

Table 28. Costs and benefits by appliance type, Australia, best case – with phase-out of greenhouse-intensive water heaters

|  | NEM SMD  Reduction in 2028, MW | Aust SMD  Reduction in 2028, MW | NPV Cost $m(a) | NPV Benefit $m(a) | NPV Net benefit $m(a) | B/C ratio  7% (a) |
| --- | --- | --- | --- | --- | --- | --- |
| Air Conditioners (SMD) | 2912 | 3157 | $616 | $9,440 | $8,824 | 15.3 |
| Pool pumps | 375 | 469 | $121 | $802 | $681 | 6.6 |
| WH (SMD) | 207 | 244 | $275 | $294 | $19 | 1.1 |
| Total | 3495 | 3871 | $1,013 | $10,536 | $9,523 | 10.4 |
| WH (WMD) | 393 | 16 | $275 | $22 | -$253 | 0.1 |
| WH (weighted) |  |  | $275 | $259(a) | -$16 | 0.9 |

Corresponds to Case 3 in Table 17. (a) NPV at 7% discount rate for costs and benefits incurred over period 2014-2028 (b) Assuming 13% of the value of further capital investment per peak MW for water heating (294 + (22 – 294) x 0.13) = 259 is related to winter-peaking transformers and lines (see Appendix 1)

#### Cost components

The breakdown of cost and benefits for the lowest and highest net benefit cases is indicated in Figure 9. The actual AS/NZS 4755 interfaces on the appliances account for about 10-16% of the total costs, activation costs for 67-68% and participation costs for 16% to 23%.

The additional testing costs to industry and administrative costs to government are relatively minor. The enforcement of mandatory compliance with AS/NZS 4755 can in most cases be integrated with existing MEPS and energy labelling requirements (Appendix 4). The total administrative costs of the E3 program are about $10 million per year, of which about $1.5 million is for product check testing (DCCEE 2010). Based on the scope for administrative efficiencies, it is estimated that the proposal will add a maximum of $0.5 million per year to the E3 program budget. The NPV of costs from 2014 to 2028 is estimated at $3.9 million (at 7% discount rate). This is about 0.3-0.5% of the total projected costs of the proposal.

Figure 9. Costs and benefits under lowest and highest net benefit cases

Description: The net present value (NPV) of costs and benefits for two cases, shown as vertical bars. For Case 8 the NPV of costs is about 800 million dollars and the NPV of benefits is about 5,000 million dollars. For Case 3 the NPV of costs is about 1,000 million dollars and the NPV of benefits is about 10,800 million dollars. The costs and benefits are broken into elements. The largest single element of the costs is AC (air conditioner) activation. The largest single element of the benefits is AC summer maximum demand (SMD) reduction. 

#### Costs and benefits by jurisdiction

Table 29 and Table 30 summarise the costs and benefits by jurisdiction, for the lowest and highest benefit cases respectively. The proposal is cost-effective in all jurisdictions except Tasmania (in the lower net benefit case). NSW and Queensland account for around four fifths of the national benefits, and SA and WA for a further 14 per cent. B/C ratios are high in all jurisdictions expect Tasmania and Victoria. In Victoria the SMD reductions are significant due to high air conditioner ownership, but the marginal cost per peak kW is low (Table 9). In Tasmania, which is winter peaking, the benefits from SMD load control from air conditioners are low, as is the marginal cost per peak kW. The proposal is narrowly cost-effective for Tasmania in the low benefit case, but definitely cost-effective in the high benefit case.

Table 29. Projected costs and benefits by jurisdiction, worst Case

|  | Routine DLC Reduction available SMD 2028, MW | Costs $m NPV (a)(b) | Benefits $m NPV (a) | Net  Benefits $m NPV (a) | % net  national  benefits | B/C  ratio |
| --- | --- | --- | --- | --- | --- | --- |
|  |
| NSW | 650 | $215 | $1,684 | $1,470 | 34.0% | 7.8 |
| Vic | 305 | $142 | $209 | $66 | 4.2% | 1.5 |
| Qld | 719 | $217 | $2,220 | $2,003 | 44.8% | 10.2 |
| SA | 101 | $38 | $204 | $166 | 4.1% | 5.4 |
| WA | 197 | $73 | $464 | $391 | 9.4% | 6.3 |
| Tas | 29 | $11 | $10 | -$2 | 0.2% | 0.9 |
| NT | 44 | $15 | $128 | $112 | 2.6% | 8.3 |
| ACT | 38 | $13 | $40 | $27 | 0.8% | 3.1 |
| Aust | 2081 | $726 | $4,960 | $4,234 | 100.0% | 6.8 |
| NEM region | 1840 | $637 | $4,368 | $3,730 | 88.1% | 6.9 |

Corresponds to Case 8 in Table 17. (a) NPV at 7% discount rate for costs and benefits incurred over period 2014-2028 (b) Excludes effect of national administrative costs of $3.9 million

Table 30. Projected costs and benefits by jurisdiction, best Case

|  | Routine DLC Reduction available SMD 2028, MW | Costs $m NPV (a)(b) | Benefits $m NPV (a) | Net  Benefits $m NPV (a) | % net  national  benefits | B/C  ratio |
| --- | --- | --- | --- | --- | --- | --- |
|  |
| NSW | 1279 | $272 | $3,759 | $3,487 | 35.4% | 13.8 |
| Vic | 598 | $182 | $451 | $269 | 2.7% | 2.5 |
| Qld | 1427 | $311 | $4,934 | $4,623 | 46.9% | 15.8 |
| SA | 194 | $44 | $427 | $383 | 3.9% | 9.7 |
| WA | 331 | $81 | $853 | $772 | 7.8% | 10.5 |
| Tas | 44 | $11 | $16 | $5 | 0.1% | 1.5 |
| NT | 84 | $22 | $275 | $254 | 2.6% | 12.8 |
| ACT | 62 | $15 | $75 | $61 | 0.6% | 5.2 |
| Aust | 4020 | $937 | $10,791 | $9,854 | 100.0% | 11.5 |
| NEM region | 3605 | $835 | $9,662 | $8,827 | 89.6% | 11.6 |

Corresponds to Case 3 in Table 17. (a) NPV at 7% discount rate for costs and benefits incurred over period 2014-2028 (a) Excludes effect of national administrative costs of $3.9 million

#### Delayed Implementation for EV Chargers

Unlike the other appliances, where annual sales volumes are in the hundreds of thousands, and can be projected with reasonable confidence, there is no EV market at present on which to base sales projections. If such a market does develop, there will be complex and at present unforeseeable interactions between EV numbers and capabilities, home recharging and non-home recharging patterns. One of the few predictable factors is that home rechargers would create a major load that, if it is not managed, will further exacerbate network problems.

The potential magnitude of the increase in peak demand from EV charging has been estimated in a recent study for the AEMC (AECOM 2012). If charging is unmanaged, the most likely combination of EV ownership and recharging behaviour is projected to lead to an increase of about 723 MW in the peak demand in the NEM by 2026 (Table 31). The worst case scenario – where all charging takes place during peak periods and with higher-power chargers – could see a peak load impact of nearly 3,000 MW.

This represents the maximum potential for peak reduction through direct load control, whether by use of AS/NZS 4755 interfaces or other means. It could increase the overall peak load benefits of load control using AS/NZS 4755 by between 21% and 105% (Table 31). These numbers can indicate two opposite effects. On the one hand they represent the potential increase in the impacts of the proposal if EV chargers participate. Conversely, if EV chargers were not controllable, then 21% to 105% of the potential load reduction from controlling air conditioners, pool pumps and water heaters could be negated by uncontrolled EV charging.

An assurance that peak load risk can be managed at low cost would overcome one of the barriers to the development of a home recharger market. Including EV charge/discharge controllers in the overall AS/NZS 4755 strategy would provide that assurance to the principal stakeholders, including electricity distributors, electricity retailers, prospective EV suppliers and prospective suppliers of home EV charge/discharge controllers.

Table 31. Potential peak load impacts of EV charging

| Electric vehicle ownership scenarios | Region | Potential increase in peak demand from EV charging | | | | Peak reduction available from other appliances 2028 | | Potential increase in impact from EVs (h) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| MW 2015 | MW 2020 | MW 2030 | A. MW 2028(c) | B. Min MW (d) | C. Max MW (e) |
| Most likely case (a) | NEM | 35 | 385 | 1,005 | 830 | 1,913 (d) | 3,605 (d) | 23-43% |
| SWIS (WA) | 5 | 50 | 155 | 124 | 197 (e) | 516 | 21-38% |
| Highest load case (b) | NEM | 140 | 1,570 | 4,130 | 3,404 | 3,228 (f) | 6,517 (f) | 52-105% |
| SWIS (WA) | 20 | 220 | 630 | 510 | 331 (g) | 605 | 73-88% |

(a) Central take-up-scenario 50% charging in peak periods, all with Level 1 (15 A) chargers (AECOM 2012, Table 33). (b) Central take-up-scenario 100% charging in peak periods, all with Level 2 (32 A) chargers (AECOM 2012, Table 33). (c) Interpolated (d) Routine load reductions, Table 16. (e) Table 29 (f) Emergency load reduction, Table 16. (g) Table 30 (h) Either increase in SAI-controllable load from SAI control of EVs, or extent of defeat of SAI control if EV load is not controllable. (For example, 830/3605 = 23%, 830/1913 = 43%).

## 5.5 Greenhouse impacts

The value of the proposal is primarily in the reduction of energy supply infrastructure costs, but the energy use permanently foregone during DR periods would lead to some minor reduction in greenhouse gas emissions. If there were a total of 30 hours of DR events impacting on participating air conditioners and pool pumps per year, the emissions reductions would reach nearly 10 kt CO2-e per annum by 2028, and total about 82 kt CO2-e between 2013 and 2028.

The potential for greenhouse reduction on the supply side depends on the amount of renewable energy that would otherwise be wasted, the share of water heaters and pool pumps capable of energy storage/time shifting (DRM4) and thereby displacing fossil fuel-generated energy, and the number of householders making their appliances’ DRM4 capability available to DLC programs. It is not possible to estimate these values at present.

There may be small energy costs for maintaining DR capability in some appliances, which need to maintain a low-voltage electrical potential across the circuits on the interface. For appliances with electronic controls (as is the case with nearly all new air conditioners and pool pump controllers), there should be no additional standby losses from maintaining the low-voltage capability.

Electric storage water heaters, and most solar-electric and heat pump water heaters, use mains voltage controls at present, so adding a low-voltage capability could also add a new source of standby energy loss. If so, this should be held to less than 1 W, the global benchmark level endorsed by Australian governments.[[54]](#footnote-54) At 1 W, the standby energy cost of maintaining DR capability in a water heater would be 8.76 kWh per year (equivalent to about 8 kg CO2-e). A 3.6 kW water heater could offset this by operating for about 2.5 hours per year under DRM4, to store heat at times when renewables-generated energy would otherwise be wasted.

There would also be additional standby losses associated with the receivers that activate the pathway from the smart meter HAN interface to the AS/NZS 4755 interface on the smart appliance. In the worst case, every such receiver would need a standby power supply of 1 W, and every non-meter DRED would also require a standby power supply of 1 W. (Activations using Controlled Load Relays on smart meters would not need an additional power supply). The total load from these devices could reach about 51 GWh per year by 2028, accounting for about 40 kt CO2-e per annum, or about 270 kt between 2014 and 2028. This would be lower if standby per device were less than 1 W, and if some devices used batteries.

The standby use of DR devices would probably be outweighed by the ability of appliances with activated DRM4 modes to make use of wind generation that would otherwise be wasted. Wind generation capacity installed in Australia in April 2012 totalled 2480 MW, producing about 6,800 GWh of energy annually. A further 14,000 MW are under consideration.[[55]](#footnote-55)

Increasing wind utilisation by just 1% would mean an additional 68 GWh displacement of fossil fuel generation each year, which would more than compensate for the standby losses from DR equipment. An AEMO study of the integration of wind energy in electricity markets found that:

‘Large amounts of new wind generation in South Australia may lead to frequent price collapse events there (up to 20% of the time), as interconnector capability is insufficient to transfer power to Victoria during times of high wind and low demand in South Australia’ (AEMO 2012).

The ability to use wind energy at short notice via DRM4-capable appliances would have significant economic as well as greenhouse impacts. Without this ability, at times of price collapse and export limitations from SA wind turbines may have to be disconnected before fossil generators (which have slower response). This would drive up the greenhouse-intensity of supply as well as reduce revenue for all generators, including wind.

# 6. Impacts and Consultations

## 6.1 Impacts on stakeholders

### Appliance and Equipment Suppliers

The majority of models would need to be redesigned, or packaged and supplied with additional components, to comply with the proposed regulation. This is not unusual – whenever higher MEPS levels are formally adopted, it is rare for more than a few models to comply at the time of announcement. Given sufficient notice, suppliers have been able to ensure that all their new models meet the requirements by the time the regulation takes effect.

#### Air conditioners

The proposed regulation would require that all air conditioner models up to 30 kW cooling capacity, imported or manufactured after mid 2014, must either:

* have an AS/NZS 4755.3.1 interface built in and ready to use; or
* be capable of achieving AS/NZS 4755.3.1 compliance with the addition of a standard part *and* the necessary separate part must be supplied with every model *and* the installation instructions must specify that the part must be installed.

About 230 of the air conditioner models registered at August 2012 (approximately 20% of the total) are known to be capable of meeting the proposed regulation now. However, a number of the suppliers of the models indicated as having ‘no capability’ in Table 4 are well aware of AS/NZS 4755.3.1, having participated in its development, and are developing models that will comply. The industry associations and the six global brands represented on the Standards working group account for over 90% of the retail market for household air conditioners in Australia.[[56]](#footnote-56)

In November 2011 DCCEE sponsored a 2-day APEC workshop on smart appliance standards for air conditioners in Seoul, Korea. At the Workshop two global air conditioner manufacturers – Daikin and Electrolux – called for AS/NZS 4755.3.1 to be adopted as a global air conditioner demand response standard.[[57]](#footnote-57)

The technical changes required to make an air conditioner model minimally compliant with AS/NZS 4755.3.1 are relatively minor. Only DRM1 capability is necessary. Given sufficient lead time, there is no technical reason why all the suppliers of air conditioners to the Australian market cannot make these changes. It has been estimated that the changes would increase the prices by about $10 per unit. This represents less than 1% of the $1,053 average retail price of household size models sold in 2009 (which averaged 5.7 kW cooling capacity).

Some air conditioners with AS/NZS 4755.3.1 interfaces will inevitably end up in aged care or commercial applications, where interruption of operation would be unacceptable. If so, the installer need not activate the interface, and even if the interface is activated, the owner or manager of the facility would presumably decide not to enter a DLC contract with the utility.

#### Swimming Pool Equipment Suppliers

For pool pump-unit controllers (PPCs), most of the design and manufacture is done in Australia. Importers as well as local manufacturers were represented in the standards process that led to the publication of AS/NZS 4755.3.2, as were the pool industry associations. Given sufficient lead time it is expected that the industry will be able to adjust.

Nearly all pools have a main filtration pump. Some of these also operate additional functions such as pumping water through rooftop solar heating panels. Where a single pump does filtration only, or filtration plus other duties, interruption during a DR event will cease all functions. This means that the cost of a single activated PPC will be set against the benefit of reducing not just the filtration load, but possibly other loads as well. Some pools have multiple pumps, each serving a different load. In these cases the value of establishing DR for pumps other than the filtration pump would be much lower. Therefore it may be cost-effective to exempt pumps that cannot be used for filtration from the requirement to have an integral AS/NZS 4755 interface.

Although AS/NZS 4755.3.2 is intended to apply to products generally used in the residential pool market, some may end up in commercial applications, where strict requirements on filtration and sanitisation make interruption of operation unacceptable. If so, the installer need not activate the interface.

#### Water Heater Suppliers

At the time of writing, the AS/NZS 4755.3.3 covering demand response requirements for electric and electric-boosted water heaters has yet to be published, although an advanced draft has been prepared by the relevant Working Group of Standards Committee EL-054. Publication of draft standard is expected in early 2013. It will closely follow Parts AS/NZS 4755.3.1 and 3.2, and cover three main technology types: electric storage water heaters, solar-electric water heaters and heat pump water heaters.

Although MCE endorsed the policy to phase out electric resistance water heaters from new and existing houses because of their high greenhouse gas-intensity, even if this policy is implemented smaller electric storage water heaters would remain on the market for apartment and commercial use.[[58]](#footnote-58) It is these smaller units, which are not suitable for off-peak tariffs due to their limited heat storage capacity, which will benefit most from DLC using AS/NZS 4755.

The circuit between the SAI and the DRED requires voltages levels of no greater than 34.5 V. Very few electric water heaters use voltages below 230 V at present, but given sufficient lead time, there is no technical reason why all the suppliers of electric, solar-electric and heat pump water heaters to the Australian market cannot make the necessary design changes.

The representation on the water heater working group of EL-054 covers 100% of the Australian market for electric water heaters, the great majority of the market for heat pump water heaters, nearly all of the producers of storage tanks for solar water heaters and nearly all the producers of water heater temperature controls. Importers as well as local manufacturers are represented, as is the water heater industry association.

#### Electric Vehicle Charger Suppliers

This is an undeveloped market at present. A few vehicle manufacturers are importing small numbers of vehicles to test the market, and it is expected that these would have to be sold (or leased) with home rechargers, which are also likely to be imported.

There is considerable work still to be done to standardise plugs and other aspects of chargers (Standards Australia 2009). This provides a window of opportunity to incorporate AS/NZS 4755 requirements into the emerging standards framework. A Working Group of Standards Committee EL-054 has drafted the relevant part of AS/NZS 4755, and publication of the standard is expected in early 2013. The Working Group includes several suppliers of EV charging services.

#### Competition

The development of demand response standard AS/NZS 4755 has been broad-based and competitively neutral, in that most (in some cases all) of the manufacturers and importers of the affected products have participated directly. Many other companies have been represented via their industry associations. There is nothing in the standards that technically favours local manufacturers over importers, or vice versa.

However, it is possible that suppliers with longer product development lead times or longer overseas supply chains could have more difficulty in ensuring that all their models comply by the target implementation date. Some suppliers may choose to withdraw from the market. If so, the number of models available on the Australian market could decline temporarily. This has been expected to occur whenever higher MEPS levels have been implemented for air conditioners, refrigerators and freezers in the past. However, post-implementation market analyses have found that changes of this kind have not produced lasting reductions in model range or consumer choice, or price increases in the past (EES 2010, EnergyConsult 2010).

### Builders, Installers and Electricians

The presence of an AS/NZS 4755 interface makes no difference to the procedures, complexity or costs of appliance installation – the installer can simply ignore the interface, as is the case with other optional features which may be ignored or de-activated at installation. (Although in the case of air conditioners supplied with a separate interface component, the manufacturer instructions must require that it be fitted, even if not activated.)

Alternatively, installers could make provision for activating the interface at the request of the client, as a value-adding service to the client, as an agent for the energy utility, or if required by local building or planning regulations (as may become the norm for new construction). Given the existing level of interest by energy utilities and others, there are likely to be incentives or market demand for activation at the time of installation. As installers could charge for this service (either to the utility directly, or the householder), they would in effect be in a position to appropriate some of the economic value created by demand response.

As the stock of SAI-equipped appliances builds up in the community, there will also be new market opportunities for installers and electricians to install DREDS and complete activation pathways either before or after appliance installations. Builders of new homes can add value for both home buyers and electricity suppliers if they ensure that the AS/NZS 4755 interfaces on the air conditioners, electric water heaters and pool pumps are activated at the time of construction. It will still be up to the homebuyers and residents whether they wish to participate in a DLC program but the utility will be able to offer a more attractive incentive because the activation costs will already have been incurred.

### Electricity Suppliers

#### Network Operators

The objective of the proposal is to support the development of a large scale direct load control strategy as a viable and cost-effective alternative to the conventional means of meeting peak load. It would directly impact on the businesses of the distribution and transmission network service providers (DNSPs and TNSPs) which are responsible for the infrastructure investment needed to accommodate growth in electricity demand and to maintain security and quality of supply.

There is a range of possible distributor responses to the build-up of AS/NZS 4755-compliant appliances in their supply areas, from ignoring them to providing cash incentives to customers to participate. The close involvement of several DNSPs and the Energy Network Association (ENA) in the development of AS/NZS 4755 strongly suggests that many will support the purchase of appliances not just with minimal demand response capabilities (DRM1) but with higher capabilities (e.g. DRM2 and DRM3 for air conditioners), and offer incentives for participation in DR programs, whether in form of rebates for appliances, regular cash payments or access to more attractive tariffs.

Many distributors will consider demand response options voluntarily (as indicated by the expressions of support reported in the present Consultation RIS) or will be required to do so by state legislation (in Queensland). Even those not disposed to consider adopting a demand response strategy may be required to do so if their recoverable revenues are constrained by AER determinations, or AER assessment of their capex proposals determines that DR would be the more prudent investment strategy (see 2103 Rule Changes, Appendix 1).

#### Electricity Retailers

Electricity retailers do not directly bear the costs of network investment, but they do have to pay the DNSPs for use of the network. The other major part of their cost is wholesale energy. It may suit them to call DRM1 and DRM2/3 events at times when there is no network stress, but wholesale energy prices are high. At summer peaks, both conditions tend to be present.

While electricity retailers can also derive cost savings and business benefits from DLC, they will most likely have to negotiate with the network operators on DLC operational issues and the sharing of costs and benefits. For example, it is possible that the retailers rather than the DNSPs will have to handle communications with customers regarding enrolment and on-going participation in DLC programs.

It may also suit retailers to call DRM4 events (to bring forward pool pump operation, EV charging and energy storage in water heaters) at times when the cost of energy is low, zero or even negative, as can occur when wind generation is on the point of being disconnected. However, this could in turn create local demand peaks that impose costs on DNSPs.

#### Generators and System Managers

Generators will be less directly impacted than DNSPs, TNSPs or retailers, although as DLC programs mature it is possible that energy retailers or demand response aggregators could bid load reductions into the pool in direct competition with generation.

Over time, the growing DLC capability built on AS/NZS 4755 appliances could alter the cost-benefit equations for various forms of generation. Owners of intermittent generators such as wind farms could contract with DR aggregators. The latter could offer users incentives to purchase and activate pool pump controllers, water heaters and EV chargers with DRM4 (store energy) and EV chargers with DRM8 (return stored energy to grid) capabilities, and contract the distributed energy storage services to the network.

The development of ‘smart grids’ and capabilities such as DLC, and price-responsive DR (that is subject to dynamic user preferences rather than DLC contracts), will require new approaches to system management. The cost of developing these approaches will need to be incurred anyway. Mandating AS/NZS 4755 interfaces for appliances will not add to these costs, but the growth in DLC participation which the measure is intended to promote will almost certainly influence the direction of system management.

### Regulators

#### Building and development regulators

A high proportion of new dwellings are now equipped with air conditioners at construction. About 50% of new dwellings built in NSW in 2008 had a refrigerative air conditioner installed, and a further 4% had ductwork ready for an air conditioner (BASIX 2009). Many new houses are also equipped with electric-boosted water heaters (solar or heat pump) and some with swimming pools. It is understood that some State regulators are considering using building and planning regulations to make AS/NZS 4755 interfaces mandatory for air conditioners installed in new homes.[[59]](#footnote-59) New dwellings also represent an obvious opportunity for the networks to require the installation of smart meters, which can act as the mode of communications with SAI-equipped appliances.[[60]](#footnote-60)

If a smart meter equipped with a Controlled Load Relay and an air conditioner equipped with an AS/NZS 4755 interface are both installed at the time of construction, it could become a requirement of the planning or building regulations that the meter should be cabled to DRM1 on the air conditioner (or if no air conditioner is installed, to the position where a future air conditioner would most likely be located). It would still be up to the electricity supplier to enrol the occupant in a DR program. The householder may prefer to connect via DRM2 or DRM3 (if available on that unit), in which case an authorised person would need to attend to change the cable from the default DRM1 position to another position.

#### Electricity Price Regulators

The costs of adding AS/NZS 4755 interfaces to appliances will be borne by appliance buyers, not electricity consumers (although of course the groups largely overlap). The Australian Energy Regulator will, however, have to approve the inclusion of activation costs and other elements of large scale DLC programs in projected expenditures if the DNSPs are to take advantage of the interfaces. Unless the costs can be passed through to network users, and/or the value of the assets included in the rate base, such programs will be less financially attractive to DNSP management.

The present RIS indicates that if AS/NZS 4755 interfaces were widely available, the benefits in terms of costs avoided (by all electricity users, not just those directly participating in DLC programs) would significantly exceed the costs of activation. The interface would therefore support a viable business case for DLC programs that are not currently cost-effective.

If the viability and reliability of DLC programs using AS/NZS 4755 interfaces is demonstrated, the AER may require that DNSPs investigate the scope for such programs as lower-cost alternatives to network expansion or reinforcement, when preparing the case for each 5-yearly price determination. The AER has publicly indicated that it would look very favourably on alternatives that limit the price impost from further investment in supply infrastructure, and is now empowered to do so by the Rule Change described in Appendix 1.[[61]](#footnote-61)

The Australian Energy Market Commission’s *Power of Choice* final report states:

‘Direct load control will continue to play an important role in managing peak demand across the NEM. We have focussed our analysis more on establishing the arrangements for metering because we consider that there are significant issues with the current arrangements that are preventing efficient investment. With respect to direct load control, we note that the recommendations regarding the demand management incentive scheme (as discussed in chapter 7) will aid networks investment and use of load management technologies. The proposed standardisation of air conditioner DLC control mechanisms and functionality through the AS 4755.3.1 interface is also expected to reduce transaction costs and enable more use of DLC’ (AEMC 2012b).

The relevant AEMC recommendation in Chapter 7 of the *Power of Choice* is:

‘To complement these reforms, we recommend that changes are made across the following areas:

• Reform the application of the current demand management and embedded generation connection incentive scheme to provide an appropriate return for DSP projects which deliver a net cost saving to consumers. This includes creating separate provisions for an innovation allowance’ (AEMC 2012b).

In its *Draft Report: Electricity Network Regulatory Frameworks*, the Productivity Commission states

‘…reflecting on the package of reforms proposed by this Inquiry, the Commission recommends that the Australian Government (including with the involvement of Standards Australia) should undertake a cost-benefit analysis of mandating a ‘demand response capability’ into the manufacturing standard of suitable appliances. Such an analysis should appropriately focus on the option of direct load control of air-conditioners, but also consider the suitability of other future options. Any such initiative should be subject to a careful analysis and show why alternatives would be worse. That would include evaluating the likelihood and timeframe over which market solutions, or other similar international standards would develop and, hence, whether an accelerated adoption would yield net benefits in preparation for smart meters and mandatory time-based tariffs. The analysis should consider the costs of departing from international standards as it could be unduly costly to prematurely mandate a standard in the absence of international momentum in that direction.’ (PC 2012)

The present RIS addresses all of the points raised by the Productivity Commission.

### Householders

It is estimated that incorporating AS/NZS 4755 interfaces would add about $10 to appliance prices – this represents less than 1% of the price for air conditioners, electric and electric-boosted water heaters, and perhaps 2 to 3% for swimming pool pumps and controllers.

The activation costs would in the order of $50 to $180 (Table 12), but these are likely to be met by the DNSP in return for an agreement to participate in a DLC program. It is assumed that participation will be voluntary, so householders who choose not to do so will pay no activation costs and derive no direct monetary benefits. Even so, they will still benefit indirectly because network costs to all electricity users are expected to be lower than otherwise, assuming that a sufficient proportion of other users do participate. (See Box 1)

Householders who decide to participate will need to make decisions about the DRMs they wish to make available for control. If the only available pathway is a single relay on the meter (or the householder does not want to use the wider DR functions available via a HAN or DRED), the decision will be relatively simple – in almost all cases they will nominate the air conditioner (DRM2 if available, DRM1 otherwise). The utility may offer advice on more complex options.

Householders who choose to participate in DLC programs could experience one or more events each year – most likely during summer peak days – when the appliances they have agreed to allow the utility to control will modify their operation. Trials show that householders are unlikely to notice operating changes at all during DLC events (Appendix 3). If they do notice a change and wish to continue the appliance operation, AS/NZS 4755 provides for optional manual over-rides on products other than air conditioners.

Where a DLC event affecting air conditioner occurs during a period of high temperature, there will be a rise in internal temperature until normal operation resumes, and then a gradual reduction, but the comfort conditions at the start of the event may not be recoverable that day. Utility trials (Appendix 3) show that the great majority of users are prepared to accept this in return for either a monetary or a non-monetary benefit. If they find this unacceptable once they experience it in practice, they would have the option of withdrawing from the DR program.

## 6.2 Consultations

### Industry Forums

The level of awareness and preparedness of the appliance industry with respect to the proposal is comparable to that at the Consultation RIS stage of previous regulatory proposals for implementation of MEPS. Representatives of the electricity supply and air conditioner industries began meeting to discuss the problem of peak demand in February 2004. This informal grouping, which came to be known as the Australian Demand Management Forum, comprised:

* Government agencies: the Australian Greenhouse Office (predecessor of DCCEE), the National Appliance and Equipment Energy Efficiency Committee (predecessor of E3) and the National Framework for Energy Efficiency (NFEE);
* Air conditioner suppliers: Air conditioning and Refrigeration Equipment Manufacturers Association of Australia (AREMA), Australian Electrical and Electronics Manufacturers Association (AEEMA – since absorbed into the Australian Industry Group, AIG), Consumer Electronics Suppliers Association (CESA) and some individual companies;
* Electricity suppliers: Energy Networks Association (ENA), Electricity Retailers Association of Australia (ERAA) and several individual distributors;
* Others: Copper Development Centre (CDC), Standards Australia, Energy Users Association of Australia (EUAA).

The Australian Demand Management Forum group formed the nucleus of Standards Committee EL-054 (see Appendix 4). The E3 program has participated in the Australian Demand Management Forum and in EL-054 from the beginning. The E3 Committee first alerted the air conditioning industry to the possibility that AS/NZS 4755 compliance could be mandated in September 2005. Since then E3 has held at least annual briefings on progress on the demand response (originally called the Australian Household Energy Load-Management Platform, or A-HELP).[[62]](#footnote-62) The possibility of demand response for swimming pool equipment was first raised by E3 at a swimming pool industry forum in Melbourne in March 2005, and at a number of industry forums since.

### International Stakeholders

If there were global standards for appliance interaction with smart grids, and if the appliances covered by this RIS met those standards, there would be no need for AS/NZS 4755. However, this is not the case now, and is not likely to be the case for the foreseeable future. E3 has maintained close contact with international developments in this area since 2005, monitoring, observing and advising relevant organisations and companies of the concept and progress of AS/NZS 4755. Interactions have included:

* Presentations on AS/NZS 4755 by E3 representatives at international meetings, including the triennial Energy Efficiency in Domestic Appliances and Lighting (EEDAL) conferences in London (2006), Berlin (2009) and Copenhagen (2011), and European Council for an Energy Efficient Economy (ECEEE) meetings in 2008 and 2011.
* Meetings on demand response between E3 representatives and officials of the California Energy Commission (CEC), European Union and the International Energy Agency (IEA) Demand Side Program;
* Standards Australia/ENA participation in the International Electrotechnical Commission (IEC) Smart Grid Strategic Group;
* Participation by E3 representatives in IEC Technical Committee TC59 Working Group 15 *Connection of household appliances to smart grids and appliances interaction,* which first met in October 2012;
* E3 sponsorship of an APEC workshop on Smart Appliance Standards for Air Conditioners and other appliances, in Seoul, in November 2011. This was attended by several global air conditioner manufacturers and several policy-makers from other countries;
* Meetings between E3 representatives, Standards Australia and proponents of relevant communications standards and protocols, including the ZigBee Alliance;
* Chinese electricity utilities have approached Standards Australia and DCCEE to seek further information on AS/NZS 4755, with a view to its possible adoption in China.

These interactions have kept E3 informed of related developments and have led to the conclusion that there would be no public benefit, and considerable risk, in deferring the adoption of AS/NZS 4755 in Australia.

As AS/NZS 4755 is the only standard of its type in the world, DCCEE is participating in IEC smart appliance processes, with the aim having AS/NZS 4755 adopted as an international standard.

# 7. New Zealand

The New Zealand government is not consulting on the mandatory adoption of AS/NZS 4755 interfaces at this time. However, the government has indicated its interest in exploring the potential for improving energy efficiency through ‘smart’ technologies. The modelling presented for New Zealand in this proposal has been developed at the request of the trans-Tasman Equipment Energy Efficiency (E3) committee, which New Zealand co-funds. The modelling is based on the methodology described in Chapter 5, except where indicated otherwise.

## 7.1 Policy and regulatory background

The Energy Efficiency and Conservation Authority (EECA), together with the Ministry of Economic Development, are responsible for setting regulations to improve the energy performance of appliances through the Energy Efficiency (Energy Using Products) Regulations 2002.

However, the successful deployment of appliance demand response is contingent on the implementation and adoption of other elements of the smart grid, including advanced metering devices and appropriate tariff structures.

In New Zealand, policy development in the area of smart or advanced metering is the responsibility of the Electricity Authority, and therefore related action to regulate demand response in appliances, such as that proposed in this RIS should be informed by the work of the Authority.

The Authority is currently undertaking a major review of its Electricity Industry Participation Code 2010 (Code) provisions on metering, and this includes development of Code governing Advanced Metering Infrastructure (AMI). The new Code is planned to be implemented late 2012 and will ensure that an advanced metering infrastructure (AMI) is installed and operated in a way that benefits the long-term interests of consumers.

In the absence of regulation on smart metering, there needs to be strong electricity industry support for the use of demand response features of appliances before New Zealand would mandate appliance demand response as a stand-alone requirement.

Australia and New Zealand have a common end-use energy efficiency framework, which seeks to ensure that:

* ‘The same regulatory standards apply to suppliers in both countries, offering improved economies of scale in local production and reduced compliance costs.
* It stimulates the development of world-class products and helps to create fairer competition in marketing products.
* Consumers are able to make informed purchasing decisions as a result of a greater number of energy-efficient products available on the market with consistent standards and labelling schemes in each country.
* Efficiency regulators deliver common regulatory proposals with resultant public sector resource savings.
* It fulfils the obligations of the Australia New Zealand Closer Economic Relations Trade Agreement and the TTMRA [Trans-Tasman Mutual Recognition Arrangement].’[[63]](#footnote-63)

Participating in the E3 program addresses the priorities identified in the New Zealand Energy Strategy 2010-2021 and the New Zealand Energy Efficiency and Conservation Strategy 2011-2016 (MED 2011).[[64]](#footnote-64) The Strategy’s Electricity System Policy states that:

‘Building on the solid framework and incentives in place for the electricity market, the Government will promote a coordinated approach to emerging electricity system technologies. The Government will further consider its role in promoting new electricity industry development and in addressing market failures and system constraints on new technologies. The scope of this work includes

* The future role of distributed generation and barriers to its deployment.
* The impact of new renewable generation technologies on the electricity system.
* System requirements of smaller-scale generation technologies.
* Demand management opportunities, including opportunities for more efficient use of electricity.
* The risks, opportunities and growth path of smart grid infrastructure.
* Smart metering opportunities and risks.
* The Government will monitor industry rollout of smart meter, smart network and smart appliance technologies, to promote consumer choice and a more efficient electricity system.’ (MED 2011).

Therefore the demand response technology which is the subject of the present RIS is consistent with the general aims of the Strategy, as is the adoption of common technical standards with Australia.

## 7.2 Impacts on New Zealand

If Australia continues a BAU strategy (Policy Option 1) or encourages voluntary adoption of AS/NZS 4755 interfaces (Policy Option 2) the impact on New Zealand will be negligible. Given the conclusion that these options would be insufficient to overcome the market barriers to large scale take-up of demand response strategies in Australia, where there is a severe and growing problem of peak load, where utilities have trialled demand response programs and where national smart metering standards incorporate AS/NZS 4755 compatibility, it follows that there would be even less chance of Options 1 and 2 being effective in New Zealand, where these factors are not present.

If AS/NZS 4755 interfaces are mandated through energy efficiency regulations in Australia (Policy Option 3) this could impact on products sold in New Zealand, even if the measure is not mandated there. For air conditioners, only 2% of registered models nominate their target market as New Zealand only. The other 98% nominate either Australia only (23%) or both countries (75%). This indicates that if Australia were to make AS/NZS 4755 compliance mandatory for air conditioners, New Zealand buyers would almost certainly receive these products, and would have to pay any consequent price increases. It is unlikely that air conditioner suppliers would go to the trouble of differentiating their model ranges in order to gain a fractional price advantage in the New Zealand market – indeed the costs of product segregation in the supply chain may well exceed the cost of the interface, which is estimated to add A$10 per unit sold.

On the other hand, the water heater models on the New Zealand and Australian markets are sufficiently different to suggest that if New Zealand did not mandate AS/NZS 4755 interfaces for water heaters, they would not be built into New Zealand products. Of the water heater models registered for MEPS compliance, 49% are available in New Zealand only, 23% in Australia only and 28% in both markets. The degree of overlap in the pool pump-unit market is not known.

At the same time, the availability of AS/NZS 4755 products would offer the New Zealand Government and electricity supply industry an opportunity to use them for direct load control (DLC) programs.

The following analysis of the potential benefits of such a strategy has been restricted to the impact on the winter maximum demand of the heating-mode operation of reverse cycle air conditioners (generally known as ‘heat pumps’ in New Zealand), for the following reasons:

* Typically, New Zealand-wide demand peaks are generally associated with cold weather events, during which domestic heating demand is high (EC 2010);
* Demand response in appliances which contribute mainly to summer peak demand is still of limited value, although it is understood that air conditioning loads are growing rapidly in the Upper North Island. Although some pool pumps may be operating at time of WMD, the ownership of pools is much lower than in Australia;[[65]](#footnote-65)
* At present, the electric water heating load is largely managed by off peak tariffs, as is the case in Australia. Unlike Australia however, there are no plans to phase out this load in favour of solar-electric or heat pump water heaters, so there is no requirement for an alternative control strategy for water heaters.

The New Zealand Government has decided not to regulate home area network interfaces or other load control aspects of smart meters, other than the preservation of existing off-peak control capability (Beatty 2010). However, trials in Australia have shown that the AS/NZS 4755 interface technology can be readily accessed via ripple control or other means (Table 11), so the ability of New Zealand electricity distributors and electricity users to take advantage of its capabilities is not dependent on the adoption of any particular metering technology. This makes it unnecessary to model the rate of smart meter rollouts in New Zealand, or to test the impact of cost assumptions related to smart meters.[[66]](#footnote-66)

It is assumed that as AS/NZS 4755 compliant air conditioners appear on the New Zealand market, they will be activated via separate DREDs (probably ripple-controlled, but not necessarily) in the same proportion as are activated via DREDs in Australia (Table 13).

Figure 10 compares the projected share of New Zealand households with reverse cycle air conditioners (i.e. those capable of heating), with the projected share of Australian households with air conditioners capable of cooling (including cooling only types). For new reverse cycle split units, which account for about 87% of the New Zealand sales, the maximum electrical power rating on heating is about 1.7 kW, the same as the power rating on cooling for new split units in Australia (E3 2010). This means that the winter maximum demand reduction available per unit participating in a direct load control program in New Zealand is similar to the summer maximum demand reduction per participating unit in Australia (Table 10).

## 7.3 Costs and benefits

The value per marginal kW of ‘mass-market’ (residential sector) load added or avoided in NZ is estimated at NZ$284 per year (Concept 2008, Table 11). This has been translated into a notional once-off capital cost imposed at the time of installing a kW of appliance load, by discounting a 15 year stream of annual costs at a rate of 5%. This gives a NPV of NZ$2,958/kW, compared to the A$2,900/kW weighted average for Australia (Table 9).

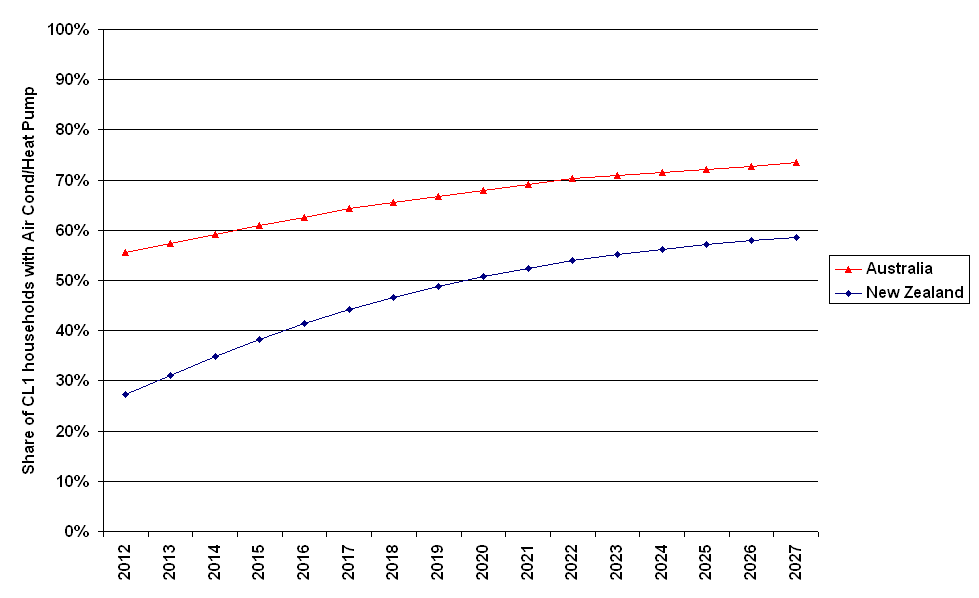
Under the low activation rate, high connection cost scenario the NPV of projected costs is NZ$72.9 million: NZ$27.1 million for appliance interfaces, NZ$36.9 million for DRED and connection costs and NZ$8.5 million for DLC program administration costs (NZ$20/yr per participant). Appliance testing costs are not included, because they would be covered by the Australian program. The NPV of projected benefits is NZ$400 million for avoided infrastructure costs (there is no benefit assigned to avoided energy cots). This gives a B/C ratio of 5.5. Assuming a higher activation rate and lower connection cost would increases the net benefit to NZ$632 million and the B/C ratio to 8.9.

Table 32. Option NZ3 and sensitivity tests, New Zealand (air conditioners only)

| Activation rate | Participation rate, 2028(a) | Connection Cost | MW Reduction  at WMD 2026 | Costs $m NPV | Benefits $m NPV | Net benefit $m NPV | B/C ratio |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Low | 26% | Low | 100 | $65 | $400 | $335 | 6.2 |
|  | 26% | High | 100 | $73 | $400 | $327 | 5.5 |
| High | 50% | Low | 177 | $80 | $712 | $632 | 8.9 |
|  | 50% | High | 177 | $90 | $712 | $622 | 7.9 |

All values NZ dollars. NPV at discount rate of 5%. (a) Share of heat pump owners participating in DR programs.

The minimum participation rate to achieve cost-effectiveness is estimated at about 3.0% of New Zealand air conditioner owning households, provided that electricity suppliers or other parties offer demand response activation services and contracts. In the event that no party in New Zealand offers demand response programs or tariffs sufficient to motivate customers to make use of the DR capability of heat pumps with AS/NZS 4755 interfaces, there could be a cost to New Zealand air conditioner/heat pump buyers of up to NZ$27.1 million (NPV, incurred over the period 2014-2028) without any direct financial benefit.

Figure 10. Projected heat pump/air conditioner ownership, New Zealand and Australia

Source: ES (2010)

# 8. Conclusions and Recommendations

## 8.1 Conclusions

The objective of the proposal is this RIS is **to contribute to reducing the future investment requirements for electricity network, generation and transmission infrastructure caused by growing peak demand, and so contribute to containing the total cost of electricity supply to consumers.**

The RIS has assessed specific options to achieve this objective by the introduction of demand response technology. Such options are unlikely to fully address the issues of peak demand, but would have a significant impact and would support and complement other approaches. The assessment does not include a detailed analysis of Time of Use or Critical Peak pricing options, as this is beyond the scope of the RIS, but the proposals in the RIS are assessed within the context of the potential for time-variable pricing.

Although time-variable pricing is likely to support the realisation of the benefits of the proposed demand response initiative, the availability of a low-cost, reliable means of demand response for air conditioners and other selected appliances during times of peak demand would contribute to the objective of containing the total cost of electricity supply to consumers, irrespective of the type of tariff or pricing.

Electricity users, electricity suppliers and other stakeholders would all benefit from the widespread availability and use of appliances equipped with smart appliance interfaces (SAI), but no group of stakeholders can be assured of gaining enough of the benefit to take the steps necessary to bring this about. Furthermore individual buyers of SAI-equipped appliances may derive no benefit from their purchase until a sufficient number of other households also purchase such appliances, and the concentration of SAI-equipped products in the community reaches the threshold required for electricity suppliers to develop and offer DLC contracts. This is a case of market failure due to a positive network externality.

As long as there is a lack of standardisation, neither appliance manufacturers nor energy utilities can risk committing to a single type of smart appliance technology. Achieving a critical mass of smart appliances requires a minimal degree of standardisation and Government intervention to overcome the market failure.

While many possible approaches and pathways have been under discussion for a number of years, there is no prospect of global standards for smart appliances in the foreseeable future, or even national standards in the countries where Australia sources its air conditioners. The most advanced standard for interfacing appliances with the grid is AS/NZS 4755. The flexibility of the AS/NZS 4755 interface lowers risk for all parties, because it enables the same smart appliances to operate in a range of communications, metering and home area network environments, and does not preclude future technological developments.

Several global air conditioner manufacturers have indicated their support for the adoption of AS/NZS 4755 as a global standard. The other priority appliances for direct load control – electric, solar-electric and heat pump water heaters and pool pump-unit controllers – are mostly designed and built in Australia, so AS/NZS 4755 could be applied with minimal risk.

Although AS/NZS 4755 was published over three years ago, the extent of voluntary compliance with it has not been sufficient to assure the critical mass of appliances necessary to justify a large scale development of demand response strategies by electricity distributors. If Australia continues a BAU strategy with regard to compliance with AS/NZS 4755 (Policy Option 1) or relies on voluntary adoption of AS/NZS 4755 interfaces (Policy Option 2), the impact will be negligible.

A mandatory requirement that all target appliances sold after mid 2014 comply with AS/NZS 4744 (Policy Option 3) would be both effective and cost-effective. It is projected that the net present value (NPV) of the benefits accrued to 2028 would most likely range between $4,234 million at a benefit/cost ratio of 6.8 and $9,854 million at a benefit/cost ratio of 11.5. The benefit/cost estimates vary only slightly with discount rates used (Table 17).

The total MW of appliance load available for curtailment during a summer emergency peak load event in the NEM region is projected to total between 3,228 and 6,517 MW by 2028. This would be equivalent to between 37% and 75% of the total projected growth in summer peak demand. In a non-emergency (or ‘routine’) summer peak load event, with air conditioners reduced to 50% load (for a total of no more than 30 hours per year) and pool pump and water heater loads switched off completely during those times, the SMD reduction available in the NEM region would be 1,913 to 3,605 MW, equivalent to 22% to 41% of the total projected growth in summer peak demand between 2013 and 2028 (Table 16).

While the benefits of equipping appliances with AS/NZS interfaces can be realised independently of smart metering, in-home displays and TOU pricing (as evident from Australian utility trials to date) there are many areas where benefits can be mutually reinforcing. One such area is the provision of AS/NZS 4755-compatible controlled load relays on all smart meters, so that the participation of households in demand response programs can be maximised.

The existing appliance labelling and MEPS regulations for air conditioners could be used to mandate compliance with AS/NZS 4755.3.1 as a condition for compliance with AS/NZS 3823 *Performance of electrical appliances—Air conditioners and heat pumps Part 2: Energy labelling and minimum energy performance standard (MEPS) requirements*.

For pool pump-unit controllers, it would be necessary to revise AS5102.2 *Performance of household electrical appliances—Swimming pool pump-units, Part 2: Energy labelling and minimum energy performance standard requirements* so that it cross-refers to AS/NZS 4755.3.2, and then mandate compliance with AS5102. For electric, solar-electric and heat pump water heaters, it would be necessary to first publish AS/NZS 4755.3.3 (currently being drafted). The existing MEPS regulations for electric storage water heaters, which call up AS1056, could be used to mandate compliance.

There would be advantages in introducing the requirement for smart interfaces for air conditioners, water heaters and pool pump-controllers at the same time. Energy utilities, electrical contractors and suppliers of products designed to access the smart interfaces could adjust to the changes in the market quickly, and households would acquire multiple smart appliances more rapidly.

The situation of electric vehicle rechargers is somewhat different from that of other products considered in this RIS. Apart from a handful of electric vehicles and rechargers locally made or imported for demonstration and research purposes, there is no industry and no real market in Australia for these products at present. However, as peak load management is a critical issue in EV market development, governments would give some assurance to stakeholders that the issue could be managed, by pre-emptively mandating that all electric vehicle rechargers must comply with AS/NZS 4755.3.4 (to be published in early 2013). This would give an early signal to the market and enable product designers to incorporate the requirements at minimal cost.

Mandatory implementation of the proposed measure in Australia would most likely mean that air conditioners sold in New Zealand would also have AS/NZS 4755 interfaces, although this would not necessarily apply to water heaters or pool pump-unit controllers. The minimum participation rate to achieve cost-effectiveness is estimated at about 3% of New Zealand air conditioner owners (compared with 2.5% in Australia). However, if New Zealand utilities chose not to offer such programs, there would be a small cost to appliance buyers in New Zealand, with no benefit.

### Risks

There are a number of risks to the realisation of the projected benefits of the proposal:

* that Australian utilities may not, after all, develop the commercial and technical aspects of demand response strategies to the point where they offer reliable alternatives (or at least reductions) to the continuing expansion of supply capacity;
* that utilities outside NSW, Victoria and Queensland (which already have near-complete coverage by communications platforms capable of supporting SAI-equipped appliances) do not develop the necessary communications platforms;
* slowness in the introduction of time of use electricity pricing that fully reflects the costs of meeting peak demand, so weakening the motivation for customers to participate in DLC programs;
* that electricity users will not take up offers of demand response contracts, if offered;
* that electricity users will withdraw from such contracts once they experience direct load control events; and
* that competing international standards will emerge to fragment the smart appliance market (the ‘Beta vs. VHS’ problem).

Leaving the choice of activation pathways and the timing of rollout programmes to the utilities (as envisaged in this RIS) is the least costly way to develop a market in direct load control services. If, however, it becomes apparent that utilities are not making use of the interface at a sufficient rate, the National Electricity Law gives governments powers to direct them to take certain actions with regard to smart meters, and these could be used – or extended – to increase the rates of demand response activity.

At the end of 2012, the confluence of public and government concern at rising electricity prices and the reviews under way of the national electricity rules, price determinations and demand side participation in the electricity market, suggests that the pressure for utilities to consider direct load control and smart appliance options in future planning will increase significantly.

If there were global standards for smart appliances and smart grids, and if the appliances covered by this RIS met those standards, there would be no need for AS/NZS 4755 or for mandating AS/NZS 4755. However, E3 has closely monitored international developments in this area since 2005 through participation in the relevant international organisations and its contacts with global companies, and has formed the view that workable smart appliance standards, other than AS/NZS 4755, are not likely for the foreseeable future. E3 is actively participating in, and to some extent leading, the co-ordination of international smart appliance standards. Furthermore AS/NZS 4755 has been explicitly designed for flexibility, so appliances can be made to work with any communication technology or protocols.

Table 33. Major risks

| Risk | Means to address or mitigate risk |
| --- | --- |
| 1. Distributors fail to develop demand response strategies as part of price determination submissions | AEMC could suggest changes to the National Electricity Rules as necessary (investigations currently under way) |
| 2. Lack of communication platform coverage outside existing coverage | Utilities in SA, WA, Tasmania and ACT are testing smart meters with a view to possible mass deployment. Even if no platforms are implemented outside NSW, Vic and Qld, about 85% of the potential national benefits could still be realised. |
| 3. No TOU tariffs, or TOU signals too weak to motivate participation | Consumers could be offered cash or other incentives to participate (trials currently under way) |
| 4. Consumers decline to participate | Test consumer response to offerings in trials (currently under way). |
| 5. Consumers withdraw from contracts | Test consumer reactions to actual demand response and appliance cycling events in trials (currently under way) |
| 6. Competing standards could confuse market, strand investments | Participate in and influence global ‘smart appliance’ standards development (currently under way) |

These risks, and the means for addressing and mitigating them, are summarised in Table 33.

At the time of writing, the Council of Australian Governments was planning to consider the issues arising from the Australian Energy Market Commission’s *Power of Choice* review (AEMC 2012c), which overlaps in its terms of reference with the Productivity Commission’s draft report on *Electricity Network Regulatory Frameworks* (PC 2012). It is likely that the issues of time of use pricing and smart metering will be clarified and progressed in ways that support and reinforce the proposals in this RIS.

The means or measures to address the others areas of risk are also in train. Electricity distributor DLC trials indicate that the risks to consumers of taking up demand response contracts are low, and can be mitigated through program and contract design. On the other hand, there is a risk that if the proposal is *not* implemented, little of the load reduction benefits expected from investment in smart grids and smart metering will be realised.

## 8.2 Recommendations

It is recommended that:

1. All air conditioners (up to 30 kW cooling capacity), electric, solar-electric and heat pump water heaters, pool pump-unit controllers and electric vehicle chargers manufactured in or imported to Australia after June 2014 should be equipped with AS/NZS 4755 smart appliance interfaces.
2. For air conditioners, the measure should be implemented by mandating compliance with the AS/NZS 4775.3.1:2012 *Interaction of demand response enabling devices and electrical products—Operational instructions and connections for air conditioners.*
3. From the implementation date, all air conditioners within the scope of AS/NZS 4755.3.1 should be ‘demand response capable’ within the meaning of AS/NZS 3823.2:2009 *Performance of electrical appliances—Air conditioners and heat pumps*; i.e. fully compliant with AS/NZS 4755.3.1 without the need to purchase further parts or components.
4. For pool pump-unit controllers, the measure should be implemented by mandating compliance with AS/NZS 4755.3.2:2012: *Interaction of demand response enabling devices and electrical products—Operational instructions and connections for swimming pool pump-unit controllers*.
5. For electric and electric-boosted water heaters, the measure should be implemented by mandating compliance with AS/NZS 4755.3.3 *Interaction of demand response enabling devices and electrical products—Operational instructions and connections for electric and electric-boosted water heaters* (forthcoming).
6. For electric vehicle chargers, the measure should be implemented by mandating compliance with AS/NZS 4755.3.4 *Interaction of demand response enabling devices and electrical products—Operational instructions and connections for charge/discharge controllers for electric vehicles* (forthcoming).
7. To maximise the probability that AS/NZS 4755-compliant appliances will be activated effectively and rapidly, governments should ensure that AS/NZS 4755 standards for demand response enabling devices are finalised as soon as possible.
8. Governments should work with the electricity supply industry to promote to appliance buyers the value of higher levels of demand response in appliances (above DRM1, the minimum mandatory level).
9. To support the above, governments should implement the mandatory disclosure of demand response capability levels in point of sale information (on energy labels or by other means).
10. Governments should commence a review of progress on large scale residential sector demand response and direct load control programs, not more than 3 years after implementation of the proposed measure.

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## Appendix 1: Projected growth in electrical energy, peak demand and network expenditure

Electricity generation, transmission and distribution systems must be designed to meet peak loads, which in Australia generally coincide with the coldest and the hottest days of the year. As peaks are of relatively brief duration (usually hours) the full capacity of the system is under-utilised and earns much less return on the capital invested in it than if the load curve were flatter. Figure 1 is a typical ‘load duration curve’ for a network with a high concentration of domestic air conditioners, in this case the South West Interconnected System (SWIS) centred on Perth. The demand exceeds 90% of the maximum demand for less than 40 hours per year. In other words, the system is under-utilised for nearly all of the time.

This situation is not expected to improve. In most regions of the National Electricity Market (NEM)[[67]](#footnote-67) and in WA, summer peak demand is projected to increase at a greater rate than energy use, which means that the ‘load factor’ of the system – an indicator of the efficiency of capital utilisation – will fall (Table 1).

In all NEM regions other than Tasmania, summer maximum demand (SMD) has been significantly higher than winter MD (WMD) over the past decade, indicating that cooling rather than heating has been the main contributor to system peak load (Table 34). SMDs in 2011-12 were significantly lower, and not typical of the preceding decade, in that 2011 was the first cooler than average year since 2001.[[68]](#footnote-68) In 2010-11 the highest ratios of SMD to WMD were in WA, SA and Victoria, because those States have both high ownership of air conditioners and high use of gas heating, so raising SMD and restraining WMD. The ratio for NSW was lower, because of lower natural gas availability and higher use of electricity for winter heating. Table 35 summarises the latest projections of SMD and WMD.

Table 34. Actual winter and summer maximum demand, 2010-11

|  | 2010  WMD MW | 2010-11  SMD MW | SMD/WMD |
| --- | --- | --- | --- |
| NSW+ACT | 13424 | 14683 | 1.09 |
| Vic | 8198 | 9978 | 1.22 |
| Qld | 7563 | 8908 | 1.18 |
| SA | 2523 | 3424 | 1.36 |
| Tas | 1784 | 1392 | 0.78 |
| Tot NEM (b) | 35764 | 40445 | 1.13 |
| NEM-wide (c) | 35049 | 37209 | 1.06 |
| Ratio of above | 0.98 | 0.92 |  |
| WA | 3274 | 4181(d) | 1.28 |

Source: AEMO (2012) (a) Medium demand growth, 50% Probability of Exceedence (POE) (b) Sum of State MDs, not coincident. (c) Coincident across NEM (d) IMO 2011.

Table 35. Projected winter and summer maximum demand, 2012-2022

|  | 2012-3 | | | 2021-22 | | | Change 2013-21 | | Annual change | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| WMD | SMD | SMD/WMD | WMD | SMD | SMD/WMD | WMD | SMD | WMD | SMD |
| NSW+ACT | 13441 | 13399 | 1.00 | 14935 | 14860 | 0.99 | 1494 | 1461 | 1.2% | 1.2% |
| Vic | 8486 | 9690 | 1.14 | 9763 | 11147 | 1.14 | 1277 | 1457 | 1.6% | 1.6% |
| Qld | 8199 | 9007 | 1.10 | 10696 | 11245 | 1.05 | 2497 | 2238 | 3.0% | 2.5% |
| SA | 2472 | 2778 | 1.12 | 2747 | 3015 | 1.10 | 275 | 237 | 1.2% | 0.9% |
| Tas | 1770 | 1371 | 0.77 | 1955 | 1516 | 0.78 | 185 | 145 | 1.1% | 1.1% |
| Tot NEM (b) | 34368 | 36245 | 1.05 | 40096 | 41783 | 1.04 | 5728 | 5538 | 1.7% | 1.6% |
| NEM-wide (c) | 33681 | 33345 | 0.99 | 39294 | 38440 | 0.98 | 5613 | 5095 | 1.7% | 1.6% |
| Ratio of above | 0.98 | 0.91 |  | 0.98 | 0.92 |  |  |  |  |  |
| WA (d) | 3274 | 4181 | 1.28 | 4365 | 6038 | 1.38 | 1091 | 1857 | 3.0% | 3.7% |

Source: AEMO (2012) (a) Medium demand growth, 50% Probability of Exceedence (POE) (b) Sum of State MDs, not coincident. (c) Coincident across NEM (d) IMO Power 2011.

#### Cost of Meeting Growing Peak Demand

The marginal cost of generation on the NEM varies every half hour, according to whether high-operating-cost generators (e.g. those using natural gas) are required to meet demand. Wholesale prices are capped under the NEM rules, although not otherwise regulated. Network charges do not generally vary by the half hour, although the Australian Energy Regulator (AER) approve network investment and hence pricing on the basis of expected aggregate load profiles and peak demands, among other factors.

Figure 11 indicates the projected network revenues for NEM jurisdictions for the period 2010-2014, as determined by the AER (which does not cover WA or the NT). The underlying data are in Table 37 to Table 43. Figure 12 illustrates the projected annual revenues per customer. AER determinations do not distinguish costs or revenues by customer class. About 88% of network customers in 2008 were residential (ESAA 2009).

As part of the AER’s determination process, it requests distribution network service providers (DNSPs) to indicate revenue requirements in standard categories, including return on capital, operating expenditure (‘opex’) and capital expenditure (‘capex’). Capex is further disaggregated into the investment required to connect new consumers, to replace assets at the end of their lives, to maintain prescribed reliability standards and to meet projected growth in peak demand. These categories have changed slightly over the period that the AER has been delivering determinations, and the initial values proposed by DNSPs are usually modified during the AER’s review and determination process. Many infrastructure investments service multiple objectives, so there is some uncertainty in the classification and different principles may be applied by different DNSPs. Table 44 presents our analysis of the DNSP estimates contained in AER draft and final decisions.

These estimates (summarised in Table 36) provide the best information publicly available of the investment in distribution infrastructure required solely or primarily for the purpose of meeting rising peak demand. Capex accounts for about 71% of DNSP revenue on the NEM (the other major elements are OPEX and regulated return on assets). In turn, peak demand growth accounts for about 38% of capex or 27% of total revenue requirement (without counting the impact of this expenditure on further increasing asset values).

Comparison of the expenditure with the projected growth in maximum demand over the same period gives an average cost per MW of increased peak load of $2,061 per kW across the NEM, or $239 per electricity customer per year over the lifetime of the latest 5-year price determinations. The cost per kW varies significantly by region and state, from about $3,020/kW in Queensland to $438/kW in Tasmania.

Table 36. Demand growth contribution to capex

|  | Quantity | Unit | Value | Source |
| --- | --- | --- | --- | --- |
| A | Average annual networks revenue | $m/yr | 9261 | Table 43 |
| B | Average annual network capex | $m/yr | 6322 | Table 44 |
| C | Capex related to demand growth | $m/yr | 2426 | Table 44 |
| D | Customers | (‘000) | 10132 | Table 43 |
|  | $/customer/yr related to demand growth | $ | 239 | D/C |
| E | Average Annual MW increase over 5 years | MW/yr | 1177 | Table 44 |
|  | Demand related capex/kW increase in peak |  | 2061 | E/C |

Information from Queensland indicates that generation and distribution investment adds about 16% to marginal cost per peak kW (DEEDI 2011). Information from EnergyAustralia, which for historical reasons has a transmission as well as a distribution network, indicates that the marginal transmission cost per peak kW adds about 14% to the cost per peak kW (AER 2009a).

Table 45 summarises the values used in this RIS for calculating the benefits of avoiding peak load growth in each State. The national weighted average value is $2,900/kW, nominally incurred in the year the kW is added.

#### Summer and Winter Peaking Sub-stations

While the system-wide peak in all mainland States now occurs in summer, the annual peaks on individual substations and transformers may occur at different times. Many sub-stations and transformers are still winter-peaking, and are projected to remain so. For those sub-stations, the ability to manage appliance load in winter is the critical factor in deferring or reducing capital expenditure. (This does not diminish the value of reducing summer load on those sub-stations, because this will still contribute to easing the system-wide summer load).

There are over 654,000 utility transformers in Australia (ESAA 2009). Of these about 10,600 are transmission-scale transformers, grouped in large sub-stations at the ‘connection points’ where energy is supplied in bulk to the distribution networks. The other 644,000 are rated at lower voltages, with the larger of these also grouped in sub-stations. The lowest voltage utility transformers, which are the most numerous, serve groups of streets, or clusters of buildings in regional areas.

The electricity transmission authorities in each State publish 10-year planning projections covering the main connection points. Some of these project actual loads in each year, which indicates whether the peak load on that point is expected to occur in summer or winter. Table 46 summaries the data for NSW, the ACT, Victoria and Queensland. (The SA and WA plans do not list each supply point, but the reports suggest that nearly all are summer peaking).

Figure 11. Projected annual network revenues, NEM Region 2010-14 ($m)

Description: Annual network revenues are shown as vertical bars broken down by jurisdiction (Queensland, ACT, NSW, Tasmania, Victoria and SA). The revenue total is about 8,100 million dollars in the financial year 2010 to 2011, rising to About 10,300 million dollars in 2013 to 2014.  Compiled from AER Determinations.

Figure 12. Projected annual network revenues per customer, NEM Region, 2010-14

Description: The annual network revenues per customer for SA increase from about 750 dollars in 2011 to about 880 dollars in 2014. For Tasmania, from 880 dollars in 2011 to 1,060 dollars in 2014. For Victoria, from 590 dollars in 2011 to 610 dollars in 2014. For NSW, from 780 dollars in 2011 to 940 dollars in 2014. For ACT, constant at $1,000 per customer. For Queensland, from 1,150 dollars in 2011 to 1,520 dollars in 2014. For the National Electricity Market as a whole, from 820 dollars in 2011 to 1,010 dollars in 2014. Compiled from AER Determinations.

Table 37. Most recent network pricing determinations, South Australia

| Total | | | | | | | |  | Per customer | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 2010-11 | 2011-12 | 2012-13 | 2103-14 | 2104-15 | Change/yr |  | 2010-11 | 2011-12 | 2012-13 | 2103-14 | 2104-15 | Change/yr | 5 yr avg |
| Revenue | $m | $610 | $656 | $703 | $754 | $802 | 7.1% | Revenue/yr | $736 | $783 | $831 | $882 | $929 | 6.0% | $832 |
| Sales | GWh | 11636 | 11543 | 11416 | 11354 | 11318 | -0.7% | kWh/yr | 14050 | 13772 | 13482 | 13283 | 13113 | -1.7% |  |
| Peak load | MW | 3159 | 3274 | 3361 | 3410 | 3477 | 2.4% | kW at MD | 3.81 | 3.91 | 3.97 | 3.99 | 4.03 | 1.4% |  |
| Customers | (000) | 828 | 838 | 847 | 855 | 863 | 1.0% | c/kWh | 5.2 | 5.7 | 6.2 | 6.6 | 7.1 | 7.8% |  |

AER (2010) Covers ETSA Utilities

Table 38. Most recent network pricing determinations, Victoria

| Total | | | | | | | |  | Per customer | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 2010-11 | 2011-12 | 2012-13 | 2103-14 | 2104-15 | Change/yr |  | 2010-11 | 2011-12 | 2012-13 | 2103-14 | 2104-15 | Change/yr | 5 yr avg |
| Revenue | $m | $1,515 | $1,466 | $1,565 | $1,667 | $1,619 | 1.7% | Revenue | $580 | $555 | $585 | $616 | $590 | 0.4% | $585 |
| Sales | GWh | 38228 | 39226 | 40208 | 41031 | 41723 | 2.2% | kWh/yr | 14627 | 14851 | 15039 | 15159 | 15197 | 1.0% |  |
| Peak load | MW | 8983 | 9322 | 9714 | 10074 | 10328 | 3.5% | kW at MD | 3.44 | 3.53 | 3.63 | 3.72 | 3.76 | 2.3% |  |
| Customers | (000) | 2613 | 2641 | 2674 | 2707 | 2746 | 1.2% | c/kWh | 4.0 | 3.7 | 3.9 | 4.1 | 3.9 | -0.5% |  |

AER (2010b) Preliminary decision: Covers CitiPower, PowerCor, Jemena, SP AusNet, United Energy

Table 39. Most recent network pricing determinations, New South Wales

| Total | | | | | | | |  | Per customer | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2103-14 | Change/yr |  | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2103-14 | Change/yr | 5 yr avg |
| Revenue | $m | $2,979 | $3,328 | $3,581 | $3,916 | $4,195 | 8.9% | Revenue | $700 | $775 | $826 | $894 | $948 | 7.9% | $829 |
| Sales | GWh | 57413 | 57501 | 57717 | 58156 | 57993 | 0.3% | kWh/yr | 13492 | 13395 | 13319 | 13283 | 13111 | -0.7% |  |
| Peak load | MW | 12647 | 12932 | 13467 | 13919 | 14360 | 3.2% | kW at MD | 2.97 | 3.01 | 3.11 | 3.18 | 3.25 | 2.2% |  |
| Customers | (000) | 4255 | 4293 | 4333 | 4378 | 4423 | 1.0% | c/kWh | 5.2 | 5.8 | 6.2 | 6.7 | 7.2 | 8.7% |  |

AER (2009a) Covers Country Energy, Energy Australian and Integral Energy

Table 40. Most recent network pricing determinations, Queensland

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Total | | | | | | | |  | Per customer | | | | | | |
|  |  | 2010-11 | 2011-12 | 2012-13 | 2103-14 | 2104-15 | Change/yr |  | 2010-11 | 2011-12 | 2012-13 | 2103-14 | 2104-15 | Change/yr | 5 yr avg |
| Revenue | $m | $2,363 | $2,669 | $2,981 | $3,291 | $3,517 | 10.5% | Revenue | $1,154 | $1,281 | $1,404 | $1,519 | $1,592 | 8.4% | $1,390 |
| Sales | GWh | 38287 | 39588 | 40916 | 42228 | 43732 | 3.4% | kWh/yr | 18698 | 18994 | 19265 | 19497 | 19797 | 1.4% |  |
| Peak load | MW | 7709 | 7996 | 8345 | 8655 | 8904 | 3.7% | kW at MD | 3.76 | 3.84 | 3.93 | 4.00 | 4.03 | 1.7% |  |
| Customers | (000) | 2048 | 2084 | 2124 | 2166 | 2209 | 1.9% | c/kWh | 6.2 | 6.7 | 7.3 | 7.8 | 8.0 | 6.8% |  |

AER (2010a) Covers Energex, Ergon

Table 41. Most recent network pricing determinations, ACT

| Total | | | | | | | |  | Per customer | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2103-14 | Change/yr |  | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2103-14 | Change/yr | 5 yr avg |
| Revenue | $m | $136 | $148 | $157 | $166 | $173 | 6.1% | Revenue | $834 | $893 | $933 | $972 | $1,001 | 4.7% | $927 |
| Sales | GWh | 2878 | 2952 | 2972 | 3018 | 3066 | 1.6% | kWh/yr | 17623 | 17828 | 17702 | 17729 | 17763 | 0.2% |  |
| Peak load | MW | 694 | 708 | 721 | 734 | 748 | 1.9% | kW at MD | 4.25 | 4.28 | 4.29 | 4.31 | 4.33 | 0.5% |  |
| Customers | (000) | 163 | 166 | 168 | 170 | 173 | 1.4% | c/kWh | 4.7 | 5.0 | 5.3 | 5.5 | 5.6 | 4.5% |  |

AER (2009b) Covers ActewAGL

Table 42. Most recent network pricing determinations, Tasmania

| Total | | | | | | | |  | Per customer | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 | Change/yr |  | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 | Change/yr | 5 yr avg |
| Revenue | $m | 344.7 | 303.0 | 309.8 | 313.5 | 323.06 | -1.6% | Revenue | $1,232 | $1,071 | $1,084 | $1,086 | $1,107 | -2.6% | $1,116 |
| Sales | GWh | 4620 | 4655 | 4960 | 4730 | 4780 | 0.9% | kWh/yr | 16512 | 16460 | 17355 | 16378 | 16381 | -0.2% |  |
| Peak load | MW | 1047.0 | 1082.0 | 1101.0 | 1124.0 | 1145 | 2.3% | kW at MD | 3.74 | 3.83 | 3.85 | 3.89 | 3.92 | 1.2% |  |
| Customers | (000) | 279.8 | 282.8 | 285.8 | 288.8 | 291.8 | 1.1% | c/kWh | 7.5 | 6.5 | 6.2 | 6.6 | 6.8 | -2.4% |  |

AER (2012) Aurora Energy

Table 43. Most recent network pricing determinations, Total NEM Area

| Total | | | | | | | |  | Per customer | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 2010-11 | 2011-12 | 2012-13 | 2103-14 | Average | Change/yr |  | 2010-11 | 2011-12 | 2012-13 | 2103-14 |  | Change/yr | 4 yr Avg |
| Revenue | $m | $8,203 | $8,781 | $9,676 | $10,383 | $9,261 | 8.2% | Revenue | $825 | $872 | $949 | $1,006 |  | 6.8% | $913 |
| Sales | GWh | 153074 | 155636 | 158334 | 160327 | 156843 | 1.6% | kWh/yr | 15388 | 15463 | 15534 | 15531 |  | 0.3% |  |
| Peak load | MW | 34521 | 35820 | 37120 | 38329 |  | 3.5% | kW at MD | 3.47 | 3.56 | 3.64 | 3.71 |  | 2.3% |  |
| Customers | (000) | 9948 | 10065 | 10193 | 10323 | 10132 | 1.2% | c/kWh | 5.4 | 5.6 | 6.1 | 6.5 |  | 6.5% |  |

Sum of Table 37 to Table 43. Not all States have projections to 2014-15. No determination for Tasmania yet available.

Table 44. Estimated breakdown of capital expenditure (capex) requirements over 5 years, distribution network service providers

| Purpose | ETSA | Ergon | Energex | QLD | Country | EnAust | Integral | NSW | ACT | Citipower | Powercor | Jemena | SPAusNet | United | Vic | Tas | NEM | WA(b) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2011-15 | 2011-15 | 2011-15 | 2011-15 | 2010-14 | 2010-14 | 2010-14 | 2010-14 | 2010-14 | 2011-15 | 2011-15 | 2011-15 | 2011-15 | 2011-15 | 2011-15 | 2013-17 | 5-year | 2013-17 |
|  | $m | $m | $m | $m | $m | $m (a) | $m | $m | $m | $m | $m | $m | $m | $m | $m | $m | $m | $m |
| Renew/replace/add assets | NA | 3103 | 1086 | 4189 | 806 | 3195 | 784 | 4786 | 173 | 331 | 648 | 275 | 489 | 252 | 1027 | NA |  |  |
| Growth (demand related) | 819 | 2076 | 2435 | 4511 | 1417 | 2781 | 1346 | 5544 | 69 | 229 | 242 | 143 | 321 | 205 | 1140 | 46 | 12129 | 1818 |
| Reliability, Quality | 407 | 125 | 287 | 412 | 899 | 367 | 73 | 1339 | 1 | 276 | 395 | 155 | 266 | 282 | 1310 | NA |  |  |
| Environment & safety | 166 | NA | 1717 | 1717 | 203 | 354 | 403 | 960 | NA | 16 | 48 | 27 | 95 | 51 | 237 | NA |  |  |
| Other | 59 | 345 | NA | 345 |  | 141 | 11 | 151 | 18 | 205 | 255 | 0 | 200 | 0 | 64 | NA |  |  |
| Total system assets | 1452 | 5649 | 5524 | 11173 | 3325 | 6838 | 2617 | 12780 | 262 | 1058 | 1588 | 600 | 1372 | 790 | 5407 | 535 | 31608 | 3581 |
| Non-system assets | 341 | 625 | 546 | 1171 | 684 | 543 | 336 | 1562 | 16 | 124 | 252 | 116 | 179 | 126 | 190 | NA |  |  |
| Total CAPEX | 1793 | 6274 | 6069 | 12344 | 4008 | 7381 | 2953 | 14342 | 278 | 1182 | 1839 | 715 | 1551 | 916 | 157 | NA |  |  |
| MW peak demand growth(c) | 398 | 491 | 1003 | 1494 | 445 | 821 | 875 | 2141 | 68 | 203 | 525 | 146 | 443 | 365 | 1681 | 105 | 5886 | 913 |
| $/kW (d) | 2061 | 4227 | 2429 | 3020 | 3183 | 3387 | 1539 | 2589 | 1019 | 1133 | 460 | 980 | 726 | 562 | 678 | 438 | 2061 | 1991 |

Source: Derived by author from AER Draft and Final Decisions (AER 2009a, 2009b, 2009c, 2010, 2010a, 2010b, 2010c, 2011) (a) Includes transmission assets within EA area.   
(b) Western Power 2012 (c) Over 5 year period of the determination (d) $m Capex for Growth (demand related) divided by MW peak demand growth x 1,000 for South-West Interconnected Network

Table 45. Estimated investment required per marginal peak load kW

|  | MW load growth | Distribution $/kW | Other (a) $/kW | Total $/kW | Rounded $/kW |
| --- | --- | --- | --- | --- | --- |
| NSW | 2589 | 2589 | 487(b) | 3076 | 3100 |
| Vic | 678 | 678 | 109 | 787 | 800 |
| Qld | 3020 | 3020 | 483 | 3503 | 3500 |
| SA | 2061 | 2061 | 330 | 2391 | 2400 |
| WA | 1370(b) | 2727(b) | 436 | 3163 | 3200 |
| Tas | 105 | 438 | 70 | 508 | 500 |
| ACT | 68 | 1019 | 487(c) | 1506 | 1500 |
| NT | 105 | 3020 | 483 | 3503 | 3500 |
|  | 9995 | 2471 | 416 | 2887 | 2900 |

(a) 15% allowance over distribution cost for transmission and generation investment. (b) Whole of WA values estimated at 50% higher than values for South-West Interconnected Network (c) Set equal to NSW value.

Nearly a third of bulk supply connection points in NSW are projected to remain winter peaking for the duration of the forecast period. Most of these are regional nodes in the west and south of the State, where there is a high demand for electric heating and no natural gas supply (while Victoria has a much higher demand for heating, the great majority of the load is met by gas. Queensland has much lower heating load than NSW, and even though this is met mainly by electricity, the winter peak has historically been offset by a high controlled water heating load.)

Table 46 indicates that over a quarter of the connection points on the NEM are projected to remain winter-peaking for the duration of the forecast period. Excluding Tasmania, the winter-peaking share is over 13%. This is at the highest level in the transmission system, but if a bulk supply point is winter peaking it means that the majority of the aggregated load it serves is also winter peaking. This ‘cascade effect’ means that the share of winter-peaking transformers at the lowest level is almost certainly higher than the 13% winter-peaking share of connection points in the mainland NEM – possibly as high as 18 to 20%.

Most of the winter-peaking connection points are smaller ones away from the capitals. Within the areas served by winter-peaking connection points, it is likely that the individual winter-peaking transformers are the most remote ones, since they are away from the regional towns which are served by natural gas. Thus the lower the voltage level the higher the probability that the transformer is winter-peaking. The more remote the load, the higher are the costs of ensuring supply standards and of maintaining and augmenting transformers, substations and distribution lines.

It is not possible to estimate the relative costs of adding or avoiding demand at any given geographical location without a detailed analysis of the entire system. However, the fact that there are so many winter-peaking connection points and transformers even within State systems that are otherwise summer-peaking indicates that measures that help control winter load still have a high value. Furthermore, the rate of growth in WMD is now projected to match or exceed the rate of growth in SMD in NEM regions (Table 35)

Table 46. Summer and winter peaking connection points by projected 2019/20 load

|  | Summer-peaking | Winter-peaking | Even load | TOTAL |
| --- | --- | --- | --- | --- |
| NSW+ACT (a) | 60 | 30 | 3 | 93 |
| Victoria (b) | 44 | 1 | 4 | 49 |
| Queensland (c) | 77 | 4 | 0 | 81 |
| SA (d) | 40 | 0 | 0 | 40 |
| Tasmania (e) | 0 | 48 | 0 | 48 |
| Total of NEM | 221 | 83 | 7 | 311 |
| SHARE OF TOTAL | 71% | 27% | 2% | 100% |
| Excluding Tasmania | 84% | 13% | 3% | 100% |

(a) Transgrid (2010) (b) AEMO (2010) (c) Powerlink (2010). Load connection points only (excludes power station busbars) Allocated on the basis of projected MW load (d) Number of load connection points from ElectraNet 2010; assume all summer peaking. (e) Number of connection points from Transend (2010); assume all winter peaking.

#### Effect of January 2013 Rule Changes

AER determinations are forward-looking assessments of the revenue required by the regulated DNSP over the coming 5-year period. Part of the DNSP’s calculation is the projected CAPEX required to meet projected net increments in peak load in each year of the period. The DNSP needs to assess the quantum of load added each year (or each month) and the shape (whether constant or varying by time of day/season), less the quantum and shape of load retired. For domestic customers this may be modelled at the population or household level or at the specific appliance stock level. For air conditioning load most DNSPs undertake detailed stock modelling.

The modelling in the RIS mimics the capital requirement calculation that DNSPs would need to undertake. If Ministers were to announce an intention in mid 2013 to require SAIs from mid 2014, then DNSPs preparing capital cost projections after that time would be able to project with certainty the rate of accumulation of SAI-equipped appliances in their area during the next determination period, and so compare the costs of meeting peak load via a (partial) load control strategy against one based solely on infrastructure construction. Recent changes to regulatory regime empower the AER (who would also be aware of the Ministers’ decision) to require DNSPs to make those calculations annually, even during the determination period (see extract, below). To the extent that the load control strategy led to a lower capital requirement, the total forward-looking revenue determination would be lower.

This RIS assumes that the projected availability of SAI-equipped appliances will be known to both DNSPs and the AER before the next regulatory periods, which are due to commence as follows: NSW and ACT (early 2014), SA (early 2015) Queensland (mid 2015), Victoria (late 2015) Tasmania (early 2017). The rule changes mean that the scrutiny is annual, funds not spent or spent imprudently can be clawed back, and there is now an obligation for DNSPs to consider demand side solutions.

##### From Summary of Rule Determination (AEMC 2012c)

###### Distribution annual planning process

Each distribution network service provider (DNSP) will be required to carry out an annual planning review covering a minimum forward planning period of five years. The planning review will apply to all distribution assets and activities undertaken by DNSPs that would be expected to have a material impact on the distribution network.

###### Distribution annual planning report

Each DNSP will be required to publish a distribution annual planning report (DAPR) by the date specified by the relevant jurisdictional government. The DAPR will report on the outcomes of each DNSPs annual planning review. Specifically, the DAPR will include information on:

• forecasts, including capacity and load forecasts, at the sub-transmission and zone substation level and, where they have been identified, for primary distribution feeders;

• system limitations, which may include limitations resulting from forecast load exceeding total capacity, the need for asset refurbishment or the need to improve network reliability;

• projects that have been, or will be, assessed under the regulatory investment test for distribution (RIT-D);

• other committed projects which are urgent and unforseen, or replacement and refurbishment projects, and which have a capital cost of $2 million or greater; and

• other high level summary information, to provide important context to DNSPs’ planning processes and activities.3

###### Demand side engagement obligations

Each DNSP will be required to develop a demand side engagement strategy. The strategy, which is to be documented and published, will detail a DNSP's processes and procedures for assessing non-network options as alternatives to network expenditure and interacting with non-network providers. DNSPs will also be required to establish and maintain a register of parties interested in being notified of developments relating to distribution network planning and expansion.

The final rule is one part of the AEMC’s broader work program to encourage more timely and meaningful engagement between network business, and consumers and other stakeholders. In addition to the new annual reporting and demand side engagement obligations on distribution businesses, our other work to enhance engagement includes:

• the power of choice review, which includes reforms designed to provide consumers with the information, education, incentives and technology they need to efficiently manage their electricity use through greater demand side participation; and

• the network regulation rule changes, which include proposals to encourage more timely and meaningful consumer engagement as part of the regulatory determination process.

###### Joint planning arrangements

DNSPs will be required to undertake joint planning with the owners of any connected networks where there are issues affecting multiple networks. The relevant network service providers will also be required to carry out the requirements of the existing regulatory investment test for transmission (RIT-T) for projects identified under the joint planning process. The final rule also provides some flexibility for the RIT-D to be carried out for joint planning projects where none of the potential options to address the network issue include a transmission component with an estimated capital cost greater than the RIT-T cost threshold level (currently $5 million).

###### Regulatory investment test for distribution

The RIT-D, which will replace the current regulatory test, establishes the processes and criteria to be applied by DNSPs in order to identify investment options which best address the needs of the network. The RIT-D will be applicable in circumstances where a network problem exists and the estimated capital cost of the most expensive potential credible option to address the identified need is more than $5 million. Certain types of projects and expenditure will be exempt from assessment under the RIT-D, including projects initiated to address urgent and unforeseen network issues and projects related to the replacement and refurbishment of existing assets.

The RIT-D rules set out the principles to which the test, when being developed by the Australian Energy Regulator (AER), must adhere. The RIT-D rules also include the procedural consultation requirements to be followed by DNSPs when applying the test. In summary, the RIT-D will require DNSPs to assess the costs and, where appropriate, the benefits of each credible investment option to address a specific network problem to identify the option which maximises net market benefits (or minimises costs where the investment is required to meet reliability standards).

## Appendix: 2 Demand Side Participation

#### What is demand side participation?

* Demand side participation (DSP) refers to the ability of consumers to make informed decisions about the quantity and timing of their electricity use, which reflects the value that they obtain from using electricity services.
* Consumers have a range of options through which to implement DSP, including peak shifting, electricity conservation, fuel switching, distributed generation and energy efficiency.

#### Why pursue demand side participation?

* Electricity consumers will shift or reduce their demand for electricity according to the incentives they face in the electricity market, in order maximise their own value.
* DSP is of interest to governments, regulators and operators because the individual or cumulative effects of these consumer decisions also result in benefits to the power system. Examples include deferring the need to augment distribution networks, or supporting system security and reliability during periods of high demand.
* Generation and network assets are built to meet the maximum demand in the system. Stakeholders have expressed concerns that assets are not utilised efficiently because of the increasing ‘peaky’ nature of demand.

#### Value of demand side participation

* DSP has two main sources of economic value within the electricity market:
* The value of lower generation costs: Consumer responses that avoid times of high wholesale demand may reduce generation operational costs, lower wholesale peak prices, avoid the need to build new generating infrastructure, or provide marginal improvements in reliability.
* The value of avoided network infrastructure costs: Consumer responses which dependably reduce demand in an area of network constraint can reduce the infrastructure augmentation required for reliable supply, avoiding the costs of new infrastructure.
* The incentives for consumers to act in a way that realises this value, and how this value is distributed among consumers and suppliers, will be determined by the market design, regulatory and commercial arrangements that are in place, including contracts and electricity pricing structures. However, there are a number of competing factors which need to be balanced when considering potential changes, to avoid unintended outcomes.

#### Business models for DSP

* As DSR is not costless, the objective should be to optimise, not maximise, DSP in the NEM. Appropriate market conditions would allow the market to find the appropriate level of DSP in the context of the National Electricity Objective.
* There is anecdotal evidence that new business models and new companies are emerging in the NEM to take advantage of DSP opportunities, particularly for customers exposed to wholesale prices:
* Large electricity users and some smaller companies are taking on contracts that expose them to spot market prices and are managing their own energy consumption. Customers can also contract with a distributor or transmission business to provide demand side response services.
* A number of companies have business plans based on the aggregation of loads for the purposes of offering packaged DSP to network providers and retailers. An ‘aggregator’ provides a facility to provide firm DSP to meet market or system events by contracting end users’ load reduction or distributed generation capacities to form commercial products.
* Electric vehicles could offer a form of DSP, since operators could coordinate the charging of a large number of vehicles, particularly to avoid peak periods.

#### Barriers to DSP

* A number of market conditions are necessary to facilitate DSP, and it is likely that sub-optimal levels of DSP currently exist due to continuing issues in each.
* **Pricing** (consumer incentives to respond): If electricity prices reflect the value of available resources (i.e. generation and network capacity), they will align the value to consumers from reducing their consumption with the long-term interests of consumers.
* **Information** (consumer willingness to respond): active participation is more likely to occur when consumers have sufficient information about the available opportunities, technologies, and services to manage energy demand. Issues in this area may include: consumer lack of interest and awareness regarding consumption and impact on costs; difficulty accessing information, and the complexity of this information; lack of information about demand side options; and lack of real-time information about energy costs.
* **Facilitative action** by distribution businesses: Choices for distribution businesses include whether to build infrastructure or to avoid/defer infrastructure building by facilitating DSP actions. Consideration should be given to whether current incentives and regulations mean that both options are in play in decision making by distribution businesses. This is a particular issue for distributed generation, where stakeholders have identified barriers including costly and time-consuming connection processes, and difficulty accessing information about network constraints and opportunities.
* **Technology and system capability** (consumer ability to respond): enabling technologies such as smart meters and/or in home displays are necessary to implement and make more effective the pricing structures which might underlie DSP, and to provide the information about energy cost and use to inform consumer decisions. Technologies such as smart appliances or distributed generation may be necessary for consumers to implement appropriate responses.

## Appendix 3: Consumer responses to real-time pricing feedback and direct load control

### Real-time Pricing Feedback

‘Real-time pricing feedback’ occurs when electricity users have access to a display with continuously updated information about how much electrical energy they are using and how much it is costing. The American Council for an Energy-Efficient Economy (ACEEE) has reviewed the results of nine large-scale trials carried out over the period 2009-2011. Half the trials involved time of use (TOU) pricing and half did not. There was also a trial involving pre-payment users in Northern Ireland, but as this represents an atypical group with lower income and an unusually strong incentive to manage electricity use, the ACEEE excludes this trial from the general findings.

The reductions in energy use (compared with a control group) ranged from 9.3% to 0%, with a simple average of 3.8%. When results are weighted by the number of participant in each trial the average saving falls to 2.1%. There is no indication that combining real-time feedback with TOU pricing increases the impact – on the contrary, the weighted average energy saving for TOU pricing was 1.4%, compared with 2.9% for non-TOU pricing.

Only three trials measured the impact on peak load. The simple average reduction in peak load energy use (compared with a control group) was 5.2% to 6.6%. When results are weighted by the number of participant in each trial the average reduction is 5.0% to 6.1%. The trials where load reduction was measured were all in the UK or Ireland, where air conditioner ownership is negligible. The measures which householders took to achieve energy and load reductions are not known.

Table 47. Results of selected trials of real-time pricing feedback

| Utility | Country | TOU | Partic- | Avg energy | Avg peak load savings | |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Pricing | ipants | Savings | Min | Max |
| Com ED CAP | US | Yes | 5550 | 0.0% |  |  |
| Stanford/Google power meter | US | No | 1065 | 5.7% |  |  |
| Cape Light Compact | US | No | 100 | 9.3% |  |  |
| Ireland CBT | Ireland | Yes | 938 | 3.2% | 11.3% | 11.3% |
| EDF | England | Yes | 740 | 5.8% | 4.0% | 8.0% |
| E.ON | England | No | 4781 | 2.8% |  |  |
| Scottish Power | Scotland | No | 1120 | 0.0% | 0.3% | 0.5% |
| SSE | UK | Yes | 1406 | 3.3% |  |  |
| Simple average of all trials | | |  | 3.8% | 5.2% | 6.6% |
| Participant-weighted average of all trials: energy | | | 15700 | 2.1% |  |  |
| Participants in TOU-pricing trials: energy | | | 8634 | 1.4% |  |  |
| Participants in non-TOU trials: energy | | | 7066 | 2.9% |  |  |
| Participants in trials where peak load is measured | | | 2798 |  | 5.0% | 6.1% |

Source: ACEEE (2012)

In most trials, the level of average energy and peak load savings were generally found to persist for the duration of the trial, although the households which made the largest initial savings tended to reduce over time.

The EDF trial found that customers on TOU rates achieved up to 8% reduction in peak electricity consumption, but these reductions occurred only for smaller households (one or two person) and primarily on weekends. Weekday savings were about 4%.

### Direct Load Control

Realisation of the benefits of the proposed ‘smart appliance’ interface will depend on a proportion of customers voluntarily entering into contracts with electricity suppliers or other commercial agents, whereby they surrender a degree of control over the operation of the appliance in return for a financial benefit, in the form of a cash payment (once-off or recurrent) or a favourable electricity tariff.

The assumptions in this RIS regarding the ratio of customers that will take up direct load control contracts are based on the following information and evidence:

* The demonstrated willingness of Australian consumers to enter load control arrangements for appliance in the past;
* Consumer surveys of willingness to enter load control arrangements for additional appliance types in the future;
* The dynamics of user interaction with specific appliances; and
* Australian electricity utility experience with load control trials.

#### Willingness of consumers to voluntarily enter load control arrangements

The wide use of off-peak water heating demonstrates that householders will readily accept load control of storage water heaters and may do so for other loads, in return for the benefit of lower energy bills, and provided they can opt out or otherwise reduce the risks of participation. Off-peak water heating is now so widely accepted that householders rarely opt out – although anyone can choose to revert to a ‘continuous tariff’ water heater which is never de-energised, and pay a price penalty.[[69]](#footnote-69)

In return for the benefit of a lower electricity price, the user willingly (or implicitly) accepts the following costs:

* A much larger storage tank than would be required by a continuously energised water heater, with the consequent loss of usable floor space or outdoor space;
* A higher standing heat loss penalty due to the larger tank: in effect the task efficiency of an OP water heater is slightly lower, so more energy is purchased (but at a much lower price);
* The (small) risk of running out of hot water between reheat periods; and
* The loss of control over the operation of the device.

#### Surveys of Consumer Attitudes

Householders are not usually concerned when storage water heaters or pool pumps are energised (or de-energised) so long as they provide the necessary service (adequate hot water and adequate pool). A high percentage are also willing to accept control for air conditioners and other appliances as well.

A CSIRO survey of over 2,000 appliance owners in four States in 2007 found that, after a short explanation of the concept and its advantages, a majority of owners expressed a willingness to have their appliances automatically controlled (Table 48). For every product, the share of owners willing to accept direct load control (DLC) is higher than the share among all respondents, indicating that familiarity with an appliance increases rather than decreases acceptance of DLC. Acceptance was highest among pool pump owners.

As awareness of utility DLC programs grows, appliance buyers are likely to pay more attention to the DLC capabilities of the appliances they buy. Under the proposal in this RIS, all models of the priority appliances would have to have DRM1, but other DRMs are optional. As suppliers gauge consumer preferences and if utilities offer incentives for customers to connect other DRMs, suppliers will offer these as well.

Customers who choose to participate in DLC programs will probably have a contract stating the maximum number of days or hours that the utility can call on each year, and the consequences (if any) of the user choosing to over-ride DR events. In order to reduce the perceived risk of accepting an automated demand response arrangement, users may wish to have the option of over-riding an interruption, e.g. to get an hour of pump operation in the event that the pool has a high swimmer load. Manual over-ride capabilities are recommended but not mandatory for products complying with AS/NZS 4755.

Table 48. Willingness to have appliances automatically controlled

|  | Product | % of respondents willing to accept control | |
| --- | --- | --- | --- |
| All respondents | Owners of product |
| Priority appliances covered in this RIS | Air conditioner | 52.8 | 61.0 |
| Electric water heater | 61.7 | 77.1 |
| Pool pump | 42.6 | 83.0 |
| Other appliances | Refrigerator | 50.4 | 50.4 (a) |
| Clothes dryer | 48.8 | 67.2 |
| Dishwasher | 51.1 | 69.2 |
| Clothes washer | 55.7 | 55.7 (a) |
| Freezer | 47.9 | 52.1 |
| Electric heater | 46.8 | 59.5 |

Source: CSIRO (2007) (a) Ownership not measured in this survey, but as it is near 100% for these appliances, % of owners would match % of all respondents.

#### The dynamics of appliance operation

Interruptions to water heating and pool pump operation and battery charging are the most acceptable to owners of those appliances (Table 49). Interruptions to air conditioners, dishwashers and clothes dryers are also acceptable to over 60% of owners. (No AS/NZS 4755 interface standards are planned for dishwashers because their contribution to peak load is negligible. Clothes dryers can have a significant impact in winter-peaking areas, but there are safety issues with stopping and restarting).

Users will not tolerate automatic curtailment of activities with high value to them and which cannot be rescheduled or substituted, e.g. having adequate light, watching TV and cooking. Table 49 represents the range of conditions conducive to the acceptance of load control. The end uses that are the most conducive are at the lower right (unshaded cells), and the opposite conditions at the upper left (dark shaded cells).

Table 49. Factors bearing on likelihood of user response to electricity pricing

| Impact on comfort and utility of varying usage | User interaction with appliance | | |
| --- | --- | --- | --- |
| High (least automated) | Medium | Low (most automated) |
| High (most likely to meet user resistance) | Direct interactions: TV, computers; lights | Heating water for immediate use | Refrigerator temperature setting |
| Medium | Routine household uses, e.g. cooking | Clothes washer, Clothes dryer | Temperature setting for space heating/cooling |
| Low (least likely to meet user resistance) | Occasional uses: ironing, vacuuming, etc | Dishwasher; combined clothes washer-dryer | Heating water for later use; pool pump operation; vehicle battery charging |

Unshaded cells represent end uses and appliances most suitable for demand response

In between these extremes are end uses such as ironing, vacuuming or the use of power tools, which could be rescheduled, at least in some households, with minimal inconvenience. However, once users start these operations, power interruption would be unacceptable. To the extent that these end uses can be made price-responsive at all, the conditions are likely to be advance notice of Critical Peak Price (CPP) periods or user awareness of TOU price periods, rather than automated response.

Another likely area of demand response is integrated cleaning/drying operations where the start can be delayed without penalty and no load transfer is required to complete the operation (e.g. dishwashers; and most combined clothes washer-dryers, which can only dry part of the maximum wash load). For separate clothes washers and dryers, delayed cycle start times and/or uncertain cycle completion times could be acceptable to some users but not others. For example, time-constrained users may want to be present to transfer clothes from the washer to the dryer (or the line) in time for them to dry that day. Interruptions to supply and unattended restarts during a cycle could raise safety and fire risk issues, especially for dryers.

Interruptions or constraints on the operation of refrigerators or freezers would lead to some upward drift in storage temperatures, which could increase the risk of food spoiling (although this could be addressed by over-riding the automated response if the door is opened during the interruption event).

#### Utility Trials in Australia

Trials in SA, Queensland, WA and NSW have demonstrated that most householders will tolerate interruption to air conditioner operation, provided that internal temperatures do not drift outside the comfort zone for too long. Air conditioner cycling trials (Table 50) have shown that the majority of occupants are not even aware when a DR event takes place, and of those that are aware, very few experience discomfort, especially if the air circulation fans continue to operate

However, DR programs will almost certainly allow householders to opt out if they find that DR events lead to unacceptable levels of discomfort or inconvenience. If that happens, there would no doubt be a reversion to less favourable tariffs and/or cessation of incentive payments.

Trial participation rates have varied from 5% to more than 30% of the targeted suburb or region (ENA 2011). However, this does not indicate the take-up rates in a general contract offering, because recruitment has been stopped once the utility has achieved the target number of participants for the trial.

Some of the results already reported by the trials are:

* 94% of survey respondents did not feel a significant impact to their comfort levels during air-conditioner cycling periods (Energex 2010);
* Over extended heatwave events and ambient temps up to 44°C (in 2008 and 2009), customers did not report effects on comfort levels for switching levels of 25% (i.e. 7.5 minutes off in each 30 minute period). Some customers were able to sustain up to 50% switching in ambient temps up to 41°C (ENA 2011);
* 90% of trail respondents indicated that they would participate again in similar programs (Energex 2010).

Table 50. Air Conditioner direct load control trials in Australia

| State, distributor | Trial Periods | Location | Commun-ication mode | Number of participants | Peak load reduction per participant (f) |
| --- | --- | --- | --- | --- | --- |
| ETSA Utilities, SA (d) | 2005-2009 | Adelaide | FM RDS(a) | 2,000 | 19-35% |
| ETSA Utilities, SA (d) | Dec 2010-Jun 2012 | Adelaide | 4G WiMAX | 1,000 |
| Energex, Qld (b) | 2008-2010 | Brisbane | Powerline Carrier | 3,500 | 13-27% |
| Energex, Qld (g) | 2011-2012 | Brisbane | Powerline Carrier | 200 | NA |
| Ergon, Qld (b) | 2008-2009 | Townsville, Magnetic Is | FM RDS & Powerline Carrier | NA | NA |
| Western Power, WA (b),(c) | 2008-2011 | Nedlands, Perth | Powerline Carrier | up to 2,200 | 20% |
| Western Power | 2011-2012 | Perth | Smart Meter | 380 | 20% (0.3-0.8 kW) with DLC; 0.1 kW without (g) |
| Endeavour Energy NSW(b) | 2009-2012 | Blacktown, Sydney | Powerline Carrier. Mesh Radio | 2,500 | 27%-36% |
| ActewAGL | Jun –Dec 2011 | ACT | NA | NA | NA |

(a) Frequency Modulated (FM) Radio Data System. (b) NSMP (2009). (c) Western Power (2009) (d) [www.etsautilities.com.au](http://www.etsautilities.com.au) (e) ENA 2011 (f) Deloitte 2012 (g) Personal communication, August 2012. Related trial of 500 participants in TOU pricing (no DLC) yielded average reductions of about 620 Wh in energy use over the 6 hour peak period, equivalent to 0.1 kW per participant.

## Appendix 4: Smart grid and demand response technologies and standards

### Communication Options

There are many options for communicating between the electricity supplier and the individual user, including internet, ‘mesh’ radio (in which signals are sent between shorter range receivers/repeaters), GSM or other mobile phone systems and the powerline itself.

One option widely used in Australia is ‘ripple control’ in which a control signal is superimposed over the normal alternating current wave-form. When the utility propagates a ripple signal from a local substation it will reach all user sites served by that substation. If there is a ripple receiver at the site it will respond, typically by switching a device such as a water heater on or off. Different utilities use different ripple systems and control strategies: some can only toggle receivers on or off as an entire group, while others can convey a wider set of instructions and address different groups of users via different signal frequencies. Frequency Modulated (FM) radio has also been used to broadcast control commands in some Australian demand response trials (Table 50). The receivers can be grouped so that different areas or zones respond differently, or at different times.

The device which ultimately receives the remote agent’s signal and initiates the change in appliance operation is termed a Demand Response Enabling Device (DRED) in Australian Standard AS4755-2007, *Framework for demand response capabilities and supporting technologies for electrical products.* Whatever system is used to get signals to the user’s site (ripple control, FM radio or other), there is no possibility of response without a final link to the appliance.

At present, the only way to externally control the load of most appliances is to cut off their power supply: the strategy used for off-peak water heaters. This it is not suitable for other appliances, for the following reasons:

* It prevents the appliance operating at a reduced level of service (e.g. half load cooling, or continued fan operation with the compressor off), which would be more attractive to many users, and enable them to participate in a DLC program which they might reject if the only option were complete loss of function;
* Many modern appliances have electronic controls which can lose settings when the appliance is de-energised (unless they have some battery backup);
* Appliances not designed for regular power interruption (as OP water heaters are) can interpret an interruption as a fault, and not automatically resume normal operation when the power is restored, unless reset by the user or a technician.

To overcome the disadvantages of complete de-energisation, it is possible to externally alter the control settings of an appliance so that it reduces load or ceases operation during a demand response event. This is the principle of the Programmable Communicating Thermostat (PCT) used in many demand responses programs in the US. However, the PCT is not suitable for Australia, because of differences in the types of air conditioner and in the patterns of air conditioner use (Table 52).

Most Australian utility trials to date (Table 50) have involved sending out technicians to break into the control circuits of users’ air conditioners (with their permission) to add a resistor. When the air conditioner receives an external demand response signal (via ripple control or FM radio), its control circuit is ‘tricked’ into interpreting it as a signal that the thermostat has reached the preset temperature, so compressor operation ceases irrespective of the actual temperature. This approach has proven expensive to implement and not suitable for all models. It requires the utility to make special arrangements with the manufacturer to get access to the control circuit wiring diagrams and agree on how the warranty implications will be handled – the manufacturer usually voids warranty and the utility assumes all risks. The newer trials are using the AS/NZS 4755 interface.

Some modern air conditioners already have the capability to over-ride the thermostat settings and limit their load to a preset level, without the need to break into their control circuits. The capability is present in the control software, or sometimes in an add-on card, and the user or an external agent can access it through pre-existing contacts without voiding warranty and without risking fault conditions. In some of the DR trials listed in Table 50 the utilities targeted models with this capability, but it was not possible to determine whether it was present, or could be added via a supplier-provided part, without a technician visit. Also, prior to AS/NZS 4755, different manufacturers used different external contact configurations, and the concentration of suitable products of any given type was too low to support a cost-effective demand response program.

### Elements of the ‘Smart Grid’

The DEWHA report *Smart Grid, Smart City: A new direction for a new energy era* gives the following definition of a Smart Grid:

‘Smart grid is a vision that includes a suite of applications, each in varied stages of maturity.

‘The applications can broadly be categorised into customer-side applications, grid-side applications, and enabling applications…

‘1. Customer-side applications

* Information (e.g. energy usage or CO2 information provided by website or in-home display)
* Controls (e.g. in-home displays, automated controls for appliances, programmable thermostats with communications)
* Tariffs that fluctuate with time of usage (e.g. Time of Use, Critical Peak Pricing, Real Time Pricing).

2. Key enabling applications

* Smart metering infrastructure (SMI) – known as advanced metering infrastructure (AMI) in Victoria.

3. Grid-side applications

* Integrated Volt-VAR control (including conservation voltage reduction)
* Fault detection, isolation and restoration (FDIR)
* Substation and feeder monitoring and diagnostics
* Wide-area measurement.

4. Renewable, distributed energy and electric vehicles

* Distributed storage (which may include electrical vehicle elements)
* Distributed generation enablement (e.g. solar photovoltaic on residential roof tops)
* Electric vehicle support

5. Data collection, processing and back-office’ (DEWHA 2009).

#### Smart Metering

There are many definitions of ‘smart’ electricity meters, but in general a smart meter will have at least the following capabilities:

* Two way communications with the utility (usually the electricity distributor, but possibly the gas and water distributor as well). This enables the customer’s energy use to be continuously monitored, and for information about changes in energy prices, emergencies etc to be conveyed to the user;
* Continuously monitoring and storing data on energy use (typically half hourly), compared with simply accumulating total energy use between readings, as with traditional meters. This function can be used for gathering data about load patterns, and also (but not necessarily) for time-of-use (TOU) pricing. It is possible to operate a smart meter with a simple flat tariff, or to switch between tariffs according to user preferences;
* The capacity to execute remote functions such as disconnect/reconnect, fault diagnosis, capacity limitation and basic load control and demand response functions, without the need for technician visits.

These capabilities are generally under the control of the utility, but smart meters may also have the capacity to interface with user-owned in-home displays (IHDs), home area networks (HANs) and smart appliances.

National technical standards for smart meters have been developed by the National Stakeholder Steering Committee (NSSC). No State or Territory governments are yet committed to a mandatory rollout except Victoria, where a roll-out is under way and scheduled for completion at the end of 2013.[[70]](#footnote-70)

#### In-Home Displays (IHDs)

A trial of Critical Peak Pricing (CPP) by EnergyAustralia, which gave IHDs to some participants but not others, found that there was ‘not a great deal of difference with and without IHD’ (NSSC 2009). An Integral Energy trial found that ‘those with IHDs reduced demand by around 41% on average compared to 37% for those without IHDs’ but that ‘IHD usage dropped from 85% at start of trial to only 55% 2 years later’ (NSSC 2009). Country Energy also ran a CPP trial in which participants had IHDs. It reported that participants reduced demand by 30% during CPP periods and reduced energy use by 4% on average, but did not report whether there were differences in response between IHD and non-IHD households.

Once customers enrol in TOU pricing, an IHD could well demonstrate the value of automated demand response with smart appliances, as distinct from relying on manual switching of appliances to avoid high-price periods. IHDs could also simulate how smart appliances would respond at various times and calculate the value of savings, to better inform customers considering participating in DLC programs.

Although the direct impact of IHDs on behaviour appears to be low (Table 47) and may fall off over time, IHDs could facilitate a transition to smart appliances by sensitising customers to prices. With advanced IHDs, customers could use the IHD to set the energy prices at which they would want specific appliances to switch off or reduce load.

### Standardisation

Standardisation can have both negative and positive impacts on the emergence of new technology. Where outcomes do not affect the public interest, the lack of standards or competing standards can be left to the market and to individual decision makers to resolve. When electronics manufacturers first introduced home video recording machines, BetaMax and VHS formats competed until VHS eventually prevailed, and individuals who purchased BetaMax lost the value of their investment.

However, lack of standardisation can be a public dis-benefit when the development of large-scale integrated systems is held back, the scale of investment is very large and there is a risk that public, rather than private investment will be stranded. Digital mobile telephony could not have developed as rapidly as it did without the government-backed adoption of Global Systems Mobile (GSM) standards (Koski 2005).

There is often a tension between standardising too many aspects of an emerging technology too soon and possibly precluding the development of better technical options, and standardising too late or not at all, with the result that the risks for commercial actors and consumers are so high that market development is stifled.

The *Smart Grid, Smart City* report identifies Standardisation as a major issue:

‘A potential barrier to a broader adoption of smart grid in Australia is the risk associated with installing technologies with a limited set of agreed standards. Lack of standards increases the risk of a stranded asset (i.e. utility deploys a technology that is no longer supported by the industry requiring de-installation of some applications prior to their expected lifetime). Standards can also help to reduce installation complexity, facilitate interoperability, and address security. Interoperability can provide third-parties, such as appliance manufacturers, the confidence and motivation to install smart grid equipment in their products. Finally, proven and accepted industry standards also reduce the utilities’ risk of being locked into one vendor solution’ (DEWHA 2009).

### Smart Appliance Standards: AS/NZS 4755

Australian Standard AS/NZS 4755 is intended to enable the large scale introduction of smart appliances despite the absence of any single agreed communications protocol, and to ensure that those appliances will be able to operate with any protocol. It is an open rather than a proprietary standard, and specifies minimum physical, functional and electrical requirements for an interface, analogous to the Universal Serial Bus (USB) standard which establishes communications between personal computers and the devices they control.

Some of the other smart appliance approaches currently being investigated are:

* A wireless link between the appliance and a HAN, smart meter or directly with the utility. There are several competing HAN standards and wireless standards (including ZigBee) and there is no agreement among appliance manufacturers to adopt any one of them[[71]](#footnote-71);
* A power-line carrier link between the appliance and a HAN, smart meter or directly with the utility. Again, there are several competing HAN standards and powerline standards (including HomePlug) and there is no agreement among appliance manufacturers to adopt any one of them;
* Each appliance to have its own Internet Protocol (IP) address, and to be connected to the internet via a WiFi capability and a home router, like a computer. This approach has no support among appliance manufacturers, although one advantage – if supported by energy utilities – is that it would be independent of meter type and would use a form of HAN that is already reasonably common in households. A disadvantage is that the HAN would not be secure and would be subject to conflict between user instructions and utility instructions.

AS/NZS 4755 provides for a flexible interface capable of linking to a range of communications pathways, including any of the above, so that pathways can be changed after appliance installation. This approach is also taken in the US Electric Power Research Institute’s Demand Responsive Appliance Interface project.[[72]](#footnote-72)

In late 2005, Standards Australia constituted a new Committee EL-054 *Remote Demand Management of Electrical Products.* This first met in May 2006 with representation from the Energy Networks Association (ENA), government agencies, AREMA, CESA, AIG, CSIRO Energy Technology, the Consumers Federation of Australia and the University of NSW.

Chaired by an ENA nominee, EL-054 initially concentrated on developing a framework for demand response (published as AS4755-2007 *Demand response capabilities and supporting technologies for electrical products*) and then established a sub-committee which developed AS4755.3.1-2008 …*Operational instructions and connections for air conditioners.* The air conditioner energy efficiency testing and labelling standard AS/NZS 3823.2:2009 *Performance of electrical appliances—Air conditioners and heat pumps* now cross-refers to AS/NZS 4755.3.1.

Pool pump controllers (PPC) and electric water heaters were incorporated into the EL‑054 process through the formation of Working Groups in 2009. Membership of the PPC working group was offered to all members of EL-15-025 *Energy Efficiency for Swimming Pool and Spa Pool Pumps*, (which drafted AS5102:2009 *Performance of household electrical appliances—Swimming pool pump-units*). Most EL-15-025 members participated in the development of AS/NZS S 4755.3.2. All major Australian electric water heater manufacturers and importers, and suppliers of water heater control technology, have participated in the development of AS/NZS 4755.3.3.[[73]](#footnote-73) The status of the parts of AS/NZS 4755 is summarised in Table 51).

The manufacturer of an appliance complying with AS/NZS 4755 must ensure that it responds in the following way when it receives the relevant signal from the DRED:

* DRM1: shut off, or operate at minimal load, for the duration of the DR event. In an air conditioner, this means the compressor must not operate, but fans and controls may continue to do so. A pool pump controller responding to DRM1 must switch the pump off (after a brief period to allow safe switching off for flow-dependent equipment such as chlorinators and heaters). An electric, solar-electric or heat pump water heater must cease the use of electricity for heating water (whether in resistance elements or pumps). During normal peak load events the utility (or the DRED) would ‘cycle’: close and open the relay so that air conditioners operate for, say, 15 minutes and then shut off for the next 15. In emergencies, a constant DRM1 signal would be propagated so that the appliances would remain off for the duration of the emergency;
* DRM2: continue operation at not more than 50% load for duration of DR event;
* DRM3: continue operation at not more than 75% load. This was differentiated from DRM2 at the request of electricity utilities, on the grounds that it will be easier to enrol customers in DR programs if they can be assured of having at least 75% cooling during DR events;
* DRM4: switch on even if timers or user settings would not require operation at that time. This is intended to allow appliances to come on at times when electric price or CO2-intensity is low, e.g. when renewable generation availability is high. It would apply to swimming pool pumps – by bringing forward but not extending daily running hours – and to electric water heaters –allowing additional energy to be stored by temporarily raising thermostat settings. Utilities may use DRM4 to pre-charge solar-electric water heaters on winter mornings, to prevent their boost elements from operating during the evening peak when space heating, lighting and cooking loads coincide.

Table 51. Status of AS/NZS 4755, December 2012

|  | Part Title | Status |
| --- | --- | --- |
| AS4755-2007 | Framework for demand response capabilities and supporting technologies for electrical products | Published April 2007. Will be superseded by AS/NZS 4755.1 (when published) |
| AS/NZS 4755.1 (a) | Framework for demand response capabilities and supporting technologies for electrical products, and requirements for demand response enabling devices | Draft unchanged since last WG meeting. Next draft planned early 2013. Completion expected by mid 2013 (will supersede AS4755). (Responsibility – WG1) |
| AS/NZS 4755.3.1 | Interaction of demand response enabling devices and electrical products—Operational instructions and connections for air conditioners (published as AS4755.3.1, 2008) | First published December 2008 as AS4755.3.1. Revision published May 2012. |
| AS/NZS 4755.3.2 | Interaction of demand response enabling devices and electrical products—Operational instructions and connections for swimming pool pump-unit controllers | Published May 2012. |
| AS/NZS 4755.3.3 | Interaction of demand response enabling devices and electrical products—Operational instructions and connections for electric and electric-boosted water heaters | Draft unchanged since last WG meeting. Next draft planned early 2013. Completion expected by mid 2013. (Responsibility – WG3) |
| AS/NZS 4755.3.4 | Interaction of demand response enabling devices and electrical products—Operational instructions and connections for charge/discharge controllers for electric vehicles. | Draft at advanced stage. Next WG meeting Brisbane 28 November. Completion expected early 2013. (Responsibility – WG4) |
| AS/NZS 4755.3.5 | Interaction of demand response enabling devices and electrical products—Operational instructions and connections for inverter energy systems (b) | Same key elements as AS/NZS 4755.3.4. Demand response rules to be included in AS4777 *Grid connection of energy systems via inverters* (forthcoming – being prepared by EL-42).  Possible future publication as a separate standard AS/NZS 4755.3.5 depends on finding a sponsor. (Responsibility – WG4) |

(a) AS/NZS 4755 Part 2 number has reserved for future use. There is no current plan to publish a part with this number. (b) For example, inverters controlling photovoltaic (PV) arrays and other distributed generation systems.

The part of the standard covering Electric Vehicle (EV) rechargers will include DRMs analogous to those above, with additional DRMs to initiate and moderate discharge of stored electricity back to the grid. These functions would be the only aspects of EV design and operation subject to AS/NZS 4755.

The AS/NZS 4755 standards architecture has also been developed to cover EV chargers (see Table 51). DRM1 (off) and DRM2 (operate at no more than 50% of power) would apply during peak load events. DRM4 (operate even if user setting is ‘off’) would take advantage of periods of low energy price or high availability of renewable generation. Where batteries are fully charged when a DRM4 event is called, the charger would obviously not operate. EV chargers capable of managing EV discharge to the grid must have a DRM5 safety mode, in which they are prevented from discharging stored (or generated) energy back to the grid – and may have DRM8, which calls on discharge if possible. This would be invoked by the remote agent when the grid requires support. DRM6 and DRM7 moderate the rate of discharge.

Pool pump controllers and water heaters may have a ‘manual over-ride’ allowing the user to obtain up to one hour of operation during a demand response event. An over-ride would be useful if a swimmer wanted to use the pool at the time, and the pool owner wanted to boost chlorination, which is interlinked with the pump. Over-ride would also be useful if a water heater ran out of hot water during an event. The energy utilities consider that an over-ride capability is valuable in recruiting customers for demand response programs, but the probability that a significant number would use the over-ride at the same time and so defeat the intent of load control is very low.

There is no manual over-ride provision for air conditioners in AS/NZS 4755.3.1, because of the higher probability that it would be used. If customers do not wish to have their ACs controlled they would not participate in an air conditioner DLC program, and if they joined and were unhappy they could ask for the arrangement to be terminated. There is sufficient utility experience with informed customer participation, with the low level of awareness of DR events when they actually occur, and with high levels of participant satisfaction, to give confidence that the lack of over-ride capability on air conditioners would not be a problem (see Appendix 3).

AS/NZS 4755 also specifies the physical and electrical aspects of the interface. The interface on the product must be either screw terminals or an RJ45 socket, as widely used with telecommunications equipment, with pairs of pins mapped to DRMs. As the circuits are intended for control signals only rather than power, the standard limits the voltage to 34.5 Volts DC (Direct Current). This has the advantage that a full electrician’s licence will not be required to connect and disconnect the interface.

#### AS/NZS 4755 Activation

There are three main ‘activation pathways’ (Figure 13). One is via a Demand Response Enabling Device (DRED), which is independent of the electricity meter. A DRED may be designed to receive signals via ripple control, GSM or other means. The DRED pathway has already been used in a number of utility trials (Table 50).

The second pathway is via a smart meter equipped with AS/NZS 4755-compliant Controlled Load Relay (CLR). This would enable the meter to pass on DLC signals to appliances directly via a cable connection without the need for additional equipment, and so would offer a simple, reliable and low-cost means of activation.

A third pathway would also be via the smart meter, but utilising the home area network (HAN) interface on the meter rather than the CLR. The HAN would link to appliances by wireless or powerline carrier signals rather than cable. This would require a receiver needing a power supply at each appliance.

All pathways connect with the AS/NZS 4755 interface, so once an appliance with an interface is installed, it can be switched from one pathway to another if, for example, a smart meter is installed later. A single DRED or SM can control more than one AS/NZS 4755-equipped product.

Figure 13. Activation pathways for AS/NZS 4755-compliant smart appliances

Line drawing describing the activation pathways between the Remote Agent and the interface in a AS/NZS 4755 compliant appliance.
The Remote Agent may link directly with a Demand Response Enabling Device (DRED), which then links with the appliance interface.
Alternatvely, the Remote Agent may link with a Smart Meter which can link to various interfaces (Home Area Network (HAN) interface, Controlled Load Relay (CLR) or a AS/NZS 475 compliant Demand Response Enabling Device), which then links to the appliance interface.

Apart from provision for activation at the appliance itself, the installer may also:

* undertake the ‘upstream’ works to complete the communications pathway to the energy utility, or perhaps a demand response aggregator or other remote agent with whom the installer has a business relationship;
* alert the customer and/or the remote agent that the appliance is DR-capable and/or activated, so the remote agent can offer incentives for participation in a DR program, and the customer can consider taking part;
* advise the customer on optimisation of DR opportunities and arrangements, especially where there is more than one AS/NZS 4755-capable appliance and DRED at the site.

#### AS/NZS 4755 and Tariff Classes

AS/NZS 4755 appliances can be operated under any tariff regime. For example, if an AS/NZS 4755 compliant heat pump water heater replaces an old-style off-peak electric water heater wired to an OP meter, it could initially be run under the same tariff conditions, say 8 hours energisation overnight. This could be done by connecting a DRED or smart meter to the interface, but only using it to operate DRM1. Even if nothing else changes the customer would get the advantage of a manual over-ride in the event that hot water runs out during the day.

If it becomes apparent that a water heater is regularly running out of hot water (e.g. if a larger family moves in) the occupants can arrange with the utility for a different load control regime. This could involve limiting to half energisation (DRM2) during weekday peak periods, authorising de-energisation (DRM1) up to an agreed number of critical peak periods a year, and authorising the utility to use DRM4 to store energy. The network operator would thus gain the value of an assured load limit during all peak periods, the additional value of complete load reduction during critical peak periods and the value of the additional energy storage capability when energy prices are low. It may sell the right to exercise these capabilities to an energy retailer or some other market intermediary.

Some of this benefit would be returned to the customers, who would not have to buy a larger heat pump, revert to less efficient electric resistance technology or go to a higher cost tariff to meet their hot water needs. In return for the value the customers assign to the network, they could receive a tariff close to the off-peak rate – or perhaps a flat cash rebate – but still minimise the risk of running out of hot water.

#### Testing, Registration and Compliance

Air conditioners are already subject to mandatory registration for energy labelling and MEPS. Since October 2009, the registration requirements in AS/NZS 3823 include a statement of whether the model complies with AS4755.3.1:2008 – the standard for which compliance would become mandatory under the proposed regulation. There would therefore be no extra registration costs involved.

The technical changes required to make an air conditioner model minimally compliant with AS4755.3.1 are relatively minor. They involve:

* Providing two screw terminals to which an installer can attach two wires from the DRED (to activate DRM1, the minimum requirement). The use of a standard RJ45 plug instead of screw terminals, and provision for other DRMs (requiring additional terminals if the RJ45 plug is not used) are optional.
* Modifying the circuitry so that power to the compressor motor is interrupted (within a specified period) when the DRM1 circuit is closed.
* Ensuring that the compressor motor restarts when the DRM1 circuit is re-opened.

AS/NZS 4755.3.1 includes tests for verifying compliance. These are relatively low-cost, because they do not have to be carried out in a controlled environment, but could be carried out at the same time as AS/NZS 3823 compliance tests.

AS/NZS 4755.3.2 covers two distinct categories of PPCs – those attached to the pump-unit (‘integral PPCs’) and those intended for separate sale (‘separate PPCs’), which often control chlorinators and solar heater pumps as well as the filtration pump-unit. A PPC that controls equipment whose safe operation relies on water flow must switch off that equipment before switching off the pump-unit. This will require some changes in electronics and programming, especially if the supplier wishes to take advantage of the more complex (and commercially attractive) provisions of the standard, such as user over-ride and run-time adjustment to make up pumping time lost during a DR event.

Integral PPCs are simpler devices, which only control the pump motor. Although a higher share of these will be imported rather than locally made, the technical changes required to make them minimally compliant with AS/NZS 4755.3.2 are relatively minor – they are the same as required for AS/NZS 4755.3.1 (see above).

There is currently a voluntary energy labelling program for pool pump-units, and a mandatory program is under discussion.[[74]](#footnote-74) If this is set up the registration of pump-unit test results to AS5102 could include a statement that the controller integral to the pump-unit complies with AS/NZS 4755.3.2. Separate pump-unit controllers are not subject to labelling or MEPS, so new regulations and registration processes would be necessary.

All electric storage water heaters, and most solar-electric and heat pump water heaters, use mains voltage in their thermostats and other controls are present, so adapting designs to the Safety Extra Low Voltage (SELV) architecture of AS/NZS 4755 would require design modifications. Nearly all the electric storage water heaters sold in Australia are made locally, with some models from China, New Zealand and Israel. Local manufacturers purchase control units from specialist companies, some of which are global brands, and it is understood that the latter are already developing products to meet AS/NZS 4755.

Most solar-electric water heaters, even those using imported collector panels and evacuated tubes, use locally made storage tanks. Therefore the design changes for electric storage water heaters should flow through to solar-electric water heaters.

Heat pump water heaters are the only affected type where a significant share of the market is supplied by fully assembled imports, mainly from China and Germany. Some of the Chinese-made products are in fact designed in Australia and made specifically for the Australian market, so it should be possible to make the changes required to comply with AS/NZS 4755.3.3 reasonably quickly. The other segment of the water heater market is supplied by global products, where adding design elements for the Australian market may require more notice.

## Appendix 5: COAG, MCE/SCER and other policy references to demand response

Key statements related to peak demand and demand response are in **bold**. The current SCER work program on demand side participation, including demand response, is at [www.scer.gov.au/files/2012/06/DSP-Work-Plan-Status-Officials-MASTER.doc](http://www.scer.gov.au/files/2012/06/DSP-Work-Plan-Status-Officials-MASTER.doc)

### COAG, February 2006

#### National Competition Policy Review

COAG endorsed a new National Competition Policy (NCP) reform agenda aimed at providing a supportive market and regulatory framework for productive investment in energy, transport and other export-oriented infrastructure, and its efficient use, by improving pricing and investment signals and establishing competitive markets. COAG noted the Productivity Commission's conclusion that NCP has delivered substantial net benefits to the Australian economy and across the community, and all governments recommitted to the principles contained in the Competition Principles Agreement. A full set of recommendations agreed by COAG are at Attachment B to this Communiqué.

[Attachment B, *National Competition Policy Review,* includes the following:

Decision 2.2

Governments will improve the price signals for energy investors and customers by:

(a) committing to the progressive roll out of electricity smart meters to allow the introduction of time of day pricing and to allow users to **respond to these prices and reduce demand for peak power**;

(b) requesting the MCE to agree on common technical standards for smart meters and implement the roll out as may be practicable from 2007 in accordance with an implementation plan that has regard to costs and benefits and takes account of different market circumstances in each State and Territory; and

(c) **implementing a comprehensive and enhanced MCE work program, from 2006, to establish effective demand-side response mechanisms in the electricity market, including network owner incentives, effectively valuing demand-side responses, regulation and pricing of distributed and embedded generation, and end user education.**

Appendix A of Attachment B:

MINISTERIAL COUNCIL ON ENERGY REFORM AGENDA

Governments have agreed to implement significant energy market reforms under the auspices of the Ministerial Council on Energy (MCE). The MCE is bringing forward further initiatives for the consideration of COAG, including arrangements for the certification of energy access arrangements on a nationally consistent basis, time bound commitments to transfer retail and distribution regulation to a national framework and the phase out of retail price regulation where effective competition can be demonstrated. These new initiatives will be formalised in amendments to the Australian Energy Market Agreement 2004 and are included in this document on that basis. The current reform agenda broadly comprises the following key initiatives:

##### User Participation

• Implement new interim consumer advocacy arrangements (mid 2006).

• Implement new long term consumer advocacy arrangements (end 2006)

• Consider **demand side response options** (late 2006)…]

### MCE, May 2006

Ministers also reviewed progress against the new initiatives set for the MCE by COAG at its meeting on 10 February 2006. These initiatives include implementing a progressive roll out of electricity smart meters that has regard to costs and benefits and takes into account different market circumstances in each state and territory; implementing a comprehensive and enhanced work program to establish effective **demand side response mechanisms** in the electricity market; and ensuring the separation of generation and transmission activities under the NEL [National Electricity Law].

### MCE, October 2006

***Working in Tandem with COAG***

Ministers reviewed progress against the initiatives set for the MCE by the Council of Australian Governments (COAG) at its meeting on 10 February 2006. These initiatives include pursuing a progressive roll out of electricity smart meters where benefits outweigh costs taking into account the different market circumstances in each state and territory; implementing a comprehensive and enhanced work program to establish effective **demand side response mechanisms** in the electricity market; and ensuring the separation of generation and transmission activities under the NEL.

Ministers agreed on a policy framework for pursuing a progressive roll out of smart meters, including an initial statement of functionality and a broad timeline for development of the initiative. Final and detailed policy decisions will reflect a cost-benefit analysis managed by MCE and stakeholder consultation. Further analysis of jurisdictional markets to identify implementation costs and benefits, and consultation with all stakeholders, will now commence.

### MCE, May 2007

***Smart Meters***

Ministers noted progress and a forward plan for implementation of a staged approach for the national mandated roll out of electricity smart meters to areas where benefits outweigh costs, as indicated by the results of the cost-benefit analysis which will take account of different market circumstances in each state and territory and the circumstances of different groups of consumers. MCE noted that a national minimum functionality for smart meters, determined following a first-stage cost-benefit analysis (and including open communication protocols to support competition and replacement criteria for existing meters), will be released for consultation by September 2007. It is expected that the full cost-benefit analysis of a smart meter roll-out will be completed by the end of 2007.

### MCE, December 2007

#### Demand Side Response

The Council noted significant progress on its commitment to facilitate efficient and effective **demand side response mechanisms in the electricity market, including research conducted into barriers to promoting the efficient uptake of demand side response by network owners and operators.** Ministers noted that this work resulted in changes to the National Electricity Rules under the economic package to support the utilization of efficient demand side response by network operators, including the **facilitation of demand management schemes, a requirement that network operators consider efficient non-network alternatives in developing capital and operating cost forecasts, service and efficiency incentive schemes, and measures to ensure tariff review where demand response is demonstrated**.

**Ministers noted that progress on Demand Side Response had also been integrated into broader project areas such as development of network connection and planning arrangements, and the cost-benefit analysis for a national smart meter roll-out, which considers both price response and load control.**

The MCE also noted that the AEMC recently instigated a review of the role of demand side management in the National Electricity Rules. This will include consideration of demand side participation in the context of congestion management, reliability and transmission planning.

### MCE, 13 June 2008

##### Key Outcomes

Ministers committed to development of a consistent national framework for smart meters in the National Electricity Market, supporting distributors to be responsible for the roll-out of smart meters. Ministers noted there continue to be some uncertainties about the costs and benefits of smart meters in some jurisdictions and that different staged approaches are being taken to support the further development of smart meters. Smart meters are to be rolled-out in Victoria and NSW, with over 5 million smart meters expected to be deployed before 2017. Queensland and some other states and territories will undertake extensive pilots and business cases prior to a further national review of deployment timelines in 2012.

##### Smart Meters

Ministers reviewed a detailed cost-benefit analysis of a national smart meter roll-out and noted a wide range of potential net benefits but that benefits and costs are not certain in all jurisdictions. On this basis, smart meter deployment will continue in Victoria and in NSW, which should result in more than half of all Australian meters being replaced by 2017. Extensive pilots and business cases will be also be progressed in most other jurisdictions to confirm benefits, cost and risks. By June 2012, Ministers will consider further deployment timelines in all jurisdictions, based on findings of the pilots at that time.

To maximise the benefits of the roll-out, MCE will develop a consistent national framework for smart meters in the National Electricity Market (which excludes WA) with the obligation for deployment placed on distributors and appropriate cost recovery. This framework will be developed with stakeholders through a co-regulatory process and will be supported by the release of an MCE Statement of Policy Principles.

SMART METER DECISION PAPER, MCE 13 June 2008

**MCE now agrees to an addition to the National Minimum Functionality of *an interface to a Home Area Network (HAN)* which allows communication with in-home devices. The HAN should use an internationally-supported, nationally consistent open standard which can be integrated easily into many types of devices.**

**This function creates the opportunity for consumers to be offered a wide range of innovative new services, like in-home displays to monitor their energy use and direct load control programs to reduce energy costs on large appliances like air conditioning and electric hot water systems.** The consultants quantified potential additional net benefits from the HAN from direct load control services alone of potentially greater than $392 million, and noted that these services are one driver of the projected greenhouse benefits. In the longer term the potential exists for further innovative services to be offered which may deliver further customer benefits and could include the ability to link in-home displays with related water and gas meters. MCE requests advice from the NSSC by the end of 2008 on the specific standard to be adopted.

MCE notes that Victoria has prescribed the use of the ZigBee open standard for wireless messaging between a smart meter and in-premises devices and that consideration of national consistency for the HAN is a priority issue to be considered by the NSSC.

**MCE notes that uptake rates of direct load control of appliances can drive significant benefits identified in the study. To support voluntary uptake of direct load control services further, MCE agrees that consideration should be given to adjusting some appliance standards, such as air-conditioning, to include the HAN standard. MCE requests advice from the NSSC on recommendations to integrate this capability into priority appliances. This analysis should be undertaken in conjunction with the existing appliance energy standards work currently being conducted by both the Equipment Energy Efficiency (E3) Committee of the National Framework for Energy Efficiency and Standards Australia. In addition MCE considers that direct load control should be further tested and explored through the smart meter pilots to identify mechanisms to maximise the benefits and to consider the level of network demand management that can be achieved. MCE seeks advice from the NSSC in this regard.**

**MCE also notes positive cost-benefit findings for a non-smart meter direct load control roll-out in some jurisdictions**, with net benefits nationally estimated to lie between $34 million and $618 million. MCE therefore supports continuation of non-smart meter direct load control trials.

### Draft Energy White Paper

Extract from *Draft Energy White Paper: Strengthening the Foundations for Australia’s Energy Future*, Department of Resources, Energy and Tourism, December 2011.

#### Balanced energy network incentives

‘While efficient pricing should provide an overall long-run incentive for energy users to manage their own consumption, there are very practical limits to the reflection of underlying cost variations in energy prices. Examples include transaction costs to install appropriate metering and administrative costs to manage price differences. For energy networks, investment can be ‘lumpy’ meaning costs might be incurred at particular places in one year, and in other places the next. Prices for network use appropriately smear these costs across network users with similar characteristics.

However, this means that network prices do not currently provide signals to energy users to look for cost-effective alternatives to specific network investments. Network regulation seeks to correct this by providing a balanced incentive for network businesses to seek out such demand-side alternatives. Such a balanced incentive should encourage lower costs of network augmentation, including by ensuring that network constraints and reliability requirements can be addressed with the most efficient combination of investment in supply-side infrastructure (generally poles and wires) and demand-side capacity.

While reforms have been made in this area, the extent to which they are effective is unclear. The Australian Government is looking to the Australian Energy Market Commission’s *Power of choice* review to consider further actions as part of a broader framework within which opportunities for demand-side response and energy efficiency can be realised. The government strongly supports the objectives of the Australian Energy Market Commission review process.

**Direct load control is an example of the type of option that could be offered to energy users. By automating the times that certain appliances are turned on, and providing control to avoid peak times, if widely taken up direct load control could reduce growth in peak demand and help improve the productivity of electricity networks.**

**Direct load control could also be used to avoid appliance energy use at times of high wholesale market prices, contributing more generally to energy system productivity. Most energy users (particularly small and medium users) would be unlikely to take on wholesale market price variations directly, meaning such targeted use of direct load control would likely be commercially offered by an energy retailer with their own exposure to wholesale costs, or an aggregator or agent acting as intermediary.**

To capture the opportunity for the highest-value network and wholesale market cost savings from products such as direct load control, coordination will be required across the supply chain. It is possible, although by no means certain, that commercial arrangements could develop to support this. Again, aggregators may play a role as an intermediary between energy users and market participants.’

## Appendix 6: Policy options and alternatives

### Peak Load Reduction through Greater Energy Efficiency

#### Air Conditioners

Household air conditioners have been subject to mandatory energy labelling since 1986. MEPS for three phase air conditioners up to 65 kW cooling capacity were first introduced in 2001, and MEPS for single phase products in 2004. MEPS levels for both single and three-phase products were made more stringent between April 2006 and October 2007. After some divergences in MEPS levels in some States during 2009 and 2010 MEPS levels were increased again in October 2011 (E3 2010).[[75]](#footnote-75)

Both energy labelling and MEPS are intended to raise the sales-weighted average energy-efficiency of new air conditioners sold. This can occur in two ways: an increase in peak cooling output for the same motor power, or a reduction in peak motor power for the same cooling output. In practice both are likely to occur, but a rise in cooling output is more likely than a fall in motor power, because:

* ACs are advertised by cooling output, not motor power, so there is more commercial advantage in increasing output than in reducing power; and
* Electric motors and compressors used in air conditioners come in standard sizes, and it would be difficult to re-engineer a family of products to a fractionally lower motor power.

Over time, as new products are designed to meet ever-rising MEPS levels (in other countries as well as Australia), compressor manufacturers may change their model ranges to slightly lower power motors, but this will most likely be a delayed and secondary effect.

While raising the energy efficiency of air conditioners would lead to some reduction in summer peak demand from air conditioners below the BAU trend, this is minor compared to what would be obtainable through direct load control.

The contribution of an air conditioner to summer peak demand will depend on whether it is operating at the time of the peak, and if so whether it is at its maximum motor power. It is estimated that the ‘diversity’ of air conditioners (the share of installed units in operation) at summer maximum demand is about 70% (Swift 2005).

If a house with an air conditioner is occupied during an extreme temperature event, that air conditioner will almost certainly be operating, irrespective of the thermal performance of the house. (If the thermal performance and shading is such that cooling is not required even on extreme days, or that adequate cooling is provided by fans or an evaporative cooler, it will probably not have an air conditioner).

Air conditioners on during summer peak demand will generally fall into two typical operating modes:

* ‘controlled cooling’ where the air conditioner has adequate cooling capacity for the house, and has been operating for long enough before the temperature peak to pre-cool the house. The house also must have enough thermal mass to damp the effects of the outside temperature peak (generally in the mid to late afternoon) so the air conditioner continues to cycle around its thermostat setting.
* ‘crisis cooling’ where the unit is switched on when the occupants come home to a hot house, operates at its maximum output throughout the peak period and may never reach its thermostat setting.

In a controlled cooling situation a more efficient air conditioner can operate at lower power (or cycle off more often, if it is a fixed rather than variable output design) so its average motor power during the peak period should be lower, all else being equal.

In a crisis cooling situation the air conditioner will be operating at its maximum irrespective of its efficiency, so its contribution to peak demand will only be reduced if the higher efficiency is manifested as lower motor power rather than increased cooling output. Otherwise the higher energy efficiency will result in the space being cooled to somewhat nearer the thermostat set point. For example, on a day when it is 40°C outside a more energy-efficient air conditioner in ‘crisis cooling’ mode may be able to reach an internal temperature of 28° instead of 30°C, but still well above the thermostat set point, which is typically about 22°C. In this example the improvement in energy efficiency is taken as higher thermal comfort rather than as a reduction in energy use (or peak demand).

The aggregate effect of higher air conditioner energy efficiency on peak demand therefore depends largely on the share of installed air conditioners operating in crisis cooling mode during peak periods. The available data indicate that this is a high proportion. South Australia has the highest ownership of refrigerative air conditioners (64% of homes in 2010) among the NEM states (the others range from 45% to 58%). The SA load is so temperature-sensitive that is about three-quarters higher on a hot day than a mild day, and SA has by far the lowest load factor (the ratio of annual averaged load to peak load) on the NEM – about 42% compared with 57% in the rest of the NEM. In 2005, SA demand for 99% of the year was below 2500 MW, and for 1% (i.e. 88 hours) it was between 2500 and 3400. This strongly suggests that a large share of the peak SA air conditioner load is ‘crisis cooling.’

A recent survey of air conditioner usage patterns gives further weight to the prevalence of ‘crisis cooling’ (Winton 2010). Respondents indicated that they were much more likely to operate their air conditioner during the evening (generally the peak demand period) than during the day, which indicates ‘crisis cooling’ of a hot house (Table 52).

As a consequence, air conditioner DLC strategies such as Programmable Communicating Thermostats (PCTs), which are popular in the USA, are not appropriate for Australian conditions. US usage patterns are typically for continuous cooling of most of the house during the day, so the air conditioner is still working within the thermostat set points during peak events. Under ‘crisis cooling’ conditions however, the air conditioner cannot even reach the upper set point during a DR event.

Table 52. Reported time of use of fixed air conditioners, summer 2009-10

|  | Total | Qld | NSW +Vic | SA+WA |
| --- | --- | --- | --- | --- |
| In the morning [5-9am] | 29.3% | 36.8% | 30.7% | 23.1% |
| During the day [9am-5pm] | 17.7% | 15.8% | 19.5% | 16.0% |
| In the evening [5-10pm] (a) | 83.6% | 68.4% | 88.1% | 85.2% |
| Overnight [10pm-5am] | 10.1% | 10.5% | 12.3% | 6.5% |
| Not running | 0.0% | 0.0% | 0.0% | 0.0% |
| Average daily periods indicated | 1.4 | 1.3 | 1.5 | 1.3 |
| Base [n=] | 525 | 95 | 261 | 169 |

Source: Winton (2010) (a) Corresponds to peak electricity load period

#### Water Heaters

State and Territory governments are working with the Commonwealth to phase out greenhouse gas-intensive water heaters. The Building Code of Australia and other State regulations effectively prohibit the installation of electric resistance water heaters in new houses, and SA and Queensland have regulations to phase them out in existing houses as well. The projected greenhouse savings from a national phase-out would be substantial: over 74 Mt CO2-e avoided between 2010 and 2030 (GWA 2010). However, the measure would also mean the gradual phase-out of the conventional electric storage hot water load, most of which is on controlled OP tariffs, in favour of gas, LPG, solar-electric and heat pump units.

The increase in solar-electric and heat pump water heater numbers could add to peak demand during winter. There are two main strategies to avoid this:

1. Forcing users of these products to select between day rate tariffs and the controlled (OP) tariffs originally developed for conventional electric storage water heaters, but which are less suited to solar and heat pump technologies. In effect, the utility would shift the risks to owners of solar and heat pump water heaters by forcing them to choose between buying a larger capacity water heater than they need so they can operate it on controlled tariff, incur a greater risk of running out of hot water, or pay more per unit of energy;
2. Introducing smart solar-electric and heat pump water heaters which can be energised at all times except high-price or high-congestion periods, and which can absorb energy at periods of low energy price or high availability of renewable generation. Under this strategy the average capacity and hence capital cost of water heaters can be also be reduced. This represents a sharing of cost and risk between the utility and the customer.

An additional benefit of developing a smart appliance strategy for electric water heaters is that it could be applied to the many small electric water heaters installed in Class 2 (apartment) dwellings, which cannot be phased out for the foreseeable future due to space and other constraints.

If no specific action towards the introduction of smart appliances is taken, however, then only strategy (1) would be available, so increasing the costs of adjustment to the phase-out of greenhouse-intensive water heaters.

#### Electric Vehicle Charge/Discharge Controllers

There is growing interest in electric vehicles (EVs) in Australia and in other countries. Their widespread adoption would exacerbate electricity network constraints and peak demand problems. A review of standards to support electric vehicles identified three levels of recharging:

* Level I – Trickle charging (average 8 hours recharge time)
* Level II – Standard charging (average 3 to 4 hours recharge time)
* Level III – Fast charging (average 30 minutes recharge time)

Level II recharging ‘will likely create a series of challenges in respect of (a) the safety of residential circuits in Australian homes and (b) efficient management of load demand for energy network operators, particularly during existing peak periods of demand.’ (Standards Australia 2009)

A Level II EV charger would have a demand of 6 to 10 kW, making it the highest-power device in most homes. It is likely that EV users would initiate charging on their return from work, coinciding with the evening peak. To manage this, utilities would either have to force EV charging on to controlled tariffs (e.g. preventing operation entirely during peak times) or use the more flexible approach developed in AS/NZS 4755, where charging would only be interrupted if there were a critical peak, an emergency or a high-price event.

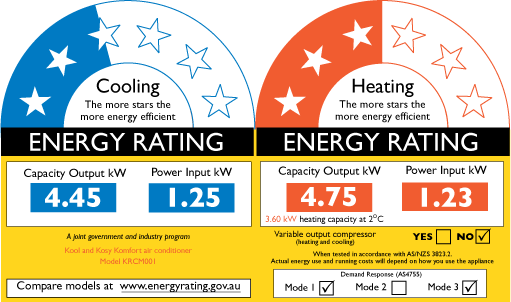
In the absence of mandatory adoption of AS/NZS 4755 for EV chargers, there is no assurance that the peak load issues could be overcome. This would severely inhibit the development of home recharging for EVs.

### Using Energy Labelling to Promote AS/NZS 4755 Compliance

The opportunity to indicate AS/NZS 4755 status varies from appliance to appliance.

The latest version of the air conditioner energy standard (AS/NZS 3823.2:2009) requires suppliers registering a model for energy labelling and MEPS to indicate whether or not it complies with AS/NZS 4755. The revised air conditioner energy label (Figure 14) also includes a space for indicating whether the model complies, and if so which DRMs it is capable of.

Figure 14. Example of AS4755 status information on air conditioner energy label



Source: AS/NZS 3823.2

### ‘Potential’ compliance with AS/NZS 4755: Air conditioners

AS/NZS 3823.2:2009 *Performance of electrical appliances—Air conditioners and heat pumps Part 2: Energy labelling and minimum energy performance standard (MEPS) requirements* sets out a possible pathway to mandating compliance with AS/NZS 4755.3.1. It includes the following definitions of ‘demand response capable’ and ‘potentially demand response capable:’

**Demand response capable**

An air conditioner which is fully compliant with AS 4755.3.1, without the need to purchase further parts or components:

* Air conditioners which are assembled from components on site are demand response capable if all components necessary to make the assembly demand response capable are supplied with every unit, and the installation instructions require all components to be assembled.

**Potentially demand response capable**

An air conditioner which is potentially fully compliant with AS 4755.3.1, once a nominated standard part or component, that is not otherwise supplied with every unit, has been added or fitted, either at the time of manufacture or at any subsequent time, e.g. pre-delivery, at installation or after installation.

* The part may be factory-installed, e.g. in response to a prior order, but must also be capable of being fitted subsequently by an authorized person at any point in the service life of the product.
* Where the supplier of an air conditioner model indicates that it is potentially demand response capable, the supplier must also identify the part or component needed to make it demand response capable, and must undertake to supply that part or component from the time this indication appears on the register to not less than 10 years after the model ceases to be registered.

Proceeding with the intention signalled in AS/NZS 3823:2 – to make either demand response capability or potential demand response capability mandatory – is one of the options considered in the present RIS. If mandated, this option would leave it up to product suppliers whether to include the smart appliance interface or to offer it as an add-on.

It is not clear whether offering an add-on rather than a built-in interface would be cheaper. Including an interface in every product would require a once-only redesign of the control software and the casing of each model, and the inclusion of a relatively simple interface on every unit shipped.

A supplier opting for ‘potential capability’ compliance would still have to redesign the control software and the casing to accommodate the possible addition of an interface and would also have to design a slot or connector to accept the interface if/when added later. (A few suppliers already provide a slot of this type in some models). The slot or connector would have to be included in every unit shipped, and may well cost as much as a fully functioning interface. If there is a pre-delivery order for an interface-equipped unit the manufacturer or a downstream agent must receive, process and comply with that order, at additional cost (which could however be charged to the ordering party).

In addition, the manufacturer must kept the interface itself (or different versions suitable for different slots) in stock for at least 10 years to comply with the AS/NZS 3823.2:2009 – a requirement that would be essentially unenforceable.

For utilities, it would be difficult to know what proportion of air conditioners complied under which option. Large scale rollouts of demand response programs would still carry the risk that making new air conditioners fully ‘smart’ might require a second technician visit after the required part is obtained (see Box 1). While this would have advantages over the present situation, under which a high proportion of existing units can never be made smart, it would not deliver the full potential for peak load reduction that would come from the universal availability of smart interfaces.

Therefore retaining the ‘potential’ compliance option would create uncertainty for air conditioner suppliers, installers and buyers as well as for electricity utilities. It would undermine the objective of the proposal – the development of a critical mass of smart appliances – with no assurance that compliance costs would be any lower.

## Appendix 7: Cost-benefit modelling

### Smart Meter and Appliance Ownership Projections

#### Smart Meter Projections

The presence of smart meters influences household participation rates in DLC program, because they make TOU tariffs more likely (so increasing the motivation to take part) and SMs will have DRED functions (so reducing the costs of participation compared with purchasing a separate DRED).

At the time of writing the only State that had committed to a mandated rollout of Smart Meters was Victoria where a rollout is well advanced. The Victorian rollout accounts for the high number of SMs installed in 2014, as shown in Figure 15. The rollout rates projected for other jurisdictions are somewhat speculative. They assume a high rate of installation in new houses built after 2013, but a lower installation rate for existing houses. Nevertheless it is assumed that nearly all existing home are retrofitted with SMs by 2024, except in Queensland and the NT.

On these assumptions the share of houses equipped with SMs rise progressively over time, as illustrated in Figure 16, reaching about 79% nationally by 2024. However, if fewer SMs were available, DREDs would account for a greater share of activations.

#### Air Conditioner Projections

The share of households with at least one refrigerative air conditioner was projected using the base data in EES (2008), updated and modified by GWA. It is projected that the national ownership rate will increase from about 56% in 2010 to 70% by 2020 (compared with EES estimate of 64%) and 75% by 2028 (Figure 17). It is assumed that only one air conditioner per house participates in DLC, even though the average number of air conditioners per house with a non-ducted AC was already 1.45 in 2010 (EES 2008). If some households allow more than one air conditioner to be controlled, the load reduction available per participant would be higher.

Figure 18 illustrates the integration of the data in Figure 16 and Figure 17 – projecting the number of houses with air conditioners (blue) and without (yellow). Within each group there are households with smart meters only (horizontal stripe). In air conditioner-owning households there are those with AS/NZS 4755 interfaces only (vertical stripe), both (hatched) and neither (blank). By 2028, 60% of households are projected to have both a smart meter and an air conditioner with an AS/NZS 4755 interface.

The projected numbers of air conditioners activated via SMs and via other DREDs are illustrated. By 2028, it is projected that nearly 49% of houses, and 3.5 million air conditioners, will be participating in air conditioner DLC programs.

#### Pool Pump Projections

It is estimated that the average electrical demand of a typical single-phase, single-speed pool filtration pump is 0.9 kW (BIS 2005). Ergon Energy advises that about 50% of pumps are operating at system peak (Wilson 2012). Again, it is assumed that only one pump will be subject to load control per participating household. In 2005, 28% of pools had a solar heater pump, and this ratio is likely to have increased since. If some participating households allowed more than one pump to be controlled, the load reduction available per participant would be higher.

Figure 15. Projected numbers of Smart Meters installed annually, Australia

Description: The number of smart meters installed annually in 'pre-2014 houses' starts at about 840,000 in 2014 then falls to about 470,000 by 2018 and remains at that level until 2021, when it starts falling again, to zero in 2024. The number of smart meters installed annually in 'post-2013 houses' is about 40,000 in 2014, reaches about 70,000 by 2017 and gradually rises to about 800,000 by 2028. 

Figure 16. Projected share of houses with a Smart Meter installed, Australia

The share of homes with smart meters rises in all jurisdictions between 2014 and 2028 except in SA and Queensland, where it remains at zero.  The highest smart meter rate is Victoria, where it rises from 36 percent of homes in 2014 to 100 percent in 2017. For Australia as a whole the smart meter rate rises to between 72 percent and 79 percent by 2023 and then remains at that level. 

Description: The jurisdiction with the highest share of houses with an air conditioner in the Northern Territory, where it rises from 77 percent in 2011 to 91 percent in 2028. The jurisdiction with the lowest share is Tasmania, where it rises from 29 percent in 2011 to 41 percent in 2028.  The average for the whole of Australia rises from 58 percent in 2011 to 75 percent in 2028.Figure 17. Share of houses with at one or more refrigerative air conditioner

Figure 18. Number of houses with air conditioners, smart meters and both

Description: The total number of houses in Australia between 2014 and 2028 broken into categories according to whether they have a smart meter, an air conditioner (either ducted or non-ducted), neither or both. 

#### Electric Water Heater Projections

All electric storage water heaters, and most solar-electric and heat pump models, can operate on either controlled (‘off-peak’) or uncontrolled tariffs. Water heaters on controlled tariffs, make no contribution to peak load. As non-controlled water heaters are able to operate at any time, their contribution to peak load depends on the probability of the heating element or heat pump motor being on at any given time.

The typical element rating of electric water heaters is about 3.6 kW. The after-diversity peak load contribution per uncontrolled electric storage water heater installed in houses (Cl 1 dwellings) is estimated at 0.6 kW during WMD and 0.4 kW during SMD.[[76]](#footnote-76) The average how water storage volume per occupant in apartments (Cl 2 dwellings) is smaller, so the probability that the unit will be reheating at any given time is higher. Therefore the after-diversity contribution per non-controlled water heater in Cl 2 dwellings is estimated to be slightly higher: 0.7 kW during WMD and 0.5 kW during SMD. The pumps (and in some cases the boost elements) of uncontrolled heat pump water heaters and the boost elements of solar-electric water heaters heater can also contribute to peak load: the estimated average is 0.4 kW during WMD and 0.2 kW during SMD.

Figure 19 and Figure 21 project the number of electricity-using water heaters by type and dwelling class under BAU projections, and with the proposed phase-out of greenhouse-intensive water heaters as modelled in GWA (2010; the forecasts go only to 2026). Figure 20 and Figure 22 project the number of water heaters controlled in different ways under BAU projections, and with the proposed phase-out of greenhouse-intensive water heaters respectively. Those controlled by off-peak tariffs (the two lowest segments) include about half of solar-electric and heat pump water heaters. The other segments (including nearly all storage water heaters in apartments) are uncontrolled, except for those with activated AS/NZS 4755 interfaces, which are indicated by the dotted areas.

### Activation and Participation Rates

The quantum of demand available for reduction during a peak event depends on the number of participating appliances, probability that they will be on at the time, their average rated electrical power and the ratio of operating power to rated power at the time. For example, if the average rating of an air conditioner is 3.0 kW, if there is a 70% probability that a unit will be on during a DR event and operating at an average 90% of rated capacity at the time (values typical of the summer peak), the average load will be 3.0 x 0.70 x 0.90 = 1.89 kW per participating air conditioner. If each operating air conditioner is cycled at 50% (i.e. equal periods on and off) the controllable reduction per participating unit is 0.95 kW.

For system planning and management purposes, this means that for each participating unit, 1.89 kW is available in an emergency to offset spinning reserve (generation that can be called at seconds’ notice). This has economic value in avoiding capital investment in networks and construction and/or operation of spinning reserve generators, even if a DR event is never called. The 0.95 kW available for reduction of peak demand has a separate value in avoiding investment in meeting non-emergency peak load – the factor which drives the capital requirements of networks.

The projected activation and participation rates for air conditioners in each jurisdiction under Option 3 are summarised in Table 53 (low participation rates) and Table 54 (high participation rates). In NSW for example, it is estimated that where air conditioners are installed in new homes in 2014, 15% will be activated via a relay on the meter, 8% via a HAN interface on the meter and 8% via a separate DRED. These rates will rise over time so that by 2028 some 49% are activated on installation, by one means or another. For air conditioners installed new in existing dwellings, total activation rates rise from 22% in 2014 to 30% by 2028.

Decriptin: The  total number of water heaters connected to electricity in Australia, rising from about 5 million in 2012 to about 5.3 million in 2026, divided into categories: heat pump, solar-electric and electric resistance (further divided into water heaters in houses and in flats, and water heaters using off-peak and day-rate tariffs). Figure 19. Electric water heaters by type, BAU (without phase-out of greenhouse-intensive water heaters)

CL1 = Class 1 dwellings, CL2 = Class 2 dwellings. DR = Day rate tariffs. OP = Off-peak tariffs

Description: The total number of water heaters connected to electricity in Australia, divided into categories: whether installed in houses or in flats, and whether on uncontrolled tariffs, controlled by off-peak tariffs, or controlled via the AS/NZS4755 interface.   Figure 20. Electric water heater types by form of demand control, BAU (without phase-out of greenhouse-intensive water heaters)

CL 1 = Class 1 dwellings, CL 2 = Class 2 dwellings. IF = AS/NZS 4755 interface

Figure 21. Electric water heaters by type, with phase-out of greenhouse-intensive water heaters

Description: As for Figure 19, but with the total number of electric water heaters falling from 5 million in 2012 to 3.5 million in 2021, then gradually increasing to 3.6 million in 2026 (compared with 5.3 million in the case where there is no phaseout of greenhouse-intensive water heaters).  CL1 = Class 1 dwellings, CL2 = Class 2 dwellings. DR = Day rate tariffs. OP = Off-peak tariffs

Decription: As for Figure 20, but with the total number of electric water heaters falling from 5 million in 2012 to 3.6 million in 2021, then gradually increasing to 3.6 million in 2026 (compared with 5.3 million in the case where there is no phaseout of greenhouse-intensive water heaters).Figure 22. Electric water heater types by form of demand control, with phase-out of greenhouse-intensive water heaters

CL1 = Class 1 dwellings, CL2 = Class 2 dwellings. IF = AS/NZS 4755 interface

Table 53. Projected costs and other key assumptions by jurisdiction, Policy Option 3 – low participation rates,

|  | | NSW (Mixed)(a) | | | | VIC (SM only) | | | Qld(DRED only) | | SA (SM only) | | WA (SM only) | | TAS (SM only) | | NT (DRED only) | | ACT (Mixed) | | NZ (DRED only) | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | FY 2015 | | FY 2028 | | FY 2015 | | FY 2028 | FY 2015 | FY 2028 | FY 2015 | FY 2028 | FY 2015 | FY 2028 | FY 2015 | FY 2028 | FY 2015 | FY 2028 | FY 2015 | FY 2028 | FY 2015 | FY 2028 |
| **Target Activations – Air Conditioners installed at time of construction** | | | | | | | | | | | | | | | | | | | | | | |
| Via SM/Relay | | 15% | | 19% | | 8% | | 8% | 0% | 0% | 19% | 30% | 15% | 30% | 8% | 15% | 0% | 0% | 23% | 23% | 0% | 0% |
| Via SM/HAN | | 8% | | 11% | | 23% | | 38% | 0% | 0% | 19% | 30% | 15% | 30% | 30% | 45% | 0% | 0% | 8% | 23% | 0% | 0% |
| Via DRED | | 8% | | 19% | | 0% | | 0% | 34% | 41% | 0% | 0% | 0% | 0% | 0% | 0% | 38% | 60% | 8% | 15% | 8% | 15% |
| Not activated | | 70% | | 51% | | 70% | | 55% | 66% | 59% | 63% | 40% | 70% | 40% | 63% | 40% | 63% | 40% | 63% | 40% | 93% | 85% |
| **Target Activations – Air Conditioners installed post-construction** | | | | | | | | | | | | | | | | | | | | | | |
| Via SM/relay | | 8% | | 8% | | 4% | | 4% | 0% | 0% | 11% | 15% | 11% | 15% | 4% | 4% | 0% | 0% | 8% | 8% | 0% | 0% |
| Via SM/HAN | | 8% | | 11% | | 15% | | 23% | 0% | 0% | 11% | 15% | 11% | 15% | 19% | 26% | 0% | 0% | 8% | 11% | 0% | 0% |
| Via DRED | | 8% | | 11% | | 0% | | 0% | 23% | 34% | 0% | 0% | 0% | 0% | 0% | 0% | 23% | 30% | 8% | 11% | 8% | 11% |
| Not activated | | 78% | | 70% | | 81% | | 74% | 78% | 66% | 78% | 70% | 78% | 70% | 78% | 70% | 78% | 70% | 78% | 70% | 93% | 89% |
| **Target householder participation rates** | | | | | | | | | | | | | | | | | | | | | | |
| Of SM/Relay activations | | 15% | | 38% | | 15% | | 30% | 0% | 0% | 15% | 30% | 15% | 30% | 15% | 30% | 0% | 0% | 15% | 30% | 0% | 0% |
| Of SM/HAN activations | | 23% | | 45% | | 30% | | 53% | 0% | 0% | 23% | 45% | 23% | 45% | 23% | 45% | 0% | 0% | 23% | 45% | 0% | 0% |
| Of DRED/HAN activations | | 60% | | 64% | | 0% | | 0% | 60% | 64% | 0% | 0% | 0% | 0% | 0% | 0% | 38% | 45% | 60% | 64% | 68% | 68% |
| **Diversity – % of Air Conditioners units on during summer peak demand periods** | | | | | | | | | | | | | | | | | | | | | | |
| Air Conds | | 70% | | 80% | | 70% | | 80% | 70% | 80% | 70% | 80% | 70% | 80% | 70% | 80% | 70% | 80% | 70% | 80% | 70% | 80% |
| AC Cycling ratio | | 50% | | 50% | | 50% | | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% |
| **Generation, Network and DR Participation Costs** | | | | | | | | | | | | | | | | | | | | | | |
| Total $/peak kW | | $3,100 | | $3,100 | | $800 | | $800 | $3,500 | $3,500 | $2,400 | $2,400 | $3,200 | $3,200 | $500 | $500 | $3,500 | $3,500 | $1,500 | $1,500 | $2,900 | $2,900 |
| $/kWh at peak (a) | | $0 | | $0 | | $0 | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Annual DR hours | | 30 | | 30 | | 30 | | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| $/yr/participant | | $20 | | $20 | | $20 | | $20 | $20 | $20 | $20 | $20 | $20 | $20 | $20 | $20 | $20 | $20 | $20 | $20 | $20 | $20 |
| **Diversity – % of Pool Pumps on during summer peak demand periods** | | | | | | | | | | | | | | | | | | | | | | |
| Pool pump | | 50% | | 50% | | 50% | | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 50% |
|  | | **2014** | | **2015** | | **2016** | | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** |  |  |  |
| Pool activation rate | | 0% | | 8% | | 15% | | 23% | 30% | 38% | 40% | 43% | 45% | 48% | 50% | 53% | 55% | 58% | 60% |  |  |  |
| Pool participation rate | | 0% | | 40% | | 48% | | 55% | 63% | 70% | 72% | 74% | 77% | 79% | 81% | 83% | 86% | 88% | 90% |  |  |  |
| WH activation rate | | 0% | | 8% | | 15% | 23% | 30% | 38% | 40% | 43% | 45% | 48% | 50% | 53% | 55% | 58% | 60% |  |  |  |
| WH participation rate | | 0% | | 20% | | 28% | 35% | 43% | 50% | 51% | 52% | 53% | 54% | 56% | 57% | 58% | 59% | 60% |  |  |  |

Figures may not add due to rounding. (a) (a) Mixed = Both SM and DRED available (see Table 11)

Table 54. Projected costs and other key assumptions by jurisdiction, Policy Option 3 – high participation rates,

|  | | | | NSW (Mixed)(a) | | | | | | VIC (SM only) | | | | Qld(DRED only) | | | | SA (SM only) | | | | WA (SM only) | | | | TAS (SM only) | | | | NT (DRED only) | | | | ACT (Mixed) | | | | NZ (DRED only) | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | FY 2015 | | | FY 2028 | | | FY 2015 | | FY 2028 | | FY 2015 | | FY 2028 | | FY 2015 | | FY 2028 | | FY 2015 | | FY 2028 | | FY 2015 | | FY 2028 | | FY 2015 | | FY 2028 | | FY 2015 | | FY 2028 | | FY 2015 | | FY 2028 | |
| **Target Activations – Air Conditioners installed at time of construction** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Via SM/Relay | | | | 20% | | | 25% | | | 10% | | 10% | | 0% | | 0% | | 25% | | 40% | | 20% | | 40% | | 10% | | 20% | | 0% | | 0% | | 30% | | 30% | | 0% | | 0% | |
| Via SM/HAN | | | | 10% | | | 15% | | | 30% | | 50% | | 0% | | 0% | | 25% | | 40% | | 20% | | 40% | | 40% | | 60% | | 0% | | 0% | | 10% | | 30% | | 0% | | 0% | |
| Via DRED | | | | 10% | | | 25% | | | 0% | | 0% | | 45% | | 55% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 50% | | 80% | | 10% | | 20% | | 10% | | 20% | |
| Not activated | | | | 60% | | | 35% | | | 60% | | 40% | | 55% | | 45% | | 50% | | 20% | | 60% | | 20% | | 50% | | 20% | | 50% | | 20% | | 50% | | 20% | | 90% | | 80% | |
| **Target Activations – Air Conditioners installed post-construction** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Via SM/relay | | | | 10% | | | 10% | | | 5% | | 5% | | 0% | | 0% | | 15% | | 20% | | 15% | | 20% | | 5% | | 5% | | 0% | | 0% | | 10% | | 10% | | 0% | | 0% | |
| Via SM/HAN | | | | 10% | | | 15% | | | 20% | | 30% | | 0% | | 0% | | 15% | | 20% | | 15% | | 20% | | 25% | | 35% | | 0% | | 0% | | 10% | | 15% | | 0% | | 0% | |
| Via DRED | | | | 10% | | | 15% | | | 0% | | 0% | | 30% | | 45% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 30% | | 40% | | 10% | | 15% | | 10% | | 15% | |
| Not activated | | | | 70% | | | 60% | | | 75% | | 65% | | 70% | | 55% | | 70% | | 60% | | 70% | | 60% | | 70% | | 60% | | 70% | | 60% | | 70% | | 60% | | 90% | | 85% | |
| **Target householder participation rates** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Of SM/Relay activations | | | | 20% | | | 50% | | | 20% | | 40% | | 0% | | 0% | | 20% | | 40% | | 20% | | 40% | | 20% | | 40% | | 0% | | 0% | | 20% | | 40% | | 0% | | 0% | |
| Of SM/HAN activations | | | | 30% | | | 60% | | | 40% | | 70% | | 0% | | 0% | | 30% | | 60% | | 30% | | 60% | | 30% | | 60% | | 0% | | 0% | | 30% | | 60% | | 0% | | 0% | |
| Of DRED/HAN activations | | | | 80% | | | 85% | | | 0% | | 0% | | 80% | | 85% | | 0% | | 0% | | 0% | | 0% | | 0% | | 0% | | 50% | | 60% | | 80% | | 85% | | 90% | | 90% | |
| **Diversity – % of Air Conditioners units on during summer peak demand periods** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Air Conds | | | | 70% | | | 80% | | | 70% | | 80% | | 70% | | 80% | | 70% | | 80% | | 70% | | 80% | | 70% | | 80% | | 70% | | 80% | | 70% | | 80% | | 70% | | 80% | |
| AC Cycling ratio | | | | 50% | | | 50% | | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | |
| **Generation, Network and DR Participation Costs** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total $/peak kW | | | | $3,100 | | | $3,100 | | | $800 | | $800 | | $3,500 | | $3,500 | | $2,400 | | $2,400 | | $3,200 | | $3,200 | | $500 | | $500 | | $3,500 | | $3,500 | | $1,500 | | $1,500 | | $2,900 | | $2,900 | |
| $/kWh at peak (a) | | | | $0 | | | $0 | | | $0 | | $0 | | $0 | | $0 | | $0 | | $0 | | $0 | | $0 | | $0 | | $0 | | $0 | | $0 | | $0 | | $0 | | $0 | | $0 | |
| Annual DR hours | | | | 30 | | | 30 | | | 30 | | 30 | | 30 | | 30 | | 30 | | 30 | | 30 | | 30 | | 30 | | 30 | | 30 | | 30 | | 30 | | 30 | | 30 | | 30 | |
| $/yr/participant | | | | $20 | | | $20 | | | $20 | | $20 | | $20 | | $20 | | $20 | | $20 | | $20 | | $20 | | $20 | | $20 | | $20 | | $20 | | $20 | | $20 | | $20 | | $20 | |
| **Diversity – % of Pool Pumps on during summer peak demand periods** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pool pump | | | | 50% | | | 50% | | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | | 50% | |
|  | **2014** | | | **2015** | | | **2016** | | | **2017** | | **2018** | | **2019** | | **2020** | | **2021** | | **2022** | | **2023** | | **2024** | | **2025** | | **2026** | | **2027** | | **2028** | |  | |  | |  | |
| Pool activation rate | 0 | | | 10% | | | 20% | | | 30% | | 40% | | 50% | | 53% | | 57% | | 60% | | 63% | | 67% | | 70% | | 73% | | 77% | | 80% | |  | |  | |  | |
| Pool participation rate | 0 | | | 40% | | | 48% | | | 55% | | 63% | | 70% | | 72% | | 74% | | 77% | | 79% | | 81% | | 83% | | 86% | | 88% | | 90% | |  | |  | |  | |
| WH activation rate | | 0 | | | 10% | | | 20% | | 30% | | 40% | | 50% | | 53% | | 57% | | 60% | | 63% | | 67% | | 70% | | 73% | | 77% | | 80% | |  | |  | |  | |
| WH participation rate | | 0 | | | 20% | | | 28% | | 35% | | 43% | | 50% | | 51% | | 52% | | 53% | | 54% | | 56% | | 57% | | 58% | | 59% | | 60% | |  | |  | |  | |

Figures may not add due to rounding. (a) Mixed = Both SM and DRED available (see Table 11)

In Victoria, all activations are projected to via smart meter, while in Queensland all are projected to be via DREDs. While appliances equipped with interfaces could be activated at any time during their service lives, only activations at time of appliance installation and replacement have been modelled. To this extent, the modelling is conservative.

Even where householders are aware that the air conditioners is activated, they may choose not to participate in a DLC program because they do not perceive that the benefits for them to outweigh the risks. It is assumed that participation rates are low at first and then increase as familiarity and acceptance rise (Table 53). Where activation is via a separate DRED, however, it is assumed that the participation rate is higher from the start, because installing a separate DRED requires more user engagement and intention than activation via the meter (which could occur more opportunistically, at the expense of the utility, with the passive consent of the user.

Unlike activations, which are modelled for the time of appliance installation, participation rates follow a smoother curve, because once appliances are activated users can contact the utility or other remote agent and commence participation at any time. (It is likely that remote agents will be able to enrol users in DR programs – or remove them if requested – remotely by software).

Figure 23 projects the number of houses in Australia with and without air conditioners, the number of air conditioners activated and the number participating in DLC. If the interface is mandated from 2014, then by 2025 nearly all air conditioner-owning households will have at least one air conditioner with an interface (the green trend line) and some will have several (it is projected that the average number of units per air conditioner-owning households in 2028 will be over 1.6). It is assumed that each participating household accepts DLC for the main air conditioner only (i.e. the one serving the living areas). As secondary air conditioners usually serve sleeping rather than living areas, their DLC value during SMD will be much lower.

Figure 23 indicates the projected number of air conditioners activated via each of the three pathways. The number participating in DLC programs (the red trend line) is less than the sum of activated air conditioners because some householders will not be participating in DLC programs even though they have an activated air conditioner – perhaps because the activation occurred before they moved in (i.e. it was approved by a previous occupant or done at the time of construction) or they were dissatisfied and withdrew from a DLC program. Figure 24 is similar to Figure 23 but with lower activation rates and the start of participation deferred to the 4th year after SAIs are mandated.

The critical concentration of interface-equipped households that makes it cost-effective for the distributor to approach customers surrounding a given substation, or in a suburb or region will depend on the local load growth, the local network constraints, the distributor’s capital works program and many other variables. Distributors will therefore roll out demand response contract offerings (and install the subsequent connections to the appliances of those who accept them) at different rates. In fact the smooth red take-up curve is a composite of a large number of separate (and currently unknowable) individual local rollouts, as illustrated by the indicative ‘expanded detail’ added to Figure 24.

Description: The total number of houses with an air conditioner, rising from about 4.4 million in 2014 to 6.5 million in 2028. These are broken into four categories: no demand response activation; with demand response activation via a smart meter relay; with demand response activation via a smart meter utility home area network; with demand response activation via a demand response enabling device. The total number of households particpating in demand repsonse programs rises form zero in 2014 to about 3 million in 2028. Figure 23. Number of households participating in air conditioner DLC Programs, high activation and participation rates – progressive implementation

Description: As for Figure 23, but with the number of households participating in demand response programs rising from zero in 2014 to about 1.1 million in 2028. The graph appears to rise smoothly, but an expanded detail shows that it rises in a series of discrete steps.   Figure 24. Number of households participating in air conditioner DLC Programs, low activation rates – deferred implementation

Figure 25 indicates the share of air conditioner-owning households that are projected to participate in DR programs via smart meters. It also shows the estimates in a study that formed part of the overall cost-benefit analysis for smart metering (NERA 2008). Although the NERA assumptions are not clear, the study appears to assume a flat participation rate of between 7.5% and 15.0%, without projecting an explicit rate of build-up. The modelling in this RIS indicates that, in households where SMs are installed, over the period 2013-2026 an average of 9% to 17% of those SMs act as the activation pathway by which an air conditioner participates in a DLC program. This is only slightly above the NERA range. This RIS also models participation via non-SM DREDs and participation rates for separate appliances, neither of which were covered in the NERA study.

Decription: The share of air conditioner-owning households particpating in demand response rises from zero in 2014 to between 35 percent (under the high (prgressive) case) and 24 percent (under the low (deferred) case) in 2028. The high case averaged over the period 2014-2028 is about 17 percent and the low case averaged over the period is about 8 percent. The NERA cases ranged from 15 percent (upper bound) to 7.5 percent (lower bound).    Figure 25. Comparison of modelled participation rates via smart meters with NERA assumptions

### Energy Use Impacts

In this RIS, no value is assigned to energy avoided during DR events. It is assumed that demand response events result in a 30 hours loss of operation each year for appliances participating in DLC. For air conditioners, this is the equivalent of 60 hours of control at 50% cycling (or 60 hrs of control at DRM2, i.e. limited to half-load operation). Owners would permanently lose the value of the cooling services that the air conditioner would have provided during the hours that it is cycled off or limited, but would also save the energy cost.

For pool pumps, a DRM1 event will result in a permanent loss of pumping time (unless the pump controller has a ‘run-time adjustment’ function, as provide for in AS4755.3.2). However, the average pool runs for 5.8 hrs/day during the swimming season, and 3.6 hrs/day during the off-season (BIS 2005), so even if the full 30 hrs are called on, the loss would be equivalent to less than 2% of annual pumping time. This is not likely to have any impact on pool water quality.

For non-off-peak water heaters, which are energised all the time, any loss of heating during DR events will start to be made up as soon as the event ends, or failing that, when the stored water temperature falls to the lower thermostat set point. If water is drawn off during the period before reheat, the temperature would be lower than if the DR event had not occurred, but the user can obtain the same target temperature by mixing slightly hotter and less cold. In cases, where hot water use is high this may result in the water heater running out of hot water during or immediately after a DR event, but again, if users consider the risk too high they can choose not to participate.

### Costs, Benefits and Cost-Benefit Ratios

The projected costs and benefits for Australia of Policy Option 3 (making AS/NZS 4755 interfaces for appliance mandatory from 2014) are summarised in Table 17. The table summarises 12 cases, or combinations of input assumptions, at the national level. Table 55 to Table 66 indicate the reduction in peak load at SMD and the cost and benefits for each jurisdiction, including New Zealand (for which the MWD impact is shown). Figure 26 illustrate the benefit/cost ratios for each jurisdiction in each of the 12 cases modelled.

Description: The benefit-over-cost ratios for each jurisdiction, all of Australia and for New Zealand, under each of 12 cases, is represented by a point on the graph. For the whole of Australia, three clusters of points  are circled. The upper cluster, tagged 'maximum particpation', ranges from 13 to 16.3. The middle cluster, tagged 'high participation', ranges from 9 to 11.5. The lower cluster, tagged 'low participation', ranges from 6.8 to 8.5. 

Figure 26. B/C ratios under Base Case and sensitivity scenarios, all jurisdictions

Table 55. Costs and benefits by jurisdiction – case 1 (low participation, low activation cost, progressive activation) (a)

|  | MW peak load | Costs | Benefits | Net | B/C |
| --- | --- | --- | --- | --- | --- |
|  | Reduction (b) | $m NPV(c) | $m NPV(c) | Benefits(c) | ratios |
| NSW | 772 | $206 | $2,194 | $1,989 | 10.7 |
| Vic | 357 | $139 | $263 | $125 | 1.9 |
| Qld | 848 | $226 | $2,867 | $2,641 | 12.7 |
| SA | 117 | $35 | $252 | $218 | 7.3 |
| WA | 214 | $64 | $534 | $470 | 8.3 |
| Tas | 30 | $9 | $11 | $2 | 1.2 |
| NT | 52 | $16 | $164 | $148 | 10.3 |
| ACT | 41 | $11 | $48 | $36 | 4.2 |
| Aust | 2431 | $705 | $6,333 | $5,628 | 9.0 |
| NEM | 2165 | $625 | $5,635 | $5,010 | 9.0 |
| NZ (a) | 102 | $46 | $332 | $286 | 7.2 |

(a) Refer Table 17 (b) (d) SMD for Australia, WMD for NZ (c) 5% discount rate; Australia 7%

Table 56. Costs and benefits by jurisdiction – case 2 (low participation, high activation cost, progressive activation) (a)

|  | MW peak load | Costs | Benefits | Net | B/C |
| --- | --- | --- | --- | --- | --- |
|  | Reduction (b) | $m NPV(c) | $m NPV(c) | Benefits(c) | ratios |
| NSW | 772 | $256 | $2,194 | $1,939 | 8.6 |
| Vic | 357 | $177 | $263 | $86 | 1.5 |
| Qld | 848 | $276 | $2,867 | $2,591 | 10.4 |
| SA | 117 | $43 | $252 | $209 | 5.8 |
| WA | 214 | $80 | $534 | $454 | 6.6 |
| Tas | 30 | $10 | $11 | $0 | 1.0 |
| NT | 52 | $20 | $164 | $144 | 8.3 |
| ACT | 41 | $14 | $48 | $34 | 3.4 |
| Aust | 2431 | $877 | $6,333 | $5,456 | 7.2 |
| NEM | 2165 | $777 | $5,635 | $4,859 | 7.3 |
| NZ (a) | 102 | $51 | $332 | $281 | 6.5 |

(a) Refer Table 17 (b) (d) SMD for Australia, WMD for NZ (c) 5% discount rate; Australia 7%

Table 57. Costs and benefits by jurisdiction – case 3 (high participation, low activation cost, progressive activation) (a)

|  | MW peak load | Costs | Benefits | Net | B/C |
| --- | --- | --- | --- | --- | --- |
|  | Reduction (b) | $m NPV(c) | $m NPV(c) | Benefits(c) | ratios |
| NSW | 1279 | $272 | $3,759 | $3,487 | 13.8 |
| Vic | 598 | $182 | $451 | $269 | 2.5 |
| Qld | 1427 | $311 | $4,934 | $4,623 | 15.8 |
| SA | 194 | $44 | $427 | $383 | 9.7 |
| WA | 331 | $81 | $853 | $772 | 10.5 |
| Tas | 44 | $11 | $16 | $5 | 1.5 |
| NT | 84 | $22 | $275 | $254 | 12.8 |
| ACT | 62 | $15 | $75 | $61 | 5.2 |
| Aust | 4020 | $937 | $10,791 | $9,854 | 11.5 |
| NEM | 3605 | $835 | $9,662 | $8,827 | 11.6 |
| NZ (a) | 182 | $55.8 | $590 | $534 | 10.6 |

(a) Refer Table 17 (b) (d) SMD for Australia, WMD for NZ (c) 5% discount rate; Australia 7%

Table 58. Costs and benefits by jurisdiction – case 4 (high participation, high activation cost, progressive activation) (a)

|  | MW peak load | Costs | Benefits | Net | B/C |
| --- | --- | --- | --- | --- | --- |
|  | Reduction (b) | $m NPV(c) | $m NPV(c) | Benefits(c) | ratios |
| NSW | 1279 | $337 | $3,759 | $3,421 | 11.1 |
| Vic | 598 | $232 | $451 | $219 | 1.9 |
| Qld | 1427 | $378 | $4,934 | $4,556 | 13.0 |
| SA | 194 | $55 | $427 | $372 | 7.8 |
| WA | 331 | $102 | $853 | $752 | 8.4 |
| Tas | 44 | $13 | $16 | $3 | 1.2 |
| NT | 84 | $26 | $275 | $249 | 10.4 |
| ACT | 62 | $18 | $75 | $57 | 4.2 |
| Aust | 4020 | $1,162 | $10,791 | $9,629 | 9.3 |
| NEM | 3605 | $1,034 | $9,662 | $8,628 | 9.3 |
| NZ (a) | 182 | $62 | $590 | $529 | 9.6 |

(a) Refer Table 17 (b) (d) SMD for Australia, WMD for NZ (c) 5% discount rate; Australia 7%

Table 59. Costs and benefits by jurisdiction – case 5 (theoretical maximum participation, low activation cost, progressive activation) (a)

|  | MW peak load | Costs | Benefits | Net | B/C |
| --- | --- | --- | --- | --- | --- |
|  | Reduction (b) | $m NPV(c) | $m NPV(c) | Benefits(c) | ratios |
| NSW | 4808 | $655 | $15,904 | $15,249 | 24.3 |
| Vic | 3080 | $702 | $2,666 | $1,964 | 3.8 |
| Qld | 1924 | $377 | $6,967 | $6,590 | 18.5 |
| SA | 1371 | $207 | $3,655 | $3,447 | 17.6 |
| WA | 1568 | $227 | $5,143 | $4,916 | 22.6 |
| Tas | 123 | $17 | $56 | $39 | 3.2 |
| NT | 133 | $28 | $476 | $449 | 17.3 |
| ACT | 174 | $27 | $267 | $239 | 9.7 |
| Aust | 13181 | $2,241 | $35,135 | $32,894 | 15.7 |
| NEM | 11480 | $1,986 | $29,515 | $27,529 | 14.9 |
| NZ (a) | 1520 | $265 | $5,077 | $4,812 | 19.2 |

(a) Refer Table 17 (b) (d) SMD for Australia, WMD for NZ (c) 5% discount rate; Australia 7%

Table 60. Costs and benefits by jurisdiction – case 6 (theoretical maximum participation, high activation cost, progressive activation) (a)

|  | MW peak load | Costs | Benefits | Net | B/C |
| --- | --- | --- | --- | --- | --- |
|  | Reduction (b) | $m NPV(c) | $m NPV(c) | Benefits(c) | ratios |
| NSW | 4808 | $793 | $15,904 | $15,111 | 20.0 |
| Vic | 3080 | $875 | $2,666 | $1,791 | 3.0 |
| Qld | 1924 | $453 | $6,967 | $6,514 | 15.4 |
| SA | 1371 | $249 | $3,655 | $3,406 | 14.7 |
| WA | 1568 | $276 | $5,143 | $4,867 | 18.6 |
| Tas | 123 | $21 | $56 | $35 | 2.7 |
| NT | 133 | $33 | $476 | $444 | 14.5 |
| ACT | 174 | $33 | $267 | $233 | 8.0 |
| Aust | 13181 | $2,734 | $35,135 | $32,401 | 12.9 |
| NEM | 11480 | $2,425 | $29,515 | $27,090 | 12.2 |
| NZ (a) | 1520 | $310.6 | $5,077 | $4,766 | 16.3 |

(a) Refer Table 17 (b) (d) SMD for Australia, WMD for NZ (c) 5% discount rate; Australia 7%

Table 61. Costs and benefits by jurisdiction – case 7 (low participation, low activation cost, deferred activation) (a)

|  | MW peak load | Costs | Benefits | Net | B/C |
| --- | --- | --- | --- | --- | --- |
|  | Reduction (b) | $m NPV(c) | $m NPV(c) | Benefits(c) | ratios |
| NSW | 650 | $174 | $1,684 | $1,511 | 9.7 |
| Vic | 305 | $113 | $209 | $96 | 1.9 |
| Qld | 719 | $178 | $2,220 | $2,042 | 12.5 |
| SA | 101 | $31 | $204 | $174 | 6.7 |
| WA | 197 | $59 | $464 | $406 | 7.9 |
| Tas | 29 | $10 | $10 | $0 | 1.0 |
| NT | 44 | $13 | $128 | $115 | 10.2 |
| ACT | 38 | $11 | $40 | $30 | 3.7 |
| Aust | 2081 | $587 | $4,960 | $4,373 | 8.5 |
| NEM | 1840 | $516 | $4,368 | $3,852 | 8.5 |
| NZ (a) | 82 | $40 | $244 | $204 | 6.1 |

(a) Refer Table 17 (b) (d) SMD for Australia, WMD for NZ (c) 5% discount rate; Australia 7%

Table 62. Costs and benefits by jurisdiction – case 8 (low participation, high activation cost, deferred activation) (a)

|  | MW peak load | Costs | Benefits | Net | B/C |
| --- | --- | --- | --- | --- | --- |
|  | Reduction (b) | $m NPV(c) | $m NPV(c) | Benefits(c) | ratios |
| NSW | 650 | $215 | $1,684 | $1,470 | 7.8 |
| Vic | 305 | $142 | $209 | $66 | 1.5 |
| Qld | 719 | $217 | $2,220 | $2,003 | 10.2 |
| SA | 101 | $38 | $204 | $166 | 5.4 |
| WA | 197 | $73 | $464 | $391 | 6.3 |
| Tas | 29 | $11 | $10 | -$2 | 0.9 |
| NT | 44 | $15 | $128 | $112 | 8.3 |
| ACT | 38 | $13 | $40 | $27 | 3.1 |
| Aust | 2081 | $726 | $4,960 | $4,234 | 6.8 |
| NEM | 1840 | $637 | $4,368 | $3,730 | 6.9 |
| NZ (a) | 82 | $43 | $244 | $201 | 5.6 |

(a) Refer Table 17 (b) (d) SMD for Australia, WMD for NZ (c) 5% discount rate; Australia 7%

Table 63. Costs and benefits by jurisdiction – case 9 (high participation, low activation cost, deferred activation) (a)

|  | MW peak load | Costs | Benefits | Net | B/C |
| --- | --- | --- | --- | --- | --- |
|  | Reduction (b) | $m NPV(c) | $m NPV(c) | Benefits(c) | ratios |
| NSW | 1064 | $221 | $2,860 | $2,639 | 12.9 |
| Vic | 505 | $144 | $354 | $210 | 2.5 |
| Qld | 1198 | $239 | $3,784 | $3,546 | 15.8 |
| SA | 166 | $38 | $344 | $307 | 9.1 |
| WA | 300 | $73 | $735 | $662 | 10.1 |
| Tas | 41 | $12 | $14 | $3 | 1.2 |
| NT | 71 | $17 | $212 | $195 | 12.8 |
| ACT | 56 | $14 | $63 | $49 | 4.6 |
| Aust | 3401 | $757 | $8,367 | $7,610 | 11.1 |
| NEM | 3030 | $667 | $7,420 | $6,753 | 11.1 |
| NZ (a) | 146 | $46 | $434 | $388 | 9.4 |

(a) Refer Table 17 (b) (d) SMD for Australia, WMD for NZ (c) 5% discount rate; Australia 7%

Table 64. Costs and benefits by jurisdiction – case 10 (high participation, high activation cost, deferred activation) (a)

|  | MW peak load | Costs | Benefits | Net | B/C |
| --- | --- | --- | --- | --- | --- |
|  | Reduction (b) | $m NPV(c) | $m NPV(c) | Benefits(c) | ratios |
| NSW | 1064 | $274 | $2,860 | $2,586 | 10.4 |
| Vic | 505 | $182 | $354 | $172 | 1.9 |
| Qld | 1198 | $291 | $3,784 | $3,493 | 13.0 |
| SA | 166 | $47 | $344 | $297 | 7.3 |
| WA | 300 | $92 | $735 | $643 | 8.0 |
| Tas | 41 | $13 | $14 | $1 | 1.1 |
| NT | 71 | $20 | $212 | $191 | 10.4 |
| ACT | 56 | $17 | $63 | $46 | 3.8 |
| Aust | 3401 | $937 | $8,367 | $7,430 | 8.9 |
| NEM | 3030 | $825 | $7,420 | $6,595 | 9.0 |
| NZ (a) | 146 | $50 | $434 | $384 | 8.6 |

(a) Refer Table 17 (b) (d) SMD for Australia, WMD for NZ (c) 5% discount rate; Australia 7%

Table 65. Costs and benefits by jurisdiction – case 11 (theoretical maximum participation, low activation cost, deferred activation) (a)

|  | MW peak load | Costs | Benefits | Net | B/C |
| --- | --- | --- | --- | --- | --- |
|  | Reduction (b) | $m NPV(c) | $m NPV(c) | Benefits(c) | ratios |
| NSW | 3995 | $483 | $12,093 | $11,609 | 25.0 |
| Vic | 2506 | $492 | $1,972 | $1,480 | 4.0 |
| Qld | 1632 | $287 | $5,413 | $5,126 | 18.9 |
| SA | 1055 | $134 | $2,501 | $2,367 | 18.6 |
| WA | 1367 | $180 | $4,172 | $3,992 | 23.1 |
| Tas | 116 | $17 | $51 | $34 | 3.0 |
| NT | 109 | $20 | $349 | $329 | 17.5 |
| ACT | 154 | $37 | $220 | $184 | 6.0 |
| Aust | 10934 | $1,650 | $26,771 | $25,121 | 16.2 |
| NEM | 9457 | $1,450 | $22,249 | $20,800 | 15.3 |
| NZ (a) | 1217 | $182 | $3,690 | $3,508 | 20.3 |

(a) Refer Table 17 (b) (d) SMD for Australia, WMD for NZ (c) 5% discount rate; Australia 7%

Table 66. Costs and benefits by jurisdiction – case 12 (theoretical maximum participation, high activation cost, deferred activation) (a)

|  | MW peak load | Costs | Benefits | Net | B/C |
| --- | --- | --- | --- | --- | --- |
|  | Reduction (b) | $m NPV(c) | $m NPV(c) | Benefits(c) | ratios |
| NSW | 3995 | $592 | $12,093 | $11,501 | 20.4 |
| Vic | 2506 | $618 | $1,972 | $1,354 | 3.2 |
| Qld | 1632 | $347 | $5,413 | $5,066 | 15.6 |
| SA | 1055 | $164 | $2,501 | $2,337 | 15.3 |
| WA | 1367 | $221 | $4,172 | $3,952 | 18.9 |
| Tas | 116 | $20 | $51 | $30 | 2.5 |
| NT | 109 | $24 | $349 | $325 | 14.6 |
| ACT | 154 | $49 | $220 | $171 | 4.5 |
| Aust | 10934 | $2,035 | $26,771 | $24,736 | 13.2 |
| NEM | 9457 | $1,790 | $22,249 | $20,459 | 12.4 |
| NZ (a) | 1217 | $215 | $3,690 | $3,475 | 17.2 |

(a) Refer Table 17 (b) (d) SMD for Australia, WMD for NZ (c) 5% discount rate; Australia 7%

Table 67. Comparison of costs and benefits of coverage scenarios

|  |  |  | $m NPV Net Benefits (7% discount rate) | | | | Benefit/cost ratios | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Effective | Particip-ation level | Activation  cost, Case | Existing coverage only | Const-rained | Universal coverage | Existing/ universal | Existing coverage only | Const-rained | Universal coverage |
| Progressive | Low (a) | 1.Low | $4,728 | $5,092 | $5,628 | 84% | 8.9 | 9.1 | 9.0 |
|  |  | 2. High | $4,589 | $4,941 | $5,456 | 84% | 7.2 | 7.4 | 7.2 |
|  | High (a) | 3. Low | $8,352 | $8,951 | $9,854 | 85% | 11.5 | 11.7 | 11.5 |
|  |  | 4. High | $8,170 | $8,752 | $9,629 | 85% | 9.4 | 9.5 | 9.3 |
|  | Max (a) | 5. Low | $23,777 | $27,980 | $32,894 | 72% | 14.5 | 15.3 | 15.7 |
|  |  | 6. High | $23,389 | $27,546 | $32,401 | 72% | 11.9 | 12.5 | 12.9 |
| Deferred | Low (a) | 7. Low | $3,622 | $3,933 | $4,373 | 83% | 8.4 | 8.6 | 8.5 |
|  |  | 8. High | $3,512 | $3,811 | $4,234 | 83% | 6.8 | 7.0 | 6.8 |
|  | High (a) | 9. Low | $6,368 | $6,873 | $7,610 | 84% | 11.1 | 11.3 | 11.1 |
|  |  | 10. High | $6,224 | $6,715 | $7,430 | 84% | 9.0 | 9.2 | 8.9 |
|  | Max (a) | 11. Low | $18,189 | $21,389 | $25,121 | 72% | 15.1 | 16.0 | 16.2 |
|  |  | 12. High | $17,893 | $21,059 | $24,736 | 72% | 12.3 | 13.0 | 13.2 |

Table 68. Existing coverage only – net benefits by jurisdiction

| Effective | Particip- ation | Activation  cost | NSW | Vic | QLD | SA | WA | Tas | NT | ACT | Total |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Immediate | Low | Low | $1,989 | $125 | $2,641 | -$8.0 | -$12.9 | -$1.4 | -$2.6 | -$1.8 | $4,728 |
|  |  | High | $1,939 | $86 | $2,591 | -$8.0 | -$12.9 | -$1.4 | -$2.6 | -$1.8 | $4,589 |
|  | High | Low | $3,487 | $269 | $4,623 | -$8.0 | -$12.9 | -$1.4 | -$2.6 | -$1.8 | $8,352 |
|  |  | High | $3,421 | $219 | $4,556 | -$8.0 | -$12.9 | -$1.4 | -$2.6 | -$1.8 | $8,170 |
|  | Max | Low | $15,249 | $1,964 | $6,590 | -$8.0 | -$12.9 | -$1.4 | -$2.6 | -$1.8 | $23,777 |
|  |  | High | $15,111 | $1,791 | $6,514 | -$8.0 | -$12.9 | -$1.4 | -$2.6 | -$1.8 | $23,389 |
| Deferred | Low | Low | $1,511 | $96 | $2,042 | -$8.0 | -$12.9 | -$1.4 | -$2.6 | -$1.8 | $3,622 |
|  |  | High | $1,470 | $66 | $2,003 | -$8.0 | -$12.9 | -$1.4 | -$2.6 | -$1.8 | $3,512 |
|  | High | Low | $2,639 | $210 | $3,546 | -$8.0 | -$12.9 | -$1.4 | -$2.6 | -$1.8 | $6,368 |
|  |  | High | $2,586 | $172 | $3,493 | -$8.0 | -$12.9 | -$1.4 | -$2.6 | -$1.8 | $6,224 |
|  | Max | Low | $11,609 | $1,480 | $5,126 | -$8.0 | -$12.9 | -$1.4 | -$2.6 | -$1.8 | $18,189 |
|  |  | High | $11,501 | $1,354 | $5,066 | -$8.0 | -$12.9 | -$1.4 | -$2.6 | -$1.8 | $17,893 |

All values NPV at 7% discount rate

Table 69. Constrained coverage only coverage – net benefits by jurisdiction

| Effective | Particip- ation | Activation  cost | NSW | Vic | QLD | SA | WA | Tas | NT | ACT | Total |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Immediate | Low | Low | $1,989 | $125 | $2,641 | $109 | $235 | -$1.4 | -$2.6 | -$1.8 | $5,092 |
|  |  | High | $1,939 | $86 | $2,591 | $104 | $227 | -$1.4 | -$2.6 | -$1.8 | $4,941 |
|  | High | Low | $3,487 | $269 | $4,623 | $192 | $386 | -$1.4 | -$2.6 | -$1.8 | $8,951 |
|  |  | High | $3,421 | $219 | $4,556 | $186 | $376 | -$1.4 | -$2.6 | -$1.8 | $8,752 |
|  | Max | Low | $15,249 | $1,964 | $6,590 | $1,724 | $2,458 | -$1.4 | -$2.6 | -$1.8 | $27,980 |
|  |  | High | $15,111 | $1,791 | $6,514 | $1,703 | $2,434 | -$1.4 | -$2.6 | -$1.8 | $27,546 |
| Deferred | Low | Low | $1,511 | $96 | $2,042 | $87 | $203 | -$1.4 | -$2.6 | -$1.8 | $3,933 |
|  |  | High | $1,470 | $66 | $2,003 | $83 | $195 | -$1.4 | -$2.6 | -$1.8 | $3,811 |
|  | High | Low | $2,639 | $210 | $3,546 | $153 | $331 | -$1.4 | -$2.6 | -$1.8 | $6,873 |
|  |  | High | $2,586 | $172 | $3,493 | $149 | $322 | -$1.4 | -$2.6 | -$1.8 | $6,715 |
|  | Max | Low | $11,609 | $1,480 | $5,126 | $1,183 | $1,996 | -$1.4 | -$2.6 | -$1.8 | $21,389 |
|  |  | High | $11,501 | $1,354 | $5,066 | $1,169 | $1,976 | -$1.4 | -$2.6 | -$1.8 | $21,059 |

All values NPV at 7% discount rate

## Appendix 8: Summary of assumptions and outputs by jurisdiction

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| National Regulation of Network Prices (AER) | | The Australian Energy Regulator (AER) regulates all electricity networks in the NEM, which excludes NT and WA. It can enforce state and territory initiatives relating to distribution and transmission pricing, including demand management schemes. Chapters 6 and 6A of the National Electricity Rules set out the framework that the AER must apply. A Rule Change published by AEMC in October 2012 obliges all DNSPs to develop demand side strategies and consider non-network options, from I January 2013 [www.aemc.gov.au/Electricity/Rule-changes/Open/distribution-network-planning-and-expansion-framework.html](http://www.aemc.gov.au/Electricity/Rule-changes/Open/distribution-network-planning-and-expansion-framework.html)  AER sets revenues and prices that a network business in the NEM can earn from transporting electricity. It can recognise State and Territory demand response initiatives and can enforce state and territory initiatives relating to distribution and transmission pricing. Currently, for example, the AER needs to ensure that a DNSP has sufficiently considered and made provision for efficient non‑network alternatives (that is, demand management) in line with Queensland demand management initiatives (from Queensland distribution determination 2010–11 to 2014–15 May 2010).  The AER will have to approve the cost of DLC activations and other elements of large scale DLC programs, if the DNSPs are to take advantage of the DR interface. | | | | | | | | |
|  | | NSW | Vic | Qld | WA | SA | Tas | ACT | NT |  |
| Economic Regulation of Electricity Networks | | AER – wtd avg price cap. Participates in Demand Management Incentive Scheme | AER – wtd avg price cap. | AER – revenue cap. Participates in DMIS | Economic Regulation Authority | AER – wtd avg price cap. Participates in DMIS | AER – revenue cap | AER – revenue cap. Participates in DMIS | Utilities Commission |  |
| Retail price regulation | | Independent Pricing & Regulatory Tribunal | None | Queensland Competition Authority | Economic Regulation Authority | Essential Services Commission of South Australia | Office of the Tasmanian Energy Regulator | Independent Competition and Regulatory Commission | Utilities Commission |  |
| State and Territory Demand Side Initiatives impacting on peak demand | | IPART D-Factor scheme | Smart Metering Strategy | QCA must consider costs of obligations under state and national energy  efficiency schemes. Utilities are required by regulation to submit demand management plans | ERA D-Factor scheme | ESCOSA Electricity Industry Guideline 12: Demand Management for Electricity Distribution Networks. ESCOSA has granted $20 m for DNSP load control trials |  | In making a decision ICRC must have regard to  demand management and least cost planning; |  |  |
| Population growth rate  2010-2020 (a) | | 1.1 % | 1.3% | 2.0% | 1.9% | 0.9% | 0.6% | Combined with NSW | 1.5% | Australia 1.4%  NEM 1.3% |
| Energy use increase rate 2012-22 (a) | | 1.1% | 1.8% | 2.2% | 2.9% | 0.7% | 0.6% | Combined with NSW | 1.7% | 1.3% for NEM region |
| Peak load increase rate 2011-22 (SMD/WMD) | | 1.2%/1.2% | 1.6%/1.6% | 2.5%/2.9% | 3.8%/2.9% | 1.0%/1.2% | 1.1% /1.1%) | Combined with NSW | NA | 1.6%/1.6% for NEM region |
| SMD increase rate compared with energy | | +0.1% | -0.2% | +0.3% | +1.1% | +0.3% | +0.0% | Combined with NSW | NA | +0.3% for NEM region |
| Projected Maximum Demand, MW | Summer 2012-13 | 13,399 | 9,690 | 9,007 | 4,181 | 2,778 | 1,371  (1,770 Winter Maximum Demand, WMD) | Combined with NSW | NA | NEM  33,345 |
| Summer  2021-22 | 14,860 | 11,147 | 11,245 | 6,038 | 3,016 | 1,516  (1,955 WMD) | Combined with NSW | NA | NEM  38,440 |

(a) Medium growth rates in ‘mass-market’ energy use (i.e. excluding large industrial or commercial customers). Mass market users contribute most to short-duration peak loads and are not exposed to peak-related pricing. Peak reduction from contracts with large industrial or commercial customers are factored into max. demand projections.

|  | NSW | Vic | Qld | WA | SA | Tas | ACT | NT |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Electricity Distributor Communications infrastructure | Ripple Control; SM trials under way | Smart meters to reach all homes by 2014 | Ripple Control | Smart meter trials under way | Smart meter trials under way | SMs on PV installations;  Additional SM rollouts planned | Smart meter trials under way | None existing or planned |  |
| Infrastructure needed at customer premises for DR activation | Ripple receiver DRED to SAI  Wireless or cable link from SM to SAI | Wireless link from SM to SAI (no provision for cable link in Vic SMI standards) | Ripple receiver DRED to SAI | Wireless or cable link from SM to SAI | Wireless or cable link from SM to SAI | Wireless or cable link from SM to SAI | Wireless or cable link from SM to SAI | Depends on infrastructure adopted – one option is auto-mated non-communicating DREDS |  |
| Notes on estimated pathway costs for accessing first AS/NZS 4755 appliance at a site. | New buildings $48-$150 Existing buildings $75-$180 | New buildings $75-$100 Existing buildings $75-$100 | New buildings $100-$150 Existing buildings $130-$180 | New buildings $48-$100 Existing buildings $75-$143 | New buildings $48-$150 Existing buildings $75-$180 | New buildings $48-$150 Existing buildings $75-$180 | New buildings $48-$150 Existing buildings $75-$180 | New buildings $48-$150 Existing buildings $75-$180 |  |
| Assumed additional establishment costs for communications platform | 0  Ripple control system exists | 0 SMs being rolled out in any case | 0  Ripple control system exists | 0 Would be needed to support SMs in any case | 0 Would be needed to support SMs in any case | 0 Would be needed to support SMs in any case | 0 Would be needed to support SMs in any case | $0.05 m Assuming lowest cost option adopted |  |

|  | | NSW | Vic | Qld | WA | SA | Tas | ACT | NT |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Estimated investment required per marginal peak load kW | | $3,100 | $800 | $3,500 | $3,200 | $2,400 | $500 | $1,500 | $3,500 |  |
| Current 5 year revenues approved by AER $b | | $18.8b | $7.8b | $14.8b | NA | $3.5b | $1.6b | Combined with NSW |  | NEM region $46.6b |
| Projected Activation rate, new air conditioners installed at time of construction | 2014  (low/ high) | 30%/40% | 30%/40% | 34%/45% | 30%/40% | 37%/50% | 37%/50% | 37%/50% | 37%/50% |  |
| 2028  (low/ high) | 49%/65% | 45%/60% | 41%/55% | 60%/80% | 60%/80% | 60%/80% | 60%/80% | 60%/80% |  |
| Projected Activation rate, new air conditioners replacing existing and post-const. | 2014  (low/ high) | 22%/30% | 19%/25% | 22%/30% | 22%/30% | 22%/30% | 22%/30% | 22%/30% | 22%/30% |  |
| 2028  (low/ high) | 30%/40% | 26%/35% | 34%/45% | 30%/40% | 30%/40% | 30%/40% | 30%/40% | 30%/40% |  |
| Forecast MW peak load reductions (SMD 2028) | MW (low/ high) | 650/1,279 | 305/598 | 719/1427 | 197/331 | 101/194 | 29/44 | 38/62 | 44/84 | Australia  2,081/4,020  NEM  1,840/3,605 |
| Projected costs and benefits $m NPV (2012 $, 7% discount rate) | Costs (low/ high) | 215/272 | 142/182 | 217/311 | 73/81 | 38/44 | 11/11 | 13/15 | 15/22 | Australia  726/937  NEM  637/835 |
| Benefits (low/ high) | 1684/3759 | 209/451 | 2220/4934 | 464/853 | 204/427 | 10/16 | 40/75 | 128/275 | Australia  4,960/10,791  NEM  4.368/9,662 |
| Net Benefits (low/ high) | 1470/3487 | 66/269 | 2003/4623 | 391/772 | 166/383 | -2/5 | 27/61 | 112/254 | Australia  4,031/9,051  NEM  4,892/10,802 |
| Benefit/cost ratio | (low/ high) | 7.8/13.8 | 1.5/2.5 | 10.2/15.8 | 6.3/10.5 | 5.4/9.7 | 0.9/1.5 | 3.1/5.2 | 8.3/12.8 | Aust 6.8/11.5 NEM 6.9/11.6 |

|  | NSW | Vic | Qld | WA | SA | Tas | ACT | NT |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Share of houses with one or more refrigerative air conditioners (2013/2028) | 62%/75% | 50%/67% | 70%/81% | 53%/70% | 68%/85% | 32%/40% | 47%/53% | 79%/90% | Australia 61%/75% |
| Assumed % of Air Conditioners on during summer peak demand periods (2013/2026) | 70%/80% | 70%/80% | 70%/80% | 70%/80% | 70%/80% | 70%/80% | 70%/80% | 70%/80% |  |
| Number of summer peaking transmission connection nodes by projected 2019/20 load | 60 | 44 | 77 | NA | 40 | 0 | Combined with NSW | NA | 221 for NEM |
| Number of winter peaking transmission connection nodes by projected 2019/20 load | 30 | 1 | 4 | NA | 0 | 48 | Combined with NSW | NA | 83 for NEM |
| Estimated capital expenditure (Capex) requirements over 5 years, DNSP determinations | $14,342 m | $6,203 m | $12,344 m | $1,818 m (demand related) | $1,793 m | $157 m | $278 m | NA | NEM region $35,117 m |
| Peak demand growth over 5 year period of determination | 2,141 | 1,681 | 1,494 | NA | 913 | 105 | 68 | NA |  |
| Household participation rates assumed where activation by SM/Relay, 2014 (low/high) | 15%/20% | 15%/20% | NA | 15%/20% | 15%/20% | 15%/20% | 15%/20% | NA |  |
| Household participation rates assumed where activation by SM/Relay, 2028 (low/high) | 38%/50% | 30%/40% | NA | 30%/40% | 30%/40% | 30%/40% | 30%/40% | NA |  |
| Household participation rates assumed where activation by SM/HAN, 2014 (low/high) | 23%/30% | 30%/40% | NA | 23%/30% | 23%/30% | 23%/30% | 23%/30% | NA |  |
| Household participation rates assumed where activation by SM/HAN, 2028 (low/high) | 45%/60% | 53%/70% | NA | 45%/60% | 45%/60% | 45%/60% | 45%/60% | NA |  |
| Household participation rates assumed where activation by DRED, 2014 (low/high) | 60%/80% | NA | 60%/80% | NA | NA | NA | NA | 38%/80% |  |
| Household participation rates assumed where activation by DRED, 2028 (low/high) | 64%/85% | NA | 64%/85% | NA | NA | NA | NA | 45%/85% |  |

1. Productivity Commission, draft report on Electricity Network Regulatory Frameworks, October 2012, p 302. [↑](#footnote-ref-1)
2. Productivity Commission, draft report on Electricity Network Regulatory Frameworks, October 2012, p 302 referencing Australian Energy Market Commission, Congestion Management Review Final Report, 2008. [↑](#footnote-ref-2)
3. Productivity Commission, draft report on Electricity Network Regulatory Frameworks, October 2012, p 11. [↑](#footnote-ref-3)
4. Productivity Commission, draft report on Electricity Network Regulatory Frameworks, October 2012, p 304. [↑](#footnote-ref-4)
5. Productivity Commission, draft report on Electricity Network Regulatory Frameworks, October 2012, p 304. [↑](#footnote-ref-5)
6. Productivity Commission, draft report on Electricity Network Regulatory Frameworks, October 2012, p 317. [↑](#footnote-ref-6)
7. Kenneth Gillingham and James Sweeney Market Failure and the Structure of Externalities in Harnessing Renewable Energy (eds.) A. Jorge Padilla and Richard Schmalensee, 2010. [↑](#footnote-ref-7)
8. Productivity Commission, draft report on Electricity Network Regulatory Frameworks, October 2012, p 303 referencing Australian Energy Market Commission fact sheet ‘Demand side participation and prices’, March 2012. [↑](#footnote-ref-8)
9. Productivity Commission, Draft Report on Electricity Network Regulatory Frameworks, October 2012, p 100. [↑](#footnote-ref-9)
10. Commonwealth Treasury figures (including GST). [↑](#footnote-ref-10)
11. Department of Resources, Energy and Tourism ‘Fact Sheet – Electricity Prices’, August 2012. [↑](#footnote-ref-11)
12. Productivity Commission, draft report on Electricity Network Regulatory Frameworks, October 2012, p 10. [↑](#footnote-ref-12)
13. Refer to Appendix 8 for further details on the information in the table. [↑](#footnote-ref-13)
14. Solar Cities, Background Paper, October 2011, p 14. [↑](#footnote-ref-14)
15. This excludes evaporative coolers, which do not have compressors and which have significantly lower electricity demand (usually well below 1 kW, compared with 2 to 6 kW for refrigerative air conditioners). [↑](#footnote-ref-15)
16. Productivity Commission, draft report on Electricity Network Regulatory Frameworks, October 2012, p 315 referencing Australian Energy Market Commission ‘Power of Choice’ review and Department of the Environment, Water, Heritage and the Arts ‘Energy use in the Australian Residential Sector: 1986 to 2020’, 2008. [↑](#footnote-ref-16)
17. Productivity Commission, Draft Report on Electricity Network Regulatory Frameworks, October 2012, p 316. [↑](#footnote-ref-17)
18. Sydney Morning Herald article ([www.smh.com.au/articles/2004/10/24/1098556297439.html](http://www.smh.com.au/articles/2004/10/24/1098556297439.html)). [↑](#footnote-ref-18)
19. Sydney Morning Herald article ([www.smh.com.au/news/environment/we-love-a-sunburnt-country-our-aircons-too/2009/02/02/1233423135557.html](http://www.smh.com.au/news/environment/we-love-a-sunburnt-country-our-aircons-too/2009/02/02/1233423135557.html)). [↑](#footnote-ref-19)
20. Consultation RIS, Minimum Energy Performance Standards for air conditioners, June 2010, p 31. [↑](#footnote-ref-20)
21. Decision Regulation Impact Statement: Air Conditioners, April 2009, p 39. [↑](#footnote-ref-21)
22. E3 Product Profile: Electric Storage Water Heaters, July 2012, p 20. [↑](#footnote-ref-22)
23. Residential Pool Pumps: Load control and demand management in Queensland, Presentation to DCCEE Swimming Pool Pump Stakeholder Meeting (R Wilson), Sydney, 1 June 2012. [↑](#footnote-ref-23)
24. ABS, Environmental Issues: Water Use and Conservation, Cat. No. 4602.055, March 2010. [↑](#footnote-ref-24)
25. E3 Pool Pump Product Overview, Swimming Pool Stakeholders Meeting, 4 August 2009. [↑](#footnote-ref-25)
26. COAG Energy Market Reform – Implementation Plan ([www.coag.gov.au/sites/default/files/COAG%20Energy%20Market%20Reform%20Implementation%20Plan%20-%20FINAL%20-%2028%20November%202012.pdf](http://www.coag.gov.au/sites/default/files/COAG%20Energy%20Market%20Reform%20Implementation%20Plan%20-%20FINAL%20-%2028%20November%202012.pdf)). [↑](#footnote-ref-26)
27. Productivity Commission, draft report on Electricity Network Regulatory Frameworks, October 2012, p 320. [↑](#footnote-ref-27)
28. Productivity Commission, draft report on Electricity Network Regulatory Frameworks, October 2012, p 321 referencing Faruqui and Palmer, The Discovery of Price Responsiveness – A Survey of Experiments Involving Dynamic Pricing of Electricity, 2012. [↑](#footnote-ref-28)
29. The residents of selected Brisbane suburbs are eligible under the Energy Conservation Communities program. Payments of $250 are offered to customers who buy an AS/NZS 4755 compliant air conditioner and have it activated on installation, and to customers who have their existing air conditioner connected to the Energex communications system. Payments of $250 are also available to customers who have their swimming pool pump controlled, and $100 for those who go on to an off peak water heating tariff. See [www.energycc.com.au](http://www.energycc.com.au/). [↑](#footnote-ref-29)
30. Productivity Commission, draft report on Electricity Network Regulatory Frameworks, October 2012, p 302 referencing Futura Consulting Power of Choice, final report commissioned by the AEMC, 2011. [↑](#footnote-ref-30)
31. Productivity Commission, draft report on Electricity Network Regulatory Frameworks, October 2012, p 321. [↑](#footnote-ref-31)
32. MEPS Requirements for Air Conditioners ([www.energyrating.gov.au/products-themes/cooling/air-conditioners/meps](http://www.energyrating.gov.au/products-themes/cooling/air-conditioners/meps/)). [↑](#footnote-ref-32)
33. Energy Rating Website: Swimming Pool Pump Product Overview ([www.energyrating.gov.au/products-themes/other/swimming-pool-pumps](http://www.energyrating.gov.au/products-themes/other/swimming-pool-pumps/)). [↑](#footnote-ref-33)
34. Productivity Commission, draft report on Electricity Network Regulatory Frameworks, October 2012, p 374. [↑](#footnote-ref-34)
35. Market shares and average prices extracted from GfK retail sales data supplied by EnergyConsult, November 2010 (communication with George Wilkenfeld). Almost all of the models covered by this survey are imported. There are several Australian-made models in the larger-capacity part of the household market, which is supplied mainly through specialist air conditioner contractors rather than appliance retailers. [↑](#footnote-ref-35)
36. Further information, including work plan and status of projects, is available at:

    [www.scer.gov.au/workstreams/energy-market-reform/demand-side-participation](http://www.scer.gov.au/workstreams/energy-market-reform/demand-side-participation). [↑](#footnote-ref-36)
37. This excludes evaporative coolers, which do not have compressors and which have significantly lower power demand (usually well below 1 kW compared with 2 to 6 kW for refrigerative air conditioners – see Table 10). [↑](#footnote-ref-37)
38. Kenneth Gillingham and James Sweeney Market Failure and the Structure of Externalities in *Harnessing Renewable Energy* (eds.) A. Jorge Padilla and Richard Schmalensee, 2010. [↑](#footnote-ref-38)
39. For example, EnergyAustralia offers a TOU tariff of 52.5 c/kWh during peak periods (2pm-8pm on work days), 21.3 c/kWh during shoulder and 13.1 c/kWh during OP. Customers can also retain a pre-existing OP service at a cost of 11.1 c/kWh, but once on the TOU tariff cannot install a new OP service. [↑](#footnote-ref-39)
40. Australian Energy Market Commission: Review of Arrangements for Compensation following an Administered Price, Market Price Cap or Market Floor Price ([www.aemc.gov.au/Media/docs/Issues%20Paper-6c2a5a6f-5c98-4f65-920f-119f78e1bc31-0.pdf](http://www.aemc.gov.au/Media/docs/Issues%20Paper-6c2a5a6f-5c98-4f65-920f-119f78e1bc31-0.pdf)). [↑](#footnote-ref-40)
41. Victorian Department of Primary Industries Website: Flexible Pricing ([www.dpi.vic.gov.au/smart-meters/flexible-pricing](http://www.dpi.vic.gov.au/smart-meters/flexible-pricing)). [↑](#footnote-ref-41)
42. For example, see the Energex PeakSmart trial at [www.energex.com.au/sustainability/rewards-for-air-conditioning-pools-and-hot-water/energy-conservation-communities-ecc](http://www.energex.com.au/sustainability/rewards-for-air-conditioning-pools-and-hot-water/energy-conservation-communities-ecc). [↑](#footnote-ref-42)
43. Personal communications: CEO of ENA (May 2010), ENA (April 2011), Ausgrid (April 2011), ETSA (April 2011), Energex (May 2011). [↑](#footnote-ref-43)
44. Australian Energy Market Commission report: Power of Choice ([www.aemc.gov.au/market-reviews/open/stage-3-demand-side-participation-review-facilitating-consumer-choices-and-energy-efficiency.html](http://www.aemc.gov.au/market-reviews/open/stage-3-demand-side-participation-review-facilitating-consumer-choices-and-energy-efficiency.html)). [↑](#footnote-ref-44)
45. Energy Rating website: MEPS Requirements for Air Conditioners ([www.energyrating.gov.au/products-themes/cooling/air-conditioners/meps](http://www.energyrating.gov.au/products-themes/cooling/air-conditioners/meps/)). [↑](#footnote-ref-45)
46. On 10 December 2010 MCE ‘agreed to the Decision Regulatory Impact Statements in relation to Minimum Energy Performance Standards (MEPS) for Air Conditioners and the phase-out of Greenhouse-Intensive Water Heaters’ ([www.ret.gov.au/Documents/mce/\_documents/2010%20bulletins/24th\_Meeting\_Communique\_10Dec2010.pdf](http://www.ret.gov.au/Documents/mce/_documents/2010%20bulletins/24th_Meeting_Communique_10Dec2010.pdf) )

    The NSW Government has since announced that it will not be proceeding: [www.trade.nsw.gov.au/\_\_data/assets/pdf\_file/0007/448684/Electric-hot-water-heaters.pdf](http://www.trade.nsw.gov.au/__data/assets/pdf_file/0007/448684/Electric-hot-water-heaters.pdf). [↑](#footnote-ref-46)
47. Energy Rating website: Swimming Pool Pump Product Overview ([www.energyrating.gov.au/products-themes/other/swimming-pool-pumps](http://www.energyrating.gov.au/products-themes/other/swimming-pool-pumps/)). [↑](#footnote-ref-47)
48. The residents of selected Brisbane suburbs are eligible under the Energy Conservation Communities program. Payments of $250 are offered to customers who buy an AS/NZS 4755 compliant air conditioner and have it activated on installation, and to customers who have their existing air conditioner connected to the Energex communications system. Payments of $250 are also available to customers who have their swimming pool pump controlled, and $100 for those who go on to an OP water heating tariff. See [www.energycc.com.au](http://www.energycc.com.au/). [↑](#footnote-ref-48)
49. Energex, personal communication, 14 August 2012. [↑](#footnote-ref-49)
50. Product coverage must be based on verifiable physical characteristics. The scope of standards for pool pump-units (AS5102) and electric water heaters (AS/NZS 4692) covers the range of product capacities that would normally be encountered in residential use. The air conditioner standards (AS/NZS 3823) cover products up to 65 kW cooling, which cover both residential and small to medium commercial applications. It is proposed that compliance with AS/NZS 4755 should be mandatory for air conditioners rated up to 30 kW cooling capacity, and voluntary for larger units. 30 kW is the upper limit for products that must be physically tested for energy performance (larger units can simulation-tested). As physical testing is necessary to determine compliance with AS/NZS 4755, this cutoff would align testing practices and cover products for household use, but may also cover some products designed exclusively for commercial use. This should be explored in consultations. [↑](#footnote-ref-50)
51. Smart meter manufacturers have indicated that the provision of an AS/NZS 4755-compliant relay, with internal hardware and software, would add between $2 and $4 to the wholesale price of a smart meter (NSSC, personal communication). These hardware and software costs are similar for appliances. [↑](#footnote-ref-51)
52. Smart meters in this context are those with capability to receive demand response instructions and transmit them to a SAI-equipped appliance (either by cable or via a wireless or powerline receiver). [↑](#footnote-ref-52)
53. Personal communications, Mr Mike Davidson, former manager of the ETSA DR trial. The DRED costs were the main costs of the trial. ETSA has since decommissioned the FM platform and is investigating smart meters, but FM remains a proven low-cost option for use elsewhere. [↑](#footnote-ref-53)
54. Australia was the first nation to publicly state that it would pursue the ‘one-watt’ target under the banner of the IEA standby power initiative. See [www.energyrating.gov.au/wp-content/uploads/Energy\_Rating\_Documents/Library/General/Equipment\_Energy\_Efficiency\_Program\_(E3)/200914-achievements.pdf](http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Library/General/Equipment_Energy_Efficiency_Program_(E3)/200914-achievements.pdf). [↑](#footnote-ref-54)
55. Clean Energy Council: Wind Energy ([www.cleanenergycouncil.org.au/technologies/wind.html](http://www.cleanenergycouncil.org.au/technologies/wind.html)). [↑](#footnote-ref-55)
56. Market shares and average prices extracted from GfK retail sales data supplied by EnergyConsult, November 2010 (personal communication). Almost all of the models covered by this survey are imported. There are several Australian-made models in the larger-capacity part of the household market, which is supplied mainly through specialist air conditioner contractors rather than appliance retailers. [↑](#footnote-ref-56)
57. Asia Pacific Economic Cooperation Expert Group on Energy Efficiency and Conservation: Workshop on Smart Appliance Standards for Air Conditioners and Other Appliances ([www.egeec.apec.org/www/egeec/webnews.php?DomainID=17&NewsID=223](http://www.egeec.apec.org/www/egeec/webnews.php?DomainID=17&NewsID=223)). [↑](#footnote-ref-57)
58. In November 2012 the NSW Government announced that it is no longer proposing to implement this policy: see [www.trade.nsw.gov.au/\_\_data/assets/pdf\_file/0007/448684/Electric-hot-water-heaters.pdf](http://www.trade.nsw.gov.au/__data/assets/pdf_file/0007/448684/Electric-hot-water-heaters.pdf). [↑](#footnote-ref-58)
59. For example, the Queensland Urban Land Authority CQU development in Rockhampton. [↑](#footnote-ref-59)
60. Ausgrid Network Price List ([www.ausgrid.com.au/Common/Network-Supply-and-Services/Electricity-supply/~/media/Files/Network/Electricity%20Supply/Network%20Pricing/20100621NetworkPricelist201011.ashx](http://www.ausgrid.com.au/Common/Network-Supply-and-Services/Electricity-supply/~/media/Files/Network/Electricity%20Supply/Network%20Pricing/20100621NetworkPricelist201011.ashx)). [↑](#footnote-ref-60)
61. ‘Rising power prices have nothing to do with the carbon tax and everything to do with ''gold plating'' – overinvestment in infrastructure – the Australian Energy Regulator has said.’

    Sydney Morning Herald article ([www.smh.com.au/national/pricing-rules-boost-power-of-electricity-suppliers-20110620-1gbz1.html](http://www.smh.com.au/national/pricing-rules-boost-power-of-electricity-suppliers-20110620-1gbz1.html)).

    Australian Energy Regulator: Chairman’s Address to the Energy Users Association of Australia ([www.aer.gov.au/sites/default/files/AER%20Chairman%20Address%20to%20EUAA%2020%20June%202011.pdf](http://www.aer.gov.au/sites/default/files/AER%20Chairman%20Address%20to%20EUAA%2020%20June%202011.pdf)). [↑](#footnote-ref-61)
62. Energy Rating website: Presentation on The Australian Household Electricity Load-management Platform ([www.energyrating.gov.au/wp-content/uploads/Energy\_Rating\_Documents/Library/General/Demand\_Management/2005ac-wilkenfeld.pdf](http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Library/General/Demand_Management/2005ac-wilkenfeld.pdf)). [↑](#footnote-ref-62)
63. Energy Rating website: Equipment Energy Efficiency Program Achievements 2008/2009 ([www.energyrating.gov.au/wp-content/uploads/Energy\_Rating\_Documents/Library/General/Equipment\_Energy\_Efficiency\_Program\_(E3)/200914-achievements.pdf](http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Library/General/Equipment_Energy_Efficiency_Program_(E3)/200914-achievements.pdf)). [↑](#footnote-ref-63)
64. New Zealand Energy Efficiency and Conservation Authority - New Zealand Energy Efficiency Strategy 2011-2016 ([www.eeca.govt.nz/node/13339](http://www.eeca.govt.nz/node/13339)). [↑](#footnote-ref-64)
65. AusEng, personal communication, October 2010. [↑](#footnote-ref-65)
66. In New Zealand, policy development in the area of Smart or Advanced Metering is the responsibility of the Electricity Authority, which is currently undertaking a major review of its Electricity Industry Participation Code 2010 provisions on metering. It is intended that the new Code, to be implemented late 2012, will ensure that advanced metering infrastructure (AMI) is installed and operated ‘in a way that benefits the long-term interests of consumers’. [↑](#footnote-ref-66)
67. The NEM comprises the interconnected networks of Queensland, NSW, ACT, Victoria, SA and Tasmania. It is operated by the Australian Energy Market Operator (AEMO) which in July 2009 succeeded the National Electricity Market Management Company (NEMMCO). The WA system is operated by the WA Independent Market Operator (IMO), and the NT system is operated by the NT Power and Water Authority (PAWA). [↑](#footnote-ref-67)
68. Bureau of Meteorology: Climate Summary 2011 ([www.bom.gov.au/climate/annual\_sum/2011/AnClimSum2011\_LR1.0.pdf](http://www.bom.gov.au/climate/annual_sum/2011/AnClimSum2011_LR1.0.pdf)). [↑](#footnote-ref-68)
69. For example, the marginal day rate tariff in Sydney from 1 July 2011 is 36.6 c/kWh, compared with 8.00 c/kWh for off-peak. [↑](#footnote-ref-69)
70. Victorian Department of Primary Industries: Smart Meters ([www.dpi.vic.gov.au/smart-meters](http://www.dpi.vic.gov.au/smart-meters)). [↑](#footnote-ref-70)
71. In May 2010 GE in the US released what it claims to be the first ZigBee-enabled appliance: a heat pump water heater intended to communicate with a ZigBee-enabled electricity meter and respond to TOU prices. However, the US is not a significant source of large appliances for the Australian market. See [www.cepro.com/article/ge\_first\_with\_zigbee\_smart\_energy\_appliances/#When:12:26:07Z](http://www.cepro.com/article/ge_first_with_zigbee_smart_energy_appliances/#When:12:26:07Z)). [↑](#footnote-ref-71)
72. EPRI (2009a) states: ‘…what is intended is a physical interface, a connector of some kind, with mechanical, electrical, and logical aspects standardized. Such a communication interface would establish modularity between appliances and a diversity of plug-in communication modules to allow appliances to participate in demand response (DR) programs of all kinds.’ [↑](#footnote-ref-72)
73. Standards New Zealand declined to join EL-054 when it was formed in 2005 but joined in late 2010, and in May 2011 requested that AS4755 become a joint AS/NZS standard. [↑](#footnote-ref-73)
74. Energy Rating website: Voluntary Energy Rating Labelling Program for Swimming Pool Pump-units

    ([www.energyrating.gov.au/wp-content/uploads/Energy\_Rating\_Documents/Library/Other/Swimming\_Pool\_and\_Spa\_Equipment/201002-swimmingpoolpump-labelling2.pdf](http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Library/Other/Swimming_Pool_and_Spa_Equipment/201002-swimmingpoolpump-labelling2.pdf)). [↑](#footnote-ref-74)
75. In 2003 New Zealand introduced MEPS that aligned with levels then applying in Australia. [↑](#footnote-ref-75)
76. Personal communications, EnergyAustralia, Energex and Ergon. [↑](#footnote-ref-76)