Australian Government

New Zealand Government

E3 Equipment Energy Efficiency

Regulation Impact Statement for Decision: 'Smart' Demand Response Capabilities for Selected Appliances

October 2019

A joint initiative of Australia, State and Territory and New Zealand Governments

Executive Summary

Background

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, automated 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 AEMO[1], the Energy Networks Association (ENA), the CSIRO[2], 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” or “behavioural” DR 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 peak 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, do not have PV systems and 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

[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

where network 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. In July 2019, the AEMC published 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 DR by industrial and commercial sector consumers only, and the AEMC has decided to defer a decision on extending the rule to cover small consumers pending a review of consumer protections.

The Problem

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 DR 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. This was first proposed in a Consultation Regulation Impact Statement (RIS) published by the Equipment Energy Efficiency (E3) Committee in 2013. The measure was favourably received by stakeholders during public consultations at the time, but did not proceed to a Decision RIS. Since then, with the growth in renewable forms of electricity generation, the challenges of variability in both generation and load have intensified.

In December 2018, the Council of Australian Governments (COAG) Energy Council agreed to re-examine and update the cost-benefit modelling undertaken in 2013/14 on the value of network cost savings, as well as consider additional benefits outside the scope of the previous work, including reduced wholesale prices to all consumers, emergency management (Reliability and Emergency Reserve Trader (RERT)) benefits, and benefits from shifting energy load to periods of minimum demand and excess export of rooftop solar PV.

The objectives of government action in this matter are "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."

A Consultation Paper released in August 2019 considered three options, and assessed the degree to which they could achieve the above objectives:

1. Business as Usual (BAU) – no new regulations;
2. Encourage the voluntary adoption of DR appliances through cash incentives and/or product labelling; 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.

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

The Consultation Paper recommended Option 3 as the preferred option: the DR capability of residential air conditioners (ACs), electric storage water heaters, pool pump controllers and electric vehicle (EV) chargers should be mandated under the Greenhouse and Energy Minimum Standards (GEMS) Act 2012, as requirements to comply with the relevant parts of AS/NZS 4755: *Demand response capabilities and supporting technologies for electrical products*. Compliance with this standard is verifiable by testing randomly selected products, similar to the testing of compliance with minimum energy performance standards (MEPS).

There are no international or national standards in use elsewhere that provide equivalent open-access DR capabilities for ACs, pool pump controllers or electric storage water heaters. EV chargers are a different case in that “smart” charging capabilities are available through other standards.

It should be noted that, while products would need to be DR-capable, it would always 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.

Projected Costs and Benefits

The calculation of costs and benefits has been informed by feedback from stakeholders during the consultation process. DR can provide four main categories of benefit:

- Network DR — employed to manage peak demand within a particular transmission or distribution network, or localised part of a network;
- Wholesale DR — 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 DR — sourced by the system operator to maintain grid frequency within its technical operating range; and
- Emergency DR — sourced by the system operator when there are predicted supply shortfalls to avoid involuntary load shedding.[7]

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.

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, to the benefit of both the DR participants who contribute to the load reduction and all other consumers using electricity over the same time period.

As the share of non-dispatchable renewable wind and solar generation grows, the time when available supply exceeds demand is increasing, making it more difficult to maintain voltage and frequency within safe levels. The DR value is reflected by estimating the total energy demand that can be presented to the grid by DR-activated products, and assigning a value to that energy.

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

Emergency response occurs under the opposite conditions – when expected load exceeds the availability of generation capacity. To address this, AEMO has set up a RERT facility. It is assumed that DR aggregators will be able to bid into the high-value RERT market.

DR could also supply ancillary services to the NEM. The services which best match the capabilities of AS/NZS 4755-compliant products are those with 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. The estimated increase in appliance purchase prices ranges from $80 for large water heaters to $10 for split unit ACs. The weighted average price increase is about $31 per compliant product sold, falling to $25 over time as production volumes increase.

The load of a DR-capable appliance does not become controllable until it is "activated" and the customer consents to participate in a demand load control (DLC) program. Activation requires either the installation of a demand response enabling device (a DRED) or connection to the internet using pathways already present in most home, such as WiFi routers or via the mobile phone network (3G/4G/5G standards). An initial average activation cost of between $120 and $140 has been assumed, based on the experience of the PeakSmart program in Queensland, which began in 2014 and now has 108,000 AS/NZS 4755-compliant ACs enrolled. 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.

Estimating the number of customers participating in DR programs at any given time is a key factor in projecting the total benefit. Low, Medium and High activation trends are modelled, with the activated share of the DR-capable product stock reaching about 22%, 37% and 39% respectively by 2036 under Option 3, compared with 3%, 4% and 5% respectively under the BAU scenario (Option 1). The minimum activation rates to achieve a benefit/cost ratio of exactly 1.0 have also been calculated. To achieve cost-effectiveness in Australia, at least 5% of the total AC stock needs to be activated by 2036, as well as 11% of the pool pump controller stock, 13% of the water heater stock and 3% of the EV charger stock. For New Zealand, the minimum cost-effective activation rates are similar.

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 2,720 MW to 5,040 MW, with the likely value around 3,400 MW (Table 1). This is equivalent to 60% of the total projected growth in peak demand on the State and Territory networks to 2036. 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 around 440 MW (Table 2).

Table 1 and Table 2 summarise the Benefit/Cost (B/C) ratios for each appliance type for Australia and New Zealand respectively. ACs account for the majority of the benefits. **Error! Reference source not found.** and **Error! Reference source not found.** show that 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.

Figure 1 illustrates the net present value (NPV) of cost and benefits for Australia (at 7% discount rate) under the Low, Medium and High activation scenarios. Figure 2 illustrates the magnitude of projected costs and benefits in each State, Territory and New Zealand. The proposal (Option 3) appears cost-effective in all jurisdictions apart from the NT and the ACT, where no growth in peak demand is projected.

The proposal is estimated to yield accrued net benefits in the range $1,430 million to $2,800 million NPV with the most likely value around $1,870 million, at a benefit/cost ratio of 2.9. This is equivalent to a net benefit of nearly $200 NPV for each Australian household, or nearly $250 NPV for each of the 7.5 million appliances projected to be under DR control by 2036.

For New Zealand, the proposal is estimated to yield accrued net benefits in the range $NZ 202 million to $403 million NPV with the most likely value around $260 million, at a benefit/cost ratio of 2.8. This is equivalent to a net benefit of about $140 NPV for each New Zealand household. Wholesale market price, load shifting and reliability benefits amount about 28% of the total benefits in Australia, and network benefits for 72%. In New Zealand, network benefits are 90% of the total.

Table 1. Projected costs and benefits by appliance, Australia (medium activation)

	Routine DLC Reduction available SMD 2036, MWe (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	
							$M Net benefit	B/C ratio
Air Conds	2164	$405	$1,420	$1,014	54.3%	3.5	$757	2.9
PP Controllers	318	$102	$192	$90	4.8%	1.9	$80	1.8
Water heaters	292	$252	$381	$129	6.9%	1.5	$121	1.5
EV chargers	626	$201	$837	$636	34.0%	4.2	$430	3.1
All products	3400	$960	$2,829	$1,869	100.0%	2.9	$1,388	2.4

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 7% discount rate for costs and benefits 2020-2036

Table 2. Projected costs and benefits by appliance, New Zealand (medium activation)

	Routine DLC Reduction available SMD 2036, MWe (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	
							$M Net benefit	B/C ratio
Air Conds	228	$56	$156	$101	38.7%	2.8	$101	2.8
PP Controllers	NA	NA	NA	NA	NA	NA	NA	NA
Water heaters	105	$61	$112	$51	19.7%	1.8	$48	1.8
EV chargers	111	$30	$139	$108	41.7%	4.6	$71	3.3
All products	444	$147	$407	$260	100.0%	2.8	$220	2.5

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 6% discount rate for costs and benefits 2020-2036

Figure 1. Projected costs and benefits of the measure at various activation rates, Australia

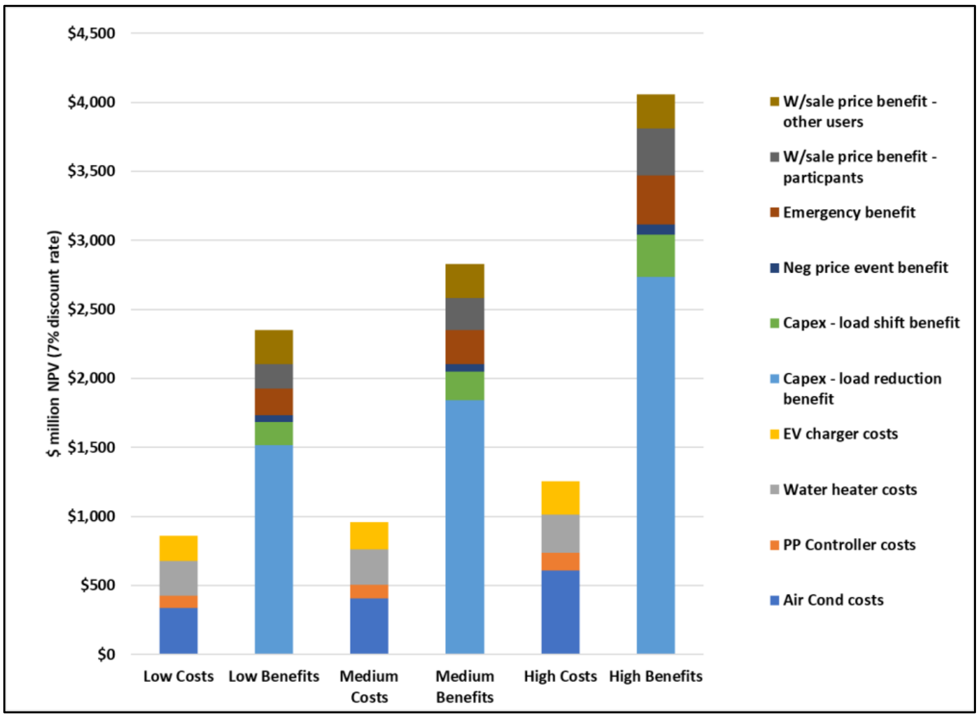
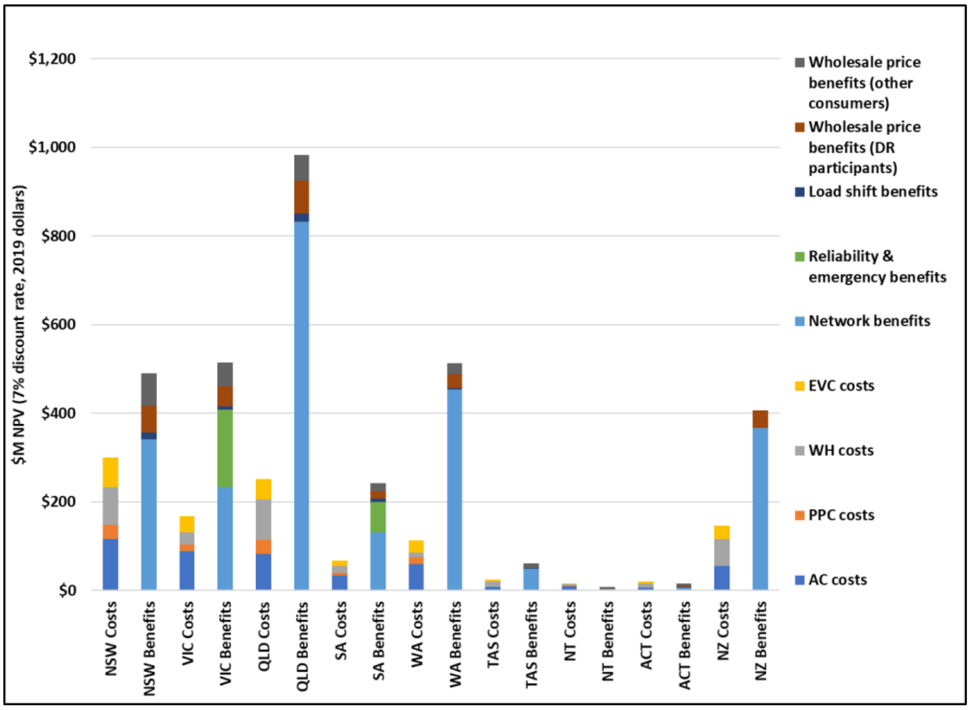


Figure 2 Costs and Benefits by Jurisdiction



Public Consultations

The Consultation Paper released on 14 August 2019 was emailed to all companies and industry associations on the E3 mailing list. Submissions were invited up to 16 September 2019 (later extended to 23 September 2019). Public consultation sessions were held in Sydney (26 August 2019), Melbourne (27 August 2019) and Wellington (29 August 2019). Additional sessions were held for invited consumer and public interest advocacy groups, in Sydney and Melbourne. In all, more than 80 individuals attended the sessions.

Over 40 written submissions were received from electricity networks, electricity retailers, AC suppliers, water heater suppliers, demand response product suppliers, the EV industry, individuals and public interest groups in Australia, and a further 10 from New Zealand.

Most submissions (even those opposed to mandating AS/NZS 4755 compliance) support the premise that a common, open technical standards framework for DR capability would enable the continued development of DR in Australia's energy markets, particularly with respect to residential and small business consumers.

Table 3 indicates the number of responses supporting and opposing the proposal to mandate compliance with AS/NZS 4755. In general, electricity industry stakeholders supported the proposal, more product manufacturers opposed it than supported it, and other respondents, including public interest groups, were strongly in favour. The balance of New Zealand submissions was also in favour, although New Zealand companies reiterated the view of their Australian counterparts. The Consultation Paper put 28 specific questions to stakeholders, eliciting a wide range of responses (reported in this Decision RIS).

There was widespread agreement that consumers should not be enrolled in AS/NZS 4755-based DR programs without a range of safeguards. Consumers should have a free choice about whether to have their appliances activated and take part in a DR program, and will need to be fully informed of both advantages (usually monetary) and disadvantages of doing so, and the ways to opt out if they change their minds.

Table 3 Number of respondents supporting and opposing mandating AS/NZS 4755 compliance

	4755 for ACs		4755 for PPCs		4755 for ESWHs		4755 for EV charger		DR standards	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Australia	20	11	15	7	17	13	19	7	17	2
New Zealand	6	2	1		5	2	5		6	

Source: See Appendix 1 for expanded summary. Excludes submissions which not express a view. Includes conditional responses, where stakeholders reported that they could change their views (either way) depending on the final text of the standards.

Implementation

For ACs and electric storage water heaters, which are covered by existing GEMS Determinations for energy efficiency, the measure can be implemented by revised Determinations under the GEMS Act 2012. Product registration systems are also in place for those products.

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. One of the recommendations of the Final Report of the Independent Review of the GEMS Act is that:

> "38. The Commonwealth Government update the GEMS Act to allow for mandatory demand response capability."[8]

The Commonwealth Government response to this recommendation will largely determine how quickly DR requirements for pool pump controllers and EV chargers might be implemented via the GEMS Act. Some jurisdictions with imminent network issues requiring more controllable devices in the system may consider an earlier implementation using local regulation.

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.

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. While compliance for battery charge controllers or PV inverters is 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. Several submissions also proposed that the DR capability of home energy management systems be considered.

Conclusions and Recommendations

Following consideration of the submissions, it is concluded that Option 3 remains the only option likely to meet the objective: "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."

Option 1 would continue the trend that began when the DR standards were first published in 2012. It has produced localised, limited DR programs for conditioners, and this is expected to continue. However, there has been no impact on the DR capability of water heaters, pool pump controllers or EV chargers.

Option 2 would require a national incentive scheme, to be developed outside the scope of the GEMS Act, that would offer incentives for the purchase of compliant products. Only those products purchased under the scheme would need to comply and others would not. In effect, Option 2 would involve Governments funding and running a demand response program, rather than setting a technical product standard. Modelling shows that the reduction in costs from such an arrangement would be minimal.

Option 3 is the only option likely to meet the objectives and remains the preferred option, subject to some modification to accommodate the responses and interests of stakeholders.

Therefore, it is **recommended** that COAG Energy Council approve the following compliance requirements and target dates:

1. Ministers endorse the adoption of nationally applicable, public, non-proprietary standards for demand response for air conditioners (ACs), electric storage water heaters, pool pump controllers and electric vehicle (EV) chargers intended for residential use.

Air conditioners

[8] GEMS Act review (2019), p 11/92.

2. Air conditioners to comply with any of the following standards:

- AS/NZS 4755.3.1:2014; or
- AS/NZS 4755.2 (when published); or
- The equivalent of the superseded AS/NZS 4755.3.1:2012 (for a limited period of 2 years from the Determination).

3. Compliance with three demand response modes (DRM1, DRM2, DRM3) to be required, for all AC types subject to MEPS (excluding portable air conditioners), up to a cooling capacity of 19kW inclusive, registered after 30 June 2023.

4. This option of complying with the equivalent of the superseded AS/NZS 4755.3.1:2012 to be no longer available for products registered after 30 June 2025.

5. A Determination to give effect to the above to be made by 1 July 2021.

Electric Storage Water Heaters (Resistive Heating)

6. Electric Storage Water Heaters to comply with either of the following standards:

- AS/NZS 4755.3.3:2014; or
- AS/NZS 4755.2 (when published).

7. Compliance with demand response mode 1 (DRM1) to be required, for electric storage water heaters of 50 to 710 litres (inclusive) nominal capacity subject to MEPS (excluding heat exchange water heaters), registered after 1 July 2023. (Other DRMs are optional).

8. A Determination to give effect to the above to be made by 1 July 2021.

Devices controlling swimming pool pump-units

9. Devices controlling swimming pool pump-units (as defined in AS/NZS 4755.3.3:2014) to comply with either of the following standards:

- AS/NZS 4755.3.2:2014; or
- AS/NZS 4755.2 (when published).

10. Compliance with demand response mode 1 (DRM1) to be required, for pool pump controllers supplied or offered for supply from 1 July 2024. (Other DRMs are optional).

11. Compliance with DRM1, DRM2 and DRM3 to be required for pool pump controllers supplied or offered for supply from 1 July 2026.

12. A Determination to give effect to the above to be made by 1 July 2022.

Electric Vehicle Charge/Discharge Controllers

13. Controllers capable of managing the charging and/or discharging to the grid of EVs, that are intended for residential applications and capable of charging at SAE Level 2 or IEC Mode 3, to comply with any of the following standards:

- AS/NZS 4755.3.4 (when published); or
- AS/NZS 4755.2 (when published); or
- an equivalent international standard, if an E3 technical working group determines by mid-2022 that there is one that provides equivalent capabilities to AS/NZS 4755.

14. Compliance with AS/NZS 4755 DRMs 0, 1,2,3,4,5 and 8 to be required (6 and 7 optional), or the equivalents in the other approved standard, for EV chargers supplied or offered for supply from 1 July 2026.

15. A Determination to give effect to the above to be made by 1 July 2024.

Additional recommendations

16. COAG Energy Council agrees to the establishment of an E3 Technical Working Group, with membership to be determined by the Senior Committee of Officials (SCO), to consider the matter of an equivalent international standard for EV charge/discharge controllers (in recommendation 13).

17. COAG Energy Council requests Standards Australia to:

- Include an additional appendix in AS 4755.2 to cover EV chargers (based on draft AS/NZS 4755.3.4);
- Expedite completion and publication of AS 4755.2; and
- Expedite completion and publication of AS/NZS 4755.3.4; and
- Prepare a new part of AS/NZS 4755 covering Home Energy Management Systems (HEMS) that are capable of providing demand response.

18. COAG Energy Council agrees to the investigation by E3 of the options, cost, benefits, advantages and disadvantages of requiring demand response capabilities meeting public, non-proprietary standards for:

- Photovoltaic (PV) inverters within the scope of AS/NZS 4777.2; and
- Controllers for grid-connected electrical energy storage systems (including residential scale batteries) within the scope of AS/NZS 4755.3.5.

Contents

Illustrations

Glossary

Acronym or term	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.
EVSE	Electric Vehicle Supply Equipment (common term in standards for fixed-wired EV chargers).

Acronym or term	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.
OCPP	Open Charge Point Protocol.
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.
WMDR	Wholesale Market Demand Response.

1. The Problem: Growing variability in electricity demand and supply

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.

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 3 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.

In 2013, the Productivity Commission 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."[9] The situation has not improved since. In its latest *Statement of Opportunities,* the Australian Energy Market Operator (AEMO) reports: "In the last three years, load factors have been decreasing, with record high maximum demand days still being observed despite operational consumption growth being in decline."[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

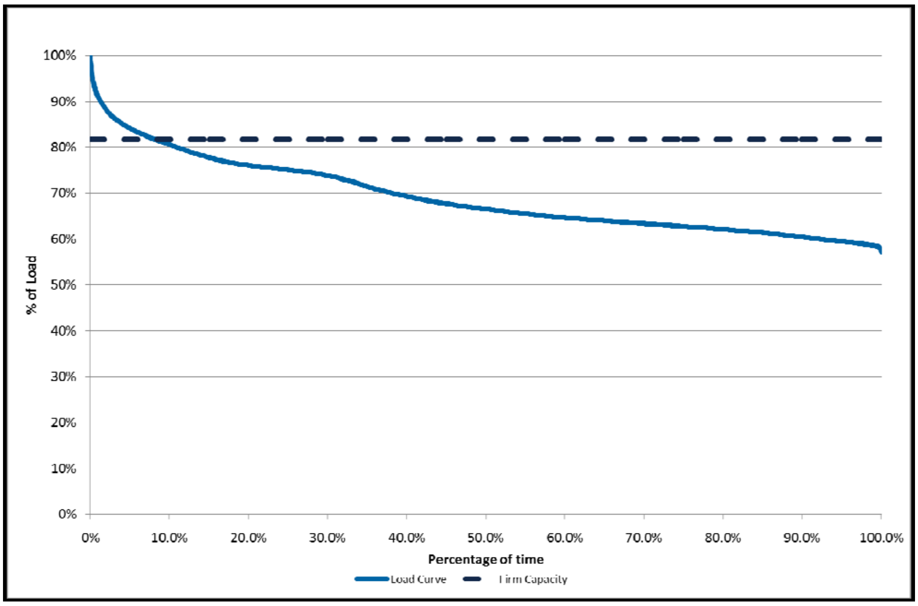
[9] PC (2013) p338.

[10] AEMO (2019). P8/124 Load factors are average consumption divided by maximum demand. Decreasing load factors indicate that the difference between average consumption and the peak is getting bigger.

[11] ACCC (2018), p6/398

population growth. However, AEMO now projects electric vehicle (EV) charging to take over as the driver of peak demand in the late 2020s and 2030s.[12]

Figure 3. 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), now present in about 20% of Australian homes. 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.

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. AEMO projects that South Australia (SA) and WA will experience regular state-wide minimum load events as early as 2026.

Figure 4 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.

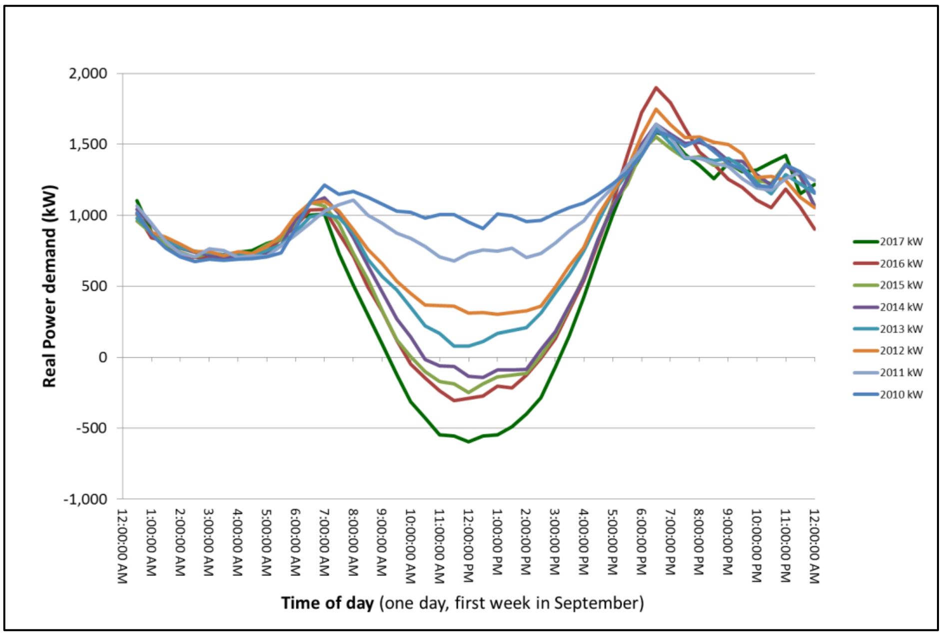
People value thermal comfort, and so may use more electricity to cool or heat their homes when the weather is very hot or cold. However, very few are made aware of the costs of using electricity at peak

[12] http://forecasting.aemo.com.au/

times, as about 88% of residential electricity consumers in Australia currently pay a flat tariff for their general consumption.[13]

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 4. The growth of solar PV brings new challenges



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

Error! Reference source not found. illustrates AEMO's projections of the widening gap between maximum and minimum demand in the largest National Electricity Market (NEM) region (New South Wales (NSW)) and the one with the highest proportion of renewable generation (SA). Over the next 20 years, the ratio of maximum to minimum demand is projected to increase from 2.5 to 3.3 for NSW, and from an already problematic 5.2 in SA to 7.3. New strategies will be required to maintain grid security and reliability in the face of growing volatility.

Table 4 Difference between projected maximum and minimum demands, NSW and SA

Year	NSW				SA			
	Maximum demand	Minimum demand	Difference MW	Ratio Max/Min	Maximum demand	Minimum demand	Difference MW	Ratio Max/Min
2019-20	13291	5405	7886	2.5	2950	568	2382	5.2
2038-39	14078	4306	9772	3.3	3102	455	2677	7.3

Source: AEMO 2019

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

Demand Response

Demand response (DR) – the rapid modification of electricity demand in response to changes in supply or in the condition of the grid – has been recognised as a key strategy for increasing the reliability, affordability and sustainability of electricity supply by AEMO[14], the Energy Networks Association (ENA), the CSIRO[15], the Australian Energy Market Commission (AEMC)[16], the Australian Competition and Consumer Commission (ACCC)[17], and the Independent Review (the Finkel Review).[18]

In its *Retail Electricity Pricing Inquiry,* the ACCC reported:

> "Demand response involves customers reducing or changing the timing of their usage of electricity (or changing their use of on-site generation or storage) in response to short-term price signals or changing market conditions. Demand response can be behavioural, in that consumers manually switch off or do not use certain devices, or automated, for example, load control devices allow for consumers to participate with little or no active engagement. Examples of demand response include customers using a local generator or battery to supply electricity to the market when there are supply constraints, or having their load automatically reduced at these times through a device in their air conditioner or pool pump that reduces the power consumption for a short period (ACCC 2018, 229/398)."

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. In Australia, trials of DR for small consumers started in 2005 and are still on-going. There have been at least 16 trials, in all mainland states and the ACT, covering tens of thousands of participants (Table 5).

The trials in the early 2010s were mostly funded through the Demand Management Innovation Allowance (DMIA), under which Distribution Network Service Providers (DNSPs) applied to the Australian Energy Regulator (AER) for additional revenue under their 5-yearly price determinations. Electricity retailers have become involved more recently, taking advantage of funding available under ARENA's Demand Response Reliability and Emergency Reserve Trader (RERT) Trials program.[19] While the earlier trials concentrated on direct load control (DLC) for ACs, the later trials have diversified to covering other products as well, and behavioural DR programs as well as DLC.

While the Behavioural DR trials have reported some success, they mostly rely on consumers having time-variable prices, which currently excludes 88% of residential electricity consumers. They rely on methods of amplifying the price signal (by messaging) and of verifying a response which are specific to particular retailers or aggregators. Very few of the trials have resulted in residential market offerings which persist beyond the trial stage and in which participation is open to any consumer who meets the program criteria.

[14] *Technical Integration of Distributed Energy Resources*, Australian Energy Market Operator, April 2019

[15] *Electricity Network Transformation Roadmap: Final Report*, Electricity Networks Australia and CSIRO, April 2017

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

[17] *Restoring electricity affordability and Australia's competitive advantage; Retail electricity pricing inquiry* – Final Report, Australian Consumer and Competition Commission, June 2018

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

[19] ARENA (2019). The DR RERT Trial is a $35.7 million program, with ARENA providing $28.55 million and the NSW Government providing $7.18 million to proponents selected in NSW. Ten projects from eight organisations were selected to trial innovative approaches to delivering emergency demand response within either 10 or 60 minutes of a request by AEMO across residential, commercial and industrial portfolios.

By far the largest of these is the Energex and Ergon PeakSmart program, which was started in 2013, and has reached 108,000 participants and is still continuing. It offers consumers a cash incentive if they purchase an AC complying with the AS/NZS 4755 DLC standard, have it fitted with a control device and consent to the DNSP modifying the ACs operation under agreed conditions.[20] The cash incentive is unrelated to either TOU pricing or the need to verify individual appliance response. The DNSP is in effect purchasing capacity in the form of kVA reductions that are accessible when required. The magnitude of reductions is indicated by monitoring the changes in demand of a sample of participating ACs, so does not require monitoring of every single enrolled appliance.[21]

Table 5 Residential Electricity Consumer Demand Response Trials in Australia, 2005-2019

State/territory	Entity (type)	Period	Participants	Approach	Appliances
SA	ETSA Utilities (D)	2005-09	2,000	DLC	Air conditioners
Qld	Ergon (D)	2008-09	NA	DLC	Air conditioners
Qld	Energex (D)	2008-10	3,500	DLC	Air conditioners
WA	Western Power (D)	2008-11	2,200	DLC	Air conditioners
NSW	Endeavour Energy (D)	2008-12	2,500	DLC (b)	Air conditioners
SA	ETSA Utilities (D)	2010-12	1,000	DLC (b)	Air conditioners
WA	Western Power (D)	2011-12	380	DLC (b)	Air conditioners
Qld	Energex (D)	2011-12	200	DLC (b)	Air conditioners
ACT	ActewAGL (D)	2011	NA	DLC	Air conditioners
NSW	Ausgrid (D)	2011-15	44	DLC	Small electric water heaters
NSW	Ausgrid (D)	2012-2016	100	DLC (b)	Air conditioners
Vic, SA, NSW	EnergyAustralia (R)(a)	2018-2019	450	BE, DLC	Air conditioners, Pool pumps, Batteries
Vic	Powershop (R)(a)	2018-2019	10,600	BE, DLC	PV, Batteries
SA, Vic	Zen EcoSystems (A)(a)	2018-2019	1,400	BE	
NSW	AGL (R)(a)	2018-2019	700,73	BE, DLC (b)	Air conditioners, EV charger
Vic	PowerCor (D)	2018-2019	NA	DLC	Air conditioners

Sources: ENA (2012), DR RIS (2014 Table 91, Ausgrid (2018), ARENA (2019). (D) = Distributor, (R) = Retailer, (A) = Aggregator, DLC = Direct load control, BE = Behavioural. (a) Funded through ARENA RERT Trials (b) Involving AS/NZS 4755-compiant products

The proliferation of DR trials and approaches, should they proceed to market offerings, carries the risk that consumers could be locked in with particular service providers through incompatible equipment and technology. This would run counter to the objective of increasing market competition by enabling consumers to switch retailers more easily if they wish.

Not all distributors and retailers have had success with DLC trials based on AS/NZS 4755-compliant products. However, the main barriers seem to be inconsistencies in compliance (products not always performing as required in the standards)[22] and the fact that the low penetration of compliant products is insufficient to sustain cost-effective market offerings.[23] Consumer acceptance of DLC has been reported to be high, even in trials not otherwise considered successful.

[20] https://www.energex.com.au/home/control-your-energy/positive-payback-program/positive-payback-for-households/air-conditioning-rewards The value of the incentive has changed over the years, but is currently up to $400 for a product with cooling capacity of 10kW or more.

[21] It also avoids the perverse incentive for consumers given notice of a DR event to turn on their ACs even if they are not home (as they can easily do via a smartphone app) in order to claim the value of the demand reduction.

[22] AGL (2018), p15/33

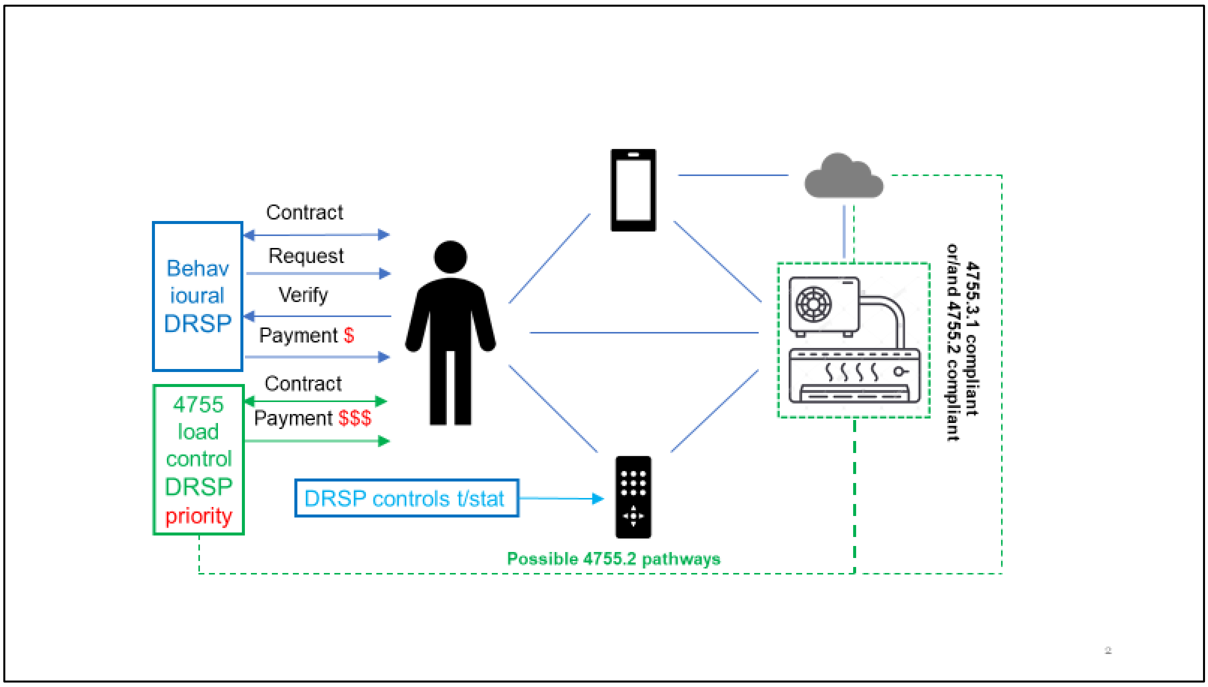
[23] Ausgrid (2016) p4/41

In 2018, ARENA commissioned a Customer Insights Report which surveyed participants in the AGL, EnergyAustralia and Powershop trials (see **Table** 5). The study asked: "Can a program in its current design be sustained over many years?" and concluded:

- The learning effect will reduce the overall impact of the program over time. As people apply energy management to their daily life, their ability to contribute at a certain event is bound to decrease…;
- It is uncertain if the current design can sustain peoples' level of interest over a longer period…;
- We saw signs of people's disappointment in the events-based rewards. Other partners…use a different reward system and it would be useful to compare the two systems;
- …many do not trust the retailer's assessment of their effort based on the baseline approach;
- While the people we researched were willing to put in the effort for each event, there was great diversity in the length they'd go to reduce their energy use. Other programs using controlled loads do not require a user's intervention and have shown to be sustainable over many years; and
- Lastly, anecdotally the cost to the overall energy system is quite large (rewards + administration). It would be instructive to compare the cost and effectiveness against other rewards systems…or the cost of a controlled load program.[24]

Behavioural and controlled load DR programs are not mutually exclusive. They can coexist, and indeed consumers can maximise their benefit by contracting with more than one DRSP. DR through DLC is more reliable and sustainable and so has a higher value to the grid. This means DRSPs will pay consumers more to access it, but will not prevent them from participating in behavioural DR at other times if they wish (Figure 5).

Figure 5 Multiple DR pathways can coexist (air conditioner example)



[24] ARENA (2018), p65/68.

Role for Government

The minority of consumers who TOU tariffs 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. These strategies are termed "behavioural demand response" in that they rely on consumers actively managing their energy-using behaviour in response to price signals, and doing so over long periods of time.

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 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 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's draft NEM rule change published in July 2019 "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" but covers DR by industrial and commercial sector consumers only. The Commission has decided to defer a decision on extending the rule to cover small consumers pending a review of consumer protections. [25]

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 DR technology because of the fragmentation of the market.

The low incidence of 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.

One option to address this market failure is to facilitate the supply of an enabling technology – demand-responsive or "smart" appliances. This will support the development of a 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. 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

[25] https://www.aemc.gov.au/rule-changes/wholesale-demand-response-mechanism The *National Electricity Amendment (Wholesale demand response mechanism) Rule 2019* was published in July and a Final Rule is due in November 2019.

enables 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 DRSPs. 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. These barriers would be much reduced if there were a consistent platform supporting DR, based on a suitable non-proprietary technical standard, such as the Australian and New Zealand Standard AS/NZS 4755: *Demand response capabilities and supporting technologies for electrical products*. Using a uniform public standard would lower costs for manufacturers and DRSPs, and facilitate the development of DR.

Co-ordinated action by national, State and Territory Governments and the mandatory adoption of uniform technical standards was necessary for the establishment of the trans-Tasman energy efficiency labelling and minimum energy performance standards (MEPS) scheme, now embodied in the Commonwealth Greenhouse and Energy Minimum Standards (GEMS) Act 2012 and the New Zealand Energy Efficiency and Conservation Act 2000. After some 14 years of inconclusive trials, Government action may also be necessary to facilitate the development of demand response quickly and reliably enough to manage the problems and costs caused by the growing variability in electricity demand and supply.

2. The Objectives of Government Action

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".**

3. 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 regulations;
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.

Trials of behavioural DR would be expected to continue, with some of them possibly leading to market offerings. Some DLC trials could also evolve into local programs, 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. Some reduction in peak demand may also occur as a result of existing E3 energy efficiency measures such as more stringent MEPS for the products in question.

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.[26]

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 Regulation Impact Statement (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.[27] 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."[28] 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.[29] The reductions under CPP were four times as great as under conventional TOU tariffs, which were much flatter.[30]

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.[31] 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.

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.

---

[26] Registration for eligibility under the PeakSmart program is considered a more reliable indication of compliance with AS/NZS 4755 than the statements of compliance on www.energyrating.gov.au, which cover 54% of models.

[27] Due to uncertainty about which model comply, the annual market share of AS/NZS 4755-compliant air conditioners outside SE Queensland cannot be accurately determined at this stage.

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

[29] Consultation Regulation Impact Statement: Mandating 'Smart Appliance' Interfaces for Air Conditioners, Water Heaters and other Appliances 2013, p136

[30] Productivity Commission, Report on Electricity Network Regulatory Frameworks, April 2013, p 356

[31] ACCC (2018), 205/398

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, the impact on peak demand has been limited and may have reached its limits, according to the AEMO 2019 Statement of Opportunities:

> In Queensland, for example, the average monthly maxima in the past 12 months are up 3% compared to a year ago, but annual energy is down 0.7%. Discussions with local network companies suggest a driver may be an increase in air-conditioner ownership coupled with consumers changing the way they use cooling, with less tolerance for high temperatures towards the end of summer. Moreover, while rooftop PV uptake continues to have noticeable impacts on operational consumption, the forecast impact on operational maximum demand, which now occurs closer to sunset, is reduced.[32]

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.[33]

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.[34] 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.[35]

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 users initiate charging on their return from work.[36]

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").[37] 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

---

[32] AEMO (2019) p58/124
[33] http://www.bom.gov.au/climate/current/statements/scs68.pdf
[34] www.energyrating.gov.au/products-themes/other/swimming-pool-pumps
[35] *Residential Pool Pumps: Load control and demand management in Queensland*, Presentation to DCCEE Swimming Pool Pump Stakeholder Meeting (R Wilson), Sydney, 1 June 2012
[36] Australian Electric Vehicle Market Study, Energeia, 2018
[37] 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.

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.

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, ACs and dishwashers, based on Australian Standard tests (the origins of the existing E3 program and GEMS Act).

In 2010, the E3 program changed the AC energy rating label to enable manufacturers to indicate whether a model complies with AS/NZS 4755.3.1. This was intended to enable 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.[38] While the main reason for dropping the option was lack of space, it had not had the market transformative effects intended. The introduction of compliant models was due largely to the Energex PeakSmart program in southeast Queensland (as well as the expectation in the industry that compliance would be mandated after the 2013 Consultation RIS).

Labelling of DR capability had no value to consumers outside SE Queensland, since no other utilities offered the same type of program. Even in the PeakSmart region, eligible models were identified not by their energy label but from a list published by Energex.

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.

The unanimous response from submissions who addressed this question was that it will remain ineffective unless supported by other measures. Using energy labels as a means of encouraging consumers to prefer appliances with "smart" or DR capabilities is problematic and has not succeeded in the USA or Japan either.[39]

Cash incentives

Cash incentive payments provide another means of encouraging buyers to voluntarily purchase products with specific DR capabilities. Under the PeakSmart program established in 2013, Energex and Ergon offer cash incentives to customers in designated areas who purchase AS/NZS 4755-compliant ACs and have them activated on installation (see Appendix 2). Energex reports that the cost of acquiring load control in this way is lower than the cost of building new capacity.[40]

---

[38] 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.

[39] 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

[40] *Customer Interactions Demand Management Outcomes 2015–20*, Energex January 2019 https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/energex-determination-2020-25/proposal Attachment 7 Part 13. "The residential program target 75 MVA will be exceeded as the PeakSmart air-conditioning initiative has grown faster than originally anticipated. At the end of 2017/18, the MVA reduction from the residential program is 65.9 MVA which is approximately 88% of the MVA

In their submissions on the Consultation Paper, most manufacturers favoured the option of offering cash incentives to consumers over the option of mandating compliance with AS/NZS 4755. This would leave the decision of whether to supply compliant products to the market up to them.

However, it is not clear how a national-scale incentive program could be implemented.

An upfront cash incentive serves several objectives:

a. targeting consumers in areas where load modification has value (e.g. by restricting offers to consumers living near problem substations);
b. motivating consumers to seek out products that are capable of linking to the DRSPs communications platform (by restricting appliance eligibility);
c. enabling the service provider to identify consumers who have purchased those products (they will be the ones claiming the incentive); and
d. rewarding those consumers for participating in the DR program (whether or not other rewards are also offered – such as pay per event – depends on the program design).

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 (b) or (c). The number of DR-capable products will build up at a predictable rate. DRSPs will still be able to target problem areas, and will in fact be able to achieve more rapid take-ups, since they will be able to draw on unactivated products already in the stock, rather than being restricted to the rate at which new products are purchased (as is the case with PeakSmart).

Therefore, incentives can work well with mandatory compliance, but to replace mandatory compliance and achieve similar outcomes, the following conditions would need to be met:

- Eligibility would need to be restricted to products that comply with AS/NZS 4755. Otherwise incentives would turbocharge the fragmentation of the market by underwriting products with unknown, unpredictable, untestable and divergent DR capabilities;
- Purchases made in any part of Australia or New Zealand would need to be eligible, to match the geographical scope of a mandatory program; and
- There would need to be a means of funding the incentives that does not depend on utilities or DNSPs (otherwise it would default to Option 1 – BAU). A new nationally available funding mechanism would need to be established. Funding could come from Commonwealth, or from States, or from surcharge on wholesale market participants including DRSPs. The funding formula would be complicated and no doubt contested.

If these conditions could be met, the most significant benefit compared with mandatory compliance is that non-activated products need not comply. The magnitude of this benefit (and any offsetting losses in terms of activation rates) are explored in Chapter 5.

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.

---

target for the 2015-2020 regulatory control period. The program has been delivered below a cost to serve target of $725/kVA, tracking at $346/kVA at 30 June 2018. Further efficiencies, cost reductions and productivity improvements will be pursued."

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 to be sold with standardised DR capabilities built-in (or in some cases accessible with an added component)[41], to allow them to connect to a range of communications systems and to participate in the DR market. For those products not already compliant, this 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 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.

[41] This option was available for air conditioners under AS/NZS 4755.3.1:2012, which permitted compliance by "Potentially demand response capable" air conditioners, defined in AS/NZS 3823:2013 as: "An air conditioner that is potentially fully compliant with AS 4755.3.1, once a nominated standard part or component, that is not otherwise supplied with every unit, has been added or fitted, either at the time of manufacture or at any subsequent time, e.g. pre-delivery, at installation or after installation. The part may be factory-installed, e.g. in response to a prior order, but must also be capable of being fitted subsequently by an authorized person at any point in the service life of the product.
Where the supplier of an air conditioner model indicates that it is potentially demand response capable, the supplier must also identify the part or component needed to make it demand response capable, and must undertake to supply that part or component from the time this indication appears on the register to not less than 10 years after the model ceases to be registered. AS/NZS 4744.3.1:2014 withdrew this means of compliance by noting "An air conditioner that *is potentially demand response capable* as defined in AS/NZS 3823 does not have demand response capability as defined in this standard"

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 6 summarises the classification of DR services for the Australian NEM adopted by the ACCC and the 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.[42]
- 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.[43]

Electricity retailers can already use DR resources to reduce price risk in the wholesale market. However, according to four applicants who 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 provide a direct signal of the wholesale price to customers, its customers have no incentive to change their energy consumption; and

[42] Queensland Energy Group, (2109) *Customer Interactions Demand Management Outcomes 2015-20*, January 2019
[43] ARENA (2019) *Demand Response RERT Trial Year 1 Report*, ARENA with Oakley Greenwood, March 2019.

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.[44]

The applicants 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 accepted most of these arguments and published a Draft Determination and the text of a proposed rule change in 18 July 2019.[45] 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 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." (p67/228)

The rule change 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 air conditioners could be part of commercial DR programs under the rule change as it stands, since residential type products are often used by small businesses).

AS/NZS 4755 is an open standard and so investment in using it could not be stranded, because another DRSP could take over management 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.

[44] 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

[45] 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

Table 6. 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.

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 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 6, 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 10, and **Table 12**) and
- assuming a lower activation rate among the range modelled (say a "low" rather than a "medium" activation rate).

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; 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 DR strategy.

Enactment of the wholesale price mechanism rule changes proposed by 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.[46]

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.

[46] 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

4. Preferred Option

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. For this to occur on a national scale, there would need to be a means of funding the incentives that does not depend on utilities or DNSPs (otherwise it would default to Option 1 – BAU). Given the network regulatory regime, governments are not able to force utilities or DRSPs to offer cash incentives, so this would require a new funding mechanism. This is outside the scope of the GEMS Act 2012.

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 21) 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 can be quantified, and used as the baseline for calculating the additional costs and benefits of Option 3. The impact of (c) cannot be 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).

Preferred Option: Option 3

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,[47] 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 3).

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, hotter summers 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.[48] There were more such events in South Australia (SA) and Victoria in January and February 2009, during the period of record temperatures leading up to the Victorian bushfires,[49] and in Melbourne again as recently as January 2018[50] and January 2019.[51] 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.[52]

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%.[53] 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.[54] 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 was narrowed to ACs up to 19 kW cooling capacity in the Consultation Paper. Comment was invited on whether this limitation is still appropriate. While most submissions indicated that it is, some advocated the limit be raised to 30kW.

---

47 Productivity Commission, report on Electricity Network Regulatory Frameworks, April 2013, p 336.
48 Sydney Morning Herald article (www.smh.com.au/articles/2004/10/24/1098556297439.html).
49 Sydney Morning Herald article (www.smh.com.au/news/environment/we-love-a-sunburnt-country-our-aircons-too/2009/02/02/1233423135557.html).
50 DELWP (2018), Post Event Review, Power Outages 28 & 29 January 2018.
51 https://www.abc.net.au/news/2019-01-26/victorian-blackouts-what-caused-them-and-is-this-the-new-normal/10751412
52 *Keep calm and carry on: Managing electricity reliability* Tony Wood, Guy Dundas and Lucy Percival (Grattan, 2019)
53 Calculated from air conditioner market projections supplied by E3.
54 Decision RIS: Air Conditioners, December 2018, p17/138.

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 was assumed in the Consultation Paper that making all AC models compliant would increase average retail prices by $5-15 per unit. After consideration of industry submissions, the projected cost impacts were doubled, to $10-30 per unit (depending on type). Given that the installed cost of a typical 5 kW household AC is about $2,500, this less than 1% of the installed cost on average.

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 395,000 electric storage water heaters are sold annually in Australia, mostly of local manufacture.[55] 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.[56] 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. This could be achieved at very low additional cost – tens of dollar per kWh of energy storage capacity compared with $800 - $2,000 per kWh of storage capacity for a household-size battery.[57]

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.[58]

AS/NZS 4755.3.3:2014 provides for a Higher Storage Mode Operation (DRM4), in which the water heater over-rides the normal upper thermostat setting (typically about 60°C) and temporarily heat to about 75°C. During the consultations, the manufacturers indicted that ensuring the integrity of the vitreous enamel lining at higher temperatures would increase manufacturing costs and create warranty problems.

Some rapid energy storage capability can be retained by applying DRM 1 (even during OP heating times) on days when high PV output is anticipated, and then relaxing DRM1 during high-PV periods. This gives appliance-level control of heating times, which is more flexible than the circuit-level control that is available (in most areas) from manipulating OP heating periods. It also means that consumers can benefit from DR arrangements for water heaters not on controlled circuits. Therefore, it is recommended that compliance with DRM1 only be mandated, to avoid manufacturer costs associated with DRM4.

---

[55] The estimate in the Consultation Paper was 530,000 units per year. This has been revised downward after submissions from the industry.
[56] Ausgrid (2016)
[57] https://solaray.com.au/how-much-do-solar-batteries-cost/
[58] 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 was invited on whether this scope is still appropriate, and all but one submission agreed that it is.

Given sufficient lead time, suppliers of electric storage water heaters to the Australian market could make the necessary design changes. It was estimated in the Consultation Paper 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. The industry made submissions to the effect that the additional costs could be as high as $200, but this was with respect to compliance with DRMs 2,3 and 4 as well as DRM1. As the proposal is now for DRM1 only, the cost estimate of $70-80 has been retained.

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.[59] 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.[60] About 180,000 pool pump-units are sold each year[61] 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 $75 to the average price of pool pump controllers (increased from $50 following the consultation period).

Electric Vehicle Charge/Discharge Controllers

There is growing interest in EVs in Australia and New Zealand. Although the Australian EV market is still small (2,300 units in 2017, or 0.2% of the new car market), vehicle manufacturers are importing more

[59] 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

[60] ABS, Environmental Issues: Water Use and Conservation, Cat. No. 4602.055, March 2010.

[61] Decision Regulation Impact Statement: Swimming Pool Pumps, September 2018.

electric models and the market is expected to grow rapidly. Australia has about 10,000 registered EVs (including plug-in hybrids) and New Zealand has about 15,000.[62]

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…"[63]

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.[64]

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." [65]

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.[66] 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 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 2[67] and in the international standard IEC 61851.1 as Mode 3.[68]

EV chargers, like pool pump controllers, are electronics-intensive products and it is assumed that DR capability would impose an average price penalty of $50 per unit. Following public consultations it is now recommended that EV chargers should be able to meet the demand response capability requirements

---

[62] https://theconversation.com/new-zealand-poised-to-introduce-clean-car-standards-and-incentives-to-cut-emissions-120896
[63] 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/
[64] Australian Electric Vehicle Market Study, Energeia, 2018 p93.
[65] https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Electric_Vehicles
[66] https://www.gov.uk/government/consultations/electric-vehicle-smart-charging
[67] https://www.sae.org/standards/content/j1772_201710/
[68] https://webstore.iec.ch/publication/33644

through means other than AS/NZS 4755 compliance. The EV industry has submitted that existing charge control standards such as Open Charge Point Protocol are equivalent. If E3 agrees, then products conforming to other standards will also comply, and if those already incorporate the necessary capability the marginal cost should be zero. Therefore, the cost of $50 has been retained as a weighted average.

Proposed Compliance Standards

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. 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. These standards and protocols are further described in Appendix 3.

Some of the DR trials funded by AREMA involved AS/NZS 4755 compliant air conditioners and some reported difficulties related to incorrect implementation of the standard by the products claiming compliance or too low an occurrence of compliant products in the population to support a cost-effective DR program.[69] Both of these issues would be resolved by making compliance mandatory and checking compliance at the time of registration. The PeakSmart program, which manages 108,000 AS/NZS 4755-compliant air conditioners, reports no technical problems with properly compliant products.

Several manufacturers now offer consumers remote control and monitoring of their appliances through proprietary apps, some using voice-activated platforms such as Google Assistant or Amazon Alexa (see **Figure 5**). However, achieving DR through these channels generally relies on consumers responding personally rather than appliances responding automatically, and so are not alternatives to 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.

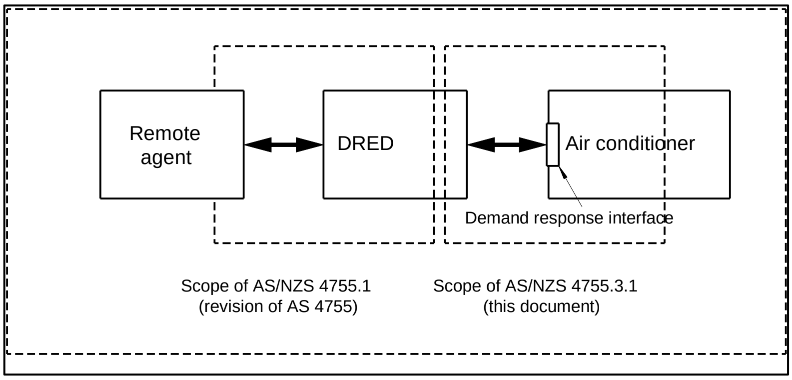
AS/NZS 4755 remains the most suitable automated DR standard for Australia and New Zealand. Most of the global AC manufacturers serving the Australian market offer AS/NZS 4755 compliant products; this was made easier by the fact that the capabilities (DRM 1, 2, 3 etc) are consistent with Echonet. A key 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 6). The DRED communicates with a "remote agent," defined in the standard as a "person, organization or entity,

[69] https://www.agl.com.au/solar-renewables/projects/peak-energy-rewards-managed-for-you p15/33

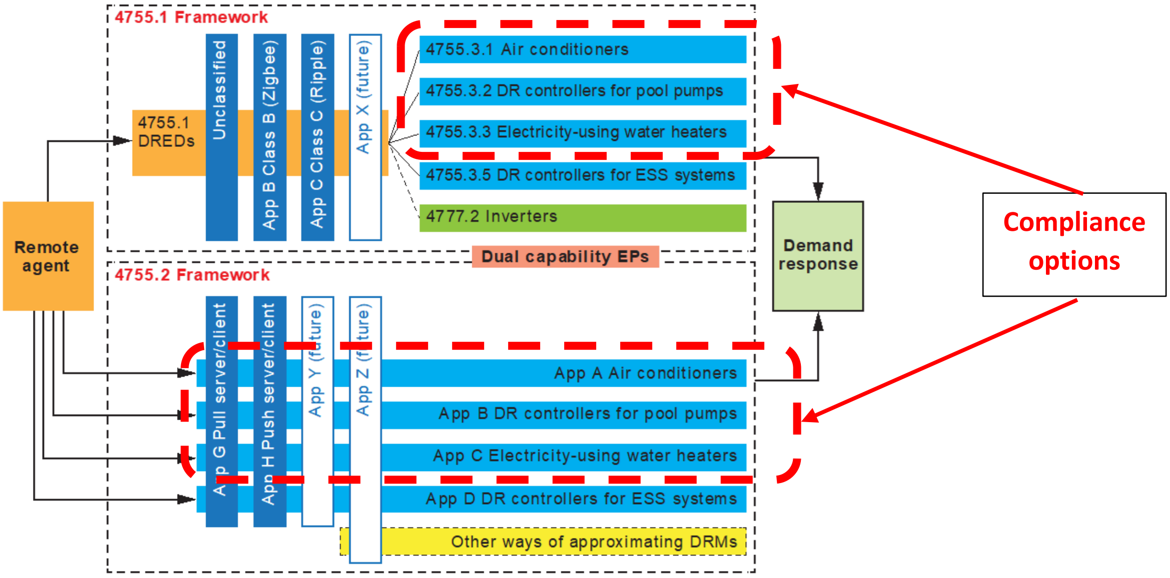
other than the user, who is authorised to initiate demand response by transmitting operational instructions in accordance with this Standard.”[70]

Figure 6. Relationship of Remote Agent and DRED to Air Conditioner



Source: AS/NZS 4755.3.1

Figure 7. New AS/NZS 4755 Framework



Source: (DR) AS 4755.2

AS/NZS 4755 does not specify the communications 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. The DRSPs then arrange the supply and installation of DREDs that connect to their communications systems or platforms.

Several parts of AS/NZS 4755 have since been updated, and new parts published (see Appendix 3). 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*

[70] AS/NZS 4755 adds Note 1: Examples include electricity distributor, electricity retailer, electricity system manager and demand response aggregator. Note 2: 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: 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.[71] AS 4755.2-compliant 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 7 – the 4755.1 framework corresponds to Figure 6). 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.X 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 emerging international standards, including OpenADR (See Appendix 3).

For further flexibility it is proposed that, for a limited period, air conditioners should also be able to comply with a previous (now withdrawn) version, AS/NZS 4755.3.1:2012. This specifies DRM 2 and DRM 3 in a different way, with the consequence that demand reductions are lower under some operating conditions.

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 more DRMs (Table 7). The potential to limit power to 50% (DRM 2) or to 75% (DRM 3) makes participation in air conditioner DR programs 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 7. 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(c)	NA	DRM 1	DRM 2,3	NA	NA	NA
Pool pump controllers	3.2 (b); 2(c)	NA	DRM 1	DRM 2 (g)	DRM 4 (g)	NA	NA
Electric water heaters	3.3 (b); 2(c)	NA	DRM 1	Optional	Optional	NA	NA
Electric vehicle chargers	3.4 (d)	DRM0 (f)	DRM 1	DRM 2,3	DRM 4	DRM 8 (e)	DRM 5 (e)

(a) Either 2012 or 2014 version. (b) 2014 version. (c) Draft AS4755.2. (d) Unpublished draft – would need to be brought to publication or the contents incorporated in a GEMS determination or similar. (e) AS/NZS 4755 framework includes DRMs 6 and 7 to constrain the rate of discharge, but these would not be mandatory. (f) Mandatory safety modes for products capable of discharge to grid. (g) After 2 year delay.

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, all of which have all three DRMs.

[71] This part is an Australian rather than a joint standard.

Most manufacturers have indicated that providing the full range of DRMs is no more costly than providing DRM 1 alone.

A major objective of the proposal is to provide the capability to switch on electric water heaters, pool pumps and EV chargers in order to shift load into excess supply periods. This can be achieved by managing DRM 1 in water heaters. For pool pumps, it is also proposed to mandate DRM 1 initially and then require DRM2 and DRM 4 (turn on) after a phase-in period. (AS/NZS 4755 does not 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 3).

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."[72]

For a DRSP to bid demand changes into the capacity and/or wholesale energy markets will take some estimation of the effect. It is simpler to estimate a AS/NZS 4755-style response (which will show as a step change in demand at the substation) 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).

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

5. 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; and
- emergency demand response—sourced by the system operator when there are predicted supply shortfalls to avoid involuntary load shedding."[73]

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 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 AEMC[74] 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.

Emergency response occurs under the opposite conditions – when expected load exceeds the availability of generation capacity. To address this, AEMO has set up a RERT facility.[75] Parties can contract to supply energy (if they have a standby generator) or reduce load during RERT events, which are typically notified a

---

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

[74] https://www.aemc.gov.au/rule-changes/wholesale-demand-response-mechanism

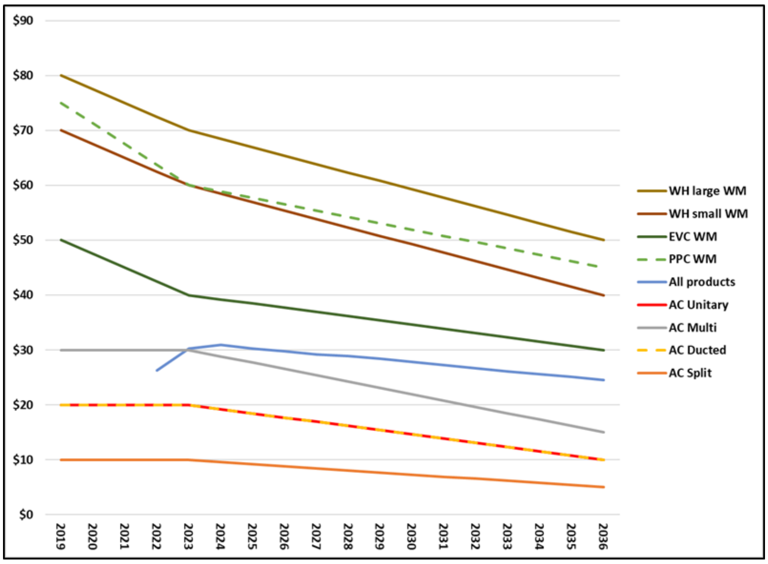
[75] https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Emergency-Management/RERT-panel-expressions-of-interest

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.[76] It is assumed that DR aggregators in those states could bid into the RERT market.

DR could also supply ancillary services to the NEM.[77] 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 8 shows estimated increase in appliance purchase prices, ranging from $80 for large water heaters to $10 for split unit ACs. The weighted average price increase is about $31 per compliant product sold, falling to $25 over time as production volumes increase.

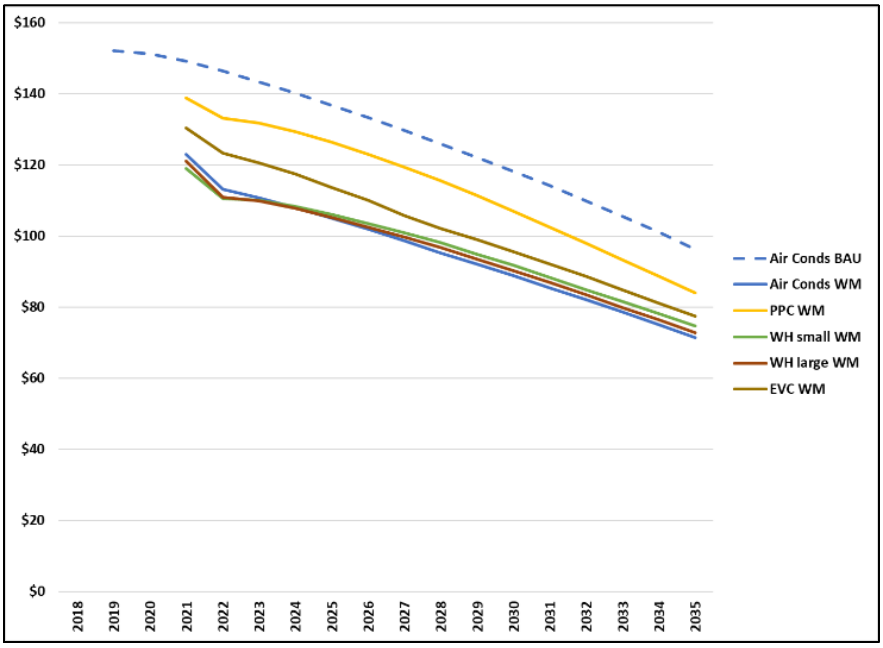
Figure 8. Projected increase in appliance costs



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.[78] For products complying with AS/NZS 4755 Part 3, activation requires the installation of a DRED. 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 9). 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.

[76] This was still below the legislated pool price cap of $14,500/MWh.
[77] *Guide to Ancillary Services on the National Electricity Market*, AEMO April 2015
[78] 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 9. 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 DR-capable 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 22%, 37% and 39% respectively by 2036, compared with 3%, 4% and 5% respectively under the BAU scenario (Option 1). Figure 10 illustrates the Medium activation rate assumptions by product (the others are in Appendix 2).

The minimum activation rates to achieve a benefit/cost ratio of exactly 1.0 (at a 7% discount rate) are also shown in Figure 10. To achieve cost-effectiveness in Australia, at least 5% of the total AC stock needs to be activated by 2036, 11% of the pool pump controller stock, 13% of the water heater stock and 3% of the EV charge controller stock. For New Zealand, the minimum cost-effective activation rates are similar.

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 $25 per activated appliance per year. Some DRSPs may opt for 3G/4G phone connections, costing up to $60 per year, but it is likely that most will use zero-marginal-cost platforms such as the home's existing WiFi router. 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 10. Projected activation rates (Medium and Minimum)

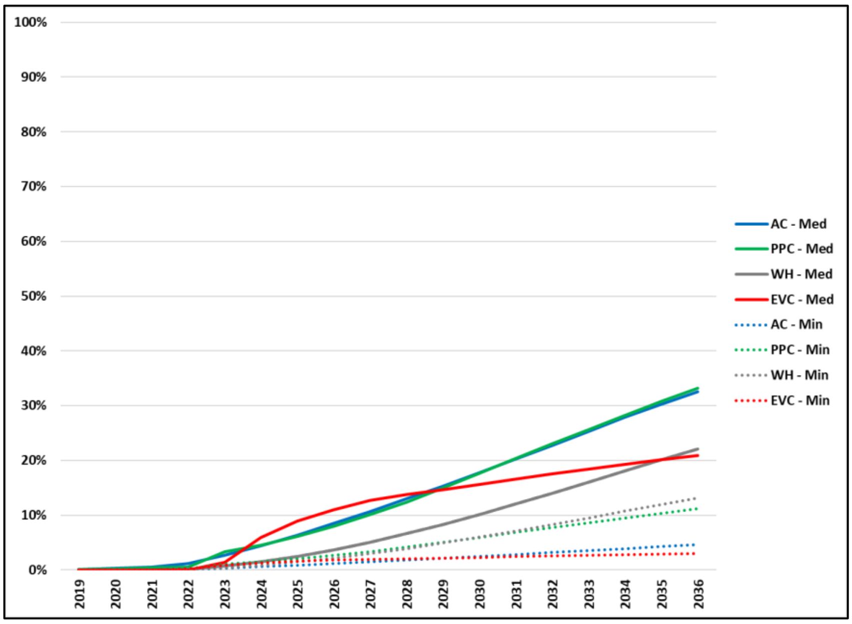
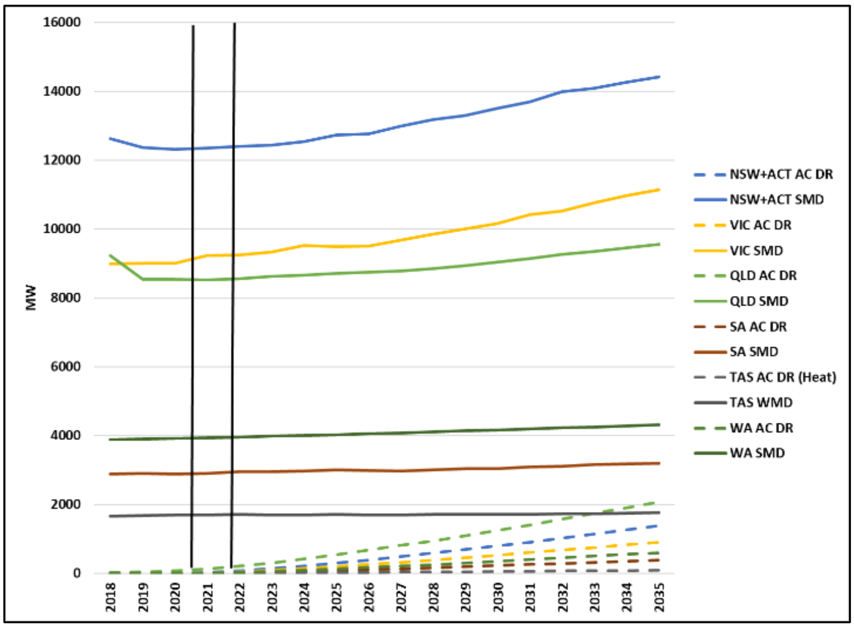


Figure 11. Projected peak demand and impact on peak demand (Medium activation) rates



All compliant products would be capable of DRM 1 (which enables cycling off and on by the remote agent). Some would also be capable of part-load operation (DRMs 2 and 3), either as a mandatory requirement or through commercial decision by manufacturers. 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 load reduction response available, and may increase participation rates if consumers are more inclined to enter a DLC contract with some 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 2,720 MW (Table 10) to 5,040 MW (Table 12), with the likely value around 3,400 MW (Table 6). This is equivalent to 60% of the total projected growth in peak demand on the State and Territory networks to 2036. 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 440 MW (Table 17).

Figure 12 illustrates the NPV of cost and benefits for Australia (at 7% discount rate) under the Low, Medium and High activation scenarios. Table 8 and Table 9 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 appears cost-effective in all jurisdictions apart from the NT and the ACT (Table 10**,** Table 11 and Table 12) because no growth in peak demand is projected.

The proposal is estimated to yield accrued net benefits in the range $1,430 million to $2,800 million net present value (NPV) with the most likely value around $1,870 million, at a benefit/cost ratio of 2.9. This is equivalent to a net benefit of nearly $200 NPV for each Australian household, or nearly $250 NPV for each of the 7.5 million appliances projected to be under DR control by 2036. (This would represent about 27% of the total stock of those appliances.)

For New Zealand, the proposal is estimated to yield accrued net benefits in the range $NZ 202 million to $403 million NPV with the most likely value around $260 million, at a benefit/cost ratio of 2.8. This is equivalent to a net benefit of about $140 NPV for each New Zealand household.

The separate cost and benefits for each appliance are indicated in Table 13 to Table 15 (for Australia) and Table 16 to Table 18 (New Zealand). In all cases, air conditioners account for the majority of the benefits. Wholesale market price, load shifting and reliability benefits amount about 28% of the total benefits in Australia, and network benefits for 72%. In New Zealand, network benefits are 90% of the total.

Figure 12. Projected costs and benefits of the measure at various activation rates, Australia

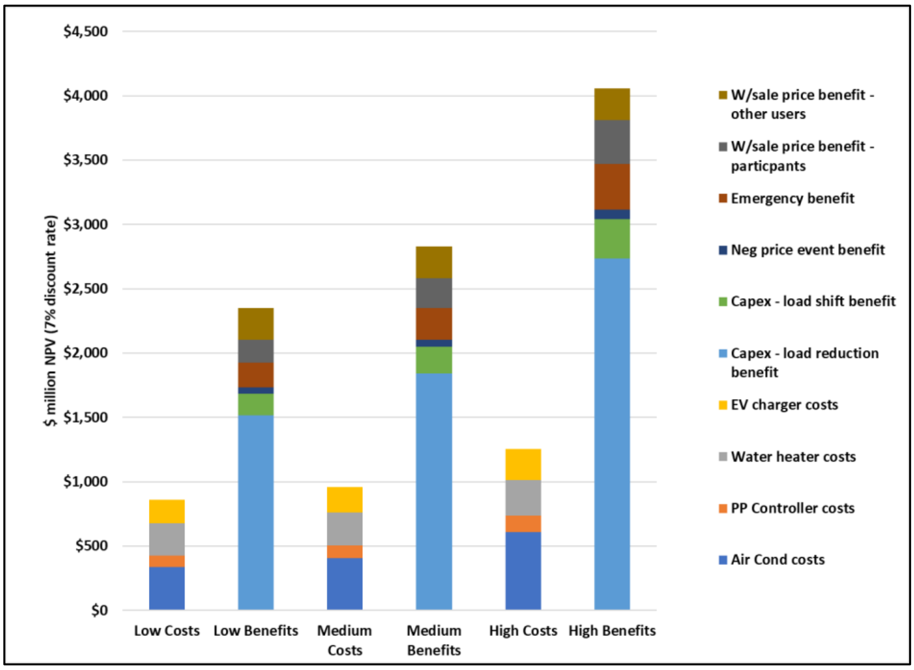


Table 8. Benefit/Cost ratio variations by discount rate and appliance type, Australia

	Medium Activation Discount rate 3%	Medium Activation Discount rate 7%	Medium Activation Discount rate 10%	Low Activation Discount rate 7%	High Activation Discount rate 7%
Air Conditioners	3.4	3.5	3.6	3.5	3.4
PP Controllers	1.9	1.9	1.9	1.7	2.2
Water heaters	1.6	1.5	1.4	1.5	1.8
EV chargers	4.3	4.2	4.1	3.6	5.0
All products	3.0	2.9	2.9	2.7	3.2

Table 9. Benefit/Cost ratio variations by discount rate and appliance type, New Zealand

	Medium Activation Discount rate 3%	Medium Activation Discount rate 6%	Medium Activation Discount rate 10%	Low Activation Discount rate 6%	High Activation Discount rate 6%
Air Conditioners	2.7	2.8	2.7	2.6	3.1
PP Controllers	NA	NA	NA	NA	NA
Water heaters	1.8	1.8	1.6	1.8	2.2
EV chargers	4.4	4.6	4.1	3.9	5.5
All products	2.7	2.8	2.5	2.5	3.3

Table 10. Projected costs and benefits by jurisdiction (low activation)

	Routine DLC Reduction available SMD 2036, MWe (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 $M Net benefit	Without whole-sale price benefit B/C ratio
NSW	771	$264	$403	$139	9.3%	1.5	$67	1.1
Vic	509	$143	$411	$268	17.9%	2.9	$262	1.3
Qld	759	$245	$865	$620	41.5%	3.5	$847	3.1
SA	205	$58	$198	$139	9.3%	3.4	$273	2.9
WA	342	$95	$400	$305	20.4%	4.2	$306	3.7
Tas (WMD)	57	$22	$55	$33	2.2%	2.5	$23	2.0
NT	33	$13	$7	-$5	-0.4%	0.6	-$11	0.2
ACT	44	$18	$14	-$4	-0.3%	0.8	-$6	0.4
Australia	2720	$858	$2,352	$1,493	100.0%	2.7	$1,762	2.2
New Zealand	268	$133	$336	$202		2.5	$171	2.3

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 7% discount rate for costs and benefits 2020-2036; 6% discount rate for NZ

Table 11. Projected costs and benefits by jurisdiction (medium activation)

	Routine DLC Reduction available SMD 2036, 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	
							$M Net benefit	B/C ratio
NSW	990	$300	$491	$191	10.2%	1.6	$56	1.2
Vic	662	$168	$514	$346	18.5%	3.0	$248	1.5
Qld	871	$252	$983	$731	39.1%	3.9	$599	3.4
SA	265	$68	$242	$174	9.3%	3.5	$139	3.1
WA	447	$113	$513	$400	21.4%	4.5	$344	4.0
Tas	68	$24	$62	$38	2.0%	2.6	$26	2.1
NT	42	$15	$8	-$7	-0.4%	0.6	-$12	0.2
ACT	55	$19	$15	-$4	-0.2%	0.8	-$12	0.4
Australia	3400	$960	$2,829	$1,869	100.0%	2.9	$1,388	2.4
New Zealand	444	$147	$407	$260		2.8	$220	2.5

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 7% discount rate for costs and benefits 2020-2036; 6% discount rate for NZ

Table 12. 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	
							$M Net benefit	B/C ratio
NSW	1437	$377	$677	$300	10.7%	1.8	$138	1.4
Vic	965	$220	$723	$504	18.0%	3.3	$385	2.8
Qld	1362	$351	$1,466	$1,115	39.8%	4.2	$948	3.7
SA	386	$88	$340	$252	9.0%	3.9	$210	3.4
WA	652	$149	$738	$590	21.1%	5.0	$518	4.5
Tas	96	$30	$83	$53	1.9%	2.8	$41	2.4
NT	60	$20	$11	-$9	-0.3%	0.5	-$15	0.2
ACT	78	$24	$20	-$4	-0.1%	0.8	-$13	0.5
Australia	5037	$1,258	$4,058	$2,800	100.0%	3.2	$2,211	2.8
New Zealand	637	$179	$581	$403		3.3	$343	2.9

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 7% discount rate for costs and benefits 2020-2036; 6% discount rate for NZ.

Table 13. Projected costs and benefits by appliance, Australia (low activation)

	Routine DLC Reduction available SMD 2036, MWe (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	
							$M Net benefit	B/C ratio
Air Conds	1709	$339	$1,188	$849	56.9%	3.5	$594	2.8
PP Controllers	122	$89	$147	$58	3.9%	1.7	$51	1.6
Water heaters	146	$252	$381	$129	8.6%	1.5	$121	1.5
EV chargers	238	$178	$635	$458	30.6%	3.6	$301	2.7
All products	2214	$858	$2,352	$1,493	100.0%	2.7	$1,067	2.2

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 7% discount rate for costs and benefits 2020-2036

Table 14. Projected costs and benefits by appliance, Australia (medium activation)

	Routine DLC Reduction available SMD 2036, MWe (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	
							$M Net benefit	B/C ratio
Air Conds	2164	$405	$1,420	$1,014	54.3%	3.5	$757	2.9
PP Controllers	318	$102	$192	$90	4.8%	1.9	$80	1.8
Water heaters	292	$252	$381	$129	6.9%	1.5	$121	1.5
EV chargers	626	$201	$837	$636	34.0%	4.2	$430	3.1
All products	3400	$960	$2,829	$1,869	100.0%	2.9	$1,388	2.4

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 7% discount rate for costs and benefits 2020-2036

Table 15. Projected costs and benefits by appliance Australia (high activation)

	Routine DLC Reduction available SMD 2036, MWe (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	
							$M Net benefit	B/C ratio
Air Conds	3288	$610	$2,060	$1,450	51.8%	3.4	$1,797	2.9
PP Controllers	448	$125	$272	$146	5.2%	2.2	$258	2.1
Water heaters	386	$278	$504	$226	8.1%	1.8	$494	1.8
EV chargers	915	$245	$1,223	$978	34.9%	5.0	$921	3.8
All products	5037	$1,258	$4,058	$2,800	100.0%	3.2	$3,469	2.8

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 7% discount rate for costs and benefits 2020-2036

Table 16. Projected costs and benefits by appliance, New Zealand (low activation)

	Routine DLC Reduction available SMD 2036, MWe (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	
							$M Net benefit	B/C ratio
Air Conds	173	$46	$118	$73	35.9%	2.6	$73	2.6
PP Controllers	NA	NA	NA	NA	NA	NA	NA	NA
Water heaters	53	$61	$112	$51	25.3%	1.8	$48	1.8
EV chargers	42	$27	$105	$78	38.8%	3.9	$50	2.9
All products	268	$133	$336	$202	100.0%	2.5	$171	2.3

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 6% discount rate for costs and benefits 2020-2036

Table 17. Projected costs and benefits by appliance, New Zealand (medium activation)

	Routine DLC Reduction available SMD 2036, MWe (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	
							$M Net benefit	B/C ratio
Air Conds	228	$56	$156	$101	38.7%	2.8	$101	2.8
PP Controllers	NA	NA	NA	NA	NA	NA	NA	NA
Water heaters	105	$61	$112	$51	19.7%	1.8	$48	1.8
EV chargers	111	$30	$139	$108	41.7%	4.6	$71	3.3
All products	444	$147	$407	$260	100.0%	2.8	$220	2.5

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 6% discount rate for costs and benefits 2020-2036

Table 18. Projected costs and benefits by appliance. New Zealand (high activation)

	Routine DLC Reduction available SMD 2036, MWe (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	
							$M Net benefit	B/C ratio
Air Conds	334	$75	$230	$155	5.5%	3.1	$155	3.1
PP Controllers	NA	NA	NA	NA	NA	NA	NA	NA
Water heaters	139	$66	$148	$82	2.9%	2.2	$78	2.2
EV chargers	163	$37	$203	$166	5.9%	5.5	$111	4.0
All products	637	$179	$581	$403	14.4%	3.3	$343	2.9

(a) 50% of total MWe of participating DR-capable products. (b) NPV at 6% discount rate for costs and benefits 2021-2036

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 10 to Table 18.

The NPV of net benefits would fall by between about $430 million (at low activation rates) and $590 million (at high activation rates). The B/C rates for Australia would remain above 2.2 in all cases. For New Zealand, excluding the benefits of wholesale price effects would lower net benefits by between NZ $59 million and NZ $32 million, but the B/C ration would remain about 2.3 in all cases.

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%.[79] 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). The number of DR events would most likely be limited under any DR contract.[80]

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 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.

[79] ACCC (2018), p6/398, p203/398

[80] 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 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

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)."[81]

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).[82] 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 them sufficient incentive they would not join, and if they found that the costs exceeded the benefits they could withdraw.

[81] ACCC (2018), p204/398
[82] ACCC (2018) p19/398

6. Consultations and Submissions

Stakeholder Engagement

The industry stakeholders most affected by this proposal have had many years of prior involvement in the issue of demand response. Electricity utilities and the AC industry have actively participated in the drafting of AS/NZS 4755, for which mandatory compliance is proposed, since 2005. The water heater industry, the pool equipment industry and some of the stakeholders in EV charging became involved in the standards development process in 2010. The current composition of the standards committee is indicated in Appendix 1.

A notice regarding COAG Energy Council's agreement of December 2018 to draft a Regulatory Impact Statement for certain electrical appliances to be demand response capable was posted on the www.energyrating.gov.au website in April 2019. The Consultation Paper[83] released on 14 August 2019 was emailed to all the companies and industry associations on the E3 mail list, to those who had registered their interest via the website and to members of the standards committee. Submissions were invited up to 16 September 2019 (later extended to 23 September).

The following public consultation sessions were held:

- Sydney – 26 August 2019;
- Melbourne – 27 August 2019; and
- Wellington – 29 August 2019.

Additional consultation sessions were held for invited consumer and public interest advocacy groups, in Sydney on 26 August 2019 and in Melbourne on 29 August 2019. More than 80 individuals in all attended the sessions.

Submissions on the consultation paper closed on 23 September 2019. Over 40 submissions were received from electricity networks and retailers, air conditioner suppliers, water heater suppliers, demand response product suppliers, the electric vehicle industry, individuals and public interest groups in Australia, and a further 10 from New Zealand. These are listed in Appendix 1.

Many of the stakeholders who attended information sessions and made submissions on the Consultation Paper had also participated in consultations on the previous proposals to mandate DR capability in 2013/14.

Overview of Submissions

Most submissions (even those opposed to mandating AS/NZS 4755 compliance) support the premise that a common, open technical standards framework for DR capability would enable the continued development of DR in Australia's energy markets, particularly with respect to residential and small business consumers.

[83] E3 (2019)

In general, electricity industry stakeholders supported the proposal, more product manufacturers opposed it than supported it, and other respondents, including public interest groups, were strongly in favour. The balance of New Zealand submissions was also in favour, although New Zealand companies reiterated the view of their Australian counterparts.

Table 19 Number of Australian respondents supporting and opposing mandating AS/NZS 4755 compliance

	4755 for ACs		4755 for PPs		4755 for WHs		4755 for EVSEs		DR standards	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Unqualified	18	11	13	7	15	10	12	7	17	2
Conditional	2		2		2	3	7			

Source: See Appendix 1 for expanded summary. Excludes submissions which not express a view

Table 20 Number of New Zealand respondents supporting and opposing mandating AS/NZS 4755 compliance

	4755 for ACs		4755 for PPs		4755 for WHs		4755 for EVSEs		DR standards	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Unqualified	6	1	1		5	1	5	0	6	
Conditional		1				1				

Source: See Appendix 1 for expanded summary.

Electricity Supply Industry

Seven of the nine Australian electricity network operator submissions, including AEMO's, support the proposal to mandate compliance with AS/NZS 4755 for all four products (i.e. Option 3). The other two supported mandating compliance with an open standard, but would prefer other standards to be adopted for some products, specifically OCPP for EV chargers. This is noted as "conditional" support for the proposal in Table 19 and Table 20. DNSPs proposed that home battery controllers, PV inverters and home energy management systems (HEMS) should be added to the scope of the proposal. Two of this group raised incentive payments as a possible supplement rather than alternative.

The New Zealand network companies both supported Option 3.

Electricity retailers, as distinct from DNSPs, were not supportive of Option 3 but did not strongly advocate any other approach. Of the six submissions from this sector, two supported Option 3 but four opposed it, on the grounds that adoption of AS/NZS 4755 would be premature, especially for EV chargers. Among the four, three supported the need for a consistent approach to a DR standard, but without agreement on the direction – some advocated better use of existing controlled load measures (i.e. off-peak) while one advocated unspecified "smart technologies." This group was silent on the question of whether incentive payments to consumers would be a better option.

Manufacturers stated that if compliance is to be mandated, lead times should be a least two and preferably three years from publication of "black-letter law." If this is interpreted as the making of a determination, rather than the publication of a COAG Energy Council decision, implementation could be as late as 2024 or 2025. Such a delay would decrease the economic benefits, and increase the risk of early action by some jurisdictions.

Air Conditioner Industry

Of the nine submissions from the AC industry (in both countries), three companies supported mandatory compliance with AS/NZS 4755 and three opposed it, as did the three industry association submissions. Of those who opposed the proposal, most wanted to retain Option 1 (voluntary compliance) backed by incentives. Most submissions made the point that if compliance was to be mandated, the option should be the 2012 version of AS/NZS 4755.3.1, not the 2014 version as proposed in the Consultation Paper. It was submitted that none of the more than 1,000 models on the market that claim compliance with AS/NZS 4755.3.1 meet the 2014 standard, and that being required to do so at short notice would drive up product costs.[84]

The other main points in AC industry submissions were:

- Product energy efficiency improvements have made DR less urgent;
- The voluntary take up of AS/NZS 4755 to date indicates that Option 1 has been successful (although there is now uncertainty about the validity of some compliance statements);
- Suppliers want to retain the option of complying through installation of an additional component, rather than building the capability into every product shipped (as required in the 2014 version of AS/NZS 4755.3.1);
- DRSPs will not use the capability, and will retain benefits if they do;
- Comfort could be compromised at higher temperature and humidity conditions; and
- Some suppliers requested exemption for Variable Refrigerant Flow (VRF) models.

Following consideration of these submissions, the recommendations regarding ACs have been changed in this Decision RIS. For further flexibility, it is proposed that, for a limited, period air conditioners should have the option of complying with the previous (now withdrawn) version, AS/NZS 4755.3.1:2012, the technical requirements of which are to be included in the GEMS Determination.

Water Heater Industry

All of the electric storage water heaters (ESWH) manufacturers in Australia made submissions, together with their New Zealand subsidiaries and the industry association. Some in the industry are conscious of and keen to promote rapid-storage capability of large ESWHs, but differ on how to do it – whether through more flexible use of the existing off-peak load framework (which is controlled differently in every state: ripple, timeclock or smart meter) or by use of something like AS/NZS 4755.

Most water heater industry submissions favoured Option 2 (incentives). They submitted that Option 1 (BAU) will not be effective in achieving objectives and the labelling part of Option 2 is ineffective without incentives. All industry opposed the Consultation Paper proposal to mandate compliance with every water

[84] This disclosure raises doubts about the statements of AS/NZS 4755.3.1 compliance made by air conditioner manufacturers when registering products on www.energyrating.gov.au. Statements made after 2014 cannot legally refer to the 2012 version, since that was automatically superseded on the publication of the 2014 version.

heater DRM specified in AS/NZS 4755.3.3 or AS 4755.2, but in several cases the opposition was conditional, based their understanding of the content of AS 4755.2.

The objections were:

- DRM 4 (high-temperature storage mode) would require vitreous enamel linings, increasing manufacturing cost and presenting warranty issues, since it would be difficult to monitor the time each unit spends in DRM4 operation; and
- The proposed standards would prevent compliant water heaters from participating in wholesale demand response mechanism under the proposed AEMC rule change, because the standards prevent two-way communications and the AEMC rules will require each unit to verify response.

The second point is based on a misunderstanding of both the standard and the AEMC draft rules. AS 4755.2 includes the option of two-way communication but does not prescribe it. The AEMC draft rule change provides for the AEMO to set the baseline and verification methods for quantifying wholesale demand response. The AEMO is likely to permit methods based on the number of products enrolled, together with statistical evidence of the response obtained in sample groups, without requiring feedback from every product.[85]

With respect to the DRM4, issue, the proposal has been modified to recommend compliance with DRM1 only. Rapid energy storage capability can still be achieved if a DRSP applies DRM1 in advance of peak PV output periods, then releases DRM1 so that the thermostat takes over during high-PV periods. This gives appliance-level control of heating times, which is more flexible than the circuit-level control that is available (in most areas) from manipulating OP heating periods. It means that a wider range of consumers can benefit from water heater DR arrangements, whether or not they are on controlled circuit tariffs.

The water heater industry agreed with the limitation of scope to electric resistance storage water heaters (some other submissions advocated the inclusion of heat pumps and solar-electric types).

Pool Equipment Industry

There was only one submission from a manufacturer of pool pump controllers. It opposed mandating compliance for pool pump controllers, but supported mandating compliance for ACs, water heaters and EV chargers, so that its own proprietary demand response system could control those products. The objection to compliance for pool pump controllers was that restriction of pumping by a DRSP without monitoring of sanitiser levels would present a health risk.[86]

Given the high support among other stakeholders for inclusion of pool pump controllers as a means of bringing on load during excess PV periods, as well as reducing load at peak times, this Decision RIS recommends mandating compliance with DRM1, but delaying the requirement to comply with DRM2 and DRM4 by two years.

As with water heaters, a load-on capability can be exercised if a DRSP applies DRM1 in advance of peak PV output periods, then releases DRM1 so that the pumping commences during high-PV periods (provided the pump controller timer settings call for pumping during that period). With DRM 4, the load-on capability would become available to a DRSP irrespective of the timer settings.

---

[85] AEMO, personal communication, 28 September 2019.

[86] Pool industry representative involved in drafting AS/NZS 4755.3.2 took the view that if the periods of interruption through demand response were restricted to an hour or so and there was an over-ride option the risks would be negligible, since most pool owners run pumps for longer than is necessary to maintain sanitiser levels.

Electric Vehicle Industry

There were submissions from four EV and motor vehicle industry associations (including one from New Zealand) and one charger supplier. There was general agreement on the value of demand response in EV charging, but disagreement with the Consultation Paper on the means to provide it.

Unlike the other products, stakeholders pointed to potentially substitutable international alternatives to mandating AS/NZS4755.3.4, such as *Open Charge Point Protocol* (OCPP), IEC 15118 *Information technology - High-Performance Parallel Interface*, and IEC 61850-90-8 *Communication networks and systems for power utility automation - Part 90-8: Object model for E-mobility*.

Given this, the fact that AS/NZS4755.3.4 is still in draft form and an appendix covering EV chargers has yet to be prepared for AS 4755.2, this Decision RIS recommends an international standard as an additional compliance option, provided that an E3 technical working group determines, by mid-2022, that there is one that provides equivalent capabilities to AS/NZS 4755.3.

Other Submissions

There were submissions from three public interest advocacy group, two DRSP companies, a university, a test and certification company, a battery manufacturer and three private individuals. All of these supported the proposal (Option 3) except for the battery manufacturer, which advocated incentives not tied to any standard, and one individual who advocated that other standards should adopted in place of AS/NZS 4755.

Main Points Raised

The Consultation Paper put 28 questions to stakeholders. The following section presents the responses grouped by the main themes, rather than question by question, as several questions covered the same issues from different perspectives.

Alternatives to Option 3

Option 3 (mandatory DR standards) was the most widely supported option. The only group showing some support for Option 1 (BAU – no new regulations, voluntary compliance backed by ad-hoc incentives) were some AC manufacturers. A few submissions advocated greater emphasis on behavioural DR programs (which are also part of Option 1).

The water heater industry did not think that Option 1 would bring AS/NZS 4755-compliant water heaters into the market.

Regarding Option 2 (encouraging the voluntary adoption of DR appliances), respondents thought that labelling DR capability without incentives would be ineffective. Those who supported Option 2 envisaged a universal incentive scheme to be financed in some way by the electricity industry or by government.

International Standards

The only product for which the relevant industry advocated the consideration of DR standards other than AS/NZS 4755 was EV chargers. That said, other industry groups expressed reservations with aspects of AS/NZS 4755, including:

- The uncertainty regarding the final content of AS 4755.2 (which is still in draft);
- The proposal to mandate DRMs which are optional in the standard; and
- The desire to use an earlier version of the standard.

These matters have been addressed in the recommendations.

International and other national DR standards are further discussed in Appendix 3.

Smart Home Devices

Several submissions mentioned "smart home devices" but each one had a different interpretation of what this meant, and there were different views about whether these represent a realistic alternative or a complement to the proposal. Some suppliers defined their own proprietary standards or products as "smart." The EV industry stated that "smartness" was already being built into EV chargers that complied with existing standards such as OCPP.

There was some agreement on the promise of Home Energy Management Systems (HEMS) to deliver DR, but in most cases through the control of AS/NZS 4755-compliant products. A number of respondents advocated the development of DR standards for HEMS so they could be brought within the scope of the proposal.

Several submissions stated that the incompatibility and diversity of existing "smart" products and systems risked fragmenting the DR market and could not provide DR capability that was reliable enough.

Cost and Benefit Assumptions

Most manufacturers submitted that the product cost impact assumptions in the Consultation Paper were too low. Accordingly, the cost assumptions have either been increased, or retained but with less stringent compliance obligations – fewer DRMs, more compliance options or phasing in of requirements.

The activation cost assumptions were largely validated by the submissions of electricity utilities and DRSPs with actual experience of AS/NZS 4755-based programs. Some submissions pointed out that some methods for communicating with controlled appliances were costly (e.g. 3G/4G connections), so the average annual cost to service participants has been increased. There was very little comment on the activation rate assumptions. One respondent thought they were on the high side but offered no alternatives.

On the value of network-related benefits, one utility respondent questioned the $/kVA assumption in the Consultation Paper, and the value for that State was revised downward accordingly. A recheck of the input assumptions resulted in a downward revision for one other State as well. No submissions questioned the methodology or assumption related to wholesale price and reliability-related benefits.

Several water heater manufacturers agreed that the proposal would create economic benefits, but that DNSPs and DRSPs would retain them and not pass them on to consumers. However, several DNSPs stated that they would pass on the benefits. The water heater industry also questioned the market size assumptions, and these have been reduced.

Time of Use Pricing

None of the electricity suppliers submitted that TOU electricity pricing was necessary for the effectiveness of the proposal. Several commented that the measures would be complementary, and the availability of DR programs could assist consumer acceptance of TOU prices, which as some utilities commented have been low. A few submissions maintained that more widespread TOU pricing would make behavioural DR programs more successful, and increase the impact of Option 1.

Consumer Safeguards

There was widespread agreement that consumers should not be enrolled in AS/NZS 4755-based DR programs without a range of safeguards:

- Clear information at all stages that the decision to participate in a DR program (and to withdraw) is the choice of the consumer;
- Contract offerings from prospective DRSPs to clearly set out conditions, including when and how often DR events can be called, and requiring informed consent;
- Similar information at the point of sale of DR-capable products;
- Some submissions drew attention to the New Energy Tech Consumer Code under consideration by the ACCC, which provides template contracts;[87]
- Specific warnings to vulnerable consumers (e.g. those with health issues) regarding the risks of participation or excluding them from participation (not clear how);
- Protocols for DRSPs and electricity retailers to inform consumers who move into premises where products are DR-activated, and giving them the choice of de-activation (at no cost to them).

There was a range of views on whether consumers must have the ability to over-ride every DR event, and whether they will only participate if they have that option. This is essentially a matter of DR program design and marketing, not a technical issue for AS/NZS 4755-compliant products.

AS/NZS 4755 provides for an optional user override to be incorporated in pool pump controllers, water heaters and EV chargers, but not air conditioners.[88] However, a user override may be incorporated in the DRED that operates an air conditioner.

PeakSmart does not offer its 108,000 participants an event override option, but reports high user satisfaction and a program withdrawal rate of less than 0.2% over 6 years.[89] Some retailer trials of AS/NZS 4755.3.1 compliant ACs have sent advance notice of DR events by SMS, with an opt-out email address or phone number. It was found that opt-out rates were low, but that the consumers sent advance notice were more aware of DR events and somewhat less satisfied than control groups who were not notified.[90]

Given that DR program designers have a range of options to provide consumer choice, opt-out is always a possibility at the program level and can already be (and has been) provided at the event level, the proposed standards appear to be adequate in this regard.

---

[87] https://www.accc.gov.au/public-registers/authorisations-and-notifications-registers/authorisations-register/new-energy-tech-consumer-code

[88] The Standards Committee considered that an on-unit override would compromise the economic value of air conditioner DR because it would make load reductions unpredictable and unreliable when they were most needed, and Remote Agents could offer event opt-out provisions in other ways.

[89] Energex, personal communication May 2019

[90] Ausgrid (2017); AGL personal communication October 2019.

Competition

This was interpreted differently with regard to the range and type of products on the market, and the range and type of DR programs available to consumers. The EV industry felt strongly that product choice would be restricted if AS/NZS 4755 was mandated, since nearly all home EV chargers are imported, and suppliers will withdraw from the Australian and New Zealand markets rather than make special products. This would presumably be addressed if other DR standards were also adopted, as is now recommended.

Almost all electric storage water heaters sold in Australia and New Zealand are locally manufactured (to mandatory AS/NZS heat loss standards) so adoption of another AS/NZS standard should have negligible impact on product choice. The water heater industry did however suggest that imported products might be able to comply at lower cost (if so this would increase competition).

The effect of voluntary AS/NZS 4755 compliance on competition in the AC market has been minimal – brand and model choice appear to be just as wide as before, and the impact on retail prices has been negligible. However, it is possible that mandatory compliance would drive some models from the market. These are no necessarily the low-cost brands, since some of those already offer AS/NZS 4755-compliant models.

With regard to competition in the DR market, there was general agreement that it would increase. Once a uniform DR platform is established the cost barriers to the entry of new DRSPs should fall, and consumers will be able to pursue their interests by moving between DRSPs and energy retailers more easily.

Electricity Market Rule Changes

All submissions that addressed this issue agreed that the proposal and the AEMC's draft wholesale demand response rule changes are complementary and mutually reinforcing. Two of the public interest groups that had made the original rule change request to the AEMC made submission on the Consultation Paper. Both were strongly supportive of the proposal and suggested that the automated DR was essential to the inclusion of small consumers in the wholesale demand response mechanism, which the AEMC is now considering.

Additional Products

Several stakeholders recommended that there should also be DR requirements for PV Inverters within the scope of AS/NZS 4777.2, grid connected electric energy storage systems (including residential scale batteries) within the scope of AS/NZS 4755.3.5 and for HEMS.

7. Implementation and Timing

It is proposed that all ACs, electric storage water heaters and pool pump controllers supplied or offered for supply by a target date would have to comply with either the relevant part or parts of AS/NZS 4755. For EV chargers, it is proposed that units offered for sale after a target date would have to comply with either the relevant part or parts of AS/NZS 4755, or an equivalent standard.

The target implementation dates on the preferred option have been developed in the context of a range of factors:

- The most likely timing of a decision by COAG Energy Council;
- The timing of the necessary GEMS Determinations;
- The time required for product suppliers to design, manufacture or import compliant models – this is less for ACs, where there are already many compliant models, than for the other products, where there are none at present;
- The time needed to finalise the necessary AS/NZS Standards so they can be referenced in GEMS Determinations; and
- In the case of EV chargers, the time required to consider and, if suitable, select an existing Standard as an additional compliance option.

For ACs and electric storage water heaters, which are covered by existing GEMS Determinations for energy efficiency, the measure can be implemented by revised Determinations under the GEMS Act 2012. Product registration systems are also in place for these products.

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 recommendations of the Final Report of the Independent Review of the GEMS Act include that:

> "38. The Commonwealth Government update the GEMS Act to allow for mandatory demand response capability."[91]

The Commonwealth Government response to the GEMS Act Review recommendations will largely determine how quickly DR requirements for pool pump controllers and EV chargers might be implemented via the GEMS Act. Some jurisdictions with imminent network issues requiring more controllable devices in the system may consider an earlier implementation using local regulation.

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.[92] 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

---

[91] GEMS Act review (2019), p 11/92.

[92] 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.

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 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.

8. Conclusions and Recommendations

In December 2018, the COAG Energy Council agreed to re-examine and update modelling that was previously undertaken in 2013/14 quantifying energy network peak cost savings, as well as consider additional benefits outside the scope of the previous work, including reduced wholesale prices to all consumers, emergency management (Reliability and Emergency Reserve Trader) benefits, and benefits from shifting energy load to periods of minimum demand and excess export of rooftop solar PV.

The objectives of government action in this matter are “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.”

A Consultation Paper released in August 2019 considered three options, and assessed the degree to which they could achieve the above objectives:

1. Business as Usual (BAU) – no new regulations;
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.

The Consultation Paper proposed that the DR capability of residential ACs, electric storage water heaters, pool pump controllers and EV chargers should be mandated under the GEMS Act 2012, as requirements to comply with the relevant parts of AS/NZS 4755, *Demand response capabilities and supporting technologies for electrical products*. Compliance with this standard is verifiable by testing randomly selected products, similar to the testing of compliance with minimum energy performance standards.

Public Submissions were invited on the Consultation Paper (as responses to 28 questions). The submissions are summarised in Chapter 6. Following consideration of the submissions, it is concluded that Option 3 remains the preferred option, subject to some modification to accommodate the responses and interests of stakeholders.

Therefore, it is recommended that the COAG Energy Council approve the following compliance requirements and target dates:

1.COAG Energy Council endorses the adoption of nationally applicable, public, non-proprietary standards for demand response for air conditioners (ACs), electric storage water heaters, pool pump controllers and electric vehicle (EV) chargers intended for residential use.

Air conditioners

2. Air conditioners to comply with any of the following standards:

- AS/NZS 4755.3.1:2014; or
- AS/NZS 4755.2 (when published); or
- The equivalent of the superseded AS/NZS 4755.3.1:2012 (for a limited period of 2 years from the Determination).

3. Compliance with three demand response modes (DRM1, DRM2, DRM3) to be required, for all air conditioner types subject to MEPS (excluding portable air conditioners), up to a cooling capacity of 19kW inclusive, registered after 30 June 2023.

5. This option of complying with the equivalent of the superseded AS/NZS 4755.3.1:2012 to be no longer available for products registered after 30 June 2025;

6. A determination to give effect to the above to be made by 1 July 2021.

Electric Storage Water Heaters (Resistive Heating)

7. Electric Storage Water Heaters to comply with either of the following standards:

- AS/NZS 4755.3.3:2014; or
- AS/NZS 4755.2 (when published).

8. Compliance with demand response mode 1 (DRM1) to be required, for electric storage water heaters of 50 to 710 litres (inclusive) nominal capacity subject to MEPS (excluding heat exchange water heaters), registered after 1 July 2023. (Other DRMs are optional).

9. A determination to give effect to the above to be made by 1 July 2021.

Devices controlling swimming pool pump-units

10. Devices controlling swimming pool pump-units (as defined in AS/NZS 4755.3.3:2014) to comply with either of the following standards:

- AS/NZS 4755.3.2:2014; or
- AS/NZS 4755.2 (when published).

11. Compliance with demand response mode 1 (DRM1) to be required, for pool pump controllers supplied or offered for supply from 1 July 2024. (Other DRMs are optional).

12. Compliance with DRM1, DRM2 and DRM3 to be required for pool pump controllers supplied or offered for supply from 1 July 2026.

13. A determination to give effect to the above to be made by 1 July 2022.

Electric Vehicle Charge/Discharge Controllers

14. Controllers capable of managing the charging and/or discharging to the grid of electric vehicle (EVs), that are intended for residential applications and capable of charging at SAE Level 2 or IEC Mode 3, to comply with any of the following standards:

- AS/NZS 4755.3.4 (when published); or
- AS/NZS 4755.2 (when published); or
- an equivalent international standard, if an E3 technical working group determines by mid-2022 that there is one that provides equivalent capabilities to AS/NZS 4755.

15. Compliance with AS/NZS 4755 DRMs 0, 1,2,3,4,5 and 8 to be required (6 and 7 optional), or the equivalents in the other approved standard, for EV chargers supplied or offered for supply from 1 July 2026.

16. A determination to give effect to the above to be made by 1 July 2024.

Additional recommendations

17. COAG Energy Council agrees to the establishment of an E3 Technical Working Group, with membership to be determined by SCO, to consider the matter of an equivalent international standard for EV charge/discharge controllers (in recommendation 14).

18. COAG Energy Council requests Standards Australia to:

- Include an additional appendix in AS 4755.2 to cover EV chargers (based on draft AS/NZS 4755.3.4);
- Expedite completion and publication of AS 4755.2; and
- Expedite completion and publication of AS/NZS 4755.3.4; and
- Prepare a new part of AS/NZS 4755 covering Home Energy Management Systems (HEMS) that are capable of providing demand response.

19. COAG Energy Council agrees to the investigation by E3 of the options, cost, benefits, advantages and disadvantages of requiring demand response capabilities meeting public, non-proprietary standards for:

- Photovoltaic (PV) inverters within the scope of AS/NZS 4777.2; and
- Controllers for grid-connected electrical energy storage systems (including residential scale batteries) within the scope of AS/NZS 4755.3.5.

*****

References

ACCC (2018) Restoring electricity affordability and Australia's competitive advantage; Retail electricity pricing inquiry – Final Report, Australian Consumer and Competition Commission, June 2018

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

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

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

AEMO (2019) Technical Integration of Distributed Energy Resources, Australian Energy Market Operator, April 2019

AEMO (2019) 2019 Electricity Statement of Opportunities, Australian Electricity Market Operator Commission, August 2019.

AGL (2018) NSW Demand Response: ARENA Knowledge Sharing Report, September 2018

ARENA (2018) Demand Response Customer Insights Report, May 2018

ARENA (2019) Demand Response RERT Trial Year 1 Report, March 2019

AS/NZS 3823.2:2013 Performance of electrical appliances—Air conditioners and heat pumps Part 2: Energy labelling and minimum energy performance standard (MEPS) requirements

AS/NZS 4755.1:2017 Demand response capabilities and supporting technologies for electrical products. Part 1: Framework for demand response capabilities and requirements for demand response enabling devices (DREDs)

4755.2 (Public comment draft 2018, unpublished) Demand response capabilities and supporting technologies for electrical products. Part 2: Demand response framework and requirements for communication between remote agents and electrical products

AS 4755.3.1:2012 (withdrawn) Demand response capabilities and supporting technologies for electrical products. Part 3.1: Interaction of demand response enabling devices and electrical products-Operational instructions and connections for air conditioners

AS 4755.3.1:2014 Demand response capabilities and supporting technologies for electrical products. Part 3.1: Interaction of demand response enabling devices and electrical products-Operational instructions and connections for air conditioners

AS 4755.3.2:2014 Demand response capabilities and supporting technologies for electrical products. Part 3.1: Interaction of demand response enabling devices and electrical products-Operational instructions and connections for devices controlling swimming pool pump-units

AS 4755.3.3:2014 Demand response capabilities and supporting technologies for electrical products. Part 3.1: Interaction of demand response enabling devices and electrical products-Operational instructions and connections for electric storage and electric-boosted storage water heaters

AS 4755.3.4 (Public comment draft 2014, unpublished) Demand response capabilities and supporting technologies for electrical products. Part 3.1: Interaction of demand response enabling devices and electrical products-Operational instructions and connections for charge/discharge controllers for electric vehicles

AS 4755.3.5:2016 Demand response capabilities and supporting technologies for electrical products. Part 3.1: Interaction of demand response enabling devices and electrical products-Operational instructions and connections for grid-connected electrical energy storage systems

Ausgrid (2016) Ausgrid Demand Management Hot water load control trials, August 2016

Ausgrid (2017) Ausgrid Demand Management CoolSaver Interim Report, February 2017

Ausgrid (2018) DMIA Annual Report 2017-18, October 2018

CSIRO (2017) Electricity Network Transformation Roadmap: Final Report, Electricity Networks Australia and CSIRO, April 2017

E3 (2013) Consultation Regulation Impact Statement: Mandating 'smart appliance' interfaces for air conditioners, water heaters and other appliances. Equipment Energy Efficiency Committee, 2013.

E3 (2014) Decision RIS: Smart Appliance Interfaces (Unpublished Draft) Equipment Energy Efficiency Committee, September 2014

E3 (2019) Consultation Paper: 'Smart' Demand Response Capabilities for Selected Appliances, August 2019

ENA (2012) Pilots and Trials Report on Smart Metering and Related Matters, Energy Networks Association, 30 June 2012

Energeia (2018) Australian Electric Vehicle Market Study, Prepared by ENERGEIA for ARENA and CEFC, FINAL May 2018

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

GEMS Act Review (2019) Independent Review of the Greenhouse and Energy Minimum Standards (GEMS) Act 2012, Final Report June 2019

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

Productivity Commission (2013) Report on Electricity Network Regulatory Frameworks, April 2013

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

Appendix 1 Consultations and Submissions

Table 21 lists the organisations and individuals that made written submissions on the Consultation Paper and Table 22 list the organisations that registered for the information sessions. Together these list the 77 parties actively involved in the consultation process: 55 in Australia and 22 in New Zealand. Table 23 lists the organisations represented on Joint Standards Australia/Standards New Zealand Committee EL-054, which is responsible for AS/NZS 4755. Table 24 summarises the main responses of Australian submitters and Table 25 summarises the main responses of New Zealand submitters.

Table 21 Submissions received on Consultation Paper

Submission from	Contact
ABB Australia (with Electric Vehicle Council)	Ian Richardson
Actron Air (confidential)	Rui Li
Australian Energy Council (AEC)	David Markham
AEMO	Monica Burkett
AGL	Kurt Winter
AI Group (for Australian Water Heating Forum)	James Thomson
APA Group	Josh Hankey
Airconditioning and Refrigeration Equipment Manufacturing Association (AREMA)	Greg Picker
Australian Sustainable Built Environment Council SBEC	Suzanne Toumbourou
Aust Electric Vehicle Association (AEVA)	Dr Christopher Jones
Australia Institute	Dan Cass
Black Diamond Technologies NZ	John Cavill
Consumer Electronic Suppliers Association (CESA)	Stuart Parker,
Chromagen	Tim Ralston
Citipower, Powercor, United Energy (joint)	Danny Jutrisa
Daikin Australia	Gary Knox
Daikin NZ	Ugur Sertan
Driveelectric NZ	Hannah Henderson
Dux	SIMON TERRY
Electric Vehicle Council (EVC)	Larissa Cassidy
Energex & Ergon Energy (joint)	Aidan Roberts
Energy Efficiency Council	Rob Murray-Leach
Energy Australia (confidential)	Selena Liu
Energy Australia	Selena Liu
Federated Chamber of Automotive Industries (FCAI)	Ashley Sanders
Fujitsu General	Kyle Rafter
Intelligent Automation	Sabur Aziz
Japan Refrigeration and Air Conditioning Industry Association (JRAIA)	Hideaki Kasahara
Martin Gill	Dr Martin Gill
Mitsubishi Heavy Industries	Oscar Xu
Mondo Power	Daniel Brass
Origin Energy	Keith Robertson

Submission from	Contact
Public Interest Advocacy Centre (PIAC)	Douglas McCloskey
Pooled Energy	John Riedl
Power Diverter Australia Pty Ltd (confidential)	Tyler Jackman
Powerco NZ	Andrew Kerr
Rheem	Gareth Jennings
Rheem NZ	Steve Bullock
Rinnai Australia	Leon Bogers
Rinnai NZ	Tim Grey
SA Power Networks	Dr Bryn Williams
Simply Energy	Anthony O'Connell
SP Ausnet	Justin Betlehem
Stiebel Eltron	Dr Raniero Guarnieri
Tasnetworks (confidential)	Laura Jones
Ted Woodley	Ted Woodley
Temperzone NZ	Adrian Kerr
Tesla (Confidential)	Sam McLean
Transpower NZ	Quintin Tahau
Underwriters Ltd (UL)	Dr Johannes Bauer
University of Otago NZ	Helen Viggers
Xtra.co.nz (Consumer advocate)	Molly Melhuish

Table 22 Organisations registered for information sessions that did *not* make submissions

Australia	New Zealand
Mitsubishi Motors Australia	Orion
Mitsubishi Electric Australia Pty Ltd	Major Electricity Users' Group (MUEG)
Kirby HVAC&R Pty Ltd	Energy Management Association of NZ (EMANZ)
Swimming Pool and Spa Association (SPASA)	Independent Electricity Generators Association (IEGA)
Electrical Trades Union	Fujitsu General NZ
Fluidra Australia	TransNet NZ
VIPAC Engineers and Scientists Ltd	Electricity Authority
Jemena	Worksafe NZ
Atlantic Australasia Pty Ltd	Embrium Holdings Limited
ACOSS	Easy Warm Limited
Electricity Consumers Association (ECA)	Project Solar
Renew	Contact Energy

Excludes government departments that participate in E3 and those who registered as individuals. Not all who registered attended.

Table 23 Organisations represented on Joint Standards Australia/Standards New Zealand Committee EL-054, Remote Demand Management of Electrical Products

Nominating Organisation	Role
AREMA	Participating Member
AREMA	Awaiting Assignment
AEC	Participating Member
AEMO	For Information Only
AEMO	Participating Member
AI Group	Participating Member
AI Group	Participating Member
AI Group	Participating Member
AI Group	Participating Member
Australian Institute of Refrigeration Air Conditioning and Heating (Inc)	Participating Member
Australian Institute of Refrigeration Air Conditioning and Heating (Inc)	Participating Member
Clean Energy Council	Participating Member
CESA	Participating Member
Consumers Federation of Australia	For Information Only
Consumers Federation of Australia	Participating Member
CSIRO	Participating Member
CSIRO	Participating Member
Department of the Environment and Energy (Australian Government)	For Information Only
Department of the Environment and Energy (Australian Government)	Awaiting Assignment
Department of the Environment and Energy (Australian Government)	Chairperson
Department of the Environment and Energy (Australian Government)	Awaiting Assignment
Electrical Engineers Association of NZ Inc	Participating Member
Energy Efficiency & Conservation Authority of New Zealand	For Information Only
Energy Networks Australia	Participating Member
Energy Networks Australia	Participating Member
Energy Networks Australia	Participating Member
Energy Networks Australia	Participating Member
Energy Networks Australia	Awaiting Assignment
Heating, Ventilation and Air Conditioning New Zealand	Participating Member
International Copper Association Australia	Participating Member
Standards New Zealand	Ex-Officio
Swimming Pool and Spa Association of Australia Ltd	Participating Member

“Awaiting Assignment” means position not currently filled. “For Information Only” positions are non-voting.

Table 24 Summary of positions – Written Submissions (Australia)

		4755 for ACs		4755 for PPs		4755 for WHs		EV Chargers	Other products; comments	Need DR standard?
Category	Name	Yes	No	Yes	No	Yes	No			
Elec networks	AEMO	1		1		1		4755	Inverters, ESS, HEMS	Yes
	Citipower (a)	1		1		1		4755		Yes
	PowerCor (a)	1		1		1		4755		Yes
	United Energy (a)	1		1		1		4755		Yes
	Energex (b)	1		1		1		Conditional on intl. stds.		Yes
	Ergon (b)	1		1		1		Conditional on intl. stds.		Yes
	SAPN	Cond		Cond		Cond		Prefer OCPP		Yes
	SP Ausnet	1				1		4755	ESS, PV	Yes
	Tasnetworks	Cond		Cond		Cond		Prefer OCPP	ESS	Yes
9	Total (unconditional)	6	0	6	0	6	0			
Elec retailers	AEC		1		1		1	Need a WG to resolve std.		Yes
	AGL		1		1		1	Need a WG to resolve std.		Yes
	EnergyAustralia	1		1		1		4755	Inverters, ESS	Yes
	Mondo Power	1		1		1		4755		Yes
	Origin		1		1		1	Need a WG to resolve std.		Yes
	Simply Energy		1		1		1	No		No
6	Total (unconditional)	2	4	2	4	2	4			
AC industry	ActronAir		1						If mandated, 2012V	
	AREMA		1						Voluntary, 2012V	
	CESA		1				1		Voluntary, 2012V	
	Daikin		1						Voluntary, 2012V	
	Fujitsu General	1							Mandate 2012V	
	JRAIA		1						Incentives, 2012V	
	Mitsubishi HI	1							If mandated, 2012V	
7	Total (unconditional)	2	5	0	0	0	1			
WH industry	AIG AWH Forum						Cond		See redraft of 4755.2	
	Chromagen						Cond		Sees logic of storage	
	Dux						1			

		4755 for ACs		4755 for PPs		4755 for WHs		EV Chargers	Other products; comments	Need DR
Category	Name	Yes	No	Yes	No	Yes	No			standard?
	Rheem						Cond		See redraft of 4755.2	
	Rinnai						1			
	Stiebel Eltron						1			
6	Total (unconditional)	0	0			0	3			
EV Industry	ABB							No; OCPP, IEC 14543.3, Behav		
	Aust EV Assoc							No; OCPP, IEC 15116, 61850		
	EV Council							No; OCPP, IEC 15118, 61850		
	FCAI							No; OCPP, IEC 15118		
4	Total (unconditional) l									
DRSP products	Intelligent Auto	1		1		1		4755	ESS, HEMS	Yes
	Pooled Energy	1			1	1		4755		
	Power Diverter	1								
3	Total (unconditional)	3	0	1	1	2	0			
APA Group	Gas utilities								Pro-gas use	
ASBEC	Public Interest	1		1		1		4755		Yes
Australia Institute	Public Interest	1		1		1		4755		
M. Gill	Private individual		1		1		1	No		
PIAC	Public Interest	1		1		1		4755		Yes
Tesla	Battery Mfr		1		1		1	No		No
UL	Test & cert								Cyberscurity paper	
E. Woodley	Private individual	1		1		1		4755		Yes
9	Total (unconditional)	4	2	4	2	4	2			

(a),(b) Joint submission, considered to represent the views of each of the parties.

Table 25 **Summary of positions – Written Submissions (New Zealand)**

Category	Name	4755 for ACs Yes	4755 for ACs No	4755 for PPs Yes	4755 for PPs No	4755 for WHs Yes	4755 for WHs No	EV Chargers	Other products; comments	Need DR standard?
Black Diamond	AC supplier		Cond							Yes
Daikin NZ	AC supplier		1							
DriveElectric	EV Ind Assoc							4755		
Melhuish	Private Individual	1				1		4755		Yes
Otago University	University	1				1		4755		Yes
Powerco	Elec DNSP	1				1		4755		Yes
Rheem NZ	WH Mfr						Cond		Subject to 4755.2	
Rinnai NZ	WH Mfr	1					1			Yes
Temperzone	AC Mfr	1				1			Subject to 4755.2;	
Transpower	Elec TNSP			1		1		4755	Electric Energy Storage Systems	Yes
10	Unconditional	5	1	1	0	5	1	5		6

Appendix 2 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."[93]

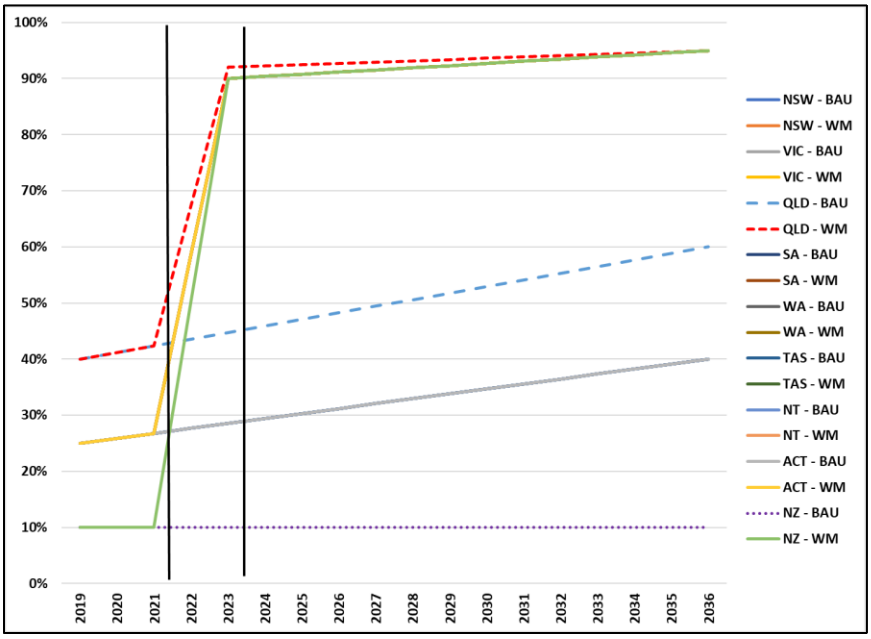
The only option likely to lead to the installation of a critical mass of smart appliances within a predictable time period is Option 3 – requiring mandatory compliance with AS/NZS 4755 for all products sold after a given date. Therefore, this is the only option for which costs and benefits can be projected, and compared with the BAU case. For the purposes of cost-benefit modelling it is assumed that:

- An intention to proceed is announced in early 2020; and
- For air conditioners and water heaters: compliance required from July 2023 (Figure 13)
- For pool pump controllers and EV chargers: compliance required from July 2024.

Experience from the introduction of appliance MEPS indicates that compliance begins to ramp up well before the mandatory compliance date, since manufacturers need to introduce compliant models progressively rather than all at the same time.

[93] ACCC (2018), p230/398

Figure 13 Projected Rates of Compliance with AS/NZS 4755, Air Conditioners (BAU and WM)



Value of Network Benefits

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 meet its projected contribution to peak demand, if 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 in effect anticipated by the network operator (as part of its capital and infrastructure planning, for which it seeks revenue approval from the AER). The costs are then 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 in each state has been calculated from the data submitted by DNSPs for the current round of AER distributor price determinations (Table 26).

Table 26. Estimated investment required per marginal peak load kW

	$/kW (a)	5-yr growth in network SMD(b)	Period of Determination	Previous $/kW (c)	Period of Determination
NSW	1017	1059	2020-24	3076	2011-15
Vic	1050	997	2016-20	787	2011-15
Qld	3614	190	2021-25	3503	2011-15
SA	625	77	2021-25	2391	2011-15
WA	3080	100	2019-24	3163	NA
Tas	1925	25	2019-24	508	2013-17
ACT	203 (d)	0	2019-24	1506	2010-14
NT	125 (e)	0	2019-24	3503	NA
NEM – weighted	1313			2502	
NZ	1942 (g)	NA	NA	NA	NA

(a) Includes 25% allowance over marginal distribution capex for transmission and generation investment. (b) Sum of each DNSP's projected growth in SMD (c) E3 (2014). Includes 35% allowance over distribution cost for transmission and generation investment. (d No load growth, but marginal transmissions cost set equal to NSW. (e) No load growth, but marginal transmissions cost set equal to SA. (g) Based on EECA, personal communication.

The 5-year growth in Summer Maximum Demand (SMD) is the sum of the increases in SMD of the 5-year forecasting period projected by each DNSP in that jurisdiction (NSW has 3 DNSPs, Victoria has 5, Queensland has 2, SA, NT and ACT have one, and the WA values are for the South West Interconnected System (SWIS)). In multi-DNSP states, the five-year growth in SMD projected by AEMO over the same period is significantly lower than the sums of DNSP growth projections in Table 26, because the peak demands on each network occur at different times. However, each network has to plan to accommodate its own peak demand, so that is the best measure of the marginal cost.

In the same way as different DNSPs have different marginal $/kVA costs, so different regions and individual substations within DNSP networks also have different marginal cost. In areas with spare capacity and/or low load growth, the marginal cost of more load is zero. In other areas, the costs are well above the average. It is expected that although the rate of growth in the distribution of DR-capable appliances will be fairly even, since it will be determined by appliance replacement and purchase rates, there will higher rates of activation in areas subject to network stress. DNSPs running DR programs will concentrate their consumer recruitment efforts there, or offer higher incentives to independent DRSPs for activations in those areas. (Electricity retailers will have less spatially-determined DR incentive structures).

The weighted average $/kW for the NEM is about 48% 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 projected peak demand growth and network augmentation capex in most NEM regions, although other capex claims not directly related to demand growth remain high.

Table 27 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 $1,170 for an air conditioner about $130 for a large water heater.

Table 27. Load reduction available from participating appliances

	Average kW (electric) at full load	% powered and operating at SMD (diversity)	Diversified kW per unit at time of peak demand 2020	Capital investment to accommodate each 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 2036 SMD	SMD 0.89 WMD 0.93	$ 1,170	SMD 0.45 (b) WMD 0.47
Pool pumps switched by controllers	0.9	50%	SMD 0.45	$ 590	SMD 0.9 (c)
Electric storage water heaters – small	3.6	100% powered, but not all heating	SMD 0.4 (d) WMD 0.6(d)	$ 525	SMD 0.4 (c) WMD 0.6 (c)
Electric storage water heaters – large	3.6	16% powered, rest on restricted tariffs	SMD 0.1 (e) WMD 0.3 (e)	$ 130	SMD 0.1 (c) WMD 0.3 (c)
EV Chargers	9.6	100% powered, but not all charging	SMD 0.26 (2020)(f) SMD 0.57 (2036)(f)	$ 750	SMD 0.26

(a) Average $/peak kW in NEM region multiplied by average diversified kW/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. Energex (2014) reported on 44 AS/NZS 4755.3.1-compliant ACs participating in its PeakSmart program during a DRM3 event (calling for 25% load reduction) in 2014:

- 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[94];
- 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).

DRM2 would produce greater load reductions than DRM 3. Ausgrid's "Coolsaver" trials on the NSW Central Coast in in 2016/17, with over 100 participating AS/NZS 4755 air conditioners, reported that DRM2 activations decreased the average customer load by around 1.5 kW whereas DRM 3 decreased the load initially by around 1.0 kW (Ausgrid 2017).

More recent trials by other utilities have returned reductions of 1.6 to 1.8 kW during DRM3 events, but it was thought this could have been due to incorrect configuration in some air conditioners, leading to a DRM1 response (no load) to a DRM3 signal. It was estimated that a correct DRM3 response by all ACs would have led to a 0.6 kW reduction, indicating that the DRM 2 estimate in Table 27 is conservative.

Other Benefits

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

[94] This is the main difference between the 2012 and 2014 versions of AS/NZS 4755.3.1. The 2014 version would require a load reduction with reference to the operating conditions at the time, not to a fixed reference value.

response mechanism rule changes currently being considered by the AEMC[95] 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 DRM4, 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 RERT facility.[96] Parties can contract to supply energy (if they have a standby generator) or reduce load during 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.[97] It is assumed that DR aggregators in those states could bid into the RERT market.

DR could also supply ancillary services to the NEM.[98] 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.

Value of Other Benefits

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 AEMC 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

95 https://www.aemc.gov.au/rule-changes/wholesale-demand-response-mechanism

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

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

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

reflected by estimating the total energy demand that can be presented to the grid by products activated through DRM4, and assigning a value to that energy.

Emergency response occurs under the opposite conditions – when expected load exceeds the availability of generation capacity. To address this, AEMO has set up a RERT facility. Parties can contract to supply energy (if they have a standby generator) or reduce load during 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. It is assumed that DR aggregators in those states could bid into the RERT market.

DR could also supply ancillary services to the NEM. 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.

Present Value of Net Benefits

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 28. 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 (at the time of activation, per DR event or both), 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:

- 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 DR program (assumed to occur simultaneously). This may be at the time of appliance purchase or later. Activation costs will generally be lower at the time of installation, because no extra service call will be necessary (for AS 4755.2 products, remote activation without a service call may also be possible);
- 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; and
- The value of other benefits (wholesale price reductions, load shifts and bidding DR into the RERT market) accrue in each year that DR is exercised for that purposes, and depend on the number of hours invoked.

The NPV (at June 2020, i.e. the start of FY 2021) of the stream of future costs and benefits accruing over the period 2020-2036 is then calculated using the range of discount rates specified by the Office of Best Practice Regulation (OBPR): 7%, with sensitivity testing at 3% and 10%. For New Zealand, the central discount rate is 6%.

Some studies treat the value of avoided investment in infrastructure as an annual benefit[99] but the two approaches are essentially equivalent, once allowance is made for discount rates and the duration of the impact of the investment-avoiding measure. It is necessary to assume that the effect of the demand-side investment-avoiding strategy is accurately projected and that it is implemented as planned – just as it is necessary to assume the same for supply-side infrastructure investments.

Table 28. Demand response costs and benefits quantified in this RIS

Electrical Products	Costs			Benefits							
	Interface costs	Connection & activation costs	Annual cost of servicing part-icipants	Reduce summer peak	Reduce winter peak (a)	Reduce w/sale price to part-icipants	Reduce w/sale price to other users	Reliability & 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 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 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 five-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 the COAG Energy Council adopt the proposal in early 2020, 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.

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

Product Sales Projections and Cost Impacts

Adding DR capability to products will impose additional design and manufacturing costs, which will be passed on in every product purchase. Figure 8 shows estimated increase in appliance purchase prices, ranging from $80 for large water heaters to $10 for split unit ACs. Across all products covered by the proposal, the weighted average price increase is about $31 per compliant product sold, falling to $25 over time as production volumes increase.

The total additional costs depend on the number of compliant products that will be purchased. Figure 14 illustrates the projected number of air conditioner sales in each market segments covered by this proposal, and Figure 15 illustrates the total new electrical load that will be added by these ACs. It also shows the electrical load of the units of higher capacity than those covered in the proposal, indicating that the great majority of demand potential is available from products below 20kW cooling capacity.

Figure 16 illustrates the projections of sales of electric storage water heaters in Australia and New Zealand (it excludes heat pump and solar-electric water heaters, which are outside the scope of the proposal). Figure 17 illustrates projected pool pump controller sales by Australian State and Territory (New Zealand does not propose to mandate DR for this product).

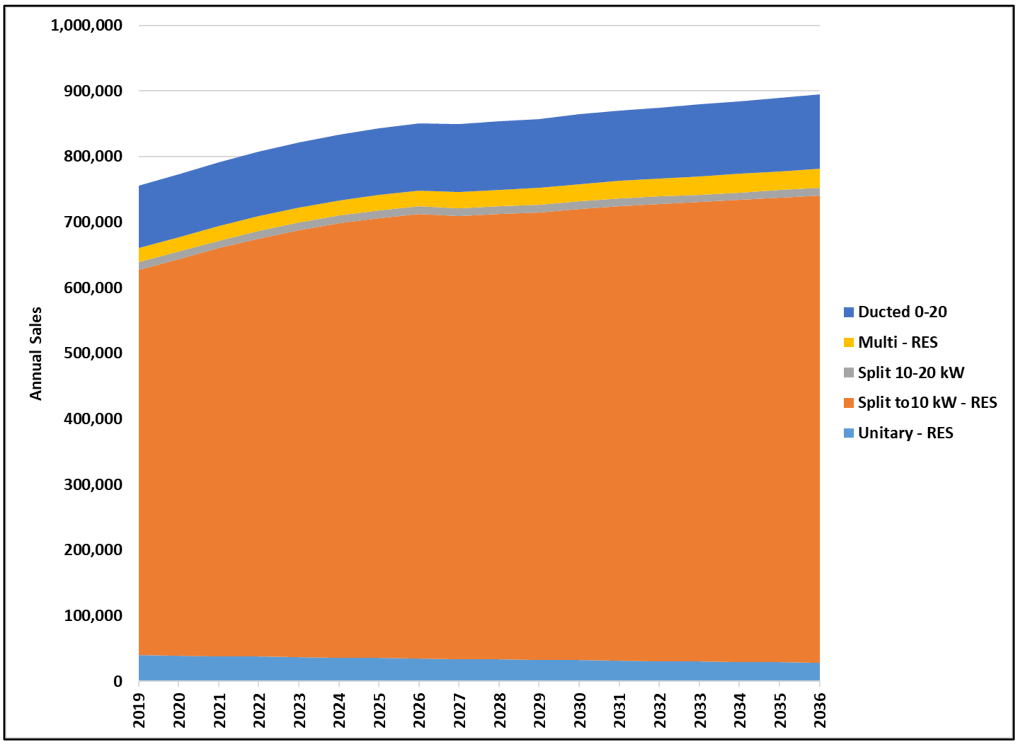
Figure 18 shows the projected ownership of small EVs per household in Australia and New Zealand. It corresponds to the "moderate intervention" EV uptake scenario published in Energeia (2018). This study was used by AEMO to forecast the impacts of EV charging on peak demand in each NEM State.[100] Dividing the projected EV impact on MD by the number of EVs in those States gives an average SMD contribution per EV, as illustrated in Figure 19 (the New Zealand average is assumed to match Victoria, the ACT average to NSW and the WA and NT averages to SA). The average contribution per EV (0.04 in Tasmania to 0.26 kW in Queensland in 2019) is much less than the average residential charge controller capacity (9.6 kW), because:

- Not all EVs will be connected to the home chargers and charging at the same time; and
- About 22% of the energy to charge small EVs will be supplied by commercial chargers (Energeia 2018, p93/103), presumably during the day and outside peak hours.

As EV numbers rise, do does the probability that some of the charging of each EV will occur during peak periods, so the average kW contribution per EV increases over time.

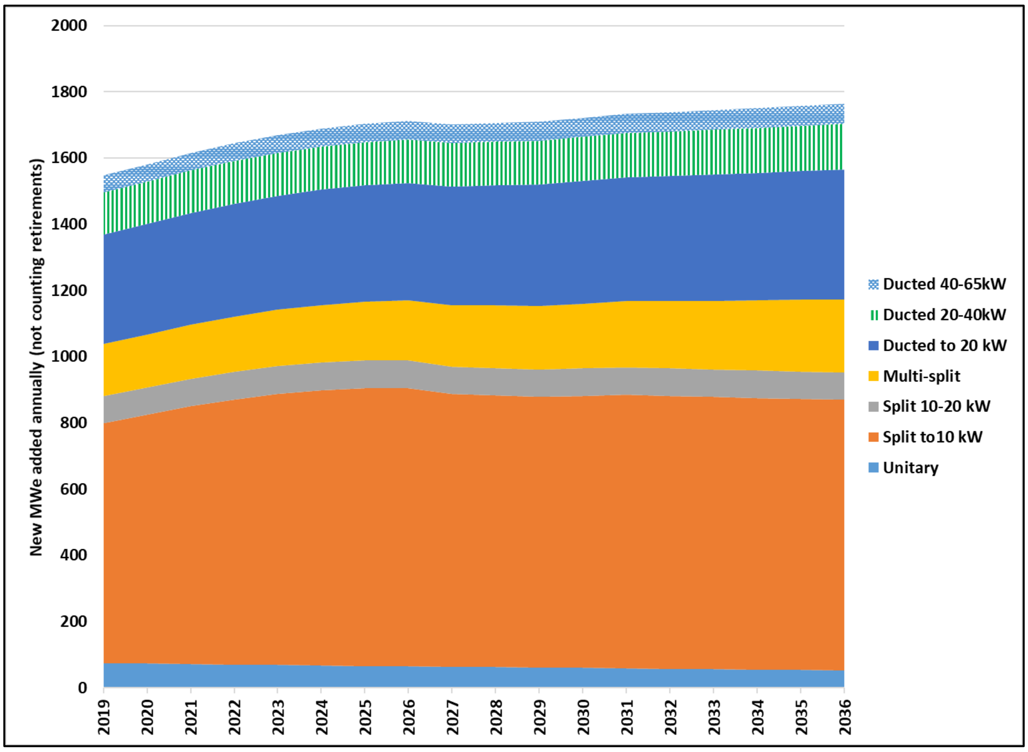
[100] http://forecasting.aemo.com.au/ The 2018 ESOO Electricity Maximum Demand Electric Vehicles values were used in this analysis. The updated 2019 ESOO Electricity Maximum Demand Electric Vehicles are nearly identical.

Figure 14 Projected air conditioner sales, Australia



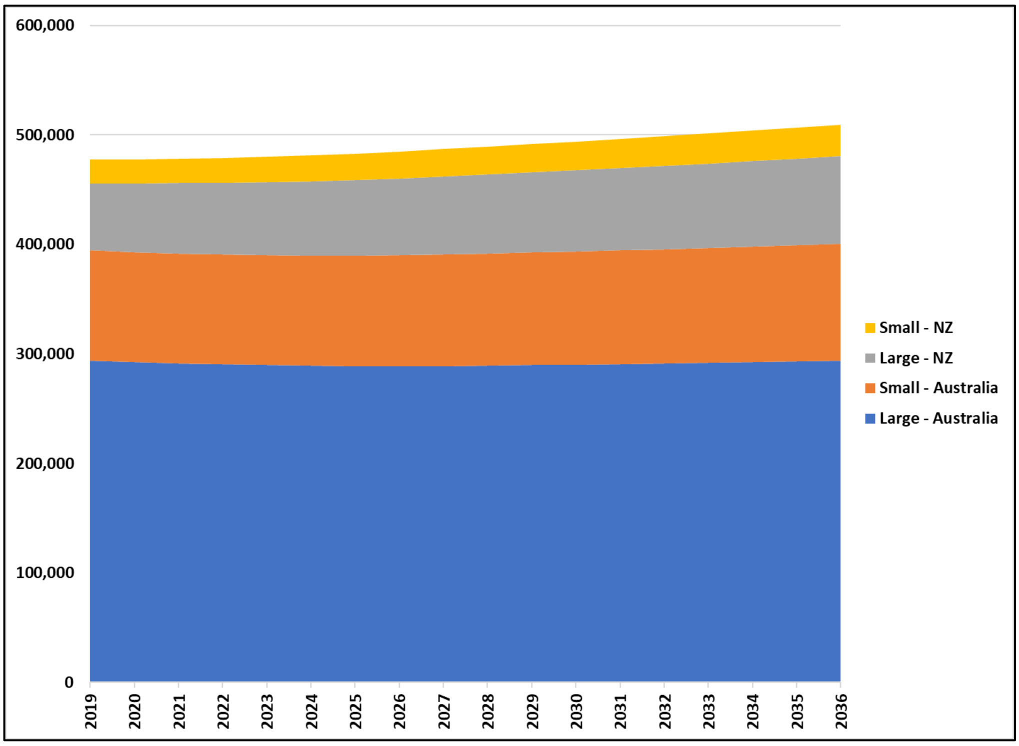
Source: AC Stock Sales V2.xlsx

Figure 15 Projected electrical load of new air conditioners, Australia



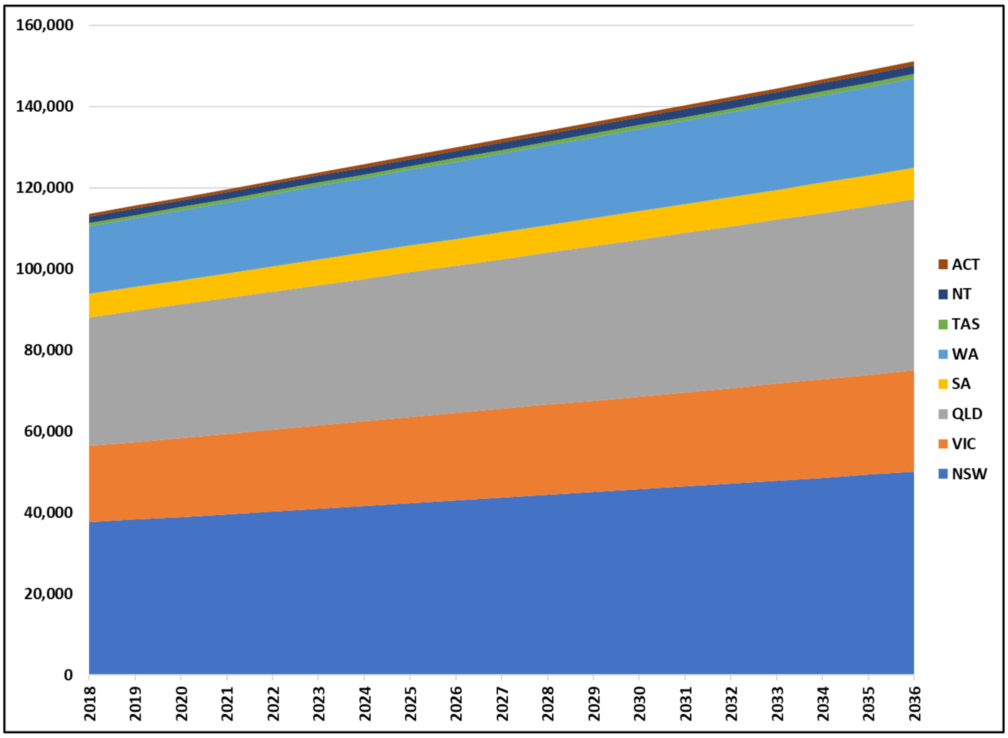
Source: AC Stock Sales V2.xlsx. Electrical load at MEPS rating cooling capacity.

Figure 16 Projected Electric Storage Water Heater Sales, Australia and New Zealand



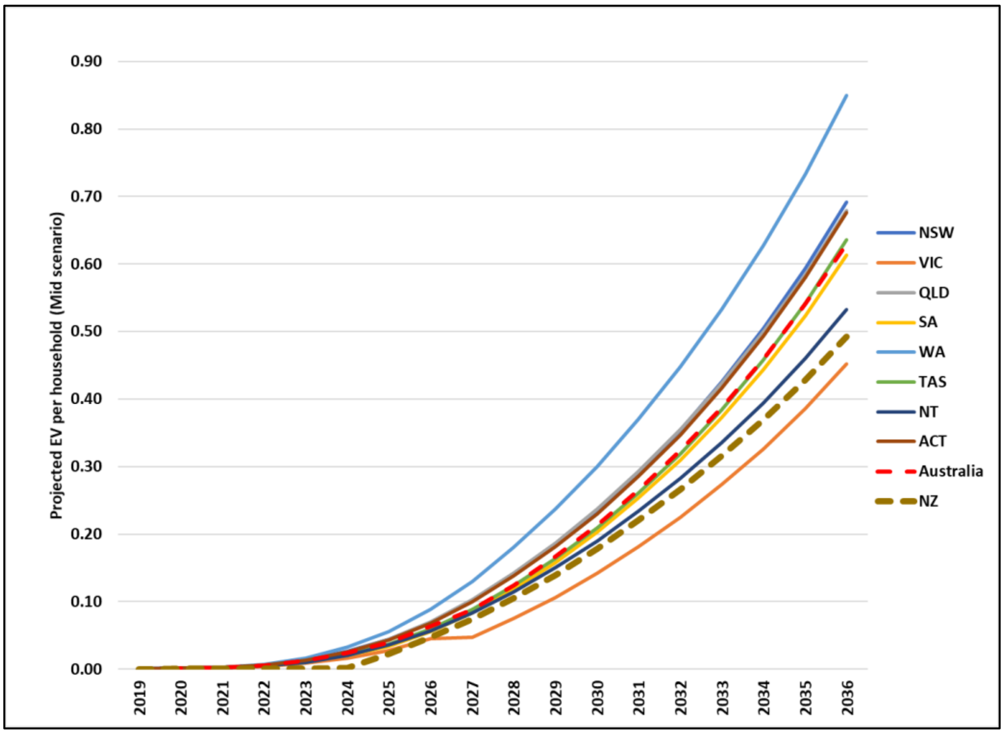
Source: DR RIS Model 2019 Macro V5.xlsx

Figure 17 Projected Pool Pump Controller Sales, Australia



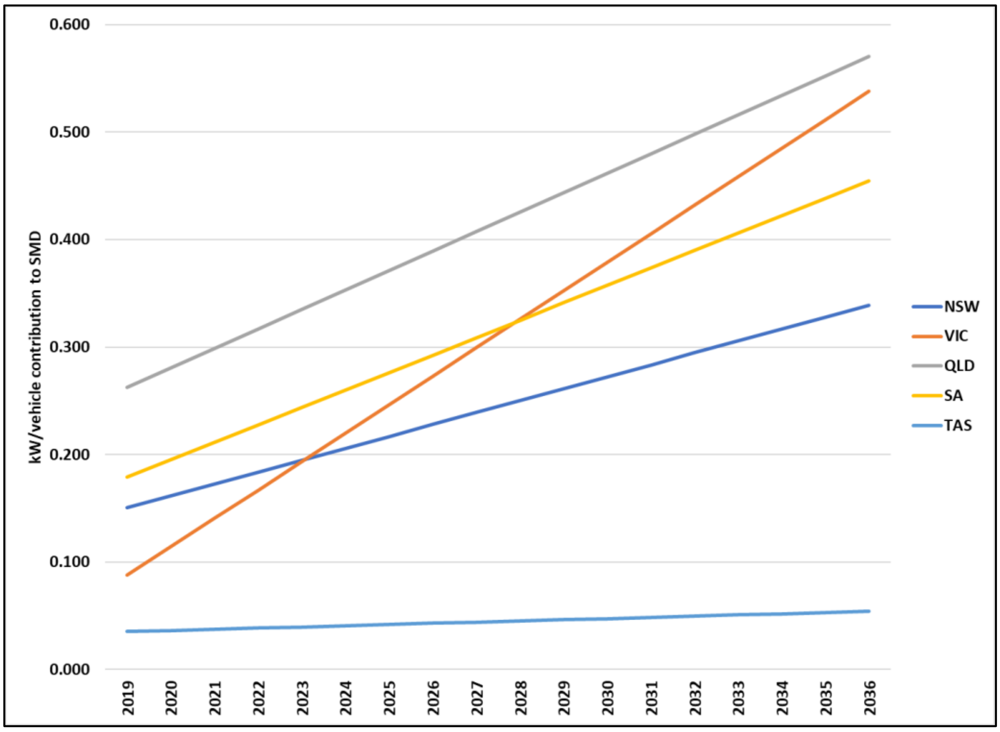
Source: DR RIS Model 2019 Macro V5.xlsx

Figure 18 Projected Electric Vehicle Ownership per Household



Source: Vehicle numbers from Energeia (2018, p82/103) divided by ABS household number projections

Figure 19 Projected Contribution of each light EV to Maximum Demand



Source: EV charging impacts on MD (50% POE) projected by AEMO at http://forecasting.aemo.com.au/ divided by number of EVS. Smoothed by linear regression

Activation Costs and Scenarios

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.[101] For products complying with AS/NZS 4755 Part 3, activation requires the installation of a DRED. 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 9).

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.

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 108,000 air conditioners enrolled since the beginning of the PeakSmart program.[102]

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. Figure 20 illustrates these scenarios for Australia as a whole, built up from separate projections for each jurisdiction. The projected 2036 activation rates for each product type are summarised in Table 29.

The plausibility of the activation 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. 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.[103]

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

[101] 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.

[102] Energex, Personal communication 3 May 2019

[103] Queensland regions compared, Census 2016, Queensland Government Statisticians' Office, 2017

in the cost-benefit analysis. 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 any other DR program offers incentives for post-installation activations of AS/NZS 4755 products, so it is not possible to test those assumptions against actual data.[104]

Figure 20 Projected activation rates (High, Medium. Low and Minimum)

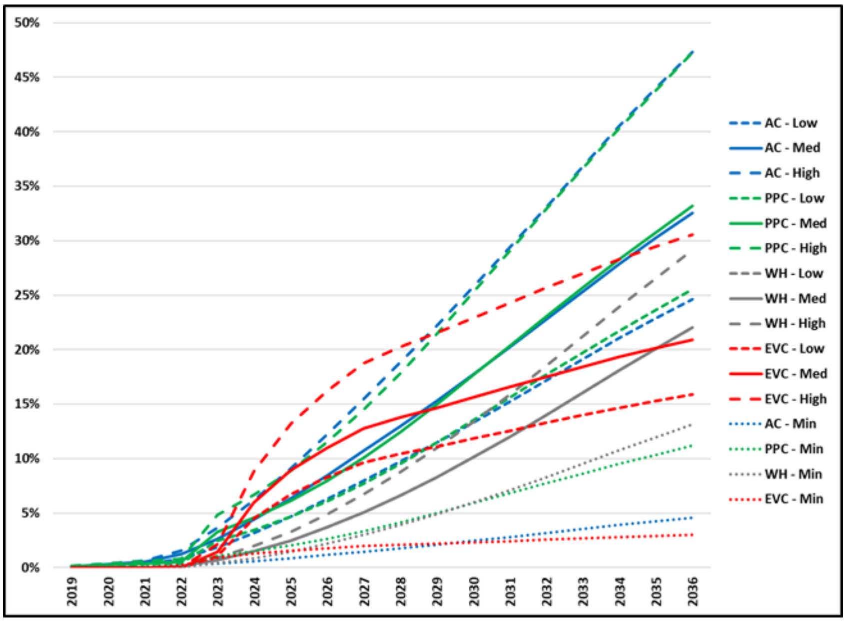


Table 29 Projected High, Medium Low Activation Rates in 2036

	Low	Medium	High
AC - BAU	4.9%	7.8%	9.5%
AC - WM	24.6%	32.6%	47.3%
PPC - BAU	3.8%	4.8%	7.3%
PPC - WM	25.5%	33.2%	47.2%
WH - BAU	0.0%	0.0%	0.0%
WH - WM	22.1%	22.1%	29.2%
EV - BAU	0.0%	0.0%	0.0%
EV- WM	15.9%	20.9%	30.6%
All Prods - BAU	2.5%	3.9%	4.8%
All Prods - WM	21.6%	27.2%	39.1%

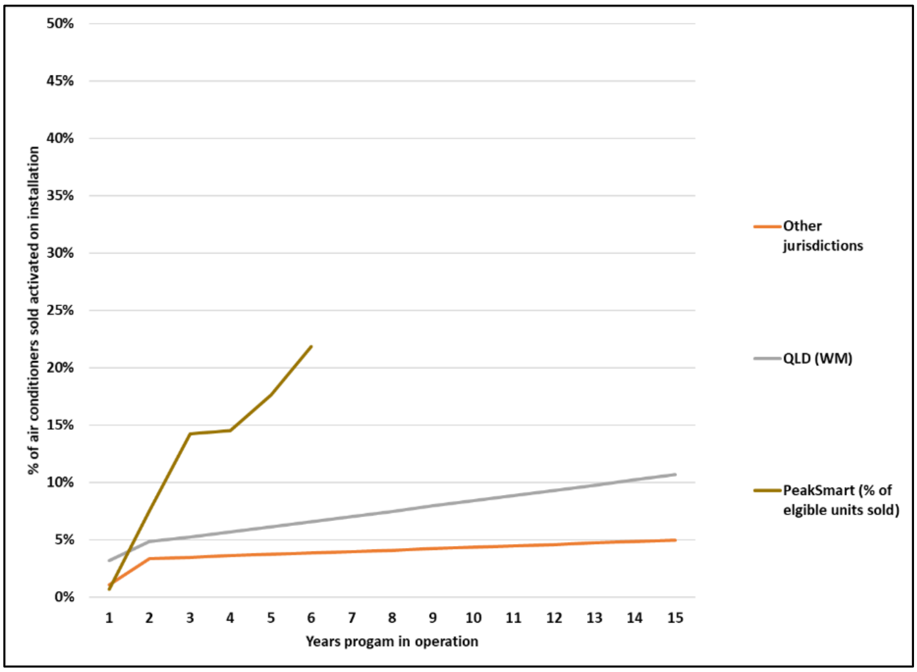
Source: Figure 10. (a) Minimum activation rates required to achieve cost-effectiveness (against zero BAU take-up)

The number of total annual AC activations required to achieve the Medium take-up rates in Figure 20 are illustrated in Figure 22. Activations on installation are shown separately from post-installation activations. The trends depart from smooth curves in the later 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

[104] 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.

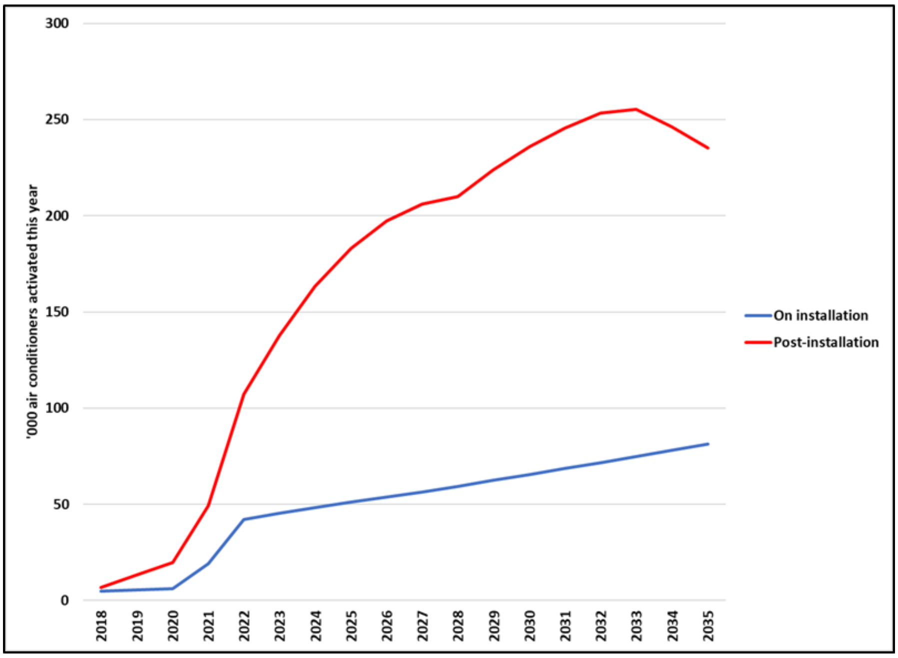
activations in Australia would be about 320,000 per year. Annual AC sales are projected to reach 1.03 million in 2035, and the total AC stock is projected to reach 13.9 million. In this context, the projected activation rates seem feasible.

Figure 21. 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.

Figure 22. Number of installation and post-installation air conditioner activations, medium activation rates



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.

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 kW per unit at time of peak demand" per activated unit in Table 27). This corresponds to the total load reduction from issuing DRM 1 commands to all activated products during SMD or WMD; and
- 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 11 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 approach 22% of summer maximum demand in Queensland (Figure 23). The routine (i.e. non-emergency) load reduction available across all jurisdictions would be equivalent to over 50% of the total projected growth in peak demand on the State and Territory networks to 2036. In other words, if properly factored into network planning, use of the projected DR capability could halve network investment requirements over the next 15 years.

Option 2

In Option 3, all of the ACs (and other products) sold after the implementation date would increase in retail cost, although only the proportion indicated in Figure 10 will be activated. In Option 2, there would be a national scheme, to be developed outside the scope of the GEMS Act, that would offer incentives for the purchase of compliant products. Only those products purchased under the scheme would need to comply and others would not.

If the same activation numbers were achieved as in the Medium Activation scenario in Option 3, but only the activated-on-install ACs had to be compliant, there could be a saving in total purchase costs of $41 million over the period to 2036 (with a NPV of $22 million). The total costs for the AC part of the proposal would fall by 5.4%, from $405 million NPV (see Table 14) to $383 million. As the number of activations would be the same, the greater part of the costs – activation and annual participant costs – would remain the same, as would the benefits. Therefore, the benefit/cost ratio would increase fractionally, from (1,420/405) = 3.5 to (1,420/383) = 3.7.

To achieve that, if a similar level of incentive was offered as for PeakSmart ($300 per purchase/activation) the total offered over the period would need to $920 million, or $66 million per year (NPV $478 million). The net benefits for ACs (which increases by the $22 million saved, from the $1,014 million in Table 14 to NPV $1,036 million) could certainly bear this, but it locks DRSPs into returning about 478/1036 = 46% of the expected benefits as upfront payments. This reduces the flexibility to reward participants in other ways, and limits the share of benefit available to non-participants.

Some incentives will also be required to induce consumers to have ACs activated under the mandatory proposal, of course, but these could be in the form of lower tariffs, annual payments etc rather than upfront incentives. This would allow more flexibility to the DRSP market, and no need for a funding mechanism capable of delivering $66 million per year.

Furthermore, the net savings estimate of $22 million does not take into account the costs to suppliers of inventory management, given that they will need to hold separate stocks of compliant and non-compliant products. It could also lead to higher prices for compliant products, which will be manufactured in lower numbers. These factors may well erode the minor cost savings.

Summary of Input and Outputs

Table 30 summarises the main input assumptions used to calculate the benefits of each category of DR for each appliance type. Figure 23 illustrates the magnitude of costs and benefits for each State, Territory and New Zealand, based on the detailed summaries in Table 37 to Table 46. Finally, Table 47 presents changes in Benefit/Cost ratios between the Consultation Paper and this analysis, which has been revised on the basis of submissions received during the consultation process.

Figure 23. Projected emergency DR air conditioner load available as % of maximum demand, Medium activation rates

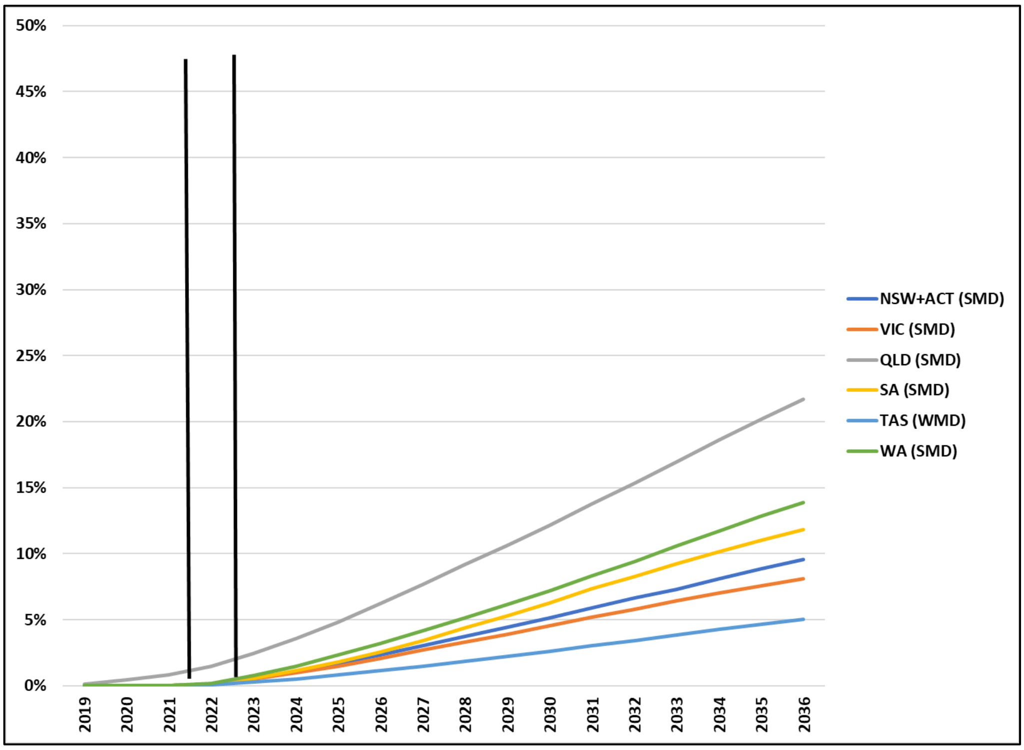


Figure 24 Costs and Benefits by Jurisdiction

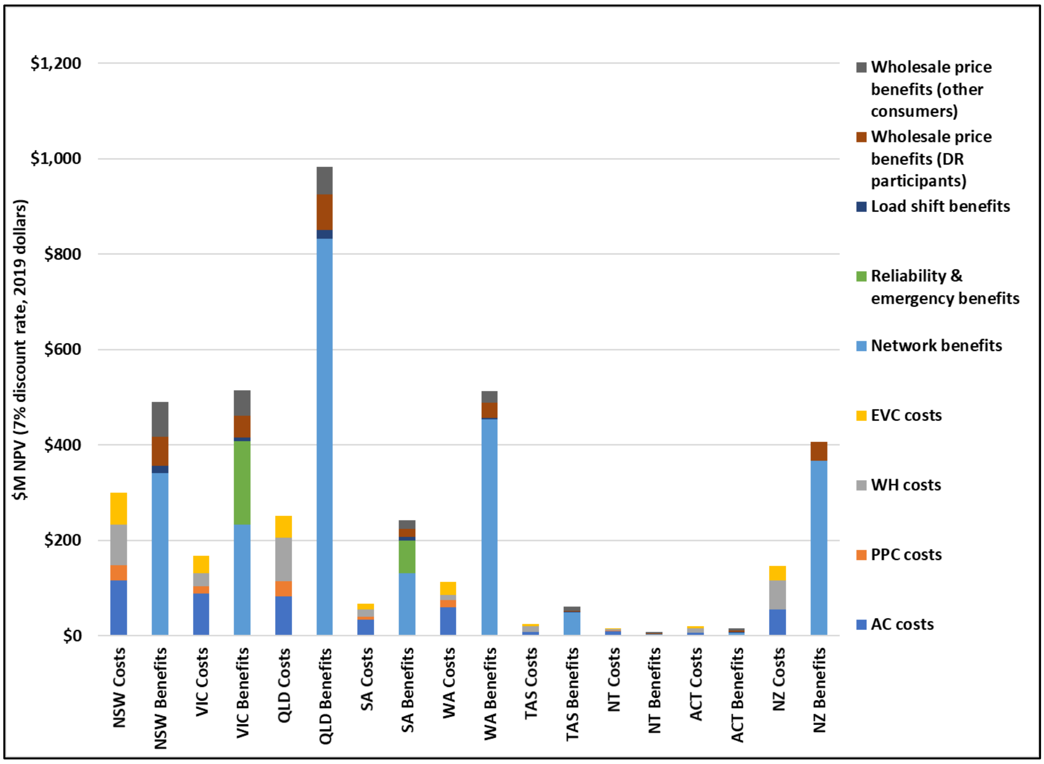


Table 30. Summary of assumptions used to calculate benefits

Product	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 (mandatory)	$/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 (mandatory)	50% of above values	50% of above values	None		
Pool pump controller, Electric storage water heater	1 (mandatory): used to manage peak reduction and storage	$/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	$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 2036	$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	None
	2/3	None	None	None	None	None
	4	None	None		None	None
EV charger – capable of charge only	0 (mandatory)	None – safety value	None – safety value	None – safety value	None – safety value	None – safety value
	1 (mandatory)	$/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 (mandatory)	50% of above values	50% of above values	None		
	4 (mandatory)	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 (mandatory)	None – safety value	None – safety value	None – safety value	None – safety value	None – safety value
	8 (c) (mandatory)	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 26 (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.

Table 31 Summary of cost and benefits by jurisdiction, Air Conditioners (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals							MW Reduction	
Cycling	BAU	WM	Capex	BAU	WM	RERT	BAU	WM	Energy	Cost				Total	Increase	Net	B/C ratio	3%	7%	10%	cf BAU	Med
40%	Capex	Capex	Savings	RERT	RERT	Savings	GWh $M	GWh $M	cost	saving to				saving	in costs	Savings	7.0%				(Max - DRM1)	
	avoided	avoided		value	value	Increase	avoided	avoided	savings	others				$M NPV	$M NPV	$M NPV	$M NPV				2026	2036
NSW	$0	$210	$210	$0.0	$0.0	$0.0	$0.0	$3.3	$3.3	$74.3				$288	$116	$172	2.5	2.4	2.5	2.6	285	1311
VIC	$0	$150	$150	$0.0	$90.9	$90.9	$0.0	$2.3	$2.3	$53.4				$297	$88	$208	3.4	3.3	3.4	3.4	199	904
QLD	$404	$718	$314	$0.0	$0.0	$0.0	$3.5	$5.7	$2.2	$58.1				$374	$83	$291	4.5	4.3	4.5	4.7	192	925
SA	$0	$37	$37	$0.0	$37.6	$37.6	$0.0	$0.9	$0.9	$18.1				$94	$35	$60	2.7	2.7	2.7	2.7	77	379
WA	$0	$292	$292	$0.0	$0.0	$0.0	$0.0	$1.5	$1.5	$24.6				$318	$60	$258	5.3	5.2	5.3	5.4	130	599
TAS	$0	$27	$27	$0.0	$0.0	$0.0	$0.0	$0.2	$0.2	$10.3				$37	$8	$29	4.6	4.4	4.6	4.8	19	84
NT	$0	$2	$2	$0.0	$0.0	$0.0	$0.0	$0.2	$0.2	$3.4				$6	$9	-$4	0.6	0.6	0.6	0.6	17	60
ACT	$0	$1	$1	$0.0	$0.0	$0.0	$0.0	$0.2	$0.2	$4.2				$6	$6	-$0	1.0	0.9	1.0	1.0	14	66
AUST	$404	$1,438	$1,034	$0.0	$128.5	$128.5	$3.5	$14.2	$10.7	$246.4				$1,420	$405	$1,014	3.50	3.4	3.5	3.6	932	4328
NZ	$0	$156	$156	$0.0	$0.0	$0.0	0	0	0	$0.0				$156	$56	$101	2.8	2.7	2.8	2.7	89	455

Table 32 Summary of cost and benefits by jurisdiction, Pool Pump Controllers (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals							MW Reduction	
Cycling	BAU	WM	Capex	BAU	WM	RERT	BAU	WM	Energy	Cost	Neg price	Neg price	DRM4	Total	Increase	Net	B/C ratio	3%	7%	10%	cf BAU	Med
100%	Capex	Capex	Savings	RERT	RERT	Savings	GWh $M	GWh $M	cost	saving to	GWh $M	GWh $M	cost	saving	in costs	Savings	7%				(Max - DRM1)	
	avoided	avoided		value	value	Increase	avoided	avoided	savings	others	avoided	avoided	savings	$M NPV	$M NPV	$M NPV	$M NPV				2026	2036
NSW	$4.7	$30.0	$25.3	$0.0	$0.0	$0.0	$0.6	$3.7	$3.1		$0.2	$1.2	$1.0	$29.3	$32.2	-$2.9	0.9	0.9	0.9	0.9	21	94
VIC	$2.4	$15.0	$12.6	$6.5	$36.3	$29.9	$0.3	$1.8	$1.5		$0.1	$0.7	$0.6	$44.6	$15.8	$28.7	2.8	2.9	2.8	2.7	10	45
QLD	$8.5	$69.4	$60.9	$0.0	$0.0	$0.0	$0.5	$3.8	$3.2		$0.2	$1.2	$1.1	$65.1	$31.5	$33.6	2.1	2.1	2.1	2.1	21	110
SA	$0.4	$3.0	$2.5	$2.0	$11.7	$9.7	$0.1	$0.6	$0.5		$0.1	$0.4	$0.4	$13.1	$5.1	$8.0	2.6	2.7	2.6	2.5	3	16
WA	$6.3	$42.6	$36.3	$0.0	$0.0	$0.0	$0.3	$1.7	$1.4		$0.1	$0.6	$0.5	$38.1	$14.6	$23.5	2.6	2.6	2.6	2.6	9	46
TAS	$0.2	$1.1	$0.9	$0.0	$0.0	$0.0	$0.0	$0.1	$0.1		$0.0	$0.0	$0.0	$1.0	$0.6	$0.3	1.5	1.4	1.5	1.5	0	2
NT	$0.0	$0.3	$0.2	$0.0	$0.0	$0.0	$0.0	$0.2	$0.1		$0.0	$0.1	$0.0	$0.4	$1.4	-$1.0	0.3	0.3	0.3	0.3	1	4
ACT	$0.0	$0.1	$0.1	$0.0	$0.0	$0.0	$0.0	$0.1	$0.1		$0.0	$0.0	$0.0	$0.1	$0.6	-$0.5	0.2	0.2	0.2	0.2	0	2
AUST	$22.6	$161.3	$138.7	$8.5	$48.0	$39.5	$2.0	$11.8	$9.9		$0.7	$4.3	$3.6	$191.7	$101.8	$89.9	1.88	1.9	1.9	1.9	66	318
NZ																						

Table 33 Summary of cost and benefits by jurisdiction, Small Water Heaters (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals							MW Reduction	
Cycling	BAU	WM	Capex	BAU	WM	RERT	BAU	WM	Energy	Cost	Neg price	Neg price	DRM4	Total	Increase	Net	B/C ratio	3%	7%	10%	cf BAU	Med
100%	Capex	Capex	Savings	RERT	RERT	Savings	GWh $M	GWh $M	cost	saving to	GWh $M	GWh $M	cost	saving	in costs	Savings	7%				(Max - DRM1)	
	avoided	avoided		value	value	Increase	avoided	avoided	savings	others	avoided	avoided	savings	$M NPV	$M NPV	$M NPV	$M NPV				2026	2036
NSW	$0.0	$11.3	$11.3	$0.0	$0.0	$0.0	$0.0	$0.7	$0.7		$0.0	$2.0	$2.0	$14.0	$15.5	-$1.5	0.9	0.9	0.9	0.9	4	22
VIC	$0.0	$4.4	$4.4	$0.0	$4.9	$4.9	$0.0	$0.2	$0.2		$0.0	$0.9	$0.9	$10.4	$5.7	$4.7	1.8	2.0	1.8	1.7	1	9
QLD	$0.0	$66.8	$66.8	$0.0	$0.0	$0.0	$0.0	$1.1	$1.1		$0.0	$3.5	$3.5	$71.4	$19.6	$51.8	3.6	3.7	3.6	3.6	7	39
SA	$0.0	$7.7	$7.7	$0.0	$2.5	$2.5	$0.0	$0.1	$0.1		$0.0	$0.9	$0.9	$11.3	$2.6	$8.6	4.3	4.5	4.3	4.1	1	5
WA	$0.0	$10.7	$10.7	$0.0	$0.0	$0.0	$0.0	$0.2	$0.2		$0.0	$0.6	$0.6	$11.5	$4.9	$6.6	2.4	2.5	2.4	2.3	1	7
TAS	$0.0	$11.5	$11.5	$0.0	$0.0	$0.0	$0.0	$0.4	$0.4		$0.0	$0.5	$0.5	$12.3	$5.4	$6.9	2.3	2.4	2.3	2.2	2	12
NT	$0.0	$0.2	$0.2	$0.0	$0.0	$0.0	$0.0	$0.1	$0.1		$0.0	$0.2	$0.2	$0.4	$1.3	-$0.9	0.3	0.3	0.3	0.3	0	2
ACT	$0.0	$1.7	$1.7	$0.0	$0.0	$0.0	$0.0	$0.2	$0.2		$0.0	$0.4	$0.4	$2.3	$3.9	-$1.6	0.6	0.6	0.6	0.6	1	6
AUST	$0.0	$114.2	$114.2	$0.0	$7.4	$7.4	$0.0	$3.0	$3.0		$0.0	$9.0	$9.0	$133.6	$58.9	$74.7	2.3	2.4	2.3	2.2	17	103
NZ	$0	$34	$34	$0.0	$0.0	$0.0	0	0.9796191	0.9796191		0	0	0	$35	$14	$21	2.5	2.4	2.5	2.3	5	33

Table 34 Summary of cost and benefits by jurisdiction, Large Water Heaters (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals							MW Reduction	
Cycling	BAU	WM	Capex	BAU	WM	RERT	BAU	WM	Energy	Cost	Neg price	Neg price	DRM4	Total	Increase	Net	B/C ratio	3%	7%	10%	cf BAU	Med
100%	Capex	Capex	Savings	RERT	RERT	Savings	GWh $M	GWh $M	cost	saving to	GWh $M	GWh $M	cost	saving	in costs	Savings	7%				(Max - DRM1)	
	avoided	avoided		value	value	Increase	avoided	avoided	savings	others	avoided	avoided	savings	$M NPV	$M NPV	$M NPV	$M NPV				2026	2036
NSW	$0.0	$27.1	$27.1	$0.0	$0.0	$0.0	$0.0	$1.4	$1.4	0	$0.0	$8.4	$8.4	$36.9	$69.3	-$32.3	0.5	0.6	0.5	0.5	6	58
VIC	$0.0	$9.2	$9.2	$0.0	$9.1	$9.1	$0.0	$0.5	$0.5	0	$0.0	$3.3	$3.3	$22.0	$21.0	$1.0	1.0	1.2	1.0	1.0	2	19
QLD	$0.0	$127.2	$127.2	$0.0	$0.0	$0.0	$0.0	$1.9	$1.9	0	$0.0	$11.4	$11.4	$140.5	$71.9	$68.6	2.0	2.1	2.0	1.9	10	80
SA	$0.0	$19.1	$19.1	$0.0	$5.6	$5.6	$0.0	$0.3	$0.3	0	$0.0	$3.8	$3.8	$28.8	$12.3	$16.5	2.3	2.5	2.3	2.2	1	12
WA	$0.0	$6.8	$6.8	$0.0	$0.0	$0.0	$0.0	$0.1	$0.1	0	$0.0	$0.7	$0.7	$7.6	$5.8	$1.8	1.3	1.4	1.3	1.2	0	5
TAS	$0.0	$8.6	$8.6	$0.0	$0.0	$0.0	$0.0	$0.2	$0.2	0	$0.0	$0.5	$0.5	$9.4	$6.1	$3.3	1.5	1.6	1.5	1.5	1	10
NT	$0.0	$0.1	$0.1	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	0	$0.0	$0.2	$0.2	$0.4	$1.8	-$1.4	0.2	0.2	0.2	0.2	0	2
ACT	$0.0	$1.3	$1.3	$0.0	$0.0	$0.0	$0.0	$0.1	$0.1	0	$0.0	$0.5	$0.5	$1.9	$5.4	-$3.5	0.4	0.4	0.4	0.3	0	5
AUST	$0.0	$199.4	$199.4	$0.0	$14.7	$14.7	$0.0	$4.6	$4.6	0	$0.0	$28.8	$28.8	$247.5	$193.5	$54.0	1.3	1.4	1.3	1.2	22	190
NZ	$0	$74	$74	$0.0	$0.0	$0.0	0	2.0065211	2.0065211	$0.0	0	0	0	$76	$46	$30	1.6	1.6	1.6	1.5	8	73

Table 35 Summary of cost and benefits by jurisdiction, Electric Vehicle Chargers (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals							MW Reduction	
Cycling	BAU	WM	Capex	BAU	WM	RERT	BAU	WM	Energy	Cost	Neg price	Neg price	DRM4	Total	Increase	Net	B/C ratio	3%	7%	10%	cf BAU	Med
100%	Capex	Capex	Savings	RERT	RERT	Savings	GWh $M	GWh $M	cost	saving to	GWh $M	GWh $M	cost	saving	in costs	Savings	7%				(Max - DRM1)	
	avoided	avoided		value	value	Increase	avoided	avoided	savings	others	avoided	avoided	savings	$M NPV	$M NPV	$M NPV	$M NPV				2026	2036
NSW	$0.0	$66.5	$66.5	$0.0	$0.0	$0.0	$0.0	$52.0	$52.0	0	$0.0	$4.0	$4.0	$122.5	$66.8	$55.7	1.8	1.9	1.8	1.8	5	161
VIC	$0.0	$57.1	$57.1	$0.0	$40.1	$40.1	$0.0	$40.1	$40.1	0	$0.0	$2.7	$2.7	$140.0	$37.4	$102.5	3.7	3.9	3.7	3.6	3	137
QLD	$0.0	$263.3	$263.3	$0.0	$0.0	$0.0	$0.0	$65.8	$65.8	0	$0.0	$3.0	$3.0	$332.1	$45.7	$286.4	7.3	7.4	7.3	7.2	7	180
SA	$0.0	$63.7	$63.7	$0.0	$14.5	$14.5	$0.0	$14.5	$14.5	0	$0.0	$1.9	$1.9	$94.5	$13.3	$81.2	7.1	7.3	7.1	6.9	1	44
WA	$0.0	$107.9	$107.9	$0.0	$0.0	$0.0	$0.0	$28.8	$28.8	0	$0.0	$1.7	$1.7	$138.4	$28.1	$110.3	4.9	5.1	4.9	4.8	3	89
TAS	$0.0	$1.3	$1.3	$0.0	$0.0	$0.0	$0.0	$0.6	$0.6	0	$0.0	$0.2	$0.2	$2.0	$4.2	-$2.1	0.5	0.5	0.5	0.5	0	2
NT	$0.0	$0.3	$0.3	$0.0	$0.0	$0.0	$0.0	$1.4	$1.4	0	$0.0	$0.1	$0.1	$1.8	$1.3	$0.4	1.3	1.4	1.3	1.3	0	4
ACT	$0.0	$2.2	$2.2	$0.0	$0.0	$0.0	$0.0	$2.9	$2.9	0	$0.0	$0.2	$0.2	$5.3	$3.8	$1.5	1.4	1.5	1.4	1.4	0	9
AUST	$0.0	$562.2	$562.2	$0.0	$54.5	$54.5	$0.0	$206.0	$206.0	0	$0.0	$13.8	$13.8	$836.6	$200.6	$636.0	4.17	4.3	4.2	4.1	20	626
NZ	$0	$101	$101	$0.0	$0.0	$0.0	0	37.716866	37.716866	$0.0	0	0	0	$139	$30	$108	4.6	4.4	4.6	4.1	2	111

Table 36 Summary of cost and benefits by jurisdiction, All Products (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals							MW Reduction	
	BAU	WM	Capex	BAU	WM	RERT	BAU	WM	Energy	Cost	Neg price	Neg price	DRM4	Total	Increase	Net	B/C ratio	3%	7%	10%	cf BAU	Med
	Capex	Capex	Savings	RERT	RERT	Savings	GWh $M	GWh $M	cost	saving to	GWh $M	GWh $M	cost	saving	in costs	Savings	7.0%				(Max - DRM1)	
	avoided	avoided		value	value	Increase	avoided	avoided	savings	others	avoided	avoided	savings	$M NPV	$M NPV	$M NPV	$M NPV				2026	2036
NSW	$4.7	$345.3	$340.6	$0.0	$0.0	$0.0	$0.6	$61.1	$60.4	$74.3	$0.2	$15.7	$15.5	$490.8	$300.1	$190.7	1.6	1.6	1.6	1.6	321	1646
VIC	$2.4	$236.2	$233.8	$6.5	$181.3	$174.8	$0.3	$44.9	$44.5	$53.4	$0.1	$7.6	$7.5	$513.9	$168.4	$345.5	3.1	3.1	3.1	3.0	216	1114
QLD	$412.3	$1,244.2	$831.9	$0.0	$0.0	$0.0	$4.0	$78.3	$74.3	$58.1	$0.2	$19.2	$19.0	$983.4	$251.9	$731.5	3.9	4.0	3.9	3.9	237	1334
SA	$0.4	$130.9	$130.4	$2.0	$71.9	$69.9	$0.1	$16.4	$16.3	$18.1	$0.1	$7.0	$6.9	$241.7	$67.9	$173.9	3.6	3.7	3.6	3.5	83	455
WA	$6.3	$459.7	$453.4	$0.0	$0.0	$0.0	$0.3	$32.3	$32.0	$24.6	$0.1	$3.6	$3.5	$513.5	$113.2	$400.2	4.5	4.5	4.5	4.5	144	746
TAS	$0.2	$49.2	$49.0	$0.0	$0.0	$0.0	$0.0	$1.4	$1.4	$10.3	$0.0	$1.1	$1.1	$61.8	$24.3	$37.5	2.5	2.5	2.5	2.6	22	110
NT	$0.0	$2.8	$2.8	$0.0	$0.0	$0.0	$0.0	$1.8	$1.8	$3.4	$0.0	$0.5	$0.5	$8.5	$15.1	-$6.6	0.6	0.6	0.6	0.6	18	72
ACT	$0.0	$6.5	$6.5	$0.0	$0.0	$0.0	$0.0	$3.4	$3.4	$4.2	$0.0	$1.1	$1.1	$15.2	$19.4	-$4.2	0.8	0.8	0.8	0.8	16	88
AUST	$426.4	$2,474.8	$2,048.4	$8.5	$253.2	$244.7	$5.5	$239.7	$234.2	$246.4	$0.7	$55.9	$55.2	$2,828.9	$960.4	$1,868.5	2.9	3.0	2.9	2.9	1057	5564
NZ	$0	$366	$366	$0.0	$0.0	$0.0	0	40.703006	40.703006	0	0	0	0	$407	$147	$260	2.8	2.7	2.8	2.5	105	672

Table 37 Summary of cost and benefits, NSW (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals				MW Reduction		Assumed annual hours of DR events					
	BAU	WM	Capex	BAU	WM	RERT	BAU	WM	Energy	Cost	Neg price	Neg price	DRM4	Total	Increase	Net	B/C ratio	cf BAU	Med	Peak	Reliabil-	W/sale	Neg price	Neg price	Total
	Capex	Capex	Savings	RERT	RERT	Savings	GWh $M	GWh $M	cost	saving to	GWh $M	GWh $M	cost	saving	in costs	Savings	7.0%	(Max - DRM1)		events	ity & em-	price	events	events	hrs
	avoided	avoided		value	value	Increase	avoided	avoided	savings	others	avoided	avoided	savings	$M NPV	$M NPV	$M NPV	$M NPV	2026	2036	(est)	ergency	events	2021	2035	2035
Air Conds	$0	$210	$210	$0	$0	$0	$0	$3	$3	$74	$0	$0	$0	$288	$116	$172	2.5	285	1311	30	0	20	0	0	50
PP Controllers	$5	$30	$25	$0	$0	$0	$1	$4	$3	$0	$0	$1	$1	$29	$32	-$3	0.9	21	94	10	0	20	25	50	80
Water heaters	$0	$38	$38	$0	$0	$0	$0	$2	$2	$0	$0	$10	$10	$51	$85	-$34	0.6	10	80	10	0	20	25	50	80
EV chargers	$0	$66	$66	$0	$0	$0	$0	$52	$52	$0	$0	$4	$4	$122	$67	$56	1.8	5	161	30	0	20	25	50	100
All products	$5	$345	$341	$0	$0	$0	$1	$61	$60	$74	$0	$16	$16	$491	$300	$191	1.6	321	1646	Total if non-coincident					310
Share of savings			69.4%			0.0%			12.3%	15.1%			3.2%	100%			0.0	0	0						

Table 38 Summary of cost and benefits, Victoria (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals				MW Reduction		Assumed annual hours of DR events					
	BAU	WM	Capex	BAU	WM	RERT	BAU	WM	Energy	Cost	Neg price	Neg price	DRM4	Total	Increase	Net	B/C ratio	cf BAU	Med	Peak	Reliabil-	W/sale	Neg price	Neg price	Total
	Capex	Capex	Savings	RERT	RERT	Savings	GWh $M	GWh $M	cost	saving to	GWh $M	GWh $M	cost	saving	in costs	Savings	7.0%	(Max - DRM1)		events	ity & em-	price	events	events	hrs
	avoided	avoided		value	value	Increase	avoided	avoided	savings	others	avoided	avoided	savings	$M NPV	$M NPV	$M NPV	$M NPV	2026	2036	(est)	ergency	events	2021	2035	2035
Air Conds	$0	$150	$150	$0	$91	$91	$0	$2	$2	$53	$0	$0	$0	$297	$88	$208	3.4	199	904	30	20	20	0	0	70
PP Controllers	$2	$15	$13	$6	$36	$30	$0	$2	$1	$0	$0	$1	$1	$45	$16	$29	2.8	10	45	10	20	20	35	60	110
Water heaters	$0	$14	$14	$0	$14	$14	$0	$1	$1	$0	$0	$4	$4	$32	$27	$6	1.2	3	28	10	20	20	35	60	110
EV chargers	$0	$57	$57	$0	$40	$40	$0	$40	$40	$0	$0	$3	$3	$140	$37	$103	3.7	3	137	30	20	20	35	60	130
All products	$2	$236	$234	$6	$181	$175	$0	$45	$45	$53	$0	$8	$7	$514	$168	$346	3.1	216	1114	Total if non-coincident					420
Share of savings			45.5%			34.0%			8.7%	10.4%			1.5%	100%			0.0	0	0						

Table 39 Summary of cost and benefits, Queensland (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals				MW Reduction		Assumed annual hours of DR events					
	BAU	WM	Capex	BAU	WM	RERT	BAU	WM	Energy	Cost	Neg price	Neg price	DRM4	Total	Increase	Net	B/C ratio	cf BAU	Med	Peak	Reliabil-	W/sale	Neg price	Neg price	Total
	Capex	Capex	Savings	RERT	RERT	Savings	GWh $M	GWh $M	cost	saving to	GWh $M	GWh $M	cost	saving	in costs	Savings	7.0%	(Max - DRM1)		events	ity & em-	price	events	events	hrs
	avoided	avoided		value	value	Increase	avoided	avoided	savings	others	avoided	avoided	savings	$M NPV	$M NPV	$M NPV	$M NPV	2026	2036	(est)	ergency	events	2021	2035	2035
Air Conds	$404	$718	$314	$0	$0	$0	$3	$6	$2	$58	$0	$0	$0	$374	$83	$291	4.5	192	925	30	0	20	0	0	50
PP Controllers	$9	$69	$61	$0	$0	$0	$1	$4	$3	$0	$0	$1	$1	$65	$32	$34	2.1	21	110	10	0	20	25	50	80
Water heaters	$0	$194	$194	$0	$0	$0	$0	$3	$3	$0	$0	$15	$15	$212	$91	$120	2.3	17	119	10	0	20	25	50	80
EV chargers	$0	$263	$263	$0	$0	$0	$0	$66	$66	$0	$0	$3	$3	$332	$46	$286	7.3	7	180	30	0	20	25	50	100
All products	$412	$1,244	$832	$0	$0	$0	$4	$78	$74	$58	$0	$19	$19	$983	$252	$731	3.9	237	1334	Total if non-coincident					310
Share of savings			84.6%			0.0%			7.6%	5.9%			1.9%	100%			0.0	0	0						

Table 40 Summary of cost and benefits, SA (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals				MW Reduction		Assumed annual hours of DR events					
	BAU	WM	Capex	BAU	WM	RERT	BAU	WM	Energy	Cost	Neg price	Neg price	DRM4	Total	Increase	Net	B/C ratio	cf BAU	Med	Peak	Reliabil-	W/sale	Neg price	Neg price	Total
	Capex	Capex	Savings	RERT	RERT	Savings	GWh $M	GWh $M	cost	saving to	GWh $M	GWh $M	cost	saving	in costs	Savings	7.0%	(Max - DRM1)		events	ity & em-	price	events	events	hrs
	avoided	avoided		value	value	Increase	avoided	avoided	savings	others	avoided	avoided	savings	$M NPV	$M NPV	$M NPV	$M NPV	2026	2036	(est)	ergency	events	2021	2035	2035
Air Conds	$0	$37	$37	$0	$38	$38	$0	$1	$1	$18	$0	$0	$0	$94	$35	$60	2.7	77	379	30	20	20	0	0	70
PP Controllers	$0	$3	$3	$2	$12	$10	$0	$1	$0	$0	$0	$0	$0	$13	$5	$8	2.6	3	16	10	20	20	69	110	160
Water heaters	$0	$27	$27	$0	$8	$8	$0	$0	$0	$0	$0	$5	$5	$40	$15	$25	2.7	2	16	10	20	20	69	110	160
EV chargers	$0	$64	$64	$0	$14	$14	$0	$14	$14	$0	$0	$2	$2	$95	$13	$81	7.1	1	44	30	20	20	69	110	180
All products	$0	$131	$130	$2	$72	$70	$0	$16	$16	$18	$0	$7	$7	$242	$68	$174	3.6	83	455	Total if non-coincident					570
Share of savings			54.0%			28.9%			6.7%	7.5%			2.9%	100%			0.0	0	0						

Table 41 Summary of cost and benefits, WA (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals				MW Reduction		Assumed annual hours of DR events					
	BAU Capex avoided	WM Capex avoided	Capex Savings	BAU RERT value	WM RERT value	RERT Savings Increase	BAU GWh $M avoided	WM GWh $M avoided	Energy cost savings	Cost saving to others	Neg price GWh $M avoided	Neg price GWh $M avoided	DRM4 cost savings	Total saving $M NPV	Increase in costs $M NPV	Net Savings $M NPV	B/C ratio 7.0% $M NPV	cf BAU (Max - DRM1) 2026	Med 2036	Peak events (est)	Reliabil-ity & em-ergency	W/sale price events	Neg price events 2021	Neg price events 2035	Total hrs 2035
Air Conds	$0	$292	$292	$0	$0	$0	$0	$1	$1	$25	$0	$0	$0	$318	$60	$258	5.3	130	599	30	0	20	0	0	50
PP Controllers	$6	$43	$36	$0	$0	$0	$0	$2	$1	$0	$0	$1	$0	$38	$15	$24	2.6	9	46	10	0	20	25	50	80
Water heaters	$0	$17	$17	$0	$0	$0	$0	$0	$0	$0	$0	$1	$1	$19	$11	$8	1.8	2	13	10	0	20	25	50	80
EV chargers	$0	$108	$108	$0	$0	$0	$0	$29	$29	$0	$0	$2	$2	$138	$28	$110	4.9	3	89	30	0	20	25	50	100
All products	$6	$460	$453	$0	$0	$0	$0	$32	$32	$25	$0	$4	$3	$513	$113	$400	4.5	144	746	Total if non-coincident					310
Share of savings			88.3%			0.0%			6.2%	4.8%			0.7%	100%			0.0	0	0						

Table 42 Summary of cost and benefits, Tasmania (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals				MW Reduction		Assumed annual hours of DR events					
	BAU Capex avoided	WM Capex avoided	Capex Savings	BAU RERT value	WM RERT value	RERT Savings Increase	BAU GWh $M avoided	WM GWh $M avoided	Energy cost savings	Cost saving to others	Neg price GWh $M avoided	Neg price GWh $M avoided	DRM4 cost savings	Total saving $M NPV	Increase in costs $M NPV	Net Savings $M NPV	B/C ratio 7.0% $M NPV	cf BAU (Max - DRM1) 2026	Med 2036	Peak events (est)	Reliabil-ity & em-ergency	W/sale price events	Neg price events 2021	Neg price events 2035	Total hrs 2035
Air Conds	$0	$27	$27	$0	$0	$0	$0	$0	$0	$10	$0	$0	$0	$37	$8	$29	4.6	19	84	30	0	20	0	0	50
PP Controllers	$0	$1	$1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1	$1	$0	1.5	0	2	10	0	20	22	30	60
Water heaters	$0	$20	$20	$0	$0	$0	$0	$1	$1	$0	$0	$1	$1	$22	$12	$10	1.9	3	22	10	0	20	22	30	60
EV chargers	$0	$1	$1	$0	$0	$0	$0	$1	$1	$0	$0	$0	$0	$2	$4	-$2	0.5	0	2	30	0	20	22	30	80
All products	$0	$49	$49	$0	$0	$0	$0	$1	$1	$10	$0	$1	$1	$62	$24	$38	2.5	22	110	Total if non-coincident					250
Share of savings			79.2%			0.0%			2.3%	16.7%			1.8%	100%			0.0	0	0						

Table 43 Summary of cost and benefits, NT (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals				MW Reduction		Assumed annual hours of DR events					
	BAU Capex avoided	WM Capex avoided	Capex Savings	BAU RERT value	WM RERT value	RERT Savings Increase	BAU GWh $M avoided	WM GWh $M avoided	Energy cost savings	Cost saving to others	Neg price GWh $M avoided	Neg price GWh $M avoided	DRM4 cost savings	Total saving $M NPV	Increase in costs $M NPV	Net Savings $M NPV	B/C ratio 7.0% $M NPV	cf BAU (Max - DRM1) 2026	Med 2036	Peak events (est)	Reliabil-ity & em-ergency	W/sale price events	Neg price events 2021	Neg price events 2035	Total hrs 2035
Air Conds	$0	$2	$2	$0	$0	$0	$0	$0	$0	$3	$0	$0	$0	$6	$9	-$4	0.6	17	60	30	0	20	0	0	50
PP Controllers	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1	-$1	0.3	1	4	10	0	20	25	50	80
Water heaters	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1	$3	-$2	0.2	0	3	10	0	20	25	50	80
EV chargers	$0	$0	$0	$0	$0	$0	$0	$1	$1	$0	$0	$0	$0	$2	$1	$0	1.3	0	4	30	0	20	25	50	100
All products	$0	$3	$3	$0	$0	$0	$0	$2	$2	$3	$0	$1	$1	$8	$15	-$7	0.6	18	72	Total if non-coincident					310
Share of savings			32.8%			0.0%			21.0%	40.3%			6.0%	100%			0.0	0	0						

Table 44 Summary of cost and benefits, ACT (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals				MW Reduction		Assumed annual hours of DR events					
	BAU Capex avoided	WM Capex avoided	Capex Savings	BAU RERT value	WM RERT value	RERT Savings Increase	BAU GWh $M avoided	WM GWh $M avoided	Energy cost savings	Cost saving to others	Neg price GWh $M avoided	Neg price GWh $M avoided	DRM4 cost savings	Total saving $M NPV	Increase in costs $M NPV	Net Savings $M NPV	B/C ratio 7.0% $M NPV	cf BAU (Max - DRM1) 2026	Med 2036	Peak events (est)	Reliabil-ity & em-ergency	W/sale price events	Neg price events 2021	Neg price events 2035	Total hrs 2035
Air Conds	$0	$1	$1	$0	$0	$0	$0	$0	$0	$4	$0	$0	$0	$6	$6	-$0	1.0	14	66	30	0	20	0	0	50
PP Controllers	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1	-$0	0.2	0	2	10	0	20	24	40	70
Water heaters	$0	$3	$3	$0	$0	$0	$0	$0	$0	$0	$0	$1	$1	$4	$9	-$5	0.5	1	11	10	0	20	24	40	70
EV chargers	$0	$2	$2	$0	$0	$0	$0	$3	$3	$0	$0	$0	$0	$5	$4	$2	1.4	0	9	30	0	20	24	40	90
All products	$0	$7	$7	$0	$0	$0	$0	$3	$3	$4	$0	$1	$1	$15	$19	-$4	0.8	16	88	Total if non-coincident					280
Share of savings			42.7%			0.0%			22.5%	27.4%			7.5%	100%			0.0	0	0						

Table 45 Summary of cost and benefits, Australia (Medium activation, 7% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals				MW Reduction	
	BAU Capex avoided	WM Capex avoided	Capex Savings	BAU RERT value	WM RERT value	RERT Savings Increase	BAU GWh $M avoided	WM GWh $M avoided	Energy cost savings	Cost saving to others	Neg price GWh $M avoided	Neg price GWh $M avoided	DRM4 cost savings	Total saving $M NPV	Increase in costs $M NPV	Net Savings $M NPV	B/C ratio 7.0% $M NPV	cf BAU (Max - DRM1) 2026	Med 2036
Air Conds	$404	$1,438	$1,034	$0	$128	$128	$3	$14	$11	$246	$0	$0	$0	$1,420	$405	$1,014	3.5	932	4328
PP Controllers	$23	$161	$139	$8	$48	$40	$2	$12	$10	$0	$1	$4	$4	$192	$102	$90	1.9	66	318
Water heaters	$0	$314	$314	$0	$22	$22	$0	$8	$8	$0	$0	$38	$38	$381	$252	$129	1.5	39	292
EV chargers	$0	$562	$562	$0	$55	$55	$0	$206	$206	$0	$0	$14	$14	$837	$201	$636	4.2	20	626
All products	$426	$2,475	$2,048	$8	$253	$245	$5	$240	$234	$246	$1	$56	$55	$2,829	$960	$1,869	2.9	1057	5564
Share of savings			72.4%			8.7%			8.3%	8.7%			2.0%	100%			0.0	0	0

Table 46 Summary of cost and benefits, New Zealand (Medium activation, 6% discount rate)

	Load reduction during peaks			Emergency load reduction			W/sale price savings, participants & others				Load shift, negative price events			Totals				MW Reduction	
	BAU Capex avoided	WM Capex avoided	Capex Savings	BAU RERT value	WM RERT value	RERT Savings Increase	BAU GWh $M avoided	WM GWh $M avoided	Energy cost savings	Cost saving to others	Neg price GWh $M avoided	Neg price GWh $M avoided	DRM4 cost savings	Total saving $M NPV	Increase in costs $M NPV	Net Savings $M NPV	B/C ratio 6.0% $M NPV	cf BAU (Max - DRM1) 2026	Med 2036
Air Conds	$0	$156	$156	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$156	$56	$101	2.8	89	455
PP Controllers																		0	0
Water heaters	$0	$109	$109	$0	$0	$0	$0	$3	$3	$0	$0	$0	$0	$112	$61	$51	1.8	13	105
EV chargers	$0	$101	$101	$0	$0	$0	$0	$38	$38	$0	$0	$0	$0	$139	$30	$108	4.6	2	111
All products	$0	$366	$366	$0	$0	$0	$0	$41	$41	$0	$0	$0	$0	$407	$147	$260	2.8	105	672
Share of savings			90.0%			0.0%			10.0%	0.0%			0.0%	100%			0.0	0	0

Table 47 Benefit/Cost Ratios in Consultation Paper and in Decision RIS

	AUSTRALIA Consultation paper (a)	AUSTRALIA Revised	NEW ZEALAND Consultation paper (e)	NEW ZEALAND Revised
Air Conds	6.5	3.5	4.5	2.8
PP Controllers	3.1	1.9		
Water heaters	2.6	1.5	2.1	1.8
EV chargers	5.1	4.2	5.0	4.6
All products	4.5	2.9	3.4	2.8

(a)E3(2019)

Appendix 3 Demand Response Standards

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 7).

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 (RA) 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.[105] New options would be added as new Appendices,

[105] 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:

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 48. 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-boosted 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

(a) Standards-based — leveraging existing Standards.
(b) Simple — easy to describe, understand, implement and deploy.
(c) Testable — implementations should be easy to test.
(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
Not mentioned - Not published at the time	4755.2 Demand response framework and requirements for **communication between remote agents and electrical products** (In public comment stage. Expected to be published at end of 2019)	Offers an alternative pathway to DR compliance for air 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)

Other "Smart" 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)[106] and the Energy Star "Connected Appliance Criteria" (USA).[107]

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 50**). 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 ACs in the USA (**Table 49**). Most of the non-ducted ACs in the USA are window-wall units. Split systems are relatively new to the US market.

Table 49. 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

[106] https://echonet.jp/product_en/echonet_lite_specification/

[107] https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version%204.0%20Room%20Air%20Conditioners%20Program%20Requirements.pdf

a smart-phone app) and DRSPs who contract with Google, to adjust the room temperature.[108] If the home is pre-cooled (or pre-heated) and the AC is maintaining a steady temperature, then adjusting 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 AC DR in the USA, the Energy Star program has published "connected criteria" for them.[109] 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.[110] 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 50. 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		✓

108 https://nest.com/energy-partners/
109 https://www.energystar.gov/products/spec/connected_thermostats_specification_v1_0_pd
110 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
Clothes dryer	✓ 2		✓
Dishwasher	✓ 0		
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 ACs[111] so addressing problem (a) above. PowerCor is using the Sensibo Sky controller[112] 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 DRM1, DRM2 and DRM3. 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 DRM2 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^{o}C space than a pre-cooled space, it may be drawing say 1.5 kW, the Sensibo would produce no power reductions whereas DRM2 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-

[111] https://www.powercor.com.au/energy-partner/
[112] https://sensibo.com.au/sensibo-features/

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

International and National Demand Response Standards

It is the practice of the E3 program to adopt "international" technical standards for the performance of appliances where possible. This could mean:

1. true international standards published by the International Electrotechnical Commission (IEC) or the International Standardisation Organisation (ISO);
2. if there are alternative regional standards (e.g. CENELEC standards in Europe, JIS in Japan, ANSI or IEEE in the US – the US does not have a single standards body) – generally the one dominating the market in the country from where Australia sources (or exports) most of that product; or
3. industry standards, which may not (yet) have been endorsed by a recognised standards body, but have a reasonable level of adherence for a particular product type.

For some products, the E3 program continues to use AS/NZS standards: e.g. electric storage water heaters and gas appliances. There is no proposal to adopt "international" standards for these products because the AS/NZS standards are uniquely suited to the styles and configurations of products on the Australian and New Zealand markets, and most of the local market is supplied by locally manufactured products.

In some cases, the E3 program recognises more than one "international" standard. For example, the GEMS Determination for electric motors specifies different MEPS levels (expressed as "minimum efficiency (%)") for motors tested under the IEC standard and under the USA IEEE standard.[113]

E3 programs have often started with AS/NZS Standards and then transitioned to international standards once these have developed – often decades later. For examples, a new Australian test standard had to be developed in 1985 for the first electrical product to be subject to mandatory energy labelling in Australia: household refrigerators and freezers (the latest version of that standard is AS/NZS 4474:2018). An IEC energy test standard for refrigerators was finally published in 2018 and adopted as AS/NZS IEC 62552.1:2018. The transition to use of that standard for the E3 program has only just commenced, and will not be completed until 2021.[114]

A DR capability that is suitable to be mandated under the GEMS Act must be:

- Present in the end use product;
- Described in a publicly available technical standard (which may be the determination itself);
- Result in a response that is measurable and repeatable (i.e. the same stimuli under the same conditions will produce the same response, within stated margins of error) and
- Reproducible (i.e. any qualified test laboratory can reproduce the same outcomes when referring to the standard and user settings specified by the manufacturer).

[113] http://www.energyrating.gov.au/products/electric-motors
[114] https://www.legislation.gov.au/Details/F2019L01066 Australia and New Zealand had a major input into the IEC's development of this standard, based on extensive experience with refrigerator testing to AS/NZS 4474.

At present the only standard that meets these criteria is AS/NZS 4755.

The European Commission (EC) is currently examining the case for mandating “smart” (including demand response) capabilities for selected appliances throughout the European Union (EU).[115] It has proposed an “architecture” of functional relationships:

> “In section 7.7, the direct flexibility interface, indirect flexibility interface and internal measurement interface for demand response use cases were discussed. It was indicated that the direct flexibility interface is considered as the most versatile interface type which makes the energy smart appliance compliant with most foreseeable demand response business models, while the indirect flexibility interface can only be used for a restricted subset of the business cases which is difficult to adapt to the remaining business cases. For that reason, it was recommended to make the direct flexibility interface “mandatory”, while it is recommended to make the indirect flexibility interface “optional”.” (p108/124).

The study does not identify any standards that meet its architecture requirements, but gives a few examples from around the world, including AS/NZS 4755 (which it characterises as a “direct flexibility interface”) and OpenADR (which it characterises as an “indirect flexibility interface”).

A “direct flexibility interface” passes on a RAs instructions to the appliance on what to do, while an “indirect flexibility interface” passes on energy price information, and whether and how the appliance reacts depends on how the user has pre-configured the settings: e.g. some may have set a higher or lower price threshold for a given response. As the remote agent may have no prior knowledge of the price pre-sets, it needs feedback from the product to know the price at which the user will permit operation to be modified and/or whether a response has actually occurred.

With a “direct flexibility” interface the response is pre-determined, and independent of either a price signal or user pre-configuration. While feedback to verify the receipt of commands is useful, it is not essential, provided there are other ways of verifying response, e.g. through statistically sampling techniques. (It is understood that AEMO proposed to permit this approach for determining baselines for the new wholesale market response mechanism).

There is no standard that meets the EU’s DR architecture criteria at present, and none are considered ready for adoption.[116]

OpenADR

The development of the Open Automated Demand Response Communications Specification, also called OpenADR, began in 2002 following the California electricity crisis. The California Energy Commission Public Interest Energy Research Program funded an OpenADR research program through the Demand Response Research Centre at Lawrence Berkeley National Laboratory. The OpenADR Profile Specification is a public document and has recently been adopted as an IEC standard (IEC 62746-10-1:2018). There are no proposals to mandate its use in the USA or elsewhere.

---

115 *Preparatory Study on Smart Appliances (Lot 33) Task 7 Report – Policy and Scenario Analysis*, European Commission, October 2018 https://eco-smartappliances.eu/en

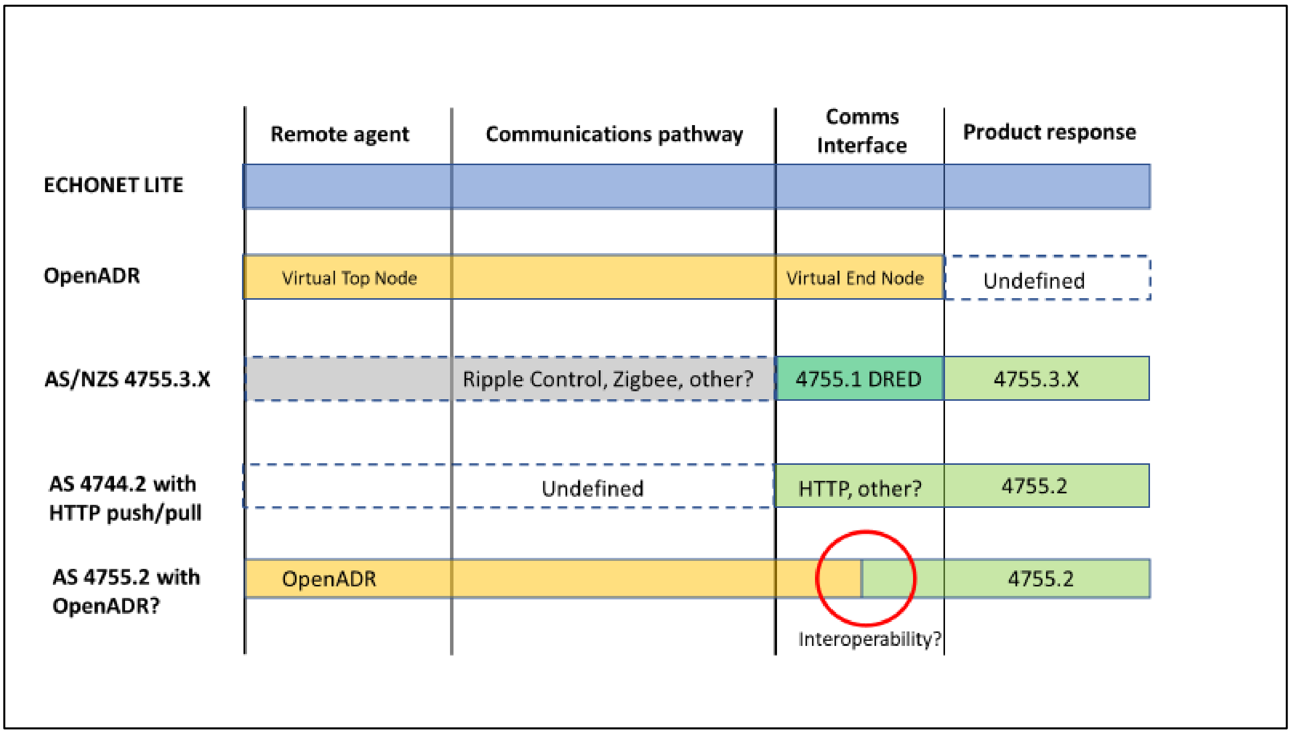
116 European Commission JRC Technical Reports: Smart Home Appliances: State of the Art, Energy, Communications, Protocols, Standards, 2019.

OpenADR is not a demand response in the same sense as AS/NZS 4755. According to the Technical Director of the OpenADR alliance (which published OpenADR):

> "OpenADR is meant to "inform and motivate" and not necessarily to directly control devices or appliances. That is not to say that it could not do that but mostly program provide price or curtailment information to a controller o[f] sorts. e.g. a building management system which then in turn controls connected devices."[117]

OpenADR provides for *communications without specifying the response*. AS/NZS 4755, on the other hand, *provides for response without specifying the mode of communications*. In AS/NZS 4755.1/3, activation of the appliance requires connection to a DRED, but the means by which the DRED communicates with the remote agent is open. Echonet is the most closed system in that all elements– communications pathways, interface and product – must be compatible. Its inflexibility makes it unsuitable for adoption in Australia, where DRSPs and product manufacturers have adopted a wide range of systems and approaches. Figure 25 illustrates these relationships.

Figure 25 Diagrammatic representation of AS/NZS 4755, Echonet and OpenADR



The products certified as compliant with OpenADR are mostly communications and control devices. There are no Open-ADR certified air conditioners, water heaters or pool pump controllers.[118] The products which come closest to the appliances of interest in the CRIS are:

[117] Personal communication from Rolf Bienert, 4 October 2019.
[118] https://products.openadr.org/

- A few click-in air conditioner communications modules (Daikin, Fujitsu, Mitsubishi Electric) – these manufacturers are active in the Australian HVAC market, and offer 4755-compliant split-unit air conditioners (some of which achieve compliance by means of click-on modules);
- A few programmable communicating thermostat (PCTs) – not relevant to the Aust market, which is dominated by split-unit air conditioners with internal controls; and
- A few commercial EV chargers.

AS/NZS4755 and OpenADR are not interchangeable, but they could be complementary. Standards Australia Committee EL-054 is currently drafting a new part, AS/NZS 4755.2. It recently established a Working Group to investigate whether the OpenADR pathway could serve as one of the options for realising the requirements of AS/NZS 4755.2. Figure 25 illustrates the potential point of interoperability between AS/NZS 4755 and OpenADR.

AS/NZS 4755, on its own, meets the criteria for a demand response capability that is suitable to be mandated under the GEMS Act. It is:

- Present in the end use product;
- Described in a publicly available technical;
- Results in a response that is measurable and repeatable; and
- Reproducible in any qualified test laboratory.

OpenADR on its own does not meet these criteria.

*****