



Australian Government

New Zealand Government



Consultation Paper: 'Smart' Demand Response Capabilities for Selected Appliances

August 2019

This work is licensed under the Creative Commons Attribution 3.0 Australia Licence. To view a copy of this license, visit the creative commons website.

The Department of the Environment and Energy on behalf of the Equipment Energy Efficiency Program asserts the right to be recognised as author of the original material in the following manner:



© Commonwealth of Australia (Department of Environment and Energy Australia) 2019.

The material in this publication is provided for general information only, and on the understanding that the Australian Government is providing professional advice. Before any action or decision is taken on the basis of this material the reader should obtain appropriate independent professional advice.

This document is available at the Energy Rating website.

While reasonable efforts have been made to ensure that the contents of this publication are factually correct, E3 does not accept responsibility for the accuracy or completeness of the content, and shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of this publication.

Foreword

The integration of electricity supply, demand and distributed energy resources (DER) are major concerns for electricity market regulators, policy makers and network managers. Peak demand events, often prompted by extreme weather, result in major spikes in electricity usage. These events have a disproportionate impact on network costs as they often require expensive investment to increase network capacity and to maintain the reliability of the electricity supply.

The rapid adoption of roof-top solar photovoltaic (PV) generation, now present in about 20% of Australian homes, has introduced new challenges. Many localities already experience periods when PV output exceeds the available load during the middle of the day. If the excess energy cannot be used or stored, it creates voltage and power quality issues which add to network costs and can result in PV inverters disconnecting from the grid. The Australian Energy Market Operator (AEMO) projects that South Australia (SA) and Western Australia (WA) will experience regular state-wide minimum load events as early as 2026.

Demand response (DR) – the rapid modification of appliance operation in response to changes in the condition of the grid – has been recognised as a key strategy for increasing the reliability, affordability and sustainability of electricity supply by AEMO¹, the Energy Networks Association (ENA), the CSIRO², the Australian Energy Market Commission (AEMC)³, the Australian Competition and Consumer Commission (ACCC)⁴, and the Independent Review (the Finkel Review).⁵

While DR has been successful with large electricity consumers, it has been difficult to engage the many millions of residential and small business consumers who, collectively, contribute most to both peak load and minimum load events. The reasons include the structure of electricity prices, and regulatory and technical issues.

The minority of consumers who face time-of-use (TOU) or critical peak pricing can already undertake ‘price-driven demand response’ by switching off appliances during high-price periods and shifting some of their electricity consumption to lower-price periods (sometimes with the use of smartphone applications (‘apps’)). Many PV owners also engage in price-driven DR by maximising consumption during times of maximum PV output, rather than exporting excess energy to the grid at low buy-back prices.

However, other approaches are needed to engage the great majority of consumers who do not face TOU tariffs, and who are not in position to – or simply too busy – to actively manage their energy loads. If consumers are willing to permit a DR service provider (DRSP) to manage some of their appliances, under agreed conditions and in return for agreed financial incentives, their aggregated DR capability can be exercised on their behalf in the electricity market. Aggregation increases both the scale and the reliability of the load reductions and load increases that can be bid into the market, to the point where network

¹ *Technical Integration of Distributed Energy Resources*, Australian Energy Market Operator, April 2019

² *Electricity Network Transformation Roadmap: Final Report*, Electricity Networks Australia and CSIRO, April 2017

³ *Distribution Market Model final report (DMM)*, The Australian Energy Market Commission, August 2017

⁴ *Restoring electricity affordability and Australia’s competitive advantage; Retail electricity pricing inquiry – Final Report*, Australian Consumer and Competition Commission, June 2018

⁵ *Independent Review of the Future Security of the National Electricity Market (Finkel Review)*, June 2017

service providers and system managers can confidently factor DR into their infrastructure planning and load scheduling.

There are both regulatory and technical barriers to the development of a small consumer DR services market in Australia. The AEMC published in July 2019 a draft determination for a National Electricity Market (NEM) rule change that “implements a wholesale demand response mechanism, which allows third parties to participate directly in the wholesale market as a substitute for generation, and be paid for providing demand response.”⁶ The AEMC draft determination covers demand response by industrial and commercial sector consumers only, and the Commission has decided to defer a decision on extending the rule to cover small consumers pending a review of consumer protections.

Removal of regulatory barriers would not on its own overcome the technical barriers. The development of a DR services market in which small consumers can participate requires DRSPs to be able to engage large numbers of consumers and to aggregate appliances of many different types from different manufacturers. Otherwise, costs will remain prohibitively high. At present, neither appliance manufacturers nor DRSPs are willing to risk investing in any particular demand response technology because of the fragmentation of the market.

Market fragmentation can be addressed by adopting a common, open (as distinct from proprietary) standard for DR capability.

It is therefore proposed that all air conditioners, electric storage water heaters, pool pump controllers and electric vehicle chargers that are supplied or offered for supply would have to comply with the full range of demand response modes (DRMs) in either the relevant part of AS/NZS 4755 Part 3 or AS 4755.2 (see Table 2). For air conditioners and electric storage water heaters, the measure would be implemented by Determinations under the GEMS Act 2012 to be made by 1 July 2021. For pool pump controllers and electric vehicle chargers, the timeframe for a GEMS Determination to be made is longer, by 1 July 2022 – due to the need to amend the GEMS Act before a Determination could be made. Some jurisdictions with imminent network issues requiring more controllable devices in the system may consider an earlier implementation using local regulation.

It should be noted that it would be up to consumers to decide whether they wish to contract with a DRSP to activate the DR capability in their appliances, in return for monetary, tariff or other benefits offered by the service provider.

Under a range of projected activation rates, the proposal is estimated to yield accrued net benefits of between \$2,260 million and \$4,270 million net present value (NPV) with the most likely value around \$2,970 million, at a benefit/cost ratio of 4.1. This is equivalent to a net benefit of over \$300 NPV for each Australian household.

For New Zealand, the proposal is estimated to yield accrued net benefits in the range \$NZ 130 million to \$330 million NPV with the most likely value around \$210 million, at a benefit/cost ratio of 2.5. This is equivalent to a net benefit of about \$115 NPV for each New Zealand household.

⁶ <https://www.aemc.gov.au/rule-changes/wholesale-demand-response-mechanism>

A Consultation RIS on a similar proposal was published in 2013.⁷ The proposal received a generally positive response during public consultations, but no Decision RIS was submitted to Ministers at the time. At its December 2018 meeting, the COAG Energy Council agreed “to draft a regulatory impact statement for certain electrical appliances to be demand response enabled.”

While it is proposed to cover the same range of products as before, key aspects have been updated to reflect changes in the electricity market and in the standards:

- Compliance would be possible with either (DR) AS 4755.2⁸ or with the part AS/NZS 4755.3 applying to that product type; and
- All DRMs in the AS/NZS 4755 framework would be mandatory.

This Consultation Paper details the proposals and raises a number of specific questions to which stakeholders are invited to respond. Responses will inform the final Decision RIS that will be submitted to Energy Ministers.

The proposal covers both Australia and New Zealand (with the exception of pool pump controllers, which are considered for Australia only).

Since the proposal was last considered in 2013, two additional product categories have become significant for peak demand and for the management of an increasingly renewables-intensive network: home storage batteries and PV inverters. As Energy Ministers have agreed that the proposal should focus on the same range of products as previously considered, these additional products are not within the scope of the proposal at present. However, stakeholders are invited to comment on the scope (in terms of both product coverage and technical requirements) and whether it should be narrowed or widened.

Have Your Say

We welcome your feedback on the proposal to mandate ‘smart’ demand response capabilities for selected appliances. A number of specific questions are included in this Consultation Paper. Feedback and enquiries can be directed to: smartappliances2019@sa.gov.au.

Submissions on this document close on: **16 September 2019**.

⁷ *Consultation Regulation Impact Statement: Mandating ‘smart appliance’ interfaces for air conditioners, water heaters and other appliances*. Equipment Energy Efficiency Committee, 2013. <http://www.energyrating.gov.au/document/consultation-regulation-impact-statement-mandating-smart-appliance-interfaces-air>

⁸ (DR) AS 4755.2 *Demand response framework and requirements for Communications between Remote Agents and Electrical Products*, open for public comment until 6 August 2019 at <https://sapc.standards.org.au/sapc/public/listOpenCommentingPublication.action>

Contents

Foreword.....	1
Have Your Say	3
Glossary.....	6
The Objective	8
Options and Regulatory Drivers	12
Products to be Covered	22
Proposed Compliance Standard	26
Summary of Costs and Benefits	30
Implementation and Timing.....	41
Questions for Stakeholders	43
Appendix 1 Costs and Benefits.....	47
Appendix 2 AS/NZS 4755	55

Illustrations

Figure 1. Electricity networks must be built for the ‘peakiest’ events.....	9
Figure 2. The growth of solar PV brings new challenges.....	10
Figure 3. Relationship of Remote Agent and DRED to Air Conditioner.....	27
Figure 4. New AS/NZS 4755 Framework	27
Figure 5. Projected increase in appliance costs	31
Figure 6. Projected activation costs	32
Figure 7. Projected activation rates (High, Medium, Low and Minimum)	33
Figure 8. Projected peak demand and impact on peak demand (Medium activation) rates	33
Figure 9. Projected costs and benefits of the measure at various activation rates, Australia.....	34
Figure 10. High install-activation rate projections vs actual PeakSmart activation rates.....	51
Figure 11. Number of installation and post-installation air conditioner activations, medium activation rates	52
Figure 12. Projected emergency DR air conditioner load available as % of maximum demand, Medium activation rates.....	53
Table 1. Types of Demand Response in the NEM.....	20
Table 2. Proposed mandatory Demand Response Modes in AS/NZS 4755	28
Table 3. Benefit/Cost ratio variations by discount rate and appliance type, Australia.....	35
Table 4. Benefit/Cost ratio variations by discount rate and appliance type, New Zealand.....	35
Table 5. Projected costs and benefits by jurisdiction (low activation).....	35
Table 6. Projected costs and benefits by jurisdiction (medium activation)	36
Table 7. Projected costs and benefits by jurisdiction (high activation)	36
Table 8. Projected costs and benefits by appliance, Australia (low activation).....	37
Table 9. Projected costs and benefits by appliance, Australia (medium activation)	37
Table 10. Projected costs and benefits by appliance Australia (high activation).....	37
Table 11. Projected costs and benefits by appliance, New Zealand (low activation)	38
Table 12. Projected costs and benefits by appliance, New Zealand (medium activation)	38
Table 13. Projected costs and benefits by appliance. New Zealand, Australia (high activation).....	38
Table 14. Estimated investment required per marginal peak load kW.....	47
Table 15. Load reduction available from participating appliances	48
Table 16. Demand response costs and benefits quantified in this RIS	49
Table 17. Summary of assumptions used to calculate benefits.....	54
Table 18. Parts of AS/NZS 4755 Demand response capabilities and supporting technologies for electrical products.....	56
Table 19. Air conditioner types installed in homes, Australia and USA	57
Table 20. Product types covered by published standards for ‘connected’ or ‘smart’ products	58

Glossary

Acronym	Definition
AC	Air conditioner.
Activated load	The total electricity demand of appliances which consumers have contracted to DR aggregators.
Activation	The provision of all the elements necessary to transmit operational instructions to an appliance complying with AS/NZS 4755.
AEMC	Australian Energy Market Commission.
AEMO	Australian Energy Market Operator.
AEC	Australian Energy Council.
AER	Australian Energy Regulator.
ARENA	Australian Renewable Energy Agency.
AS/NZS	Australian Standard/New Zealand Standard.
Available load	The maximum electricity load of participating appliances that are likely to be available for modified operation during a DR event, given that some appliances will be off.
BAU	Business as usual (no new regulations).
B/C	Benefit/cost.
COAG	Council of Australian Governments.
CPP	Critical Peak Pricing.
DEE	The Department of the Environment and Energy.
DER	Distributed energy resources.
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 AS 4755).
DR Program	An arrangement in which remote agents offer, and appliance owners/users may accept, contracts for remote agents 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.
DRSP	Demand response service provider; May be DNSP, a Retailer or an independent DRSP.
(DR)	Draft – in relation to a standard.
E3	Equipment Energy Efficiency (Program or Committee).
ENA	Energy Networks Association (Australia – there is also a New Zealand ENA).
EV	Electric Vehicle.

Acronym	Definition
FCAS	Frequency Control Ancillary Services.
GEMS	Greenhouse and Energy Minimum Standards (Commonwealth Act, 2012).
HEMS	Home Energy Management System.
kW	Kilowatts.
MD	Maximum Demand.
MASP	Market Ancillary Service Providers.
MEPS	Minimum Energy Performance Standards.
MW	Megawatts (kW x 1,000).
NEL	National Electricity Law.
NEM	National Electricity Market.
NPE	Negative price event.
NPV	Net present value.
OP	Off-Peak (electricity price).
Participating load	The total electricity demand of appliances that are activated and where the owner/user has agreed to participate in a DR program.
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.
RRO	Retailer Reliability Obligation.
PCT	Programmable Communicating Thermostat.
RERT	Reliability and Emergency Reserve Trader.
RIS	Regulation Impact Statement.
SMD	Summer maximum demand.
Take-up	The rate at which households with DR-capable appliances consent to have them activated in order to enter direct load control programs with utilities or DRSPs. (May also denote the percentage of appliance owners participating in demand response programs at a given time).
TNSP	Transmission Network Service Provider.
TOU	Time-of-use (electricity price).
WM	With Measure (i.e. with compliance mandated).
WMD	Winter maximum demand.

The Objective

The objective of the proposal is **‘to contribute to reducing the future investment requirements for electricity network, generation and transmission infrastructure due to growth in peak electricity demand, and to address network costs arising from the rapid growth in customer-side renewable generation, by facilitating development of the demand response market.’**

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 are of brief duration (hours at most, occurring on only a few days each year), the full capacity of the electricity system (or parts of the electricity system) is under-utilised for most of the time.

Figure 1 shows a typical load duration curve forecast for a zone substation (in this case, in Sydney). It shows that demand is projected to exceed the existing firm capacity about 9.5% of the time, or 830 hours per year. If capital were invested in the substation to meet the full projected load, the last 10% of capacity would be utilised for less than 200 hours per year. If the extremes of the peak could be avoided through demand response (DR), significant capital investment could be saved.

People value thermal comfort, and so may use more electricity to cool or heat their homes when the weather is very hot or cold. However, very few are made aware of the costs of using electricity at peak times, as about 88% of residential electricity consumers in Australia currently pay a flat tariff for their general consumption.⁹ The Productivity Commission has concluded that “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.”¹⁰

The cost of inefficient investment in network capacity is passed on to consumers in their electricity bills. Wholesale electricity prices are also impacted, because the highest-cost peaking plant sets the pool price during peak events. In its 2018 *Inquiry into Retail Electricity Tariffs*, the ACCC found that average residential tariffs increased by 56% in real terms between 2007/08 and 2017/18.¹¹ The main reasons were network charges (accounting for 38% of the increase) and wholesale electricity prices (27%).

Maximum demand on electricity networks continues to rise, albeit at a more moderate rate than in the past decade. Even so, the rate of growth in peak demand is projected to exceed the rate of growth in energy supplied in all jurisdictions except Western Australia (WA) and New Zealand, indicating that load factors – a primary indicator of economic efficiency – will continue to decline.

Since the 1990s, the main driver of summer maximum demand has been the rising ownership of air conditioners (ACs). The rate of increase in ownership is slowing, but AC numbers will continue to rise due to population growth. However, the Australian Energy Market Operator (AEMO) now projects electric vehicle (EV) charging to take over as the driver of peak demand in the late 2020s and 2030s.¹²

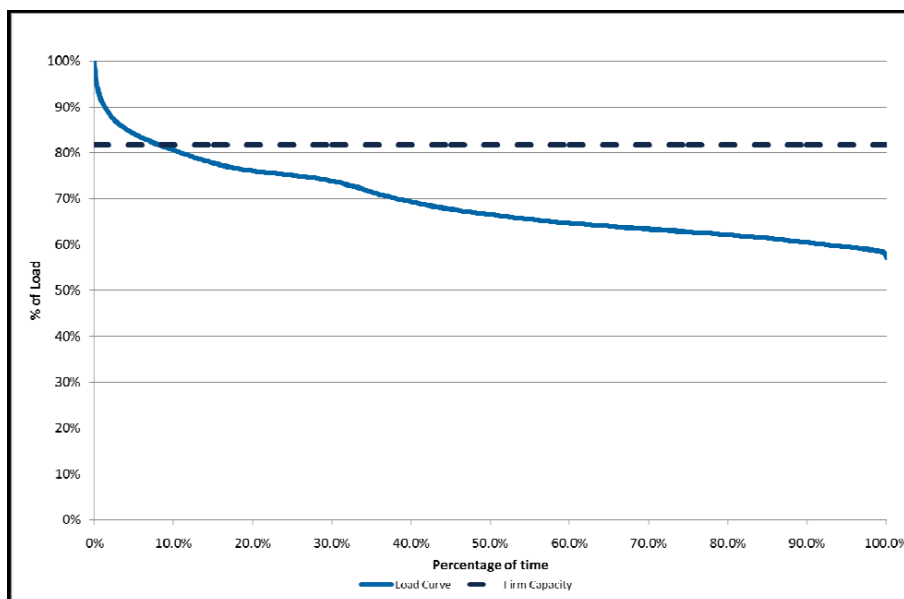
⁹ ACCC (2018) p206/398. Many consumers also have controlled tariff supply for water heating and some other uses.

¹⁰ PC (2013) p338.

¹¹ ACCC (2018), p6/398

¹² <http://forecasting.aemo.com.au/>

Figure 1. Electricity networks must be built for the 'peakiest' events



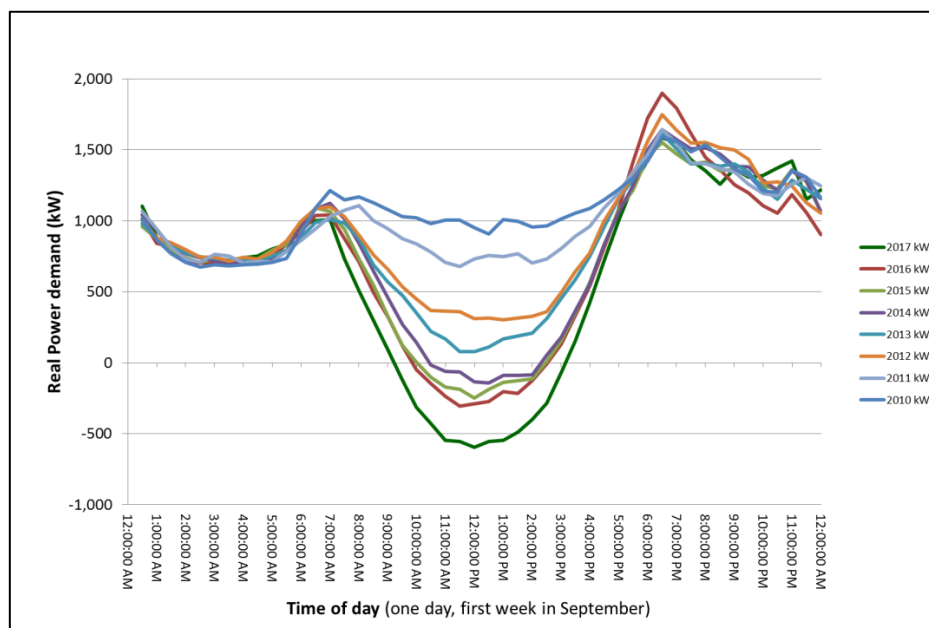
Source: Ausgrid (2018) Macquarie Park Zone Substation, demand projections for 2021/22

One of the factors moderating growth in afternoon peak demand is solar photovoltaics (PV). While this brings financial benefits to the owners and reduces the greenhouse gas-intensity of electricity supply, it also imposes network costs which need to be recouped from all network users, including householders without PV. **Figure 2** illustrates the changes in daily load pattern on a residential feeder in Queensland at yearly intervals between 2010 and 2017, as the local concentration of PV has increased. Since 2015, the daytime load has become negative, so the local area back-feeds energy through the zone substation. The increase in daily variance makes it more challenging to keep the network voltage within statutory limits, and can result in decreased asset life as voltage regulation devices operate more frequently.

This increasingly typical load shape (known in the electricity supply industry as the “duck curve”) also means that fossil fuel generators must be brought on more quickly to meet the rapid rise in the post-solar evening peak.

A lack of cost reflective price signals has been a major contributor to the peak demand problem, encouraging over consumption at peak times and inefficient supply side investment which may only be utilised for a handful of days a year. At the same time, PV owners do not receive effective signals of the costs of generating and exporting energy at times of low load, further encouraging inefficient supply side investment. The cost of additional network capacity is spread across all consumers regardless of whether or not their actions contribute to inefficient supply-side investments, so creating significant cross subsidies.

Figure 2. The growth of solar PV brings new challenges



Source: Energy Queensland (2018). Daily load curves, Burrum feeder, 2010-17

This issue can be addressed by:

- Appropriate pricing that reflects the cost of electricity and provides clear signals that encourage consumers to manage their demand;
- Enabling technologies such as smart metering and in-home or in-app displays which support the ability of consumers to undertake DR manually; and
- The development of automated DR.

The low incidence of time-of-use (TOU) signals in electricity pricing is a regulatory failure that needs to be addressed through the actions of governments, electricity regulators and consumers. However, it is compounded by a market failure in the provision of services and technologies that can contribute to more economically efficient load management, irrespective of the pricing regime.

It is proposed to address this market failure by facilitating the supply of an enabling technology – demand-responsive or “smart” appliances. This will support the development of a Direct Load Control (DLC) DR market which does not rely on TOU pricing, but which will provide more options to consumers to respond to price signals as they become more prevalent in the electricity market.

The development of demand-responsive appliances is inhibited by market failure in the form of “network externality” in which the benefit an individual can derive from a product or service depends on the number of other users. In order for an individual consumer to benefit from having an appliance with a particular DR capability, a sufficient number of other consumers must have products with the same capabilities. This enables DR service providers (DRSPs) to achieve economies of scale, making it feasible for them to offer DR schemes to all consumers.

Currently, competing technologies and a lack of standardisation undermine the economies of scale, increasing costs and risks for appliance manufacturers and deterring potential DR service providers. They also increase transaction costs for DRSPs, who have to pay large upfront incentives to get consumers to purchase specific technologies or models compatible with the service provider’s systems.

The Australian and New Zealand Standard AS/NZS 4755 *Demand response capabilities and supporting technologies for electrical products*, which is proposed for mandatory adoption, is an open rather than a proprietary standard. Using an open standard would lower costs for manufacturers and DRSPs, and facilitate the development of DR.

Options and Regulatory Drivers

Of the options available to governments to address the objectives of the proposal, the following are considered:

1. Business as Usual (BAU) – no new regulation;
2. Encourage the voluntary adoption of demand responsive appliances; or
3. Mandate the presence of DR capabilities in the products which contribute (or are likely to contribute) most to peak demand, and for the products where DR could help alleviate network and power quality problems.

Option 1 – Business as Usual (BAU) – No New Regulations

Under this scenario, the development of DR initiative would be left to the market. Compliance with AS/NZS 4755 or any other standard would not be mandated. Any DRSP could offer incentives for consumers to purchase products with any capability. Although some DLC initiatives may continue, management of peak demand and power quality would probably rely primarily on electricity pricing and price-related DR.

If the voluntary adoption of demand responsive appliances were sufficient to support a DR market, this approach would be more flexible than a mandatory scheme. The inclusion of DR capability in appliances would be market led rather than determined by government, and would not impose additional mandatory requirements on manufacturers.

Phasing in cost reflective electricity pricing would create some interest in DR, but most consumers would need to respond manually because automated DR programs would be limited in number and scale. It is expected that only a minority of AC owners would respond manually to cost-reflective pricing during extreme summer peak demand events, which is when a response is most needed. Consumer awareness of the risk of increased energy costs during peak periods would most likely increase resistance to adopting cost-reflective pricing.

Some reduction in peak demand may also occur as a result of existing E3 energy efficiency measures such as more stringent Minimum Energy Performance Standards (MEPS) for the products in question.

Trials of DR Functionality

The 2013 Consultation Regulation Impact Statement (RIS) reported 9 Australian trials of air conditioner DR between 2005 and 2012, involving ETSA Utilities, Energex, Ergon, Western Power, Endeavour Energy and ActewAGL.¹³ Only one of those trials evolved into a full scale program (Energex PeakSmart, using AS/NZS 4755 compliant products). The Australian Renewable Energy Agency (ARENA) is currently supporting 8 DR trials targeting residential consumers, involving EnergyAustralia, Powershop, United Energy, Zen Ecosystems and AGL.¹⁴ Powercor is running a separate “Energy Partner” program (see Appendix 2). All of these trials use different approaches and, where they depend on automated response rather than user reaction to price signals, different technologies. Some of the DLC trials could evolve into local programs,

¹³ Consultation Regulation Impact Statement: Mandating ‘smart appliance’ interfaces for air conditioners, water heaters and other appliances. Equipment Energy Efficiency Committee, 2013, p136/179.

¹⁴ ARENA (2019) Demand Response RERT Year 1 Report, March 2019, p3/20

but the diversity and incompatibility of the platforms, their reliance on proprietary technology and the risk to consumers of being stranded with incompatible appliances if they change retailers will limit their reach.

Voluntary Compliance with AS/NZS 4755

As the option of voluntary compliance with AS/NZS 4755.3.1 has been available since 2008, it is possible to gauge the level of supplier response. In November 2010, only 0.2% of household size AC models had the capability built in, rising to 1.2% by August 2011. There was some increase in compliance in early 2012 by suppliers wishing to take advantage of the Energex PeakSmart rebate offer, but the share of models with the capability built in was still less than 5%. It reached 14% by mid-2014, then 33% by April 2019.

It is likely that the original driver for introduction of AS/NZS 4755 compliant ACs was the expectation among manufacturers, following publication of the Consultation RIS in April 2013, that compliance would become mandatory and there would be a nation-wide advantage in moving early. In the end, the commercial advantage was restricted to the region where the PeakSmart program supported compliant AC sales with cash incentives. It is questionable whether PeakSmart would have been possible at all had manufacturers not anticipated a mandatory requirement.

The market share of AS/NZS 4755-compliant ACs may be different from the model share. If the market share were lower than the model share, it would indicate that models which are not compliant with AS/NZS 4755 outsell those that are.¹⁵ The Department of the Environment and Energy estimated in 2018 that “about 20 per cent of air conditioners installed in homes today are capable of having their demand remotely controlled by third party operators.”¹⁶ The share participating in DR programs is lower still: outside the Queensland PeakSmart program the number is negligible.

The parts of AS/NZS 4755 applying to pool pump controllers and electric water heaters have been available since 2012 and 2014 respectively, but no complying products have been introduced. Therefore, it is unlikely that there will ever be a sufficient critical mass of pool pump controllers and electric water heaters with standard capabilities to make DR through DLC cost-effective for utilities or DRSPs.

Electricity Pricing

The phasing in of cost reflective pricing could eventually have a significant impact on peak demand, but it is difficult to predict the extent or the timing. In seven Australian trials of TOU and Critical Peak Pricing (CPP), the average reductions in peak demand were between 13-40% during peak events.¹⁷ The reductions under CPP were four times as great as under conventional TOU tariffs, which were much flatter.¹⁸

However, no government has permitted retailers to force residential consumers to accept TOU tariffs (let alone CPP) and only 12% have chosen to do so.¹⁹ One disincentive for consumers is the risk of being unable to avoid energy use at high-price periods, if they are out or have forgotten to turn off or reset appliances. Offering TOU pricing is not enough, on its own, to support an efficient consumption response.

¹⁵ The annual market share of DR-capable air conditioners is currently being clarified, using sales data collected by E3.

¹⁶ Greenhouse and Energy Minimum Standards (GEMS) Act Review - Draft Report, November 2018, p78

¹⁷ Consultation Regulation Impact Statement: Mandating ‘Smart Appliance’ Interfaces for Air Conditioners, Water Heaters and other Appliances 2013, p136

¹⁸ Productivity Commission, Report on Electricity Network Regulatory Frameworks, April 2013, p 356

¹⁹ ACCC (2018), 205/398

E3 Program Measures

The Equipment Energy Efficiency (E3) program has a number of policy measures in place that are aimed at improving the energy efficiency of ACs, water heaters and pool pumps. Pool pump controllers and electric vehicle (EV) chargers are not currently regulated by the E3 program.

AC energy efficiency requirements have been updated several times, most recently in 2019. While this has led to an improvement in the efficiency of ACs and has contributed to reduced household energy consumption, there has been little impact on peak demand. This is due to the increase in the number of installed ACs and their typical usage patterns. Maximum demand occurs on the hottest days when most ACs are operating at maximum output, irrespective of their efficiency. Extreme hot days have become more frequent in recent years.²⁰

A Decision RIS recommending mandatory labelling and MEPS for swimming pool pumps was approved by the Council of Australian Governments (COAG) Energy Council and published in December 2018.²¹ These measures should help reduce peak demand, because it is estimated that around 50% of pool pumps are also operating during AC-induced peak events.²²

The widespread adoption of EVs would almost certainly exacerbate electricity network constraints and peak demand problems. A Level 2 (fixed-wired) home charger will have a maximum demand of 6 to 10 kilowatts (kW), making it the highest single load in most homes. The energy-efficiency of EV chargers will probably be high, so MEPS may not be required. However, energy-efficiency will have negligible impact on easing demand if, as is likely, users initiate charging on their return from work.²³

Option 2 – Encourage Voluntary Adoption of Demand Responsive Appliances

The means available to government to encourage the voluntary adoption of demand responsive appliances include the funding of trials and demonstrations, mandating the disclosure of the DR capabilities of products and offering cash incentives for the purchase of DR capable products. The funding of trials and demonstrations through ARENA is already under way, so is part of the BAU option.

Labelling DR Capability

At present, any manufacturer is able to claim that their product is “smart” because “smart” is not a technical term but an undefined marketing term (such as “sustainable” or “eco-friendly”).²⁴ A consumer cannot know if the purchase of one particular product will have some additional DR value to them unless they are aware that it complies with a standard or specification or has certain capabilities that enable it to participate in a DR program. Even if it does, the consumer may still need access to a third party offering a DR program compatible with those standards and capabilities.

²⁰ <http://www.bom.gov.au/climate/current/statements/scs68.pdf>

²¹ www.energyrating.gov.au/products-themes/other/swimming-pool-pumps

²² *Residential Pool Pumps: Load control and demand management in Queensland*, Presentation to DCCEE Swimming Pool Pump Stakeholder Meeting (R Wilson), Sydney, 1 June 2012

²³ Australian Electric Vehicle Market Study, Energeia, 2018

²⁴ The published standards covering DR for appliances uses terms such as “demand responsive”, “connected” or “controllable” – none define or use the term “smart” on its own.

In this respect, the status of the term “smart” is similar to the status of the term “energy-efficient” in the 1980s. Several manufacturers claimed that their products were energy-efficient, using criteria of their own devising and which naturally favoured their own products. Consumers were unable to compare products from different manufacturers. This prompted the New South Wales (NSW) and Victorian governments to introduce, in 1985, mandatory energy labelling for refrigerators, freezers, air conditioners and dishwashers, based on Australian Standard tests (the origins of the existing GEMS Act and E3 program).

In 2010, the E3 program changed the air conditioner energy rating label to enable manufacturers to indicate whether a model complies with AS/NZS 4755.3.1. This enabled them to voluntarily introduce compliant products and to indicate this on the energy label. Recently however, the AC label design has been changed again, and no longer offers the option of indicating DR capability.²⁵ Although the main reason for dropping the option was lack of space, using energy labels as a means of encouraging consumers to prefer appliances with “smart” or DR capabilities is problematic and has not succeeded where it has been tried, such as in the USA and Japan.²⁶ A further barrier in Australia is the fact that there is no energy labelling for electric water heaters, pool pump controllers or EV chargers, so a new “DR capable” labelling system would need to be introduced for those products.

Cash incentives

Cash incentive payments provide another means of encouraging buyers to voluntarily purchase products with specific DR capabilities. Two Queensland utilities, Energex and Ergon, now offer cash incentives to customers in designated areas who purchase AS/NZS 4755-compliant ACs and have them activated on installation (see Appendix 1).

While local incentive programs would increase the take-up of DR-capable appliances in the areas where they are offered, and for the duration of the offers, they are unlikely to create a permanent market shift towards demand-responsive appliances throughout Australia. A sustained and near-universal incentive program where governments require utilities or independent DRSPs to offer the necessary incentives may well have this outcome.

An upfront cash incentive serves three objectives:

- a. to motivate consumers to seek out products that are capable of linking to the DRSPs communications platform;
- b. to enable the service provider to identify consumers who have purchased those products (they will be the ones claiming the incentive); and
- c. rewarding those consumers for participating in the DR program.

If it is mandatory for all products sold to have a uniform, non-proprietary capability that is accessible to all DRSPs, then it is not necessary to offer incentives for objective (a) or (b), and objective (c) could be achieved in more efficient ways.

²⁵ Greenhouse and Energy Minimum Standards (Air Conditioners up to 65kW) Determination 2019. The new label shows 6 scales of 10 star each with a map, whereas the old label showed two scales of 6 stars each and no map.

²⁶ G. Wilkenfeld (2017) *Labelling for “Smartness”*: Problems for energy labelling and standards schemes, in Proceedings of the 9th international conference on Energy Efficiency in Domestic Appliances and Lighting (EEDAL '17) <https://e3p.jrc.ec.europa.eu/publications/proceedings-9th-international-conference-energy-efficiency-domestic-appliances-and-0>

If cash incentives were withdrawn in the absence of mandatory compliance, the sales share of AS/NZS 4755 ACs may stagnate and then start to drop. Manufacturers may see little advantage in including DR capability in new models, or may revert to a proprietary rather than an open standard, so fragmenting the market and increasing stranded investment risks for both DRSPs and consumers. Once the current group of compliant models reach the end of their model cycle (in 3-5 years), the availability of AS/NZS 4755 products could fall away.

Assessment of Options 1 and 2

Voluntary adoption of AS/NZS 4755 has been available to manufacturers for over a decade. There has been considerable adoption for ACs, but not for the other products, and only where cash incentives are offered. Indicating the presence of DR capabilities on energy labels has not been effective.

In the absence of a uniform DR capability, incentive payments need to be high enough to motivate suppliers to introduce, and for consumers to seek out, compatible DR-capable models. This increases the costs of DR programs. Given the network regulatory regime, governments are not able to force utilities or DRSPs to offer cash incentives, and have not indicated a willingness to use public funds for this purpose.

However, some continuing DR activity is assumed under the BAU scenario:

- a. the rates of DR activation at the time of air conditioner purchase that are currently being achieved in Queensland (**Figure 10**) increase slightly over time (whether through continuation of PeakSmart or other means); and
- b. there is some activation of ACs post-purchase in Queensland, (i.e. through programs introduced by new DRSPs taking advantage of the build-up of DR-capable units);
- c. in other jurisdictions, the activations of ACs due to existing DR trials resulting in limited DR programs is very low; and
- d. there are no DR activations of water heaters, pool pump controllers or EV chargers in any jurisdiction (beyond continued access to traditional controlled load tariffs).

The costs and benefits of (a) and (b) above are quantified, and used as the baseline for calculating the additional costs and benefits of Option 3. The impact of (c) is not quantified. If at the time of a DR event the load was already modified (upward or downward) due to the operation of DR approaches not involving AS/NZS 4755 capabilities, then the additional benefits from AS/NZS product compliance and activation would be lower. The implications for cost-benefit analysis can be inferred by assuming a lower activation rate among the range modelled (say a “low” rather than a “medium” activation rate).

Even so, there should be enough scope to accommodate all approaches without saturating or exhausting the potential benefit. For example, under the medium activation scenario, the impact of a DRM 2 event would be equivalent to 60% - not 100% - of the total projected growth in peak demand on the State and Territory networks to 2035 (see Summary of Costs and Benefits).

Option 3 – Mandate the Presence of Demand Response Capabilities

Under this option, all ACs, electric storage water heaters, pool pump controllers and EV charge/discharge controllers intended for household use would have to comply with AS/NZS 4755. These appliances will therefore have to be sold with standardised DR capabilities built-in, to allow them to connect to a range of

communications systems and to participate in the DR market. Compliance will require changes in product design and manufacture, the costs of which will be passed on to all purchasers.

There will be additional costs for those products that are “activated” (connected to a communications platform). As activation would be at the choice of the consumer, only a proportion of products would be activated (whether at the time of installation or later) and the DR capability of the rest would remain unused.

Mandating compliance with AS/NZS 4755 in ACs 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. The stock of DR-capable appliances would build up at a predictable rate to the thresholds at which it becomes cost-effective for utilities and DRSPs to market commercial offerings to consumers.

A DR capability that is reliable and of sufficient scale can provide a viable alternative to supply side investment for meeting future demands on the electricity network. It would enable DR to be targeted to the parts of the network under stress, so reducing the risk of network outages. At the same time, all consumers – not just those participating in DR programs – would benefit from lower electricity prices and greater protection from the impacts of peak load events, including the risk of blackouts.

If there were evidence of significant BAU take-up of appliances with other DR capabilities (in addition to or in place of AS/NZS 4755 compliance) prior to the announcement of a decision to implement the proposed measure then this would be a reason to reconsider. This was seen as a risk in 2005, when Standards Australia started working on AS/NZS 4755, and 14 years later that standard still appears to be the most effective option. Therefore, while a (currently unforeseeable) global standard may make AS/NZS 4755 obsolete, there is an equal risk that failure to adopt it will miss the benefits of DR. Also, compliance with AS/NZS 4755 does not preclude building in other types of “smart” capability into the same product, so it is not a binary decision.

Regulatory Drivers

The proposal is intended to provide a technical platform that would lower the costs and increase the take-up of DR programs throughout Australia and New Zealand, so enabling a significant increase in the supply of DR services. However demand for DR services is ultimately determined by regulatory drivers.

The revenues which the Australian Energy Regulator (AER) permits to regulated network services providers depends partly on the value of their asset base and on the prudent expenditures which they claim will be necessary to maintain electricity supply at acceptable (sometimes statutory) levels of reliability and security. To counter any bias towards maximising capital investment to boost the asset base (“gold plating”), the AER applies tests of “prudence” – whether the purpose of expenditure is legitimate and whether it is possible to achieve the objective at lower cost.

Table 1 summarises the classification of DR services for the Australian NEM adopted by the Australian Competition and Consumer Commission (ACCC) and the Australian Energy Market Commission (AEMC), along with their status under the current regulatory drivers. All of these drivers would enable DRSPs to realise the value for DR programs for the appliances in scope, provided the costs of such programs were low enough and yielded DR resources of sufficient a scale and reliability for DRSPs to bid into the relevant DR markets:

- Network DR: The largest Australian residential AC DR program to date (PeakSmart) was implemented and continues under existing Demand Management Incentive Scheme (DMIS) and Demand Management Incentive Allowance (DMIA) rules, so there are no regulatory barriers.²⁷
- Emergency DR: A number of large commercial and industrial consumers already participate in the Reliability and Emergency Reserve Trader (RERT) market. In 2017, ARENA and AEMO called for proposals to trial ways of involving residential consumers in emergency DR. The barriers to doing so are technical (scale, cost and reliability) rather than regulatory.²⁸

Electricity retailers can already use DR resources to reduce price risk in the wholesale market. However, according to four applicants who have requested the AEMC to make rule changes under the National Electricity Law (NEL):

- a) The requirement that third party DRSPs either be registered as a retailer or have a commercial relationship with a retailer to provide wholesale demand response is creating challenges for the integration of DR in the NEM;
- b) There are commercial barriers to developing the required partnerships between retailers and DRSPs, which has contributed to a sub-optimal level of DR in the NEM in comparison to other energy markets;
- c) A key concern of DRSPs is that their investments (for example, in equipment to facilitate DR) are at risk of becoming stranded should their customers change retailers, as a subsequent retailer may decide not to continue with the previous retailer's existing demand response arrangement;
- d) If a retailer does not offer DR products, or to provide a direct signal of the wholesale price to customers, its customers have no incentive to change their energy consumption; and
- e) the lack of a mechanism for portfolio DR, and the fact that consumers may not have the capacity to manage their demand at all times, limits consumers' ability to take advantage of DR offerings.²⁹

The applicants have proposed the introduction of a wholesale demand response mechanism in the NEM and creation of a new category of market participant, to be called either a DRSP or demand response aggregator.

The AEMC Draft Determination and the text of the proposed rule change were published on 18 July 2019.³⁰

The introduction states:

“The draft rule implements a wholesale demand response mechanism, which allows third parties to participate directly in the wholesale market as a substitute for *generation*, and be paid for providing demand response. The draft rule also makes a number of complementary changes to increase the transparency of other types of wholesale demand response.” (p3/228, emphasis added).

The main focus of the rule is on addressing shortfalls in generation (by rewarding reductions in load or additional generation), but it would also have secondary effects on local network problems. While the rule

²⁷ Queensland Energy Group, (2109) *Customer Interactions Demand Management Outcomes 2015-20*, January 2019

²⁸ ARENA (2019) *Demand Response RERT Trial Year 1 Report*, ARENA with Oakley Greenwood, March 2019.

²⁹ AEMC (2018) Consultation Paper: Wholesale Demand Response Mechanisms; Proponents: Public Interest Advocacy Centre, Total Environment Centre, The Australia Institute, Australian Energy Council, South Australian Government, AEMC, 15 November 2018, p17/86

³⁰ AEMC (2019) draft Rule Determination: National electricity amendment (wholesale demand response mechanism) rule 2019; National energy retail amendment (wholesale demand response mechanism) rule 2019, 18 July 2019

change would incentivise a new group of DRSPs, at present these would only be able to bid the loads of industrial and commercial consumers into the wholesale market:

“For the purposes of this draft rule determination, the Commission has determined to not make a draft rule in relation to the retail rules for this request. Instead, the Commission will consider, in a formal review, the application of consumer protections to new energy service providers more generally, including DRSPs. The Commission considers that this approach is preferable given that it allows consumer protections to be considered in a holistic, comprehensive manner so that these can be made fit for purpose, no matter what the future may bring.”³¹

The rule change approved by the AEMC would commence on 1 July 2022. If a retail rule change is also approved, by then or later, DRSPs would be in a position to engage residential consumers. If not, then the wholesale market benefits attributed to the mandating of AS/NZS 4755 could only be realised by retailers. In either case, a build-up of AS/NZS 4755 compliant appliances in the stock would provide a cost-effective, reliable and universally available DR platform to any stakeholder permitted to engage with residential consumers (and AC DR could be an element of commercial DR programs under the rule change as it stands).

AS/NZS 4755 is an open standard and so investment in using it could not be stranded, because another DRSP could take over DLC of the same appliance (with the consumer’s consent) without even visiting the site – addressing issue (c) above. Its adoption would help address the retail consumer protection issues which the AEMC is now intending to investigate.

Adoption of AS/NZS 4755-compliant products can help address issues (d) and (e) under existing regulations, even without a retail rule change. There is nothing to prevent Distribution Network Service Providers (DNSPs) approaching customers on their network to engage them in Network Demand Response programs even if the retailer is unwilling to engage them in wholesale market demand response. In fact, the DNSP can sell the use of the same DR capability to retailers, for use at times when it will have a wholesale market value rather than a network value (provided this is consistent with the terms of the DNSP’s contract with the customer).

AS/NZS is designed expressly to address issue (e), by automating response for consumers who do not have the capacity to manage their demand at all times.

The extent to which the AEMC rule changes could impact on the categories of DR in **Table 1**, and so reduce the benefits obtainable from the proposal to mandate AS/NZS 4755 compliance, can be reflected by:

- Subtracting the wholesale market benefits (separately identified in **Table 5**, and **Table 7**) and
- assuming a lower activation rate among the range modelled (say a “low” rather than a “medium” activation rate).

³¹ AEMC (2019) p67/228

Table 1. Types of Demand Response in the NEM

Type	Description	Current Status
Wholesale demand response	Demand response used to change the quantity of electricity bought in the wholesale market, which could be used to manage spot price exposure, or to help market participants manage their positions.	Due to the lack of transparency around how much wholesale demand response is currently being utilised, it is difficult to draw firm conclusions about how much demand response is occurring in the NEM, or whether this level is efficient.
Ancillary service demand response	Demand response employed by the system operator during supply emergencies, with the service being centrally dispatched or controlled to avoid involuntary load shedding. This is generally provided by out-of-market reserves.	Large energy users have used demand response to provide FCAS. Market ancillary service providers (MASPs) can offer customers' loads into FCAS markets. Currently, there are two MASPs using demand response to provide FCAS.
Emergency demand response	Demand response employed by the system operator during supply emergencies, with the service being centrally dispatched or controlled to avoid involuntary load shedding. This is generally provided by out-of-market reserves.	Demand response can – and currently is – participating in the Reliability and Emergency Reserve Trader (RERT). The Commission is currently considering ways to enhance the RERT through its consideration of AEMO's rule change request on enhancing the RERT
Network demand response	Demand response employed to help a network business to provide network services to consumers.	The existing regulatory framework provides a number of incentives and obligations for non-network options (including demand response) to be adopted by a network service provider where it is efficient to do so. For example, the Demand Management Incentive Scheme (DMIS) provides distribution network service providers (DNSPs) with an incentive to undertake efficient expenditure on relevant non-network options relating to demand management and the Demand Management Incentive Allowance (DMIA) mechanism provides an allowance to DNSPs to undertake innovative projects related to demand management. The ACCC recommended in its Retail Electricity Pricing Inquiry that both the DMIS and DMIA be extended to also apply to transmission network service providers (TNSPs).

Source: AEMC (2019), Table 2.1. Wholesale and emergency demand response are the focus of the rule change determination published by the AEMC in July 2019.

To sum up, the deployment of a DR capability based on AS/NZS 4755 would interact with the DR regulatory environment in the following ways:

- Network DR: The proposal is consistent with and would have value under the existing rules, by lowering the costs of DR programs for DNSPs and their contracted DRSPs;
- Emergency DR: The proposal is consistent with and would have value under the existing rules, and would lower the costs of DR programs for retailers and their contracted DRSPs, so helping resolve the technical and cost barriers identified in the current ARENA trials;
- Ancillary services DR: the proposal could help create value in this market (see Summary of Costs and Benefits); and

- Wholesale DR: The proposal is consistent with and would have value under the existing rules, and would lower the costs of using small-consumer DR as a wholesale market strategy by retailers.

Enactment of the wholesale price mechanism rule changes currently before the AEMC is likely to lead to the entry of a new class of DR aggregators into the wholesale market (who would most likely make use of a universal AS/NZS 4755 DR platform if it were available). While the two measures would be mutually reinforcing, realising the benefits of the present proposal does not depend on the AEMC rule changes.

The Retailer Reliability Obligation (RRO), which took effect on 1 July 2019, could increase the value of the proposed measure. The RRO is designed to incentivise retailers and other market customers to support the reliability of the NEM by wholesale supply contracting strategies which reduce wholesale spot price volatility, increase DR and invest in dispatchable energy.³²

Under the RRO, AEMO must undertake an annual assessment of potential reliability gaps in future years. If it assesses that there will be a material reliability gap, it may request that the AER make a reliability instrument.

A reliability instrument would trigger an obligation on energy retailers to make adequate contracts with generation, storage or DRSPs to meet their share of a one-in-two-year peak demand, should it occur during the forecast reliability gap period. AEMO will be empowered to act as “Procurer of Last Resort” if a gap is still evident one year out. This will create a strong new regulatory driver for DR capability which can be deployed quickly, reliably and at scale. A pool of AS/NZS-compliant appliances already present in households would provide an ideal resource to support the RRO.

³² National Electricity (South Australia) (Retailer Reliability Obligation) Amendment Act 2019
[https://www.legislation.sa.gov.au/LZ/B/CURRENT/NATIONAL%20ELECTRICITY%20\(SOUTH%20AUSTRALIA\)%20\(RETAILER%20RELIABILITY%20OBLIGATION\)%20AMENDMENT%20BILL%202019.aspx](https://www.legislation.sa.gov.au/LZ/B/CURRENT/NATIONAL%20ELECTRICITY%20(SOUTH%20AUSTRALIA)%20(RETAILER%20RELIABILITY%20OBLIGATION)%20AMENDMENT%20BILL%202019.aspx)

Products to be Covered

Suitability for DR depends on whether appliances are (or are likely to be) major contributors to peak demand, and whether their demand can be reduced. Appliances whose operation can be modified or rescheduled at minimal cost and inconvenience to consumers will also provide significant benefits for network reliability and security.

Shifting the operation of electric storage water heaters, swimming pool pumps and EV chargers out of peak and into low-load periods will have negligible impact on consumer utility but significant effect on demand. By contrast, consumers will not tolerate automatic curtailment of activities with high value to them and which cannot be rescheduled or substituted – for example lighting, television and cooking.

Air Conditioners

In the case of ACs, which are the largest contributor to summer maximum demand,³³ many consumers have already shown their willingness to accept a reduced level of service at times of high demand in return for financial incentives. DR programs and trials in Australia have shown that most consumers will tolerate interruptions to air conditioner operations, and that reduced levels of cooling for short periods cause little or no discomfort. Indeed, the majority of participants are not even aware when a DR event has occurred (see Appendix 1).

As ACs replace gas heating, their contribution to winter maximum demand is increasing, especially in winter-peaking jurisdictions such as Tasmania and New Zealand. Interruption of the compressor (DRM 1) is less acceptable when the unit is heating than when it is cooling, but the reduced output modes (DRM 2 and 3) will still provide thermal comfort while reducing power.

The proportion of Australian households with at least one refrigerative AC was steady at around 25% through the 1990s, but reached 56% in 2010 and is projected to exceed 70% by 2020. Rising incomes and the declining cost of ACs are key causes of this trend, along with the increasing size of new homes.

The ownership rate in New Zealand, where ACs are usually called “heat pumps”, is about half the Australian rate, and the products are used for heating rather than cooling.

Household ACs have contributed to emergency load shedding and blackouts in several Australian States since February 2004, when heavy AC use during heat waves caused blackouts in Perth and parts of Melbourne.³⁴ There were more such events in SA and Victoria in January and February 2009, during the period of record temperatures leading up to the Victorian bushfires,³⁵ and in Melbourne again as recently as January 2018³⁶ and January 2019.³⁷ Apart from these State- and city-wide events, many network constraints are local, and occur at times when there is more than enough total generation available.³⁸

³³ Productivity Commission, report on Electricity Network Regulatory Frameworks, April 2013, p 336.

³⁴ Sydney Morning Herald article (www.smh.com.au/articles/2004/10/24/1098556297439.html).

³⁵ Sydney Morning Herald article (www.smh.com.au/news/environment/we-love-a-sunburnt-country-our-aircons-too/2009/02/02/1233423135557.html).

³⁶ DELWP (2018), Post Event Review, Power Outages 28 & 29 January 2018.

³⁷ <https://www.abc.net.au/news/2019-01-26/victorian-blackouts-what-caused-them-and-is-this-the-new-normal/10751412>

³⁸ *Keep calm and carry on: Managing electricity reliability* Tony Wood, Guy Dundas and Lucy Percival (Grattan, 2019)

About 920,000 refrigerative ACs are sold each year, with Queensland accounting for about 30% of the market, NSW for 26%, Victoria for 19%, WA for 13%, SA for 7% and the Australian Capital Territory (ACT), Northern Territory (NT) and Tasmania combined for 5%.³⁹ There are 50 registered AC suppliers in Australia and New Zealand. The majority of ACs are imported, mainly from China, Thailand, Japan, Korea and Malaysia. There are also some local assemblers, particularly of ducted split systems.⁴⁰ Some imported and locally manufactured models already have AS/NZS 4755 DR capabilities.

The 2013 Consultation RIS proposed that all ACs up to 30 kW cooling capacity should comply with AS/NZS 4755. Stakeholders submitted that the proposal captured many models which sell in low numbers (so requiring high retooling costs per unit) and mainly into the commercial market. This market differs from the residential market in that TOU energy pricing constitutes a greater incentive for reducing electricity consumption at peak times and many commercial buildings have energy management systems which give more sophisticated control than AS/NZS 4755.

Therefore, the scope has been narrowed to ACs up to 19 kW cooling capacity in this Consultation Paper. Comment is invited on whether this limitation is still appropriate (see Questions for Stakeholders at the end of this document). Many ducted refrigerative ACs with a cooling capacity greater than 19 kW are installed in residential applications, and these could be attractive targets for DR programs.

There is no evidence that any of the AS/NZS 4755 compliant models currently on the market are priced higher than similar non-compliant models. Nevertheless, it is conservatively assumed that making all AC models compliant would increase average retail prices by \$5-15 per unit. Given that the installed cost of a typical 5 kW household AC is about \$2,500, this represents well under 1% of the installed cost.

Electric Water Heaters

There are about 5.3 million electricity-using storage water heaters in Australia: 83% are electric resistance water heaters, 13% are solar with electric boost and 4% are heat pumps. About 530,000 electric storage water heaters are sold annually in Australia, mostly of local manufacture. The New Zealand market is about 100,000 per year. NSW accounts for about 34% of the Australian market, Queensland 32%, Victoria 11%, WA 7%, SA 6%, Tasmania 5%, the ACT 3% and the NT 2%.

A DR capability would contribute to reducing winter peak demand more than summer peak demand. Most larger units are already on controlled load off-peak (OP) tariffs and so do not heat during peak periods. However, DR is the only practical option for managing the load of the electric water heaters that are too small to be eligible for OP tariffs. Even for larger water heaters, AS/NZS 4755 provides a more flexible form of load management than the simple power on/off exercised by OP controls.

Demand-responsive water heaters could be switched on at times when there is excess PV generation, to store energy as heat. A few manufacturers have introduced “solar diverters” and water heaters with these capabilities, using their own proprietary standards rather than AS/NZS 4755, and limited to installations where both the PV and the water heaters are at the same site. An open standard would enable DRSPs to match PV output to water heater energy storage across an entire suburb. The *E3 Policy Framework for Hot Water Systems in Australia and New Zealand*, 2018, has included ‘smart’ controls and DR in its strategy.⁴¹

³⁹ Calculated from air conditioner market projections supplied by E3.

⁴⁰ Decision RIS: Air Conditioners, December 2018, p17/138.

⁴¹ <http://www.energyrating.gov.au/document/policy-framework-hot-water-systems-australia-new-zealand>

The 2013 Consultation RIS proposed that all electric resistance, solar-electric and heat pump water heaters should comply with AS/NZS 4755. Stakeholders submitted that the reductions in peak demand from controlling solar-electric and heat pump water heaters would be too small to be cost-effective. Therefore, the scope has been narrowed in this Consultation Paper to electric resistance water heaters with a delivery of 10 to 700 litres. Comment is invited on whether this scope is still appropriate (see Questions for Stakeholders at the end of this document).

Given sufficient lead time, suppliers of electric storage water heaters to the Australian market could make the necessary design changes. It is estimated that the requirement would add about \$70-80 to the cost of electric storage water heaters, since very few models at present have suitable electronic controls and most models would have to be re-designed.

Swimming Pool Pump Controllers

A DR capability for pool pump controllers would contribute to reducing network summer maximum demand, because it is estimated that around half of pumps are on during AC-induced peak events.⁴² Like water heaters, they could also be switched on at times when there is excess PV generation. One local manufacturer has introduced a pool pump controller with these capabilities, but using its own proprietary standard rather than AS/NZS 4755.

There are about 1.2 million residential pools in Australia: 29% of these are in NSW, 33% in Queensland, 13% in Victoria, 16% in WA, 5% in SA and 4% in Tasmania, NT and ACT combined.⁴³ About 180,000 pool pump-units are sold each year⁴⁴ but fewer controllers, as they have longer service lives. Pool pump controllers sold in Australia are a mix of locally manufactured and imported products.

Simple controllers attached directly to pump-units themselves would be excluded from the requirement. The DR capabilities would need to be exercised by a higher level controller because of the need to switch other components that rely on water flow for their safe operation, such as chlorinators and heaters. Some pools have multiple pumps, each serving a different water circulation system (e.g. pool filtration, solar heating circuit and spa). AS/NZS 4755 only requires the controller to switch off or modify the operation of the filtration pump.

It is estimated that the compliance would add about \$50 to the average price of pool pump controllers.

Electric Vehicle Charge/Discharge Controllers

There is growing interest in EVs in Australia. Although the EV market is still small (2,300 units in 2017, or 0.2% of the new car market), vehicle manufacturers are importing more electric models and the market is expected to grow rapidly.

⁴² Wilson, R (2012) Residential Pool Pumps: Load control and demand management in Queensland. Presentation to DCCEE Swimming Pool Pump Stakeholder Meeting, Sydney, 1 June 2012

⁴³ ABS, Environmental Issues: Water Use and Conservation, Cat. No. 4602.055, March 2010.

⁴⁴ Decision Regulation Impact Statement: Swimming Pool Pumps, September 2018.

The New Zealand government has set up a contestable fund “to be invested in projects that accelerate the uptake of EVs and for innovations that would not otherwise be funded. This would include initiatives to promote a shift in consumer attitude and facilitate the utilisation of EVs...”⁴⁵

AEMO projects that by 2038, EVs will consume about 9% of the electricity delivered by the NEM. Nearly 80% of the energy used by privately owned EVs is expected to be delivered by home chargers, which will contribute significantly to local network peak demands if charging starts as soon as drivers return home from work.⁴⁶

The 2018 Senate *Select Committee on Electric Vehicles* concluded that:

“6.28...The Committee agrees with the evidence provided that making sure EVs do not overload the electricity network at times of peak demand will also be important for maintaining grid stability and preventing price spikes.”⁴⁷

Indeed, many EV industry stakeholders expect that home chargers will be demand-controlled. DR-capable chargers could be managed to interrupt or constrain charging during times of network stress or high wholesale prices, and resume charging when conditions ease.

In July 2019, the UK Government commenced a consultation paper on the introduction of mandatory DR standards for EV chargers from 2022.⁴⁸ The paper states:

“Without government intervention, it is unlikely that smart charging will be taken up at the rate required to achieve the full benefits for consumers and the electricity system during the mass transition to EVs, and there is a risk of variable standards and inadequate protection for the grid and consumers. This is why the Government proposes to intervene now - to introduce regulations under the AEV Act [Automated and Electric Vehicles Act 2018] to increase uptake and set minimum standards.”

While EV sales in Australia and New Zealand are currently modest, there is a risk that when the market starts to grow there will be a repeat of the peak load problems caused by the unexpected surge in AC sales in the late 1990s, which contributed to tens of billions of dollars in avoidable network costs. Building DR capabilities into EV chargers at the beginning of market growth is a relatively low-cost risk-management strategy. It is proposed to require DR capabilities in EV charge controllers designed for hard-wired residential use, with capacities up to 20 kVA. These are classified in the relevant US standard as SAE J1772 Level 2⁴⁹ and in the international standard IEC 61851.1 as Mode 3.⁵⁰

EV chargers, like pool pump controllers, are electronics-intensive products and it is assumed that DR capability would impose a similar price penalty of \$50 per unit.

⁴⁵ Cabinet submission by Minister of Transport, *Electric Vehicles: Package of Measures to Encourage Uptake*, undated (2016) <https://www.transport.govt.nz/multi-modal/climatechange/electric-vehicles/>

⁴⁶ Australian Electric Vehicle Market Study, Energeia, 2018 p93.

⁴⁷ https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Electric_Vehicles

⁴⁸ <https://www.gov.uk/government/consultations/electric-vehicle-smart-charging>

⁴⁹ https://www.sae.org/standards/content/j1772_201710/

⁵⁰ <https://webstore.iec.ch/publication/33644>

Proposed Compliance Standard

Australian and New Zealand Standard AS/NZS 4755

The previous Consultation RIS proposed that products be required to comply with the relevant parts of AS/NZS 4755 *Demand response capabilities and supporting technologies for electrical products* as published (or expected to be published) at the time. AS/NZS 4755 specifies a number of DRMs for each product type, and ways in which the DRMs can be verified through testing.

At the time, there were no internationally accepted standards for appliance demand response capability, and this is still the case.⁵¹ ARENA has funded a number of trials of different DR technologies and approaches.⁵² None were more successful than those using AS/NZS 4755 products.⁵³ There are some open DR standards in use in Japan and the USA, but none have been adopted throughout their home countries or gained widespread international use. The nearest in scope to AS/NZS 4755 is the Japanese Echonet specification, which is supported by a number of Japanese appliance manufacturers.⁵⁴

Manufacturers have been more interested in offering consumers remote control and monitoring of their appliances through proprietary apps, some using voice-activated platforms such as Google Assistant or Amazon Alexa. However, achieving DR through these channels generally relies on consumers responding personally rather than appliances responding automatically, and so are not alternatives for an automated load control platform such as AS/NZS 4755. The most common example of *automated* response in the USA, the Programmable Communicating Thermostat (PCT), was developed for ducted ACs and is unsuitable for the split units prevalent in Australia and New Zealand (see Appendix 2).

AS/NZS 4755 remains the most suitable DR standard for Australia and New Zealand. Several global AC manufacturers have introduced AS/NZS 4755 products into Australia; this was made easier by the fact that the capabilities (DRM 1, 2, 3 etc) are consistent with Echonet. A key advantage of AS/NZS 4755 is that compliance can be verified through testing products: an essential requirement for standards that are called up in legislation.

Products complying with AS/NZS 4755.3.1, 3.2 and 3.3 (collectively called ‘Part 3’) must have a physical interface designed to connect to an external Demand Response Enabling Device (DRED) (**Figure 3**). The DRED communicates with a “remote agent,” defined in the standard as a “person, organization or entity, other than the user, who is authorised to initiate demand response by transmitting operational instructions in accordance with this Standard.”⁵⁵

⁵¹ There are some standards for communications related to demand response, such as OpenADR (republished as IEC 62746-10-1:2018) but these are not specific to appliances. Verification is usually limited to whether an end node has received an instruction, and actual responses can only to be determined statistically across many installations rather than individually on a single appliance.

⁵² <https://arena.gov.au/news/aemo-arena-demand-response/>

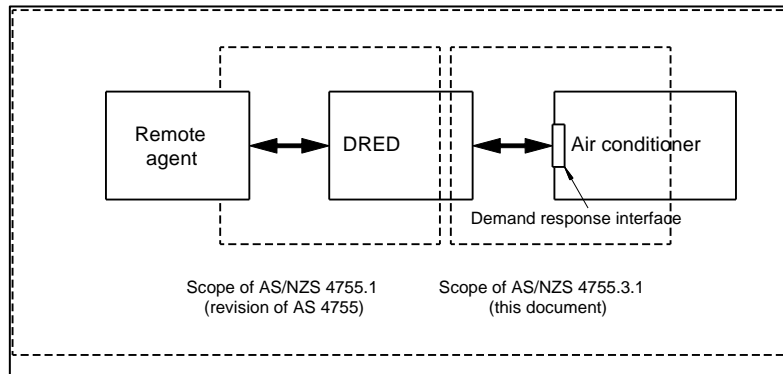
⁵³ The limiting factor in one case was that too few of the volunteers had AS/NZS 4755 air conditioners - see <https://www.agl.com.au/solar-renewables/projects/peak-energy-rewards-managed-for-you> p15/33

⁵⁴ https://echonet.jp/product_en/echonet_lite_specification/

⁵⁵ AS/NZS 4755 adds the following notes: Note 1 to entry: Examples include electricity distributor, electricity retailer, electricity system manager and demand response aggregator.

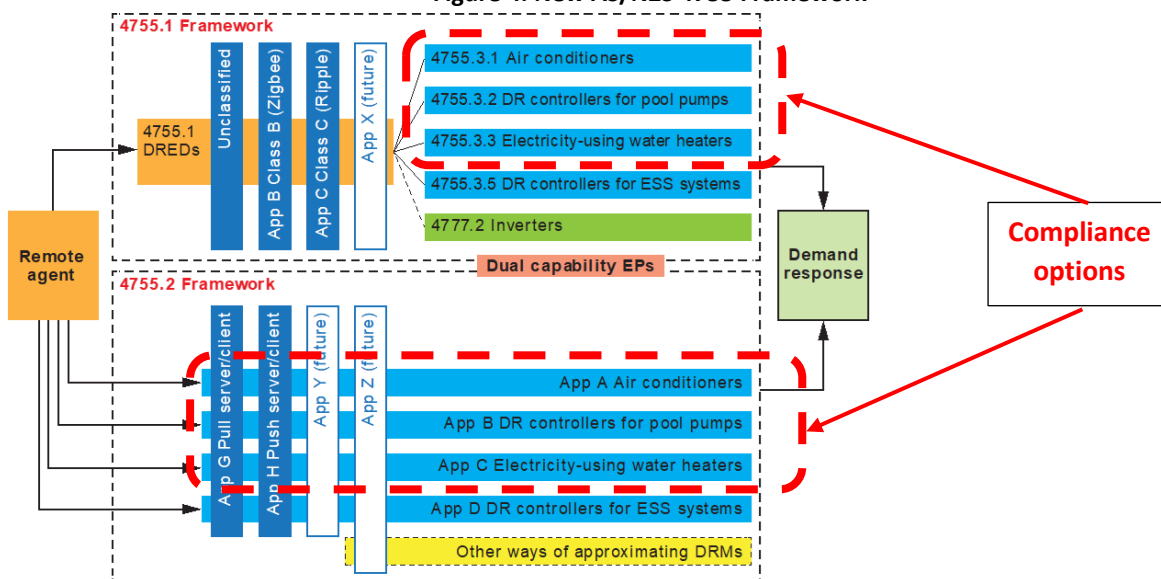
AS/NZS 4755 does not specify communications standards, or the pathways by which signals are transmitted from a remote agent to the DRED (or, in 4755.2, from the remote agent to the product). Leaving the mode of communication flexible lowers commercial risk for all stakeholders, including appliance manufacturers and DRSPs: any DRSP can connect to any appliance with the standard interface, so appliance manufacturers can realise the commercial value of compliant products irrespective of where they are sold. DRSPs would normally arrange for the supply and installation of DREDs that connect to their communications systems or platforms.

Figure 3. Relationship of Remote Agent and DRED to Air Conditioner



Source: AS/NZS 4755.3.1

Figure 4. New AS/NZS 4755 Framework



Source: (DR) AS 4755.2

Several parts of AS/NZS 4755 have since been updated, and new parts published (see Appendix 2). The Joint Standards Australia/Standards New Zealand Committee EL-054, *Remote Demand Management of Electrical* has recently drafted a new part (DR) AS 4755.2 *Demand response framework and requirements*

Note 2 to entry: The remote agent will generally have a contractual relationship with the user in which the user gives prior consent for the remote agent to initiate demand response under agreed conditions.

Note 3 to entry: An electrical product can have only one remote agent at a time, but may be available to respond to other requests for demand response, provided that operational instructions from the sole remote agent take priority.

for Communications between Remote Agents and Electrical Products.⁵⁶ AS 4755.2 electrical products would be able to interact with a remote agent without the presence of a DRED or a physical interface, as is required for products conforming to Part 3. Once (DR) AS 4755.2 is published, there will be two classes of electrical products within the AS/NZS 4755 framework — those conforming to AS/NZS 4755.3 and those conforming to AS 4755.2 (**Figure 4** – the 4755.1 framework corresponds to **Figure 3**). An electrical product could also comply with both, provided it is capable of managing potential conflicts.

It is proposed that the mandatory requirement for DR capabilities could be met either by compliance with AS/NZS 4755.3 or with AS 4755.2. The current draft of AS 4755.2 provides only for communications over HTTP (PULL Server or PUSH Server). However, it is intended to add other options in future, so providing a path to integration with any emerging international standards (See Appendix 2).

Demand Response Modes

The minimum capability required to comply with AS/NZS 4755 is DRM 1, which is to turn the appliance off or to change it to minimum load settings on receipt of a load control signal. For example, a compliant AC must cease compressor operation during a DRM 1 event.

The present proposals are broader than those in the 2013 Consultation RIS in that they would require compliance with the full range of DRMs covered in AS/NZS 4755 (see **Table 2**). The potential to limit power to 50% (DRM 2) or to 75% (DRM 3) makes participation in DR more acceptable to consumers, since they can be assured of some cooling or heating during DR events. The Energex and Ergon PeakSmart program, for example, only incentivises models with all three DRMs.

Table 2. Proposed mandatory Demand Response Modes in AS/NZS 4755

Product	Demand Response Modes (DRMs)						
	AS/NZS 4755 part (alternatives)	Safety Disc-connect	Minimum load/off	Reduce load	Switch on / store energy	Discharge energy if capable	Do not discharge energy
Air conditioners	3.1 (a); 2(b)	NA	DRM 1	DRM 2,3	NA	NA	NA
Pool pump controllers	3.2 (a); 2(b)	NA	DRM 1	DRM 2	DRM 4	NA	NA
Electric water heaters	3.3 (a); 2(b)	NA	DRM 1	DRM 2,3	DRM 4	NA	NA
Electric vehicle chargers	3.4 (c)	DRM0 (e)	DRM 1	DRM 2,3	DRM 4	DRM 8 (d)	DRM 5 (e)

(a) Published part. (b) Draft of AS4755.2 is at public comment stage, so DRM numbers indicative only. (c) Unpublished draft – would need to be brought to publication or the contents incorporated in a GEMS determination or similar. (d) AS/NZS 4755 framework includes DRMs 6 and 7 to constrain the rate of discharge, but these would not be mandatory. (e) Mandatory safety modes for products capable of discharge to grid.

Of the 3,942 AC models registered on www.energyrating.gov.au in April 2019, 54% claim compliance with AS/NZS 4755.3.1, and of those about 95% claim DRM 2 and DRM 3 as well as DRM 1 (the actual compliance rate is likely to be around 33%, based on PeakSmart approved models). Manufacturers have indicated that providing the full range of DRMs is no more costly than providing DRM 1 alone.

It is also proposed to mandate DRM 4 (turn on) for pool pump controllers, electric water heaters and EV chargers, in order to build up a capability to shift load into excess supply periods. AS/NZS 4755 does not

⁵⁶ This part is an Australian rather than a joint standard. It is available for public comment until 6 August 2019 at <https://sapc.standards.org.au/sapc/public/listOpenCommentingPublication.action>

include a DRM 4 for ACs, because it would bring a significant risk of wasting energy on cooling or heating empty houses.

Products complying with AS/NZS 4755 have particular advantages for regulators and DRSPs. The demand reductions required under each DRM are quantified in relation to either a fixed reference point (for ACs, the kW when operating at the output capacity used to determine MEPS) or a dynamic reference point (for pool pump controllers, the average kW over the five minutes immediately preceding the DR event). There must be a measurable step change in demand within a specified time after a DR event commences, and this has been verified in field monitoring (Appendix 1).

This simplifies the calculation of “baselines” – notional consumption patterns against which notional demand changes are estimated. Incorrect baselines can distort DR markets by either over- or under-rewarding consumer actions. The review of the first year of operation of the ARENA DR trials reported that:

“Several proponents noted that particularly for residential and smaller commercial customers, consumption against the baseline can vary significantly across the customers within a portfolio in regard to any particular DR event, and for any particular customer across DR events.”⁵⁷

The PeakSmart program offers customers what is in effect a capacity payment (based on kW made available) rather than an energy payment (notional kWh avoided per event). For a DRSP to bid this into the capacity and/or energy markets will take some estimation of the effect, but it is statistically simpler to estimate a AS/NZS 4755-style response (which will show as a step change in demand at the substation) rather than to compile and aggregate individual baselines for every consumer with an AC operating when the event starts (which is a condition of payment under some current trial schemes – so creating a perverse incentive for absent consumers to switch on their AC via their app).

⁵⁷ ARENA (2019) Demand Response RERT Trial Year 1 Report, ARENA with Oakley Greenwood, March 2019

Summary of Costs and Benefits

The ACCC Retail Electricity Pricing Inquiry identified four main services that demand response can provide:

- “network demand response—employed to manage peak demand within a particular transmission or distribution network, or localised part of a network
- wholesale demand response—used to reduce the quantity of electricity bought in the wholesale market, either to reduce prices, to help market participants manage their contract market positions, or defer investment in new generation capacity
- ancillary services demand response—sourced by the system operator to maintain grid frequency within its technical operating range
- emergency demand response—sourced by the system operator when there are predicted supply shortfalls to avoid involuntary load shedding.”⁵⁸

The benefits of managing peak load are captured by estimating the net present value (NPV) of the reductions in projected network capital investment from substituting a MW of reliable demand reduction for a MW of additional peak demand. This benefit was quantified in the 2013 Consultation RIS. The net present value (NPV) per future MW avoided on the distribution and transmission systems has been updated, based on the latest distribution pricing submissions to the AER (see Appendix 1).

The benefits of wholesale price reductions are captured by assuming that retailers or other DR aggregators can withdraw sufficient load from the market to make it unnecessary for the next-highest cost dispatchable generator (usually gas) to bid into the pool. It is assumed that this would reduce the wholesale price by \$100/MWh for about 20 hours each year, to benefit both the DR participants who contribute to the load reduction and all other consumers using electricity over the same time period. The wholesale demand response mechanism rule changes currently being considered by the AEMC⁵⁹ would widen the range of actors able to participate in the market in this way.

As the share of non-dispatchable renewable wind and solar generation grows, the time when available supply exceeds demand is increasing. If the grid operator (AEMO) does not take action under these circumstances, or PV inverters do not automatically disconnect, grid voltage and frequency levels will move outside the statutory operating ranges, so risking damage to supply infrastructure and to consumers’ equipment. During “negative price events” (NPE), generators supplying the pool receive no payment and must pay the pool to continue to supply. If there is still insufficient load, they have to reduce output or, in the extreme, disconnect. Generators effectively pay for load to come on during NPEs. The DR value is reflected by estimating the total energy demand that can be presented to the grid by products activated through DRM 4, and assigning a value to that energy (see Appendix 1).

Emergency response occurs under the opposite conditions – when expected load exceeds the availability of generation capacity. To address this, AEMO has set up a Reliability and Emergency Reserve Trader (RERT) facility.⁶⁰ Parties can contract to supply energy (if they have a standby generator) or reduce load during

⁵⁸ Restoring electricity affordability and Australia’s competitive advantage; Retail electricity pricing inquiry – Final Report, Australian Consumer and Competition Commission, June 2018, p230/398

⁵⁹ <https://www.aemc.gov.au/rule-changes/wholesale-demand-response-mechanism>

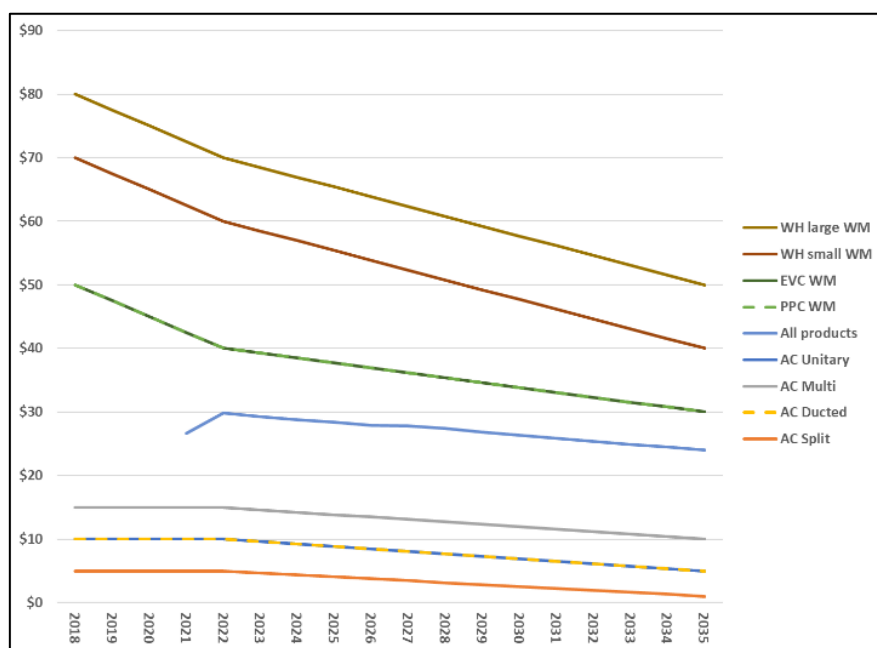
⁶⁰ <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Emergency-Management/RERT-panel-expressions-of-interest>

RERT events, which are typically notified a day ahead. RERT prices are high: for example, RERT events in January 2019 paid \$9,800 per MWh to contractors in Victoria and SA over 13.5 hours.⁶¹ It is assumed that DR aggregators in those states could bid into the RERT market.

DR could also supply ancillary services to the NEM.⁶² The services which best match the capabilities of AS/NZS 4755-compliant products are those frequency and voltage control which require responses within five minutes. The value of such services has not been quantified.

Adding DR capability to products will impose additional design and manufacturing costs, which will be passed on in every product purchase. **Figure 5** shows estimated increase in appliance purchase prices, ranging from \$80 for large water heaters to \$5 for split unit ACs. The weighted average price increase is \$30 per compliant product sold, falling over time as production volumes increase.

Figure 5. Projected increase in appliance costs



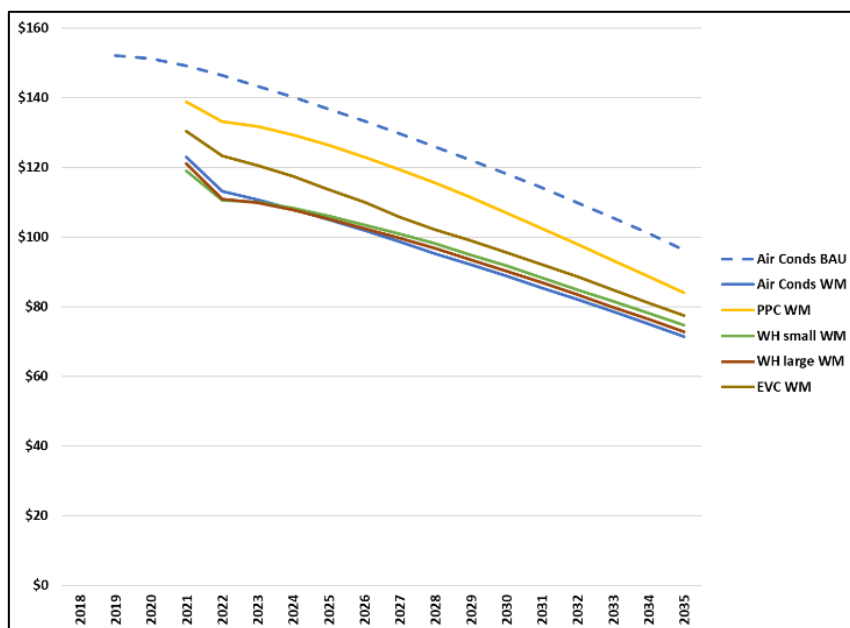
The load of a DR-capable appliance does not become actually controllable until it is “activated” and the customer consents to participate in a DLC program.⁶³ For products complying with AS/NZS 4755 Part 3, activation requires the installation of a DRED. (DR) AS 4755.2-compliant products could connect to the internet using pathways already present in most home, such as WiFi routers or via the mobile phone network (3G/4G/5G standards). Some methods of activation would require a service call, others not. An initial average activation cost of between \$120 and \$140 has been assumed, declining over time (**Figure 6**). Some modes of activation will support several DR-capable appliances at the one site, so as time passes and households activate multiple DR-capable products the cost per new activation should fall.

⁶¹ This was still below the legislated pool price cap of \$14,500/MWh.

⁶² *Guide to Ancillary Services on the National Electricity Market*, AEMO April 2015

⁶³ AS/NZS 4755 products can also be connected to and managed by a customer’s own home energy management system, without involving a DR service provider. Whether or not the customer operates the products in a way that supports network or generation constraints is uncertain, and will depend largely on the clarity of price signalling. The potential additional benefits of this form of price-drive demand response using AS/NZS 4755-compliant products have not been quantified.

Figure 6. Projected activation costs



The rate, timing and location of activations will depend on the DR programs offered by 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 consumer familiarity grows, the costs of acquiring new activations should fall, and the rate of DR program offerings and take-ups would be expected to increase. Estimating the number of customers participating at any given time is a key factor in projecting the total benefit. Under the three levels of activation modelled – Low, Medium and High – the share of all installed AS/NZS 4755-compliant products activated would reach about 26%, 38% and 49% respectively by 2035 (**Figure 7**).

The minimum activation rates to achieve a benefit/cost ratio of exactly 1.0 (at a 7% discount rate) are also shown on **Figure 7**. To achieve cost-effectiveness in Australia, at least 2% of the total AC stock needs to be activated by 2035, 6% of the pool pump controller stock, 11% of the water heater stock and 3% of the EV charge controller stock. For New Zealand, the minimum cost-effective activation rates are higher.

There will also be on-going administrative and business costs to service providers associated with maintaining records of activated appliances and communicating with participants, estimated at \$20 per activated appliance per year. It is assumed that this will also cover business profits for DRSPs. Payments to participants – whether as targeted incentives or general tariff reductions – do not constitute a separate cost to DR programs. They represent one financial channel for returning economic benefit to consumers. Other channels include tariff adjustments, annual bonuses and payments per DR event.

Figure 7. Projected activation rates (High, Medium, Low and Minimum)

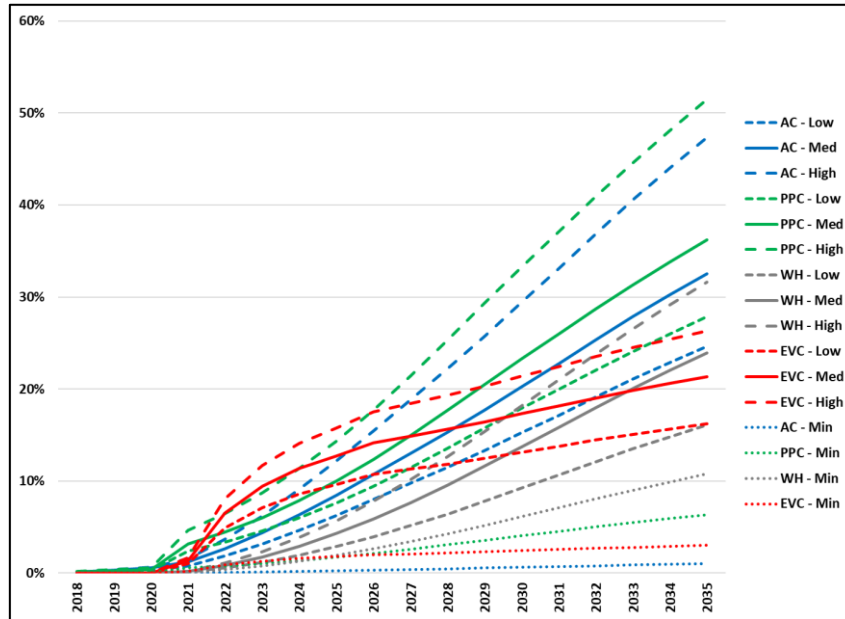
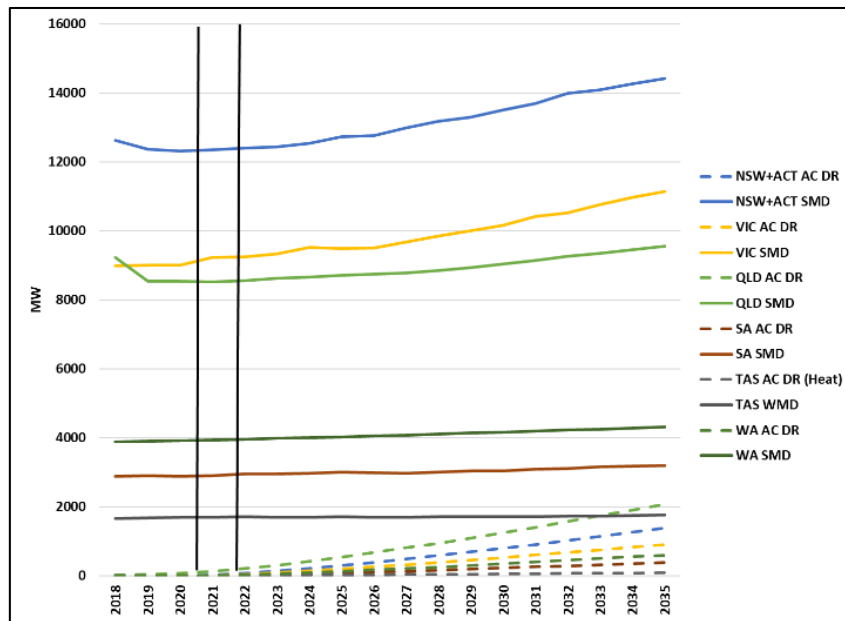


Figure 8. Projected peak demand and impact on peak demand (Medium activation) rates



All compliant products would be capable of DRM 1 (which enables cycling off and on by the remote agent) as well as part-load operation (DRMs 2 and 3). The strategy which DRSPs follow when exercising DLC will depend on the granularity of their control systems, i.e. whether they broadcast the same DLC signals throughout their network or call different groups of appliances and different DRMs in different areas. The presence of DRM 2 and DRM 3 increases the flexibility of response available, and increases participation rates because consumers are more inclined to enter a DLC contract if there is assurance of partial service during peak events. DRM 4 is necessary for events where increased load is required.

The total MW of appliance load available for curtailment during non-emergency (or ‘routine’) peak load events in Australia, with ACs reduced to 50% load and pool pump, water heater and EV charging loads switched off completely, ranges from about 2,800 MW (Table 5) to 5,190 MW (Table 7), with the likely

value around 3,620 MW (**Table 6**). This is equivalent to 60% of the total projected growth in peak demand on the State and Territory networks to 2035. In other words, if properly factored into network planning, use of the projected DR capability could more than halve network investment requirements over the next 15 years. The most likely load available for routine curtailment in New Zealand is 380 MW.

Figure 9 illustrates the NPV of cost and benefits for Australia (at 7% discount rate) under the Low, Medium and High activation scenarios. **Table 3** and **Table 4** summarise the Benefit/Cost (B/C) ratios for each appliance type for Australia and New Zealand respectively. Changing the discount rates has negligible effect on the B/C ratios 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 energy efficiency measures. The proposal is cost-effective in all jurisdictions apart from the NT (see **Table 5** to **Table 7**).

The proposal is estimated to yield accrued net benefits in the range \$2,260 million to \$4,270 million net present value (NPV) with the most likely value around \$2,970 million, at a benefit/cost ratio of 4.1. This is equivalent to a net benefit of over \$300 NPV for each Australian household, or nearly \$400 for each of the 7.5 million appliances projected to be under DR control by 2035. (This would represent about 28% of the total stock of those appliances.)

For New Zealand, the proposal is estimated to yield accrued net benefits in the range \$NZ 130 million to \$330 million NPV with the most likely value around \$210 million, at a benefit/cost ratio of 2.5. This is equivalent to a net benefit of about \$115 NPV for each New Zealand household.

The separate cost and benefits for each appliance are indicated in **Table 10** (for Australia) and to **Table 13** (New Zealand). In all cases, ACs account for the majority of the benefits.

Figure 9. Projected costs and benefits of the measure at various activation rates, Australia

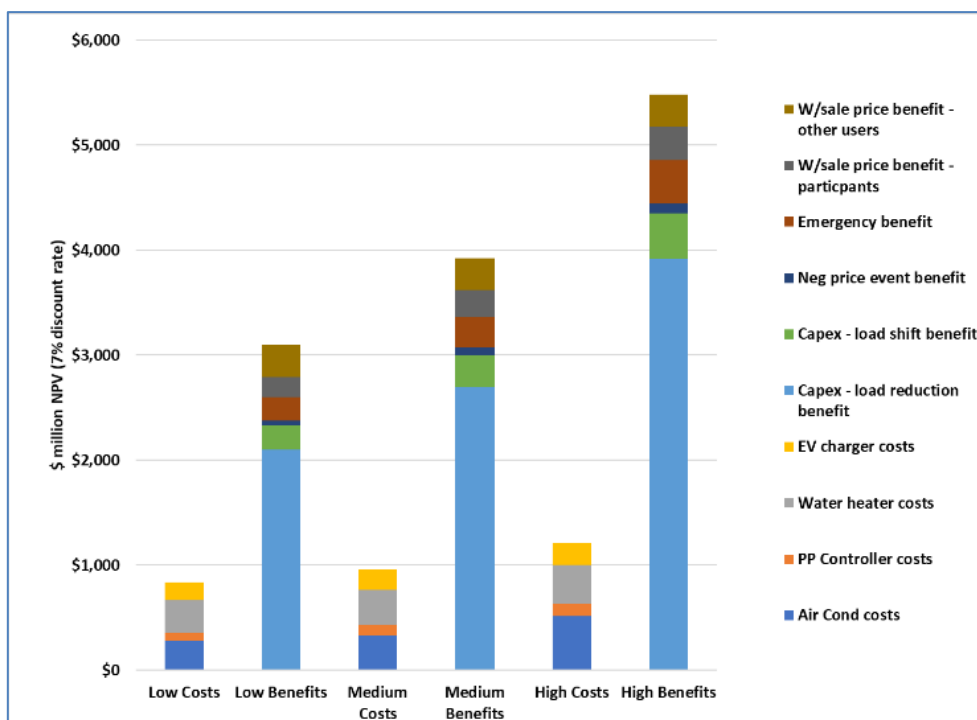


Table 3. Benefit/Cost ratio variations by discount rate and appliance type, Australia

	Medium Activation			Low Activation	High Activation
	Discount rate 3%	Discount rate 7%	Discount rate 10%	Discount rate 7%	Discount rate 7%
Air Conditioners	6.3	6.5	6.6	6.6	6.3
PP Controllers	2.8	2.8	2.8	2.5	3.2
Water heaters	2.0	1.9	1.8	1.4	2.3
EV chargers	4.6	4.5	4.3	3.8	5.0
All products	4.1	4.1	4.1	3.7	4.5

Table 4. Benefit/Cost ratio variations by discount rate and appliance type, New Zealand⁶⁴

	Medium Activation			Low Activation	High Activation
	Discount rate 3%	Discount rate 6%	Discount rate 10%	Discount rate 6%	Discount rate 6%
Air Conditioners	4.3	4.5	4.5	4.3	4.8
PP Controllers	NA	NA	NA	NA	NA
Water heaters	2.0	2.1	2.0	1.5	2.5
EV chargers	0.4	0.4	0.4	0.3	0.5
All products	2.4	2.5	2.5	2.0	2.9

Table 5. Projected costs and benefits by jurisdiction (low activation)

	Routine DLC Reduction available SMD 2035, MWe (a)	Costs \$M NPV (b)	Benefits \$M NPV (b)	Net Benefits \$M NPV (b)	% net national benefits	B/C ratio	Without wholesale price benefit	
							Net benefit	B/C ratio
NSW	773	\$246	\$455	\$209	9.1%	1.8	\$67	1.3
Vic	516	\$134	\$499	\$364	15.8%	3.7	\$262	2.0
Qld	792	\$250	\$1,231	\$981	42.6%	4.9	\$847	4.4
SA	209	\$56	\$365	\$309	13.4%	6.5	\$273	5.9
WA	358	\$100	\$463	\$363	15.8%	4.6	\$306	4.1
Tas (WMD)	54	\$23	\$60	\$37	1.6%	2.6	\$23	2.0
NT	54	\$10	\$6	-\$4	-0.1%	0.6	-\$11	0.2
ACT	43	\$17	\$1	\$2	0.1%	1.1	-\$6	0.6
Australia	2798	\$839	\$3,100	\$2,261	100.0%	3.7	\$1,762	3.1
New Zealand	275	\$125	\$255	\$130		2.0	\$255	2.0

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 7% discount rate for costs and benefits 2021-2035; 6% discount rate for NZ

⁶⁴ Only demand reductions are valued for New Zealand, since the wholesale market structure is different from the NEM and high PV effects are not a concern.

Table 6. Projected costs and benefits by jurisdiction (medium activation)

	Routine DLC Reduction available SMD 2035, MW (a)	Costs \$M NPV (b)	Benefits \$M NPV (b)	Net Benefits \$M NPV (b)	% net national benefits	B/C ratio	Without whole-sale price benefit	
							Net benefit	B/C ratio
NSW	1029	\$286	\$578	\$292	9.9%	2.0	\$135	1.5
Vic	685	\$160	\$642	\$482	16.3%	4.0	\$368	2.3
Qld	975	\$269	\$1,506	\$1,237	41.7%	5.6	\$1,083	5.0
SA	278	\$66	\$481	\$415	14.0%	7.2	\$374	6.6
WA	476	\$118	\$606	\$488	16.5%	5.1	\$423	4.6
Tas	75	\$26	\$78	\$52	1.8%	3.0	\$38	2.5
NT	46	\$16	\$10	-\$6	-0.2%	0.6	-\$12	0.2
ACT	58	\$20	\$24	\$4	0.1%	1.2	-\$5	0.8
Australia	3621	\$960	\$3,926	\$2,965	100.0%	4.1	\$2,405	3.5
New Zealand	379	\$142	\$353	\$211		2.5	\$211	2.5

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 7% discount rate for costs and benefits 2021-2035; 6% discount rate for NZ

Table 7. Projected costs and benefits by jurisdiction (high activation)

	Routine DLC Reduction available SMD 2035, MW (a)	Costs \$M NPV (b)	Benefits \$M NPV (b)	Net Benefits \$M NPV (b)	% net national benefits	B/C ratio	Without whole-sale benefit	
							Net benefit	B/C ratio
NSW	1453	\$349	\$766	\$416	9.7%	2.2	\$241	1.7
Vic	964	\$202	\$869	\$667	15.6%	4.3	\$540	3.7
Qld	1459	\$356	\$2,203	\$1,847	43.2%	6.2	\$1,672	5.7
SA	393	\$83	\$666	\$582	13.6%	8.0	\$538	7.5
WA	671	\$148	\$835	\$686	16.1%	5.6	\$612	5.1
Tas	106	\$31	\$104	\$73	1.7%	3.4	\$58	2.9
NT	65	\$20	\$12	-\$8	-0.2%	0.6	-\$15	0.3
ACT	80	\$23	\$31	\$8	0.2%	1.3	-\$2	0.9
Australia	5190	\$1,213	\$5,484	\$4,271	100.0%	4.5	\$3,644	4.0
New Zealand	534	\$168	\$495	\$327		2.9	\$327	2.9

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 7% discount rate for costs and benefits 2021-2035; 6% discount rate for NZ.

Table 8. Projected costs and benefits by appliance, Australia (low activation)

	Routine DLC Reduction available SMD 2035, MWe (a)	Costs \$M NPV (b)	Benefits \$M NPV (b)	Net Benefits \$M NPV (b)	% net national benefits	B/C ratio	Without wholesale price benefit	
							Net benefit	B/C ratio
Air Conds	1709	\$277	\$1,818	\$1,541	68.2%	6.6	\$1,222	5.4
PP Controllers	136	\$80	\$204	\$124	5.5%	2.5	\$115	2.4
Water heaters	157	\$311	\$432	\$121	5.3%	1.4	\$112	1.4
EV chargers	242	\$171	\$647	\$475	21.0%	3.8	\$313	2.8
All products	2243	\$839	\$3,100	\$2,261	100.0%	3.7	\$1,762	3.1

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 7% discount rate for costs and benefits 2021-2035

Table 9. Projected costs and benefits by appliance, Australia (medium activation)

	Routine DLC Reduction available SMD 2035, MWe (a)	Costs \$M NPV (b)	Benefits \$M NPV (b)	Net Benefits \$M NPV (b)	% net national benefits	B/C ratio	Without wholesale price benefit	
							Net benefit	B/C ratio
Air Conds	2164	\$335	\$2,167	\$1,832	61.8%	6.5	\$1,511	5.5
PP Controllers	354	\$94	\$266	\$172	5.8%	2.8	\$160	2.7
Water heaters	467	\$341	\$642	\$301	10.2%	1.9	\$288	1.8
EV chargers	637	\$191	\$851	\$660	22.2%	4.5	\$446	3.3
All products	3621	\$960	\$3,926	\$2,965	100.0%	4.1	\$2,405	3.5

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 7% discount rate for costs and benefits 2021-2035

Table 10. Projected costs and benefits by appliance Australia (high activation)

	Routine DLC Reduction available SMD 2035, MWe (a)	Costs \$M NPV (b)	Benefits \$M NPV (b)	Net Benefits \$M NPV (b)	% net national benefits	B/C ratio	Without wholesale price benefit	
							Net benefit	B/C ratio
Air Conds	3288	\$514	\$3,210	\$2,696	63.1%	6.3	\$2,367	5.6
PP Controllers	500	\$119	\$377	\$258	6.0%	3.2	\$241	3.0
Water heaters	617	\$370	\$848	\$478	11.2%	2.3	\$460	2.2
EV chargers	785	\$211	\$1,050	\$839	19.6%	5.0	\$576	3.7
All products	5190	\$1,213	\$5,484	\$4,271	100.0%	4.5	\$3,644	4.0

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 7% discount rate for costs and benefits 2021-2035

Table 11. Projected costs and benefits by appliance, New Zealand (low activation)

	Routine DLC Reduction available SMD 2035, MWe (a)	Costs \$M NPV (b)	Benefits \$M NPV (b)	Net Benefits \$M NPV (b)	% net national benefits	B/C ratio
Air Conds	173	\$35	\$148	\$113	87.2%	4.3
PP Controllers	NA	NA	NA	NA	NA	NA
Water heaters	47	\$65	\$98	\$33	25.4%	1.5
EV chargers	5	\$25	\$9	-\$16	-12.6%	0.3
All products	224	\$125	\$255	\$130	100.0%	2.0

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 6% discount rate for costs and benefits 2021-2035

Table 12. Projected costs and benefits by appliance, New Zealand (medium activation)

	Routine DLC Reduction available SMD 2035, MWe (a)	Costs \$M NPV (b)	Benefits \$M NPV (b)	Net Benefits \$M NPV (b)	% net national benefits	B/C ratio
Air Conds	228	\$43	\$195	\$152	72.2%	4.5
PP Controllers	NA	NA	NA	NA	NA	NA
Water heaters	139	\$71	\$146	\$75	35.7%	2.1
EV chargers	12	\$28	\$12	-\$17	-7.8%	0.4
All products	379	\$142	\$353	\$211	100.0%	2.5

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 6% discount rate for costs and benefits 2021-2035

Table 13. Projected costs and benefits by appliance. New Zealand, Australia (high activation)

	Routine DLC Reduction available SMD 2035, MWe (a)	Costs \$M NPV (b)	Benefits \$M NPV (b)	Net Benefits \$M NPV (b)	% net national benefits	B/C ratio
Air Conds	334	\$60	\$287	\$227	5.3%	4.8
PP Controllers	NA	NA	NA	NA	NA	NA
Water heaters	184	\$77	\$193	\$117	2.7%	2.5
EV chargers	15	\$31	\$14	-\$17	-0.4%	0.5
All products	534	\$168	\$495	\$327	7.7%	2.9

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 6% discount rate for costs and benefits 2021-2035

Wholesale Price Effects

The benefits of the proposed measure can be realised under the NEL as it stands. While the AEMC's wholesale price mechanism rule changes are likely to lead to the entry of a new class of DR aggregators into the wholesale market (who would most likely make use of a universal AS/NZS 4755 DR platform if it were available, and if they were permitted to contract with retail customers), realising the benefits of the present proposal does not depend on them. However, if the wholesale price savings projected in the cost-benefit analysis failed to materialise, the overall net benefit and the B/C ratios would be lower, as indicated in the last two columns of **Table 5** to **Table 7**.

The NPV of net benefits would fall by between about \$500 M (at low activation rates) and \$630 M (at high activation rates). While the B/C rates for Australia would remain above 3 in all cases, the ACT would join the NT as a jurisdiction in which the measure would not be cost-effective. There is no change for New Zealand, since wholesale price savings are not part of the cost-benefit analysis.

Retail Tariff Effects

Costs and benefits are calculated from the viewpoint of the entire electricity supply chain (generation, transmission, distribution and retailing, DR program costs and appliance costs). It is assumed that the cost savings between the BAU and with measure (WM) cases will be passed back to those consumers who voluntarily accept activation of their AS/NZS 4755-compliant appliances as well as to other electricity consumers. The extent to which different categories of consumers can benefit, as well their propensity to participate in DR programs, will depend partly on the type of tariffs they face.

The ACCC Retail Electricity Pricing Inquiry estimated that in 2017/18 wholesale electricity costs made up 34% of the price of each kWh to Australian households, network charges 43%, retail costs and margins 17% and environmental programs 6%.⁶⁵ The ACCC identified different ways in which the costs of using the network are signalled to consumers: flat tariffs, TOU tariffs, demand tariffs, capacity tariffs and CPP tariffs.

Customers on flat tariffs (88% of all customers at present) would derive no direct *tariff* benefit from participating in DR programs, but can be motivated to participate through cash incentives (up-front as in PeakSmart, annual bonuses or per DR event). They would incur some comfort cost during AC DR events, because cooling output would be restricted (although surveys have found that very few people are aware of this, and of those that are aware only a small proportion consider it so unacceptable that they withdraw from the program – see Appendix 1).

If the AC is still on after the DR event, it will try to cool a space that is warmer (or in winter, warm a space that is cooler) than if it had not responded. The total energy used over the same period (from the start of the DR event until the end of that session of AC operation) may well be higher than if there had been no DR event. In that case, a flat tariff consumer would be slightly worse off after each DR event (probably by a number of cents rather than a number of dollars) but this would be set against participation payments that are likely to be in the hundreds of dollars. The number of DR events would most likely be limited under any DR contract.⁶⁶

⁶⁵ ACCC (2018), p6/398, p203/398

⁶⁶ The AGL "Managed for You" trial DR program for AS/NZS 4755 air conditioners states: "We agree to limit Peak Events during the Program Duration as follows:– each Peak Event will be a maximum of 2 hours long;– a maximum of

Network tariffs are likely to be high during periods of network congestion and low at other times. The ACCC states:

“In contrast to both flat rate and ToU pricing, which are based on kWh usage, a demand tariff differs in that it is based on the maximum point in time demand (in kW or kVA) of a customer during pre-defined ‘peak windows’. The windows are set by reference to the usual peak network demand. Usage outside of the relevant pre-defined period does not contribute to the demand charge component (although usage charges and fixed charges may still apply).”⁶⁷

The ACCC has recommended that DNSPs adopt this form of pricing, initially for the charges that retailers have to pay them for the load of each consumer (so indirectly giving the retailer the motivation to manage the loads of consumers who incur high network costs) and eventually for each consumer to face demand charges directly (i.e. they would no longer be permitted to remain on flat tariffs once they get a smart meter).⁶⁸ The ACCC notes:

“Given the potential for negative bill shock outcomes from any transition to cost-reflective network tariffs should retailers pass these network tariffs through to customers, governments should legislate to ensure transitional assistance is provided for residential and small business customers. This assistance should focus on maximising the benefits, and reducing the transitional risks, of the move to cost-reflective pricing structures. This includes:

- compulsory ‘data sampling period’ for consumers following installation of a smart meter
- a requirement for retailers to provide a retail offer using a flat rate structure
- additional targeted assistance for vulnerable consumers.”

Enrolling consumers in an automated load-control DR program would be a very effective means of reducing their price exposure risk. It is theoretically possible that an appliance that is demand-managed during a DR event will try to recover that operation (and energy use) during a subsequent period when network charges are higher, and so impose higher tariff costs on the consumer.

However, this is contrary to logic. DRSPs would derive most commercial benefit from activating the DR capability under their control at the times of *highest* network costs, so shifting usage into times when network charges and tariffs are lower. Also, it would be relatively straightforward for DRSPs to contractually indemnify their customers against any such price risk.

The ultimate protection for consumers, however, is that participation in any DR programs, including those using the capabilities of their AS/NZS 4755-compliant products, would be voluntary. If the DRSP were unable to offer then sufficient incentive they would not join, and if they found that the costs exceeded the benefits they could withdraw.

1 Peak Event per day;— a maximum of 2 consecutive days with a Peak Event; and— a maximum of 8 peak events for the Duration of the Program.” <https://www.agl.com.au/terms-conditions/managed-for-you-terms-and-conditions>

⁶⁷ ACCC (2018), p204/398

⁶⁸ ACCC (2018) p19/398

Implementation and Timing

It is proposed that all ACs, electric storage water heaters, pool pump controllers and EV chargers that are supplied or offered for supply would have to comply with either the relevant part of AS/NZS 4755 Part 3 or with AS 4755.2.

For ACs and electric storage water heaters, which are covered by existing GEMS Determinations for energy efficiency, the measure will be implemented by revised Determinations under the GEMS Act 2012 to be made by 1 July 2021.

For pool pump controllers and EV chargers, implementation is less straightforward. There are no existing GEMS Determinations for these products, and the GEMS Act would need to be amended to allow a stand-alone GEMS Determination covering this type of requirement to be made. The final recommendations of the independent review of the GEMS Act, and the Commonwealth Government and COAG Energy Council responses to these recommendations, will largely determine whether this approach is possible. Given the timeframes involved with amending an Act, implementation under this approach would see a GEMS Determination by 1 July 2022.

Some jurisdictions with imminent network issues requiring more controllable devices in the system may consider an earlier implementation using local regulation.

This timing is predicated on COAG Energy Council Ministers deciding to proceed by the end of 2019.

It is envisaged that in New Zealand, any policy proposals would be approved by Cabinet before being adopted under the Energy Efficiency (Energy Using Products) Regulations 2002.

At present, there is no part of AS/NZS 4755 covering EV chargers. A draft (AS/NZS 4755.3.4) was released for public comment in 2013, but later withdrawn.⁶⁹ It will be necessary to re-commence drafting of AS/NZS 4755 and/or add a new Appendix to (DR) AS 4755.2, if the same compliance options are to be available for EV chargers as for the other products. Alternatively, implementation could be achieved by including the technical content in a GEMS Determination.

Since the 2013 Consultation RIS, two additional product categories have become significant for peak demand and for the management of an increasingly renewables-intensive network: home storage batteries and PV inverters. Some PV owners are installing batteries to absorb energy at peak solar times when their electricity demand is low and the excess energy would otherwise be sent to the grid, generally for a low buy-back rate. While battery owners usually manage charging and discharging to optimise their financial returns, this can create network peaks if all batteries charge or discharge simultaneously, as might occur at tariff step times.

The ENA sponsored the development of AS/NZS 4755.3.5:2016 *Operational instructions and connections for grid-connected electrical energy storage systems* (including battery charge controllers) in order to have a means of reducing this risk through DR. While compliance for battery charge controllers or PV inverters is

⁶⁹ Much of the technical content of (DR) AS/NZS 4755.3.4 was later incorporated in AS/NZS 4755.3.5:2016 *Operational instructions and connections for grid-connected electrical energy storage systems* and in Appendix D of (DR) AS 4755.2.

not part of this proposal, there would be a longer-term opportunity to incorporate all major elements of distributed energy (generation, load and storage) into a unified, open-standard demand response platform.

Questions for Stakeholders

Written submissions are invited on any of the material in this Consultation Paper, but particularly on 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.
 - a. Is there any viable alternative options for meeting the objectives of the proposal, apart from the BAU case or mandating compliance with AS/NZS 4755?
 - b. Do you agree that including demand response capabilities on energy efficiency labelling and voluntary compliance with AS/NZS 4755 is not a viable alternative option?
3. Do you support:
 - a. permitting compliance with *either* AS/NZS 4755.3 or (DR) AS 4755.2?
 - b. requiring compliance with all Demand Response Modes (DRMs)?
4. Do you agree with the scope of the proposal:
 - a. air conditioners: up to 19 kW cooling capacity;⁷⁰
 - b. pool pump-unit controllers;
 - c. electric storage water heaters (excluding solar-electric and heat pump water heaters);⁷¹ and
 - d. charge/discharge controllers for electric vehicles (SAE Level 2 or IEC Mode 3).
 - e. If not, what products (or capacity limits) would you propose be included or excluded, and why?
5.
 - a. Do you have information that demonstrates the ability of so-called “smart home” devices and systems to achieve automated demand response for the appliances within the scope of this proposal? If so, please provide this information and specify which particular “smart” devices? (Please be specific with regard to the capabilities you envisage for such devices or systems, and whether you would expect them to conform to any particular standards).
 - b. Would adoption of proprietary “smart home” systems undermine the benefits of peak demand reduction into the future?
 - c. How many products currently on the market have the ability to connect to demand response programs? If so, which or what type of programs?
 - d. Is there a risk that a mandatory AS/NZS 4755 standard may become obsolete as new technologies/innovative products achieve the same objectives without using AS/NZS 4755?

⁷⁰ The 2013 Consultation RIS proposed a limit of 30 kW cooling capacity, but this was revised to 19kW following the previous consultations.

⁷¹ The 2013 Consultation RIS proposed that solar-electric and heat pump water heaters should also comply, but this was revised following the previous consultations.

6. What is your estimate of how much complying with the requirement will increase the price of each product? If a product complies with DRM 1, are there any additional costs incurred for a product to comply with the other DRM modes?
7. Are the data and assumptions used in the cost-benefit estimates reasonable? Do you have information or data that can improve these estimates?
8. Do you think the estimates of activation rates and costs are reasonable? Do you have information or data that can improve these estimates?
9. Do you think the estimates of annual participant costs are reasonable? Do you have information or data that can improve these estimates?
10. Is lack of demand response capable products a barrier to the introduction of demand response programs for small consumers? Do you think that mandating demand response capability for these products will lead to their activation and to consumer enrolment in DR programs?
11. It is assumed that the cost of communications platforms to support demand response and direct load control services will be low (e.g. through the use of existing electricity supply infrastructure such as ripple controls or smart meters, or general infrastructure such as WiFi or 3G/4G/5G). Do you agree? If not, can you provide estimates of the platform set-up costs?
12. What implications (positive or negative) would the proposals have for your industry, in terms of activity, profitability and employment?
13. What can appliance suppliers, installers and energy utilities do to facilitate customer enrolment in direct load control or demand response programs?
14. 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)?
15. If the measure is implemented, what is the earliest feasible date by which products could comply? How much lead time should there be after publication of the final requirements?
16. Do you consider that there are any major technical or functional issues related to the proposal? If so, how should these be addressed?
17. How should the changes in demand or energy during DR events involving AS/NZS 4755-compliant products be measured? What would be the notional “baselines?” Is the estimation of baselines more or less reliable than for other DR approaches?
18. How will the proposal impact on electricity prices and energy network costs and investment requirements?

19. 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?
20. In regard to the regional aspects of the proposal do you consider that it would provide significantly more benefits in certain regions? If so which ones? Will any regions be largely unaffected? If so which ones? What causes these differences in impacts between regions?
21. (To electricity network service providers, electricity retail companies and DR aggregators specifically).
 - a. Is it your company's intention to offer tariff or other incentives for customers to have demand response capabilities 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?
 - b. Would you offer tariff or other incentives to customers to participate in demand response programs using "smart home" device functionality? (if so, please specify the type of functionality/ies). Are there any specific barriers (or lack of incentives) that would prevent your company from offering and promoting such programs?
 - c. In your opinion, what proportion of householders with appliances with the above type of "smart home" device functionality/ies will participate in demand response programs? Do you have survey or other evidence to support your view?
 - d. What would be the total MW of appliance demand response capability (or number of participating appliances) required to defer the need for network investment to manage peak demand in your area/s of operation?
22. In your opinion, what proportion of householders with AS/NZS 4755-compliant appliances will have the demand response capabilities activated and will participate in demand response programs? Do you have survey or other evidence to support your view?
23. (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?
24. (To electricity market regulators). Do you consider that the regulatory arrangements provide utilities and potential DR aggregators with sufficient incentive to offer (or commission) small-consumer demand response as a means of reducing investment in supply-side infrastructure?
25. How do existing electricity market rules which enable and encourage DNSPs and TNSPs to invest in demand response programs impact on, or interact with the proposal?
26.
 - a. How would changes to electricity market rules (the Retailer Reliability Obligation and the wholesale market demand response mechanism draft determination announced by the AEMC) impact on or interact with the proposal?
 - b. Would a new class of DR aggregators make use of AS/NZS 4755 DR platform? If so, why. If

not, why not?

c. Would the potential AEMC wholesale demand response mechanism be material to the benefits of mandating AS/NZS 4755 for the four selected appliances? Why or why not?

d. Would the benefits of deferring investment in network capacity from the wholesale demand response mechanism changes announced by AEMC also reduce the network investment benefits attributable to mandating AS/NZS 4755?

27. Could an option for Government to require utilities or independent DR service providers to offer incentives, or have the Government fund these incentives, achieve the same benefits as the mandatory standard but at a lower overall cost to the community?

28. (To manufacturers and distributors of the products in the scope of this proposal). What percentage of the products you sold in Australia and in New Zealand in the last year:

a. Meet the minimum requirements of the relevant part of AS/NZS 4755;

b. Meet additional requirements (e.g. additional DRMs); and

c. Comply with other published DR standards (please state which)?

Appendix 1 Costs and Benefits

Quantified Benefits

The only option likely 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 it is assumed that:

- An intention to proceed is announced by the end of 2019; and
- All products within the scope of the Determination must comply.

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 purchase, 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. The ‘Medium’ values in **Table 14** were calculated using the data presented by DNSPs for the current round of AER distributor price determinations. The weighted average \$/kW for the NEM is about 12% lower than in the 2013 Consultation RIS. The previous round of determinations led to historically high network costs and retail prices. The latest round of determinations has seen a moderation of network Augmentation Capex in NSW, ACT and NT, although other Capex claims (not directly related to demand growth) remain high.

Table 14. Estimated investment required per marginal peak load kW

	Medium \$/kW (a)	Low \$/kW (b)	High \$/kW (c)	Period of Latest Determination
NSW	1017	783	1323	2020-24
Vic	1050	808	1365	2016-20
Qld	3614	2780	4698	2021-25
SA	3563	2741	4632	2021-25
WA	3080	2369	4004	2019-24
Tas	1925	1481	2503	2019-24
ACT	203	157	265	2019-24
NT	713	548	926	2019-24
NEM – weighted	1800	1385	2340	
NZ	1942	1494	2525	

(a) Extracted from DNSP submissions to latest round of AER price determinations. Includes 25% allowance over distribution cost for transmission and generation investment. (b) 76% of Medium value (c) 130% of Medium value.

Table 15 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 diversified peak demand contribution of each appliance. This ranges from an average of \$1,600 for an air conditioner about \$400 for an EV charger.

Table 15. Load reduction available from participating appliances

	Average kW (electric) at full load	% operating at time of MD	Diversified curtailable kW per activated unit available in 2020	Capital investment to accommodate peak load, per unit, 2020 (a)	Average controllable kW per activated unit available in 2020
All air conds (weighted average of all categories)	1.27 (Cooling) 1.33 (Heating)	70% at 2020 SMD 80% at 2035 SMD	SMD 0.89 WMD 0.93	\$ 1,600	SMD 0.45 (b) WMD 0.47
Pool pumps switched by controllers	0.9	50%	SMD 0.45	\$ 810	SMD 0.9 (c)
Electric storage water heaters – small	2.4	100%	SMD 0.4 WMD 0.6	\$ 1,080	SMD 0.4 (d) WMD 0.6
Electric storage water heaters – large	3.6	100%	SMD 0.3 WMD 0.5	\$ 900	SMD 0.3 (e) WMD 0.5
EV Chargers	9.6	100%	SMD 0.22	\$ 400	SMD 0.22 WMD 0.4

(a) Average \$/peak kW in NEM region multiplied by average curtailable kW/activated unit at SMD. (b) At DRM 2 - limited to 50% of reference load during DR events. (c) DRM1 during DR events (d) Water heaters on uncontrolled tariffs. (e) Includes water heaters on 16-hr heating tariffs topping up during peak periods. (f) Includes diversification factors

The estimates of diversified curtailable kW per activated AC can be tested against field monitoring of 44 AS/NZS 4755.3.1-compliant air conditioners participating in the Energex PeakSmart program during a DRM 3 event on 17 March 2014 (15:00 – 16:30 hrs, temp range 29-30°C, relative humidity range 54-58%).⁷²

- 40 units received the instruction (i.e. 90% communications success rate);
- 20 were off at the time;
- 10 were running under the reference power level and so did not deliver load reductions;
- 10 were running above the reference power level and delivered a total of 10kW load reduction (1.0 kW/unit for those 10 units, or 0.5 kW per unit for the 20 units that were operating at the time).

DRM 2 would produce greater load reductions in operating AC than DRM 3, so the assumptions in **Table 15** are conservative. The economic benefit that would be created by the proposal comes from the gross values created by the reduction in the real costs of the physical infrastructure needed to meet peak demand, compared to BAU, and the other system benefits identified in **Table 16**. The quantum of net benefit is the difference between the sum of these values and the cost of establishing and operating the DR programs.

The timing and allocation of net benefits among customers is up to the electricity utilities or DRSPs. 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 DR 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 DRSPs to devise the right balance of incentives to achieve the necessary participation rates.

The timing of costs and benefits is modelled as follows:

⁷² Energex (2014) PeakSmart Air Conditioning Demand Response Control Event Report, Energex, November 2014

- The additional costs which DR-capability adds to the price of appliances is borne by consumers in the year in which those appliances are purchased;
- The activation costs are incurred in the year the DR capability is activated and the consumer joins a DLC program (assumed to occur simultaneously). This may be at the time of appliance purchase or later. Activation costs will be lower at the time of installation, because no extra service call is necessary;
- The benefit of avoiding infrastructure investment to meet future maximum demand (after accounting for the diversity of the load under control) accrues in the year that the appliance is activated;
- The value of other benefits (wholesale price reductions, load shifts and bidding DR into the reliability and emergency market) accrue in each year that DR is invoked for that purposes, and depend on the assumed number of hours invoked.

Table 16. Demand response costs and benefits quantified in this RIS

Electrical Products	Costs			Benefits							
	Interface costs	Connec-tion & activation costs	Annual cost of servicing participants	Reduce summer peak	Reduce winter peak (a)	Reduce w/sale price to participants	Reduce w/sale price to other users	Reliab-ility & Emerg-ency (b)	Energy storage & time-shift	Return energy to grid	User-managed DR with 4755 products
Air conditioners	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	NA	NA	Not quantified
Pool pump controllers	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	NA	Not quantified
Small electric storage water heaters	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	NA	Not quantified
Large electric storage water heaters	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	Quantified	NA	Not quantified
Electric Vehicle charge/discharge	Quantified	Quantified	Quantified	Quantified	quantified	Quantified	Quantified	Quantified	Quantified	Not quantified	Not quantified
Relevant DRMs(b)	All DRMs	All DRMs	All DRMs	DRM 1,2,3	DRM 1,2,3	DRM 1,2,3	DRM 1,2,3	DRM 1,2,3	DRM 4	DRM 5,6,7,8	All DRMs

Green cells indicate quantified benefit. Orange cells indicate possible additional benefits not quantified.

(a) Benefits to projected winter peak calculated for Tasmania and New Zealand only, since other jurisdictions are summer peaking. (b) Calculated for Victoria and SA only, where RERT contracts have been used.

The net present value (at June 2019, i.e. at the start of FY 2020) of the stream of future costs and benefits is then calculated using the range of discount rates specified by the Office of Best Practice Regulation (OBPR): 7%, 3% and 10%.

Some studies treat the value of avoided investment in infrastructure as an annual benefit⁷³ 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.

The realisation of the projected infrastructure benefits will rely on DNSPs building in the expected impacts of DR programs into their planning (whether they implement the programs themselves or purchase aggregated DR from electricity retailers or other DRSPs). In assessing the timing of benefits, it should be noted that AER determinations are forward-looking assessments of the revenue required by DNSPs over

⁷³ e.g. *Automated and Zero Emission Vehicle Infrastructure Advice: Energy Impact Modelling*, KPMG for Infrastructure Victoria, Final Report, July 2018

the coming 5-year period. Part of the calculation is the projected capital expenditure (CAPEX) required to augment the network to meet projected net increments in peak load in each year of the 5-year period. The DNSP must make an assessment of the quantum of load added each year 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 is the case here).

If COAG Energy Council Ministers adopt the proposal by the end of 2019, then DNSPs preparing their capital cost projections after that time would be able to project with high confidence the rate of accumulation of DR-capable 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. To the extent that the load control strategy leads to a lower capital requirement, the total forward-looking revenue determination would be lower.

Participation Costs

There will be on-going administrative costs associated with maintaining records of activated appliances and communicating with participants. These are estimated at \$20 per activated appliance per year. These assumptions were presented in the Consultation RIS (E3 2013) and considered reasonable by submitters. It is assumed that this would also cover the profit margins of DRSPs.

Activation Scenarios

Three conditions must be satisfied for a product to be part of a utility DR program: it must comply with AS/NZS 4755, the DR capability must be activated by connection to a DRSPs communications platform and the consumer must agree to participate by accepting a DR contract. The mathematical product of these three factors – compliance rates, activation rates and participation rates – will give the number of appliances which participate in DR programs in any given year.

For simplicity, participation rates are assumed to be the same as activation rates, but this is not necessarily so. Some products may be activated speculatively by the installer or builder, but the occupant may never be approached by a DRSP or may decline to participate. Alternatively, consumers may decide to participate but drop out later. Energex reports a drop-out rate of less than 0.2% of about 100,000 air conditioners enrolled since the beginning of the PeakSmart program.⁷⁴

It is assumed that activations can begin immediately. The 2013 Consultation RIS assumed that DR-capable products could not be activated in some jurisdictions until new communications platforms were established, and that it would not be economic for DRSPs to invest in these until the stock of compliant appliances reached a critical threshold, in the fourth year after the measure was introduced. Given the changes in AS/NZS 4755 and the near-universal access to the likely activation pathways (3G/4G/5G wireless and WiFi routers) such a delay is no longer technically necessary.

High, Medium and Low activation scenarios have been modelled.

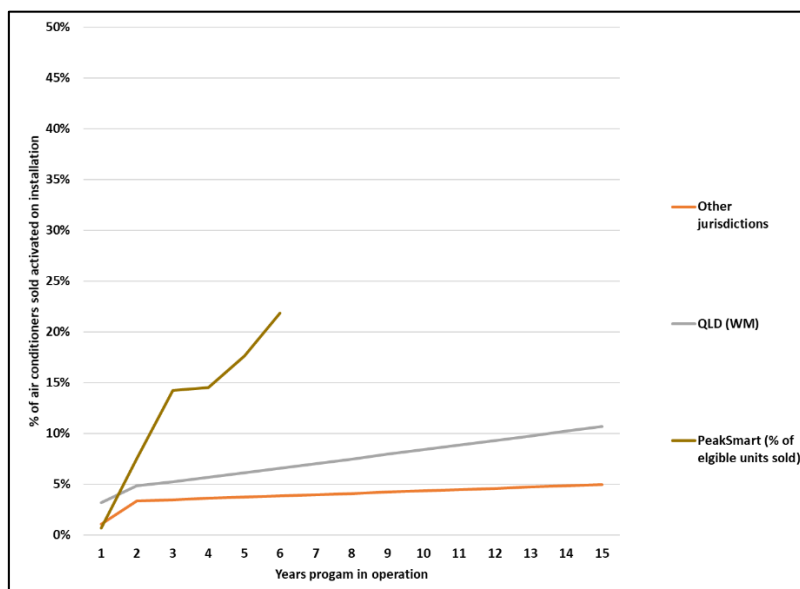
⁷⁴ Energex, Personal communication 3 May 2019

Figure 7 illustrates these scenarios for Australia as a whole, built up from separate projections for each jurisdiction. The plausibility of the scenarios can be tested against the actual experience with the take-up of AS/NZS 4755 ACs in the Energex supply area over the period 2012-2018.

The Energex PeakSmart program only incentivised activation at the time of installation, not post-installation, and only for split unit and ducted ACs up to 10 kW cooling capacity (not 19kW). It is possible to estimate the total number of the target range of ACs that would have been sold in the Energex supply area, given that Energex serves about 61% of the Queensland population.⁷⁵ Comparing the number of PeakSmart incentives paid each year with the number of ACs of the target type sold in the same region indicates activation-on-installation rates significantly higher than the High rate used in the cost-benefit analysis (**Figure 10**). The actual rate reached 22% in the sixth year of the program, compared with a projection of 13% for Queensland in the sixth year after mandating of AS/NZS 4755, and 8% in other jurisdictions. Neither PeakSmart nor other does program offers incentives for post-installation activations of AS/NZS 4755 products, so it is not possible to test those assumptions against actual data.⁷⁶

The number of total annual AC activations required to achieve the Medium take-up rates in **Figure 7** are illustrated in **Figure 11**. Activations on installation are shown separately from post-installation activations. The trends depart from smooth curves in the out years due to internal consistency checks (i.e. annual activations can never exceed the “non-activated pool” in any given year). By the 2030s, annual AC activations in Australia would be about 320,000 per year. Annual AC sales are projected to reach 1.03 million in 2035, and the total AC stock is projected to reach 13.9 million. In this context, the projected activation rates seem feasible.

Figure 10. High install-activation rate projections vs actual PeakSmart activation rates

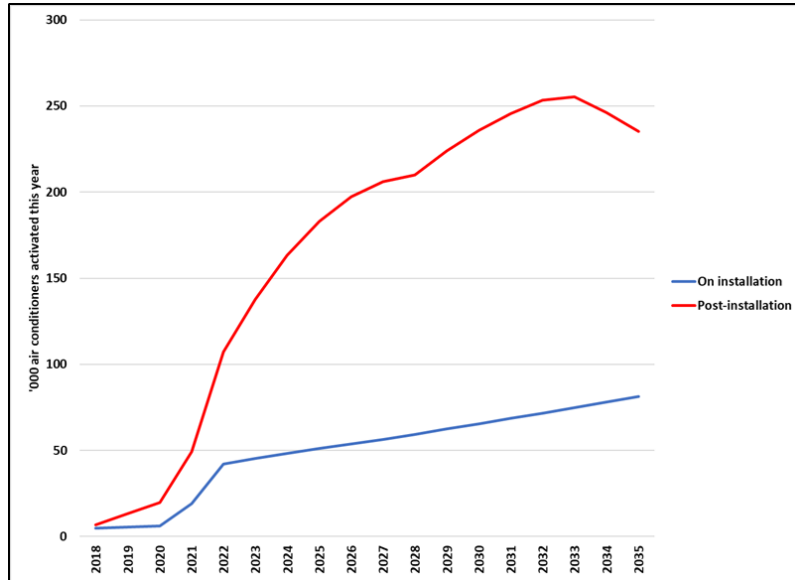


Source: Author estimate based on personal communications from Energex, May 2019. The same rates are projected for all jurisdictions other than Queensland, so their trendlines are superimposed.

⁷⁵ Queensland regions compared, Census 2016, Queensland Government Statisticians’ Office, 2017

⁷⁶ An ARENA-funded AGL trial of post-installation offers to activate AS/NZS 4755 air conditioners was unsuccessful because too few of the volunteers had AS/NZS 4755 air conditioners.

Figure 11. Number of installation and post-installation air conditioner activations, medium activation rates



Projected Demand Reductions

There are three ways to estimate the potential impact of DR:

- The theoretical maximum electricity load of all activated appliances, as if all were switched on and operating at maximum capacity during a DR event, or (for DRM 4) if all were off and switched on;
- The emergency load available for DR, i.e. the MWe at full output multiplied by the probability of that product being on and drawing energy at the time of peak demand (the “Diversified curtailable kW per activated unit” in **Table 15**). This corresponds to the total load reduction from issuing DRM 1 commands to all activated products during SMD or WMD;
- The routine DR load available. DRSPs will usually issue DRM 2 commands to ACs during non-emergency DR events, so consumers still get cooling or heating at reduced levels. The DRM 2 load reductions are used to calculate benefits of the proposal. This understates the likely value, since DRM 1 would be acceptable for pool pumps, water heaters and EV chargers.

Figure 8 shows the projected maximum demand and the routine DR load available in each Australian jurisdiction, excluding the NT (with NSW and ACT combined; AEMO does not publish separate projections). At Medium activation rates, the emergency DR available from ACs alone would exceed 22% of summer maximum demand in Queensland (**Figure 12**). The routine (i.e. non-emergency) load reduction available across all jurisdictions would be equivalent to 60% of the total projected growth in peak demand on the State and Territory networks to 2035. In other words, if properly factored into network planning, use of the projected DR capability could more than halve network investment requirements over the next 15 years.

Figure 12. Projected emergency DR air conditioner load available as % of maximum demand, Medium activation rates

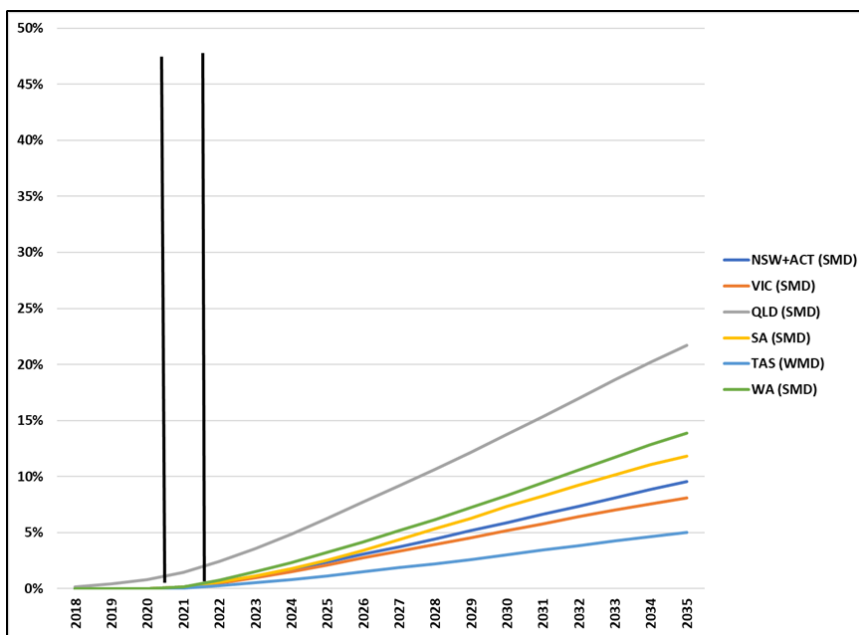


Table 17. Summary of assumptions used to calculate benefits

Product	Mandatory DRMs (a)	Peak load reduction value (b)	Reliability & emergency reserve trader (RERT) value	Load-on value	Wholesale price impact value for DR participants	Wholesale price impact value for non-participants
Air conditioner	1	\$/marginal peak load MW avoidable at SMD from all activated load, except for Tas and NZ: \$/marginal peak load MW avoidable at WMD	RERT costs in SA and Vic \$10,000/MWh avoided (20 hrs/yr) None in other regions	None	\$100/MWh wholesale price reduction when a 50% reduction in the total activated load is bid into the pool. Energy calculated from load bid x 20hrs/yr	Same wholesale price reduction as for participants during same time periods. Energy calculated as 80% of SMD or WMD x 20hrs/yr (less DR participant energy use over same periods)
	2/3	50% of above values	50% of above values	None		
Pool pump controller, Electric storage water heater	1	\$/marginal peak load MW avoidable at SMD from all activated load	RERT costs in SA and Vic \$10,000/MWh avoided (20 hrs/yr) None in other regions	None	\$100/MWh wholesale price reduction when a 50% reduction in the total activated load is bid into the pool. Energy calculated from load bid x 20hrs/yr	
	2/3	50% of above values	50% of above values	None		
	4	None	None	\$80/MWh for 100% of activated load switched on during negative price events. 20-60 hrs/yr in 2020 rising to 30-110 hrs/yr in 2035	None	None
EV charger – capable of charge only	0	None – safety value	None – safety value	None – safety value	None – safety value	None – safety value
	1	\$/marginal peak load MW avoidable at SMD from all activated load	RERT costs in SA and Vic \$10,000/MWh avoided (20 hrs/yr) None in other regions	None	\$100/MWh wholesale price reduction when a 50% reduction in the total activated load is bid into the pool. Energy calculated from load bid x 20hrs/yr	Same wholesale price reduction as for participants during same time periods. Energy calculated as 80% of SMD or WMD x 20hrs/yr (less DR participant energy use over same periods)
	2/3	50% of above values	50% of above values	None		
	4	None	None	\$80/MWh for 100% of activated load switched on during negative price events. 20-60 hrs/yr in 2020 rising to 30-110 hrs/yr in 2035	None	None
EV charger capable of discharge	5	None – safety value	None – safety value	None – safety value	None – safety value	None – safety value
	8 (c)	No additional value assigned	No additional value assigned	No additional value assigned	No additional value assigned	No additional value assigned

Shaded cells indicate DRMs used to calculate benefits. (a) Proposal is to mandate more DRMs than currently required for voluntary compliance with AS/NZS 4755 (b) See values Table 14 (c) Response to a discharge request would be subject to an EV with sufficient charge being connected at the time. Additional DRMs 6 and 7 to remain optional.

Appendix 2 AS/NZS 4755

The AS/NZS 4755 framework is intended to support DR programs which optimise the operation of the electricity supply system and allow the efficient planning and use of capital equipment, while minimising the risks to the comfort and amenity of the users of electrical products. There are two pathways for achievement of demand response within the AS/NZS 4755 framework (see **Figure 4**).

The AS/NZS 4755.1 pathway involves electrical products which conform to a part of the AS/NZS 4755.3 series, connected to a DRED complying with AS/NZS 4755.1. The Remote Agent interacts with the electrical products via the DRED. (It is not essential to have a DRED that complies with AS/NZS 4755.1 to achieve DR. AS/NZS 4755.3 electrical products could be activated by a Home Energy Management System (HEMS) or other DRED-like device, so long as it is connected to, and electrically compatible with, the physical interface on the product, but strictly speaking this is outside the AS/NZS 4755 framework.)

The AS 4755.2 pathway involves electrical products which conform to (DR) AS 4755.2. As there is no separate DRED in this pathway, the essential communications and other functions of the DRED have to be supported by the electrical product itself. Another key difference is that this Standard does not require the presence of a physical interface.

There are therefore two categories of electrical product within the AS/NZS 4755 framework — those conforming to AS/NZS 4755.3 and those conforming to AS 4755.2. The same an electrical product could conform to both, provided it is capable of managing the potential conflicts that could arise if different remote agents try to access it by different pathways.

The AS/NZS 4755 framework is also relevant to AS/NZS 4777, *Grid connection of energy systems via inverters, Part 2: Inverter requirements*. Inverters of the kind covered in AS/NZS 4777.2 may have a means of connecting to a DRED, or an alternative pathway to be used for demand response if a DRED is not present. The detailed requirements for inverters are covered in AS/NZS 4777.2, and (DR) AS 4755.2 cross-refers to AS/NZS 4777.2 where relevant.

The DRMs described in Appendices A, B, C, and D of (DR) AS 4755.2 replicate the DRMs in AS/NZS 4755.3.1, AS/NZS 4755.3.2, AS/NZS 4755.3.3 and AS/NZS 4755.3.5 respectively, but without the use of DREDs. An electrical product which conforms with (DR) AS 4755.2 has to have a means of receiving commands from a remote agent. The formats for conveying commands using Hyper-Text Transfer Protocol (HTTP) Application Programming Interface (API) in pull and push modes are described in Appendices G and H respectively of (DR) AS 4755.2.

However, it is intended to add other options to the standard in the future, so providing a path to integration with any emerging international standards.⁷⁷ New options would be added as new Appendices,

⁷⁷ The Preface to (DR) AS 4755.2 states: “Users of this standard are invited to propose new appendices to Committee EL-054, provided that electrical products embodying those means and formats of communications can be physically tested to ensure they meet the requirements of the standard. Proposals should be:

- (a) Standards-based — leveraging existing Standards.
- (b) Simple — easy to describe, understand, implement and deploy.
- (c) Testable — implementations should be easy to test.

to be published as future amendments. It is also possible that more electrical products will be added to the AS/NZS 4755 framework over time.

Table 18. Parts of AS/NZS 4755 Demand response capabilities and supporting technologies for electrical products

Referred to in 2013 Consultation RIS	Now	Comment
Not mentioned - Not published at the time	4755.1 Framework for demand response capabilities and requirements for demand response enabling devices (DREDS)	Compliance does not need to be mandated. DR can be achieved by connecting a compliant electrical product to either a compliant or non-compliant DRED or HEMS
4755.3.1:2012 Interaction of demand response enabling devices and electrical products— Operational instructions and connections for air conditioners	4755.3.1:2014 Interaction of demand response enabling devices and electrical products— Operational instructions and connections for air conditioners	The 2013 RIS recommended compliance with either version: it is no longer necessary to refer to the now obsolete 2012 version.
4755.3.2:2014 Operational instructions and connections for swimming pool pump-unit controllers	No change – version still current	No change
4755.3.3:2014 Operational instructions and connections for electric storage and electric-booster storage water heaters	No change – version still current	Scope includes electric resistance, solar-electric and heat pump water heaters, but compliance was recommended for electric resistance types only
4755.3.4 Operational instructions and connections for charge/discharge controllers for electric vehicles	Draft was released for public comment in 2014 but has not been published.	If this product is to be covered, either new version of 4755.3.4 or a new standard is required. Alternatively, technical content could be in GEMS determination.
Not mentioned - Not published at the time	4755.3.5:2016 Operational instructions and connections for grid-connected electrical energy storage systems	Covers battery storage, among other storage technologies. Developed at request of Energy Networks Association (ENA). Mandating compliance not proposed for time being
Not mentioned - Not published at the time	4755.2 Demand response framework and requirements for	Offers an alternative pathway to DR compliance for air

- (d) Reliable — auto-recovery after transient failures.
- (e) Secure — security of both the electrical product and the remote agent should be maintained.
- (f) Flexible — should allow for a variety of deployment patterns.
- (g) Efficient — should be mindful of network bandwidth and power usage.
- (h) Compatible — should fit the AS 4755 framework.
- (i) Fully documented so both RAs and testers are able to replicate it.”

Referred to in 2013 Consultation RIS	Now	Comment
	<p>communication between remote agents and electrical products</p> <p>(In public comment stage. Expected to be published at end of 2019)</p>	<p>conditioners, pool pump controllers, water heaters and grid-connected electrical energy storage systems. No physical interface or DRED required. DRMs 1,2,3 etc. same as in other parts. Developed at request of Australian Energy Council (AEC)</p>

Alternative “Smart Home” Products and Standards

Globally, the three sets of public DR standards supported by actual models of the appliances within the scope of this Consultation Paper are AS/NZS 4755 (Australia), Echonet (Japan)⁷⁸ and the Energy Star “Connected Appliance Criteria” (USA).⁷⁹

For ACs, the AS/NZS 4755 DRMs are a similar to Echonet capabilities, and many split system models are registered as compliant with both (Table 20). The USA Energy Star program has published “connected” criteria for “room” (window-wall) ACs, but not split unit or ducted ACs. The reason for the lack of interest in split units (which represent three quarters of the installed stock in Australia, and over 90% in New Zealand) is the prevalence of whole-house ducted air conditioning in the USA (Table 19). Most of the non-ducted ACs in the USA are window-wall units. Split systems are relatively new to the US market.

Table 19. Air conditioner types installed in homes, Australia and USA

Type	Aust 2018 (a)	NZ (a)	USA 2015 (b)
Unitary	12%	2%	42% (c)
Split	75%	91%	
Ducted	13%	7%	58%
% of HH with air conditioning	70%	NA	85%

(a) Decision RIS: Air Conditioners, E3, December 2018. (b) U.S. Energy Information Administration, Office of Energy Consumption and Efficiency Statistics, Forms EIA-457A and EIA-457C of the 2015 Residential Energy Consumption Survey. (c) “Individual” air conditioners: split and unitary not differentiated.

Most AC DR programs in the USA rely on Programmable Communicating Thermostats (PCTs) such Google’s “NEST.” These replace the standard wall thermostat used to control ducted ACs and so enable the user (via a smart-phone app) and DR service providers who contract with Google, to adjust the room temperature.⁸⁰ If the home is pre-cooled (or pre-heated) and the AC is maintaining a steady temperature, then adjusting

⁷⁸ https://echonet.jp/product_en/echonet_lite_specification/

⁷⁹

<https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%204.0%20Room%20Air%20Conditioner%20Program%20Requirements.pdf>

⁸⁰ <https://nest.com/energy-partners/>

the thermostat upward during SMD or downward during WMD is likely to result in lower energy use and hence lower power consumption during a DR event (and higher energy consumption after the event if the user or the remote agent restores the pre-event setting).

As PCTs are the most common approach to air conditioner DR in the USA, the Energy Star program has published “connected criteria” for them.⁸¹ Compliance with the criteria must be demonstrated empirically through field trials with a statistically valid number of households.

PCTs are not suitable for AC DR programs in Australia or New Zealand because:

- a) They do not work with split unit ACs;
- b) Their demand impact relies on a pre-cooled or pre-heated dwelling with adequate thermal mass; the predominant mode of use in Australia is to switch the AC on when coming home from work or school on a hot day.⁸² The unit struggles to reach the thermostat setting in any case, so simply adjusting the setting will have no impact on power;
- c) The actual load reduction (if any) during a DR event depends on the thermal mass, layout and temperature conditions of the home at the time, and so the response cannot be verified from monitoring the PCT alone. By contrast, an AS/NZS 4755-compliant AC must deliver a measurable load reduction during DR events and this must be verifiable in a laboratory or field test. (see Appendix 1); and
- d) Both the DRSP and the customer are locked into a proprietary system, so inhibiting market flexibility and risking stranded investments.

Table 20. Product types covered by published standards for ‘connected’ or ‘smart’ products

Product category	US EPA Energy Star “connected” criteria	Australia/New Zealand Standard AS/NZS 4755	Japan Echonet Lite
Air conditioner – window-wall	✓ 7	✓ 0	✓
Air conditioner – split unit		✓ 990	✓ 26 families (a)
Air conditioner – central/ducted		✓ 113	✓
Electric resistance heating			✓
Pool pump controller		✓ 0	
Water heater – heat pump		✓ 0	✓ 11
Water heater – resistance		✓ 0	
Refrigerator & freezer	✓ 41		✓
Clothes washer & washer-dryer	✓ 0		✓
Clothes dryer	✓ 2		✓
Dishwasher	✓ 0		

⁸¹ https://www.energystar.gov/products/spec/connected_thermostats_specification_v1_0_pd

⁸² Winton (2010) A Quantitative Research Study into Ownership and Usage Patterns of Single-Duct Portable Space Conditioners and Fixed Air Conditioners, Winton Sustainable Research Strategies, for DCCEE, May 2010

Product category	US EPA Energy Star “connected” criteria	Australia/New Zealand Standard AS/NZS 4755	Japan Echonet Lite
Light fixtures	✓ 241		✓
Connected thermostat	✓ 47		✓
Energy battery storage system		✓ 5	✓46
Electric vehicle charger (EVSE)	✓ 0	✓ (b)	✓1
Photovoltaic/battery inverter		✓ (c)	✓23
Controller for other devices		✓ 0	✓213

✓ indicates that there are standards or rules published for these products. Shading indicate there is energy labelling for that product (voluntary endorsement label for Energy Star, mandatory comparative label for Australia and Japan). Numbers indicate distinct models listed as compliant (June 2019). (a) Echonet listings cover model families, so number of models not shown. (b) Standard/rule under development. (c) Via cross-reference in AS/NZS 4777.

One Victorian DNSP, PowerCor, is trialling a product that enables temperature adjustment signals to be sent to split unit ACs⁸³ so addressing problem (a) above. PowerCor is using the Sensibo Sky controller⁸⁴ which acts as a “smart” replacement for the standard line-of-sight infra-red remote control supplied with most ACs. The controller is WiFi enabled, so all the normal on/off and adjustment functions can be operated via a smartphone app that controls the Sensibo. The company has contracted with PowerCor (and hence with the PowerCor consumers involved) for permission to manipulate thermostat temperature setting at PowerCor’s request. This pathway is an alternative to using each air conditioner manufacturer’s own app for this purpose, so the Sensibo is in effect a form of aggregator. However, it does not overcome problems (b), (c) or (d) above.

The approaches discussed above (loosely termed “smart” or “internet of things”) do not offer the reliable and verifiable DR outcomes of AS/NZS 4755-compliant products, and are therefore not direct competitors. There is nothing to prevent an AS/NZS 4755-compliant and activated AC from being controlled by a Sensibo-like device, so long as the AC responds to DRM 1, DRM 2 and DRM 3. The Sensibo control only could mean that the power setting at the beginning of a DR event is slightly lower because the AC is operating at a higher temperature (say 0.8 kW rather than 1 kW, a 0.2 kW reduction) so DRM 2 will produce a power reduction of a further 0.4 kW rather than 0.5 kW. Under conditions when the AC is running in an over-26°C space than a pre-cooled space, it may be drawing say 1.5 kW, the Sensibo would produce no power reductions whereas DRM 2 would produce 0.75 kW.

Therefore, the wider adoption and use of other ‘smart’ approaches would have minimal impact on the case for and cost-effectiveness of mandating compliance with AS/NZS 4755. The same appliances could support both approaches. Under AS/NZS 4755, DR commands from the remote agent must have priority while the product is activated in accordance with AS/NZS 4755, but consumers could continue to take part in price-driven DR at other times if they wish. The user or other authorised party could access the appliance by a proprietary app instead of activating the AS/NZS 4755 capabilities, or – for activated products – using the other capabilities outside AS/NZS 4755 DR events. Furthermore, manufacturers of appliances with

⁸³ <https://www.powercor.com.au/energy-partner/>

⁸⁴ <https://sensibo.com.au/sensibo-features/>

proprietary DR capabilities have the option of incorporating their systems in the AS/NZS 4755 framework by proposing new appendices for AS 4755.2.
