# Consultation Regulation Impact Statement – Air Conditioners and Chillers

**Regulatory reform opportunities and improving energy efficiency outcomes**

**February 2016**

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

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# Contents


EXECUTIVE SUMMARY ........ V

1. INTRODUCTION ........ 1

2. THE PROBLEM ........ 5
Problems with the current requirements ........ 5
Other policies that impact these problems ........ 13

3. OBJECTIVE ........ 15

4. OPTIONS ........ 16
Business as Usual ........ 17
Option A ........ 18
Option B1 ........ 25
Option B2 ........ 27

5. IMPACTS ........ 29
Business As Usual ........ 29
Option A ........ 30
Option B1 ........ 32
Option B2 ........ 32
Cost Benefit Analysis ........ 32
2011 Decision RIS ........ 38

6. CONSULTATION ........ 39
Consultation to date ........ 43

7. CONCLUSION ........ 44
Recommended option ........ 44

8. IMPLEMENTATION AND REVIEW ........ 46
Review ........ 46

ATTACHMENT A – DEVELOPMENT OF ZONED ENERGY RATING LABEL ........ 47

ATTACHMENT B – MODELLING ........ 53

I. METHODS AND KEY INPUTS ........ 56
Method for calculating energy and greenhouse gas impacts ........ 56
Key inputs ........ 58

II. SALES AND STOCK ........ 69
Sales trends ........ 69
Stock Trends ........ 78

III. POLICY OPTION IMPACTS – ENERGY AND COST/BENEFIT ........ 83
Options considered ........ 83
Air Conditioners ........ 84
Chillers ........ 89

IV. BAU ENERGY CONSUMPTION ........ 95
Air conditioners ........ 95
Chillers ........ 97

ATTACHMENT B1 – ELECTRICITY PRICES AND GHG EMISSIONS FACTORS ........ 98

REFERENCES ........ 99

## LIST OF FIGURES


Figure 1 Percentage of Australian households with a refrigerative air conditioner, 1985 to 2014 .......... 1
Figure 2 Cooling energy efficiency ratings – Australian air conditioners less than 4 kW capacity, 2000 -2014 .......... 3
Figure 3 Efficiency of all New Zealand heat pump/air conditioners 2004-2014 .......... 4
Figure 4 Current Energy Rating Label .......... 5
Figure 5 Aldi supermarkets catalogue, October 2015 .......... 9
Figure 6 Zoned Energy Rating Label .......... 20
Figure 7 Typical annual temperature frequencies, Richmond NSW .......... 23
Figure 8 Survival function of ducted AC .......... 62
Figure 9 Survival function of non-ducted AC .......... 62
Figure 10 Price per kW of output capacity vs efficiency (EER) over 2003 – 2014: 6- 10 kW non-ducted split AC.... 67
Figure 11 Price vs EER for non-ducted split AC in 2014FY .......... 67
Figure 12 Forecast annual sales of AC – non-ducted: Australia .......... 69
Figure 13 Forecast annual sales of AC – ducted AC: Australia .......... 70
Figure 14 Forecast annual sales of AC – multi-split and other AC: Australia .......... 71
Figure 15 Forecast annual sales of AC – non-ducted AC: New Zealand .......... 72
Figure 16 Forecast annual sales of AC – ducted AC: New Zealand .......... 73
Figure 17 Forecast annual sales of AC – multi-split and other AC: New Zealand .......... 74
Figure 18 Forecast annual sales of chillers: Australia .......... 76
Figure 19 Forecast annual sales of chillers: New Zealand .......... 77
Figure 20 Forecast stock of AC by category –Australia & New Zealand .......... 79
Figure 21 Forecast stock of chillers by category – Australia & New Zealand .......... 81


## LIST OF TABLES


Table 1 Policy options .......... vi
Table 2 Cost benefit estimates - Australia .......... vii
Table 3 Cost benefit estimates - New Zealand .......... vii
Table 4 Policy options .......... 17
Table 5 Proposed MEPS levels for air conditioners >65 kW (Option A) .......... 25
Table 6 Proposed MEPS levels for chillers <350 kW (Option A) .......... 25
Table 7 Proposed MEPS levels for chillers (Option B1/B2) .......... 26
Table 8 Evaluation of impacts – air conditioners and chillers .......... 29
Table 9 Assumptions and model parameters .......... 35
Table 10 Cost benefit estimates - Australia .......... 37
Table 11 Cost benefit estimates - New Zealand .......... 37
Table 12 2011 Decision RIS results .......... 38
Table 13 Table of assumptions and model parameters .......... 53
Table 14 AC product categories and average rated capacity .......... 58
Table 15 Chiller product categories and average rated capacity .......... 59
Table 16 AC product categories and average efficiency in 2013 – Australia .......... 60
Table 17 AC product categories and average efficiency in 2013 – New Zealand .......... 60
Table 18 Chiller product categories and average efficiency in 2013 – Australia and New Zealand .......... 61
Table 19 AC State/Zone average annual operating hours - Residential .......... 63
Table 20 AC State/Zone heating and cooling operating hours adjustment - Residential .......... 64
Table 21 AC equipment zoning and product adjustment to average annual operating hours - Residential .......... 64
Table 22 AC State/Zone average annual operating hours - Business .......... 65
Table 23 Chiller state/zone average annual operating hours .......... 65
Table 24 Chiller equipment adjustment to average annual operating hours .......... 66
Table 25 Total annual sales of AC 2010-2030, by state region .......... 75
Table 26 Total annual sales of chillers 2010-2030, by state region .......... 78
Table 27 Stock of AC 2010-2030, by state/region .......... 80
Table 28 Stock of chillers 2010-2030, by state/region .......... 82
Table 29 Residential electricity prices (real 2014 cents/kWh) for Australia and New Zealand .......... 98
Table 30 GHG emission factors for electricity (kg CO2-e/kWh) for Australia and New Zealand .......... 98

# Executive Summary

This Regulation Impact Statement (RIS) considers two products – air conditioners and chillers:

- Air conditioners provide a cooling and heating (or cooling only) service to improve the thermal comfort of an indoor space – such as a room, house or apartment building. Air conditioners are also used in commercial and industrial buildings such as offices, shopping centres and manufacturing premises. This RIS covers air source air conditioners that use the vapour compression refrigeration cycle (refrigerative air conditioners).
- Chillers produce chilled water that is used by space cooling equipment in buildings and many industrial processes. Heat is removed from a circulating cold water loop and discharged to the outside air. This occurs through a cooling tower (in the case of water cooled chillers) or through an air cooled condenser (in the case of air cooled chillers). Chillers within the scope of this RIS are generally used for commercial air conditioning.

Around one million refrigerative air conditioners are sold in Australia per year, with an estimated stock of almost 12 million in 2014. A further 100 000 refrigerative air conditioners (referred to as 'air conditioners' hereafter) are sold in New Zealand each year, with an estimated stock of 1.1 million in 2014. Chillers sales in Australia and New Zealand were around 1000 and 100 units respectively in 2014. The installed stock of chillers is estimated to be around 20 000 units in Australia and 2000 units in New Zealand.

The Equipment Energy Efficiency (E3) Program currently applies Minimum Energy Performance Standards (MEPS) and Energy Ratings Labels (ERLs) to a number of air conditioning products sold in Australia and New Zealand. The MEPS for air conditioners were subject to a number of revisions through the 2000s. This policy action was a direct response to the rapid increase in the household penetration of air conditioners (from 24 per cent in 1999 to 52 per cent in 2008) and the subsequent increase in electricity demand, including peak electricity demand. Peak demand represents the highest point of electricity demand over a given period, for example a day or year. Chillers are subject to MEPS requirements only.

The current regulations have largely achieved their objective by promoting the development and adoption of energy efficient air conditioners and chillers. However, there are aspects of the requirements where there is scope for significant simplification and harmonisation changes to be made which can address adverse consequences and improve energy efficiency.

The objective of the proposed government action is therefore to address these regulatory failures:

- The current energy efficiency rating method, used for the ERL, has not kept pace with technology changes and hence does not provide some important information about the relative energy efficiency and running costs of different air conditioning options;
- Consumers are being supplied with or purchasing air conditioners that may not be suited to their location, despite potentially being presented with a high star rating or capacity output figure on the current ERL;
- The scope of the current energy efficiency labelling requirements appears to be inadequate;
- The current regulations inhibit the ability of consumers to purchase relatively energy efficient portable air conditioners;
- Consumers are unable to meaningfully compare the energy efficiency and capacity of portable air conditioners with other types of air conditioners;
- MEPS requirements for air conditioners and chillers are divided between the GEMS Act and National Construction Code (NCC) in Australia, which is likely to impose additional regulatory costs for some suppliers;
- MEPS requirements for air conditioners and chillers covered by the NCC in Australia do not apply to the replacement market for these products and do not apply at all in New Zealand;
- The Australia/New Zealand specific test standard for chillers results in higher regulatory burden than is necessary – this can be removed to align with international standards without jeopardising energy efficiency outcomes;

- MEPS requirements for air conditioners are inconsistent across portable products; fixed and variable speed air conditioners; the GEMS Act and NCC; and Australia and New Zealand; and
- Chiller MEPS requirements are inconsistent across GEMS, the NCC and the updated levels due to be implemented in the USA.

A number of policy options (options A, B1 and B2) have been identified to address these problems. A summary of these changes are provided in Table 1 below, with details of the options provided in the body of the RIS.

**Table 1 Policy options**

| Reform proposal | Option A | Option B1 | Option B2 |
|---|---|---|---|
| 1. For air conditioners (A/C) adopt the Seasonal Energy Efficiency Ratio (SEER) standard AS/NZS 3823.4 for rating products with capacity up to 30 kW. | X | X | X |
| 2. Remove the existing Energy Rating Label and replace it with a Zoned Energy Rating Label that provides energy efficiency information for three distinct climate zones across Australia and New Zealand to A/C with capacity up to 30 kW. Air enthalpy tests would be accepted for ducted, three-phase and certain 'commercial use' products. Multi-split systems would continue to be excluded from physical labelling but would be subject to the SEER standard, with rating information for the registered combination made available on the Energy Rating website. | X | X | X |
| 3. Double duct portable A/C subject to the SEER standard AS/NZS 3823.4, Zoned Energy Rating Label and a reduced MEPS level of 2.60 based on Annual Energy Efficiency Ratio/Annual Coefficient of Performance (AEER/ACOP). Single duct portable A/C subject to Zoned Energy Rating Label (with proxy for operating time data) and tested to AS/NZS 3823.1.5. | X | X | X |
| 4. Remove the unique Australian/New Zealand chiller test standard and align with the United States (US) Air conditioning, Heating and Refrigeration Institute (AHRI) test standard 551/591:2011. | X | X | X |
| 5. Include the energy efficiency requirements for A/C >65 kW capacity and chillers <350 kW under GEMS/NZ regulations and in Australia remove these from the NCC. | X | X | X |
| 6. Retain current NCC MEPS levels under GEMS/NZ regulations (refer to Table 5 and Table 6 for proposed levels). | X | | |
| 7. Align >65 kW A/C MEPS levels to 39 to 65kW GEMS MEPS (i.e. AEER/ACOP 2.90). Align chiller MEPS levels to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) energy efficiency standard 90.1:2013 where the US levels are higher (refer to Table 7 for the proposed levels). | | X | X |
| 8. Single duct portable A/C subject to a MEPS level of 2.60 based on AEER/ACOP. | | X | X |
| 9. Align New Zealand's residential cooling MEPS to match Australia's levels. | | X | X |
| 10. Align the MEPS levels for fixed and variable speed air conditioners, by removing the 'part load' compliance option. | | X | X |
| 11. SEER rating of A/C ≥30 kW capacity, with rating information made available on the Energy Rating website. | | | X |

The estimated impacts of the proposals are shown in Table 2 and Table 3 below in terms of costs/benefits, energy savings and greenhouse gas emission reductions.

**Table 2 Cost benefit estimates - Australia**

| Option | Energy Saved (cumulative to 2030 - GWh) | GHG Emission Reduction (cumulative to 2030) Mt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Option A | 3,371 | 3.0 | $715 | $174 | $541 | 4.1 |
| Option B1 | 5,857 | 5.2 | $1,182 | $290 | $892 | 4.1 |
| Option B2 | 6,672 | 6.0 | $1,335 | $308 | $1,027 | 4.3 |

*Note: This table uses discount rates of 7% for Australia*

**Table 3 Cost benefit estimates - New Zealand**

| Option | Energy Saved (cumulative to 2030- GWh) | GHG Emission Reduction (cumulative to 2030) kt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Option A | 427 | 41.3 | $106 | $21 | $85 | 5.0 |
| Option B1 | 659 | 64.6 | $159 | $32 | $126 | 4.9 |
| Option B2 | 670 | 65.7 | $161 | $33 | $128 | 4.9 |

*Note: This table uses discount rates of 5% for New Zealand*

Based on the cost benefit analysis, the recommended policy option is option B2. This option provides the greatest net benefit to the Australian and New Zealand communities - $1,027 million and $128 million respectively. This policy option remains cost effective if the costs of the proposals are increased by 50 per cent, or if the discount rate applied is increased to 11 per cent, with the benefit/cost ratios remaining above 2.0. Regulatory costs associated with the policy options have also been estimated and offsets identified in accordance with Australian Government requirements.

Stakeholder feedback is sought on the policy options presented in this Consultation RIS. This is to ensure that any recommendation and/or decision to change the current energy efficiency requirements is based on an understanding of the full range of stakeholder views. Questions that stakeholders may wish to consider are provided in the Consultation questions section. Public consultation events on this RIS will be held in:

- Sydney: 10:00-12:00 Monday, 15 February, Level 5, 341 George Street;
- Brisbane: 10:00-12:00 Tuesday, 16 February, Level 12, 100 Creek Street;
- Melbourne: 10:00-12:00 Wednesday, 17 February, Southern Cross West Tower, Level 5, 111 Bourke St;
- Adelaide: 10:00-12:00 Thursday, 18 February (registration required);
- Perth: 10:00-12:00 Friday, 19 February, St Martins Tower, Level 25, 44 St Georges Terrace; and
- Wellington: 9:30-11:30 Tuesday 23 February, 30 The Terrace.

To register your interest in attending an Australian consultation session, please email energyrating@industry.gov.au noting the names of attendees and the location of the meeting you wish to attend. Note: Adelaide attendees – you must register: security requirements require pre-registration to allow building access. You will also need to ensure you bring photo identification when attending.
For New Zealand participants, please email regs@eeca.govt.nz.

The closing date for written submissions is **5pm AEDT Friday 18 March 2016** and should include the subject: 'Consultation RIS – Air Conditioners and Chillers'.

Australian submissions should be sent via email to:

**Email:** energyrating@industry.gov.au

New Zealand submissions should be sent via email to:

**Email:** regs@eeca.govt.nz

# 1. Introduction

## Background

This section provides background information about air conditioners and chillers.

### Air Conditioners

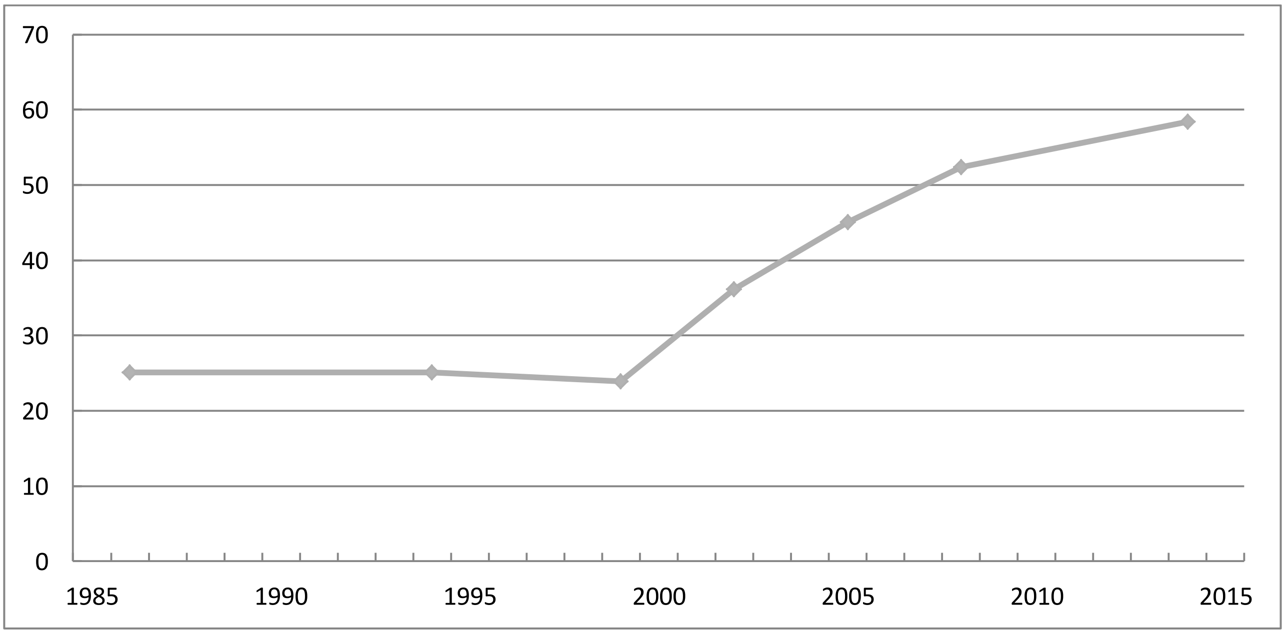
#### Market

Air conditioners provide a cooling and heating (or cooling only) service to improve the thermal comfort of an indoor space – such as a room, house or apartment building. Air conditioners are also used in commercial and industrial buildings such as offices, shopping centres and manufacturing premises.

Air source[1] refrigerative air conditioners use a technique called the vapour compression cycle to move energy from one space to another. This is generally a very efficient process and the amount of heat moved is typically three or more times the energy required to run the compressor system. This means the cooling or heating output is three or more times greater than the power input - an efficiency of 300 per cent plus. Evaporative air conditioners (which do not have compressors) are not subject to energy efficiency requirements and are not within the scope of this Regulation Impact Statement (RIS). Some work is underway to develop the test standard for this product type.

Around one million air conditioners using the vapour compression refrigeration cycle (refrigerative air conditioners) are sold in Australia per year, with an estimated stock of almost 12 million in 2014. A further 100 000 of these air conditioning units are sold in New Zealand each year, with an estimated stock of 1.1 million in 2014. Figure 1 shows the proportion of Australian households with at least one refrigerative air conditioner (simply referred to as 'air conditioners' hereafter).

**Figure 1 Percentage of Australian households with a refrigerative air conditioner, 1985 to 2014**




**Source: ABS Environmental Issues: Energy use and Conservation, March 2014 and June 1994, cat. no. 4602.0; ABS National Energy Survey 1985-86, cat. no. 8212.0.**

1 Air source air conditioners extract and/or expel heat directly from/to the outdoor air. Water source air conditioners extract and/or expel heat from/to water. The current regulations for water source air conditioners and heat pumps within the scope of AS/NZS 3823.1.3:2005 will remain unchanged.

The Australian Bureau of Statistics (ABS) data show that the household penetration of air conditioners in Australia was largely steady at around 25 per cent from the mid 1980s through the 1990s. However, this proportion increased rapidly through the 2000s to reach 58 per cent in 2014. Note the data above does not include evaporative air conditioners – the proportion of households with this type of air conditioner increased from 6 to 13.5 per cent between 1994 and 2014.

Further, ownership of multiple air conditioners is common in some areas of Australia - over half of all Queensland homes now own two or more air conditioners, with the proportion in northern Queensland even higher at 89 per cent.[2] In New Zealand, around 25 per cent of households had an air conditioner (where they are generally referred to as heat pumps) in 2010.[3] The proportion is higher at 45 per cent of new homes in New Zealand.

Rising incomes, the declining cost of air conditioners, higher expectations of thermal comfort and the increasing size of new homes are key drivers of this trend.[4] This increasing household penetration of air conditioning has also been a major contributor to the growth of electricity demand.[5]

There are 45 registered air conditioner suppliers in Australia and New Zealand.[6] The majority of air conditioners are imported, mainly from China, Thailand, Japan, Korea and Malaysia. There are also some local assemblers, particularly of ducted split systems (which are generally installed as whole house air conditioners and in commercial premises) and ducted packaged units (generally installed in commercial premises).

## Current regulations

The Equipment Energy Efficiency (E3) Program currently applies Minimum Energy Performance Standards (MEPS) and Energy Rating Labels (ERLs) to a number of air conditioning products sold in Australia and New Zealand.

Residential air conditioners were first required to carry an ERL in 1987 and have been subject to MEPS requirements since 2004. Larger three-phase air conditioners (which are often used in non-residential buildings but include large ducted household units) have been subject to MEPS since 2001 and can voluntarily apply the ERL.

These MEPS were subject to revisions through the 2000s. This policy action was a direct response to the rapid increase in the household penetration of air conditioners and the subsequent increase in electricity demand, including peak demand. Residential air conditioners account for 38 per cent of peak demand in Australia.[7] Peak demand represents the highest point of electricity demand over a given period, for example a day or year.

The requirements are aimed at promoting the development and adoption of energy efficient air conditioning products. They are given effect under the *Greenhouse and Energy Minimum Standards Act 2012* (GEMS Act) in Australia and the *Energy Efficiency (Energy Using Products) Regulations 2002* in New Zealand. Note that air conditioner units above 65 kilowatt (kW) capacity are subject to energy efficiency requirements through the Australian National Construction Code (NCC), which covers new buildings only. These units are not regulated in New Zealand.

There have been significant improvements in the energy efficiency of air conditioners, partly as a result of the regulatory requirements. A case study of this is shown in Figure 2 below.

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[2] Highlights from the 2014 Energex Queensland Household Energy Survey. www.energex.com.au/__data/assets/pdf_file/0008/260909/2014-highlights.pdf

[3] Buckett NR (Ed), Marston NJ (Ed), Saville-Smith K, Jowett JH, Jones MS, 2011. Preliminary BRANZ 2010 House Condition Survey Report – Second Edition. BRANZ Study Report 240. BRANZ Ltd, Judgeford, New Zealand

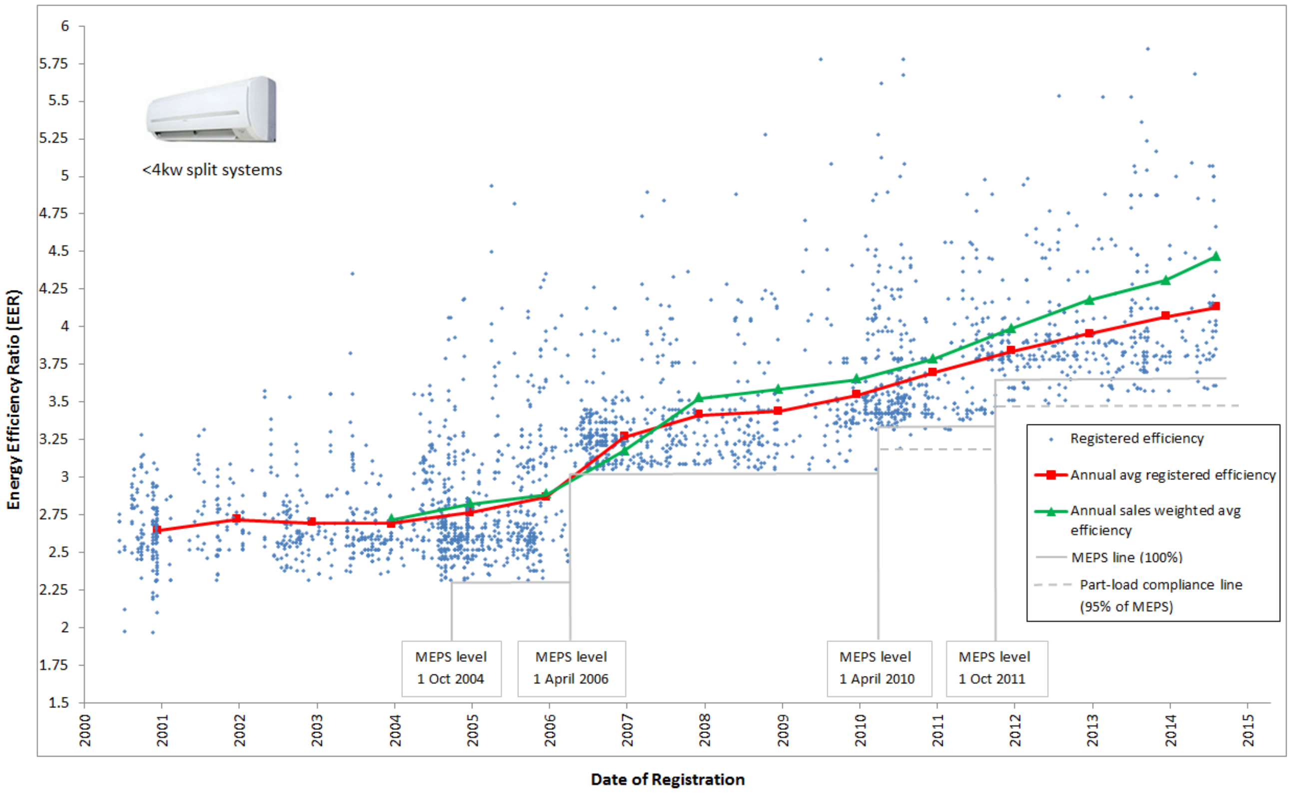
[4] Dear R. and White S. 'Residential air conditioning, thermal comfort and peak electricity demand management' Proceedings of Conference: Air Conditioning and the Low Carbon Cooling Challenge, Cumberland Lodge, Windsor, UK, 27-29 July 2008.

[5] Department of the Environment, Water, Heritage and the Arts 'Energy use in the Australian Residential Sector: 1986 to 2020', 2008.

[6] Energy Rating database at 1 June 2015 www.energyrating.gov.au

[7] Saman W, et al. 'A framework for adaptation of Australian households to heat waves', 2013.

**Figure 2 Cooling energy efficiency ratings – Australian air conditioners less than 4 kW capacity, 2000 - 2014**




**Source: Energy Rating database [www.energyrating.gov.au](http://www.energyrating.gov.au) at August 2014.**

Figure 2 shows the cooling energy efficiency improvement of Australian non-ducted air conditioners with an output of 4 kW[8] or less since 2000:

- The blue dots indicate the cooling efficiency ratings of individual product models;
- The red line shows the average annual registered efficiency of these products; and
- The green line shows average annual efficiency weighted for sales.

Figure 2 indicates that since the last MEPS increase in 2011, the least efficient Australian air conditioner available in this category has been more efficient than the most efficient model released in 2001 – a 50 per cent improvement in a decade. Between 2004 and 2014, the sales weighted price in this category decreased from $1220 to $854 (in 2013 Australian dollars). The 4 kW category currently represents around a third of air conditioners sold per annum.

The figure also shows that it is not until 2008 that a preference for more energy efficient products is evident. This is the point at which the green line (average efficiency weighted for sales) crosses over the red line (average registered efficiency). Further, between 2008 and 2015 the revealed preference of consumers for more energy efficient products has increased. This could be a response to the above average increases in electricity prices that began around 2007/8. Consumers preferred products with an Energy Efficiency Ratio (EER – the ratio of cooling output to electrical input) 0.34 above the registered average in 2014 – which equates to at least half a star on the energy efficiency rating scale for this size category.

In New Zealand air conditioners or heat pumps have been subject to similar MEPS and ERL revisions, most recently in 2013, with a resulting increase in heating and cooling performance. New Zealand also promotes the ENERGY STAR label for heat pumps with high heating performance, and their performance in cold temperatures is tested. In 2014 most sales were for heat pumps with a high Coefficient of Performance (COP or heating energy efficiency) and 72 per cent of room heat pumps sold were ENERGY STAR qualified.

[8] This category is presented as the parameters (0 to 4kW) have remained constant over time in energy efficiency regulations. Further, a time series of sales data is available for the category.

**Figure 3 Efficiency of all New Zealand heat pump/air conditioners 2004-2014**

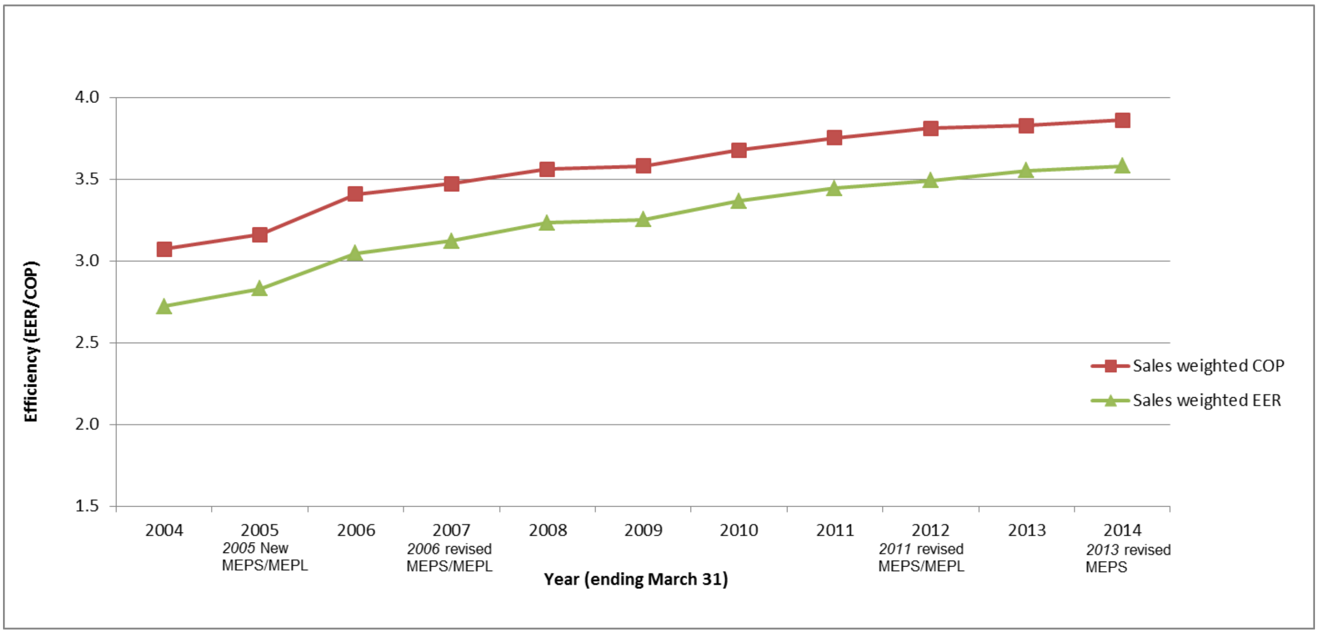



Figure 3 shows the energy efficiency improvement of heat pumps/air conditioners in New Zealand between 2004 and 2014. This sales data indicates that heating and cooling energy efficiency has improved 26 and 32 per cent respectively over the period.

## Chillers

### Market

Chillers produce chilled water that is used by space cooling equipment in buildings and many industrial processes. Heat is removed from a circulating cold water loop and discharged to the outside air. This occurs through a cooling tower (in the case of water cooled chillers) or through an air cooled condenser (in the case of air cooled chillers). Chillers within the scope of this RIS are generally used for commercial air conditioning.

In recent years, smaller capacity chillers have been competing with the emerging Variable Refrigerant Flow (VRF) multi-split air conditioners. VRF multi-split units consist of one outdoor unit which can be connected to up to 50 indoor units, and are therefore capable of conditioning a large building.

There are currently 12 registered suppliers of chillers on the Australian and New Zealand market.[9] Chiller sales in Australia and New Zealand were around 1000 and 100 units respectively in 2014. The installed stock of chillers is estimated to be around 20 000 units in Australia and 2000 units in New Zealand.

### Current requirements

As with air conditioners, the energy efficiency requirements for chillers are divided between GEMS and the NCC:

- Units above 350 kW are regulated under the GEMS Act in Australia and by New Zealand's Regulations.
- Units under 350 kW - MEPS are specified in the NCC in Australia, which applies to new buildings only. These units are not regulated in New Zealand.

The MEPS requirements for chillers were introduced to the NCC in 2005 and expanded in 2006, with the E3 Program's requirements introduced in 2009. The NCC requirements were updated in 2010 – partly to address overlap with the E3 requirements.

[9] Energy Rating database at 14 January 2015 www.energyrating.gov.au. This covers suppliers of chillers greater than 350kW capacity.

# 2. The problem

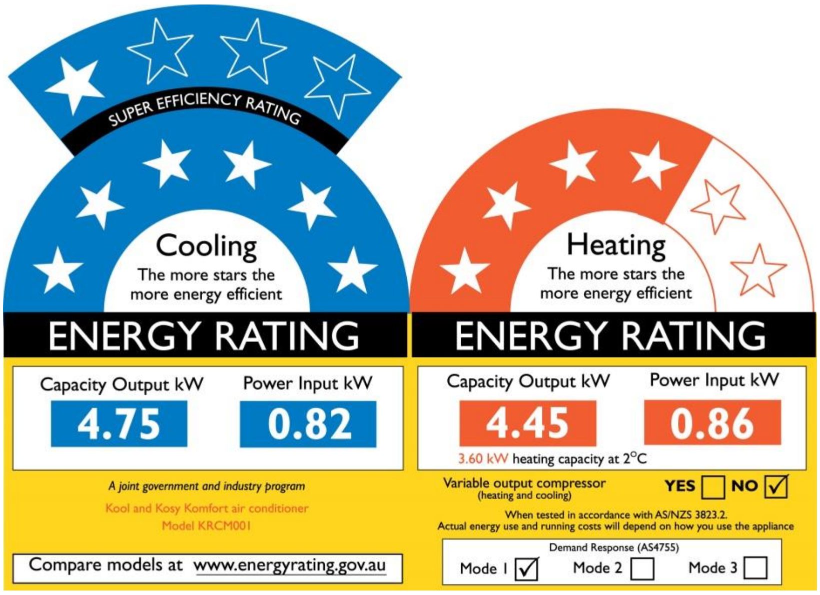
## Problems with the current requirements

The current regulations have largely achieved their objective by promoting the development and adoption of energy efficient air conditioners and chillers. An evaluation of the requirements is provided in the Impacts section. However, there are aspects of the requirements where there is scope for significant simplification and harmonisation changes to be made which can address adverse consequences and improve energy efficiency. In this section, these *regulatory failures* are outlined.

### Air Conditioners

**Australia/New Zealand efficiency rating method**

**Figure 4 Current Energy Rating Label**




**Source: Energy Rating website**

The current ERL shown in Figure 4 above rates energy efficiency performance based on the underpinning test standard AS/NZS 3823 *Performance of electrical appliances – Air conditioners and heat pumps*. The tests are performed at 'full load' (maximum) conditions at the two test points of 35 °C and 7 °C (for cooling and heating respectively). These temperature points have been the international rating points for air conditioners since the 1970s, with residential air conditioners first required to carry an ERL in Australia in 1987 based on these rating points.[10]

However, air conditioning technology has since changed markedly. A key advance is that variable speed products (air conditioners that have the ability to turn down and run more efficiently at a reduced capacity) now dominate the market, whereas fixed or single speed products (that can only turn on or off) were the dominant product type in the late 1980s.

[10] The heating rating point changed slightly in 1998, when the previously Australian only test standard was superseded by an Australian/New Zealand version of an International Standards Organisation test standard.

The overall performance of air conditioners is not captured by the current rating method. For example, variable speed products spend a considerable amount of time operating at less than full capacity over the course of a year. Also higher temperatures, humidity and frosting conditions can all affect an air conditioner's energy efficiency and performance. This means a product that rates well at 35°C and 7°C may not be the best option in the hot-humid climate of Darwin, or may struggle to heat effectively in the very cold conditions of Canberra or parts of New Zealand.

The impact of climate on an air conditioner's performance can be pronounced in cold temperatures. At temperatures of approximately 5.5°C and below, ice builds up on the outdoor heat exchanger and some units have inadequate defrosting strategies to deal with this. As a result, the capacity of the unit—and therefore the area or amount of space it can heat—may be dramatically impacted. In most cases, the heating output drops below the rated capacity (at 7°C), which is the main figure used to size products for installation, while the efficiency of the unit will also reduce at least slightly.

Currently, cold weather performance is indicated on the label on a voluntary basis (see on Figure 4 3.60 kW heating capacity at 2°C) in the form of a unit's kW heating capacity output at 2°C - referred to as the 'H2' test point. Equivalent energy efficiency information is not provided (i.e. electrical input at 2°C, from which energy efficiency performance can be calculated). Of the current 2539 air conditioner registrations[11], only 28 (around one per cent) make this voluntary declaration on the ERL.[12] A slightly higher proportion of units (104 models or around four per cent) voluntarily declare capacity output at H2 as part of their registration via the Energy Rating website. Information for these models is available online on downloadable spreadsheets, but most consumers would not have the time or understanding of the technical detail to comprehend the information due to the search costs (time and effort) involved, or even know to look for it.

Of the 104 registered models that provide H2 data, changes in heating capacity from the 7°C (H1) to 2°C (H2) test points range considerably - from a decrease of 43 per cent to an increase of 109 per cent[13]. Sixty-three per cent or 65 of the 104 models show a decrease in capacity. Energy efficiency reductions range from 6 per cent to 40 per cent, with an average reduction of 27 per cent. Note this sample data of H2 performance is likely to reflect the better performing products, as the models that experience significant drops in efficiency or output are presumably less likely to voluntarily declare performance at this test point.

Regardless, for over 95 per cent of products, consumers are unable to obtain information on the cold weather capacity output or energy efficiency performance of products. There appears to be a number of reasons that companies do not voluntarily declare performance in cold conditions:

- Products will often "look worse" in terms of output when compared with competing products that do not provide this information.
- To declare capacity at H2, a model's efficiency has to meet a particular MEPS level that some products do not achieve. This could mean a supplier is indirectly disclosing that some of their product range does not perform effectively in the cold if they provide data on H2 performance for only some of their models. However, based on the available information the H2 MEPS level does not appear to be stringent or binding as the vast majority of products that provide H2 capacity sit well above the MEPS level.

There is anecdotal evidence on product review websites and numerous threads on online forums such as Whirlpool where consumers are critical of the performance of air conditioners in cold temperatures. These forums enable consumers to share their experiences with products or particular technologies; for example inappropriate model or product selection and poorly performing products. Further, comments on these forums suggest that some installers do not select products suited to the local climate conditions. The Australian Competition and Consumer Commission has also received a small number of complaints about air conditioner performance in cold regions in recent years.

To address the significant problems with the current rating method and performance in cold conditions, this consultation RIS investigates the costs and benefits of adopting the Seasonal Energy Efficiency Ratio (SEER) test method. The SEER test method comprehensively measures a product's performance by taking account of energy efficiency across all temperatures over the course of a year, using a further two or more test points. The SEER test

[11] www.energyrating.gov.au as at 4 September 2014.

[12] Note these 28 units are supplied by two manufacturers. The manufacturer that supplies the majority of these products (24 of the 28) informed the Department of Industry, Innovation and Science in mid-2014 that they will be ceasing to make this declaration. No reason was provided.

[13] This can occur for variable speed units, where the inverters can run "over speed" in cold conditions to maintain or increase capacity.

method is already used in the United States of America (USA), China, the European Union (EU), Japan, South Korea and Canada and is due to be implemented or under consideration in Taiwan, Thailand, India, Vietnam Philippines, Singapore, Malaysia, Indonesia and Hong Kong. This covers all of the countries which export air conditioners to Australia. Alignment with the SEER test method will also provide the opportunity to significantly improve the provision of energy efficiency information to consumers on the proposed Zoned Energy Rating Label (Zoned Label). The Zoned Label and the SEER test method are discussed further in the Options section.

## Energy efficiency labelling – testing requirements, noise and scope

There is considerable scope to simplify the current labelling parameters. The ERL is:

- Mandatory for non-ducted single-phase[14] units;
- Prohibited for multi-split systems, due to practical considerations[15]; and
- Voluntary for ducted, commercial use and three-phase systems.[16]

However where the ERL is voluntarily applied, calorimeter room testing[17] is required, which can be difficult for ducted and some commercial use products (e.g. ceiling cassettes), due to the large size of these air conditioners. Calorimeter room testing is around five per cent more accurate than the alternate air enthalpy method[18]; however, it is also around three times more expensive. A likely consequence of this is that only six per cent of ducted products currently provide an ERL.[19] Non-labelled products can demonstrate compliance with MEPS using the air enthalpy test method.

It has also been argued previously that because three-phase, ducted or commercial use air conditioners are often sold by specialist retailers that do not display products in a showroom or are provided by builders/installers, consumers are not likely to see an ERL prior to purchase. However, there are various indications that the current scope of energy efficiency labelling is not meeting the needs of consumers or industry:

- Ducted air conditioners are often installed with very little information provided to allow the owner/user to assess their energy efficiency. If the unit had to be supplied with an energy efficiency label, builders and installers would be more likely to take energy efficiency and location specific performance into account in supplying or recommending products to their customers.
- Sections of the air conditioner industry have informally indicated support for labelling domestic ducted units. As per the point above, they point to split incentives that see builders seeking less expensive (and often less energy efficient) products, while owners/users are often indicating a preference for higher efficiency products.
- The lack of ERL information on most ducted units and the difficulty in comparing the energy efficiency of different models is a question/complaint that is often received via the Energy Rating website.

Website analytics reveal that between May and August 2015 the most popular product information on the Energy Rating website were the Frequently Asked Questions, comparison tool and star rating pages for air conditioners - which all appeared in the top ten. Further, about a third of consumers use the internet to research air conditioners before making a purchase.[20] Note that while it is not mandatory under the GEMS Act or New Zealand Regulations

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[14] Single-phase is the type of electrical connection generally used in household situations. As a general rule, this is capable of powering products below approximately 15 kW cooling capacity. Units larger than this use more electricity and will generally require a three-phase electricity connection.

[15] Registration of multi-split systems are based on the outdoor unit, however their exact performance depends on the combination of indoor units that form the system for the registration. Different installations will have different performance characteristics and it is impractical to require every combination to be labelled. Furthermore, many single-split indoor units are also used as part of a multi-split system, meaning one indoor unit would have to carry two or more different labels - which could cause consumer confusion.

[16] Note these categories are not mutually exclusive – for instance a ducted unit will often require a three-phase electrical connection. A ducted air conditioner has a unit that sits outside of the conditioned space and sends conditioned air through ductwork.
For the purposes of the current labelling requirements, a 'commercial use' product is a single-phase, non-ducted unit that is designed and promoted for non-residential applications only.

[17] A calorimeter room measures the performance of the equipment under test conditions by measuring and accounting for all of the energy flows on both sides of the equipment's refrigeration cycle. It uses a minimum of two precisely controlled chambers to simulate the indoor and outdoor environments. It is considered the most accurate measuring device, and while it is relatively simple and cost effective for small, simple equipment such as single split systems, testing large and complex equipment can become difficult and costly.

[18] Air enthalpy tests measure the temperature and humidity of air entering and leaving the equipment under test. From this, cooling or heating performance can be calculated. The setup of this test is relatively easy and inexpensive, even for large or complex equipment.

[19] www.energyrating.gov.au as at 10 April 2015. 65 of the 1010 registered ducted models (6 per cent) voluntarily provide an ERL.

[20] The Household Appliance Market in Australia: climate control, BIS Shrapnel, 2014, page 32.

for manufacturers or installers to provide energy rating information on their own websites, many suppliers do this for labelled products.

Finally, the noise generated by air conditioners is an issue in the community. It is a negative externality, as it is a cost of air conditioner use that can be borne by another party (e. g. a neighbour) that did not choose to incur that cost. A 2011 survey reported that five per cent of the population had been annoyed or bothered by air conditioner noise.[21] Those affected by air conditioner noise are often highly impacted, with the average duration per incident around 6 hours. Currently, New South Wales (NSW) and Western Australia have noise labelling schemes for air conditioners. Queensland and Victoria previously had noise labelling schemes but removed them in anticipation of a national scheme being implemented. However, work on an Australian national noise labelling scheme for air conditioners has stalled.

As a result, the Chair and Chief Executive Officer of the NSW Environmental Protection Agency (who was leading this work under the Council of Australian Government's (COAG) Standing Committee on the Environment and Water) wrote to the Secretary of the then Department of Industry in August 2014 and requested that the noise produced by air conditioners be considered by the E3 Program. Separately, suppliers have approached E3 requesting that the GEMS Act unify the disparate state and local government requirements into a coherent approach.

The GEMS Act has scope to deal with product performance issues like noise that are related to the energy efficiency of products. This is to mitigate the risk of an unintended consequence of products subject to energy efficiency requirements such as air conditioners. For example, manufacturers could develop energy efficient but noisy products.

As indicated, there are a number of reasons to re-examine the current labelling requirements. This RIS will consider options to reduce testing costs and, where it is cost effective, to maximise the provision of energy efficiency and noise information to consumers and installers through the proposed Zoned Energy Rating Label.

### Portable air conditioners

Portable air conditioners are an important component of the Australian air conditioner market. They are able to provide a heating/cooling service to the 25 per cent of Australian households that rent and therefore may not be in a position to install a fixed air conditioner. Portable air conditioning options are also important for low income households that may not be able to afford the higher upfront capital cost (including installation costs) of a fixed air conditioner. Double duct portable air conditioners are subject to energy efficiency requirements, whereas single duct portables are not.

A perverse outcome of the current requirements is that relatively energy efficient products such as double duct portable air conditioners appear unable to meet the MEPS levels set in 2011. Their compact, portable size means that they have small heat exchangers (a key determinant of an air conditioner's energy efficiency) and are unlikely to be able to meet current MEPS. There are currently none of these products registered and therefore available for supply in Australia or New Zealand. Yet double duct portables are often significantly more energy efficient than single duct portables, which are the other main portable option.

Single duct portable air conditioners are not subject to any requirements. They were excluded from earlier RIS assessments because a suitable test standard was not available and they were relatively new to the Australian and New Zealand markets, with minimal sales recorded in the early 2000s. However, a test standard was published in August 2015 and sales of single duct portables have ranged between 50 000 and 100 000 units per annum in recent years.

No change was made to the proposed requirements for double duct portables at the time of the previous RIS process, as it does not appear to have been an issue raised in consultation with stakeholders. Instead of improving the energy efficiency of double duct products to meet the new MEPS, relevant suppliers appear to have simply switched to supplying other air conditioning products (such as the unregulated single duct option). The E3 Program became aware of the lack of availability of double duct portables through the work on developing a portables test standard and is now seeking to address this issue.

Internationally, the EU implemented energy efficiency labelling for portable (single and double duct) air conditioners in 2002, with MEPS requirements introduced in 2013 and subsequently increased in 2014. The USA is currently investigating policy options for these products. Further, the E3 Program's Air Conditioning and

[21] Draft Consultation RIS: Noise Impacts from Air Conditioners and Portable Gardening Equipment, page iii, for COAG's former Standing Council on Environment and Water.

Commercial Refrigeration Advisory Committee (ACRAC – which is primarily made up of key industry stakeholders) wrote to the E3 Committee (the E3 Program's governing body) in March 2013 requesting that a test standard for single duct portables be developed and they be considered in the next air conditioner RIS.

There are a number of regional test standards that have been used to test and rate single duct portable air conditioners. However, these tests have largely been designed by the portable air conditioner industry to present their products as favourably as possible. This makes it difficult for regulators or law enforcers to take any action in relation to performance claims, as the products will often perform as claimed when measured according to a test designed by the industry.

Single duct portables are often inexpensive but are generally highly inefficient. Currently, unsubstantiated performance declarations are published that indicate these products provide a significantly more powerful and efficient cooling option than they are capable of providing. Therefore, information about single duct portables in stores and product literature is not able to be meaningfully compared with alternative air conditioning products. This, however, inevitably occurs - an example of this is shown in Figure 5 below.

**Figure 5 Aldi supermarkets catalogue, October 2015**


Sales catalogues like the above and in-store displays where single duct portable air conditioners and fixed air conditioners are displayed side-by-side are common. But while most of the performance information for the fixed air conditioner is standardised to allow consumer comparisons within this category, there are currently no requirements in relation to the disclosure of single duct air conditioner performance.

The advertisement in Figure 5 indicates that the single duct portable costs $A220 less than the fixed unit, is 52 per cent more powerful, will cool twice the space and requires no qualified installation. However, the performance (output and efficiency) claims for the single duct portable are not comparable to the fixed air conditioner, despite both products claiming to provide a similar service.

This is because portable air conditioners are tested differently to other air conditioning products. The single duct portable's performance information is likely to have been obtained from a test that measured the cold air produced. Fixed air conditioners are tested to measure their cooling effect on an enclosed space. These are very different tests – while a single duct portable may blow cold air onto a person, if its performance was tested in the same way as a fixed air conditioner it would possibly have a net heating effect on the room it was trying to cool.[22]

Laboratory testing of 10 single duct portable air conditioners was undertaken by the E3 Program in early 2014 to inform development of the portables test standard. This testing found that both the cooling output and energy efficiency of these models was around 25 per cent below supplier claims. This does not take into account the

[22] See for instance 'Energy Conservation Program for Consumer Products: Test Procedure for Portable Air Conditioners', USA Department of Energy, 10 CFR Part 430, 5 May 2014 http://doe.federalregisterwatch.com/a/2014/May-9/2014-10692/4

additional performance and capacity reduction that occurs from air outside the conditioned space being drawn in to replace the air expelled through the single exhaust duct. This factor significantly limits the ability of these products to provide an effective air conditioning service.

In a recent study, the USA's Department of Energy estimated that simply upgrading a single duct unit to a double duct configuration will dramatically increase performance for very little cost.[23] The addition of a second duct that utilises outdoor air to cool the condenser will yield an efficiency gain of 103 per cent for a retail price increase of around $US8 (from $US534 to $US542) – a price/efficiency ratio of 1:103 (i.e. a one per cent increase in price provides a 103 per cent increase in efficiency). However, as double duct portables are currently not available on the Australian and New Zealand markets, suppliers are unable to communicate the benefits of these products over the single duct varieties.

The problems arising from the current uneven testing and regulatory requirements are significant, as the portable air conditioning market is now comprised only of the relatively ineffective and inefficient single duct products. Therefore, this RIS plans to assess options that address the perverse outcomes of the current requirements.

### Requirements split between GEMS and NCC framework

Energy efficiency regulations for air conditioners have previously not been applied cohesively. In Australia, they are divided between the GEMS Act and the NCC:

- Systems up to 65 kW are regulated under the GEMS Act in Australia and by New Zealand's regulations;
- For systems above 65 kW, MEPS are specified in the NCC in Australia (which applies to new buildings only) and are not regulated in New Zealand.

Initial consultation on MEPS for air conditioners in 1994 recommended that the regulations apply up to 50 kW capacity, subject to further consultation and review.[24] Units beyond this size were deemed unsuitable for inclusion due to the large variety of configurations that made setting MEPS difficult. The subsequent policy document was released in 1998 and revised the scope to include products up to 65 kW.[25] The first MEPS requirements under the E3 Program were introduced in 2001.

Following this, international test standards (and Australian/New Zealand adoptions) were released that allowed larger air conditioners to be tested and rated. When governments decided to introduce MEPS requirements for larger air conditioners in 2006 (i.e. greater than 65 kW capacity), the most convenient way at the time for this to occur was through the NCC - which already specified installation requirements for air conditioners. However, the GEMS Act in Australia was specifically created to address the energy efficiency of appliances. The NCC is designed to regulate the construction of buildings and is better suited to specifying requirements in relation to the installation of fixed appliances, rather than efficiency requirements.

Further, the NCC covers new construction installations but not the replacement of air conditioners – whereas both are covered under the GEMS Act. Because of this, the NCC is estimated to apply to only around 50 per cent of installations in the 65 kW plus category – undermining the integrity of these requirements. Air conditioner industry bodies have cited examples of products being used in the replacement market that do not meet the NCC MEPS levels for new buildings (or new building works in existing buildings). The GEMS Act is also seen as having more effective compliance arrangements, due to its registration and check testing requirements.

The replacement market is important to consider as less energy efficient products are more likely to be installed. This is due to the tendency for 'like for like' installations – i.e. purchasing the same or similar product, rather than considering the pros and cons of alternatives to make an informed decision. A 'like for like' installation may be a valid market response if it is not cost effective to invest in other more energy efficient options. However, it could also be an adverse consequence of the replacement market being outside the scope of the NCC energy efficiency requirements.

Specifying the MEPS requirements in Australia in separate regulations may also have created additional regulatory costs, particularly where some product ranges are spread across both GEMS and NCC requirements. For instance,

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23 Technical support document: Energy efficiency program for consumer products and commercial and industrial equipment: portable air conditioners, February 2015, page ES-8.

24 'Energy Performance Standards And Energy Labelling For Industrial And Commercial Equipment' Energetics Pty Ltd and George Wilkenfeld and Associates, April 1994.

25 Proposed energy efficiency program for packaged air conditioners; Final report. Unisearch Limited and George Wilkenfeld and Associates. June 1998.

the Lennox Landmark series of packaged commercial air conditioners has models from 10.5 to 88 kW, splitting this range across both pieces of legislation.[26]

The dual legislative frameworks are also complex in relation to commercial VRF multi-split systems. The outdoor unit of these systems is rated using the specific combination of indoor units required for each unique commercial application, and each application will yield a different rated capacity. Therefore, a VRF outdoor unit can be subject to the GEMS Act for one installation and the NCC for another. This creates a complex regulatory environment for the companies affected.

Utilising the NCC to set energy efficiency levels for 65 kW capacity and above air conditioners that doesn't apply in New Zealand was a piecemeal response to a policy void. This RIS therefore seeks to rectify this historical anomaly.

### 'Part load' compliance option

Suppliers are currently able to register variable speed (inverter) products meeting 95 per cent of MEPS at 'full load' (i.e. full capacity) if they have good 'part load' (e.g. 50 per cent capacity) performance. This compliance pathway was made available as part of the introduction of MEPS requirements in 2001. The provision recognised that the then relatively new variable speed products could be more efficient when used at less than full capacity. Part load compliance currently requires:

- A mandatory test at 50 per cent of capacity for comparative purposes and as an option to meet MEPS requirements; and
- If the 50 per cent test result cannot demonstrate energy efficiency that meets MEPS requirements, an additional test between 50 and 99 per cent of capacity.

However, if the SEER standard and associated Zoned Label are adopted it will allow variable speed compressors to demonstrate their superior energy efficiency performance over fixed speed compressors, and incentivise improvements in part load energy efficiency performance. Thus, the rationale for the part load compliance pathway would no longer exist.

Further, the SEER standard only requires a 50 per cent test, so some products will still require an additional test for compliance under the part load pathway. Therefore, removing this option could reduce costs for suppliers by streamlining compliance arrangements. Removing the part load compliance option will also put the energy efficiency requirements for fixed and variable speed air conditioners on a level platform.

However, removing the part load compliance option will impact the approximately 15 per cent of current registrations that utilise this option to meet MEPS. Therefore, the benefits need to be considered with the costs arising from any adverse market or other impacts. This is particularly important for low priced models or models with other features that are valued by consumers.

Measures for addressing this problem will be considered in the policy options as required.

### Changes to Minimum Energy Performance Standards

#### Inconsistent MEPS levels

There are various areas of inconsistent and misaligned MEPS levels that have generally arisen due to energy efficiency requirements being set inconsistently. They include:

- MEPS are applied to double duct portable air conditioners but not single duct portables, as a suitable test standard was not previously available;
- Different MEPS are applied to fixed and variable speed air conditioners due to the current rating method not suiting variable speed products;
- Air conditioner MEPS levels are inconsistent across the separate GEMS and NCC legislative requirements. These differences have arisen because GEMS/New Zealand MEPS levels have been updated but NCC MEPS levels have not;
- Chiller MEPS levels are inconsistent across GEMS, the NCC and the updated levels specified in the internationally referenced US energy efficiency standard, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 90.1 (chillers are discussed in the next section). As with the point above, the NCC MEPS levels were not updated in line with GEMS/NZ requirements. The ASHRAE MEPS levels were updated in January 2013 and so the current Australian or New Zealand MEPS levels are not aligned; and

[26] www.heatcraft.com.au/component/docman/doc_view/176-lennox-landmark-packaged-rooftop-units

- New Zealand's residential air conditioning MEPS for cooling are lower than Australia's, reflecting New Zealand's heating dominated climate. However there are now very few products sold in New Zealand that do not meet Australian MEPS, so there is a limited need for the lower levels.

These inconsistencies can add regulatory costs to business and also result in less energy efficient products being selected by consumers or provided by agents (builders/installers) as a consequence of the differing requirements, rather than on the merits of the options.

Measures to address these inconsistencies will be considered in the policy options as required.

**General increase to air conditioner MEPS levels**

The 2011 Air Conditioner Decision RIS recommended indicative MEPS levels for consideration in the next review of regulations. This would involve a 10 to 20 per cent increase (depending on the product category) to the current full load MEPS levels for air conditioners.

Previous RISs identified that inefficient levels of peak electricity demand were a problem in Australia and increases to air conditioner MEPS were a policy response that could assist with addressing this issue.[27] Electricity demand typically peaks on a handful of days of extreme temperatures in summer, when air conditioning loads are highest. In Australia, a succession of hot summers and the rapid increase in the household penetration of air conditioners were significant contributors to maximum electricity demand rising steadily until 2008-09.

However, while maximum demand was projected to continue to rise it has since plateaued in both Australia and New Zealand. The Australian Energy Market Operator (AEMO) now forecasts maximum electricity demand will remain below historical peaks in most regions for at least the next 20 years (with Queensland the exception).[28] Further, more targeted policy responses to peak demand management are under investigation or being implemented.

This means that air conditioner MEPS increases to lessen their impact on peak demand are not expected to be required in most areas for the foreseeable future. Therefore, analysis of the MEPS levels is only included in the Impacts section to fulfil the previous Decision RIS recommendation – it will not be a policy option pursued as part of this RIS.

## Chillers

### Australia/New Zealand specific test standard

The *Greenhouse and Energy Minimum Standards (Liquid-chilling Packages Using the Vapour Compression Cycle) Determination 2012* offers flexibility for registrants to demonstrate compliance with MEPS. Registrants can provide:

- A physical test report to the local test standard AS/NZS 4776:2008; or
- A certification certificate from the USA's Air Conditioning, Heating and Refrigeration Institute (AHRI); AHRI certificates are the world's most commonly used compliance pathway and specifically certify performance equivalent to AHRI 550/590:2011; or
- A certificate from Europe's equivalent scheme, Eurovent.

However, there are problems with the local test standard. AS/NZS 4776 was based on a draft International Organisation for Standardisation (ISO) standard which was abandoned in 2013 and incorporates elements (such as rating conditions) of AHRI 550/590. It no longer covers all technology types and features and is causing difficulties for regulators and for the two percent of applicants that utilise this compliance pathway. For instance, AS/NZS 4776 has no means of interpolating energy efficiency ratings for products that are unable to be measured at the standard load points. It has therefore become necessary to either update AS/NZS 4776 or replace it. Further, suppliers need to obtain AS/NZS 4776 to know how to utilise the AHRI and Eurovent compliance pathways.

AHRI 550/590 was one of the early major standards to address chiller performance and has been adopted by many regions of the world. Currently, the USA, Canada, Japan, China and Chinese Taipei all use it to some extent. Of current GEMS chiller registrations, 73 per cent rely on AHRI certification. Australia and New Zealand's current rating conditions (e.g. testing temperatures) are based on this standard.

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[27] Successive increases to air conditioner MEPS levels through the 2000s indirectly targeted the increasing peak demand levels. These MEPS increases made a significant contribution to reducing the peak demand levels to below what they would have otherwise been.
[28] Australian Energy Regulator 'State of the Energy Market 2014', page 24.

The EU currently has voluntary performance disclosure through the Eurovent certification scheme, and MEPS requirements in the United Kingdom and France. The EU is in the process of phasing in uniform regulatory requirements from 2017. The Eurovent certification scheme was originally based largely on the AHRI testing and rating procedure. However, the EU has been developing their own test standards for chillers and air conditioners that will see their test standards significantly deviate from the rest of the world's testing and rating methods. Twenty-four per cent of GEMS registrations rely on Eurovent certification to AHRI and Australian/New Zealand conditions.

The RIS will therefore consider replacing the largely obsolete local test standard with the similar and widely used US test standard AHRI 551/591:2011. AHRI 551/591:2011 is the updated and metric version of AHRI 550/590:2003 (the standard that the NCC currently uses). This would apply to chillers currently within scope of the GEMS determination, along with including <350 kW capacity units currently under the NCC (if these are included under the GEMS/NZ requirements).

Adoption of the AHRI test standard for Australia and New Zealand is preferable to adopting the EU's. This is because the new European test standard uses different testing and rating points to the current Australian and USA test points. Adopting it would require all current registrations to submit new test reports to these different rating points. However, Eurovent certification will still be accepted to demonstrate performance to the existing Australian/New Zealand/AHRI 551/591 rating conditions. This approach is consistent with the Australian Government Industry Innovation and Competitiveness Agenda.[29]

### Requirements split between GEMS and NCC framework

As with air conditioners, specifying the MEPS requirements for chillers in separate regulations is the result of a piecemeal approach to energy efficiency policy development. When governments decided to address the energy efficiency of chillers, the most convenient way to do this was through the forthcoming iteration of the NCC which already specified the installation requirements. Therefore, in 2005 energy efficiency requirements were specified for chillers up to 125 kW in some types of buildings (classes 2, 3 and 4). In 2006, this was extended to other classes of buildings.

Around this time, E3 started to investigate options to improve the energy efficiency of chillers. The 2008 decision to apply MEPS to chillers larger than 350 kW under the E3 Program was made following consultation with industry and took into account the lack of local testing capacity for the smaller products (i.e. less than 350 kW). Subsequently, the 2010 review of the NCC resulted in a decision to fill the gap and include MEPS for 125 to 350 kW chillers. This approach is not ideal and does not utilise the respective strengths of the two regulations. This RIS seeks to rectify this historical inconsistency.

This split in requirements has also created unforeseen issues. An example of this is where some chiller product ranges are split across both GEMS and NCC requirements. This is particularly a problem for modular chiller systems. For example, one modular chiller range has a module capacity of 140 kW. Installing one or two of these means requirements are specified in the NCC, but installing three or more shifts the requirements to the GEMS Act. This means that a supplier may sell multiple modules to a company but cannot control if the product goes into an application of one or two where the NCC applies, or three or more where the GEMS Act applies. Simplifying the regulatory environment is likely to reduce costs for suppliers of these products and reduce the risk of non-compliance.

Further, specifying the MEPS requirements for chillers with less than 350 kW capacity in the NCC means that the replacement market for these products is not covered (estimated to be around 50 per cent of the market). As with air conditioners, this undermines the integrity of the NCC MEPS requirements for these products.

## Other policies that impact these problems

The problems outlined above relate to the regulatory failures or burden arising from the current energy efficiency requirements for air conditioners and chillers. Although these issues cannot be specifically addressed by other policies, other Australian or New Zealand government programs that will promote the adoption of more energy efficient air conditioning and chiller products are discussed below:

[29] Department of Industry, Innovation and Science website

## Commercial Building Disclosure program

In July 2010, the Commercial Building Disclosure (CBD) program commenced. It requires energy efficiency information to be provided when commercial office space of 2000 square metres or more is offered for sale or lease. The aim of the CBD program is to improve the energy efficiency of Australia's large office buildings by ensuring prospective buyers and tenants are informed about the building's energy efficiency performance. The information disclosed is based on measured and verified energy performance data, such as utility bills, and converting that into a star rating scale from one to six stars. By providing this rating information, CBD positively influences the energy efficiency performance of air conditioners and chillers that are within the program's 2000 square metre plus scope. This is estimated as chillers and air conditioning systems with an output of around 350 kW and higher.

## National Electricity Market rule change for cost reflective network prices

In November 2014, the Australian Energy Market Commission (AEMC) announced a rule change that requires regulated network companies to structure their prices to better reflect the consumption choices of individual users. Under the changes, network prices will better reflect the actual costs of providing electricity to consumers at different times and in different locations. These changes will enable consumers to see the value of their choices – such as decisions to purchase more energy efficient appliances, particularly energy intensive appliances like air conditioners. The AEMC rule change positively supports the objectives of this RIS. Network businesses are required to have the new price structures start no later than 2017. The pricing structures and prices must be approved by the Australian Energy Regulator (AER) to ensure that they adequately manage the transition of customers to the new prices, have been developed with effective customer consultation and meet other related requirements.

## Emissions Reduction Fund

The Emissions Reduction Fund (ERF) commenced in late 2014. The ERF is designed to provide incentives for achieving lowest cost emissions reduction activities across the Australian economy. A number of methods have been approved for use under the ERF, including building and industrial energy efficiency which allow for upgrades to heating, ventilation and cooling systems. These methods ensure that emissions reductions are genuine—that they are both real and additional to business as usual operations. More new methods are now being developed to further expand the coverage of the ERF, such as methods to incentivise more energy efficient commercial appliances (including air conditioners and chillers). These methods have the potential to positively influence the adoption of energy efficient products by increasing the sales of these products above what would have otherwise occurred (business as usual), however the methods will not address the issues identified in this RIS.

## Building energy ratings and audits

EECA Business in New Zealand have a NABERSNZ™ (National Australian Built Environment Rating System New Zealand) programme. Commercial buildings can gain a certified rating to benchmark the building or tenancy for its energy efficiency. Along with energy audits, this can encourage building owners to improve the energy efficiency of their air conditioning systems.

# 3. Objective

## Why is government action needed?

The objective of the proposed government action is to address issues with the current requirements that impede the supply and/or purchase of energy efficient or effective air conditioning products.

Government action is needed to address regulatory failures with the current energy efficiency requirements for air conditioners and chillers. In some circumstances, the requirements are distorting the market for these products. For instance:

- The current energy efficiency rating method, used for the ERL, has not kept pace with technology changes and hence does not provide some important information about the relative energy efficiency and running costs of different air conditioning options;
- Consumers are being supplied with or purchasing air conditioners that may not be suited to their location, despite potentially being presented with a high star rating or capacity output figure on the current ERL;
- The scope of the current energy efficiency labelling requirements appears to be inadequate;
- The current regulations inhibit the ability of consumers to purchase relatively energy efficient portable air conditioners;
- Consumers are unable to meaningfully compare the energy efficiency and capacity of portable air conditioners with other types of air conditioners;
- MEPS requirements for air conditioners and chillers are divided between the GEMS Act and NCC in Australia, which may impose additional regulatory costs for some suppliers;
- MEPS requirements for air conditioners and chillers covered by the NCC in Australia do not apply to the replacement market for these products and do not apply at all in New Zealand;
- The Australia/New Zealand specific test standard for chillers results in higher regulatory burden than is necessary – this can be removed without jeopardising energy efficiency outcomes;
- MEPS requirements for air conditioners are inconsistent across portable products; fixed and variable speed air conditioners; the GEMS Act and NCC; and Australia and New Zealand; and
- Chiller MEPS requirements are inconsistent across GEMS, the NCC and the updated levels due to be implemented in the USA.

The objectives of this RIS are consistent with Principle 6 of the COAG RIS Guidelines. This principle seeks the review of regulation "with a view to encouraging competition and efficiency, streamlining the regulatory environment, and reducing the regulatory burden on business arising from the stock of regulation". The proposals in this Consultation RIS are also aligned with the Australian Government Industry Innovation and Competitiveness Agenda[30].

Without government action, the market distortions and unnecessary regulatory costs arising as a result of the current energy efficiency requirements will continue.

[30] www.dpmc.gov.au/publications/Industry_Innovation_and_Competitiveness_Agenda/index.cfm

# 4. Options

## Policy options under consideration

The following policy options are considered to address the problems identified in this RIS:

- No changes to the existing requirements - **Business as Usual** (BAU);
- **Option A** involves reforming the existing requirements to address the problems and inconsistencies identified earlier in the RIS. The focus of this 'light touch' regulatory option is to improve the provision of energy efficiency information to consumers of air conditioning products. It is also designed to limit the cost impacts on suppliers by not proposing any increases to the current MEPS levels. Option A includes:
  - Remove the current Australia/New Zealand specific rating method AS/NZS 3823.2, used for the ERL, and adopt the SEER standard AS/NZS 3823.4[31] for products less than 30 kW capacity;
  - Remove the existing ERL and replace it with a Zoned Label;
  - Expand the scope of energy efficiency labelling requirements and reduce the associated compliance costs;
  - Lower the MEPS on double duct portable air conditioners;
  - Apply the Zoned Label to single and double duct portable air conditioners;
  - Remove the Australia/New Zealand specific test standard for chillers and align with the US test standard; and
  - Remove the energy efficiency requirements for air conditioners and chillers from the NCC and include them under the E3 Program.
- **Option B1** builds on Option A by including all of its elements but also includes addressing the lack of alignment of various MEPS levels. In doing this, option B involves higher costs for suppliers compared with option A but will also provide greater benefits in terms of energy savings than option A. Option B1 also includes:
  - Align MEPS for air conditioners greater than 65 kW capacity to match the current levels for 39 to 65 kW capacity units (i.e. AEER/ACOP 2.90);
  - Align MEPS levels for chillers to the updated MEPS levels specified in the US standard ASHRAE 90.1:2013 where the US levels are higher;
  - Introduce a MEPS level for single duct portable air conditioners that is aligned with the EU;
  - Align New Zealand's cooling MEPS for air conditioners to Australia's levels; and
  - Align the MEPS levels for fixed and variable speed air conditioners by removing the option for variable speed products with good 'part load' performance to comply if they meet 95 per cent of the 'full load' MEPS level.
- **Option B2** is the same as option B1 except that it includes applying the SEER rating method to all air conditioners, rather than only 30 kW capacity units and below. In developing the policy options there was less certainty about the need for this proposed change, which is why it has been separately identified.

[31] The new SEER standard is essentially a calculation standard that uses test results from the three existing Australian/New Zealand test standards (AS/NZS 3823.1.1 for non-ducted air conditioners, AS/NZS 3823.1.2 for ducted air conditioners and AS/NZS 3823.1.4 for multi-split air conditioners). Note the climate files, temperature bins and operating hours are being examined following industry feedback and the availability of updated climate files.

The reform options include various deregulatory aspects to reduce costs for both business and consumers where possible and to improve energy efficiency outcomes. The options are summarised in Table 4 and discussed below in further detail.

**Table 4 Policy options**

| Reform proposal | Option A | Option B1 | Option B2 |
|---|---|---|---|
| 1. For air conditioners (A/C) adopt the SEER standard AS/NZS 3823.4 for rating products with capacity up to 30 kW. | X | X | X |
| 2. Remove the existing Energy Rating Label (ERL) and replace it with a Zoned ERL that provides energy efficiency information for three distinct climate zones across Australia and New Zealand to A/C with capacity up to 30 kW. Air enthalpy tests would be accepted for ducted, three-phase and certain 'commercial use' products. Multi-split systems would continue to be excluded from physical labelling but would be subject to the SEER standard, with rating information for the registered combination made available on the Energy Rating website. | X | X | X |
| 3. Double duct portable A/C subject to the SEER standard AS/NZS 3823.4, Zoned Energy Rating Label and a reduced MEPS level of 2.60 based on AEER/ACOP. Single duct portable A/C subject to Zoned Energy Rating Label (with proxy for operating time data) and tested to AS/NZS 3823.1.5. | X | X | X |
| 4. Remove the unique Australian/New Zealand chiller test standard and align with US test standard AHRI 551/591:2011. | X | X | X |
| 5. Include the energy efficiency requirements for A/C >65 kW capacity and chillers <350 kW under GEMS/NZ regulations and in Australia remove these from the NCC. | X | X | X |
| 6. Retain current NCC MEPS levels under GEMS/NZ regulations (refer to Table 5 and Table 6 for proposed levels). | X | | |
| 7. Align >65 kW A/C MEPS levels to 39 to 65 kW GEMS MEPS (i.e. AEER/ACOP 2.90). Align chiller MEPS levels to the US energy efficiency standard ASHRAE 90.1:2013 where the US levels are higher (refer to Table 7 for the proposed levels). | | X | X |
| 8. Single duct portable A/C subject to a MEPS level of 2.60 based on AEER/ACOP. | | X | X |
| 9. Align New Zealand's residential cooling MEPS to match Australia's levels. | | X | X |
| 10. Align the MEPS levels for fixed and variable speed air conditioners, by removing the 'part load' compliance option. | | X | X |
| 11. SEER rating of A/C ≥30 kW capacity, with rating information made available on the Energy Rating website. | | | X |

## Business as Usual

Under BAU, the energy efficiency benefits of the existing requirements continue to accrue as the existing stock of air conditioners and chillers is turned over and replaced by more energy efficient products that meet the current MEPS levels. Further, the natural improvement in the average energy efficiency of air conditioners and chillers is projected to continue. Another factor that contributes to improvements in energy efficiency are increases in energy efficiency regulations overseas that flow through to the stock of air conditioners and chillers in Australia and New Zealand.

The BAU option assumes no changes to existing requirements in Australia and New Zealand. Details of the existing requirements are set out below, so that they can be compared with the proposed changes in the policy reform options.

## Air conditioners

- Requirements are specified under the GEMS Act in Australia and by New Zealand's regulations for units up to 65 kW capacity.
- Units above 65 kW capacity are not regulated in New Zealand. In Australia, MEPS are specified in the NCC - which applies to new buildings only. The MEPS in the NCC are lower than the closest size category covered by the GEMS Act.
- MEPS requirements for units up to 65 kW capacity are based on a full load Annual Energy Efficiency Ratio (AEER) for cooling at 35 °C (T1) and a full load Annual Coefficient of Performance (ACOP) for heating at 7°C (H1). The "Annual" refers to the average of a year's worth of hourly inoperative power (standby and crankcase heater power), which is added to the power input of the EER and COP equation. This effectively raises the MEPS for a unit's operating efficiency. MEPS requirements in the NCC for >65 kW units are based on EER and COP only.
- A part load MEPS compliance option is provided for variable speed models. This means that suppliers only have to achieve 95 per cent of the full load (i.e. 100 per cent capacity) MEPS level if the unit demonstrates good energy efficiency at part load (i.e. 50 to 99 per cent capacity).
- New Zealand's cooling MEPS requirements for most domestic sized units remain unchanged from their April 2011 levels and are therefore not aligned with Australia.
- The current ERL continues to be applied and is mandatory for non-ducted single phase units (excluding those deemed for commercial use), but not multi-split systems.
- The current ERL for ducted units, commercial use units and three-phase units remains voluntary. However if the ERL is applied, the information provided must be based on calorimeter room testing, which is often impractical for ducted, three-phase and commercial use units due to their large size.

## Portable air conditioners

- Single duct units are not subject to any requirements.
- Double duct units are subject to MEPS and labelling requirements. These units can be tested to the non-ducted test standard AS/NZS3823.1.1 (similar to a window/wall air conditioner). However, due to their compact, portable size they have small heat exchangers. This means these units appear unable to meet the current MEPS levels - no products of this type are currently registered for supply in Australia/New Zealand.

## Chillers

- MEPS requirements apply to units above 350 kW. They are required to meet both:
  - COP – the ratio of full load cooling capacity divided by power input (the same as EER for air conditioners which measures cooling efficiency, whereas COP for air conditioners measures heating efficiency); and
  - IPLV (Integrated Part Load Value) – a 'seasonal' metric that combines energy efficiency at 25, 50, 75 and 100 per cent load points.
- In New Zealand, units below 350 kW are not regulated. In Australia, MEPS for both COP and IPLV are specified in the NCC, which applies to new buildings only.
- A unique Australian/New Zealand standard (AS/NZS 4776) is used under the E3 Program, whereas the US standard AHRI 550/590:2003 applies under the NCC (i.e. two different test standards). The Australian/New Zealand Standard no longer covers some of the recent technology changes in the chiller market. While AS/NZS 4776 provides the option of using Eurovent or AHRI certification to demonstrate compliance with MEPS, suppliers need to obtain the standard to know how they can utilise these alternate compliance pathways.

# Option A – Zoned label adoption, international alignment, streamline requirements and address issues with portable air conditioners

Option A is aimed at addressing the problems with the current requirements – the relevant reform proposals are outlined below.

## Adopt the Seasonal Energy Efficiency Ratio (SEER) rating method and Zoned Label and expand the scope of energy efficiency labelling

The first reform proposal under option A involves:

- Removing the current Australia/New Zealand specific rating method AS/NZS 3823.2 and adopting the SEER standard AS/NZS 3823.4[32] for rating products less than 30 kW capacity;
- Removing the existing ERL and replacing it with a Zoned Label; and
- Expanding the scope of energy efficiency labelling requirements and reducing the associated compliance costs.

This proposal is explained further below.

**Remove the current Australia/New Zealand specific rating method and adopt the SEER standard**

The new SEER standard AS/NZS 3823.4 published in October 2014 is a significant improvement on the current Australia/New Zealand specific rating method AS/NZS 3823.2 as it takes account of the impact of climate on the efficiency and output of an air conditioner. It does this by assessing efficiency across all temperatures over the course of a year, which can then be applied to a given area's climate data. This is achieved by testing at a number of temperatures at both full and part loads and extrapolating this into a curve of performance that covers all temperature points.

The SEER standard is an adoption of an ISO standard 16358 *Air-cooled air conditioners and air-to-air heat pumps – Testing and calculating methods for seasonal performance factors*. The Australian/New Zealand version uses measured performance at internationally standardised test points, weighted for local climate files.[33] Overseas versions of this standard use the same test points, but weight the results against their own climate files.

Adopting the SEER standard aligns with the Australian Government Industry Innovation and Competitiveness Agenda.[34] This policy commits Australian regulators not to impose any additional requirements if a system, service or product has been approved under a trusted international standard, unless good reason can be demonstrated. As stated, the only change in the Australia/New Zealand version of the ISO SEER standard was to include the necessary local climate information. This means that where a SEER test has been conducted overseas, suppliers do not need to repeat the test for Australia/New Zealand. The Australia/New Zealand SEER test standard was published in October 2014[35] and is therefore available to be 'called up' by regulation if required. Adoption of the SEER standard is considered the only viable option to address the problems with the current rating method. Further, mandatory adoption of the SEER standard is considered necessary to ensure that all products are able to be compared – otherwise it is likely that suppliers will only make information available for their relatively more energy efficiency products.

Strong feedback from the Air Conditioner Consultation RIS in 2010 was received from industry supporting adoption of a SEER test standard. This suggestion was not adopted in the subsequent Decision RIS, as the international SEER standard was still being drafted at the time. However, the feedback resulted in a recommendation to investigate adopting the SEER standard in the next review of the requirements.

**Remove the existing Energy Rating Label and replace it with a Zoned Energy Rating Label**

Alignment with the SEER test standard also provides the opportunity to significantly improve the provision of energy efficiency information to consumers and installers via the proposed Zoned Energy Rating Label (Zoned Label). The Zoned Label is intended to show the impact that climatic conditions have on the energy efficiency and performance (i.e. capacity) of air conditioners. It will do this by displaying the SEER based efficiency and annual energy consumption of a product across three distinct climate zones in Australia and New Zealand. The Zoned Label concept is shown in Figure 6.

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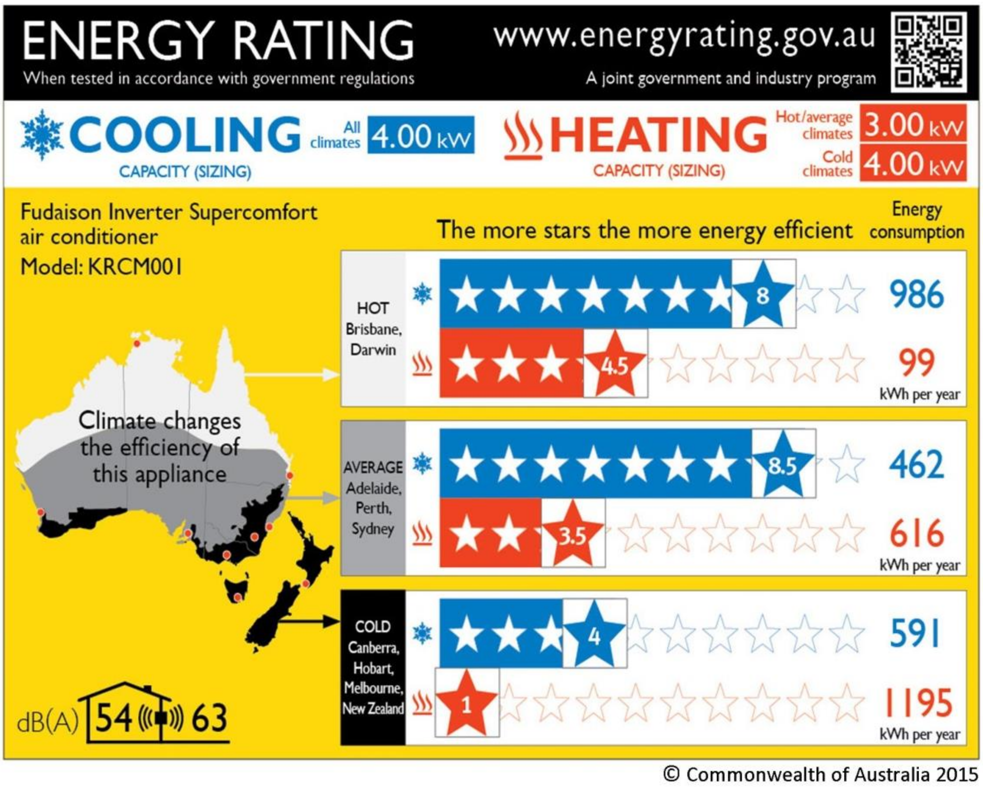
[32] The new SEER standard is essentially a calculation standard that uses test results from the three existing Australian/New Zealand test standards (AS/NZS 3823.1.1 for non-ducted air conditioners, AS/NZS 3823.1.2 for ducted air conditioners and AS/NZS 3823.1.4 for multi-split air conditioners).

[33] A climate file consists of historic, hourly weather observation data (e.g. dry bulb temperature). SEER standards around the world use Typical Meteorological Year (TMY) files for a given locality. These are obtained by analysing historical weather data and choosing the 'most typical', or average, monthly file and combining them into a year. This climate data is then used to 'weight' the efficiency of an air conditioner against the time spent at each temperature point for that location.

[34] www.dpmc.gov.au/publications/Industry_Innovation_and_Competitiveness_Agenda/index.cfm

[35] http://infostore.saiglobal.com/store/

**Figure 6 Zoned Energy Rating Label**




Energy labels incorporating maps and climate specific information are being introduced internationally. The EU introduced their SEER label for air conditioners in January 2013[36] and for all space heating[37] and water heating[38] products in September 2015. In January 2015, the USA implemented a map-based label to display SEER ratings as well as their regional performance standards.[39] This international adoption acknowledges the importance of physically displaying the impact climate can have on the energy efficiency and performance of air conditioners.

A Zoned Label will:

- Indicate the differences in energy efficiency dependant on installed location, discouraging products that are not suited to certain climates from being marketed there and promoting manufacturer innovation in designing products to be efficient and perform effectively in warmer and colder climates;
- Show annual energy consumption in a consistent way;
- Allow covered appliances that provide a space conditioning service to be meaningfully compared; and
- Provide opportunities for additional information to be accessed, including an online calculator (for instance by the inclusion of a QR code).

The Zoned Label is intended to provide consumers and advisers (i.e. retailers and installers) with the enhanced information made available by the adoption of the SEER test standard. This will improve the information available on the current ERL (full load performance at 35 °C and 7 °C or the T1 and H1 test points) by giving a star rating that takes into account the varied efficiencies of products at full and part load across an average year, using the relevant representative climate files.

For the Zoned Label, the locations that will represent the three climate zones are those specified in the SEER standard:

- The 'hot/humid' zone is based on the Typical Meteorological Year (TMY) file for Rockhampton, Queensland. Rockhampton is situated on the Tropic of Capricorn and is located geographically and meteorologically between the milder climates of the heavily populated south-east of the zone and the sparsely populated northern tropical areas.

[36] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011R0626
[37] http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1440476886208&uri=CELEX:32013R0811
[38] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R0812
[39] https://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/75

- The ‘mixed’ zone is based on the TMY file for Richmond, New South Wales. The mixed zone covers a large population and represents areas where both very hot and very cold weather can be encountered. As heating performance at H2 is important for determining seasonal performance, it is desirable to have a representative location that has an adequate number of hours at lower temperatures for this performance to be demonstrated. Coastal locations tend to have milder overnight temperatures, so Richmond, which is slightly inland, allows the calculation of seasonal performance at both low and high temperatures.
- The ‘cold’ zone is based on the TMY file for Canberra, Australian Capital Territory. In addition to a high annual heating load, Canberra experiences many hours within the critical frosting temperature range. Locations closer to the coast, while still having a high annual heating load, will not adequately demonstrate seasonal energy consumption that reflects H2 performance. Canberra also has a sufficient number of cooling hours to allow meaningful cooling performance to be demonstrated. This is not the case for the colder, largely unpopulated alpine and sub-alpine regions of Australia.

Declaration of product capacity at 2 $^{o}$C (the H2 test point) as well as 7 $^{o}$C (H1) will be mandatory to ensure consumers in cold areas can select a product that will be suitable for heating (as well as maintaining a sufficient capacity) in these conditions. Using the Zoned Label alone will allow consumers and advisers to more readily select a product suited to their location.

By providing the three zones with three different heating and cooling profiles it enables the supply of an annual energy consumption figure (in kWh). The current ERL is relying solely on full load single temperature point testing, whereas the Zoned Label will draw on both the enhanced testing data from the SEER standard as well as the climate zones. The zones will also separate products used mainly for cooling, mainly for heating and for both. The energy consumption figures will take into account both efficiency at different temperature points and hours of use data from the SEER standard calculated by specifying the annual number of hours at various temperature points for the three zones. A certain load is assigned to each temperature point that reflects that an air conditioner is not required to work as hard when the outside temperature is, for example, 25 $^{o}$C rather than 35 $^{o}$C.

Providing this information simplifies the process for consumers to estimate the total (purchase and running) costs of a product. While this has not been possible under the existing rating and labelling scheme, the enhanced testing and performance data from the SEER standard will better illustrate the potential for running cost savings on higher efficiency products and enable consumers to better understand the potential energy use of the products they are considering purchasing.

For consumers and advisers who are more engaged in their purchasing decisions, the addition of a QR code will link directly to an online tool (or provide an option for a smartphone application) that can use Global Positioning System (GPS) or keyed in postcode to use climate data more specific to their actual location. This data is available for each of the 69 Nationwide House Energy Rating Scheme (NatHERS) zones for Australia and 18 Home Energy Rating System (HERS) zones for New Zealand. Energy tariffs and location optimised operating hours would pre-fill but be editable for those requiring greater insight. A feature like this would make decisions between a cheaper, less efficient model and a more expensive but more efficient option easier by providing likely life cycle costs.

The Zoned Label will also require the disclosure of indoor and outdoor sound power levels (also required by the EU’s air conditioner label) in order to assist consumers who consider noise an important consideration for either amenity reasons, or to meet body corporate or local or state government requirements.

The Zoned Label aligns with the Australian Energy White Paper policy position that “Consumers should be empowered to make better choices to manage their energy costs and use”.[40] The Zoned Label will help to ensure consumers are able to more easily compare the energy costs of different air conditioning options. The Zoned Label is also aligned with achieving overall economic efficiency:

- Productive efficiency – while the Zoned Label will involve some regulatory costs, it does not impose increased production costs.
- Allocative efficiency – by improving the allocation of air conditioning products across different climate zones, it strongly fits with this criterion.
- Dynamic efficiency – it provides an incentive for manufacturers to innovate and produce products that perform best in particular climates.

The development of an Australian and New Zealand Zoned Label has involved extensive design and research stages. Label design options were drafted and tested in a range of locations across Australia and New Zealand. This

[40] 2015 Energy White Paper, page 16.

work has examined the best way to display the climate information that will be meaningful to both consumers and the range of advisers who supply or recommend these types of products.

Following several rounds of qualitative and quantitative testing that involved appliance installers, retailers and consumers; a single draft zoned design was selected and has since been agreed to by the E3 Committee. The reports from these tests are available on the Energy Rating website. The Zoned Label will continue to undergo minor amendments based on feedback, and additional refinement and research work will continue to develop the Zoned Label and the focus of any accompanying education campaigns. Further detail on the work to develop the Zoned Label is at Attachment A.

**Expand the scope of energy efficiency labelling requirements and reduce compliance costs**

The scope of the energy efficiency rating and labelling program could be expanded as part of any change to a Zoned Label. The proposed policy change will be to make application of the Zoned Label mandatory for all air conditioners with an output of up to 30 kW. This would incorporate ducted, three-phase and commercial use units below the 30 kW threshold – for which labelling is currently voluntary.

Multi-split air conditioners would continue to be excluded from physical labelling, due to the practical issues with requiring these products to be labelled.[41] However, they would be subject to the new SEER standard and sound power testing on the outdoor unit and this performance (based on the registered combination) would be disclosed on the Energy Rating website as indicative performance.

The proposed 30 kW output threshold covers the maximum output of air conditioning systems that are marketed to households. From 30 kW and above, suppliers are able to demonstrate compliance with MEPS through simulation testing. This is proposed to continue, as it becomes increasingly difficult and expensive to physically test air conditioners larger than 30 kW.

The requirement for calorimeter room testing for application of the ERL to ducted and commercial use air conditioners will also be removed as part of this proposal. Instead, air enthalpy tests will be permitted. Air enthalpy tests are more practical and less costly (approximately one third of calorimeter room testing costs), but approximately five per cent less accurate than calorimeter room testing. Air enthalpy tests can currently be used to demonstrate MEPS compliance (but not for use of the ERL). Calorimeter room testing will be maintained for non-ducted, single phase units as per the current requirements. Calorimeter room check tests will also be maintained as the preferred compliance check-test method when practical, due to their slightly greater accuracy.

**No changes to the current MEPS requirements**

Adopting the SEER test standard and Zoned Label for rating the energy efficiency of air conditioners will not result in any change to existing MEPS requirements, which will be maintained at the current AEER/ACOP levels. These requirements ensure a minimum level of efficiency at full load (maximum) performance at the two test points of T1 (35°C) and H1 (7°C) (for each for cooling and heating). Note that under the proposed SEER based rating scheme, improvements in the energy efficiency performance of products (as measured at full load) beyond the MEPS level would not be incentivised to the current extent. This is because performance at T1 and H1 would no longer be the sole factor determining the energy efficiency star rating.

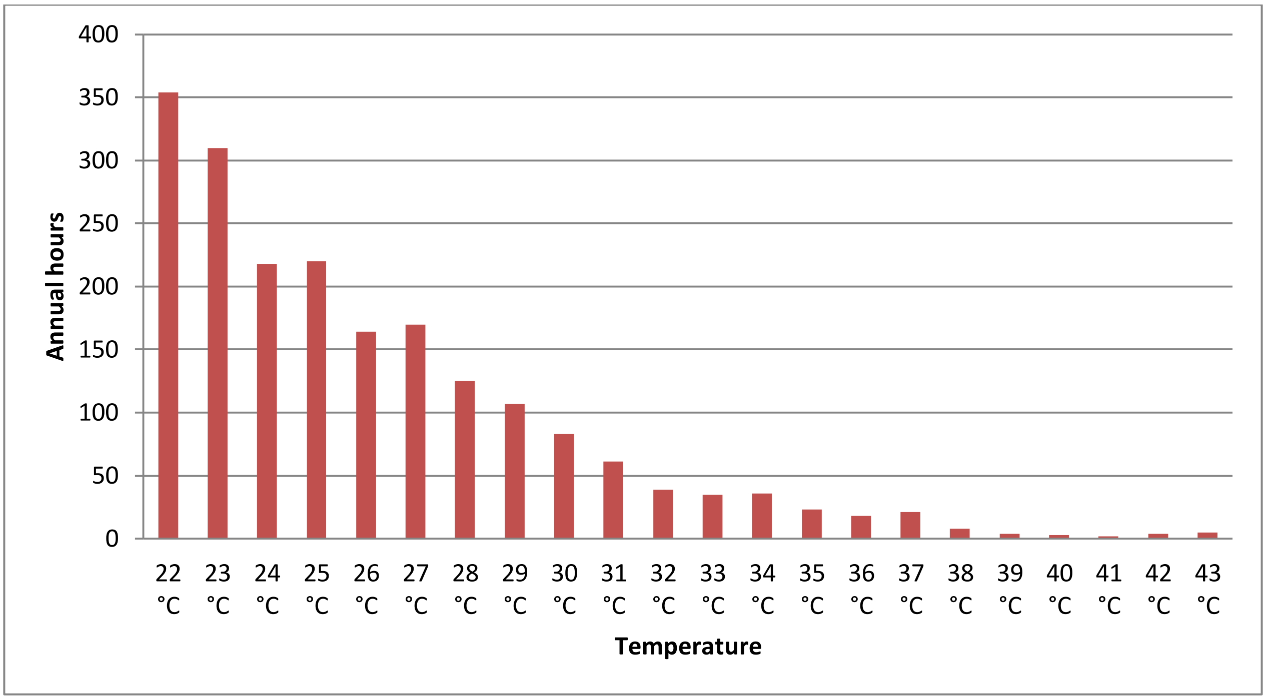
The MEPS requirements at 35°C and 7°C are a critical feature of the current energy efficiency policy settings. Over the course of a year, electricity demand generally peaks on a small number of days with extreme temperatures - when air conditioning loads are highest. The AER[42] states that since 2008-9, maximum electricity demand has plateaued. However, Victoria and South Australia recorded an increase in maximum demand in 2013-14, peaking during one of south east Australia's most significant heatwaves on record. The AER[43] notes that maximum electricity demand on 16 January 2014 approached but did not reach historical levels, partly because the heatwave occurred during a holiday period when commercial and industrial loads are lower. This recent event highlights the need to maintain the current MEPS settings for air conditioners, so as not to risk an adverse outcome for peak electricity demand.

[41] Registration of multi-split systems are based on the outdoor unit, however their exact performance depends on the combination of indoor units that form the system for the registration. Different installations will have different performance characteristics and it is impractical to require every combination to be labelled. Furthermore, many single-split indoor units are also used as part of a multi-split system, meaning one indoor unit would have to carry two or more different labels - which could cause consumer confusion.

[42] Australian Energy Regulator, State of the Energy Market 2014, page 23.

[43] Australian Energy Regulator, State of the Energy Market 2014, page 24.

**Figure 7 Typical annual temperature frequencies, Richmond NSW**




A move to a SEER based MEPS would risk increasing peak electricity demand, as air conditioning units are likely to be tuned for peak cooling performance at lower temperatures - which occur far more commonly across the year. As an example, Figure 7 above shows that in the Richmond climate zone (which includes the large population west of Parramatta to the edge of the Blue Mountains in New South Wales) there are a limited number of hours at 35 $^{o}$C compared with the number of hours 30 $^{o}$C and below.

Issues with SEER based MEPS have occurred in overseas markets. To address this, the US Department of Energy (which had implemented a SEER based MEPS) re-introduced EER based MEPS requirements on air conditioners sold into the hot/dry states (e.g. Arizona) from January 2015 in order to improve energy efficiency performance at 35$^{o}$C.

Further, due to the wide variation in climate across Australia and New Zealand, selecting a climate file to base the SEER MEPS on would be difficult. A 'hot' climate file may penalise air conditioners that are primarily designed as heaters, while a 'cold' climate file may penalise products that are designed as coolers. Setting different SEER MEPS levels for different geographic locations is also not considered practical under the GEMS Act as it regulates the supply of products (not their installation) and a supplier cannot stop a product from being sold in one location but installed elsewhere.

Finally, implementing a SEER based MEPS would be difficult without SEER rating registration information based on Australian and New Zealand climate data. Furthermore, it is possible that fine-tuning for the new seasonal test could see existing products rapidly achieve higher SEER values than may otherwise be expected. This means that appropriate SEER based MEPS levels would only become apparent after collecting registration data for two or three years following the introduction of the proposed new rating method.

## Portable air conditioners – Zoned Label and lower MEPS for double ducts

This reform proposal includes:

- Lowering the MEPS on double duct portable air conditioners; and
- Applying the Zoned Label to single and double duct portable air conditioners.

### Lower MEPS for double duct portable air conditioners

Under this proposal, the AEER and ACOP MEPS level for double duct portables will be lowered from 3.10 to 2.60, to match the current cooling MEPS level for single and double duct air conditioners sold in the European Union.[44] This proposal is necessary because double duct portable air conditioners appear to have been unavailable on the

[44] Commission Regulation (EU) No 206/2012 of 6 March 2012.

Australian/New Zealand market since at least the last MEPS increase in 2011. There are no products of this type registered with the E3 Program.

This is a perverse outcome of the current requirements, as double duct portables have the ability to be significantly more efficient than the single duct portables that now dominate this segment of the air conditioner market. These products are particularly suitable for renters that are not allowed to install a fixed air conditioner, and low income households unable to afford the generally higher upfront capital cost (including installation costs) of a fixed air conditioner.

**Apply the Zoned Label to portable air conditioners**

Applying the Zoned Label to portable air conditioners will assist consumers to compare the energy efficiency of these products with other portable units as well as other types of air conditioners (i.e. single splits). Double duct portables will be tested to the new SEER standard, with the Zoned Label to replace the ERL that currently nominally applies. Single duct portables do not currently have any requirements for energy efficiency labelling, but will be required to be tested to the new standard AS/NZS 3823.1.5 (published in August 2015) and to apply the Zoned Label.

The new Australian/New Zealand standard accounts for the unit leaking hot air and radiating heat into the room. This provides a more meaningful measurement of the cooling output of a single duct portable than other regional test standards. However, the new standard applies the principles used in two European test standards that negate the effect of hot outside air being drawn into the cool inside room – the main drawback of single duct portables. To address this, a theoretical cooling/heating capacity correction could be applied to single duct units based on the measured exhaust airflow of each unit (this data is already recorded through the test standard). Then the energy ingress per litre per second that is being drawn into a room could be deducted. Some technical questions in relation to how this could work are outlined in the Consultation section.

The new test standard for single duct portables is also not comparable to the SEER test standard. Firstly, the portables standard only tests full load performance at 35 °C for cooling and 20 °C for heating, while the SEER standard tests at different loads and temperatures. Secondly, the SEER standard additionally applies a load to each temperature based on how hard the air conditioner will have to work to meet the load.

This means that to make the information included on the Zoned Label for single duct portables comparable to other air conditioners, running hours will be based on the same cooling/heating hours per zone (adjusted for the likelihood of a unit actually being switched on). For instance in the Richmond climate file (Figure 5 above), cooling hours at the lower end of the temperature scale will be reduced. The SEER test standard achieves a similar outcome by applying a building load that recognises that at milder temperatures, an air conditioner will not have to work as hard.

In conjunction with the new test standard, these steps will ensure the performance (in terms of both efficiency and output) of single duct portables is adequately reflected on the Zoned Label and can be effectively compared to other air conditioners subject to labelling requirements.

Some portable air conditioners (both single and double duct) have a supplementary water evaporation feature that temporarily increases energy efficiency and capacity. The EU labelling scheme allows these types of products to use this temporary performance for meeting MEPS and labelling requirements, as long as the supplementary water tank lasts for four hours or more without being refilled. However, this RIS proposes that labelled performance is based on the maximum continuous performance. The presence of a supplementary water evaporation feature could be noted on the Zoned Label and the additional, temporary performance could be displayed on the online comparison tool on the Energy Rating website.

## Alignment with the US test standard for chillers

This reform proposal also forms part of option A and involves removing the flawed Australian/New Zealand test standards for chillers and adopting a US test standard - the American National Standards Institute (ANSI)/AHRI 551/591:2011. Note that this is the newer, metric version of the standard that the NCC uses for chillers with less than 350 kW capacity.

Adopting the US test standard for chillers is also aimed at reducing regulatory costs for suppliers and is in line with the Australian Government Industry Innovation and Competitiveness Agenda. The current MEPS levels for chillers will remain unchanged under this option, as will the option of demonstrating MEPS compliance through Eurovent or AHRI certification.

### Remove the energy efficiency requirements for air conditioners and chillers from the NCC and include them under the GEMS Act in Australia/extend to New Zealand's Regulations

Under this proposal (the final component of option A), the energy efficiency requirements for air conditioners with a capacity greater than 65 kW and for chillers with less than 350 kW capacity will be removed from the NCC in Australia and included instead under the GEMS Act. In New Zealand, the existing energy efficiency regulations will be extended to cover the relevant product categories (i.e. air conditioners >65 kW and chillers <350 kW).

The MEPS levels specified in the NCC will be unchanged if transferred to the GEMS Act in Australia, and the NCC MEPS levels for these size categories will be applied in New Zealand. Air conditioner MEPS levels are specified in Table 5 below while chiller MEPS are specified in Table 6. Consultation with industry so far indicates a move to specify all energy efficiency requirements under the GEMS Act for all air conditioning and chiller products is widely supported.

**Table 5 Proposed MEPS levels for air conditioners >65 kW (Option A)**

| Rated cooling capacity | Cooling only AEER* | Reverse Cycle AEER/ACOP* |
|---|---|---|
| 65-95 kW | 2.70 | 2.60 |
| >95 kW | 2.80 | 2.70 |

** Note that the NCC only specifies cooling energy efficiency levels based on EER. Option A will align with the current GEMS and New Zealand regulations in terms of being based on AEER and ACOP (where applicable).*

**Table 6 Proposed MEPS levels for chillers <350 kW (Option A)**

| Chiller type | COP | IPLV |
|---|---|---|
| <350 kW air cooled | 2.50 | 3.40 |
| <350 kW water cooled | 4.20 | 5.20 |

## Option B1 – Zoned label adoption, international alignment, streamline requirements, address issues with portable air conditioners and MEPS alignment

In addition to the reform proposals discussed above (zoned label adoption, international alignment, addressing issues with portable air conditioners and streamlined requirements) that form option A, option B1 includes proposals to align and simplify the current MEPS levels. These proposals are outlined below for the various product categories.

### MEPS alignment - air conditioners and chillers

Under this proposal, the MEPS levels for air conditioners greater than 65 kW capacity (currently specified in the NCC) will be increased to match the current levels specified for 39 to 65 kW units under the GEMS Act (i.e. AEER/ACOP of 2.90).

The MEPS levels for chillers with less than 350 kW capacity will be aligned with the updated MEPS levels specified in the internationally referenced US energy efficiency standard (ASHRAE 90.1:2013) where this is feasible. This international alignment of the current Australian/New Zealand MEPS levels is proposed, rather than the potential future MEPS levels that were proposed for the category in AS/NZS 4776.2:2008.

ASHRAE 90.1 is a building code that specifies minimum energy efficiency levels for a number of 'built in', or 'fixed' appliances. It specifies chiller MEPS levels for both COP and IPLV. The US Department of Energy issued an affirmative determination in relation to ASHRAE 90.1 in September 2014 indicating that the updated standard would achieve greater energy efficiency in buildings subject to the code. Following this determination, each State is required to certify within two years (i.e. September 2016) that the provisions of its commercial building code regarding energy efficiency meet or exceed the revised standard.[45]

Note that ASHRAE 90.1 allows two application specific compliance pathways - one with higher COP MEPS levels and another with higher IPLV MEPS levels. This RIS proposes to specify IPLV and COP MEPS levels based on the lowest of the respective US levels. This is because it is difficult for suppliers to ensure compliance with requirements that are application specific, as once a supplier has sold a product to a customer they generally do not control how the product is used. MEPS are applied to the act of supply or the intent to supply, so the multiple compliance pathways based on end use outlined in AS/NZS 4776.2:2008 (similar to ASHRAE 90.1) are not considered feasible.

MEPS levels will be increased where they are higher than the current Australian/New Zealand MEPS, with the current chiller size categories to be maintained. This will increase MEPS levels for some size categories while leaving others unchanged. This is outlined in Table 7.

**Table 7 Proposed MEPS levels for chillers (Option B1/B2)**

| Size (kW) | Cooling medium | Current COP | Proposed COP | COP % increase | Current IPLV | Proposed IPLV | IPLV % increase |
|---|---|---|---|---|---|---|---|
| <350* | Air-cooled | 2.50* | 2.87 | 15 | 3.40* | 4.05 | 19 |
| 350-499 | | 2.70 | 2.87 | 6 | 3.70 | 4.05 | 9 |
| 500-699 | | 2.70 | 2.87 | 6 | 3.70 | 4.14 | 12 |
| 700-999 | | 2.70 | 2.87 | 6 | 4.10 | 4.14 | 1 |
| 1000-1499 | | 2.70 | 2.87 | 6 | 4.10 | 4.14 | 1 |
| >1500 | | 2.70 | 2.87 | 6 | 4.10 | 4.14 | 1 |
| <350* | Water-cooled | 4.20* | 4.51 | 7 | 5.20* | 6.14 | 18 |
| 350-499 | | 5.00 | 5.00 | 0 | 5.50 | 6.14 | 12 |
| 500-699 | | 5.10 | 5.10 | 0 | 6.00 | 6.46 | 8 |
| 700-999 | | 5.50 | 5.50 | 0 | 6.20 | 6.52 | 5 |
| 1000-1499 | | 5.80 | 5.80 | 0 | 6.50 | 6.77 | 4 |
| >1500 | | 6.00 | 6.00 | 0 | 6.50 | 6.91 | 6 |

** MEPS levels currently specified in the NCC in Australia.*

## MEPS alignment - single duct portable air conditioners

Under this proposal, the EU MEPS level of 2.60 that is proposed for double duct portable air conditioners in option A will be extended to also cover single duct portable air conditioners. As per option A, MEPS and zoned labelling performance will be based on the maximum continuous performance, with the presence of a supplementary water evaporation feature noted and referenced on the registration website. The scaling of operating hours and star rating algorithms will be investigated to ensure they reflect that single duct portables draw unconditioned, outside air into the room, unlike other air conditioning products. However, a MEPS level of 2.60 will mean that a capacity correction method may not be necessary, as this is likely to remove the majority of single duct portable products from the market.

## MEPS alignment – air conditioners in New Zealand (cooling)

This proposal will mean that New Zealand's cooling MEPS for air conditioners are aligned to match Australia's. Currently, cooling MEPS levels in New Zealand are lower than for heating (which are fully aligned with Australia) on some classes of air conditioners, whereas in Australia the heating and cooling MEPS levels are the same. This policy change will allow air conditioner suppliers to treat Australia and New Zealand as a single market in terms of

[45] https://www.energycodes.gov/determinations

MEPS requirements and improve the cooling efficiency of available products for New Zealand households. About 2 per cent of sales in New Zealand would be affected by the proposed change, based on 2014 sales data.

### MEPS alignment – fixed and variable speed air conditioners

Under this reform proposal, the option for air conditioner suppliers to register variable speed (inverter) models that meet 95 per cent of MEPS at full load (i.e. 100 per cent capacity) if they have good part load performance, will be removed. Part load performance can be demonstrated at any point between 50 and 99 per cent of full load.

Removing this provision will simplify the current requirements, which will allow faster approval and auditing processes. It should also be noted that if the part load provision is retained, it will have to be modified to suit the proposed adoption of the SEER test standard AS/NZS 3823.4. Retaining the part load compliance option will mean that an additional test point may be required for registration and compliance, beyond what is needed for the SEER standard. This is because the SEER standard measures part load performance at 50 per cent of capacity and at this point some products may not demonstrate MEPS compliance.

For the air conditioning industry, the part load provision has been contentious as the MEPS levels are effectively more stringent for fixed speed air conditioners. The previous Consultation RIS recommended the removal of this option, but the Decision RIS retained the allowance. This was because removing the part load option prior to the introduction of the SEER could have had the perverse effect of removing products from the market that are more energy efficient on an annual basis than some other products that would remain available.

Approximately 15 per cent of current registrations are utilising the part load option to meet MEPS requirements. Removing this option will further increase the minimum energy efficiency of air conditioners on the market, but it could also increase the average purchase price of the models that are affected.

### Maintain current rating requirements

Under option B1, the existing energy efficiency rating requirements for all units greater than 30 kW output will be maintained.[46] This is because SEER rating may not be necessary in this market, as these larger air conditioners are not sold to households. This policy change will therefore be examined separately in option B2.

## Option B2 – Option B1 plus SEER rating for all air conditioners (i.e. including units with greater than 30 kW capacity)

In addition to the reform proposals outlined in option B1, option B2 includes the rating of air conditioners greater than 30 kW capacity using the new SEER test standard AS/NZS 3823.4. This will replace the AEER/ACOP rating method that is currently used.

Under this proposal, the comparison tool at Energy Rating will make SEER data available for all air conditioners larger than 30 kW, including the disclosure of energy efficiency and output at the H2 test point. This is important information for many parts of Australia and all of New Zealand. Note that it is not proposed to require sound power tests for these larger products.

This option will allow assessment of the costs and benefits of extending SEER testing to air conditioning units that are primarily used in the commercial market. As outlined earlier in this RIS, the current rating method is not necessarily a good indicator of energy efficiency and performance over the course of a year. The provision of the extra information afforded by the SEER testing and rating method will allow installers, owners, designers and architects to make more informed decisions when selecting an air conditioner.

Further, there appears to be similar or greater potential for split incentives (building owners purchasing products with lower capital costs that are also less energy efficient – for which they do not bear the operating costs) in the 30 kW plus market for commercial buildings (such as shopping centres and office buildings) than in the residential sector (below 30 kW). Data was difficult to locate, but one source indicates that only 22 per cent of commercial buildings are privately owned/occupied.[47] Data could not be found for industrial buildings, but due to the often specialised nature of activity in these buildings it could be expected that a higher proportion would be owner occupied than in the commercial sector.

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[46] The existing rating requirements are based on full load (maximum) performance at the two test points of 35 °C and 7 °C (one each for cooling and heating).

[47] 22 per cent of commercial property is privately owned/occupied - NSW Office of Fair Trading, Regulation of Commercial Property Agents Under the Property Stock and Business Agent Act 2002, Discussion paper.

However, the market for 30 kW plus capacity air conditioners is likely to be more sophisticated than the less than 30 kW capacity products that are generally sold to the household market. This is due to the higher cost of these systems, in terms of both capital and running costs. Therefore this reform proposal has only been included as a sub option, so that the costs and benefits can be separately identified.

# 5. Impacts

This section identifies who in the community is likely to be affected by each option. It outlines the costs and benefits for each option, as well as the distribution of these costs and benefits.

## Business As Usual

### Evaluation

Under BAU, there is no change to the current requirements for air conditioners and chillers. This means that the energy efficiency benefits arising from the existing requirements continue to accrue. The service life of air conditioners and chillers means that older, less energy efficient products are being replaced over time with newer products that meet the current energy efficiency requirements. Further the current ERL, despite its issues, is still enabling consumers, installers and manufacturers to buy or supply increasingly energy efficient products.

Table 8 shows an evaluation of the benefits, costs and energy and emissions savings associated with the current regulations for air conditioners and chillers.[48]

**Table 8 Evaluation of impacts – air conditioners and chillers**

| Indicator | 2008 to 2015 | | 2008 to 2020 | |
|---|---|---|---|---|
| Country | Australia | New Zealand | Australia | New Zealand |
| Energy Savings (GWh cumulative) | 2,321 | 195 | 7,157 | 621 |
| Emissions Savings ($CO_2$-e cumulative) | 2.3Mt | 30kt | 6.8Mt | 90kt |
| Benefits | $1.0bn | $109m | $1.7bn | $189m |
| Costs | $0.5bn | $43m | $0.8bn | $84m |
| Net Present Value | $0.6bn | $65m | $0.9bn | $104m |
| Benefit : cost ratio | 2.1 | 2.5 | 2.1 | 2.2 |

The evaluation indicates that up to 2015, significant energy and emissions savings have been realised in a cost-effective manner. Up to 2015, the policy interventions are estimated to have delivered a net benefit of around $600 million in Australia and $65 million in New Zealand. The cumulative emissions savings up to 2015 are estimated at around 2.3 million tonnes $CO_2$-e in Australia and 30 kilotonnes $CO_2$-e in New Zealand. Based on current sales trends, these benefits are projected to continue to increase out to 2020.

The evaluation made use of the cost assumptions in the previous RISs. This is because it is difficult to establish a relationship between price and efficiency, which could be used to calculate any increase in product costs due to increased MEPS levels. Yet it seems reasonable to assume some costs exist. The inability to find a relationship is likely because the price of air conditioning has declined over time, a trend unrelated to improvements in the average efficiency of products.

Compared to what was projected in the RIS documents, the benefits are projected to be around 36 per cent lower for air conditioners in Australia. This is because sales in the 2009 and 2010 RISs were projected to be around 1.25 to 1.4 million units per annum in 2020, while the sales in 2020 are now projected to be around 40 per cent lower. The sales of air conditioners in the period 2007 to 2010 were growing at 5 to 6 per cent per annum and the

[48] The evaluation is in 2014 dollars and covers the decision to implement policy interventions for chillers in 2008 and air conditioners in 2009 and 2010. The evaluation estimates were produced by EnergyConsult.

projections in the RISs were based on these high levels of sales growth. However, sales growth from 2010 to 2013 has decreased or flattened, so this lower growth trend has now been factored into the evaluation.

Note that as the benefits and costs of the current requirements accrue under BAU, they do not form part of the cost benefit analysis of the policy options in this RIS. The net benefit shown is in comparison to a counter-factual scenario of what could have occurred in the absence of the energy efficiency requirements.

## Reform opportunities

However, under BAU the market distortions and unnecessary regulatory costs arising from the current requirements will also continue, which may be harming overall economic efficiency. These include:

- The current ERL continues to apply. For consumers the current ERL does not provide them with some important information, such as energy efficiency performance relevant to their location and indicative annual energy consumption. For suppliers, the current rating method is likely to impose additional costs as it is out of step with other major economies and markets.
- Double duct portable air conditioners are likely to remain unavailable on the Australian and New Zealand markets. For suppliers, this means they are unable to import or sell these products. Customers such as renters and low income households that do not have the option or ability to install a fixed air conditioner are restricted to inefficient and ineffective single duct portable products. Further, other consumers that would like to purchase a double duct portable product are unable to have their preference met.
- The NCC energy efficiency requirements for air conditioners and chillers only cover new buildings. For customers, this means those that purchase or are supplied with a replacement air conditioner or chiller which is not within the scope of the NCC energy efficiency requirements may face lower upfront costs but higher running costs than necessary.[49] Suppliers of products that are covered by the NCC or outside of the scope of the NCC will continue to incur lower regulatory costs compared with suppliers of products covered by GEMS.
- The inconsistent MEPS levels that currently apply will continue. Customers that purchase or are supplied with products that are subject to the inconsistencies and distortions in the current energy efficiency requirements may face lower upfront costs but higher running costs than necessary. For suppliers of products not currently within the scope of the requirements or suppliers of products that will need to take action to comply with any revised MEPS levels, costs will remain unchanged.
- For chillers, suppliers and regulators will continue to encounter problems with the outdated Australian/New Zealand test standard.

This RIS therefore considers policy options to address these issues and improve the requirements, consistent with COAG Best Practice Regulation Principle 6 “ensuring that regulation remains relevant and effective over time”.

# Option A

Under option A, the impacts of the individual policy proposals will be:

Replace ERL with a Zoned Label

- For consumers this will significantly improve the current information available about the running costs of air conditioners, by displaying the seasonal energy efficiency and energy consumption of products across three climate zones in Australia and New Zealand. The Zoned Label will also provide information about the noise produced by air conditioners. It is likely to result in a small increase to the upfront cost of air conditioners in the short term as there will be implementation costs borne by suppliers. However, as the underpinning SEER test standard aligns with the approach used in most other major economies, it is not expected to involve significant implementation costs for most suppliers. This is because where a test has already been conducted for another market, suppliers do not need to repeat the test for Australia/New Zealand.

[49] This is in line with standard economic analysis, which suggests that energy efficiency policy interventions bring the market to a new equilibrium where appliances have higher upfront prices and lower operating costs. However, some studies suggest that prices do not increase as forecast due to regulation (e.g. MEPS requirements) inducing innovation by suppliers. See for instance ‘A retrospective investigation of energy efficiency standards: policies may have accelerated long term declines in appliance costs’, Buskirk, Kantner, Gerke and Chu, 2014.

- Further, noise tests are generally performed for overseas markets, state-based environmental protection requirements or for inclusion in marketing material. A standardised and streamlined approach to noise disclosure will allow for the removal of differing state requirements and assist local government to enforce noise laws more effectively. For suppliers, adoption of the SEER standard and Zoned Label is also likely to give energy efficient and/or relatively quiet products an advantage, and conversely disadvantage suppliers of energy inefficient or noisy products. By disclosing capacity and energy efficiency in cold climates, the Zoned Label will also advantage suppliers of products that perform effectively in cold conditions (and vice versa).

Expand the scope of energy efficiency labelling to apply a Zoned Label to products up to 30 kW capacity

- For consumers, this will significantly improve the information available about the energy efficiency and noise of those air conditioners to which the current ERL does not apply (ducted, commercial use or three-phase air conditioners - note these categories are not mutually exclusive). For consumers, it will also increase the upfront costs of these products as suppliers respond to the new labelling requirements. However, these cost increases will be limited by allowing suppliers to use the more appropriate air enthalpy test method to apply the Zoned Label to these product categories. Expanding the scope of energy efficiency labelling will also be likely to increase the sales of suppliers of relatively more energy efficient products (and vice versa).

Single duct portable air conditioners subject to a Zoned Label

- For consumers, again this will significantly improve the information available about the energy efficiency and noise of these products. For consumers it will also increase the upfront costs of these products, due to the new requirement to carry out energy efficiency and noise tests and apply the Zoned Label. For suppliers, application of the Zoned Label is expected to increase costs and significantly reduce the sales of single duct portables by highlighting the poor energy efficiency and cooling performance of these products. Suppliers with higher efficiency products may be able to market their better products more effectively and differentiate themselves from poor models by using a trusted, government operated labelling scheme.

Double duct portable air conditioners subject to a Zoned Label and reduced MEPS of 2.60

- Double duct portables will re-enter the market, which will provide consumers, in particular renters and low income households, better access to affordable and relatively energy efficient portable cooling options. The Zoned Label will improve the information available to consumers about the energy efficiency and noise produced by these products. The requirement to apply the Zoned Label will increase the upfront cost of these products for consumers, due to the implementation costs that will be borne by suppliers to transition from the current ERL. For suppliers, reducing the MEPS level to make double duct portables available will increase sales of these products.

Remove energy efficiency requirements for air conditioners and chillers from the NCC and include these under the GEMS Act/New Zealand regulations

- For customers that purchase or are supplied with products that will now be within scope, the requirements will act to lower running costs but increase upfront costs. For suppliers, this change will increase costs for those businesses supplying products that are out of scope or in the replacement market that currently do not need to comply with the GEMS Act or the New Zealand regulations. Further, this change will involve some initial implementation costs for suppliers, as those responsible for ensuring compliance with requirements in Australia are used to referring to the two set of regulations. It will also result in new compliance costs for suppliers in the replacement market in Australia and for suppliers in the size categories not covered by MEPS in New Zealand.
  - The E3 Program is not aware of any air conditioner suppliers in Australia that do not currently need to deal with both the NCC and the GEMS Act. However, the E3 Program is aware of some chiller companies that only supply products in Australia with an output less than 350 kW, and so currently only need to deal with the NCC. Incorporating all chillers under the GEMS Act will allow, for example, modular systems (less than 350 kW capacity) to be dealt with holistically

whereby the base module could be subject to GEMS requirements, while systems made of these modules will not require further registration.

Remove the outdated Australian/New Zealand test standard for chillers and align with the USA test standard

- This will involve implementation costs for the two percent of applications from suppliers that currently only test to the Australia/New Zealand standard, which may increase the cost of these products. However, it will also reduce regulatory costs for the other 98 per cent of suppliers that currently need to purchase the Australian/New Zealand standard to know how to utilise the alternate Eurovent or AHRI compliance pathways. Alignment with the USA test standard will also remove duplicate testing costs incurred by some suppliers, which will act to reduce the upfront cost of these products for consumers.

# Option B1

In addition to the impacts in option A, option B1 includes:

- Align all chiller MEPS to revised ASHRAE levels due to be implemented in all US states by September 2016.
- Align >65 kW air conditioner MEPS levels from Australia's NCC to the 39 to 65 kW GEMS MEPS level (i.e. AEER/ACOP of 2.90).
- Single duct portable air conditioners regulated for MEPS of 2.60.
- Align New Zealand's residential cooling MEPS to match Australia's levels.
- Air conditioner MEPS levels must be met i.e. remove the option to comply with 95 per cent of MEPS for variable speed products with good efficiency at part load (part load compliance).

The impacts of these individual policy proposals will be similar. Where MEPS levels are raised or expanded in scope, the proposals will increase costs for suppliers that do not meet the revised standards by requiring them to source or manufacture products that comply. For customers, the proposals are likely to reduce running costs for affected products through improved energy efficiency, but increase upfront costs.

# Option B2

In addition to the impacts in options A and B1, option B2 includes:

- SEER rating of air conditioners with capacity greater than 30 kW.

For suppliers of these products, there will be implementation costs associated with adopting the SEER rating method. SEER rating is the preferred method internationally, so for many suppliers it is not expected to significantly increase costs. For customers, disclosure of SEER rating information (via either the registration website or voluntary application of the Zoned Label) is likely to reduce running costs, by encouraging suppliers to provide more energy efficient products at a higher upfront cost. Disclosure of SEER rating information will tend to advantage suppliers of more energy efficient products (and vice versa).

# Cost Benefit Analysis

The cost benefit analysis of the policy options is outlined in this section. The analysis was prepared by the consultancy firm Energy Consult, who have significant experience and expertise in the air conditioning sector. The full methodology and analysis is available in Attachment B.

## Method for calculating energy and greenhouse gas impacts

### Energy consumption

The energy used by air conditioners and chillers is a function of average electrical input power, number of operating units and average number of hours of operation. In turn the greenhouse gas (GHG) emissions are a function of energy consumption and the emission factors determined by the electricity generation mix.

To calculate the energy consumption under the BAU and policy scenarios, a detailed and elaborate stock model of units installed and operating was developed. The number of operating units in a particular year is a function of existing stock, replacements and new sales. Estimates of stock and sales were made for Australia and New Zealand, as detailed in the stock and sales section. Units were also retired from operation according to a "survival function" that reflected the life span of typical equipment. These life spans were developed in previous RISs and updated in consultation with Australia and New Zealand suppliers in workshops and interviews. Hence, a complete stock model of the air conditioner and chiller market was developed by state/region and year, with additional details such as category, capacity range, average efficiency (at multiple load points and standby power) and year of purchase or installation. These units were multiplied by BAU and policy average power input figures at various load points and corresponding average number of hours of operation for each category/load point to obtain the total energy consumption by state, category and capacity range.

It is worth noting that operating hours vary according to the state/region and if operating in the business or residential sector. In addition, the proportion of time operating at various load points also varies depending on the region where the equipment is installed.

To determine the average BAU input power to the air conditioners, data on the rated efficiency of the units was used. The input power to air conditioners is a function of the COP (heating efficiency) and/or EER (cooling efficiency). The COP/EER and heating or cooling capacity in kW are the commonly used technical attributes of air conditioners. For chillers, the COP and the IPLV is used as the measure of efficiency. The input power in kW for each load point can be calculated as:

$$\text{Input Power (kW)} = \frac{\text{Cooling/Heating Capacity (kW)}}{EERorCOP}$$

Standby and crankcase power consumption (or non-operational power) was also used in the calculations of total annual energy consumption for air conditioners.

The BAU average efficiency was determined from sales weighted average or model weighted average EER/COP over the last 10 years (or from when the products were registered), and projected to 2030 with an autonomous annual efficiency improvement of between 0.25% and 0.5%. Efficiency increases due to the current Australian/New Zealand MEPS were included in the BAU average efficiency. The average efficiency of the units as a result of the policy options being assessed was determined on the basis of the increase in sales weighted average EER or COP at each load point (or COP/IPLV for chillers), due to the scenario being examined for each particular category and capacity range.

Energy consumption was determined for the BAU and policy scenarios. The difference in the projections of energy consumption provided the net energy savings used to calculate the impacts reported later in this section.

**Greenhouse Gas Emissions**

GHG can be determined by multiplying the energy used by the air conditioners by the relevant emission factor for the state in which they operate. The emission factor refers to the amount of greenhouse emissions produced through the supply of a given unit of electricity. In the model, the GHG emissions were estimated by using the state/region energy calculations combined with the GHG Emissions Factors listed in Attachment B.

A financial analysis has been conducted on the societal cost benefits of the proposals being reviewed, with the analysis conducted at the state and national level. In the analysis the following costs and benefits are included:

**Costs:**

- To the consumer, due to increases in the upfront price of products reflecting costs passed on by suppliers;
- To government for implementing and administering the requirements; and
- To the product supply businesses for complying with the new or modified regulatory requirements of the program (i.e. testing, administration and training for modified or new product categories).

**Benefits:**

- To the consumer, due to improving the information available for comparing the energy efficiency of products and the improved energy efficiency of available products resulting in avoided electricity purchase costs;
- To government from simplification of the regulatory framework;
- To suppliers from simplifications to the regulatory framework; and
- To society from reduced GHG emissions.

In terms of an approach for the cost-benefit analysis, it is necessary to do this from either a consumer or societal perspective. The social approach is the appropriate methodology for the analysis, but the consumer approach can be used where it approximates the results that would be obtained from the societal perspective. As electricity prices closely reflects the marginal cost of producing electricity, due to generators providing power in response to a competitive bidding system for the wholesale energy market, the market price can be used as a proxy for the resources saved in production. Consequently, the results should closely resemble those that would be obtained from an analysis from the social perspective.

An analysis from a consumer perspective involves the use of retail product prices and marginal retail energy prices. Since the objective is to assess whether product buyers (consumers) as a group would be better off, transfer payments such as taxes are included. The analysis includes retail mark-ups and taxes that will be passed onto the consumer and including these in the costs will simplify the analysis process, while still remaining appropriate.

All Net Present Value (NPV) figures are real 2014 dollars. NPV is a calculation that allows decision makers to compare the costs and benefits of various alternatives on a similar time scale by converting all options to current dollar figures. NZ values are shown in NZ dollars, calculated with an exchange rate of 1.08 NZD to AUD (average over 2014) where necessary.

## Key inputs

The various inputs are detailed below and are derived from available data, industry interviews or where necessary, realistic assumptions.

The data research used was obtained from multiple sources (past RIS analysis, industry data/interviews, published sources, and unpublished industry data) and checked with industry in a series of interviews and a workshop. The interviews were conducted with over 25 suppliers from Australia and New Zealand during late 2013 and 2014. They followed a structured interview guide to obtain information on the market trends, lifetimes of products, shares of sales to business vs. residential sectors, efficiency trends, price trends, size trends and technology barriers to greater energy efficiency.

An industry workshop was also undertaken in April 2014, where the preliminary stock and sales numbers for the modelling were presented and feedback sought. This workshop was attended by 50 stakeholders and feedback was obtained over the day, and during discussions by telephone and in person at the Air Conditioning, Refrigeration and Building Services conference in May 2014.

In the case of New Zealand stakeholders, another set of interviews were conducted in 2014 to obtain feedback on the preliminary modelling results for New Zealand. As a result of these interviews and workshops, the model parameters were adjusted.

These are outlined in Table 9 below.

## Table 9 Assumptions and model parameters

| KEY FEATURES | MODEL PARAMETER |
|---|---|
| **Scenarios** | Several policy options (shown below) were combined in multiple scenarios:<br>**Option A**: Zoned label adoption, international alignment, streamline requirements and address issues with portable air conditioners<br>➢ For air conditioners (A/C), adopt seasonal energy efficiency rating standard AS/NZS 3823.4 that takes account of climate and includes mandatory zoned labelling up to 30 kW.<br>➢ Single duct portable A/C subject to zoned labelling (with proxy for operating time data) and tested to AS/NZS 3823.1.5. Double duct portable A/C subject to zoned labelling to SEER standard AS/NZS 3823.4 and a reduced MEPS of 2.60.<br>➢ Multi-split systems subject to the SEER standard.<br>➢ Include A/C >65 kW capacity and chillers <350 kW under GEMS and remove these requirements from the National Construction Code (NCC). Retain current NCC MEPS levels (see Table 5 and Table 6).<br>➢ MEPS for A/C <65 kW maintained at current AEER/ACOP levels.<br>**Option B1**: Option A + MEPS alignment<br>➢ Align >65 kW a/c MEPS levels to 39-65 kW GEMS MEPS (i.e. AEER/ACOP 2.90). Align all chiller MEPS to US levels if higher than current Australian levels (see Table 7 for the proposed MEPS levels).<br>➢ Both single and double duct portable A/C regulated for MEPS of 2.60.<br>➢ Align New Zealand's residential cooling MEPS to match Australia's level.<br>➢ A/C MEPS levels must be met i.e. remove the option to comply with 95 per cent of MEPS for variable speed products with good efficiency at part load (part load compliance).<br>**Option B2**: Option B1 + SEER rating for all AC<br>➢ SEER rating of A/C >30 kW (with voluntary labelling). |
| **Sales** | Historical sales based GfK sales data from 2003 to 2014 and industry data for categories not covered by GfK.<br>Forecast sales based on projected trends and industry feedback on these trends presented at workshops and by interviews in 2014. |
| **Projection Period** | 14 years (2017-2030, cohort ending in 2050)<br>14 years was chosen as the modelling period as the zoned label will significantly affect product purchases over at least 5 years after implementation and have a continuing effect over the following 10 years. Cohort modelling refers to tracking the effect of the products installed up to 2030 for their remaining lifespan, which ranges from 10 to 20 years.<br>This approach has been used to capture the ongoing savings of the policy induced technology changes installed in the period up to 2030. |
| **Efficiency** | Historical EER and COP values are sales weighted or model weighted from 2000 to 2014, based on the registration database, categorised by product type. Non-operating power is also weighted by sales or models registered and modelled separately to obtain the Annual EER and COP. BAU efficiency projections from 2014 are based on historical trends during non-policy periods and found to increase by 0.5% pa at full load. Part load BAU efficiency is assumed to increases at a greater rate, in proportion to the number of variable capacity models being installed. The efficiency changes induced by the various policy proposals are shown below:<br>**Option A**: Assumes that zoned label will induce an increase in the sales weighted average part load efficiency of air conditioners below 30 kW. This is implemented in the model by increasing the ratio of part load to full load EER/COP for variable speed products by 1% p.a. in 2017 for 5 years following the implementation, and then to revert to the BAU assumed increase of 0.2% pa. The label change is assumed to transform the market for more efficient part load models, as they will rate higher. This type of transformation has occurred in other areas (such as TVs) when new labels are introduced or re-aligned and the product suppliers move to supply higher rated products. In cold climates (Victoria, Tasmania, Australian Capital Territory, and New Zealand), the zoned label is also assumed to increase the purchase of higher efficiency heating products (modelled as a 1% increase in full load COP in the year of implementation). For portable air conditioners, it is assumed that the zoned label will encourage sales of double duct units and they will represent 50% of sales in the portables market.<br>**Option B1**: Assumes that all chiller products will meet the new requirements from 2017. The removal of the part load compliance MEPS option for A/C will increase the sales weighed average full load efficiency, which is modelled by assuming the units in the registration database that utilise this option for compliance are upgraded. For portable air conditioners, it is assumed that the MEPS level will shift 95% of the sales to double duct units, as most single duct units will not be able to comply with the MEPS.<br>**Option B2:** Assumes that SEER rating will induce an increase in the sales weighted average part load efficiency of air conditioners above 30 kW. This is implemented in the model by increasing the ratio of part load to full load EER/COP for variable capacity products by 0.5% pa in 2017 for 5 years following the implementation, and then to revert to the BAU assumed increase of 0.2% pa. It is assumed that the impact of the zoned label will be lower in the business sector (where most of the 30 kW plus products are sold), due to the market using this information less in decision making than in the below 30 kW market (primarily households). |

| KEY FEATURES | MODEL PARAMETER |
|---|---|
| **Capital Costs** | All incremental capital/development costs are assumed to be passed on to the consumer.<br>**Option A:** The average price increase for those product categories affected by the zoned label was assumed to be 5%, to account for the product modifications (such as optimisations of variable speed compressors, implementation of variable speed drives, etc.). As this technology is currently widely used, the average price increase was reduced by 33% pa following implementation due to rapid learning. In cold climates where the COP is modelled as increasing by 1%, the price efficiency ratio of 0.5 is used. Portable AC costs increase in proportion to the double duct sales share (effectively average weighted price increase is 20%).<br>**Options B1 and B2:** A price efficiency (PE) ratio was derived from the GfK data for split units and applied to all categories for MEPS increases. The ratio used was 0.5 for Proposals B1 and B2. With a PE ratio of 0.5, every 1% increase in average efficiency sees the price increases by 0.5%. The range of PE values shown in the analysis was between 0.14 and 1.84, with an average of 0.7 to 0.9. A ratio of 0.5 was used as it represents the cost of efficiency improvements to meet the minimum standard (i.e. MEPS level), not the average. The average price increase was reduced by 10% pa following implementation due to learning. Portable AC costs increase in proportion to the double duct sales share (effectively the average weighted price increase is 40%) Double duct portable AC are assumed to cost approximately 50% more than single duct portable AC, due to both the increase in cost from the extra ducting and the efficiency improvements necessary to meet the MEPS. For chillers, a PE ratio of 1.0 was used. |
| **Registration Admin costs and Costs of Compliance** | Government administration costs are made up of salary, program administration, check testing, consumer information/education and miscellaneous (market research, etc.). As most of the product categories are already regulated for MEPS and labelling, there is only a small increase in government costs.<br>The incremental administration cost for Australia and New Zealand are assumed to be $140,000 per annum. In addition, an establishment cost of $350,000 is counted in the year of implementation. |
| **Energy Consumption** | Energy consumption of the stock is calculated for each product group (26 AC, 11 chillers) by calculating the power consumption for each of the 7 modes (e.g. standby, 50 and 100 per cent capacity), then multiplying this by the annual operating hours and cohort stock quantity. Products are retired from the stock according to a survival function, which varies from average replacement after 8 years for portable AC to 12 or 15 years for non-ducted and ducted split air conditioners. Chillers have longer survival functions (e.g. 20 to 28 years). The energy consumption of each category is undertaken at the State level and summed for national results for Australia.<br>BAU is based on registration data from the registration database with sales data where available. The alternative proposals are based on the efficiency assumptions shown above.<br>Energy Prices are:<br>- Australia: based on (Residential + Business) Electricity price index, from AEMO 2014.<br>- New Zealand: based on Energy Information & Modelling Group's 2011 Energy Outlook results, Reference Scenario. |
| **GHG emissions** | Australia: Projected Factors from 2014 - derived from 2013 National Greenhouse Account (NGA) factors but varied by trends in Electricity Sent out emission intensity by state, the No Carbon Scenario, from The Treasury and DIICCSRTE, 2013 ->.<br>New Zealand: Ministry of Business, Innovation and Employment, New Zealand's Energy Outlook \| Electricity Insight, June 2013. Historical values to 2012 and Forecast is the data from Mixed Renewables Scenario from 2013. |
| **Industry costs** | Registration costs for new products within the scope of the proposals are $670/model for the registration fee, which is treated as an income to the government for modelling purposes as partial cost recovery for government of administering the regulations in Australia. There are no registration fees in New Zealand.<br>Other costs of compliance (for example testing, staff education, record keeping) are accounted for using the Regulatory Burden Measurement tool (for Australia) and are included as a component of the cost benefit analysis. |
| **Sensitivity Analysis** | NPV:<br>• Australia - 7% discount rate, with sensitivity tests at 0%, 3% and 11%.<br>• New Zealand – 5% discount rate, with sensitivity tests at 0%, 3% and 8%.<br>Costs:<br>• Average incremental costs due to efficiency increase are increased and decreased by 50%. |
| **Key Assumptions** | Reduction in energy use is due to new policy options described above in 2017.<br>Rebound (take back) treated as zero in relation to energy use. Rebound occurs where the increased energy efficiency of a product results in a consumer making greater use of the product. Any rebound would occur through the conversion of potential energy savings into increased thermal comfort (i.e. if consumers spend some of the energy savings to cool or heat their home more) but this does not decrease the total benefit the consumer receives, it is simply a conversion of the energy savings benefit into another form. This means there is no reduction in benefits from the consumers' perspective from rebound; hence it can be ignored for the cost benefit analysis.<br>For Australia the additional benefits of lower levels of greenhouse gas emissions have been included in the benefits with a value of $13.95 per t $CO_2$-e[50], and reduced by 25% to account for any potential rebound.<br>Benefits due to reduced peak demand due to lower power consumption are intrinsically included in the electricity prices used for the cost benefit analysis. |

Further information on the various air conditioner and chiller product categories used in the modelling, such as average rated heating/cooling capacities, efficiency levels, operating hours, price/efficiency ratios and stock and sales projections is outlined in Attachment B.

[50] Department of Environment, email correspondence 2 October 2015.

## Summary of key energy/emission impacts and cost/benefits

The summary impacts of the proposals are shown for Australia and New Zealand in Tables 10 and 11 below in terms of costs/benefits, energy savings and greenhouse gas emission reductions.

**Table 10 Cost benefit estimates - Australia**

| Option | Energy Saved (cumulative to 2030 - GWh) | GHG Emission Reduction (cumulative to 2030) Mt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Option A | 3,371 | 3.0 | $715 | $174 | $541 | 4.1 |
| Option B1 | 5,857 | 5.2 | $1,182 | $290 | $892 | 4.1 |
| Option B2 | 6,672 | 6.0 | $1,335 | $308 | $1,027 | 4.3 |

*Note: This table uses discount rates of 7% for Australia*

**Table 11 Cost benefit estimates - New Zealand**

| Option | Energy Saved (cumulative to 2030- GWh) | GHG Emission Reduction (cumulative to 2030) kt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Option A | 427 | 41.3 | $106 | $21 | $85 | 5.0 |
| Option B1 | 659 | 64.6 | $159 | $32 | $126 | 4.9 |
| Option B2 | 670 | 65.7 | $161 | $33 | $128 | 4.9 |

*Note: This table uses discount rates of 5% for New Zealand*

The analysis indicates that option B2 provides the largest net benefit in Australia and New Zealand at $1,027 million at$128 million respectively. Option B2 also provides the greater amount of energy and greenhouse gas savings. Option B2 provides greater net benefits than option B1 in both countries.

The benefit cost ratios are similar across the policy options, with option B2 having the highest benefit/cost ratio for Australia at 4.3. Option A has the highest benefit cost ratio for New Zealand at 5.0, which is marginally above the benefit cost ratio of 4.9 for options B1 and B2. Compared with Australia, the higher benefit/cost ratios for New Zealand are generally due to the greater amount of time air conditioners spend in use (primarily as heaters).

Option A provides a net benefit due to:

- Improvements in the part load efficiency and heating efficiency of air conditioners, due to adoption of the SEER test standard and Zoned Label and expanding the scope of energy efficiency labelling up to 30 kW;
- Adoption of the Zoned Label for portable air conditioners (single and double duct portables) and the lower MEPS level for double duct portable air conditioners, which significantly increases the average efficiency of portable air conditioners sold;
- Removal of the outdated Australian/New Zealand test standard for chillers; and
- Improvements in the average efficiency of >65 kW capacity air conditioners and <350 kW capacity chillers due to their inclusion under GEMS/NZ regulations.

The benefits associated with these policy changes are offset by costs, with the modelling results indicating a benefit/cost ratio of 4.1 for Australia and 5.0 for New Zealand.

Option B1 provides a greater quantum of net benefit than option A ($351 million in Australia and $41 million in New Zealand) due to:

- The introduction of a MEPS for single duct portable air conditioners;
- An increase in MEPS for >65 kW air conditioners;
- An increase in MEPS for <350 kW capacity chillers;
- An increase in New Zealand's residential cooling MEPS for air conditioners; and
- An increase in MEPS for variable speed air conditioners.

The additional benefit provided by these MEPS levels comes at a greater cost, however the benefit/cost ratio only changes marginally.

Option B2 provides a greater quantum of net benefit than option B1 ($135 million in Australia and $2 million in New Zealand) due to the extension of the SEER rating method to air conditioners greater than 30 kW capacity. In Australia the benefit/cost ratio increases marginally compared to option B1, from 4.1 to 4.3 but remains the same in New Zealand.

The investment costs are mainly the costs to businesses for improving the energy efficiency of their products. Around 50 per cent of this investment cost is estimated to be the cost to business, with the remainder attributed to other costs such as distribution and retail costs. This means that the total cost to New Zealand businesses is between $10.5 and $16.5 million over the period, depending on the policy option.

The policy options can also reduce the cost to Australia and New Zealand of meeting greenhouse gas abatement targets by providing cost positive emissions abatement. For Australia, the cost is estimated to be about $-160/tonne.

Detailed cost/benefit results, energy savings and emissions reductions by state/region, product category and sensitivity scenarios are in Attachment B.

# 2011 Decision RIS

The 2011 Air Conditioner Decision RIS stated "Option C will be the indicative MEPS levels for 2014, but be subject to a further RIS and the investigation of a SEER metric". Option C specified a 10 to 20 per cent increase to the current MEPS levels for air conditioners, depending on the product category.

As outlined in the Problem section, option C has been included in the costs benefit analysis to fulfil the 2011 Decision RIS recommendation. For this option, where the increase in sales weighted efficiency was greater than 10 per cent and most products were removed from the market, a price/efficiency ratio of 2.0 was assumed due to the major increase in average efficiency required. The average price increase was reduced by 5 to 10 per cent per annum following implementation due to learning. Note the modelling results also incorporate the policy changes proposed in option B1. The results are shown in Table 12 below.

**Table 12 2011 Decision RIS results**

| Country | Energy Saved (cumulative GWh) | GHG Emission Reduction (cumulative) | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Australia | 11,893 | 10.6 Mt | $2,304 | $2,584 | -$280 | 0.9 |
| New Zealand | 1,443 | 143.4 kt | $342 | $229 | $112 | 1.5 |

The modelling results indicate the proposal is not cost effective in Australia and marginally cost effective in New Zealand, with benefit/cost ratios of 0.9 and 1.5 respectively. This option would impose net costs on the Australian and New Zealand communities in total and it has been excluded from consideration as a policy proposal as part of this RIS process.

# 6. Consultation

## Purpose

Stakeholder feedback is sought on the policy options presented in this Consultation RIS. This is to ensure that any recommendation and/or decision to change the current energy efficiency requirements is based on an understanding of the full range of stakeholder views.

### Consultation events and written submissions

Public consultation events on this RIS will be held in:

- Sydney: 10:00-12:00 Monday, 15 February, Level 5, 341 George Street;
- Brisbane: 10:00-12:00 Tuesday, 16 February, Level 12, 100 Creek Street;
- Melbourne: 10:00-12:00 Wednesday, 17 February, Southern Cross West Tower, Level 5, 111 Bourke St;
- Adelaide: 10:00-12:00 Thursday, 18 February (registration required);
- Perth: 10:00-12:00 Friday, 19 February, St Martins Tower, Level 25, 44 St Georges Terrace; and
- Wellington: 9:30-11:30 Tuesday 23 February, 30 The Terrace.

To register your interest in attending an Australian consultation session, please email energyrating@industry.gov.au noting the names of attendees and the location of the meeting you wish to attend. Note: Adelaide attendees – you must register: security requirements require pre-registration to allow building access. You will also need to ensure you bring photo identification when attending.
For New Zealand participants, please email regs@eeca.govt.nz.

The closing date for written submissions is **5pm AEDT Friday 18 March 2016** and should include the subject: 'Consultation RIS – Air Conditioners and Chillers'.

Australian submissions should be sent via email to:

**Email:** energyrating@industry.gov.au

New Zealand submissions should be sent via email to:

**Email:** regs@eeca.govt.nz

Feedback from the submissions received on the Consultation RIS will inform the preparation of any Decision RIS. The Decision RIS is the final document presented to Ministers on which they make a decision about any changes to the current requirements.

### Consultation questions

Stakeholders are welcome to provide feedback on any matter in relation to this RIS – there is no obligation to answer any or all of the questions listed. Questions that stakeholders may wish to consider in providing a submission include:

- Will the proposed policy options address the identified problems? Have all relevant policy options been considered?
- Is the cost benefit analysis of the policy options based on accurate data and realistic assumptions?
- Are there any implementation barriers or possible unintended consequences in relation to any of the policy options under consideration?
- Do you agree the MEPS requirements for air conditioners and chillers in the NCC should be removed and included under the GEMS Act/New Zealand regulations? Do you have data or information about products that do not meet the NCC MEPS levels being supplied in the replacement market for either or both of these products?

- Do you agree that SEER rating should be applied to air conditioning products greater than 30 kW capacity?

Please provide relevant data or evidence to support your claims. Stakeholders should note that if feedback is not provided on a particular proposal then it will be assumed there are no issues or concerns that were not considered in the Consultation RIS.

## Technical/administrative questions

Feedback is also sought on a number of specific technical and/or administrative issues. These issues have been identified and/or raised through a number of sources, including the ACRAC; the GEMS Regulator function (Registration and Compliance Teams); the Air Conditioning Team in the Appliance Energy Efficiency Branch (responsible for policy development); and the Standards Australia Room Air Conditioner Committee (EL-056).

**Fully aligning to international test standards when appropriate:** The ISO are likely to publish updated versions of the air conditioner test standards, ISO 5151 (non-ducted), ISO 13253 (ducted) and ISO 15042 (multi-split) sometime during 2016. These have previously been adopted as the local test standards AS/NZS 3823.1.1, 1.2 and 1.4 respectively. The drafts of these updated ISO versions appear technically equivalent to the previous versions. The main changes seem to fix known problems and provide clarifications on a range of issues. Indeed, some of these changes fix issues that the local adoption has previously addressed. It appears that creating further local adoptions of these three test standards is unnecessary and a future GEMS Determinations for air conditioners could call these three ISO test standards up directly. Would you support this change?

**Updating international based test standards:** Australia and New Zealand's test standards are generally local adoptions of international test standards. When these international test standards undergo minor amendments that have zero cost impacts, do you support the adoption or use of these test standards without a formal RIS process?

**Water-source heat pumps:** The ISO is considering an update of the water-source heat pump test standard, ISO 13256:1998. This standard was locally adopted as AS/NZS 3823.1.3:2005 but is only called into regulation in Australia. Do you support:

a) New Zealand considering the costs and benefits of aligning with Australia by regulating water-source air conditioners under the scope of AS/NZS 3823.1.3 for MEPS subject to a further RIS; and

b) updating AS/NZS 3823.1.3 if ISO 13256 is updated?

**Remove H2 MEPS requirements:** The current GEMS Determination for air conditioners stipulates MEPS for the rated H2 COP for products making a voluntary declaration at H2 (2°C). If it is decided to adopt the SEER testing and rating standard AS/ZNS 3823.4 and the Zoned Label, the H2 test point will become mandatory with the performance reflected in the SEER rating (and hence, the star rating).

Do you agree that if a SEER rating is implemented, a separate H2 MEPS is no longer required?

**Simulation testing of ≥30 kW units under a SEER scenario:** If it is decided to adopt option B2 and apply the SEER test standard to air conditioners larger than (or equal to) 30 kW, will this present an issue in terms of simulating the required extra test points (e.g. the H2 test point)? If so, can this be overcome in some way?

**Multi-split registration:** Multi-splits systems are currently registered on an outdoor unit basis, rather than as a matched 'system' of indoor and outdoor units. This interpretation is necessary due to the regulatory burden that would be created by requiring registration of the large number of possible indoor unit combinations. The regulations for air conditioners therefore need to be clarified to reflect that for registration purposes, a multi-split system is only comprised of an outdoor unit. Note that the current testing arrangements, whereby a representative combination of indoor units is nominated will be maintained.

Furthermore, modular VRF multi-split systems are currently being registered as both a base outdoor unit module and in systems that rely on multiple outdoor unit modules. This can result, for example, in a 20 kW module being registered as a 20 kW system and a 40 kW system that comprises of two 20 kW modules. This is likely to create unnecessary regulatory burden. Therefore, it is proposed to clarify in the next update of air conditioner regulations that only the base modules of a VRF multi-split system require registration.

Do you agree with these proposed changes?

**'Add-on' coolers:** There are a number of companies that supply cooling only ducted split system air conditioners that are designed to 'add-on' to ducted gas heater systems. Many of these products even utilise the ducted gas heater's fan rather than their own. There appears to be a misconception by some sectors of the air conditioner industry that these products are exempt from energy efficiency requirements. Other elements of industry have raised concerns over the possible lack of energy efficiency of these systems, especially given the physical restrictions on size that many of the indoor evaporator coils used in add-on units have.

After liaising with one such company, the E3 Program acknowledged the difficulties faced by this sector of the industry. In a situation akin to multi-split registrations, companies offer a limited number of outdoor units that are matched to a potentially large selection of indoor unit evaporators that are designed to be compatible with a wide range of gas heaters; even gas heaters from their competitors.

There are a number of options to make compliance with the current requirements easier and more practical. Do you support either of the following options or would you suggest an alternative option?

a) Clarifying and applying the existing requirements that refer to clause 3.4 (d) of AS/NZS 3823.2:2013. This means that all possible combinations of indoor/outdoor units would require registration as a system. Systems (i.e. matched combinations) that are sold less than 10 times per annum could use simulation testing to support the registration, while systems that are sold 10 or more times per annum would require a physical test report. Compliance check-tests are based on a registered system. Annual sales declarations would need to be provided for compliance upon request.

b) Registration is required on an outdoor unit basis, with the matchable indoor units being registered as a family against the appropriate outdoor unit. A physical test report using one of the appropriate indoor units would be needed to support the MEPS registration. A compliance check-test could choose to test any combination in this registered family. If the compliance test fails, the whole family (i.e. the outdoor unit and all indoor units registered as part of the family) would have its registration cancelled.

**Supply of outdoor units only:** The current requirements make it difficult to supply MEPS compliant outdoor units for the replacement market because they treat air conditioner systems as an indoor and matched outdoor unit. However, given that most of the system's working parts are contained in the outdoor unit, supplying MEPS compliant outdoor units only is a common request. It is proposed that the next air conditioner GEMS Determination/NZ regulations will specify the outdoor units of split systems as separate categories, matching the size classes and MEPS levels of the current requirements. Registration would still require a test report using a nominated indoor unit that is both readily available for possible check testing purposes and matches refrigeration capacities and configurations (i.e. is 'like for like', as per the requirements for multi-splits specified in clause 3.11 of AS/NZS 3823.2:2013).

Do you have any comments on this proposal?

**Noise test standard:** If the decision is made to apply the Zoned Label to domestic air conditioners, the disclosure of indoor and/or outdoor sound power will be required with the intention it will replace other state-based requirements in Australia. However, the continuing suitability of ISO 7574-4:1985 *Acoustics - Statistical methods for determining and verifying stated noise emission values of machinery and equipment - Part 4: Methods for stated values for batches of machines* has been called into question because it has become outdated. There are currently two choices for a new sound power test standard:

a) The same test standard used by the EU for their air conditioner and heat pump water heater energy labelling scheme – EN 12102:2013 *Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors for space heating and cooling. Measurement of airborne noise. Determination of the sound power level*; or

b) The same test standard recommended as part of E3's 2013 Consultation RIS for heat pump water heaters - ISO 3741 *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Precision methods for reverberation test rooms.*

Would you support the use of either of these test standards, or do you recommend a different test standard? If you recommend a different test standard, please provide an explanation why.

**Noise test points:** Air conditioner noise levels (especially those of variable capacity units) can vary greatly depending on outdoor temperature, indoor temperature and a variety of user-defined settings. For practicality and comparability, it is proposed to follow the EU's practice of testing at the standard full load T1 (35 $^{o}$C) test point or H1 (7 $^{o}$C) for heating only units.

Do you agree with this proposal?

**Noise test requirements:** It is proposed that indoor/outdoor testing requirements will apply to different categories of air conditioners <30 kW cooling capacity in the following way:

- Non-ducted split systems: indoor and outdoor noise levels.
- Ducted units (both split and unitary units): outdoor noise levels only.
- Non-ducted unitary units (e.g. window/wall units): indoor and outdoor noise levels.
- Single and double duct 'portable' unitary units that sit wholly in the conditioned space: indoor noise levels only.
- Multi-split systems: outdoor noise level of single outdoor units, based on the representative combination used for registration.

Do you agree with this proposal?

**Fixed speed air conditioners - degradation coefficient:** The seasonal test standard ISO 16358 (AS/NZS 3823.1.5) recognises that fixed speed air conditioners use a certain amount of electricity turning on and off to meet part load conditions. This is reflected in the calculation of seasonal performance through a degradation coefficient ($C_D$) with a default value of 0.25. The EU's seasonal testing and labelling standard EN 14825:2012 uses the same default value. While ISO 16358 (AS/NZS 3823.1.5) allows an applicant to change the default $C_D$ value via a test procedure in Annex C of the test standard, E3's experience of this optional test encountered reproducibility issues. This RIS is therefore proposing that the default $C_D$ value of 0.25 is used for all registrations and will not be able to be changed by the applicant.

Do you have any comments on this proposal?

**Measurement of non-operative power consumption:** Australia and New Zealand were amongst the first jurisdictions in the world to incorporate a measurement of non-operative power (e.g. standby, crankcase heaters) into the energy efficiency metric in 2009. It is incorporated into the Annual Energy Efficiency Ratio to assess compliance with MEPS and calculate the star rating algorithm (see Clause 2.4 of AS/NZS 3823.2:2013 for details).

The proposed SEER standard, AS/NZS 3823.4:2014 (the local adoption of ISO 16358) describes a different method for measuring non-operative power for incorporating into the seasonal metric, which in turn would be used for a new star rating algorithm. It requires a unit to be tested at two to four temperature points for a minimum of 10 to 16 hours (see Annex B of AS/NZS 3823.4:2014, noting that this Annex would need to be updated for local weighting factors and hours if it is to be used). It should be noted that exploratory tests conducted by E3 in 2013 found that the two methods yielded similar results (i.e. within a few watts for the products tested).

Given that the AEER/ACOP and the new SEER metric both need a measurement of non-operative power, E3's preference is to fully align with the new ISO SEER standard (AS/NZS 3823.4:2014) and therefore use it for both AEER/ACOP and SEER. Do you agree with this proposal?

**Capacity correction for single duct portable air conditioners:** As outlined in the The problem and Options sections, single exhaust duct air conditioners have a unique design feature that inhibits their energy efficiency - they must draw outside air directly or indirectly into the room they are trying to condition. For every litre of air exhausted through their single exhaust duct, a litre of outside air must replace it. This means that in summer, hot outside air must enter the building and in winter, cold outside air must enter the building. While the new Australian/New Zealand test standard is an improvement on other regional test standards in that it deducts the heat that leaks out of and radiates from the unit, it still does not deduct the heat (or cold) that must be drawn into the room.

A theoretical cooling/heating capacity correction could be applied to single duct units based on the measured exhaust airflow of each unit (this data is already recorded through the test standard). Then the energy infiltration per litre per second that is being drawn into a room could be deducted. To do so, standard indoor/outdoor temperature differences would have to be established. Fixed air conditioners are tested and rated using indoor/outdoor temperatures of 27°C/35°C for cooling and 20°C/7°C for heating. These temperature points could form the logical basis on which to calculate capacity corrections. The US Department of Energy[51] are proposing to apply such a correction factor and appear to have settled on an infiltration air temperature of 35°C.

In addition to the Zoned Label and/or MEPS proposals outlined in the Options section for single duct portables, do you support the development of a capacity correction method as outlined above for the purpose of labelling single

[51] Department of Energy, Energy Conservation Program: Test Procedures for Portable Air Conditioner., Supplemental notice of proposed rulemaking. Docket No. EERE-2014-BT-TP-0014, 17 November 2015.

exhaust duct products? Furthermore, do you support the use of the proposed temperature points, or do you suggest other temperatures? Please supply data or evidence to support your proposal.

**Heat pump and reverse cycle liquid chilling packages:** Heat pump and reverse cycle chillers (capable of providing a heating service) are excluded from the scope of the current requirements. However, this technology is becoming more common, especially in Europe and could become more popular in Australia and New Zealand as a viable alternative to commercial gas fired heating solutions. The proposed chiller test standard, ANSI/AHRI551/591, is capable of rating full load heating energy efficiency and capacity for these units. Including these products under the GEMS Determination/NZ regulations might facilitate the development of this section of the market. For instance, having the performance of the products recorded in the E3 registration database may assist this technology's inclusion in various government energy efficiency incentive schemes.

Would you support investigating the merits of including heating only and reverse cycle liquid chilling packages under the GEMS Act/New Zealand regulations through a future RIS process?

**Inverter over-capacity:** It has been noted by several authors that some inverter air conditioners have the ability to significantly increase their capacity above rated at the expense of energy efficiency. This could be a particular problem for some units that are installed in situations where their rated capacities are insufficient to meet the cooling/heating requirements and during extreme weather events. E3 performed initial investigations on eight inverter air conditioners in 2013 and found that a number of these do perform less than optimally under certain test scenarios.

Do you agree that this issue warrants further investigation by E3, to inform whether any policy action is needed to address the issue?

# Consultation to date

Implementation of any policy changes will be informed by the results of feedback from this Consultation RIS and ongoing additional consultation. E3 is committed to continual engagement with a range of stakeholders - for example through ACRAC, the E3 Review Committee and Standards Australia.

## Air conditioner and Commercial Refrigeration Advisory Committee

E3 representatives regularly meet with industry through the ACRAC. ACRAC meetings are held two to three times per year and allow industry members to receive regular updates on E3 activities, to discuss issues and make submissions to E3. The ACRAC Committee's Terms of Reference and minutes from previous meetings can be found on the Energy Rating website.

## E3 Review Committee

E3 representatives also meet with key stakeholder groups (industry and consumer bodies) through the E3 Review Committee. The E3 Review Committee is a forum for key stakeholder groups to provide advice to government across the entire E3 Program and meets twice per year.

## Standards Committees

E3 works with industry to develop relevant standards through a number of Standards Australia committees. Recent work with the Room Air Conditioner Committee (EL-056) has seen the development of a test standard for single duct portable air conditioners as well as the local adoption of the international SEER test standard, ISO 16358. E3 is also contributing to the industry initiated domestic cooling and heating appliances installation standard through committee EE-001.

## Workshops and interviews

Interviews were conducted with over 25 suppliers from Australia and New Zealand during late 2013 and 2014 to check data inputs for the cost benefit analysis for this RIS. An industry workshop with 50 participants was undertaken in April 2014, where the preliminary results of the modelling were presented and feedback sought. This was followed by further consultation at the Air Conditioning, Refrigeration and Building Services conference in May 2014. In New Zealand, a number of stakeholder interviews were conducted in 2014 to obtain feedback on the preliminary modelling results for New Zealand.

# 7. Conclusion

## Recommended option

Based on the current analysis, the recommended policy option is option B2. This option provides the greatest net benefit to both the Australian and New Zealand communities - $1,027 million and $128 million respectively. Option B2 also provides the largest energy and greenhouse gas emissions savings for both countries. This policy option remains cost effective if the costs of the proposals are increased by 50 per cent, or if the discount rate applied is increased (to 11 per cent in Australia or 8 per cent in New Zealand), with the benefit cost ratios remaining above 2.0.

### Option B2

Option B2 incorporates the following policy changes:

1. For air conditioners, adopt the SEER standard AS/NZS 3823.4 and replace the current ERL with the Zoned Energy Rating Label.
2. Apply the Zoned Label to all air conditioners with capacity up to 30 kW, with air enthalpy tests accepted for ducted, three-phase and certain commercial use products. Multi-split systems would continue to be excluded from physical labelling but would be subject to the SEER standard, with rating information for the registered combinations made available on the Energy Rating website.
3. Double duct portable air conditioners subject to the SEER standard AS/NZS 3823.4, a reduced MEPS level of 2.60 based on AEER/ACOP and Zoned Energy Rating Label to be applied.
4. Single duct portable air conditioners subject to a Zoned Label and a MEPS level of 2.60 based on AEER/ACOP.
5. Remove the unique Australian/NZ test standard for chillers and align with the USA test standard AHRI 551/591:2011. The Eurovent and AHRI compliance pathways will remain.
6. Include air conditioners >65 kW capacity and chillers <350 kW capacity under GEMS/NZ regulations and remove these requirements from the NCC in Australia (refer to Table 5 and Table 6 for MEPS levels).
7. Align chiller MEPS to the US energy efficiency standard ASHRAE 90.1:2013 where the US levels are higher (MEPS levels specified in Table 7).
8. Align >65 kW air conditioner MEPS levels from the NCC in Australia to the 39 to 65 kW MEPS level (i.e. AEER/ACOP of 2.90) and apply it in both Australia and New Zealand.
9. Align New Zealand's residential cooling MEPS to match Australia's levels.
10. Air conditioner MEPS levels must be met i.e. remove the option to comply with 95 per cent of MEPS for variable speed units (part load compliance).
11. SEER rating of air conditioners ≥30 kW capacity - with rating information made available on the Energy Rating website.

The key difference between option B2 and option A is that B2 involves changes to the current MEPS for various product categories. This includes increasing the MEPS for some product categories and the introduction of a MEPS level for single duct portable air conditioners. These MEPS changes are proposed to achieve international alignment, address distortions that can arise due to the current requirements, and improve the integrity of the requirements.

Compared with option B1, B2 also incorporates applying the SEER method to air conditioners with output greater than 30 kW (with voluntary application of the Zoned Label).

Note that option B2 (as with the other proposals) is made up of various individual policy changes. Consultation with stakeholders through this RIS may identify issues not yet considered in relation to the individual elements of the proposals. This may result in a different combination of the individual elements, or variations to the individual elements to those listed above, being recommended through a Decision RIS.

# 8. Implementation and review

## Implementation - next steps

### Australia

- Following stakeholder feedback on this Consultation RIS, the comments and feedback received will be considered before proceeding to a Decision RIS.
- If it is resolved to proceed, a Decision RIS (incorporating feedback on the Consultation RIS policy proposals) will be submitted to the COAG Energy Council.
- If a policy proposal in the Decision RIS is approved by the COAG Energy Council, the following legal instruments (referred to as GEMS Determinations) will be revised:
  - *Greenhouse and Energy Minimum Standards (Air Conditioners and Heat Pumps) Determination 2013;* and
  - *Greenhouse and Energy Minimum Standards (Liquid-chilling Packages Using the Vapour Compression Cycle) Determination 2012*.
- Once Ministerial approval is provided for the revised Determinations, there will be a period before any policy change comes into force.

### New Zealand

- Any policy proposals will be approved by Cabinet before being adopted under the *Energy Efficiency (Energy Using Products) Regulations 2002*.

Given the E3 Program's experience with implementing or revising energy efficiency requirements, the risks associated with implementation are considered low. Any transitional arrangements will be developed in close consultation with industry.

## Review

### Compliance monitoring

The GEMS Regulator already undertakes education and compliance activities for the current energy efficiency requirements. This involves outreach activities, surveys and store visits. If policy changes in this paper are adopted, the Australian GEMS Regulator will need to monitor compliance with any new requirements. This includes:

- Testing of selected models within scope in independent laboratories to verify performance claims; and
- Checking that models within scope are supplied with the ERL/Zoned Label.

In New Zealand, education and compliance activities are undertaken by the Energy Efficiency and Conservation Authority.

### Evaluation

The E3 Program uses various sources of information to evaluate both the effectiveness of the program and product category requirements. This includes retrospective reviews to compare the effect of policies versus what was projected in RIS analysis; analysing sales data to understand consumer awareness and usage of energy efficiency labelling; tracking the hits on the Energy Rating website; and utilising ABS and other surveys of consumer intent and consideration of energy efficiency in purchase decisions.

# Attachment A – Development of zoned energy rating label

## Background

Australian and New Zealand air conditioning industry representatives have proposed the Equipment Energy Efficiency (E3) Committee examine a move a SEER based rating scheme. To support the inevitable move to a SEER scheme, a zone-based energy efficiency labelling system is logically required. An examination of enhanced, climate zoned based labelling is also supported by consumer groups such as Choice. The E3 Committee agreed to commit resources to examine a Zoned Energy Rating Label (Zoned Label) in March 2013. While the existing Energy Rating Label (ERL) provides key information to consumers and users of labelled products, industry have identified some key opportunities to improve energy efficiency information in the market by incorporating enhanced information that provides ratings and energy consumption information for three distinct climate zones.

Space conditioning can account for around 35-40 per cent of the average household's energy use. The energy efficiency of these appliances is heavily impacted by the climate in which they are installed. Currently there is no easily accessible information available to consumers to help them select models most suited to their local climate, or other requirements such as cold weather performance and noise. This is impeding consumers' and installers' ability to select a comparably priced appliance that can provide energy and cost savings. In essence, by improving the information available and enabling appliances to be installed in the location they are most suited to, consumers will be able to save money on their power bills.

The local climate can influence the performance of appliances in a range of ways. Variations in air temperature, water temperature, frosting, humidity and cloud cover can all influence the energy efficiency of appliances, often quite dramatically. For example, the energy efficiency of reverse cycle air conditioners and heat pump water heaters can be significantly lower below approximately 5.5 °C when ice forms on the outdoor heat exchanger. Systems without appropriate defrost functions can result in very poor heating energy efficiency or significantly reduced capacity output. While this feature is important in cold regions, in warmer areas where temperatures will not drop below 5.5 °C, it is unnecessary.

While air conditioners have carried energy efficiency labels since 1987, these existing labels do not enable consumers to select a model that will be efficient in their location. In addition, manufacturers are not required to supply performance information for cold weather performance and as such consumers may believe the stars on the label reflect likely performance in conditions they are likely to experience.

The current ERL is also unable to convey some important appliance performance information. Key features such as noise, sizing information for cold climates and estimated annual energy use are all important factors to consumers, yet there is no consistent or comparable way this information is made available. Introducing a label that incorporates this information, along with location-based energy efficiency ratings, is likely to benefit consumers.

It is intended that a label of this type would have a consistent rating system to minimise the need for regular re-rating of products. This would reduce confusion on rating scales and also remove the requirement to supply a date of test or manufacture on a label.

As a zoned energy label merely improves the potential for existing appliances on the market to be installed in locations where they will operate efficiently, it requires no physical changes to existing products, and would have very little cost. While the costs would be small, the potential energy savings or improved comfort arising from more appropriate models being installed in each climate are likely to be substantial.

Additionally, providing a label that will allow demonstration of a range of climate zones will provide manufacturers with a greater incentive to innovate and target models to individual climates (e.g. tropics, temperate, alpine). Further, suppliers have an incentive to stock only suitable models for their climate. This is likely to result in greater consumer satisfaction with available products.

The label development process has been underpinned by three key objectives:

1. Changes to the existing ERL should be driven by user preferences, not decision makers' preferences. Users of this label are broad and include consumers, retailers and installers.
2. Design options must be adaptable to all climate influenced appliances to enable users to better compare different technology types.
3. Changes to the current ERL must be underpinned by evidence that changes will improve user understanding of the information and increased label recognition.

To ensure that the users have the largest role in the development of the labels, the development process involved three stages:

| | |
|---|---|
| Stage 1: | Design a broad range of layout and content options, using international experiences and then test these options on users through focus groups. |
| Stage 2: | Re-development of a refined set of options based on the most positively received features suggested by Stage 1 focus groups, and additional testing on a second round of focus groups. |
| | Refine the map of Australia and New Zealand to ensure the best possible separation of climate zones. |
| Stage 3: | Finalisation of most positively received option, with quantitative testing and further qualitative testing to refine particular elements as applicable. |

# Stage 1

## The initial design process

The graphic designers selected to undertake the work have a speciality in presenting scientific concepts in simplified ways. They were asked to design layout options (concepts) that met the following specifications:

- Adaptation of existing ERL to incorporate necessary climate and other performance information with minimal other changes;
- Designs that incorporate some elements of the current ERL (colours, fonts etc.) while changing other features that were expected to improve user interpretation; and
- Complete new versions, based on designer's knowledge and understanding of overall goal of label, with no requirement to tie in with existing label.

Apart from these broad instructions, the designers were encouraged to use their own expertise for the label layout decisions, including colours, fonts, amount of white space and text. This was to ensure that the necessary information could be presented in the most effective ways.

Three appliance technologies (reverse cycle air conditioners, gas space heaters and heat pump water heaters) were considered initially to ensure that a broad range of systems can be integrated into a consistent label design. These particular appliance groups allowed for the variances in requirements between appliance and fuel type to be tested in the initial stages.

In addition to the zone specific information, other key performance features were required to be included on the labels, including noise, sizing and an annual energy consumption figure (which is present on most existing appliance labels but not for air conditioners).

In total, ten labels in four concept layouts were finalised for focus group testing. As well as the necessary differences between appliance types (e.g. different capacity/sizing information for water heaters than space heaters, different symbols for electricity than gas), some variations within the concepts were made; including the way the star ratings were represented, layout of maps for climate zones and colours.

Details on the labels tested and more comprehensive feedback are available in the focus group report found on the Energy Rating website.

In addition to the zoned rating labels, the existing ERL for air conditioners was also tested as a reference for assessment.

## The testing process

A series of focus groups were held in Sydney, Melbourne and Auckland in July 2013. A total of nine sessions took place, with two consumer groups and one industry group (including retailers and installers) per city.

All consumer participants were household appliance decision makers, who had either recently (within the past 6 months) purchased, or were actively planning to purchase a water heater, air conditioner or space heater. Prior to the focus groups, each participant was asked to complete a questionnaire to find out more information about the way they make purchase decisions for appliances.

For the industry groups, participants were selected from a range of areas, including retailers (of relevant appliances), plumbers and installers. This was to target the members of industry who provide advice to consumers on which appliances to purchase. For water heaters particularly, this is often the sole source of research for a purchase.

The focus groups consisted of two main stages, an initial discussion about purchase processes and decision making, followed by testing and examination of the label designs.

### Consumer decision process

The preliminary discussion in the consumer sessions centred around the decision making process for these types of appliances, what research (if any) was undertaken, whether (and when) energy efficiency was taken into account, and other factors that impacted on purchase decisions.

Broadly it was found that consumers rely heavily on advice from experts for these types of appliances. This included tradespeople friends, retailers and friends and family who have made similar purchases. This echoes previous research on these types of purchases from the 2014 BIS Shrapnel survey, *The Household Appliance Market in Australia*, which shows over speaking to retailers or suppliers, family and friends' recommendations and online product reviews as most useful research prior to purchasing both ducted and non-ducted products.

Energy efficiency was found to be a consideration when making appliance purchases; however is not generally a primary requirement. The main question related to energy efficiency asked by consumers is the product's star rating. Information provided on the label beyond this is rarely asked, or seemed to be misunderstood or not noticed by consumers. Some retailers were found to volunteer information about energy efficiency, though this information is not regularly offered in the early process of advising a consumer.

It was found that ERLs tend not to be used by consumers as part of their initial decision making, but rather to help make the final choice between narrowed down options. So while the ERL and energy efficiency in general is not a first order consideration when selecting an appliance, once key features have been decided, the ERL assists in the decision between similar products.

### Industry advice process

The industry focus groups found that retailers are perceived as having the highest level of influence over consumer purchases. As purchase decisions are often made in a retail environment, staff can help consumers understand the information they have gathered, and may be able to recommend particular options.

The focus groups found that plumbers and installers do not see themselves as the main source of information for consumers, and their recommendations tend to be based on ease of installation and confidence in particular products. Reasons given were that if there is an issue with the product later on, it is up to them to fix it or replace it. They tended to pay less attention to an ERL, and they base their opinions on actual experiences with products. In general they are reluctant to have conversations with customers regarding energy ratings and believe that their role should not be an advisory one.

The retailers in the focus group commented that they are cautious in suggesting particular products based on their energy rating, and tend to base recommendations on their knowledge of quality and reliability of models, using the rating more as a comparison later in the decision process.

Additionally, the main concern regarding the new labels in the industry group was the likelihood that providing a label would ultimately lead to them having to explain more information to consumers and spend more time to make a sale or installation. They also believed that additional information risks confusing people. While there was an appreciation of the importance in demonstrating differences in efficiencies between the climate zones, generally the industry members were concerned that the provision of additional information would result in more questions and time taken for a sale.

### Consistent focus group feedback

Label opinions across all focus groups were fairly consistent, with few variances between the consumer and industry sessions. The main differences occurred between the Australian and the New Zealand attendees.

Adaptations of the current ERL were not well received or interpreted.

Two label variants were agreed as the most viable to undergo small amendments and continue for further testing.

# Stage 2

## Map/zone development

The map used in the initial label development and focus group testing was a rough amalgamation of existing climate zones (including the Australian and New Zealand building code zones) to give an approximation of likely zone boundaries. Feedback from the focus group testing identified that more than three climate zones on a map was likely to be too complex for consumers and this is reinforced internationally with three zones used in the EU and in the USA.

The University of Queensland was contracted to develop methodologies to establish climate zones appropriate for a heat pump appliance (air conditioners and heat pump water heaters). This project included the examination of a range of climatic data and conditions balanced with population data to determine the best distribution of climate zones.

The heat pump device maps separate:

- A heating zone, which includes areas that have a much larger heating season when compared to the cooling season, as well as areas prone to frosting (Cold Zone);
- A cooling zone, which includes areas with a much larger cooling season when compared to the heating season, including areas with high levels of humidity where an evaporative device will not be suited (Hot-Humid Zone); and
- A mixed zone, where both heating and cooling seasons are more similar (Mixed Zone).

While the map for space heating and most water heater labels is to only have three zones, the analysis of data and conditions will include other existing climate data sources (including that of the Nationwide House Energy Rating Scheme, or NatHERS for Australia and the similar Home Energy Rating System in New Zealand) to enable a more high resolution set of performance results to be available through a smart phone application in the future. This will allow consumers and advisors to access more localised climate conditions to give a better estimation of running costs and energy usage.

More information is available in a report 'Climate Zone Mapping – Air Conditioners and Heat Pumps' available on the Energy Rating website.

## Second round of testing

Based on the feedback from the focus groups, a range of decisions were made on changes to be tested on a further round of qualitative testing. The most significant change made to both label concepts was to adjust the physical size of the labels, to ensure their overall dimensions would be no larger than the current air conditioner label (the reverse cycle label with heating and cooling ratings is 130mm high and 180mm wide). This was an important change to ensure manufacturers would not be required to make any changes to existing printing systems, and also to ensure that labels would not reach such a size where they would no longer physically fit on an appliance. Other minor amendments were made in line with feedback from the focus groups.

Following the revisions, the two label concepts were tested again in focus groups across Australia and New Zealand. Groups were held in Sydney, Brisbane, Perth and Christchurch to cover all climate zones, with two groups in the mixed zone where the greatest number of people live.

For the mixed zone, Perth was selected due to its geographical separation to assess if this impacts in the interpretation of the map on the label. Sydney was selected again for this zone due to its large population. Christchurch was chosen to represent New Zealand and the cold zone, due to increased sales of water heaters and reverse cycle air conditioners in the city following earthquake reconstruction work. For its large population, Brisbane represented the hot-humid zone.

Considering the reliance on intermediaries for the advice on the climate influenced appliances, the focus groups again included one group of industry, encompassing retailers and installers, and one group of consumers in each city. Each group was given labels for either heat pump water heaters or air conditioners. This was to allow for better concentration on the label design itself, without causing additional confusion from differing elements between appliances, which occurred in the initial round of testing. By limiting the number of physical labels and options each group was to examine, it allowed for a more thorough and in-depth discussion, and also reduced the potential for information overload for the participants.

Further care was taken in the selection process in the second round to ensure all participants have or would have a greater role in the actual selection or recommendation of products. This was particularly important for the selection of participants in the industry groups. In the first round, some of the installers in the industry group mostly installed appliances supplied to them from builders or other third parties, rather than having any real input into the selection process. A label would play no decision making role for people in these situations and thus their input would be less important in the refining process. This round ensured that participants would have an active recommendation or decision making role and be in a position where a label could potentially impact their roles and the products they install and suggest to customers.

The consumer groups were also more carefully selected, with particular care taken to ensure all participants had personally participated in the selection of a new appliance (or were planning on doing so). This was to ensure that consumers who had recently purchased a new home would be excluded as in most cases appliances are selected by builders or third parties without input from the occupant.

The second round of focus groups showed that retailers had noted more of an interest from consumers in appliance running costs. Consumers were said to be showing more of a willingness to pay a higher initial purchase cost if the appliance will be cheaper to operate over its lifetime. The retailers did note that their advice was not always trusted so would be supportive of a trustworthy source of this information and a label to make explaining options to customers easier.

Generally results on purchasing decisions and processes, along with general label feedback reflected outcomes from the initial groups. One design was selected comprehensively as the preferred option which would be the final layout. More detail on these focus groups is available on the Energy Rating website.

In addition to the focus groups, a series of in-depth interviews were held with retailers in each of the four cities. This was to allow additional questioning to members of industry likely to be using these labels on a regular basis and get a good idea of how they and their customers may use the label now (for air conditioners and gas products, as applicable). The interviews were held with a mix of specialist and general retailers of air conditioners and water heaters. The results from the interviews reinforced opinions from the focus groups and did not diverge significantly in any area.

In general, the outcomes from the interviews were similar to the outcomes from the focus groups. Retailers were particularly supportive of the label and generally thought its implementation would be positive and helpful for them in selling and explaining particular products. This s because the information that is government backed and theoretically more trustworthy. This can help in providing confidence in the energy efficiency information and remove some potential of retailers attempting to shift particular products for their own reasons – higher margins, shifting old stock etc.

# Stage 3

## Quantitative testing

After the completion of the second round of qualitative focus groups, a selection of label options were finalised by the graphic designer. Having been reduced to a single design concept, there were several elements that were not conclusively decided in qualitative testing. These involved some minor icon and positioning options but the general 'look and feel' was the same. The primary purpose of the testing, however, was to ensure that increasing the available information did not significantly decrease understanding. To test this, the existing ERL was included in the survey questions.

Approximately 1500 consumers across all three zones in Australia and New Zealand undertook the survey. In addition, 50 consumers were tested in in-store locations in Melbourne and a small number of industry members (primarily installers) also took part.

The survey consisted of eight 'test' questions, where there were right and wrong answers. The remaining questions were seeking opinions on design and other label features.

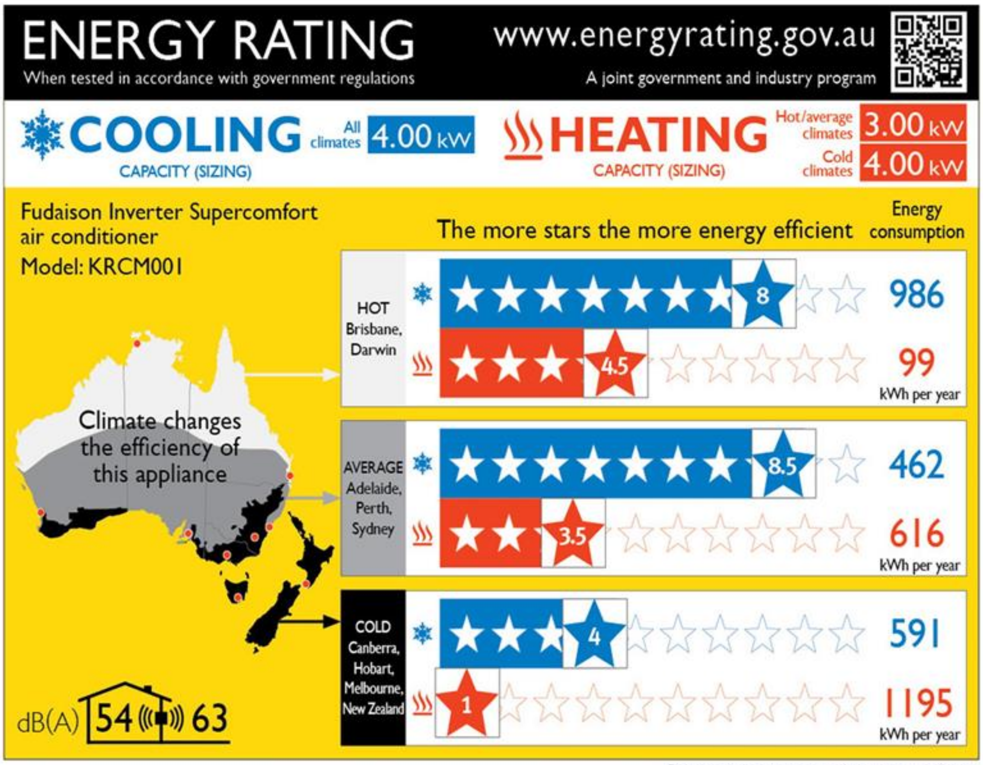
- The zoned energy rating label performed as effectively, and in some cases, significantly *more* effectively than the existing label – despite it substantially increasing the amount of information being presented

- Consumer comprehension ranged from 50 to 80% in the online survey, with 70-80% finding the correct 'more efficient' product
- These figures are of similar magnitude to results from EU label testing in 2012
- No significant differences noted between gender, age and employment status
- Only notable factor was educational level – those educated at university were more likely to correctly answer 6 of the 8 'test' questions
- Installers generally scored better, though correct answers still ranged between 50-100%
- 16% of consumers scored 100%, with 64% getting at least 2/3 correct
- 53% of installers got all answers right and 72% got at least 2/3

For comprehensive results and explanation of the survey and questions asked, please see the report on the Energy Rating website.

## Design approval

The E3 Committee approved the design of the zoned label in October 2014, following the favourable quantitative testing results. While some additional changes may be made in the future, the label as shown below is generally the design expected to accompany the options explored in this RIS.

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# Attachment B – Modelling

## Purpose

The aim of this document is to provide supporting technical and modelling outputs for a Consultation Regulation Impact Statement (RIS) affecting refrigerative cooling and heating equipment, including air conditioners and chillers.

MEPS and labelling requirements for air conditioners were last updated between 2011 and 2014 on a staged basis, depending on the product category. MEPS for chillers were introduced in 2009 under the E3 Program.

## Summary of key assumptions and model parameters

**Table 13 Table of assumptions and model parameters**

| KEY FEATURES | MODEL PARAMETER |
|---|---|
| **Scenarios** | Several policy options (shown below) were combined in multiple scenarios:<br>**Option A**: Zoned label adoption, international alignment, streamline requirements and address issues with portable air conditioners<br>➢ For air conditioners (A/C), adopt seasonal energy efficiency rating standard AS/NZS 3823.4 that takes account of climate and includes mandatory zoned labelling up to 30 kW.<br>➢ Single duct portable A/C subject to zoned labelling (with proxy for operating time data) and tested to AS/NZS 3823.1.5. Double duct portable A/C subject to zoned labelling to SEER standard AS/NZS 3823.4 and a reduced MEPS of 2.60.<br>➢ Multi-split systems subject to the SEER standard.<br>➢ Include A/C >65 kW capacity and chillers <350 kW under GEMS and remove these requirements from the National Construction Code (NCC). Retain current NCC MEPS levels for Australia and apply these in New Zealand.<br>➢ MEPS for A/C <65 kW maintained at current AEER/ACOP levels for Australia and apply these in New Zealand.<br>**Option B1**: Option A + MEPS alignment<br>➢ Align >65 kW a/c MEPS levels to 39-65 kW GEMS MEPS (i.e. AEER/ACOP 2.90). Align all chiller MEPS to US levels if higher than current Australian levels (see Table 7 for the proposed MEPS levels).<br>➢ Both single and double duct portable A/C regulated for MEPS of 2.60.<br>➢ Align New Zealand's residential cooling MEPS to match Australia's level.<br>➢ A/C MEPS levels must be met i.e. remove the option to comply with 95 per cent of MEPS for variable speed products with good efficiency at part load (part load compliance).<br>**Option B2**: Option B1 + SEER rating for all AC<br>➢ SEER rating of A/C >30 kW (via the registration website or with voluntary labelling). |
| **Sales** | Historical sales based GfK sales data from 2003 to 2014 and industry data for categories not covered by GfK.<br>Forecast sales based on projected trends and industry feedback on these trends presented at workshops and by interviews in 2014. |
| **Projection Period** | 14 years (2017-2030, cohort ending in 2050)<br>14 years was chosen as the modelling period as the zoned label will significantly affect product purchases over at least 5 years after implementation and have a continuing effect over the following 10 years. Cohort modelling refers to tracking the effect of the products installed up to 2030 for their remaining lifespan, which ranges from 10 to 20 years.<br>This approach has been used to capture the ongoing savings of the policy induced technology changes installed in the period up to 2030. |

| KEY FEATURES | MODEL PARAMETER |
| --- | --- |
| **Efficiency** | Historical EER and COP values are sales weighted or model weighted from 2000 to 2014, based on the registration database, categorised by product type. Non-operating power is also weighted by sales or models registered and modelled separately to obtain the Annual EER and COP. BAU efficiency projections from 2014 are based on historical trends during non-policy periods and found to increase by 0.5% pa at full load. Part load BAU efficiency is assumed to increases at a greater rate, in proportion to the number of variable capacity models being installed. The efficiency changes induced by the various policy proposals are shown below:<br>**Option A**: Assumes the zoned label will induce an increase in the sales weighted average part load efficiency of air conditioners below 30 kW. This is implemented in the model by increasing the ratio of part load to full load EER/COP for variable speed products by 1% pa in 2017 for 5 years following the implementation, and then to revert to the BAU assumed increase of 0.2% pa. The label change is assumed to transform the market for more efficient part load models, as they will rate higher. This type of transformation has occurred in other areas (such as TVs) when new labels are introduced or re-aligned and the product suppliers move to supply higher rated products. In cold climates (Victoria, Tasmania, Australian Capital Territory, and New Zealand), the zoned label is also assumed to increase the purchase of higher efficiency heating products (modelled as a 1% increase in full load COP in the year of implementation). For portable air conditioners, it is assumed that the zoned label will encourage sales of double duct units and they will represent 50% of sales in the portables market.<br>**Option B1**: Assumes all chiller products will meet the new requirements from 2017. The removal of the part load compliance MEPS option for A/C will increase the sales weighed average full load efficiency, which is modelled by assuming the units in the registration database that utilise this option for compliance are upgraded. For portable air conditioners, it is assumed that the MEPS level will shift 95% of the sales to double duct units, as most single duct units will not be able to comply with the MEPS.<br>**Option B2:** Assumes SEER rating will induce an increase in the sales weighted average part load efficiency of air conditioners above 30 kW. This is implemented in the model by increasing the ratio of part load to full load EER/COP for variable capacity products by 0.5% pa in 2017 for 5 years following the implementation, and then to revert to the BAU assumed increase of 0.2% pa. It is assumed that the impact of the zoned label will be lower in the business sector (where most of the 30 kW plus products are sold), due to the market using this information less in decision making than in the below 30 kW market (primarily households). |
| **Capital Costs** | All incremental capital/development costs are assumed to be passed on to the consumer.<br>**Option A:** The average price increase for those product categories affected by the zoned label was assumed to be 5%, to account for the product modifications (such as optimisations of variable speed compressors, implementation of variable speed drives, etc.). As this technology is currently widely used, the average price increase was reduced by 33% pa following implementation due to rapid learning. In cold climates where the COP is modelled as increasing by 1%, the price efficiency ratio of 0.5 is used. Portable AC costs increase in proportion to the double duct sales share (effectively the average weighted price increase is 20%).<br>**Options B1 and B2:** A price efficiency (PE) ratio was derived from the GfK data for split units and applied to all categories for MEPS increases. The ratio used was 0.5 for Proposals B1 and B2. With a PE ratio of 0.5, every 1% increase in average efficiency sees the price increase by 0.5%. The range of PE values shown in the analysis was between 0.14 and 1.84, with an average of 0.7 to 0.9. A ratio of 0.5 was used as it represents the cost of efficiency improvements to meet the minimum standard (i.e. MEPS level), not the average. The average price increase was reduced by 10% pa following implementation due to learning. Portable AC costs increase in proportion to the double duct sales share (effectively the average weighted price increase is 40%) Double duct portable AC are assumed to cost approximately 50% more than single duct portable AC, due to both the increase in cost from the extra ducting and the efficiency improvements necessary to meet the MEPS. For chillers, a PE ratio of 1.0 was used. |
| **Registration Admin costs and Costs of Compliance** | Government administration costs are made up of salary, program administration, check testing, consumer information/education and miscellaneous (market research, etc.). As most of the product categories are already regulated for MEPS and labelling, there is only a small increase in government costs.<br>The incremental administration cost for Australia and New Zealand are assumed to be $140,000 per annum. In addition, an establishment cost of $350,000 is counted in the year of implementation. |
| **Energy Consumption** | Energy consumption of the stock is calculated for each product group (26 AC, 11 chillers) by calculating the power consumption for each of the 7 modes (e.g. standby, 50 and 100 per cent capacity), then multiplying this by the annual operating hours and cohort stock quantity. Products are retired from the stock according to a survival function, which varies from average replacement after 8 years for portable AC to 12 or 15 years for non-ducted and ducted split air conditioners. Chillers have longer survival functions (e.g. 20 to 28 years). The energy consumption of each category is undertaken at the State level and summed for national results for Australia.<br>BAU is based on registration data from the registration database with sales data where available. The alternative proposals are based on the efficiency assumptions shown above.<br>Energy Prices are:<br>- Australia: based on (Residential + Business) Electricity price index, from AEMO 2014.<br>- New Zealand: based on Energy Information & Modelling Group's 2011 Energy Outlook results, Reference Scenario. |
| **GHG emissions** | Australia: Projected Factors from 2014 - derived from 2013 National Greenhouse Account (NGA) factors but varied by trends in Electricity Sent out emission intensity by state, the No Carbon Scenario, from The Treasury and DIICCSRTE, 2013 ->.<br>New Zealand: Ministry of Business, Innovation and Employment, New Zealand’s Energy Outlook \| Electricity Insight, June 2013. Historical values to 2012 and Forecast is the data from Mixed Renewables Scenario from 2013. |
| **Industry costs** | Registration costs for new products within the scope of the proposals are $670/model for the registration fee, which is treated as an income to the government for modelling purposes as partial cost recovery for government of administering the regulations in Australia. There are no registration fees in New Zealand.<br>Other costs of compliance (for example testing, staff education, record keeping) are accounted for using the Regulatory Burden Measurement tool (for Australia) and are included as a component of the cost benefit analysis. |

| KEY FEATURES | MODEL PARAMETER |
|---|---|
| **Sensitivity Analysis** | NPV:<br>• Australia - 7% discount rate, with sensitivity tests at 0%, 3% and 11%<br>• New Zealand – 5% discount rate, with sensitivity tests at 0%, 3% and 8%<br>Costs:<br>• Average incremental costs due to efficiency increase are increased and decreased by 50%. |
| **Key Assumptions** | Reduction in energy use is due to new policy options described above in 2017.<br>Rebound (take back) treated as zero in relation to energy use. Rebound occurs where the increased energy efficiency of a product results in a consumer making greater use of the product. Any rebound would occur through the conversion of potential energy savings into increased thermal comfort (i.e. if consumers spend some of the energy savings to cool or heat their home more) but this does not decrease the total benefit the consumer receives, it is simply a conversion of the energy savings benefit into another form. This means there is no reduction in benefits from the consumers' perspective from rebound; hence it can be ignored for the cost benefit analysis.<br>For Australia the additional benefits of lower levels of greenhouse gas emissions have been included in the benefits with a value of $13.95 per t $CO_2$-e[52], and reduced by 25% to account for any potential rebound.<br>Benefits due to reduced peak demand due to lower power consumption are intrinsically included in the electricity prices used for the cost benefit analysis. |

[52] Department of Environment, email correspondence 2 October 2015.

# i. Methods and key inputs

## Method for calculating energy and greenhouse gas impacts

### Energy consumption

The energy used by air conditioners and chillers is a function of average electrical input power, number of operating units and average number of hours of operation. In turn the Greenhouse Gas (GHG) emissions are a function of energy consumption and the emission factors determined by the electricity generation mix.

To calculate the energy consumption under the BAU and policy scenarios, a detailed and elaborate stock model of units installed and operating was developed. The number of operating units in a particular year is a function of existing stock, replacements and new sales. Estimates of stock and sales were made for Australia and New Zealand, as detailed in the stock and sales section. Units were also retired from operation according to a "survival function" that reflected the life span of typical equipment. Hence, a complete stock model of the air conditioner and chiller market was developed by state/region and year, with additional details such as category, capacity range, average efficiency (at multiple load points and standby power) and year of purchase or installation. These units were multiplied by BAU and policy average power input figures at various load points and corresponding average number of hours of operation for each category/load point to obtain the total energy consumption by state, category and capacity range.

It is worth noting that operating hours vary according to the state/region and if operating in the business or residential sector. In addition, the proportion of time operating at various load points also varies depending on the region where the equipment is installed.

To determine the average BAU input power to the air conditioners, data on the rated efficiency of the units was used. The input power to air conditioners is a function of the Coefficient of Performance (COP, the ratio of heating output to electrical input) and/or Energy Efficiency Ratio (EER, the ratio of cooling output to electrical input) of the air conditioners. The COP/EER and cooling capacity in kW are the commonly used technical attributes of air conditioners. For chillers, the COP and the Integrated Part Load Value (IPLV –the weighted efficiency when running at part load – e.g. 25, 50, 75 per cent and 100) is used as the measure of efficiency. The input power in kW for each load point can be calculated as:

$$\text{Input Power (kW)} = \frac{\text{Cooling/Heating Capacity (kW)}}{EER or COP}$$

Standby and crankcase power consumption (or non-operational power) were also used in the calculations of total annual energy consumption for air conditioners.

The BAU average efficiency was determined from sales weighted average or model weighted average EER/COP over the last 10 years (or from when the products were registered), and projected to 2030 with an autonomous annual efficiency improvement of between 0.25% and 0.5%. Efficiency increases due to the current Australian/New Zealand MEPS were included in the BAU average efficiency. The average efficiency of the units as a result of the policy options being assessed was determined on the basis of the increase in sales weighted average EER or COP at each load point (or COP/IPLV for chillers), due to the scenario being examined for each particular category and capacity range.

Energy consumption was determined for the BAU and policy scenarios. The difference in the projections of energy consumption provided the net energy savings used to calculate the impacts reported later in this section.

**Greenhouse gas emissions**

GHG emissions can be determined by multiplying the energy used by the air conditioners by the relevant emission factor for the State in which they operate. The emission factor refers to the amount of greenhouse emissions produced through the supply of a given unit of electricity. In the model, the GHG emissions were estimated by using the State/region energy calculations combined with the GHG Emissions Factors in Attachment B1.

## Cost benefit methodology

A financial analysis has been conducted on the societal cost benefits of the proposals being reviewed, with the analysis conducted at the State and national level. In the analysis the following costs and benefits are included:

**Costs:**

- To the consumer, due to increases in the upfront price of products reflecting costs passed on by suppliers;
- To government for implementing and administering the requirements; and
- To the product supply businesses for complying with the new or modified regulatory requirements of the program (i.e. testing, administration and training for modified or new product categories).

**Benefits:**

- To the consumer, due to improving the information available for comparing the energy efficiency of products and the improved energy efficiency of available products resulting in avoided electricity purchase costs,
- To government from simplification of the regulatory framework;
- To suppliers from simplifications to the regulatory framework; and
- To society from reduced GHG emissions.

In terms of an approach for the cost-benefit analysis, it is necessary to do this from either a consumer or societal perspective. The social approach is the appropriate methodology for the analysis, but the consumer approach can be used where it approximates the results that would be obtained from the societal perspective. As electricity prices closely reflects the marginal cost of producing electricity, due to generators providing power in response to a competitive bidding system for the wholesale energy market, the market price can be used as a proxy for the resources saved in production. Consequently, the results should closely resemble those that would be obtained from an analysis from the social perspective.

An analysis from a consumer perspective involves the use of retail product prices and marginal retail energy prices. Since the objective is to assess whether product buyers (consumers) as a group would be better off, transfer payments such as taxes are included. The analysis includes retail mark-ups and taxes will be passed onto the consumer and including these in the costs will simplify the analysis process, while still remaining appropriate.

The consumer approach is also recommended for the development of RIS's associated with the E3 Program (NAEEEP 2005). The alternative analysis approach, of assessing from a resource perspective, would require a new set of factors and assumptions to be introduced to the analysis, particularly regarding manufacturing costs, and would also mean the impact of varying discount rates would be very much more difficult to assess.

All Net Present Value (NPV) figures are real 2014 dollars. NPV is a calculation that allows decision makers to compare the costs and benefits of various alternatives on a similar time scale by converting all options to current dollar figures. NZ values are shown in NZ dollars, calculated with an exchange rate of 1.08 NZD to AUD (average over 2014) where necessary.

# Key inputs

The various inputs are detailed below and are derived from available data, industry interviews or where necessary, realistic assumptions.

The data research used for this attachment was obtained from multiple sources (past RIS analysis, industry data/interviews, published sources, and unpublished industry data) and checked with industry in a series of interviews and a workshop. The interviews were conducted with over 25 suppliers from Australia and New Zealand during late 2013 and 2014. They followed a structured interview guide to obtain information on the market trends, lifetimes of products, shares of sales to business vs residential sectors, efficiency trends, price trends, size trends and technology barriers to greater energy efficiency.

An industry workshop was also undertaken in April 2014, where the preliminary stock and sales numbers for the modelling were presented and feedback sought. This workshop was attended by 50 stakeholders and feedback was obtained over they day, and during discussions by telephone and in person at the Air Conditioning, Refrigeration and Building Services conference in May 2014.

In the case of New Zealand stakeholders, another set of interviews were conducted in 2014 to obtain feedback on the preliminary modelling results for New Zealand. As a result of these interviews and workshops, the model parameters were adjusted.

## Product categories assessed

For each of the classes of equipment, multiple product categories were utilised to ensure the impacts of potential policy changes are assessed. The following product categories were utilised, along with the key inputs of average rated output.

### AC product categories

**Table 14 AC product categories and average rated capacity**

| Product Category | Heating Capacity (kW) | Cooling Capacity (kW) |
|---|---|---|
| Ducted 0-20kW - RES & BUS | 12.7 | 12.0 |
| NDucted Split 0-4kW - RES & BUS | 3.2 | 2.9 |
| NDucted Split 4-6kW - RES & BUS | 5.5 | 5.0 |
| NDucted Split 6-10kW - RES & BUS | 8.0 | 7.3 |
| NDucted Split 10-20 kW - RES & BUS | 13.4 | 12.2 |
| Multi Splits - RES & BUS | 9.4 | 8.5 |
| Portables - RES | 2.8 | 2.4 |
| NDucted Unitary 0-10kW - RES & BUS | 3.8 | 4.0 |
| Ducted 20-40kW - BUS | 28.1 | 27.5 |
| Ducted 40-65kW - BUS | 51.0 | 50.0 |
| Ducted >65kW - BUS | 91.8 | 90.0 |
| NDucted 20-40kW - BUS | 28.9 | 27.5 |
| NDucted >40kW - BUS | 52.5 | 50.0 |
| Multi Splits - VRF - BUS | 28.4 | 27.0 |

*Notes: Ducted = ducted air conditioner, NDucted = non-ducted air conditioner, BUS = Business sector, RES = Residential sector.*

## Chillers product categories

**Table 15 Chiller product categories and average rated capacity**

| Product Category | Heating Capacity (kW) | Cooling Capacity (kW) |
|---|---|---|
| Air Cooled < 350 kW | NA | 132.0 |
| Air Cooled >350 - < 500 kW | NA | 425.0 |
| Air Cooled >500 - < 700 kW | NA | 610.0 |
| Air Cooled >700 - < 1000 kW | NA | 850.0 |
| Air Cooled >1000 kW | NA | 1,450.0 |
| Water Cooled < 350 kW | NA | 132.0 |
| Water Cooled >350 - < 500 kW | NA | 425.0 |
| Water Cooled >500 - < 700 kW | NA | 610.0 |
| Water Cooled >700 - < 1000 kW | NA | 850.0 |
| Water Cooled >1000 - < 1500 kW | NA | 1,300.0 |
| Water Cooled >1500 kW | | 2,000.0 |

# BAU efficiency in 2013

The average efficiency of products sold in a particular year was determined from sales of models matched with the EER/COP from the energy rating registrations database (all products that have MEPS or Energy Rating Labels are registered and the technical characteristics recorded in this database). Where sales data was not available, the model weighted average efficiency was determined from the registration database. 2013 data is presented here as this was the most complete year of data for all equipment types and in NZ (though some 2014 data e.g. GfK was used in the modelling). Each product type is discussed below.

## AC efficiency

The BAU operational EER/COP at full load is shown below for Australia and New Zealand, with most categories derived from sales weighted average data, and other categories derived from model weighted data. The BAU efficiency of portable AC and ducted >65kW were derived from available test data and discussions with industry stakeholders. Values were calculated for most products from 2003 to 2013, with some data being available from 2000.

The model separates the calculations of energy consumption into six loads for each of heating and cooling modes, as follows: 125 per cent, 100 per cent, 75 per cent, 50 per cent, 25 per cent and minimum. The non-operational power (NOP) (standby + crank case) is also calculated separately. The average NOP is derived from the registrations database.

Therefore, a total of 13 points are calculated for each product category. This separation allows the impact of Zoned Labels on the part load characteristics of the equipment to be assessed. The part load efficiency values are calculated from the use of the default ratios of efficiency of part load to full load applied in the SEER testing and rating standard, ISO 16358 (AS/NZS 3823.4), in combination with the average efficiency at full load and 50% load recorded in the registrations database for applicable models.

The average forecast autonomous efficiency improvement was calculated from past periods of no policy action and found to be 0.5 per cent per annum. This increase in efficiency was applied to forecast BAU and policy options.

**Table 16 AC product categories and average efficiency in 2013 – Australia**

| Product Category | Heating COP (W/W) | Cooling EER (W/W) |
|---|---|---|
| Ducted 0-20kW - RES & BUS | 3.58 | 3.23 |
| NDucted Split 0-4kW - RES & BUS | 4.44 | 4.31 |
| NDucted Split 4-6kW - RES & BUS | 3.80 | 3.57 |
| NDucted Split 6-10kW - RES & BUS | 3.57 | 3.36 |
| NDucted Split 10-20 kW - RES & BUS | 3.64 | 3.33 |
| Multi Splits - RES & BUS | 4.20 | 3.64 |
| Portables - RES | 2.41 | 1.71 |
| NDucted Unitary 0-10kW - RES & BUS | 3.34 | 3.29 |
| Ducted 20-40kW - BUS | 3.58 | 3.23 |
| Ducted 40-65kW - BUS | 3.57 | 3.32 |
| Ducted >65kW - BUS | 3.40 | 3.10 |
| NDucted 20-40kW - BUS | 3.36 | 2.86 |
| NDucted >40kW - BUS | 3.80 | 3.45 |
| Multi Splits - VRF - BUS | 3.43 | 3.12 |
| Ducted 0-20kW - RES & BUS | 3.75 | 3.34 |

**Table 17 AC product categories and average efficiency in 2013 – New Zealand**

| **Product Category** | **Heating COP (W/W)** | **Cooling EER (W/W)** |
|---|---|---|
| Ducted 0-20kW - RES & BUS | 3.48 | 3.08 |
| NDucted Split 0-4kW - RES & BUS | 4.26 | 4.08 |
| NDucted Split 4-6kW - RES & BUS | 3.74 | 3.41 |
| NDucted Split 6-10kW - RES & BUS | 3.58 | 3.30 |
| NDucted Split 10-20 kW - RES & BUS | 3.69 | 3.35 |
| Multi Splits - RES & BUS | 4.20 | 3.64 |
| Portables - RES | 2.41 | 1.71 |
| NDucted Unitary 0-10kW - RES & BUS | 3.07 | 3.17 |
| Ducted 20-40kW - BUS | 3.48 | 3.08 |
| Ducted 40-65kW - BUS | 3.55 | 3.18 |
| Ducted >65kW - BUS | 3.41 | 2.92 |
| NDucted 20-40kW - BUS | 3.29 | 2.78 |
| NDucted >40kW - BUS | 3.80 | 3.45 |
| Multi Splits - VRF - BUS | 3.43 | 3.12 |
| Ducted 0-20kW - RES & BUS | 3.75 | 3.34 |

The New Zealand BAU efficiency was derived from the sales weighted average efficiency as EECA collect sales data from suppliers. Most categories were based on sales weighted values and some categories were assumed values from Australian/New Zealand industry interviews and test reports.

## Chiller efficiency

The BAU operational COP at full load and IPLV is shown below for Australia (with the assumption that New Zealand values are the same as Australia). All product categories were derived from model weighted average data using the registration database, except for <350 kW, where it was assumed that this category just meets the minimum COP required by the NCC in 2010 (so some products are below the minimum). BAU values were calculated from the registration database from 2009 to 2013, with earlier values derived from the 2008 Chiller RIS.

The model separates the calculations of energy consumption into 4 loads for cooling modes, as per the IPLV load points of 100 per cent, 75 per cent, 50 per cent and 25 per cent. The COP at each load point is calculated using a ratio of 100 per cent load COP to each of the 75 per cent, 50 per cent and 25 per cent load point COP. The ratio of COP at various load points was calculated from data used to develop the 2008 Chiller RIS and validated against the model weighted average IPLV from the registration database.

**Table 18 Chiller product categories and average efficiency in 2013 – Australia and New Zealand**

| Product Category | Cooling COP (W/W) | Cooling IPLV (W/W) |
|---|---|---|
| Air Cooled < 350 kW | 2.52 | 3.93 |
| Air Cooled >350 - < 500 kW | 3.06 | 4.78 |
| Air Cooled >500 - < 700 kW | 3.06 | 4.78 |
| Air Cooled >700 - < 1000 kW | 3.13 | 4.79 |
| Air Cooled >1000 kW | 3.00 | 4.60 |
| Water Cooled < 350 kW | 4.23 | 5.85 |
| Water Cooled >350 - < 500 kW | 5.45 | 7.92 |
| Water Cooled >500 - < 700 kW | 5.45 | 7.92 |
| Water Cooled >700 - < 1000 kW | 5.61 | 8.26 |
| Water Cooled >1000 - < 1500 kW | 6.04 | 8.78 |
| Water Cooled >1500 kW | 6.24 | 9.41 |

## Life of equipment (Survival)

The forecasts of stock were subjected to appropriate "survival functions" for each category and size. Examples of the different survival functions are shown in Figure 8 and Figure 9, where a graphical view is presented of the percentage of air conditioners (Rt) in useful service over the life in years from purchase (t).

**Figure 8 Survival function of ducted AC**

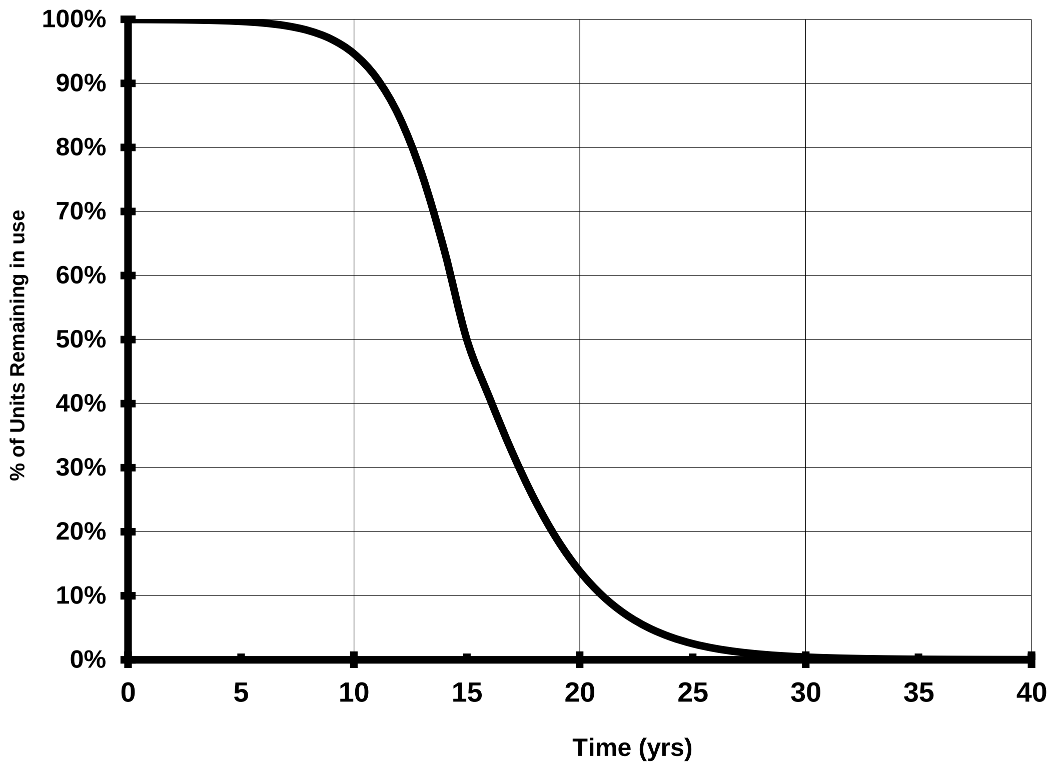
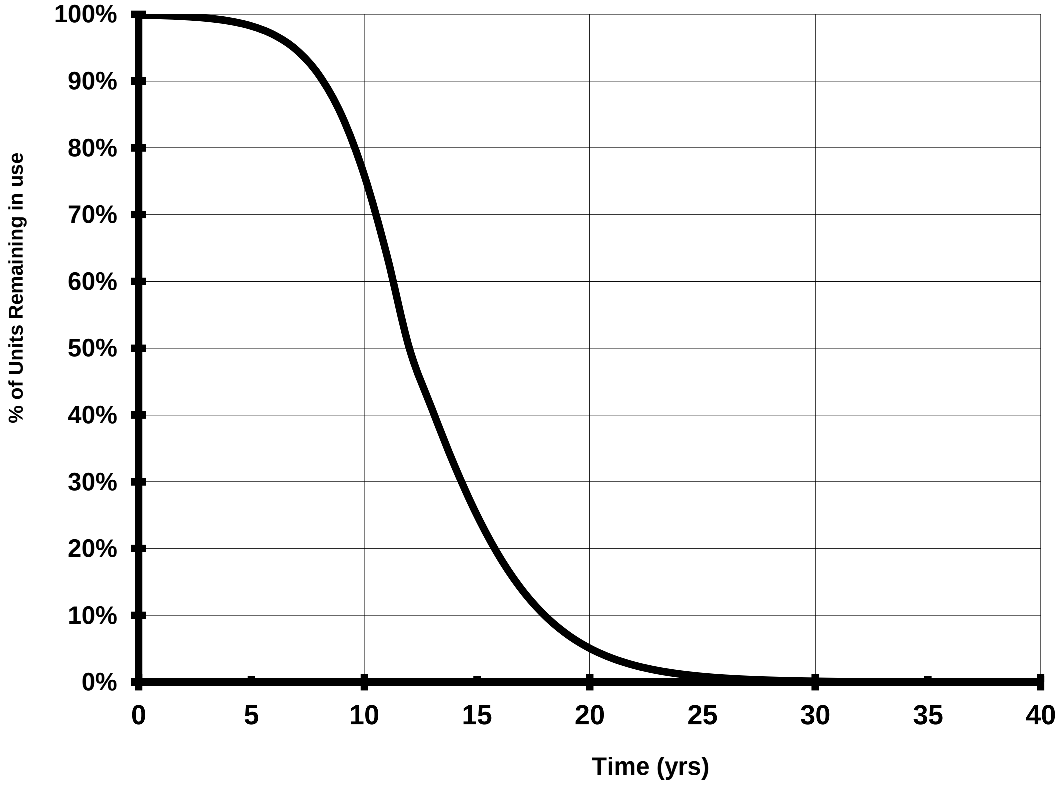



**Figure 9 Survival function of non-ducted AC**



For AC equipment, the following assumptions for 50 per cent life were used:

- Ducted AC – 15 years
- Non ducted and Multi split AC – 12 years
- VRF AC – 15 years
- Non ducted Unitary AC – 15 years for residential and 8 years for business
- Portable AC – 8 years

For chillers, similar survival functions were used, however the 50 per cent life assumed was 18 years for air cooled chillers and 25 years for water cooled chillers.

These life assumptions were developed in consultation with the Australia and New Zealand suppliers in workshops and interviews.

## Operating hours

The operating hours for all products were the estimated operating hours of the equipment at various load points. The following data and calculations were used to calculate the operating hours.

### AC operating hours

The AC operating hours were derived from the Australian Bureau of Statistics Household Energy Consumption Survey (ABS 2012) and are shown below.

**Table 19 AC State/Zone average annual operating hours - Residential**

| State/Zone Operating Hours Factor | Heat | Cool |
|---|---|---|
| NSW | 378 | 503 |
| ACT | 877 | 346 |
| NT | 20 | 1577 |
| QLD | 303 | 707 |
| SA | 378 | 493 |
| TAS | 1516 | 394 |
| VIC | 533 | 364 |
| WA | 345 | 631 |
| NZ | 1516 | 394 |

*Note: NZ was assumed to be approximately the same as Tasmania, and this is supported by interviews in NZ*

The operating hours were adjusted by a number of factors to account for occupied households, percentage of households using the heating functions of the air conditioner and the number of air conditioners in the house. As approximately 10 per cent of households are unoccupied, the hours of use were first multiplied by 0.9.

To account for the number of air conditioners used for heating, the ABS HEC (ABS 2012) survey was used to derive the following adjustments.

**Table 20 AC State/Zone heating and cooling operating hours adjustment - Residential**

| State/Zone Operating Hours Factor | Heat | Cool |
|---|---|---|
| NSW | 70% | 100% |
| ACT | 70% | 100% |
| NT | 10% | 100% |
| QLD | 60% | 100% |
| SA | 70% | 100% |
| TAS | 95% | 100% |
| VIC | 45% | 100% |
| WA | 70% | 100% |
| NZ | 95% | 100% |

*Note: NZ was assumed to be approximately the same as Tasmania, and this is supported by interviews in NZ*

These operating hours were then adjusted to account for more than one product in the household and user specific behaviour when operating different types of air conditioning systems. The adjustments are shown below.

**Table 21 AC equipment zoning and product adjustment to average annual operating hours - Residential**

| Product Category | Factor - Cooling | Factor - Heating |
|---|---|---|
| Ducted 0-20kW - RES - Exist | 1.00 | 1.00 |
| Ducted 0-20kW - RES - Post2005 | 1.00 | 1.00 |
| NDucted Split 0-4kW - RES - Exist | 0.75 | 0.75 |
| NDucted Split 0-4kW - RES - Post2005 | 0.75 | 0.75 |
| NDucted Split 4-6kW - RES - Exist | 0.75 | 0.75 |
| NDucted Split 4-6kW - RES - Post2005 | 0.75 | 0.75 |
| NDucted Split 6-10kW - RES - Exist | 0.75 | 0.75 |
| NDucted Split 6-10kW - RES - Post2005 | 0.75 | 0.75 |
| NDucted Split 10-20 kW - RES - Exist | 0.75 | 0.75 |
| NDucted Split 10-20 kW - RES - Post2005 | 0.75 | 0.75 |
| Multi Splits - RES | 0.75 | 0.75 |
| Portables - RES | 0.50 | 0.10 |
| NDucted Unitary 0-10kW - RES | 0.60 | 0.20 |

Business operating hours were estimated for each state based on the previous 2011 AC RIS, which assessed the likely business operating hours in each zone, considering that most commercial buildings require cooling (due to the higher loads) more than heating, and that many commercial buildings have gas heating. The values used are shown in the following table.

**Table 22 AC State/Zone average annual operating hours - Business**

| State/Zone Operating Hours Factor | Heat | Cool |
|---|---|---|
| NSW | 438 | 1753 |
| ACT | 438 | 1753 |
| NT | 0 | 2192 |
| QLD | 26 | 2192 |
| SA | 175 | 1753 |
| TAS | 1578 | 482 |
| VIC | 88 | 1753 |
| WA | 44 | 1929 |
| NZ | 1578 | 482 |

The heating and cooling operating hours were then allocated to each of the six load points for each State/Zone. The basis of this allocation was modelling commissioned by the Department of Industry, Innovation and Science for the development of the Zoned Label. The modelling provided the amount of time an air conditioner would be operating in various temperature ranges for both heating and cooling mode. The proportion of time in each temperature range was allocated to the load points (125 per cent, 100 per cent, 75 per cent, 50 per cent, 25 per cent and minimum).

Finally, the non-operational time was determined as the remaining time in the year when the heating and cooling modes were not operating.

## Chiller operating hours

The chiller operating hours were based on estimates of operating hours by type of building and the share of energy consumption for each building type from the Baseline Energy Consumption and Greenhouse Gas Emissions in Commercial Buildings in Australia study (DCCEE 2012) and information from the previous RIS (MCE 2008); and are shown in Table 23.

**Table 23 Chiller state/zone average annual operating hours**

| State/Zone Operating Hours Factor | Cool |
|---|---|
| NSW | 3506 |
| ACT | 3068 |
| NT | 3945 |
| QLD | 3945 |
| SA | 3506 |
| TAS | 1753 |
| VIC | 3243 |
| WA | 3506 |
| NZ | 1753 |

These operating hours were adjusted to account for the installation of redundant chillers. The adjustments are shown in Table 24 and are based on stakeholder interviews.

**Table 24 Chiller equipment adjustment to average annual operating hours**

| Product Category | Factor |
|---|---|
| Air Cooled < 350 kW | 0.90 |
| Air Cooled >350 - < 500 kW | 0.90 |
| Air Cooled >500 - < 700 kW | 0.90 |
| Air Cooled >700 - < 1000 kW | 0.80 |
| Air Cooled >1000 kW | 0.80 |
| Water Cooled < 350 kW | 0.90 |
| Water Cooled >350 - < 500 kW | 0.90 |
| Water Cooled >500 - < 700 kW | 0.90 |
| Water Cooled >700 - < 1000 kW | 0.80 |
| Water Cooled >1000 - < 1500 kW | 0.80 |
| Water Cooled >1500 kW | 0.80 |

The cooling operating hours were then allocated to each of the four load points for each State/Zone. The basis of this allocation was industry stakeholder interviews and the IPLV calculations in the ASHRAE standards. The IPLV calculations allocate the amount of time a chiller would be operating in various IPLV load points for cooling mode. The proportion of time in each temperature range was allocated to the load points (100 per cent, 75 per cent, 50 per cent and 25 per cent) as follows.

| Region/Load | 100% | 75% | 50% | 25% |
|---|---|---|---|---|
| NSW/SA/WA | 20% | 35% | 35% | 10% |
| VIC/ACT | 10% | 35% | 35% | 20% |
| QLD | 25% | 35% | 35% | 5% |
| NT | 30% | 40% | 25% | 5% |
| NZ/TAS | 5% | 40% | 45% | 10% |

## Price efficiency ratio

A key input for the modelling of the costs of the policy option is the impact on the price of the product to the consumer. The assumption used in the modelling is that more efficient equipment is more expensive than a similar performing product with lower efficiency.[53] This approach has been used for past RISs in determining the relative costs of efficiency improvements due to the policy intervention.

A range of options exist for determining the potential price changes as a result of the policy, such as engineering/cost deconstruction, surveys of the suppliers to obtain price increments vs efficiency performance, analysis of the price versus efficiency relationship from matched model sales and technical data. The latter two approaches were used in this modelling exercise.

The aim of this price versus efficiency research is to obtain a value for the Price Efficiency (PE) ratio that can be used to assess the cost impacts of the policy option. For example, if a 1% increase in the average efficiency of the products being sold/installed is achieved with an average price increase of 1.5%, this results in a PE ratio of 1.5.

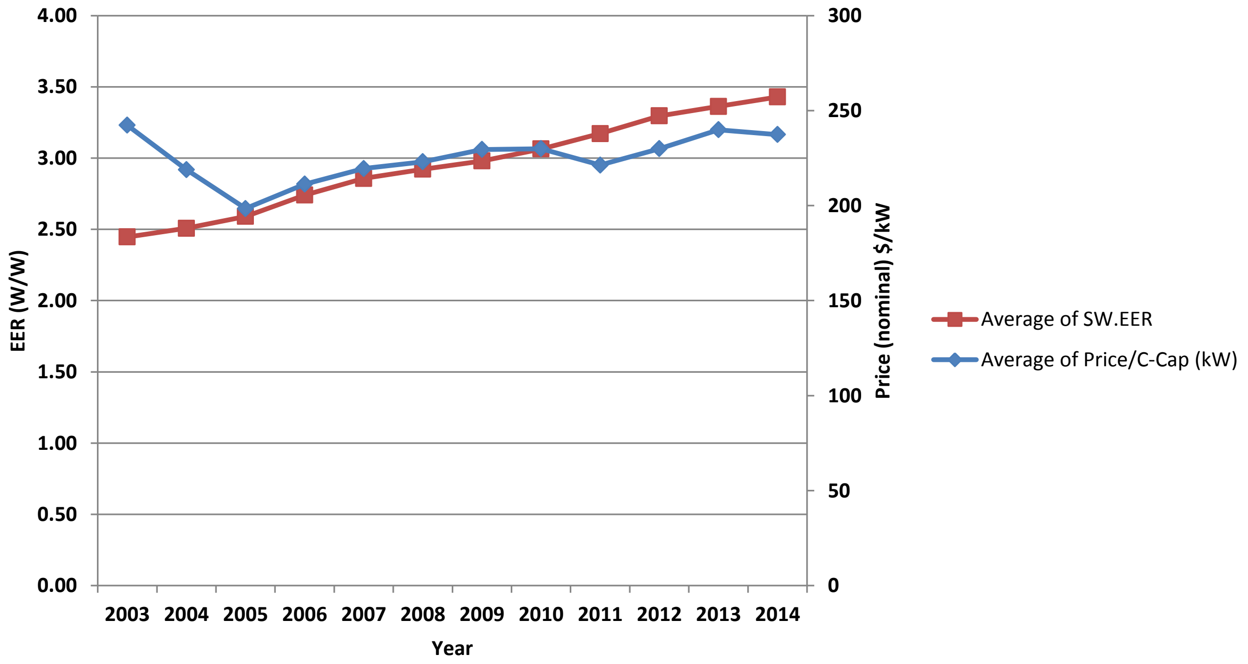
### AC price efficiency ratio

GfK data on the sales of non-ducted air conditioners from 2003 to 2014 was matched with models registered in the energy rating database. This enables a detailed assessment of the price versus efficiency of products over time and by efficiency cohort in particular years. Figure 10 shows the results of the efficiency versus price over time for non-

[53] Although this assumption is used – it is not necessary supported by evidence from evaluations of efficiency programs, see ‘Evaluation of Energy Efficiency Policy Measures for Household Air Conditioners in Australia’, EnergyConsult 2010.

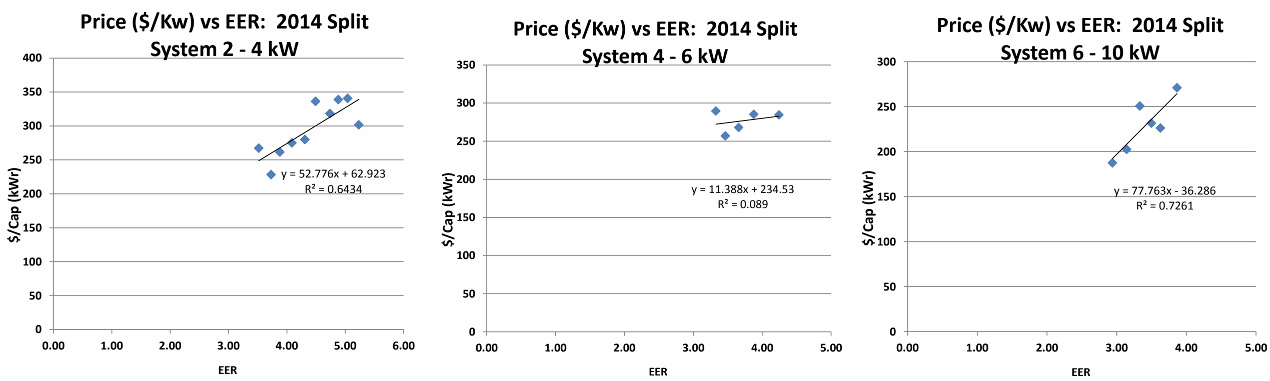
ducted 6- 10 kW split AC over the period 2003 – 2014. This graph shows that there is not a strong relationship between nominal prices ($/kW) and EER. In fact, if inflation is taken into account, prices have actually decreased.

**Figure 10 Price per kW of output capacity vs efficiency (EER) over 2003 – 2014: 6- 10 kW non-ducted split AC**




However, the analysis of various cohorts of efficiency for the recent 2014 financial year shows some relationship in price versus efficiency. The PE ratio ranges from 0.14 to 1.2 when examining all the 2014 data with sufficient sales by EER bins of 0.2 EER, as shown in Figure 11 (the slope of the line when normalised to percentage of efficiency and price provides the PE Ratio).[54] The average PE ratios is 0.6, however there is a wide range of $R^2$ and correlation coefficient.

**Figure 11 Price vs EER for non-ducted split AC in 2014FY**




When examining the higher EER cohorts (those units with EER of about 10 per cent or higher than the current MEPS levels), the PE ratio ranges from 0.33 to 1.84, with an average of 0.9. However, there are less data points and therefore lower confidence in the strength of the relationship. Nevertheless, this does suggest that the relationship may not be linear over the range of efficiency and that the PE ratio used to assess the costs of policy options should increase with the more stringent policy (where only high efficiency units are available).

54 The PE ratio is the ratio of the percentage increase in both price and efficiency. The figures show the non-normalised actual costs (in $ per kwr vs EER).

To reflect the results of this analysis, the PE ratio used for the CBA range from 0.5 for the least stringent policy options to 2.0 for the stringent 2011 Decision RIS recommended MEPS levels.

For the Zoned Label policy option, the increase in costs is assumed to be an average 5 per cent increase in price to account for the costs of product suppliers optimising the current variable capacity output products or adding variable capacity features to their products. Considering that the majority of products currently on the market already feature variable capacity outputs, this assumption is considered conservative, and was tested during interviews with suppliers.

In the portable AC product category, the price of the products reflect changes to the market share of double duct and single duct portable units (where single duct units are assumed to have lower market shares due to either the Zoned Label requirements or MEPS requirements).

### Chiller price efficiency ratio

The price efficiency ratio used for the assessment of costs in the CBA for chillers was 1.0, based on stakeholder workshops and interviews.

## Discount rates

All the outputs of the CBA were assessed in Australia at a 7 per cent discount rate, with sensitivity tests at 0, 3 and 11 per cent. For New Zealand a 5 per cent discount rate is used, with sensitivity tests at 0, 3 and 8 per cent.

## Electricity prices

The electricity prices and forecasts used in the CBA are taken from the documented research conducted by EnergyConsult for the Residential Baseline Study[55]:

- In Australia they are based on (Residential + Business) Electricity price index, from AEMO 2014.
- In New Zealand they are based on Energy Information & Modelling Group's 2011 Energy Outlook results - Reference Scenario.

Table 29 in Attachment B1 provides the current and forecast electricity prices for the residential sector used in the modelling; business prices are not permitted to be published.

## GHG emission factors

The GHG emission factors and forecasts used in the modelling are taken from the documented research conducted by EnergyConsult for the Residential Baseline Study:

- Australia: Projected Factors from 2014 - derived from 2013 NGA factors but varied by trends in Electricity Sent out emission intensity by state, the No Carbon Scenario, from The Treasury and DIICCSRTE, 2013 ->.
- New Zealand: Ministry of Business, Innovation and Employment, New Zealand's Energy Outlook | Electricity Insight, June 2013. Historical values to 2012 and Forecast is the data from Mixed Renewables Scenario from 2013.

Table 30 in Attachment B1 provides the current and forecast GHG emission factors used in the modelling.

[55] *Residential Baseline Study: Australia.* August 2015, Department of Industry and Science on behalf of the trans-Tasman Equipment Energy Efficiency (E3) Program. And, *Residential Energy Baseline Study: New Zealand.* August 2015, Department of Industry and Science on behalf of the trans-Tasman Equipment Energy Efficiency (E3) Program.

# ii. Sales and stock

## Sales trends

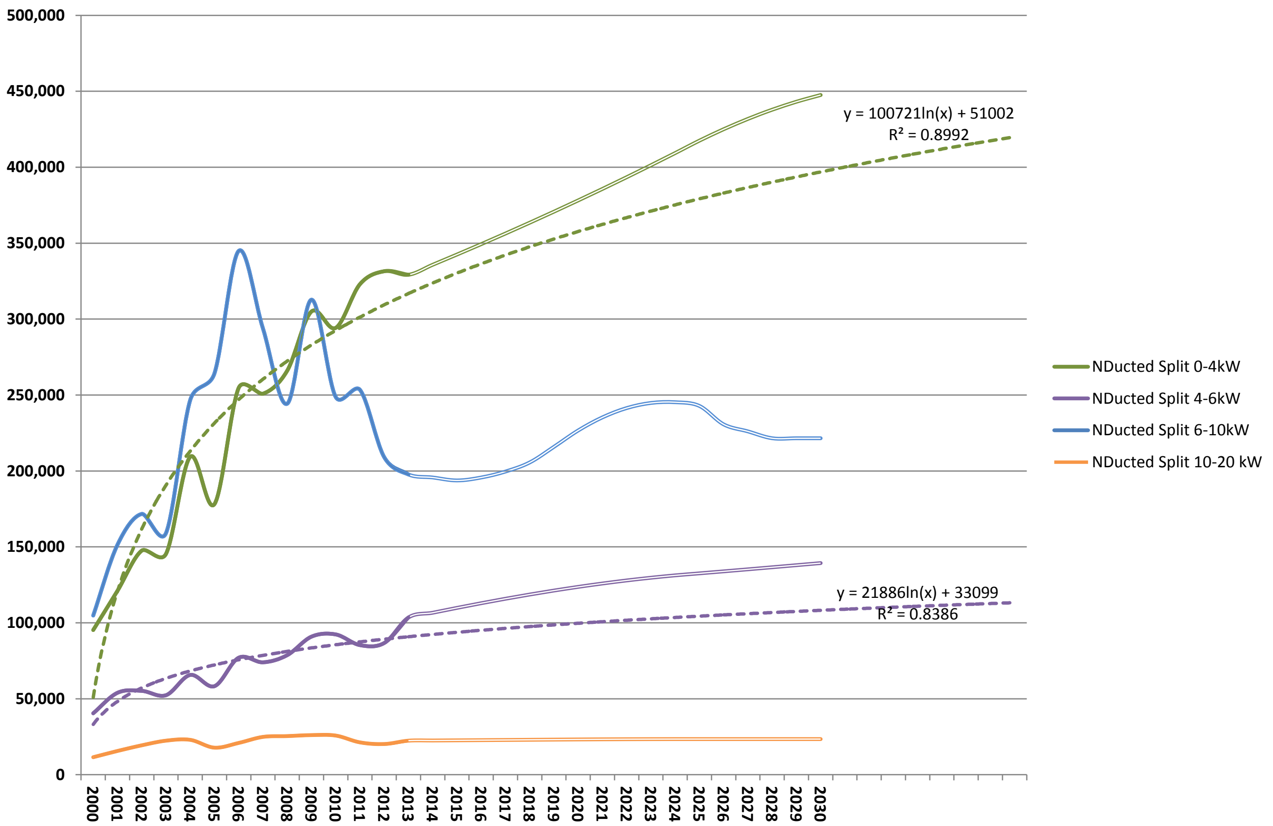
The sales of AC and chillers are a function of economic growth and consumer/business product preferences. The sales data from published and unpublished sources has been utilised to determine the most probable forecast that matches the historic data and trends. These sales forecasts have been developed in consultation with industry stakeholder workshops and interviews in Australia and New Zealand during 2014.

### AC – Sales trends

#### Sales by category

Figure 12, Figure 13 and Figure 14 show the resulting historical and forecast sales of air conditioners to 2030 in Australia by category. Figure 15, Figure 16 and Figure 17 show the resulting historical and forecast sales of air conditioners to 2030 in New Zealand by category

**Figure 12 Forecast annual sales of AC – non-ducted: Australia**




*Note: the dotted lines are best fit regressions that were used to determine the forecast growth rates; Non-ducted over 20 kW have very small sales and are not shown on the graphic*

**Figure 13 Forecast annual sales of AC – ducted AC: Australia**

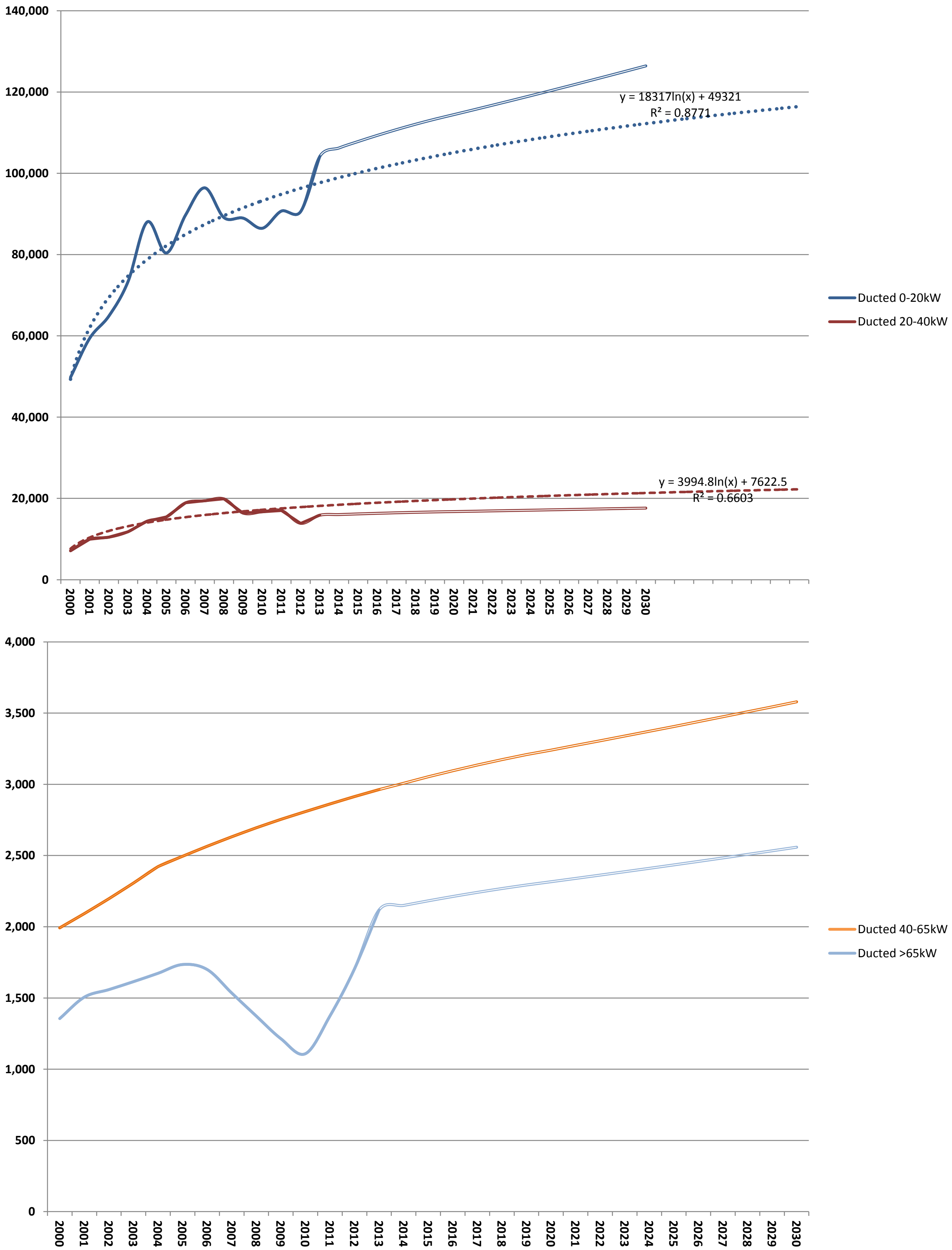
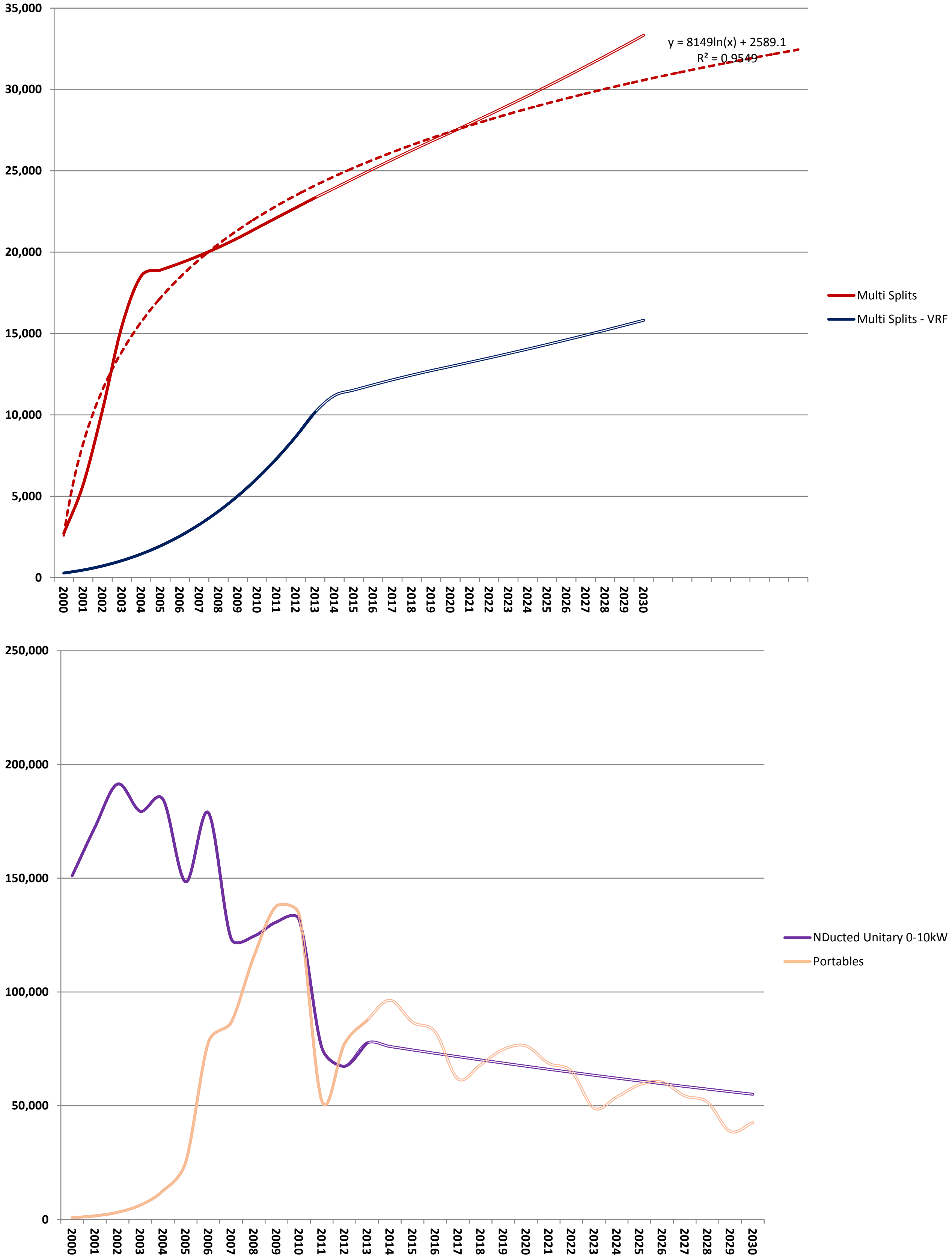
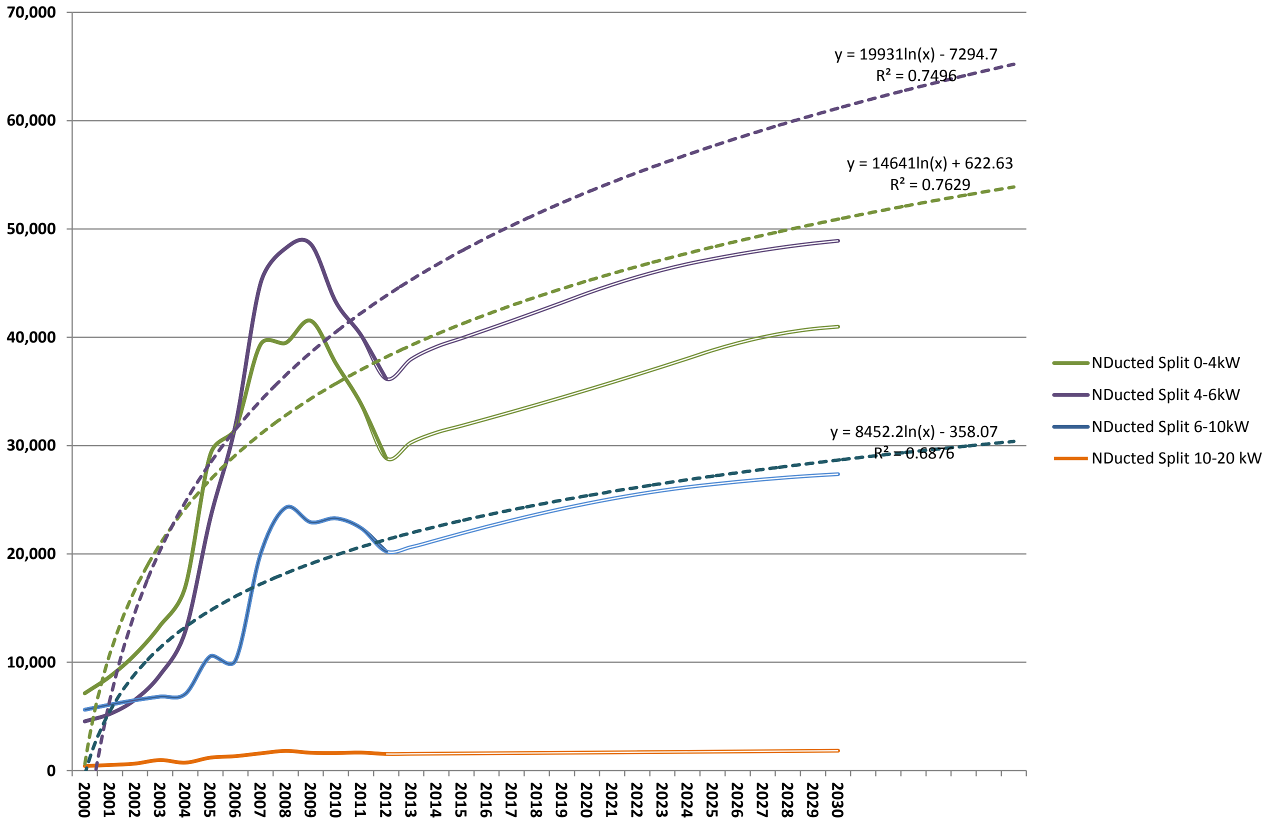


**Figure 14 Forecast annual sales of AC – multi-split and other AC: Australia**



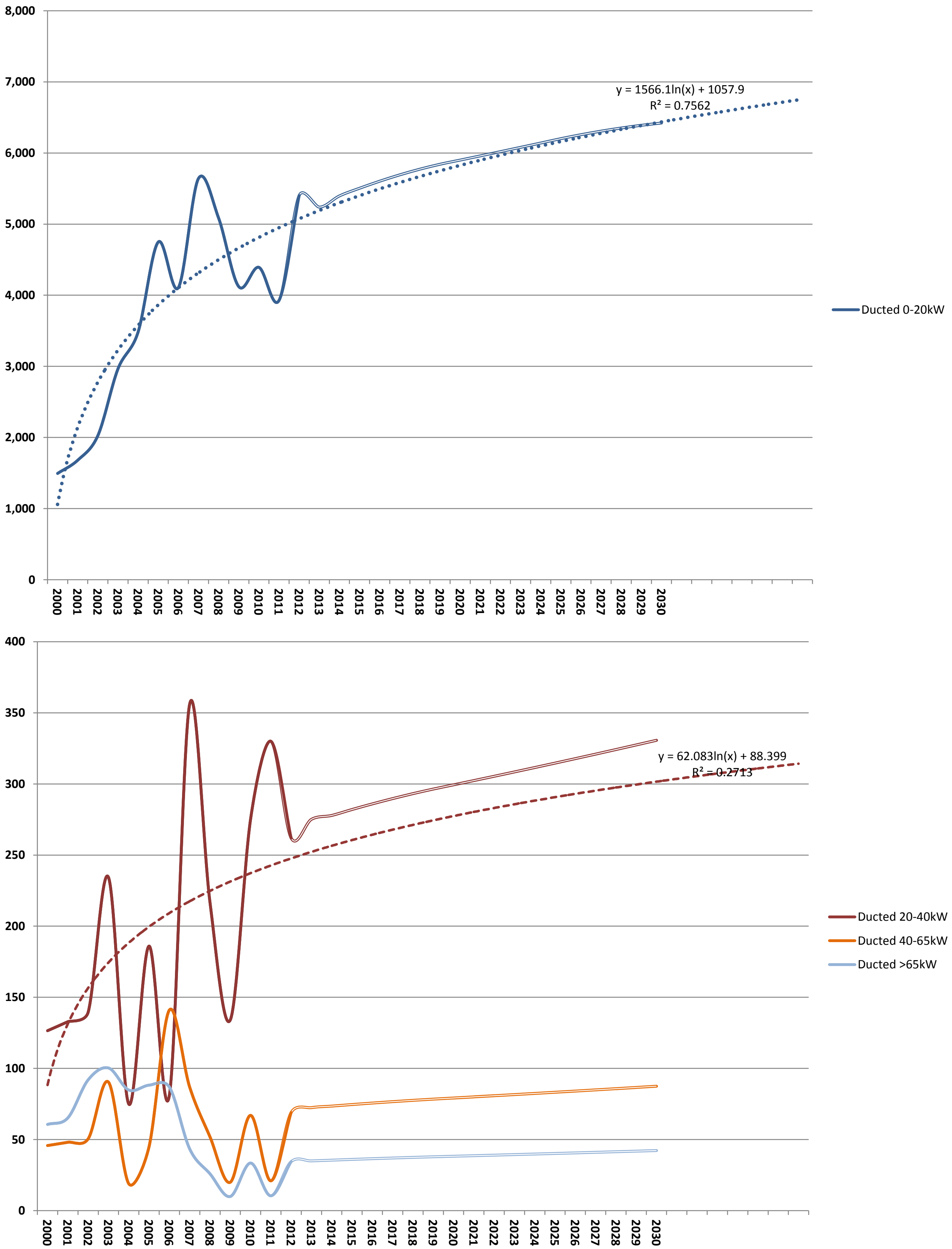

*Note: the dotted lines are best fit regressions that were used to determine the forecast growth rates*

**Figure 15 Forecast annual sales of AC – non-ducted AC: New Zealand**



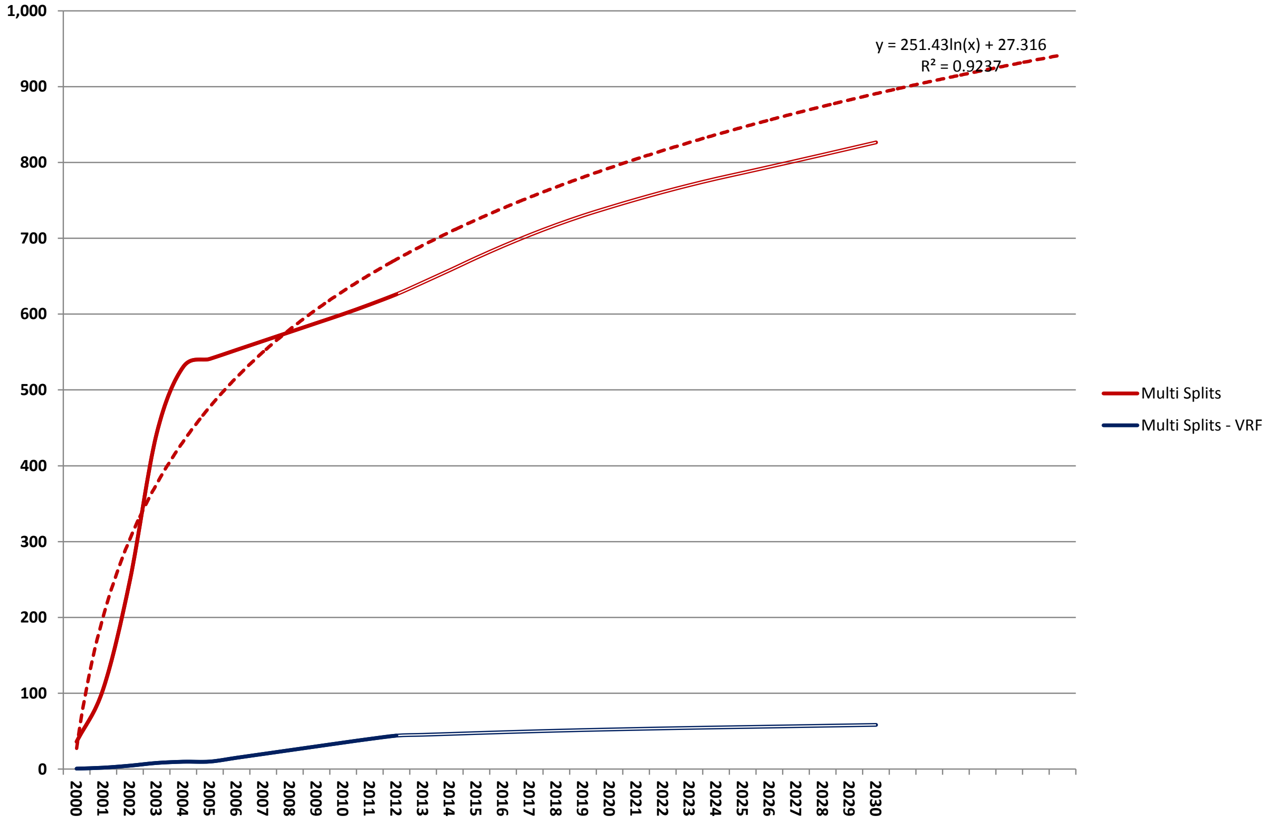

*Note: the dotted lines are best fit regressions that were used to determine the forecast growth rates; Non-ducted over 20 kW have very small sales and are not shown on the graphic*

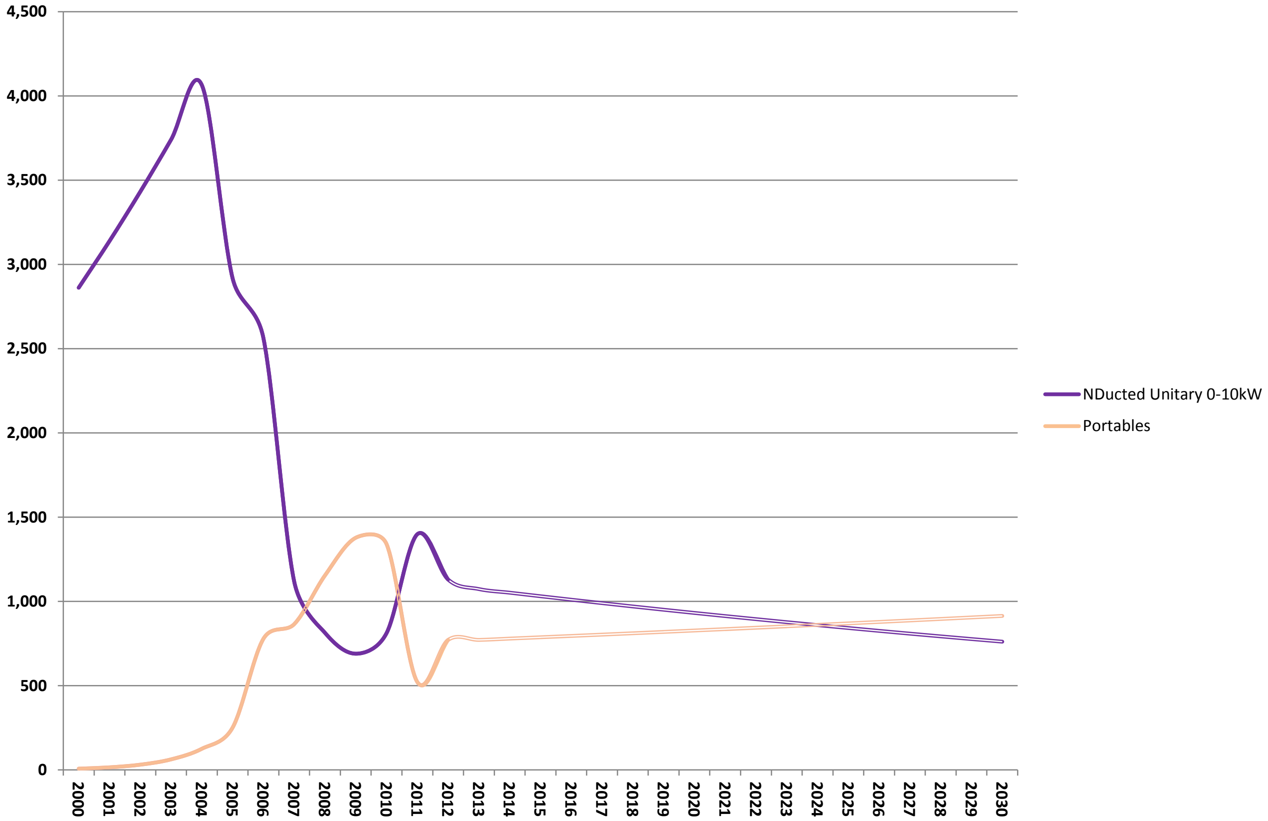
**Figure 16 Forecast annual sales of AC – ducted AC: New Zealand**




*Note: the dotted lines are best fit regressions that were used to determine the forecast growth rates*

**Figure 17 Forecast annual sales of AC – multi-split and other AC: New Zealand**




*Note: the dotted lines are best fit regressions that were used to determine the forecast growth rates*

### Sales by region

Based on the earlier forecasts of sales, ABS data and the share of sales by state/region, the sales for the period 2010 to 2030 are shown in Table 25.

**Table 25 Total annual sales of AC 2010-2030, by state region**

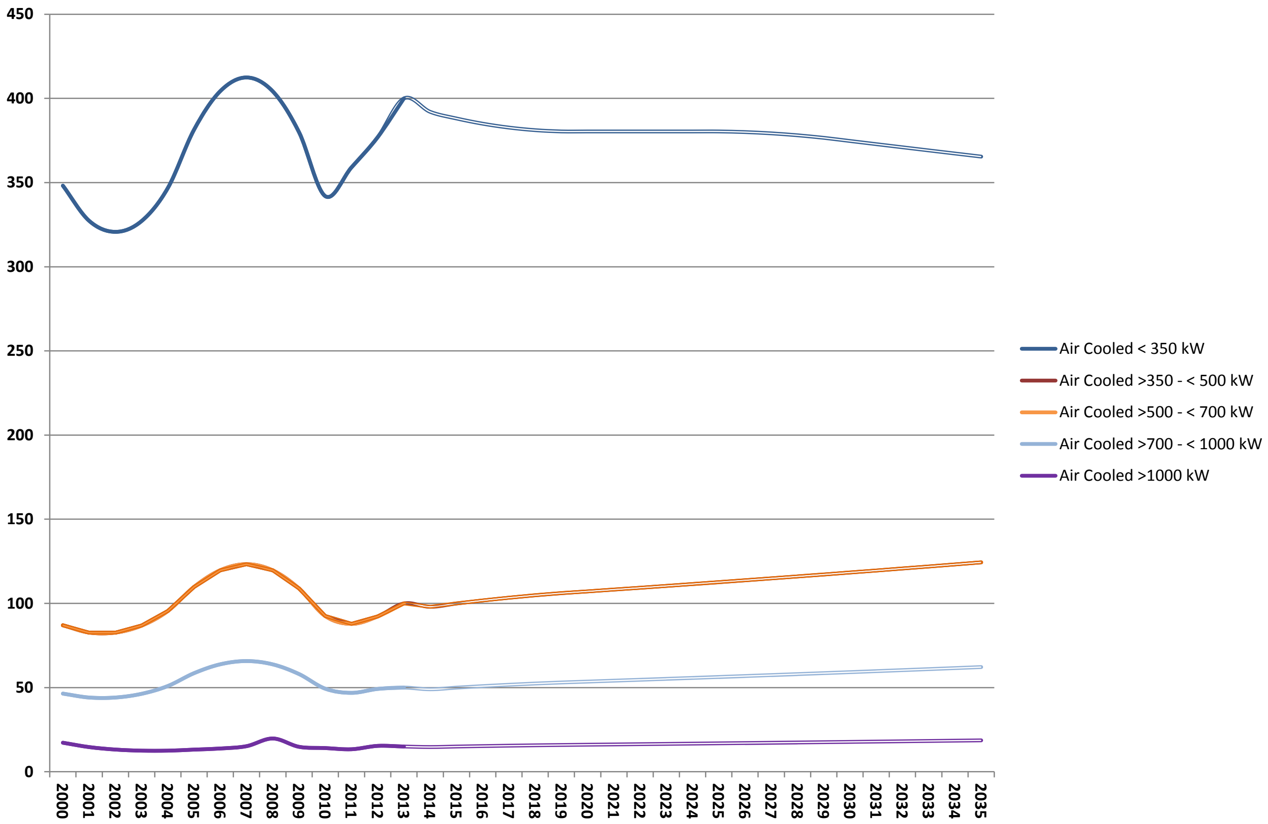
| Year/ Region | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | AU Total | NZ |
|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | 13,328 | 265,958 | 21,014 | 300,783 | 78,944 | 15,726 | 214,509 | 152,173 | **1,062,435** | **113,346** |
| 2011 | 11,759 | 234,647 | 19,741 | 271,571 | 68,188 | 13,672 | 191,746 | 141,754 | **953,077** | **105,008** |
| 2012 | 11,363 | 226,740 | 19,320 | 258,908 | 65,992 | 13,132 | 191,648 | 146,326 | **933,429** | **95,185** |
| 2013 | 11,851 | 236,484 | 19,802 | 265,121 | 69,662 | 13,710 | 202,852 | 158,130 | **977,611** | **98,673** |
| 2014 | 12,245 | 244,332 | 20,334 | 272,544 | 70,689 | 14,277 | 204,939 | 157,210 | **996,569** | **101,522** |
| 2015 | 12,358 | 246,588 | 20,704 | 276,937 | 70,351 | 14,471 | 201,887 | 152,957 | **996,251** | **103,701** |
| 2016 | 12,599 | 251,406 | 21,210 | 283,296 | 70,612 | 14,846 | 201,106 | 149,971 | **1,005,045** | **105,874** |
| 2017 | 12,636 | 252,143 | 21,596 | 287,739 | 69,835 | 14,941 | 196,276 | 144,281 | **999,447** | **108,038** |
| 2018 | 13,086 | 261,132 | 22,288 | 297,245 | 71,031 | 15,626 | 199,003 | 143,165 | **1,022,577** | **110,189** |
| 2019 | 13,606 | 271,504 | 23,040 | 308,387 | 72,483 | 16,440 | 202,670 | 142,338 | **1,050,469** | **112,325** |
| 2020 | 14,061 | 280,574 | 23,742 | 319,134 | 73,553 | 17,181 | 204,806 | 140,355 | **1,073,406** | **114,442** |
| 2021 | 14,206 | 283,468 | 24,077 | 323,826 | 74,127 | 17,415 | 206,595 | 141,308 | **1,085,021** | **116,463** |
| 2022 | 14,376 | 286,872 | 24,432 | 328,406 | 74,858 | 17,661 | 208,958 | 142,743 | **1,098,307** | **118,381** |
| 2023 | 14,325 | 285,844 | 24,634 | 330,063 | 74,537 | 17,572 | 207,233 | 141,736 | **1,095,945** | **120,189** |
| 2024 | 14,537 | 290,073 | 25,022 | 334,197 | 75,541 | 17,824 | 210,583 | 144,064 | **1,111,841** | **121,883** |
| 2025 | 14,715 | 293,628 | 25,388 | 337,478 | 76,416 | 18,002 | 213,404 | 146,202 | **1,125,232** | **123,456** |
| 2026 | 14,695 | 293,238 | 25,591 | 336,721 | 76,435 | 17,835 | 212,936 | 146,683 | **1,124,135** | **124,857** |
| 2027 | 14,668 | 292,687 | 25,769 | 336,994 | 76,322 | 17,716 | 212,017 | 146,526 | **1,122,699** | **126,078** |
| 2028 | 14,682 | 292,967 | 25,953 | 337,564 | 76,407 | 17,659 | 211,904 | 146,853 | **1,123,990** | **127,111** |
| 2029 | 14,604 | 291,408 | 26,050 | 337,689 | 75,983 | 17,510 | 209,888 | 145,760 | **1,118,892** | **127,950** |
| 2030 | 14,758 | 294,484 | 26,283 | 340,208 | 76,690 | 17,689 | 212,282 | 147,421 | **1,129,814** | **128,591** |

## Chillers – sales trends

### Sales by category

Figure 18 and Figure 19 show the resulting historical and forecast sales of chillers to 2035 in Australia and New Zealand by category.

**Figure 18 Forecast annual sales of chillers: Australia**



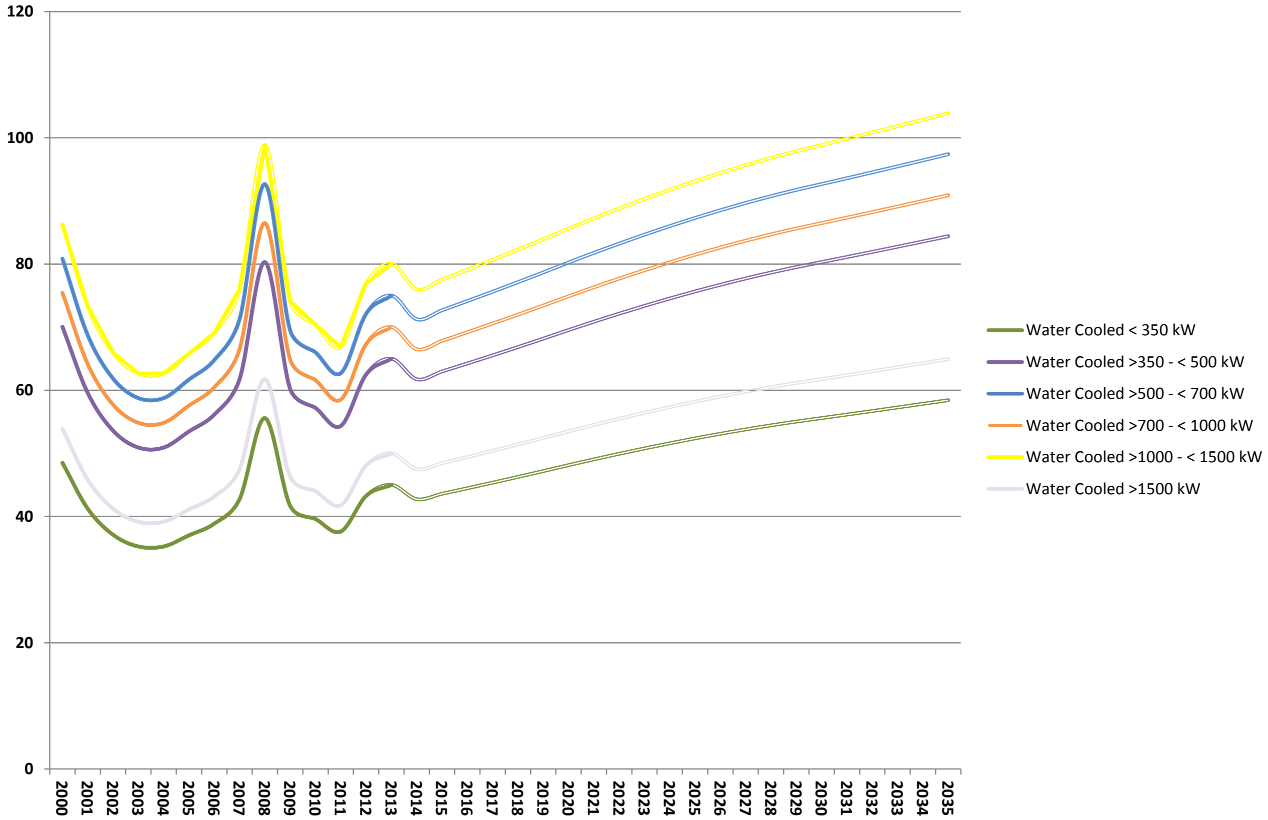
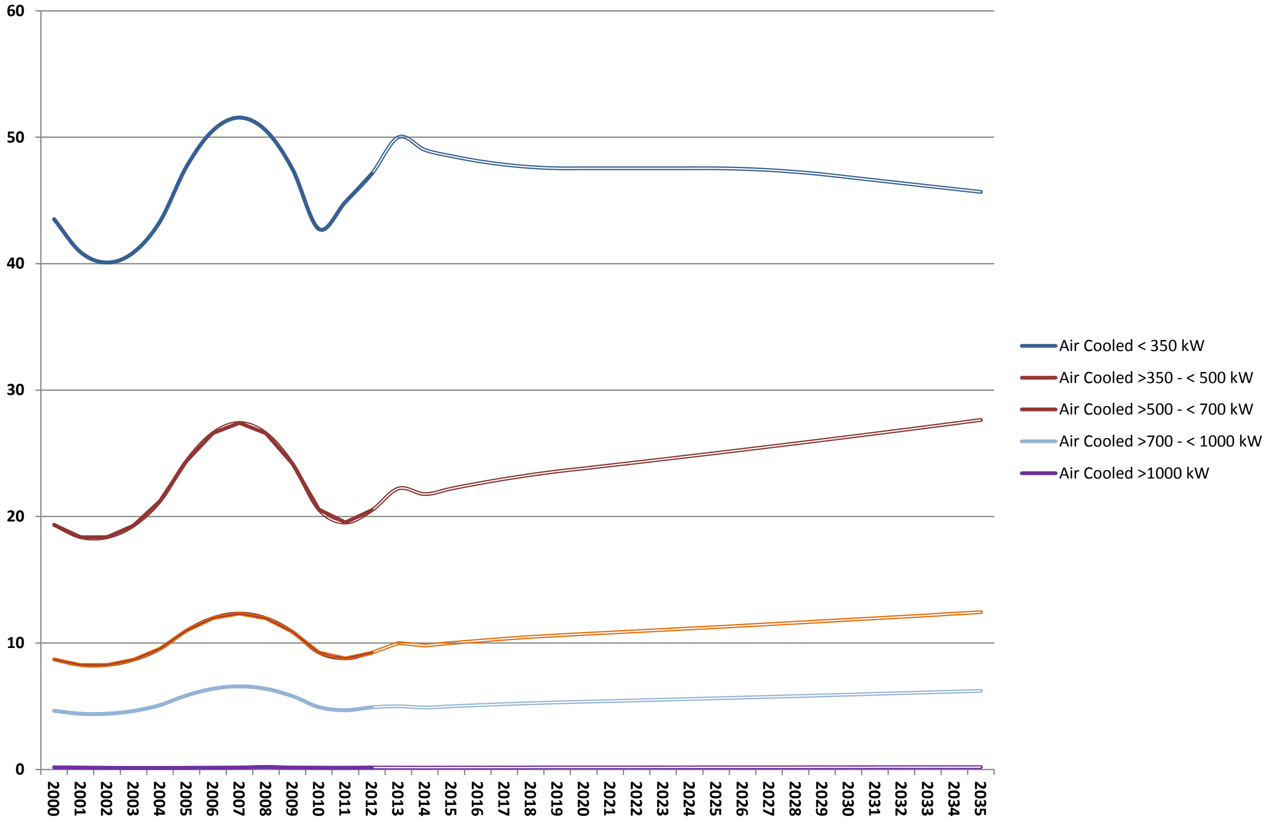
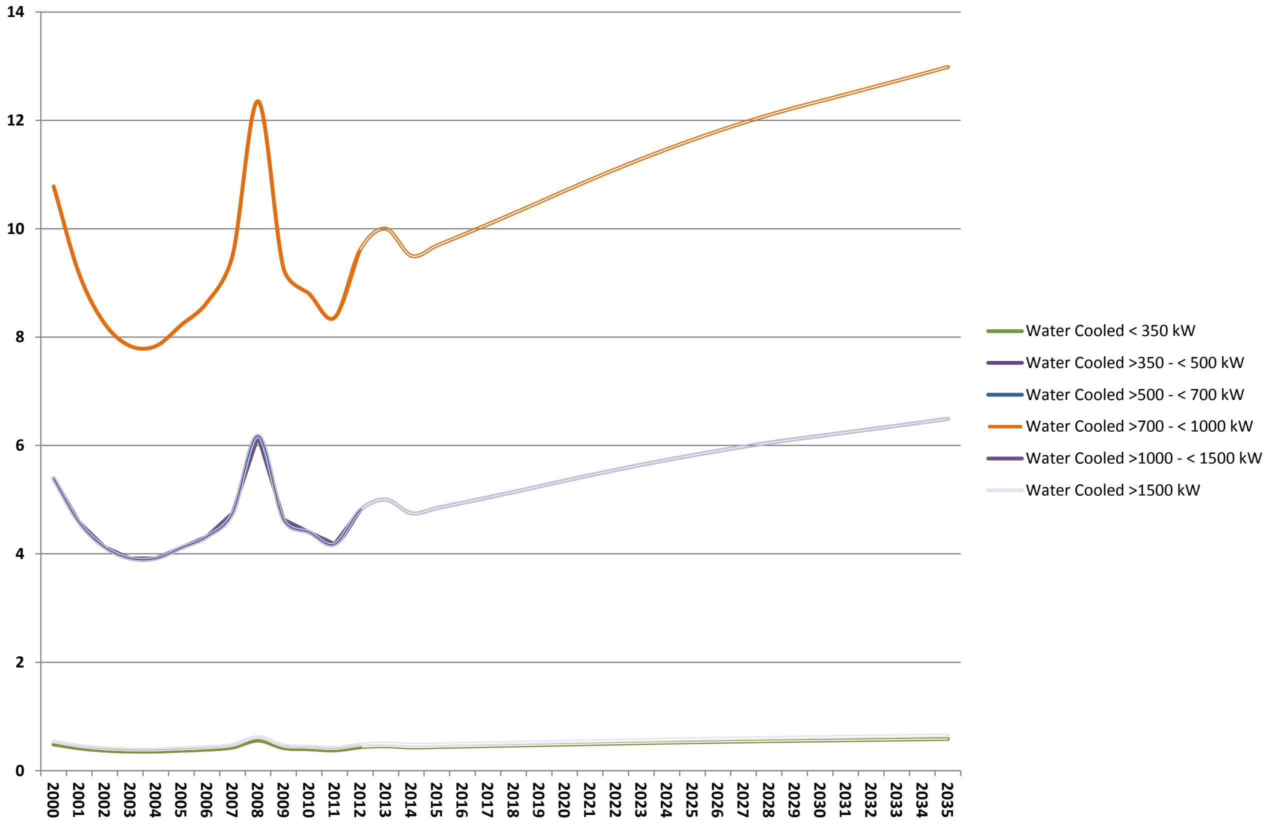



**Figure 19 Forecast annual sales of chillers: New Zealand**



### Sales by region

Based on the earlier forecasts of sales and the share of sales by state/region, the estimated sales for the period 2010 to 2030 are shown in Table 26.

**Table 26 Total annual sales of chillers 2010-2030, by state region**

| Year/Region | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | AU Total | NZ |
|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | 14 | 280 | 14 | 224 | 82 | 12 | 170 | 134 | **929** | **100** |
| 2011 | 14 | 278 | 13 | 212 | 80 | 12 | 170 | 138 | **917** | **100** |
| 2012 | 15 | 298 | 15 | 225 | 84 | 13 | 192 | 155 | **996** | **107** |
| 2013 | 16 | 314 | 16 | 230 | 86 | 13 | 206 | 168 | **1,050** | **113** |
| 2014 | 15 | 307 | 16 | 225 | 84 | 12 | 198 | 161 | **1,017** | **110** |
| 2015 | 15 | 309 | 16 | 230 | 84 | 13 | 199 | 160 | **1,026** | **111** |
| 2016 | 16 | 312 | 16 | 235 | 84 | 13 | 199 | 159 | **1,035** | **112** |
| 2017 | 16 | 315 | 17 | 241 | 85 | 14 | 200 | 158 | **1,045** | **113** |
| 2018 | 16 | 319 | 17 | 246 | 85 | 14 | 201 | 157 | **1,055** | **114** |
| 2019 | 16 | 322 | 17 | 252 | 86 | 15 | 202 | 156 | **1,065** | **114** |
| 2020 | 16 | 326 | 18 | 258 | 86 | 15 | 202 | 154 | **1,076** | **115** |
| 2021 | 16 | 329 | 18 | 261 | 87 | 15 | 205 | 156 | **1,087** | **116** |
| 2022 | 17 | 331 | 18 | 264 | 88 | 15 | 207 | 157 | **1,097** | **117** |
| 2023 | 17 | 334 | 18 | 267 | 88 | 16 | 209 | 159 | **1,107** | **118** |
| 2024 | 17 | 336 | 18 | 270 | 89 | 16 | 211 | 160 | **1,117** | **119** |
| 2025 | 17 | 338 | 19 | 273 | 90 | 16 | 213 | 162 | **1,127** | **120** |
| 2026 | 17 | 340 | 19 | 276 | 90 | 16 | 215 | 163 | **1,136** | **121** |
| 2027 | 17 | 342 | 19 | 278 | 91 | 16 | 217 | 164 | **1,144** | **121** |
| 2028 | 17 | 343 | 19 | 281 | 91 | 17 | 218 | 165 | **1,151** | **122** |
| 2029 | 17 | 345 | 19 | 283 | 92 | 17 | 220 | 166 | **1,158** | **123** |
| 2030 | 17 | 346 | 20 | 285 | 92 | 17 | 221 | 167 | **1,164** | **123** |

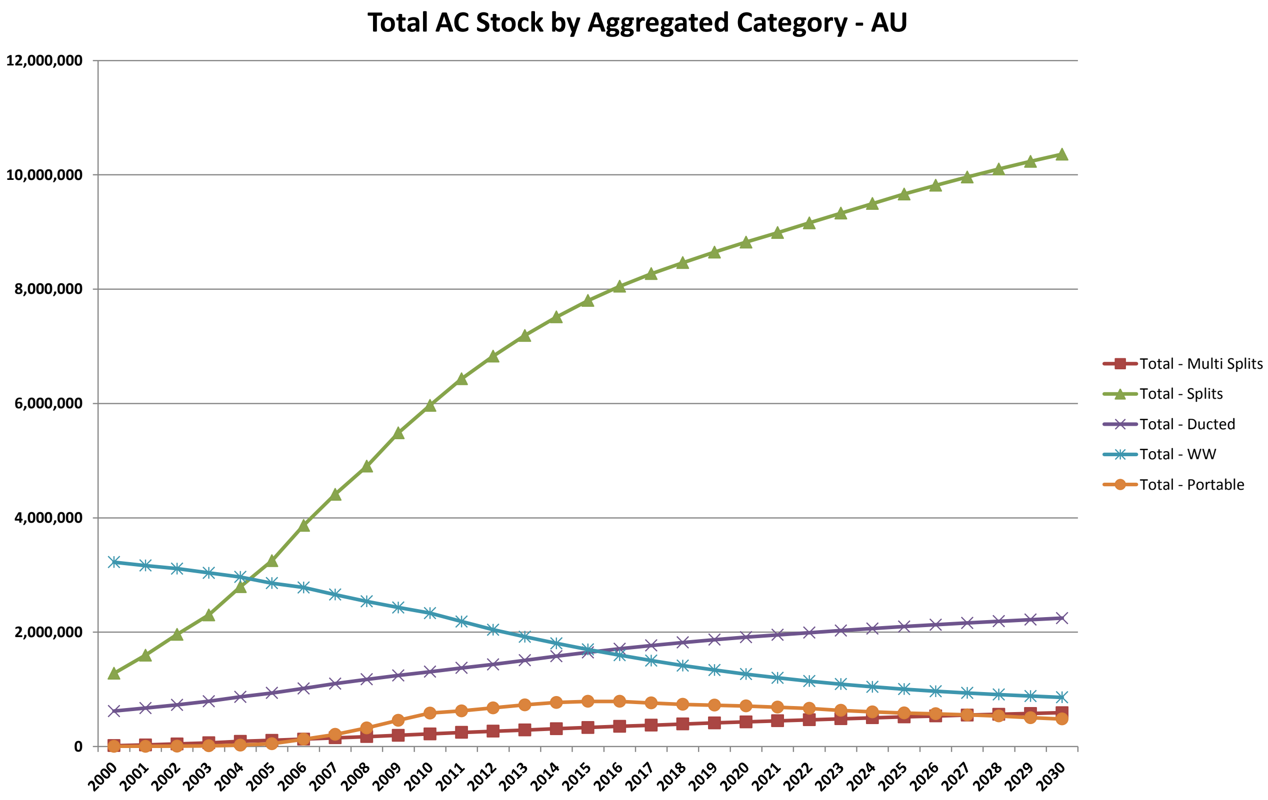
# Stock Trends

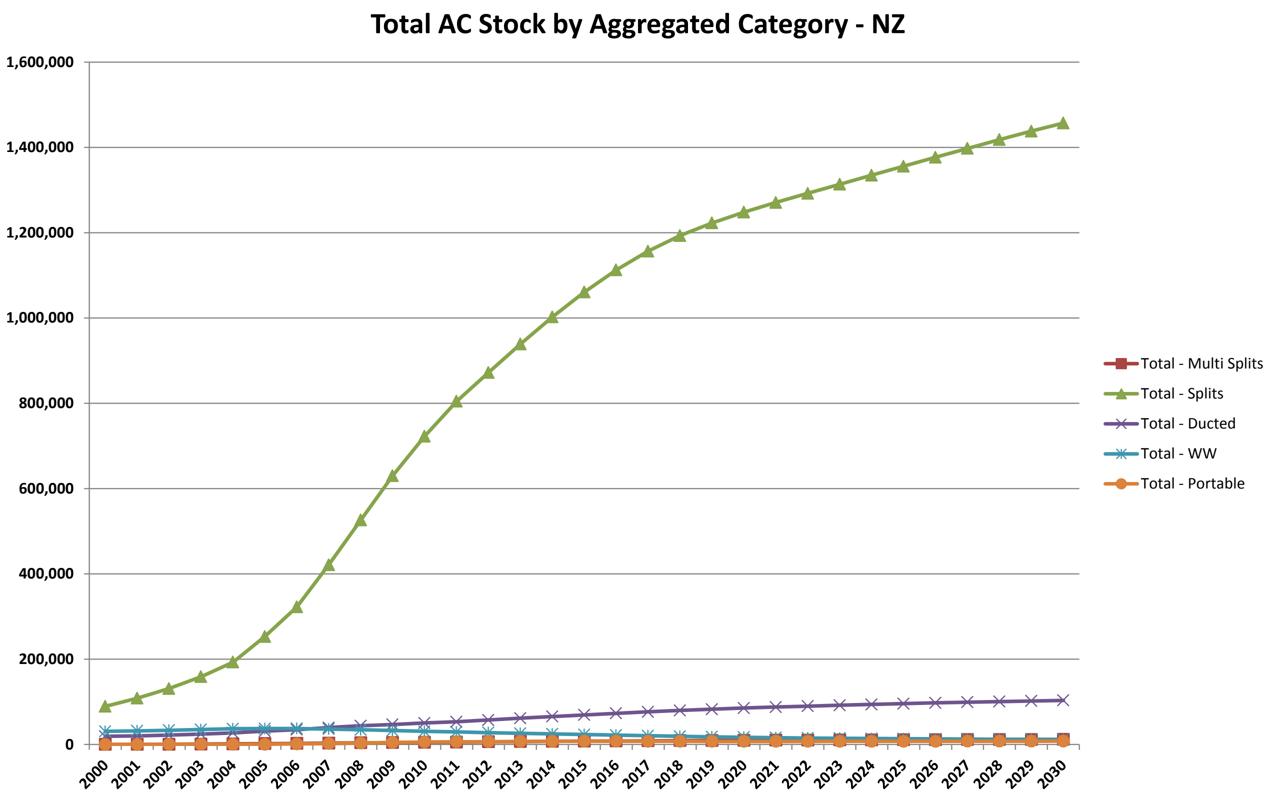
## AC – Stock trends

### Stock by category

The estimated stock of AC by category for Australia and New Zealand over the period 2000 to 2030 is shown in Figure 20.

**Figure 20  Forecast stock of AC by category –Australia & New Zealand**



## Stock by region

The estimates of AC stock for the period between 2010 and 2030 by State/region are provided in Table 27.

**Table 27 Stock of AC 2010-2030, by state/region**

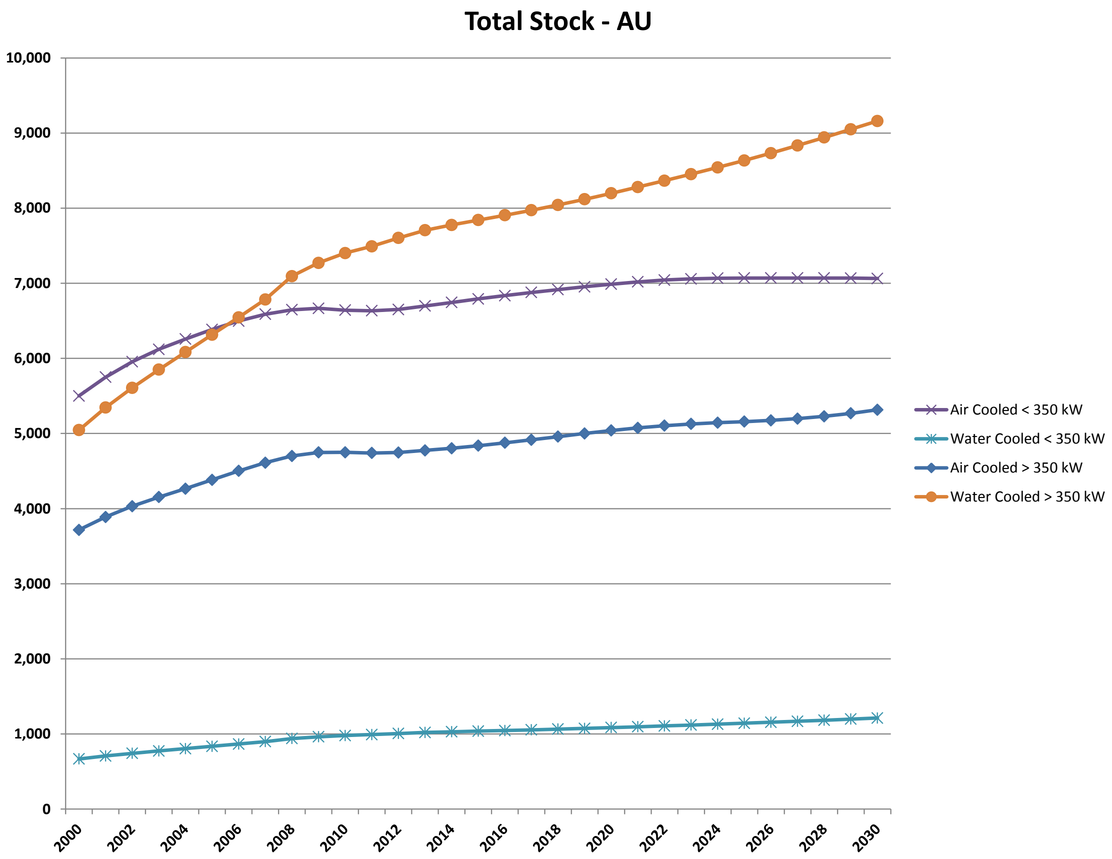
| Year/Region | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | AU Total | NZ |
|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | 143,110 | 2,855,677 | 189,700 | 2,953,915 | 904,932 | 136,973 | 1,984,126 | 1,322,449 | **10,490,881** | **814,571** |
| 2011 | 148,040 | 2,954,059 | 199,999 | 3,081,748 | 924,253 | 145,360 | 2,081,168 | 1,402,777 | **10,937,406** | **899,240** |
| 2012 | 151,957 | 3,032,218 | 209,311 | 3,185,368 | 938,607 | 152,377 | 2,170,352 | 1,482,341 | **11,322,532** | **970,392** |
| 2013 | 155,637 | 3,105,655 | 218,388 | 3,281,524 | 953,376 | 158,965 | 2,261,018 | 1,567,160 | **11,701,724** | **1,040,353** |
| 2014 | 158,913 | 3,171,010 | 227,119 | 3,369,715 | 965,435 | 165,006 | 2,342,279 | 1,643,458 | **12,042,935** | **1,107,185** |
| 2015 | 161,495 | 3,222,545 | 235,266 | 3,446,341 | 973,385 | 170,088 | 2,408,435 | 1,707,624 | **12,325,179** | **1,168,709** |
| 2016 | 163,459 | 3,261,733 | 242,790 | 3,511,363 | 977,405 | 174,315 | 2,460,479 | 1,760,028 | **12,551,571** | **1,223,313** |
| 2017 | 164,817 | 3,288,829 | 249,701 | 3,566,367 | 977,579 | 177,650 | 2,496,850 | 1,799,359 | **12,721,151** | **1,269,768** |
| 2018 | 166,123 | 3,314,882 | 256,297 | 3,618,092 | 976,585 | 180,861 | 2,526,750 | 1,830,812 | **12,870,402** | **1,308,533** |
| 2019 | 167,724 | 3,346,838 | 262,867 | 3,673,628 | 976,073 | 184,435 | 2,554,280 | 1,856,211 | **13,022,056** | **1,340,174** |
| 2020 | 169,567 | 3,383,611 | 269,319 | 3,732,448 | 975,670 | 188,276 | 2,577,257 | 1,873,620 | **13,169,767** | **1,367,198** |
| 2021 | 171,399 | 3,420,164 | 275,332 | 3,789,390 | 975,086 | 191,964 | 2,595,963 | 1,886,035 | **13,305,333** | **1,391,506** |
| 2022 | 173,444 | 3,460,969 | 281,198 | 3,848,638 | 975,620 | 195,779 | 2,614,127 | 1,895,616 | **13,445,391** | **1,414,667** |
| 2023 | 175,482 | 3,501,649 | 286,773 | 3,907,318 | 976,250 | 199,416 | 2,627,979 | 1,900,218 | **13,575,085** | **1,437,576** |
| 2024 | 177,809 | 3,548,066 | 292,364 | 3,969,114 | 978,612 | 203,254 | 2,643,890 | 1,904,326 | **13,717,435** | **1,460,574** |
| 2025 | 180,348 | 3,598,731 | 297,977 | 4,032,855 | 982,615 | 207,167 | 2,661,785 | 1,908,651 | **13,870,128** | **1,483,295** |
| 2026 | 182,836 | 3,648,392 | 303,443 | 4,093,779 | 987,327 | 210,755 | 2,678,686 | 1,912,444 | **14,017,661** | **1,505,905** |
| 2027 | 185,206 | 3,695,686 | 308,689 | 4,151,682 | 992,296 | 214,014 | 2,694,024 | 1,915,451 | **14,157,048** | **1,528,281** |
| 2028 | 187,446 | 3,740,385 | 313,695 | 4,205,954 | 997,487 | 216,961 | 2,708,641 | 1,918,628 | **14,289,199** | **1,550,242** |
| 2029 | 189,451 | 3,780,375 | 318,374 | 4,255,810 | 1,002,357 | 219,474 | 2,720,905 | 1,921,207 | **14,407,951** | **1,571,468** |
| 2030 | 191,420 | 3,819,677 | 322,845 | 4,303,030 | 1,007,876 | 221,847 | 2,735,110 | 1,926,159 | **14,527,966** | **1,591,657** |

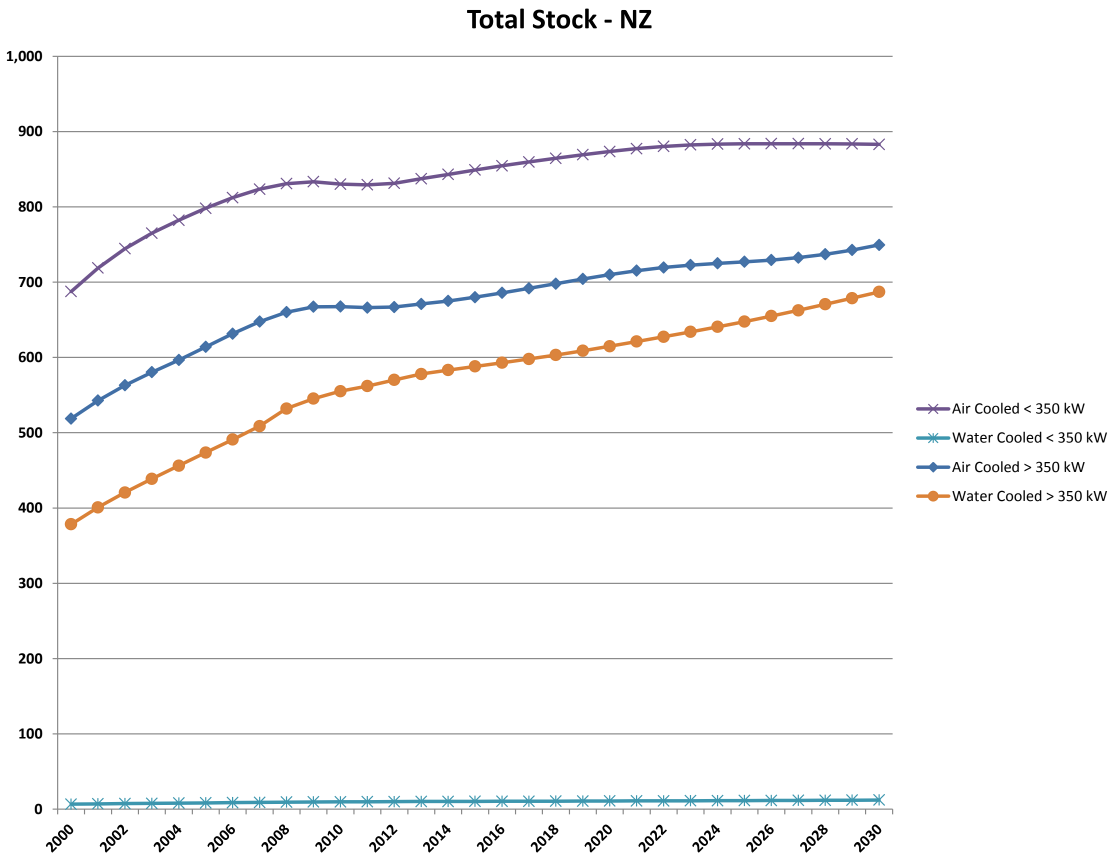
# Chiller – stock trends

## Stock by category

The estimated stock of chiller by category for Australia and New Zealand over the period 2000 to 2030 is shown in Figure 21.

**Figure 21 Forecast stock of chillers by category – Australia & New Zealand**



## Stock by region

The estimates of chiller stock for the period between 2010 and 2030 by State/region are provided in Table 28.

**Table 28 Stock of chillers 2010-2030, by state/region**

| Year/Region | ACT | NSW | NT | QLD | SA | TAS | VIC | WA | AU Total | NZ |
|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | 299 | 5,964 | 253 | 5,353 | 1,808 | 307 | 3,379 | 2,409 | **19,773** | **2,063** |
| 2011 | 300 | 5,979 | 256 | 5,352 | 1,802 | 308 | 3,421 | 2,440 | **19,858** | **2,067** |
| 2012 | 301 | 6,010 | 261 | 5,359 | 1,800 | 310 | 3,480 | 2,487 | **20,007** | **2,079** |
| 2013 | 303 | 6,056 | 266 | 5,365 | 1,801 | 311 | 3,550 | 2,548 | **20,201** | **2,097** |
| 2014 | 305 | 6,093 | 271 | 5,362 | 1,799 | 312 | 3,610 | 2,601 | **20,354** | **2,112** |
| 2015 | 307 | 6,132 | 277 | 5,361 | 1,798 | 313 | 3,668 | 2,653 | **20,509** | **2,128** |
| 2016 | 309 | 6,172 | 282 | 5,363 | 1,796 | 314 | 3,725 | 2,703 | **20,664** | **2,144** |
| 2017 | 311 | 6,213 | 288 | 5,368 | 1,795 | 315 | 3,781 | 2,751 | **20,821** | **2,160** |
| 2018 | 313 | 6,255 | 293 | 5,377 | 1,793 | 316 | 3,836 | 2,797 | **20,982** | **2,176** |
| 2019 | 316 | 6,299 | 299 | 5,389 | 1,792 | 318 | 3,891 | 2,842 | **21,146** | **2,193** |
| 2020 | 318 | 6,344 | 305 | 5,405 | 1,790 | 320 | 3,945 | 2,884 | **21,312** | **2,209** |
| 2021 | 320 | 6,387 | 311 | 5,420 | 1,788 | 322 | 3,999 | 2,925 | **21,472** | **2,225** |
| 2022 | 322 | 6,426 | 317 | 5,433 | 1,784 | 324 | 4,051 | 2,965 | **21,621** | **2,238** |
| 2023 | 324 | 6,459 | 323 | 5,443 | 1,780 | 326 | 4,100 | 3,002 | **21,758** | **2,250** |
| 2024 | 325 | 6,489 | 329 | 5,453 | 1,775 | 328 | 4,148 | 3,038 | **21,885** | **2,260** |
| 2025 | 327 | 6,516 | 334 | 5,464 | 1,771 | 330 | 4,193 | 3,072 | **22,007** | **2,270** |
| 2026 | 328 | 6,543 | 340 | 5,479 | 1,769 | 332 | 4,238 | 3,106 | **22,134** | **2,280** |
| 2027 | 329 | 6,571 | 347 | 5,500 | 1,769 | 334 | 4,282 | 3,140 | **22,272** | **2,291** |
| 2028 | 331 | 6,602 | 353 | 5,528 | 1,772 | 337 | 4,326 | 3,174 | **22,423** | **2,303** |
| 2029 | 333 | 6,635 | 360 | 5,562 | 1,778 | 339 | 4,369 | 3,208 | **22,585** | **2,317** |
| 2030 | 334 | 6,669 | 367 | 5,602 | 1,786 | 342 | 4,410 | 3,242 | **22,752** | **2,332** |

# ii. Policy option impacts – energy and cost/benefit

## Options considered

Several policy options (shown below) were combined in multiple scenarios shown in the table below:

| Reform proposal | Option A | Option B1 | Option B2 |
|---|---|---|---|
| 1. For air conditioners (A/C) adopt the SEER standard AS/NZS 3823.4 for rating products with capacity up to 30kW. | X | X | X |
| 2. Remove the existing Energy Rating Label and replace it with a Zoned Label that provides energy efficiency information for three distinct climate zones across Australia and New Zealand to A/C with capacity up to 30 kW. Air enthalpy tests would be accepted for ducted, three-phase and certain 'commercial use' products. Multi-split systems would continue to be excluded from physical labelling but would be subject to the SEER standard, with rating information for the registered combination made available on the Energy Rating website. | X | X | X |
| 3. Double duct portable A/C subject to the SEER standard AS/NZS 3823.4, Zoned Label and a reduced MEPS level of 2.60 based on AEER/ACOP. Single duct portable A/C subject to Zoned Label (with proxy for operating time data) and tested to AS/NZS 3823.1.5. | X | X | X |
| 4. Remove the unique Australian/New Zealand chiller test standard and align with US test standard AHRI 551/591:2011. | X | X | X |
| 5. Include the energy efficiency requirements for A/C >65kw capacity and chillers <350kW under GEMS/NZ regulations and in Australia remove these from the NCC. | X | X | X |
| 6. Retain current NCC MEPS levels under GEMS/NZ regulations (refer to Table 5 and Table 6 for proposed levels). | X | | |
| 7. Align >65kW A/C MEPS levels to 39 to 65kW GEMS MEPS (i.e. AEER/ACOP 2.90). Align chiller MEPS levels to the US energy efficiency standard ASHRAE 90.1:2013 where the US levels are higher (refer to Table 7 for the proposed levels). | | X | X |
| 8. Single duct portable A/C subject to a MEPS level of 2.60 based on AEER/ACOP. | | X | X |
| 9. Align New Zealand's residential cooling MEPS to match Australia's levels. | | X | X |
| 10. Align the MEPS levels for fixed and variable speed air conditioners, by removing the 'part load' compliance option. | | X | X |
| 11. SEER rating of A/C ≥30kW capacity, with rating information made available on the Energy Rating website. | | | X |

# Air Conditioners

The summary impacts of the proposals are shown below in terms of the energy savings and greenhouse gas emission reductions.

## Summary of key energy/emission impacts and cost benefits by proposal

### Australia

| Proposal | Energy Saved (cumulative GWh to 2030) | GHG Emission Reduction (cumulative) Mt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Proposal A | 3,237 | 2.9 | $691 | $170 | $521 | 4.1 |
| Proposal B1 | 4,521 | 4.0 | $927 | $262 | $665 | 3.5 |
| Proposal B2 | 5,336 | 4.8 | $1,080 | $280 | $801 | 3.9 |

*Note: This table uses discount rates of 7% for Australia*

### New Zealand

| Proposal | Energy Saved (cumulative GWh to 2030) | GHG Emission Reduction (cumulative) kt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Proposal A | 420 | 40.6 | $105 | $21 | $84 | 5.1 |
| Proposal B1 | 595 | 58.2 | $145 | $29 | $117 | 5.1 |
| Proposal B2 | 606 | 59.3 | $148 | $29 | $119 | 5.1 |

*Note: This table uses discount rates of 5% for New Zealand*

## Summary energy savings and emissions reductions by proposal

### Australia

| Proposal | Energy Savings (GWh pa) in 2020 | Energy Savings (GWh pa) in 2030 | Energy Savings Cumulative 2030 (GWh) | GHG Reduction Cumulative (kt CO2-e) |
|---|---|---|---|---|
| Proposal A | 70 | 494 | 3,237 | 2,879 |
| Proposal B1 | 123 | 649 | 4,521 | 4,027 |
| Proposal B2 | 136 | 787 | 5,336 | 4,762 |

### New Zealand

| Proposal | Energy Savings (GWh pa) in 2020 | Energy Savings (GWh pa) in 2030 | Energy Savings Cumulative 2030 (GWh) | GHG Reduction Cumulative (kt CO2-e) |
|---|---|---|---|---|
| Proposal A | 8 | 66 | 414 | 40 |
| Proposal B1 | 15 | 88 | 595 | 58 |
| Proposal B2 | 15 | 90 | 606 | 59 |

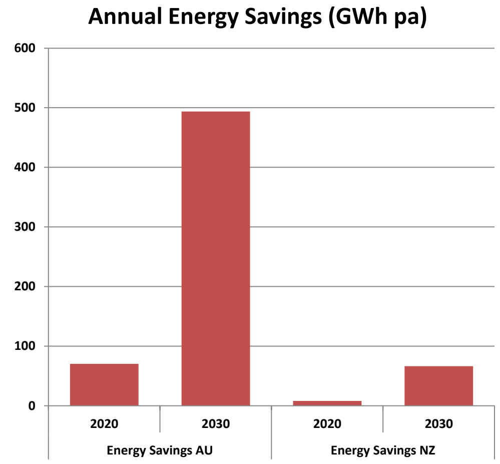
## Proposal A – Detail by state/region and category

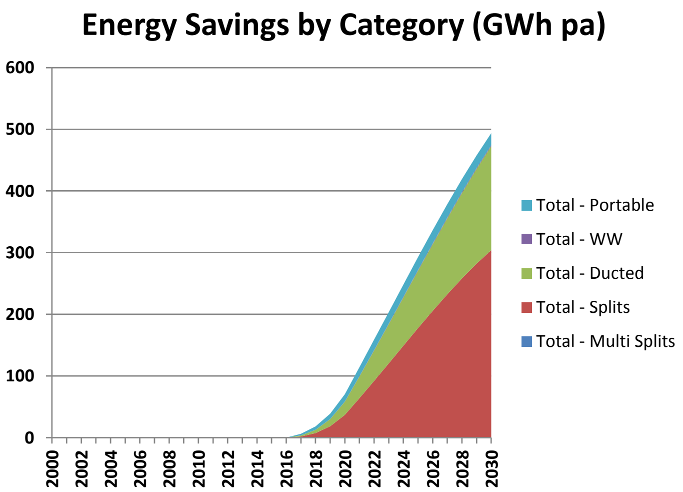
### State/region summary energy greenhouse and CBA

| Impact | ACT | NSW | NT | Qld | SA | TAS | Vic | WA | Australia (total) | New Zealand |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Benefit ($m) | 7.0 | 209.0 | 17.5 | 201.1 | 50.9 | 13.1 | 105.3 | 87.0 | 690.7 | 104.6 |
| Total Cost ($m) | 2.6 | 51.2 | 2.7 | 40.9 | 12.5 | 2.6 | 34.1 | 23.7 | 170.2 | 20.6 |
| Benefit Cost Ratio | 2.7 | 4.1 | 6.5 | 4.9 | 4.1 | 5.0 | 3.1 | 3.7 | 4.1 | 5.1 |
| Energy Saved (GWh cumulative) | 49.4 | 1,005.2 | 90.5 | 903.2 | 216.6 | 58.2 | 465.6 | 447.9 | 3,237 | 420 |
| Greenhouse gas emission reduction (kt CO2-e cumulative) | 45.2 | 919.1 | 60.4 | 835.5 | 98.9 | 13.4 | 563.8 | 342.6 | 2,879 | 41 |

*Note: This table uses discount rates of 7% for Australia and 5% for New Zealand*

### Energy savings by year and category



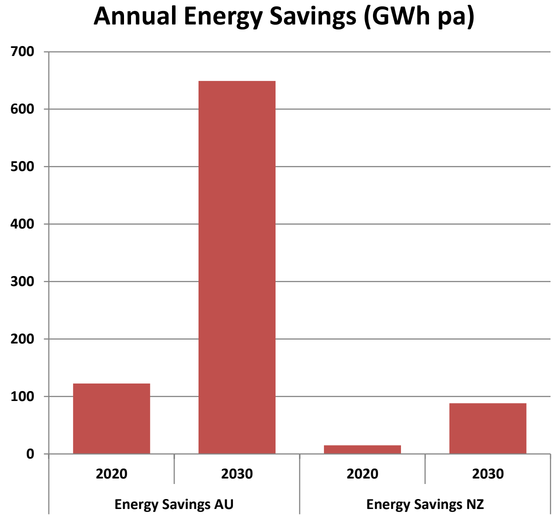

## Proposal B1 – Detail by state/region and category

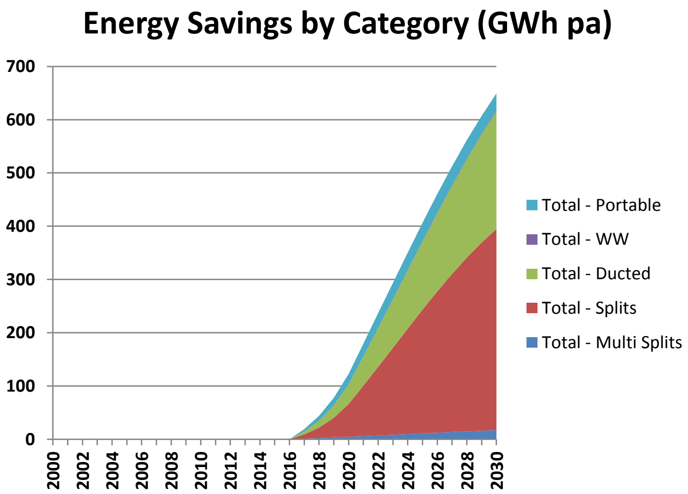
### State/region summary energy greenhouse and CBA

| Impact | ACT | NSW | NT | Qld | SA | TAS | Vic | WA | Australia (total) | New Zealand |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Benefit ($m) | 10.0 | 277.7 | 22.8 | 260.4 | 68.3 | 19.2 | 147.0 | 121.8 | **927.0** | **145.3** |
| Total Cost ($m) | 3.9 | 78.0 | 4.0 | 61.0 | 18.9 | 4.2 | 54.4 | 37.2 | **261.5** | **28.6** |
| *Benefit Cost Ratio* | 2.5 | 3.6 | 5.7 | 4.3 | 3.6 | 4.6 | 2.7 | 3.3 | **3.5** | **5.1** |
| Energy Saved (GWh cumulative) | 73.6 | 1,408.5 | 119.7 | 1,215.6 | 303.1 | 87.8 | 676.7 | 636.1 | **4,521** | **595** |
| Greenhouse gas emission reduction (kt $CO_2$-e cumulative) | 67.3 | 1,288.6 | 80.0 | 1,125.6 | 139.0 | 20.2 | 820.2 | 486.5 | **4,027** | **58** |

*Note: This table uses discount rates of 7% for Australia and 5% for New Zealand*

## Energy savings by year and category



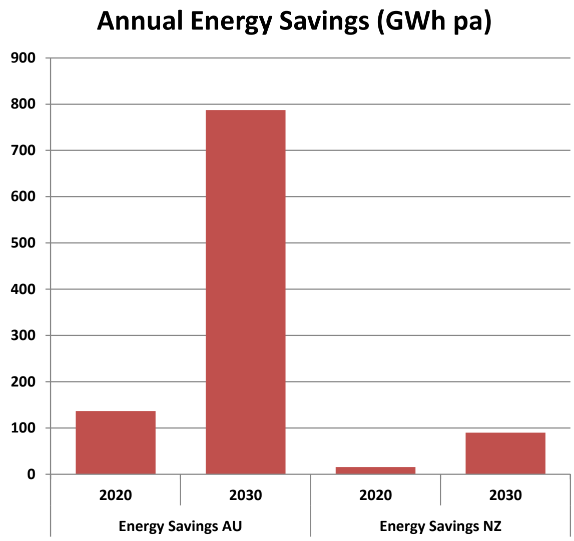

# Proposal B2 – Detail by state/region and category

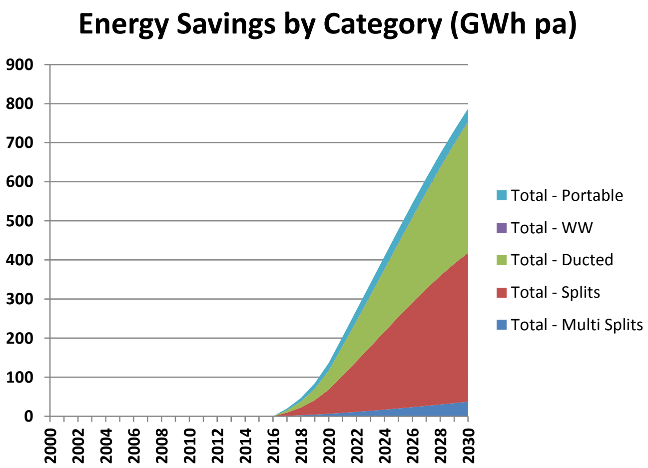
## State/region summary energy greenhouse and CBA

| Impact | ACT | NSW | NT | Qld | SA | Tas | Vic | WA | Australia (total) | New Zealand |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Benefit ($m) | 11.7 | 330.6 | 25.2 | 292.9 | 81.0 | 19.6 | 171.0 | 148.4 | 1,080.4 | 147.6 |
| Total Cost ($m) | 4.2 | 84.0 | 4.3 | 65.3 | 20.4 | 4.3 | 57.5 | 39.8 | 279.7 | 29.0 |
| Benefit Cost Ratio | 2.8 | 3.9 | 5.9 | 4.5 | 4.0 | 4.6 | 3.0 | 3.7 | 3.9 | 5.1 |
| Energy Saved (GWh cumulative) | 89.2 | 1,726.7 | 129.6 | 1,384.1 | 362.9 | 90.9 | 801.4 | 751.0 | 5,336 | 606 |
| Greenhouse gas emission reduction (kt CO2-e cumulative) | 81.6 | 1,579.4 | 86.6 | 1,281.4 | 166.2 | 20.9 | 971.1 | 574.5 | 4,762 | 59 |

*Note: This table uses discount rates of 7% for Australia and 5% for New Zealand*

## Energy savings by year and category



## Sensitivity tests: discount rates

| Summary Australia | NPV Nil (0%) | NPV Low (3%) | NPV Med (7%) | NPV High (11%) |
|---|---|---|---|---|
| **Proposal A** | | | | |
| Total Costs | $238,534,596 | $205,175,801 | $170,198,430 | $143,116,510 |
| Total Benefits | $2,178,349,248 | $1,292,933,001 | $690,722,626 | $395,045,146 |
| Net Benefits | $1,939,814,652 | $1,087,757,201 | $520,524,196 | $251,928,636 |
| *Benefit Cost Ratio* | 9.1 | 6.3 | 4.1 | 2.8 |
| **Proposal B1** | | | | |
| Total Costs | $388,644,025 | $325,109,381 | $261,539,327 | $214,544,067 |
| Total Benefits | $2,856,717,763 | $1,711,447,882 | $926,973,424 | $538,204,650 |
| Net Benefits | $2,468,073,739 | $1,386,338,501 | $665,434,098 | $323,660,583 |
| *Benefit Cost Ratio* | 7.4 | 5.3 | 3.5 | 2.5 |
| **Proposal B2** | | | | |
| Total Costs | $413,821,761 | $346,870,117 | $279,685,362 | $229,867,612 |
| Total Benefits | $3,382,133,224 | $2,011,990,412 | $1,080,422,185 | $622,455,407 |
| Net Benefits | $2,968,311,463 | $1,665,120,294 | $800,736,823 | $392,587,794 |
| *Benefit Cost Ratio* | 8.2 | 5.8 | 3.9 | 2.7 |

| Summary New Zealand | NPV Nil (0%) | NPV Low (3%) | NPV Med (5%) | NPV High (8%) |
|---|---|---|---|---|
| **Proposal A** | | | | |
| Total Costs | $26,366,524 | $22,672,769 | $20,609,569 | $17,985,462 |
| Total Benefits | $240,631,360 | $143,907,355 | $104,642,908 | $67,040,221 |
| Net Benefits | $214,264,837 | $121,234,586 | $84,033,339 | $49,054,759 |
| *Benefit Cost Ratio* | 9.1 | 6.3 | 5.1 | 3.7 |
| **Proposal B1** | | | | |
| Total Costs | $37,972,175 | $31,880,018 | $28,582,135 | $24,499,681 |
| Total Benefits | $327,584,782 | $198,177,089 | $145,295,117 | $94,311,818 |
| Net Benefits | $289,612,607 | $166,297,071 | $116,712,983 | $69,812,137 |
| *Benefit Cost Ratio* | 8.6 | 6.2 | 5.1 | 3.8 |
| **Proposal B2** | | | | |
| Total Costs | $38,489,312 | $32,326,728 | $28,989,235 | $24,856,115 |
| Total Benefits | $333,088,498 | $201,374,439 | $147,580,184 | $95,742,215 |
| Net Benefits | $294,599,186 | $169,047,711 | $118,590,949 | $70,886,099 |
| *Benefit Cost Ratio* | 8.7 | 6.2 | 5.1 | 3.9 |

## Sensitivity tests: higher and lower incremental costs

The direct incremental costs of each proposal were tested for sensitivity. These costs are the incremental product costs required to meet the required efficiency improvement associated with the proposal.

### Australia – 50% increase of incremental costs

| Proposal | Energy Saved (cumulative GWh to 2030) | GHG Emission Reduction (cumulative) Mt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Proposal A | 3,237 | 2.9 | $691 | $254 | $436 | 2.7 |
| Proposal B1 | 4,521 | 4.0 | $927 | $391 | $536 | 2.4 |
| Proposal B2 | 5,336 | 4.8 | $1,080 | $419 | $662 | 2.6 |

*Note: This table uses discount rates of 7% for Australia*

### New Zealand – 50% increase of incremental costs

| Proposal | Energy Saved (cumulative GWh to 2030) | GHG Emission Reduction (cumulative) kt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Proposal A | 420 | 40.6 | $105 | $31 | $74 | 3.4 |
| Proposal B1 | 595 | 58.2 | $145 | $43 | $103 | 3.4 |
| Proposal B2 | 606 | 59.3 | $148 | $43 | $104 | 3.4 |

*Note: This table uses discount rates of 5% for New Zealand*

### Australia – 50% decrease of incremental costs

| Proposal | Energy Saved (cumulative GWh to 2030) | GHG Emission Reduction (cumulative) Mt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Proposal A | 3,237 | 2.9 | $691 | $86 | $605 | 8.0 |
| Proposal B1 | 4,521 | 4.0 | $927 | $132 | $795 | 7.0 |
| Proposal B2 | 5,336 | 4.8 | $1,080 | $141 | $940 | 7.7 |

*Note: This table uses discount rates of 7% for Australia*

### New Zealand – 50% decrease of incremental costs

| Proposal | Energy Saved (cumulative GWh to 2030) | GHG Emission Reduction (cumulative) kt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Proposal A | 420 | 40.6 | $105 | $11 | $94 | 9.9 |
| Proposal B1 | 595 | 58.2 | $145 | $15 | $131 | 10.0 |
| Proposal B2 | 606 | 59.3 | $148 | $15 | $133 | 10.0 |

*Note: This table uses discount rates of 5% for New Zealand*

# Chillers

The summary impacts of the proposals are shown below in terms of the energy savings and greenhouse gas emission reductions. For chillers there is no difference between proposals B1 and B2 so they are combined in the tables below.

## Summary of key energy/emission impacts and cost benefits by proposal

### Australia

| Proposal | Energy Saved (cumulative GWh to 2030) | GHG Emission Reduction (cumulative) Mt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Proposal A | 135 | 0.1 | $24 | $4 | $20 | 6.4 |
| Proposal B1/B2 | 1,336 | 1.2 | $255 | $28 | $226 | 9.0 |

*Note: This table uses discount rates of 7% for Australia*

### New Zealand

| Proposal | Energy Saved (cumulative GWh to 2030) | GHG Emission Reduction (cumulative) kt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Proposal A | 7 | 0.7 | $1 | $1 | $1 | 2.6 |
| Proposal B1/B2 | 64 | 6.4 | $13 | $4 | $10 | 3.6 |

*Note: This table uses discount rates of 5% for New Zealand*

## Summary Energy Savings and Emissions Reductions by Proposal

### Australia

| Proposal | Energy Savings (GWh pa) in 2020 | Energy Savings (GWh pa) in 2030 | Energy Savings Cumulative 2030 (GWh) | GHG Reduction Cumulative (kt CO2-e) |
|---|---|---|---|---|
| Proposal A | 5 | 18 | 135 | 120 |
| Proposal B1/B2 | 49 | 182 | 1,336 | 1,199 |

### New Zealand

| Proposal | Energy Savings (GWh pa) in 2020 | Energy Savings (GWh pa) in 2030 | Energy Savings Cumulative 2030 (GWh) | GHG Reduction Cumulative (kt CO2-e) |
|---|---|---|---|---|
| Proposal A | 0 | 1 | 7 | 1 |
| Proposal B1/B2 | 2 | 9 | 64 | 6 |

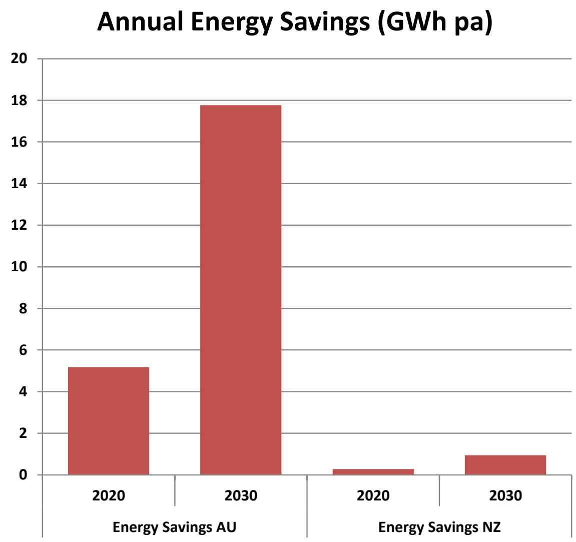
## Proposal A – Detail by state/region and category

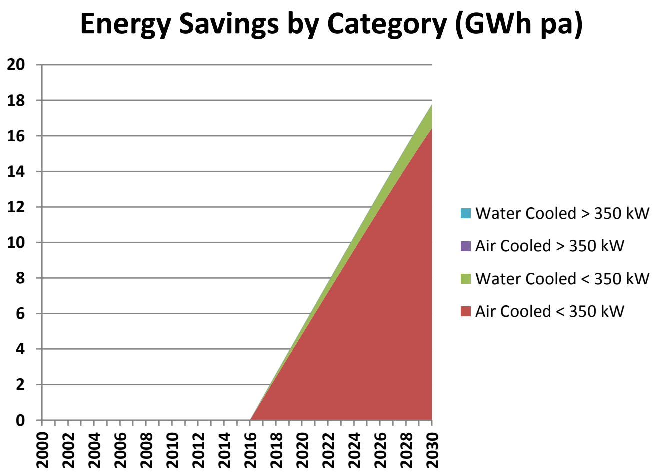
### State/region summary energy greenhouse and CBA

| Impact | ACT | NSW | NT | Qld | SA | TAS | Vic | WA | Australia (total) | New Zealand |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Benefit ($m) | 0.2 | 8.4 | 0.3 | 4.2 | 2.6 | 0.1 | 3.3 | 4.6 | **23.8** | **1.4** |
| Total Cost ($m) | 0.1 | 1.5 | 0.0 | 0.6 | 0.4 | 0.0 | 0.7 | 0.6 | **3.8** | **0.5** |
| *Benefit Cost Ratio* | 3.0 | 5.7 | 10.6 | 7.4 | 7.3 | 1.4 | 5.0 | 8.3 | **6.4** | **2.6** |
| Energy Saved (GWh cumulative) | 2.1 | 55.1 | 1.1 | 23.8 | 13.2 | 0.5 | 18.5 | 20.4 | **135** | **7** |
| Greenhouse gas emission reduction (kt $CO_2$-e cumulative) | 1.9 | 50.5 | 0.7 | 22.1 | 6.1 | 0.1 | 22.5 | 15.6 | **120** | **1** |

*Note: This table uses discount rates of 7% for Australia and 5% for New Zealand*

### Energy savings by year and category



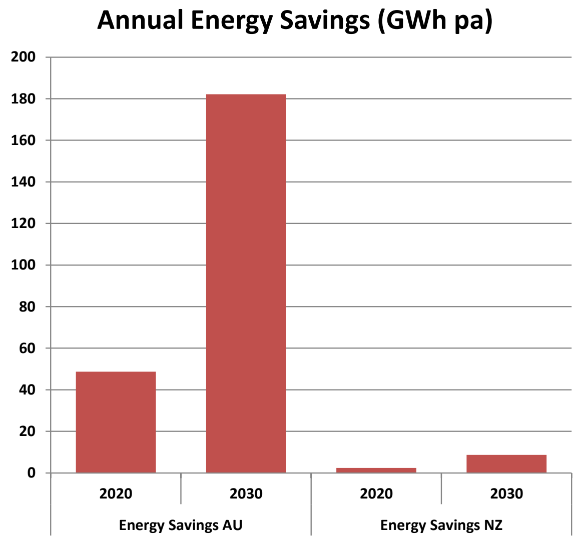
## Proposal B1 – detail by state/region and category

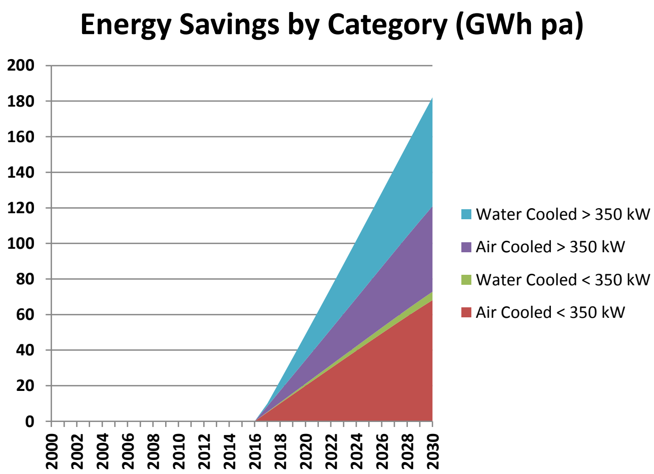
### State/region summary energy greenhouse and CBA

| Impact | ACT | NSW | NT | Qld | SA | TAS | Vic | WA | Australia (total) | New Zealand |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Benefit ($m) | 1.7 | 63.9 | 7.2 | 68.3 | 22.9 | 1.0 | 41.2 | 48.5 | **254.6** | **13.3** |
| Total Cost ($m) | 0.5 | 9.1 | 0.4 | 6.0 | 2.4 | 0.3 | 5.2 | 4.3 | **28.3** | **3.6** |
| *Benefit Cost Ratio* | 3.8 | 7.0 | 18.2 | 11.4 | 9.4 | 3.1 | 7.9 | 11.2 | **9.0** | **3.6** |
| Energy Saved (GWh cumulative) | 15.8 | 399.9 | 28.1 | 358.3 | 109.1 | 8.6 | 214.2 | 202.0 | **1,336** | **64** |
| Greenhouse gas emission reduction (kt $CO_2$-e cumulative) | 14.5 | 366.2 | 18.8 | 332.4 | 50.4 | 2.0 | 259.9 | 154.5 | **1,199** | **6** |

*Note: This table uses discount rates of 7% for Australia and 5% for New Zealand*

### Energy savings by year and category



## Sensitivity tests: discount rates

| Summary Australia | NPV Nil (0%) | NPV Low (3%) | NPV Med (7%) | NPV High (11%) |
|---|---|---|---|---|
| **Proposal A** | | | | |
| Total Costs | $6,214,327 | $4,945,523 | $3,750,750 | $2,923,967 |
| Total Benefits | $78,580,965 | $45,404,285 | $23,834,845 | $13,640,985 |
| Net Benefits | $72,366,638 | $40,458,762 | $20,084,095 | $10,717,019 |
| *Benefit Cost Ratio* | 12.6 | 9.2 | 6.4 | 4.7 |
| **Proposal B1/B2** | | | | |
| Total Costs | $46,902,927 | $37,311,134 | $28,281,289 | $22,034,867 |
| Total Benefits | $891,999,994 | $500,402,299 | $254,620,017 | $142,322,296 |
| Net Benefits | $845,097,068 | $463,091,165 | $226,338,727 | $120,287,429 |
| *Benefit Cost Ratio* | 19.0 | 13.4 | 9.0 | 6.5 |

| Summary New Zealand | NPV Nil (0%) | NPV Low (3%) | NPV Med (5%) | NPV High (8%) |
|---|---|---|---|---|
| **Proposal A** | | | | |
| Total Costs | $787,188 | $628,565 | $546,597 | $449,409 |
| Total Benefits | $3,268,213 | $1,927,017 | $1,397,306 | $899,472 |
| Net Benefits | $2,481,026 | $1,298,452 | $850,709 | $450,063 |
| *Benefit Cost Ratio* | 4.2 | 3.1 | 2.6 | 2.0 |
| **Proposal B1/B2** | | | | |
| Total Costs | $5,276,356 | $4,202,563 | $3,648,158 | $2,991,474 |
| Total Benefits | $32,419,650 | $18,615,963 | $13,301,769 | $8,407,312 |
| Net Benefits | $27,143,294 | $14,413,400 | $9,653,611 | $5,415,837 |
| *Benefit Cost Ratio* | 6.1 | 4.4 | 3.6 | 2.8 |

## Sensitivity tests: higher and lower incremental costs

### Australia – 50% increase of incremental costs

| Proposal | Energy Saved (cumulative GWh to 2030) | GHG Emission Reduction (cumulative) Mt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Proposal A | 135 | 0.1 | $24 | $6 | $18 | 4.3 |
| Proposal B1/B2 | 1,336 | 1.2 | $255 | $42 | $212 | 6.0 |

*Note: This table uses discount rates of 7% for Australia*

### New Zealand – 50% increase of incremental costs

| Proposal | Energy Saved (cumulative GWh to 2030) | GHG Emission Reduction (cumulative) kt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Proposal A | 7 | 0.7 | $1 | $1 | $1 | 1.8 |
| Proposal B1/B2 | 64 | 6.4 | $13 | $5 | $8 | 2.4 |

*Note: This table uses discount rates of 5% for New Zealand*

### Australia – 50% decrease of incremental costs

| Proposal | Energy Saved (cumulative GWh to 2030) | GHG Emission Reduction (cumulative) Mt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Proposal A | 135 | 0.1 | $24 | $2 | $22 | 12.2 |
| Proposal B1/B2 | 1,336 | 1.2 | $255 | $14 | $240 | 17.9 |

*Note: This table uses discount rates of 7% for Australia*

### New Zealand – 50% decrease of incremental costs

| Proposal | Energy Saved (cumulative GWh to 2030) | GHG Emission Reduction (cumulative) kt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Proposal A | 7 | 0.7 | $1 | $0 | $1 | 4.7 |
| Proposal B1/B2 | 64 | 6.4 | $13 | $2 | $11 | 7.2 |

*Note: This table uses discount rates of 5% for New Zealand*

## 2011 Decision RIS estimates

A scenario where MEPS levels are increased to 3.5 or approximately 10 per cent higher than current MEPS was also modelled, as per the 2011 Air Conditioner Decision RIS recommendation. The tables below shows the AEER/ACOP MEPS level used and the cost benefit estimates for this proposal.

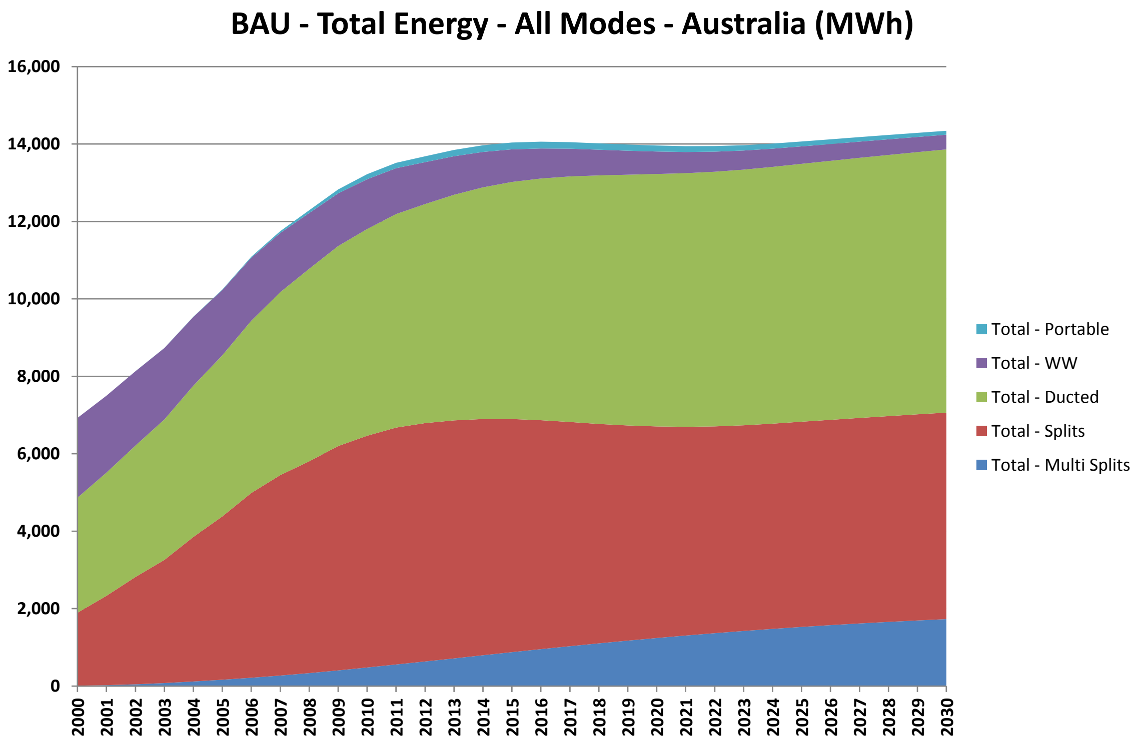
| Category | MEPS |
|---|---|
| Double duct portable | 3.5 |
| Non-ducted Split <4kW | 4.5 |
| Non-ducted Split 4kW to <10kW | 3.65 |
| Non-ducted split 10kW to 19kW | 3.5 |
| Non-ducted unitary <10kW | 3.5 |
| Non-ducted unitary 10kW to 19kW | 3.5 |
| Ducted <10kW | 3.5 |
| Ducted 10kW to 19kW | 3.5 |
| All 19kW to 39kW | 3.5 |
| All >39kW | 3.5 |

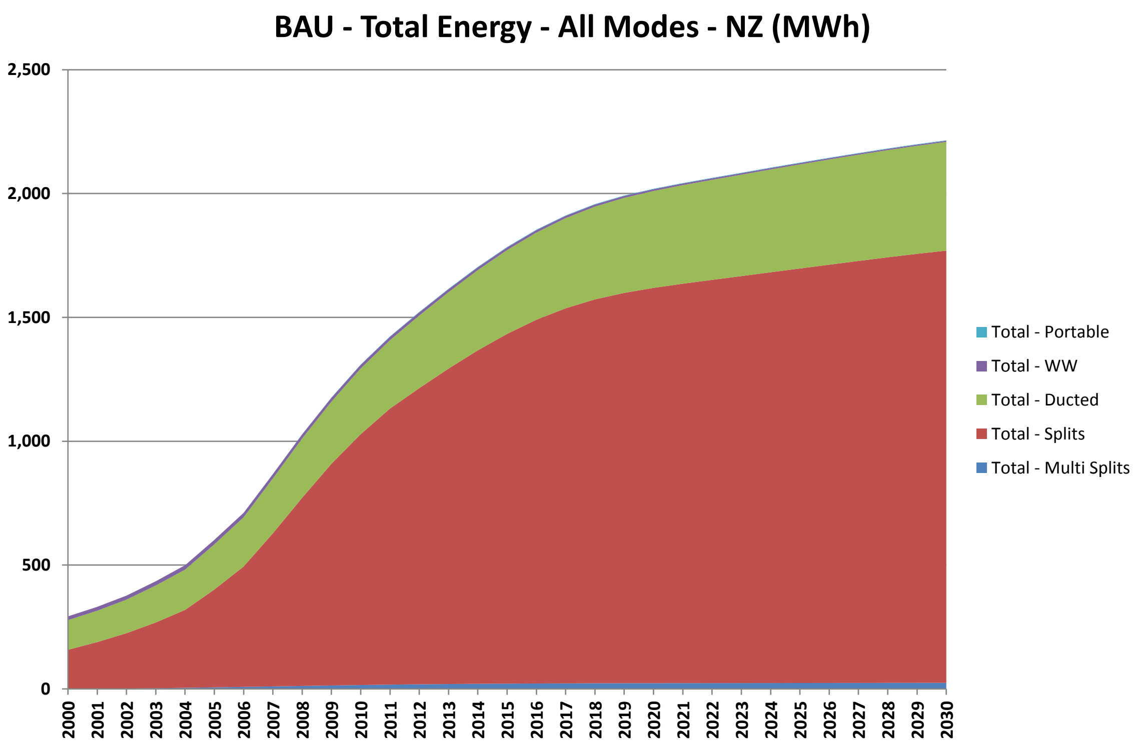
| Country | Energy Saved (cumulative GWh) | GHG Emission Reduction (cumulative) Mt | Total Benefit ($M) | Total Investment ($M) | Net Benefit ($M) | BCR |
|---|---|---|---|---|---|---|
| Australia | 11,893 | 10.6 | $2,304 | $2,584 | -$280 | 0.9 |
| New Zealand | 1,443 | 143.4 | $342 | $229 | $112 | 1.5 |

# v. BAU energy consumption

The modelled BAU energy consumption for Australia and New Zealand is shown in the following sections for air conditioners and chillers.

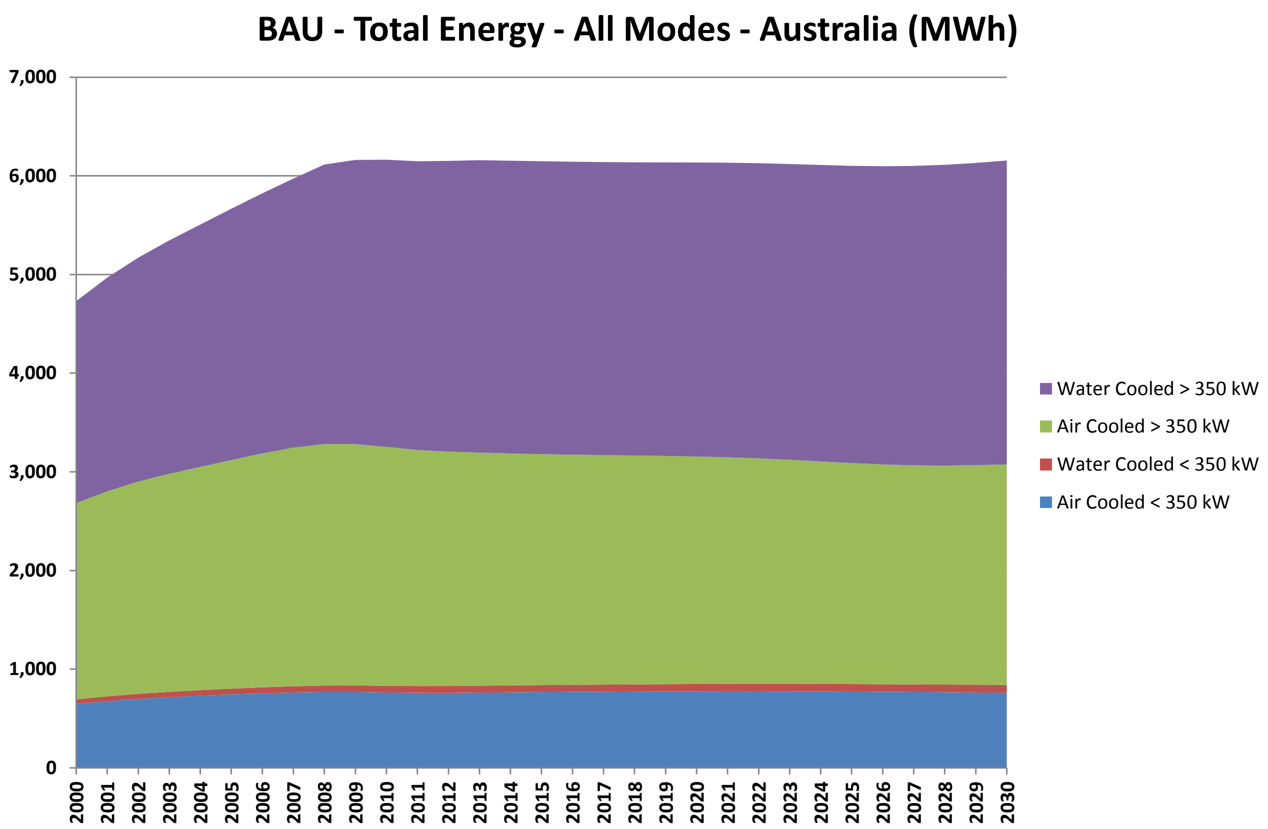
## Air conditioners

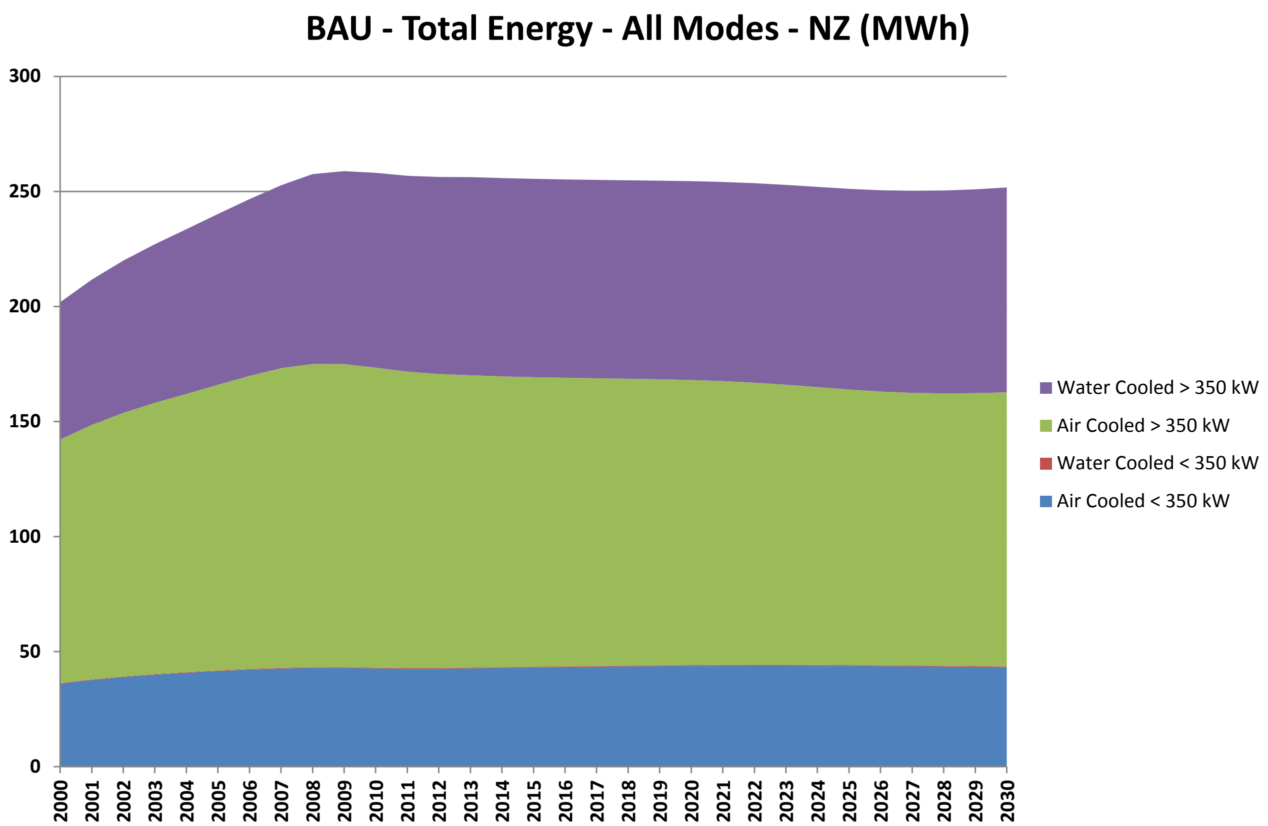




BAU - Total Energy - All Modes - NZ (MWh)
2,500
2,000
1,500
1,000
500
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Total - Portable
Total - WW
Total - Ducted
Total - Splits
Total - Multi Splits

# Chillers


BAU - Total Energy - All Modes - Australia (MWh)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Water Cooled > 350 kW
Air Cooled > 350 kW
Water Cooled < 350 kW
Air Cooled < 350 kW


BAU - Total Energy - All Modes - NZ (MWh)
300
250
200
150
100
50
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Water Cooled > 350 kW
Air Cooled > 350 kW
Water Cooled < 350 kW
Air Cooled < 350 kW

# Attachment B1 – Electricity prices and GHG emissions

**Table 29 Residential electricity prices (real 2014 cents/kWh) for Australia and New Zealand**

| Region/year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NSW | 30.00 | 30.31 | 27.00 | 27.25 | 27.50 | 27.96 | 28.45 | 28.99 | 29.44 | 31.12 | 31.44 | 31.68 | 31.97 | 32.25 | 32.51 | 32.68 | 32.94 | 33.21 |
| ACT | 20.10 | 20.31 | 18.09 | 18.25 | 18.43 | 18.74 | 19.06 | 19.42 | 19.73 | 20.85 | 21.06 | 21.23 | 21.42 | 21.61 | 21.78 | 21.90 | 22.07 | 22.25 |
| NT | NA | 27.13 | 25.60 | 26.92 | 26.91 | 26.78 | 25.78 | 25.29 | 25.98 | 25.87 | 25.75 | 25.37 | 25.27 | 25.23 | 25.22 | 25.23 | 25.23 | 24.82 |
| QLD | 25.00 | 28.36 | 26.69 | 30.06 | 29.96 | 27.74 | 28.23 | 28.81 | 27.67 | 29.16 | 29.52 | 29.83 | 30.23 | 30.63 | 30.95 | 31.23 | 31.51 | 31.86 |
| SA | 32.50 | 31.21 | 28.93 | 29.14 | 29.34 | 29.76 | 30.26 | 30.80 | 31.26 | 32.35 | 32.56 | 32.66 | 32.89 | 33.20 | 33.45 | 33.61 | 33.82 | 34.17 |
| TAS | 29.00 | 28.18 | 25.86 | 26.15 | 26.39 | 26.87 | 27.39 | 27.94 | 28.40 | 29.71 | 29.96 | 30.10 | 30.40 | 30.77 | 31.09 | 31.29 | 31.52 | 31.83 |
| VIC | 30.00 | 30.82 | 28.41 | 28.57 | 28.82 | 29.29 | 29.80 | 30.33 | 30.79 | 32.12 | 32.34 | 32.46 | 32.73 | 33.10 | 33.38 | 33.57 | 33.77 | 34.07 |
| WA | NA | 27.27 | 24.60 | 25.86 | 25.86 | 25.73 | 24.77 | 24.30 | 24.96 | 24.86 | 24.74 | 24.38 | 24.28 | 24.24 | 24.23 | 24.24 | 24.24 | 23.85 |
| NZ (NZ cents) | 16.85 | 16.85 | 16.85 | 17.58 | 17.63 | 17.58 | 17.58 | 17.92 | 18.03 | 17.92 | 18.14 | 18.22 | 18.30 | 18.09 | 18.37 | 18.58 | 18.67 | 18.70 |

**Table 30 GHG emission factors for electricity (kg CO2-e/kWh) for Australia and New Zealand**

| Region/year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NSW | 0.990 | 0.999 | 1.004 | 1.003 | 0.989 | 0.965 | 0.936 | 0.909 | 0.910 | 0.911 | 0.915 | 0.919 | 0.918 | 0.917 | 0.918 | 0.911 | 0.913 | 0.908 |
| ACT | 0.990 | 0.999 | 1.004 | 1.003 | 0.989 | 0.965 | 0.936 | 0.909 | 0.910 | 0.911 | 0.915 | 0.919 | 0.918 | 0.917 | 0.918 | 0.911 | 0.913 | 0.908 |
| NT | 0.780 | 0.781 | 0.782 | 0.746 | 0.746 | 0.747 | 0.751 | 0.698 | 0.660 | 0.661 | 0.662 | 0.662 | 0.663 | 0.664 | 0.666 | 0.666 | 0.667 | 0.669 |
| QLD | 0.930 | 0.946 | 0.966 | 0.979 | 0.982 | 0.970 | 0.966 | 0.959 | 0.949 | 0.935 | 0.933 | 0.929 | 0.927 | 0.925 | 0.921 | 0.920 | 0.914 | 0.918 |
| SA | 0.720 | 0.741 | 0.733 | 0.716 | 0.651 | 0.578 | 0.519 | 0.494 | 0.462 | 0.467 | 0.460 | 0.490 | 0.486 | 0.488 | 0.448 | 0.431 | 0.432 | 0.428 |
| TAS | 0.230 | 0.230 | 0.230 | 0.230 | 0.230 | 0.230 | 0.230 | 0.230 | 0.230 | 0.230 | 0.230 | 0.230 | 0.230 | 0.230 | 0.230 | 0.230 | 0.230 | 0.230 |
| VIC | 1.340 | 1.327 | 1.324 | 1.324 | 1.304 | 1.275 | 1.244 | 1.226 | 1.222 | 1.221 | 1.219 | 1.217 | 1.214 | 1.212 | 1.209 | 1.206 | 1.203 | 1.200 |
| WA | 0.830 | 0.845 | 0.844 | 0.817 | 0.791 | 0.779 | 0.767 | 0.760 | 0.752 | 0.754 | 0.758 | 0.765 | 0.767 | 0.770 | 0.771 | 0.767 | 0.765 | 0.763 |
| NZ | 0.1529 | 0.1512 | 0.1396 | 0.1413 | 0.1442 | 0.1471 | 0.1479 | 0.1210 | 0.1110 | 0.1117 | 0.1047 | 0.1035 | 0.0911 | 0.0922 | 0.0915 | 0.0940 | 0.0964 | 0.0883 |

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