Queensland

Electricity Amendment Regulation (No. 2) 2009

Regulatory Impact Statement for* SL 2009 No. 138

made under the

Electricity Act 1994

Liquid chilling packages

* Under the *Statutory Instruments Act 1992*, section 46(1)(h), a regulatory impact statement (RIS) need not be prepared for proposed subordinate legislation if it only provides for, or to the extent it only provides for, a matter involving the adoption of an Australian or international protocol, standard, code, or intergovernmental agreement or instrument, if an assessment of the benefits and costs has already been made and the assessment was made for, or is relevant to, Queensland.

A RIS was not prepared for the above item of subordinate legislation on the basis that it provides for the adoption of an Australian Standard however a RIS was prepared for the Equipment Energy Efficiency Committee, which reports to the Ministerial Council on Energy, in relation to the subject matter.

The RIS in relation to the subject matter prepared may be viewed at the following site—

http://www.energyrating.gov.au/library/pubs/200716-ris-chillers.pdf

Copies of the RIS provided to the Queensland Government are attached.

www.energyrating.gov.au
EQUIPMENT ENERGY EFFICIENCY

Decision Regulatory Impact Statement:

Minimum Energy Performance Standards and Alternative Strategies for Chillers

Issued by the Equipment Energy Efficiency Committee under the auspices of the Ministerial Council on Energy.

July 2008

This Decision Regulatory Impact Statement (RIS) was prepared by EnergyConsult Pty Ltd for the Equipment Energy Efficiency Committee, which reports to the Ministerial Council on Energy. The MCE determines end-use equipment energy efficiency regulatory proposals involving all Australian Governments (Commonwealth, State and Territory) and the New Zealand Government.

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Contents

Appendices

List of Tables

List of Figures

Glossary and Abbreviations

ABS	Australian Bureau of Statistics
AGO	Australian Greenhouse Office
AREMA	Air Conditioning and Refrigeration Equipment Manufacturers Association of Australia
ARI	Air-Conditioning and Refrigeration Institute
AS/NZS	Australian Standards and New Zealand Standards
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAU	Business-as-usual
BCA	Building Code of Australia
BCR	Benefit-cost Ratio
CBA	Cost Benefit Analysis
CEC	California Energy Commission
CO_2-e	Carbon dioxide equivalent units
COAG	Council of Australian Governments
DEW	Department of the Environment and Water Resources
DoE	Department of Energy (USA)
E3	Equipment Energy Efficiency Committee (formerly NAEEEC)
EC	European Commission
EECA	Energy Efficiency and Conservation Authority – New Zealand
EEEP	Equipment Energy Efficiency Program (formerly NAEEEP)
EPA	Environment Protection Agency (USA)
ETS	Emission Trading Scheme
EU	European Union
EUROVENT	EUROVENT Certification Programme
GATT	General Agreement on Tariffs and Trade
GHG	Greenhouse Gas
GTBT	General Agreement on Tariffs and Trade (GATT) Technical Barriers to Trade
GWA	George Wilkenfeld & Associates
GWh	Giga Watt hour – 1 million Watt hours
IEA	International Energy Agency
IEC	International Energy Commission
IESNA	Illuminating Engineering Society of North America
kt	Kilo Tonnes – 1 thousand Tonnes
kWh	Kilo Watt hour – 1 thousand watt hours
kWr	Kilo Watt refrigeration
MCE	Ministerial Council of Energy
MEPS	Minimum Energy Performance Standards
MRET	Mandatory Renewable Energy Target
Mt	Mega Tonnes – 1 million Tonnes
NAEEEC	National Appliance Equipment and Energy Efficiency Committee (now E3)
NAEEEP	National Appliance Equipment and Energy Efficiency Program (now EEEP)

NFEE	National Framework on Energy Efficiency
NGS	National Greenhouse Strategy
NPV	Net Present Value
NZ	New Zealand
RIS	Regulatory Impact Statement
TTMRA	Trans Tasman Mutual Recognition Arrangement
UNFCCC	United Nations Framework Convention on Climate Change

Executive Summary

This decision regulatory impact statement (RIS) proposes the introduction of common minimum energy performance standards (MEPS) in Australia and New Zealand for liquid-chilling packages using the vapour compression cycle (commonly called chillers in this document).

An initial Cost-Benefit Analysis (CBA) of the proposal (E3 Committee 2007) was released in August 2007.[1] It was prepared and issued by the Equipment Energy Efficiency Committee (E3 Committee) under the Ministerial Council on Energy of the Australian federal, state and territory governments and the New Zealand Government. Stakeholder submissions called for changes to that proposal and this RIS, taking account of those stakeholder submissions, represents the latest proposed recommendations of energy efficiency regulators to the Ministerial Council on Energy.

Chillers were identified for policy action in the National Appliance & Equipment Energy Efficiency Program (NAEEEP), today the Equipment Energy Efficiency Program, from 2003. A plan was published by NAEEEP in October 2004 for improving the efficiency of chillers which proposed that mandatory regulations might better meet the Australian and New Zealand governments' efficiency goals. Since this time, significant industry and government consultation has occurred to provide a suitable framework for the introduction of MEPS.

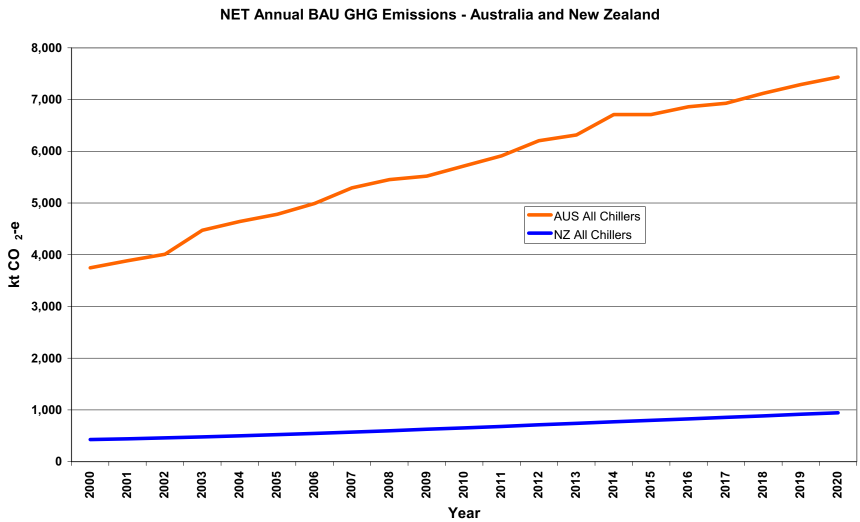
The Problem

Chillers produce cooled water that is used by building space cooling equipment and many industrial processes. Chillers remove heat from a circulating cold water loop and discharge that heat to the outside air through a cooling tower in the case of water cooled chillers and through the air cooled condenser of the chiller in the case of air cooled chillers. Chillers within the scope of this RIS are generally used for commercial air conditioning, though chillers of the type specified in the report can also be used for industrial purposes. The sales of these products have been steadily increasing at around 3% pa from around 1,400 in 2000 to over 1,700 in 2006. In addition, the installed stock of all types of chillers is estimated at around 21,000 in Australia and 4,200 in New Zealand in 2006.

The annual direct electricity consumption of all these products for the year 2006 has been estimated to be 4,900 GWh/yr in Australia and 790 GWh/yr in New Zealand. The net energy resulting from the use of chillers is projected to grow to over 8,310 GWh in Australia and 1,330 GWh in New Zealand by the year 2020. Currently the overall electricity used by chillers accounts for nearly 9% of total commercial electricity usage.

[1] Available from http://www.energyrating.gov.au/library/details200708-CBA-chillers.html

The share of chiller energy use of overall commercial energy consumption is expected to rise to 10% by 2020. Similarly the share of chillers of overall electricity-related greenhouse gas (GHG) emissions is expected to grow from 2.6% in 2006 to 3.3% in 2020 in Australia. The figure following provides the estimated annual BAU GHG emissions by chillers in Australia and New Zealand to 2020.



The choice of a chiller can affect the energy usage requirements of a building, with case studies showing $10,000s of saving due to the replacement of inefficient chillers (DOE 2000, DOE 2004). As the installation of more energy efficient chillers need not lead to higher initial installation costs, it would appear the market should automatically move towards the installation of more efficient chillers. However, there are several factors which contribute to deficiencies in the chiller market and make this outcome less likely, these being:

- Many commercial buildings are tenanted, so their developer or owner may have no direct financial motivation to choose the most efficient technologies for the building, and tenants may have no influence over chiller decisions (Energy Strategies 2006).
- Chillers may be chosen and installed by sub-contractors who may not be required to choose the most energy efficient chiller.
- A lack of knowledge in the market of the energy and cost impact of choosing efficient versus inefficient chillers.

The result of this disconnection between the rewards of choosing energy efficient chillers, i.e. lower energy costs, and the authority to select the chiller, means cost efficiencies alone will not be sufficient to drive the uptake of more efficient chillers.

The Objective

The objective of the proposed strategies for chillers is to bring about reductions in Australia's and New Zealand's greenhouse gas emissions below what they are otherwise projected to be (i.e. the "business-as-usual" or BAU case), in a manner that is in the broad community's best interests. Within the objective, it must also provide a broad positive financial benefit to end consumers, without compromising equipment quality or functionality.

The Proposal

The proposed strategy involves introducing mandatory MEPS that cover chillers of greater than 350 kWr from October 2008. The regulation would stipulate the minimum efficiency levels for these products in order to be sold in the Australian and New Zealand market. MEPS aims to remove the worst performing products from the marketplace, rather than promoting the best. This Australian/ New Zealand MEPS is tailored to mirror international requirements, while being moderated to address local industry technical issues. In this regard, the proposed MEPS has been developed in close consultation with the chiller supply industry over the period 2004 to 2007.

The proposed MEPS includes minimum requirements for full load Coefficient of Performance (COP) and importantly, minimum requirements for part load (called Integrated Part Load Values or IPLV). The proposed MEPS does not differentiate between types of chiller compressor technologies, but does vary depending on the size and the type of heat rejection (water cooled or air cooled).

Assessment

In the analysis, two annual sales growth scenarios have been analysed:

- a base sales scenario that is used for the RIS with product sales increasing at approximately 3.5% pa from 2007; and
- a low sales scenario with sales increasing at only 0.5% pa from 2007.

Australia

The following table summarises the analyses for Australia for the period 2007 to 2020. The data presented is based upon Net Present Value calculations at a discount rate of 7.5%.

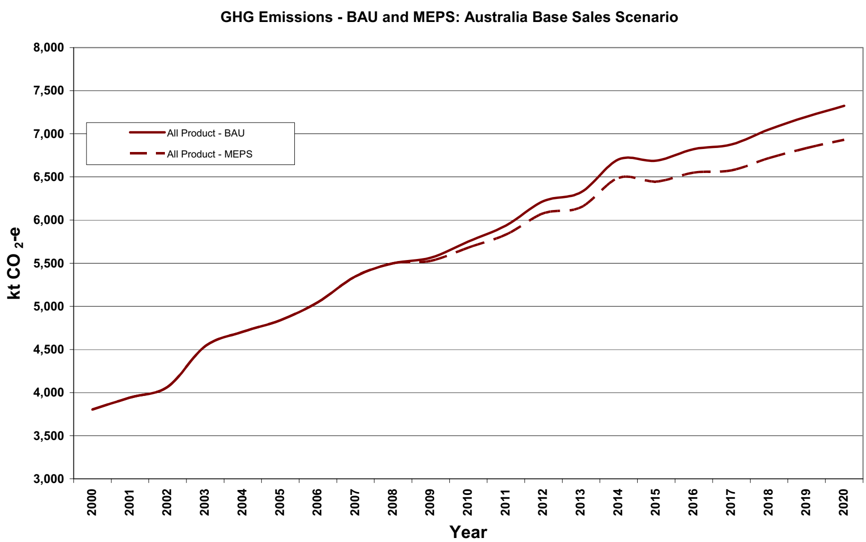
Summary Data for Alternative BAU Sales Australia – 7.5% Discount Rate

Scenario	Base Sales	Low Sales
Energy Saved (cumulative)	2,862 GWh	2,521 GWh
GHG Emission Reduction (cumulative)	2.6 Mt CO_2-e	2.3 Mt CO_2-e
Total Benefit	$760M	$641M
Total Investment	$125M	$106M
Benefit Cost Ratio	6.1	6.0

If the incremental costs of improved product to meet the MEPS are increased by 50% from the values assumed in the RIS analysis, the benefits are still approximately 4.1 times the costs under the base sales scenario.

Although the future carbon price under the forthcoming Australian emissions trading scheme (ETS) is uncertain at present, emissions trading will mean the estimated benefits will always be higher than without emissions trading (i.e., the benefits will always be higher when the carbon price is above zero). The benefit-cost ratio increases to 6.3 for the base sales scenario if the benefits of reducing GHG emissions under the ETS are included from 2012 (see Appendix 7).

The estimated GHG emission reductions for all chillers of the proposed MEPS is 393 kt CO2-e/yr under the Base Sales scenario in 2020, compared to the BAU as shown in the figure below.



New Zealand

The following table summarises the analyses for New Zealand for the period 2007 to 2020. The data presented is based upon Net Present Value calculations at a discount rate of 5%.

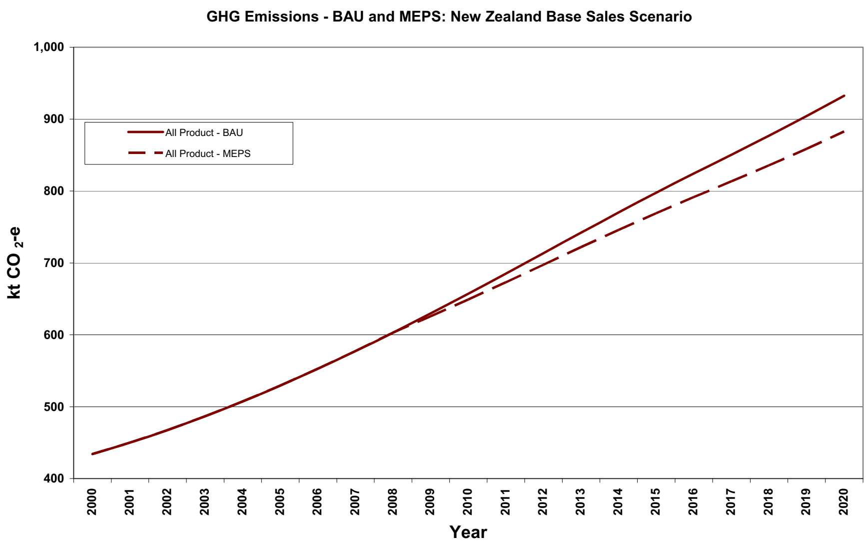
Summary Data for Alternative BAU Sales New Zealand – 5% Discount Rate

Scenario	Base Sales	Low Sales
Energy Saved (cumulative)	460 GWh	405 GWh
GHG Emission Reduction (cumulative)	321 kt CO_2-e	282.8 kt CO_2-e
Total Benefit	$145M	$122M
Total Investment	$35M	$30M
Benefit Cost Ratio	4.1	4.1

Note that NZ Govt requires analysis of alternative proposals with 5% discount rate

At the individual application level, the mix of benefits and costs depends on usage patterns. The analysis indicates that, in all usage cases, end-users will benefit from the proposed regulation.

The estimated GHG emission reductions for all chillers of the proposed MEPS is 50 kt CO2-e/yr under the Base Sales scenario in 2020, compared to the BAU as shown in the figure below.



Alternative Options

The other options considered for achieving the objective were:

- voluntary efficiency standards;
- levies and emissions trading;
- a certification program;
- dis-endorsement labelling;
- mandatory energy labelling.

Voluntary efficiency standards rely on equipment suppliers being effectively encouraged to meet certain minimum energy efficiency levels voluntarily, i.e. in the absence of regulation. As there are few commercial incentives for doing so, it is unlikely that suppliers would willingly make these changes without significant government incentives. Chiller suppliers were interviewed (EnergyConsult 2004) and provided feedback that suppliers would not participate as this would affect their competitiveness and may perversely encourage the use of poorer performing lower cost products.

Levy options are not currently government policy and would require extensive consultation at the highest levels of government. Hence these options cannot be considered until such time as government policy changes to favour levy schemes.

The Australian Government has announced that a domestic ETS will be implemented no later than 2012. This could eventually lead to the full cost of GHG emissions impacts being reflected in energy prices, but it is unlikely that an ETS alone and the energy price rises that might flow from it in the future would quickly lead to purchasers being concerned about the energy efficiency of chillers.

Certification is unlikely to succeed as the program is likely to cover only a proportion of the chillers available.

A dis-endorsement labelling scheme is very unlikely to be effective for chillers, as chillers are not a retail item but are sold on the basis of their technical specifications and price. It would therefore appear to be unjustified and inappropriate in Australia and New Zealand.

As chillers are not sold to consumers but are a business product, sold on the basis of their technical specifications and price, an energy rating label is highly unlikely to affect the market for more efficient chillers.

The implication is that the impact of the other non-MEPS options for Australia and New Zealand would be negligible in comparison to the BAU case.

Recommendations

It is recommended that the Ministerial Council on Energy (MCE) agree:

1. To implement mandatory energy performance standards for liquid-chilling packages using the vapour compression cycle in regulation.
2. That products covered by this RIS include all those chillers above 350 kWr output capacity included in the scope of AS/NZS 4776, Part 1.1.
3. To review chillers with an output capacity of less than 350 kWr, with a view to introducing MEPS for these products by 2010
4. To use the test method AS/NZS 4776.1.2 which specifies the method of testing liquid-chilling packages using the vapour compression cycle to verify the capacity, power and efficiency requirements at a specific set of conditions.
5. That liquid-chilling packages must meet or surpass the energy performance requirements that are proposed in this document and will be set down in Australian and New Zealand Standard AS/NZS 4776.2 (MEPS requirements for liquid-chilling packages using the vapour compression cycle).
6. That the amendments take effect not earlier than 1 October 2008.
7. To have all jurisdictions take the necessary administrative actions to ensure that the suite of regulations can take effect from not earlier than 1 October 2008.

1 Scope

1.1 General

This Decision Regulatory Impact Statement (RIS) has been prepared to demonstrate the benefits of regulating mandatory energy performance standards for this type of energy-using equipment, in accordance with the *COAG Principles and Guidelines* (COAG 2004). A RIS is required whenever new or more stringent mandatory measures are proposed by government. Under the guidelines agreed by all Australian jurisdictions and New Zealand, product regulation is undertaken only where the benefits outweigh the costs to the community; and the cost of improving appliance efficiency is outweighed by the energy and greenhouse gas emissions savings made over the lifetime of the product.

This Decision RIS has been prepared to justify regulation of chillers, and follows two stages of detailed stakeholder consultation. The Equipment Energy Efficiency (E3) Committee released a Cost-Benefit Analysis (CBA) titled *Equipment Energy Efficiency Committee Cost-Benefit Analysis: Minimum Energy Performance Standards and Alternative Strategies for Chillers*[2] in August 2007. One formal submission was received that dealt with formatting issues. Subsequently, the Consultation RIS (MCE 2007) was released in December 2007 and four submissions were received. The submissions and responses to the Consultation RIS are set out in Section 6.

1.2 Australian and New Zealand Policy Responses to Global Warming

This regulatory proposal cannot be assessed in isolation; it forms part of a coordinated response by Governments to undertaking regulatory measures for any energy-using product that are cost-effective and meet agreed environmental and energy goals.

Australia's Response to Climate Change

Australia's greenhouse abatement and climate change policies have evolved consistently for more than 15 years, since the release of the National Greenhouse Response Strategy in 1997. The paper received overall bi-partisan support, including for national energy efficiency measures. Appendix 2 records some of the more important stages in that development.

In May 2007, the Prime Minister's Task Group released its report on the Introduction of an Australian Emissions Trading system, which endorsed the support of complementary measures as a means to address market failures where an Emissions Trading Scheme was not effective:

2 Available from http://www.energyrating.gov.au/library/details200708-CBA-chillers.html

"Beyond information-based policies, energy efficiency policies could target areas where market barriers are likely to be more fundamental and enduring. This is likely to be in areas where consumers make infrequent decisions and where it is difficult to judge the energy and emissions implications. There is a good case for continuing the development of well-designed and consistent regulated minimum energy standards for buildings and households appliances. Purchase of energy-efficient products can have a large impact on aggregate emissions over time, and reduce the impact on household budgets of any rise in carbon prices". (DPMC 2007 pp135)

Similarly in July 2007, the Prime Minister released Australia's Climate Change Policy – our economy, our environment, our future (ACCP 2007). The policy again reasserted that energy efficiency regulation remains a key element of cost effective greenhouse abatement:

"Energy efficiency is an important way to reduce greenhouse gas emissions cheaply. Demand for electricity in Australia is expected to more than double by 2050. Improvements in energy efficiency have the potential to lower that projected growth, and avoid greenhouse gas emissions. They can also deliver a net financial gain for firms and consumers. … The MEPS programme is one of the main success stories of the National Framework for Energy Efficiency (NFEE). The NFEE was developed cooperatively across jurisdictions and covers a range of policy measures, designed to overcome market barriers to energy efficiency." (pp 16-17)

Most recently On 11 March 2008, Australia's ratification of the Kyoto Protocol was officially recognised by the United Nations Framework Convention on Climate Change (UNCCC). Under Kyoto, Australia is obliged to limit its greenhouse gas emissions in 2008-2012 to 108 percent of 1990 emission levels. The Australian Government has also released a report demonstrating how Australia intends to measure the reductions in emissions required under Kyoto titled Australia's Initial Report under the Kyoto Protocol.

New Zealand's Response to Climate Change

New Zealand climate change policies have a similar history of long-term support by government. New Zealand ratified the Kyoto Protocol in 2002, and has committed to reducing its greenhouse gas emissions back to 1990 levels, on average, over the period 2008 to 2012 (or to take responsibility for any emissions above this level if it cannot meet this target).

In October 2007 the New Zealand Minister of Energy released the New Zealand Energy Efficiency and Conservation Strategy (NZEECS), which proposes ways to promote energy efficiency, energy conservation and the use of renewable sources of energy. It includes measures to reduce electricity demand, address energy use in transport, buildings and industry, and promote greater consideration of sustainable energy in the development of land, settlements and energy production. The strategy is available at http://www.eeca.govt.nz/eeca-library/eeca-reports/neecs/repor t/nzeecs-07.pdf

The New Zealand Energy Efficiency and Conservation Strategy (NZEECS) is a key part of the government's response to meeting its energy, climate change, sustainability and economic transformation goals. It has been written as a companion document to, and will give effect to a number of the objectives set out in, the New Zealand Energy Strategy (NZES).

The introduction of minimum energy performance standards and labelling for appliances continues to form part of New Zealand's climate change strategy, as part of implementing the National Energy Efficiency and Conservation Strategy (NZEECS).

The MCE Moves beyond "No Regrets" Energy Efficiency Measures

In October 2006, the Ministerial Council on Energy (MCE) of Australian federal, state and territory and New Zealand government energy ministers agreed to new criteria for assessing new energy efficiency measures. The MCE replaced its previous *"no regrets"* test (that a measure have private benefits excluding environmental benefits which are greater than its costs) with the criteria that the MCE would consider *"new energy efficiency measures which deliver net public benefits, including low cost greenhouse abatement measures that do not exceed the cost of alternate measures being undertaken across the economy"*.

This policy means the MCE will consider new regulatory measures that may have net up-front costs but have greater private economic and greenhouse benefits over the long term. The policy is based on the principle that prudent investment now may avoid more costly intervention later. This bipartisan agreement demonstrates the on-going commitment of all participating jurisdictions to using regulatory measures that deliver effective, measurable abatement.

IEA Sees Improving Energy Efficiency as Top Priority

Australian and New Zealand policy is in accord with international endeavours in this field.

> *"The IEA estimates that under current policies, global emissions will increase 50% by 2030 and more than double by 2050. However, if we act now, this unsustainable and dangerous pattern can be curbed. IEA findings show that emissions could be returned to current levels by 2050 and even reduced thereafter, while an ever-growing demand for energy services, notably in developing countries, can be fully satisfied. Improving energy efficiency in the major consuming sectors – buildings and appliances, transport and industry – must be the top priority. While alleviating the threat of climate change this would also improve energy security and have benefits for economic growth."* – Claude Mandil, Executive Director, International Energy Agency (IEA), Paris, February 2007.

Australian and New Zealand policies are at the forefront of international work to improve the energy efficiency of globally traded equipment, which lower trading costs while still delivering environmental and economic benefits.

Equipment Energy Efficiency Program

In Australia, regulatory intervention in the market for energy-using products was first introduced with mandatory appliance energy labelling by the NSW and Victorian Governments in 1986. Between 1986 and 1999 most state and territory governments introduced legislation to make energy labelling mandatory, and agreed to co-ordinate labelling and minimum energy performance standards (MEPS) decision making through the MCE. New Zealand has participated in monitoring the Australian program for more than a decade and has been a partner in decision-making for several years. Regulatory interventions have consistently met the requirements to demonstrate the actual benefit increasing energy efficiency standards, which address market failure relating to life-time energy cost information for appliances and equipment.

The proposed regulation is an element of the Equipment Energy Efficiency Program (E3), formerly known as National Appliance and Equipment Energy Efficiency Program (NAEEEP). E3 embraces a wide range of measures aimed at increasing the energy efficiency of products used in the residential, commercial and manufacturing sectors in Australia and New Zealand. E3 is an initiative of the MCE comprising ministers responsible for energy from all jurisdictions, and is an element of both Australia's National Framework for Energy Efficiency (NFEE) and New Zealand's National Energy Efficiency and Conservation Strategy. It is organised as follows:

- Implementation of the program is the direct responsibility of the Equipment Energy Efficiency Committee (referred to as the "E3 Committee"), which comprises officials from Australian federal, state and territory government agencies and representatives from New Zealand. These officials are responsible for implementing product energy efficiency initiatives in the various jurisdictions.

- The E3 Committee reports through the Energy Efficiency Working Group (E2WG) to the MCE and is ultimately responsible to the MCE.

- The MCE has charged E2WG to manage the overall policy and budget of the national program.

- The Australian and New Zealand members of the E3 Committee work to develop mutually acceptable labelling requirements and MEPS. New requirements are incorporated in Australian and New Zealand Standards and developed within the consultative machinery of Standards Australia.

- The program relies on State and Territory legislation for legal effect in Australia, enforcing relevant Australian Standards for the specific product type. National legislation performs this task in New Zealand.

The broad policy mandate of E3 has been regularly reviewed over the last decade and was most recently refreshed in 2004. Not only is any energy-using equipment type potentially included in resulting work plans for possible regulation but set-top boxes were specifically nominated for regulatory impact assessment.

To be included in the program, appliances and equipment must satisfy certain criteria relating to the feasibility and cost effectiveness of intervention. These include potential for energy and greenhouse gas emissions savings, environmental impact of the fuel type, opportunity to influence purchase, the existence of market barriers, access to testing facilities, and considerations of administrative complexity. Policy measures are subject to a cost-benefit analysis and consideration of whether the measures are generally acceptable to the community.

E3 provides stakeholders with opportunities to comment on specific measures as they are developed by issuing reports (including fact sheets, technical reports, cost-benefit analyses and regulatory impact statements) and by holding meetings. Regulation of chillers has been a topic of discussion with key industry leaders for many years.

1.3 Chiller Products

This report focuses on chillers for commercial air conditioning, though chillers of the type specified in the report can also be used for industrial purposes. However, generally an industrial chiller is a refrigeration system that cools water or some other fluid to provide a constant stream of coolant for cold storage (including cool rooms), manufacturing and laboratory processes. These industrial chillers are not generally used in air conditioning, but may be used for food processing and storage, process cooling, plastic moulding, solvent coolers, milk coolers, aerospace production, medical facilities etc. Hence the majority of the chillers that are the focus of this report are used for air conditioning in the commercial sector.

Chiller Product Description

Chillers produce water that is used by building space cooling equipment and many industrial processes. Chillers remove heat from a circulating cold water loop and discharge that heat to the outside air through a cooling tower in the case of water cooled chillers and through the air cooled condenser of the chiller in the case of air cooled chillers.

Chillers are generally used in commercial buildings to provide chilled-water. The chiller is usually located on in the plant room of the building. It cools water to between 4 and 9°C. This chilled water is then piped throughout the

building and connected to air handlers as needed.

The chiller is part of a system that is called "applied" air conditioning, where the system is usually specified by the building designer/ engineer. This is compared to unitary (all-in-one) systems where the air conditioners are "packaged" and cool air is ducted around the building.

The product type included in this RIS is based on the draft standard produced by Standards Australia committee ME-086. This document (currently called DR 07278) will become *AS/NZS 4776.1 Liquid-chilling Packages Using the Vapour Compression Cycle*. In general this broad product description will include chillers with the following characteristics:

- Factory assembled vapour compression units designed to cool water using an evaporator, with an integral water or air cooled condenser and controls
- Cooling only units
- The components of chillers such as motor, compressor, evaporator, economiser, condenser, receiver, water connections and passes, control panel, purge equipment, fastenings and couplings, refrigerant charge oil and pump if included
- Different types of compressors including reciprocating, screw, scroll and centrifugal
- The heat rejection process is via air cooled or water cooled condensers.

Energy consumption from chillers is estimated to be over 4,900 GWh/yr in Australia and over 790 GWh/yr in New Zealand in 2006. In addition, cooling functions are estimated to result in about 28% of greenhouse gas emissions from the average commercial buildings (ES 2005).

1.4 Australian/New Zealand Policies and Programs

National product regulation can only be justified where the benefits outweigh the costs to the community; where the costs of improving efficiency are outweighed by the energy savings made over the lifetime of the product. To date, the cooling cycle of three phase air conditioners are regulated for MEPS and single phase (domestic) air conditioners are regulated for MEPS and energy labelling. In addition, the Building Code of Australia has been updated to include Minimum Energy Performance Standards for chillers in new non-residential buildings.

Package Air Conditioners

Since 1 October 2001, three phase air conditioners with a cooling capacity of up to 65kW manufactured in or imported into Australia must comply with Minimum Energy Performance Standards (MEPS) requirements which are set out in AS 3823.2-2001. MEPS covers three phase non-ducted or ducted room air conditioners of the vapour compression type of up to 65kW cooling (commercial or residential). It covers only those units with a single compressor with a single indoor control such as single packaged units, packaged ducted units, double and triple split systems and single split systems. It does not cover multi-split systems, portable systems without an exhaust duct or evaporative coolers. Manufacturers can choose to label three phase air conditioners, but this is not mandatory.

Packaged Air conditioning MEPS introduced in 2001 are projected to save 14.6 Mt CO_2e from 2000 to 2015 and save the community $400 million (NPV - 10% discount). The benefits exceed costs by 6:1. These MEPS levels are due to increase in October 2007.

Single Phase Air Conditioners

From 1 October 2004, all single phase air conditioners manufactured in or imported into Australia must comply with Minimum Energy Performance Standards (MEPS) requirements which are set out in AS/NZS 3823.2-2003. MEPS covers single phase non-ducted or ducted room air conditioners of the vapour compression type (commercial or residential) within the scope of AS/NZS 3823.1.1 or AS/NZS 3823.1.2. These MEPS levels were further increased for many non-ducted single phase models effective from April 2006 and for other units from October 2007.

Building Code of Australia and New Zealand Building Code

The development of the Building Code of Australia (BCA) energy efficiency provisions for commercial buildings has proceeded in two stages. Firstly, provisions for Class 2, 3 and 4 buildings (e.g., apartments and hotels) were included in BCA 2005. Secondly, provisions for Class 5, 6, 7, 8 and 9 buildings (e.g., offices, shops, warehouses, factories, health care buildings, auditoriums and schools) were included in BCA 2006. These provisions include MEPS for chillers installed in new buildings only.

The New Zealand Building Code includes provisions for energy efficiency under clause H1 Energy Efficiency, which was last revised in 2001. The NZ Department of Building and Housing (DBH) has proposed changes to the heating, ventilating and air-conditioning (HVAC) systems be covered by the energy efficiency requirements of Clause H1 of the New Zealand Building Code, leading to more stringent energy efficiency standards and lower energy use for such systems in commercial buildings (DBH NZ 2007). A proposal was released for discussion in April 2007, with submissions closing on 29 June 2007. After considering the submissions, the DBH will report its recommendations back to Government in October 2007. These provisions include MEPS for chillers installed in new buildings only and are identical to those in the Australian BCA 2006.

1.5 Chiller Market

In research undertaken by the UK's Building Research and Information Association (BSRIA), the world air conditioning market was estimated to be in the vicinity of AUD$50 billion in 2002. Approximately 10% of this market value has been attributed to air conditioning water chillers. With the Australian air conditioning water chiller market estimated at AUD$125M, this represents around 2.5% of the total world market and is considered modest compared to the room and unitary air conditioning market of over AU$800M (Infomark 2004). Based on the estimated sales of chillers in New Zealand, the value of the New Zealand market would be NZ$22M.

There is little or no published data on the energy performance characteristics Australian/New Zealand chillers. Therefore, information in this section is primarily derived from personnel interviews with major suppliers of chillers to Australia and New Zealand.

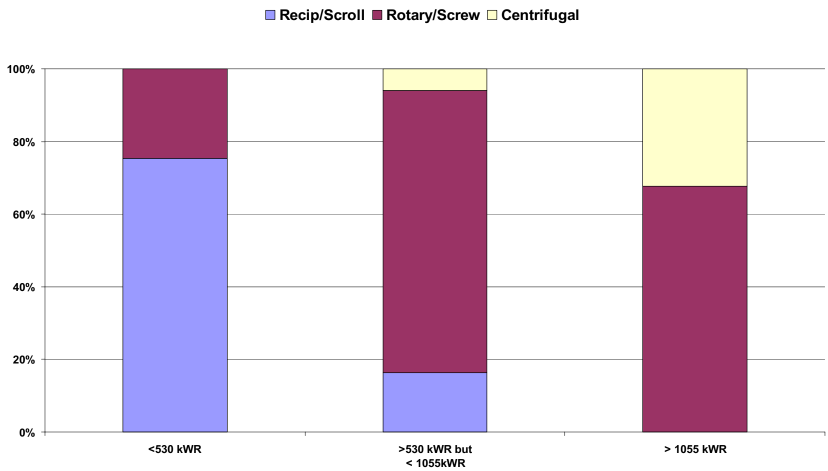
Current Installed Base and Sales

There are no Australian Bureau of Statistics data on the installed number of commercial chillers in Australia. In addition, the data contained in other studies (Burbank 2002, AGO 1999) of the commercial market do not appear to detail the number of installed chillers. To estimate the number of installed chillers, extensive consultation was conducted with key organisations representing the majority of sales of chillers in Australia. Many of the organisations were members of the Air Conditioning and Refrigeration Equipment Manufacturers Association of Australia (AREMA) and these companies also sell chillers into New Zealand. From these consultations, it is estimated that there were some 21,000 chillers in 2006 of varying technology types, efficiencies and refrigerants are currently installed in Australian commercial buildings, entertainment complexes and retails facilities. Approximately half of these chillers are believed to be air cooled. In New Zealand the estimated stock of chillers is 4,200, with a similar proportion of air cooled.

Chiller Capacity Range

The capacity range of chillers available in today's Australian and New Zealand market can range from 10kW up to 4,000 kW in cooling capacity. In large installations it is not unusual to have multiple chillers, with different capacities and different compressor types.

Figure 1 - Chiller Sales by Type & Range



Source: EnergyConsult 2004

Figure 1 shows the range of sales by type of chiller. Applications with cooling requirements below 250 kW are mainly dominated by scroll compressors, with other applications up to 1,000 kW using a mixture of helical rotary (screw) and reciprocating compressors. Cooling capacity requirements above 1,000 kW is usually managed by the use of screw and centrifugal compressors.

Sales Trends

Chiller sales vary from year to year and correlate closely with building industry activity. The chiller market varies depending on the influence of many factors that include: economic downturn; oversupply of commercial office space; outbreaks of SARS, global conflicts and uncertainty in both Australian and US economies. In 2006 the market was estimated to be 1700 units per annum[3] in Australia and 330 in New Zealand. Of these sales, it is estimated that around 40% are for replacement of existing equipment. Total sales growth is estimated at around 3% pa.

There has been a trend towards greater installations of air cooled chillers over the past decade and it is estimated that these chillers represent about 75% of chiller sales, mainly influenced by increasing range of available air cooled chillers and regulations surrounding cooling towers, waste water management, chemical treatment costs and escalating maintenance costs.

[3] From presentation by Greg Groppenbacher, November 2006.

Expected Chiller Service Life

Service life is based around the time in which a particular system or component remains in its original service application. Estimated service life of new equipment can be obtained from manufactures. For consistency the datum for chiller service life has traditionally been based on American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) "Estimates of Service Life" where chiller life is between 20 to 23 years. The changes in design, design standards, manufacturing standards, materials and installation conditions has raised a re-estimate amongst industry that believes air cooled chillers now have a life of 15 years, with water cooled chillers between 20 and 30 years. It is important to note that the energy efficiency of air cooled chillers decreases much faster that water cooled chillers over time. This is due to the corrosion that can attack the air cooled condenser fins.

1.6 Australia and New Zealand Market Players

Almost all chillers supplied in Australia and New Zealand are imported from such companies as Trane, Carrier, McQuay, York, Airwell, Cooline, Matsu, MTA, and Daikin. Fluid Chillers, Sharpe & Rendry and PowerPax manufacture chillers in Australia. It is estimated that there are approximately 18 suppliers of chillers in Australia and New Zealand.

It would appear, with the exception of PowerPax the local manufacturers focus on the lower capacity market (< 300 kWr). It is estimated that chillers under 350 kWr represent about 10% of the water chillers to the commercial sector. Many of the smaller chillers are used in industrial applications. Table 22 (Appendix 4) provides the market shares by technology and by cooling capacity in year 2000.

2 The Problem

The United Nations Framework Convention on Climate Change (UNFCCC) was agreed in 1992 and came into force in 1994. It places much of the responsibility for taking action to limit greenhouse gas emissions on the developed countries, which are collectively referred to as Annex 1 countries, including New Zealand and Australia. Annex 1 countries are required to report each year on the total quantity of their greenhouse gas emissions and on the actions they are taking to limit those emissions.

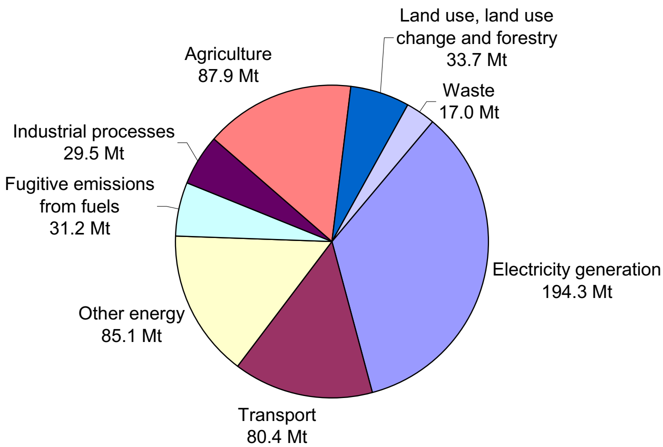
The Kyoto Protocol to the UNFCCC was agreed in December 1997, and came into force in 2005. Australia ratified the Kyoto Protocol on 3 December 2007 and has committed to reduce its greenhouse gas emissions by 60% of 2000 levels by 2050.

New Zealand ratified the Kyoto Protocol on 19 December 2002, and has committed to reducing its greenhouse gas emissions back to 1990 levels, on average, over the period 2008 to 2012 or to take responsibility for any emissions above this level if it cannot meet this target. The introduction of minimum energy performance standards for inefficient energy consuming equipment continues to form part of Australia and New Zealand's climate change strategy.

2.1 Energy and Greenhouse Gas Emissions

Figure 2 shows estimated Australian greenhouse gas emissions by sector for 2005. The estimated total greenhouse gas emissions for 2005 are 559.1 million tonnes of CO_2-e (NGGI 2007). The electricity sector represents the greatest contribution to Australia's greenhouse gas emissions, as illustrated in Figure 2.

Figure 2: Australian Greenhouse Gas Emissions by Sector 2005 (Source: NGGI 2007)



The largest contribution to stationary energy emissions comes from the generation of electricity (69.5%). Electricity generation accounted for 194.3 Mt or 34.7% of national emissions in 2005. Electricity generation emissions increased by 0.7 Mt (0.4%) from 2004 to 2005, and by 64.8 Mt (50.1%) from 1990 to 2005.

The Australian Bureau of Agricultural and Resource Economics projects total electricity use to increase by an average of 2.2% p.a. between 2004/05 and 2010/11 (ABARE 2006). Electricity use in the residential sector is projected to account for around 23% of the increase in total electricity use over the period to 2030. Slowing, and ultimately reversing, the growth in electricity-related emissions is thus a high priority in Australia's greenhouse gas reduction strategy.

In New Zealand, thermal electricity generation accounted for 24.5% of CO_2 emissions from the energy sector in 2005. In 2005, emissions from this source increased significantly by 35.2% compared with 2004 due to increased consumption of coal (MED NZ 2006). In total, thermal electricity generation produced almost 8 Mt CO_2-e in 2005. Total greenhouse gas emissions from the energy sector is projected to grow by about 30% between 2005 and 2030 (MED NZ 2006b).

2.2 Contribution of Chillers to Energy Use and Emissions

Like any electrical appliance, the contribution of chillers to energy use and emissions is a function of number of units in operation, technical attributes of the units, and usage behaviour of the users.

Total Chiller Market

As previously discussed, there are an estimated 21,000 chillers operating in Australia and 4,200 in New Zealand, with an annual growth in stock of around 1000 units pa in Australia and 200 units pa in New Zealand.

The net annual energy consumption of all chillers for the in 2006 is estimated at 4,900 GWh/yr in Australia and 790 GWh/yr in New Zealand. The net energy resulting from the use of chillers is projected to grow to over 8,310 GWh/yr in Australia and 1,330 GWh/yr in New Zealand by 2020.

Table 1 provides the estimated net energy consumption for all Australian states and territories, Australia as a whole, and New Zealand for the years 2000 to 2020 under the BAU conditions. The total estimated net energy consumption by size category and type of chiller is shown in Figure 3 for Australia and Figure 4 for New Zealand. Figure 5 provides the estimated GHG emissions by product category in Australia and Figure 6 for New Zealand.

Table 1: Net annual BAU energy consumption of Chillers by States, Australia as a whole and New Zealand (GWh)

YEAR	NSW & ACT	NT	QLD	SA	TAS	VIC	WA	AUST	NZ
2000	1,325	51	1,028	280	52	746	390	**3,872**	**622**
2001	1,373	53	1,065	290	54	774	404	**4,013**	**645**
2002	1,426	55	1,107	301	56	804	420	**4,169**	**670**
2003	1,484	58	1,152	314	58	837	437	**4,339**	**697**
2004	1,547	60	1,201	327	61	872	455	**4,523**	**727**
2005	1,614	63	1,254	341	63	910	475	**4,720**	**758**
2006	1,685	65	1,309	356	66	950	496	**4,928**	**792**
2007	1,760	68	1,368	372	69	993	518	**5,147**	**827**
2008	1,838	71	1,428	389	72	1,037	541	**5,376**	**864**
2009	1,919	75	1,492	406	75	1,083	564	**5,613**	**902**
2010	2,002	78	1,557	424	79	1,130	589	**5,858**	**941**
2011	2,088	81	1,623	442	82	1,178	614	**6,108**	**982**
2012	2,174	85	1,691	460	85	1,227	639	**6,361**	**1,022**
2013	2,261	88	1,758	478	89	1,276	665	**6,615**	**1,063**
2014	2,346	91	1,825	497	92	1,324	690	**6,865**	**1,103**
2015	2,430	95	1,890	514	96	1,371	715	**7,110**	**1,143**
2016	2,511	98	1,953	531	99	1,417	738	**7,347**	**1,181**
2017	2,590	101	2,015	548	102	1,462	762	**7,581**	**1,218**
2018	2,671	104	2,078	565	105	1,508	786	**7,816**	**1,256**
2019	2,754	107	2,142	583	108	1,554	810	**8,059**	**1,295**
2020	2,840	110	2,210	601	112	1,603	835	**8,313**	**1,336**

Figure 3: Net annual BAU energy consumption by Product Categories - Australia

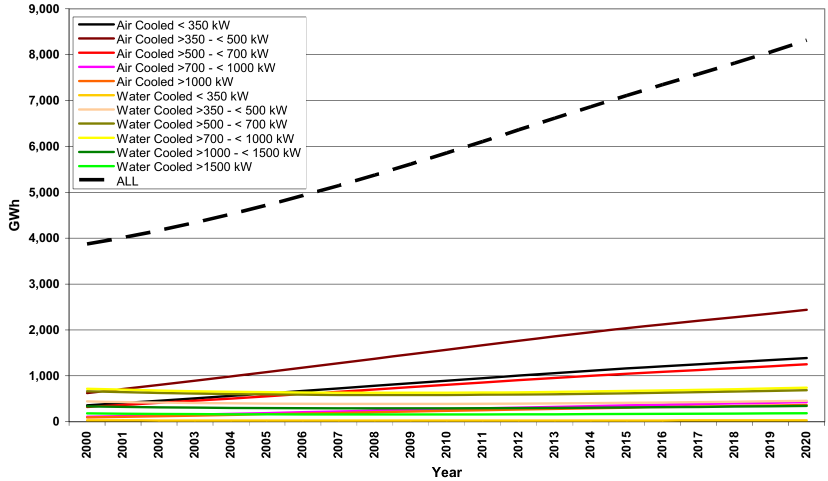
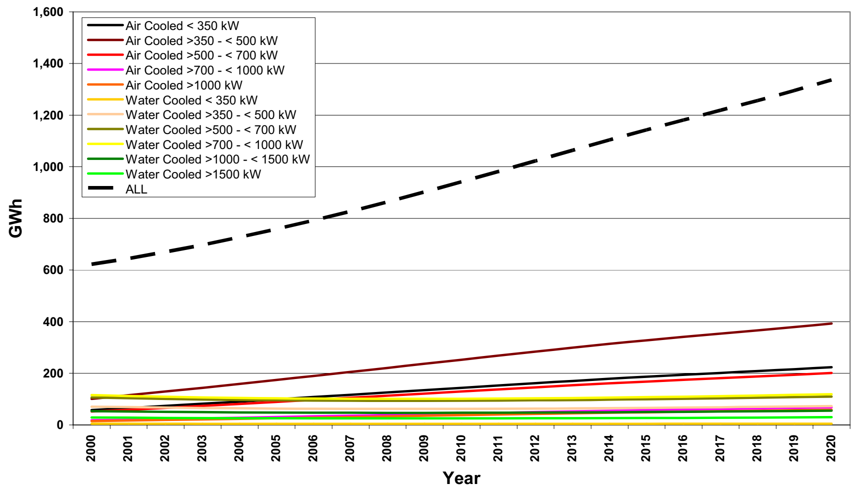


Figure 4: Net annual BAU energy consumption by Product Categories – New Zealand



It is evident from Figure 3 and Figure 4 that the growth in net annual energy, which is closely related to annual sales, is relatively constant from 2000 to 2020.

Figure 5: Annual BAU GHG emissions by Product Categories – Australia

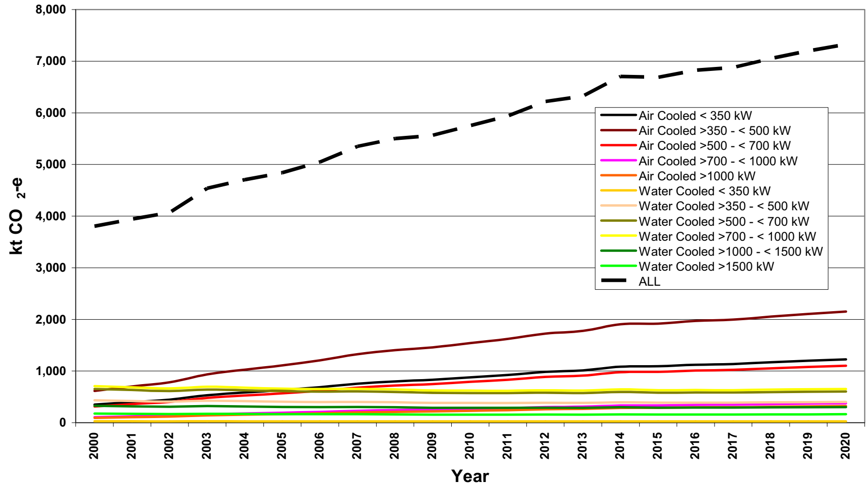
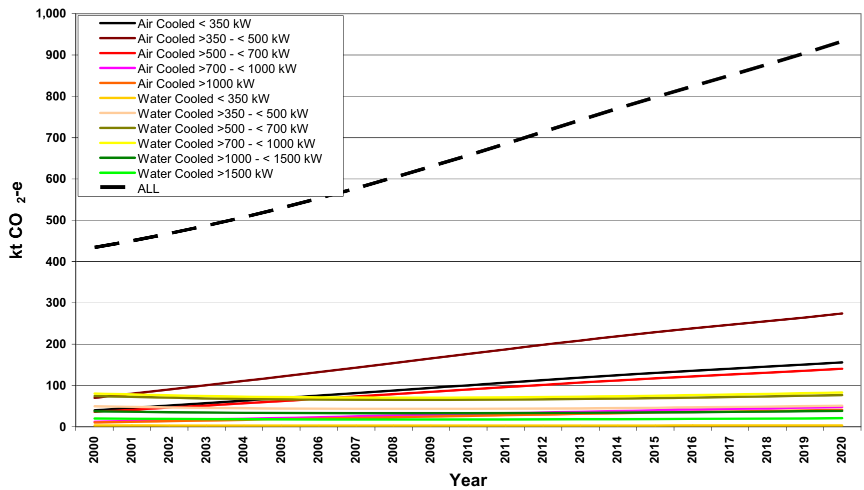


Figure 6: Annual BAU GHG emissions by Product Categories – New Zealand



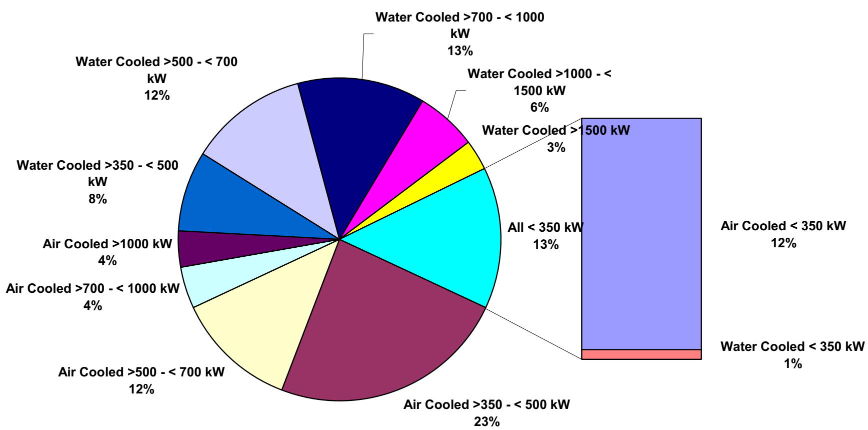
Currently the overall electricity used by chillers accounts for nearly 9% of total commercial electricity usage in Australia (EMET 2004). The share of chiller energy use of overall commercial sector energy consumption is expected to rise to 10% by 2010. Similarly, for Australia the share of chillers of overall electricity-related GHG emissions is expected to grow from 2.6% in 2006 to 3.3% in 2020.

In New Zealand the overall electricity used by chillers accounts for 20% of total commercial/storage sector electricity usage in 2002 (EECA 2007). Therefore, the share of total electricity related GHG emissions in New Zealand from chillers is approx 2.3% in 2002.

Chiller Energy Consumption by Size and Type

The focus of the proposals to improve the energy efficiency of chillers is for those of large capacity where the vast majority are installed in commercial buildings. Therefore it is important to examine the contribution to the total energy consumption of chillers by size range. Figure 7 shows the estimated share of total BAU energy consumption by category of chiller in 2006. The figure shows that chillers of less than 350 kWr contribute to only 13% of the total energy consumption for chillers in Australia, which justifies the focus of potential policy options on the larger units (<350 kWr). Further development of policy options for this smaller chiller market will be considered in 2008 and 2009 as greater testing capacity is established in the Australia/New Zealand region and explained in Section 4.7.

Figure 7: Share of net annual BAU energy consumption by Product Categories: 2006 Australia



2.3 Chiller Technologies and Energy Efficiencies

Preliminary research of the Australian market shows that chillers being sold in Australia and New Zealand are generally of lower efficiency than the USA and other countries where a MEPS applies. Internationally, the range of efficiency for commercial chillers is wide and there is scope for improvements to energy efficiency.

Range of Chiller Efficiencies

Chiller efficiency is measured as Coefficient of Performance (COP). COP is defined as "the ratio of the rate of heat removal to the rate of energy input". This measurement is also quoted at Full Load capacity of the chiller or at Part Load conditions. The development of the Integrated Part Load Value (IPLV) when assessing the performance and efficiency of chillers is significant especially considering that operation is usually at 'off design(99%)' rather than 'design conditions (1%)' for a majority of its operating time. The IPLV provides a single measure of efficiency weighted by the amount of time operating at full and part load conditions.

It would appear that a majority of chillers now benchmark their ratings, capacity and efficiency, against current international test procedures and standards. The main driver for this process has been the need to assure consistent treatment for ratings of similar products by the industry in general. The majority of chiller equipment is rated and tested according Air-Conditioning and Refrigeration Institute (ARI) 550/590 or the EUROVENT Certification Programme (EURVENT[4]) procedures. In the USA their efficiency levels are benchmarked against ASHRAE Standard 90.1 which is a "proxy" MEPS for Chillers in the USA, and applies to new building construction.

In Australia, based on surveys of major suppliers, the estimated average efficiency for Australian chillers are shown in Table 2. This Australian survey data reveals that the average efficiency for Australian chillers are already exceeding the BCA/NZ Building Code requirements, for all chiller sizes except water cooled >1000 kWr. However, the data also reveals that in comparison with the ASHRAE Standard 90.1 benchmark (see Table 19 page A-8), Australian chillers are consistently less efficient than this de facto international benchmark.

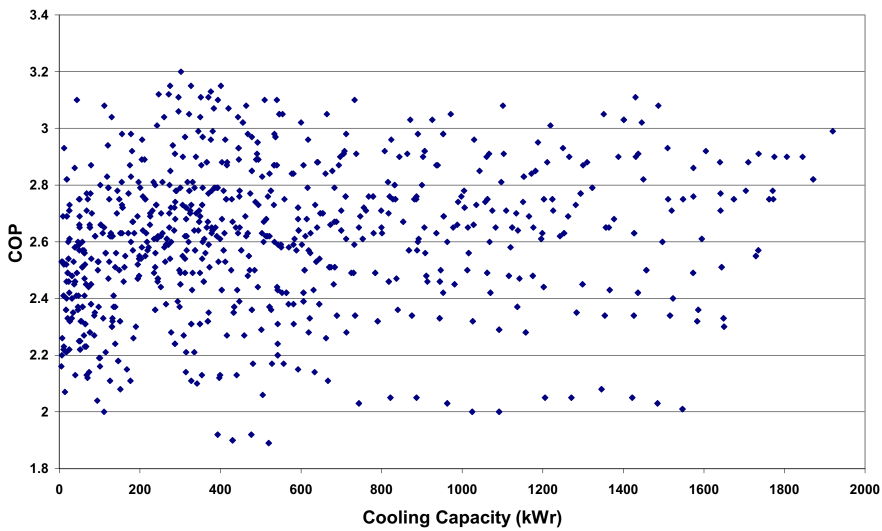
4 EUROVENT is an organisation to representing the European ventilating, air conditioning and refrigeration manufacturers and national trade associations on international and European issues

Table 2: Chiller Efficiency in Australia (estimated from surveys 2006-07) & BCA MEPS

Chiller Type	Capacity (kWR)	Average COP of Australian Units	BCA/NZ Building Code MEPS
Air Cooled	≤ 350 kWr	2.47	2.20
	>350 - ≤ 500 kWr	2.55	2.20
	>500 - ≤ 700 kWr	2.55	2.50
	>700 - ≤ 1000 kWr	2.63	2.50
	>1000 kWr	2.63	2.50
Water Cooled	≤ 350 kWr	4.23	4.20
	>350 - ≤ 500 kWr	4.63	4.20
	>500 - ≤ 700 kWr	4.77	4.50
	>700 - ≤ 1000 kWr	5.07	4.50
	>1000 - < 1500 kWr	5.23	5.50
	>1500 kWr	5.50	5.50

The range of efficiency for chillers is large with COP for air cooled chillers ranging from 2 to 3.2. Figure 8 shows the range of efficiency by capacity for air cooled units registered on the EUROVENT database in Europe. The chiller suppliers in Australia and New Zealand have confirmed that majority of the units registered in Europe by their organisations are available in Australia. This distribution also reveals that the vast majority of air cooled chillers already exceed the BCA/NZ Building Code requirements.

Figure 8: Chiller Efficiency (COP) of Air Cooled Units by Capacity



Source: EUROVENT 2006

Chiller Efficiency and Australian and New Zealand Building Standards

In order to improve the overall energy efficiency of commercial buildings, a MEPS for chillers has been introduced into the Building Code of Australia and proposed in the New Zealand Building Code (NZBC). The MEPS levels for Australia and New Zealand are the same and are shown in Table 3.

Table 3: Building Code of Australia and Proposed NZ Building Code MEPS

Chillers	Capacity (KWr)	Min COP	Min IPLV
Air Cooled	>125- ≤ 525 kWr	2.20	3.05
	>525 kWr	2.50	3.10
Water Cooled	>125- ≤ 525 kWr	4.20	5.20
	>525- ≤ 1000 kWr	4.50	5.60
	>1000 kWr	5.50	6.10

The use of MEPS for chillers in the Building Code of Australia (BCA) and the NZBC will provide some help to improve the efficiency level of some Australian/NZ chillers, but the use of the Standards has some limitations, including:

- The Building Code of Australia (ABCB 2006a) and the NZBC is applicable to new buildings, and so will not affect the replacement of chillers in existing buildings which constitute about 40% of annual chiller sales.
- As shown in Table 3, the average efficiency for Australian chillers are already exceeding the BCA/NZ Building Code requirements, for all chiller sizes except water cooled >1000 kWr. This means the Standards will eliminate only a small proportion of chillers of below average efficiency. The distribution of air cooled chillers shown in Figure 8 also indicated the efficiency of the vast majority of chillers already exceeds the BCA Standards.
- The BCA/NZBCA MEPS is not set at current best practice efficiency levels for chillers, as defined by the ASHRAE Standard 90.1.

These limitations on the impact of the Building Standard suggest that though the Standards should eliminate the worst of the inefficient chillers from being installed in new buildings, this will only affect a small proportion of chillers and greater efficiencies could still be achieved.

Chiller Cost versus Efficiency

For chillers with capacity between 350 and 1000 kW, the additional cost of choosing a higher efficiency unit over standard efficiency is between 12% and 20%. This is estimated based on the results of surveys of key chiller suppliers. This implies that energy savings over the life of the chiller would need to produce energy cost savings greater than 12-20% of the cost of the chillers to produce a positive net cost benefit.

On the basis of overseas markets, particularly Canada and the USA, studies have found cost effective efficiency improvements are achievable. In Canada (NRCan 2003), a benefit-cost analysis was undertaken to determine the economic attractiveness of improving the energy efficiency of packaged water chillers. Following this study, NRCan decided to go ahead and adopt the proposed minimum energy performance standards.

Testing Standards for Chillers

A new standard is under development that defines the methods of measuring and rating the efficiency of liquid-chilling packages using the vapour compression cycle and will be published as AS/NZS 4776.1.1:200X and AS/NZS 4776.1.2:200X (Standards Australia 2007). This standard is based on ISO document PWD 19298-1. The method of test and rating is also directly comparable to the ARI 550/590 and the method required for registration to the EUROVENT certification programme.

2.4 Assessment of Market Deficiencies and Failures

The choice of a chiller can affect the energy usage requirements of a building, with case studies in the USA showing US$10,000s pa of saving due to the replacement of inefficient chillers (DOE 2000, DOE 2004). Given the similarities in building stock and chiller equipment in the USA and Australia, plus the generally higher electricity prices in Australia, these case studies suggest the choice of chiller will have similar or greater energy cost impacts in Australia. As the installation of more energy efficient chillers need not lead to higher initial installation costs, it would appear the market should automatically move towards the installation of more efficient chillers. However, there are several factors which contribute to deficiencies in the chiller market and make this outcome less likely, these being:

- A developer may manage the construction of the building with the intention of selling it, so they have no direct motivation to choose the most efficient technologies for the building.
- Many commercial buildings are tenanted, so the landlord may have no direct motivation to choose the most efficient technologies for the building, as energy costs will be passed through to the tenants.
- Tenants, who could be motivated to choose efficient chillers, have no influence over building infrastructure decisions.
- Chillers may be chosen and installed by sub-contractors, to meet design specifications, but unless these specifications include energy efficiency requirements the sub-contractors will not be required to choose the most energy efficient chiller.
- There may be a lack of knowledge in the market of the energy and cost impact of choosing efficient versus inefficient chillers, reducing the likelihood of more efficient chillers being chosen.

These issues are well recognised in the industry, as supported by recent extensive industry research, presented in a discussion paper concerning HVAC and efficiency prepared for the Equipment Energy Efficiency Committee, Canberra, (Energy Strategies, 2006). This paper summarises the energy efficiency situation with regard to HVAC as 'there is currently no robust market mechanism to motivate of reward designers and builders for the performance of their builders in the performance of their buildings'. They further note that there is 'no clear economic link between investments in energy efficiency by the construction industry and the commercial buildings sector, and the beneficiaries of energy efficiency, such as building tenants' *(page 7)*.

The result of this disconnect between the rewards of choosing energy efficient chillers, i.e. lower energy costs, and the authority to select the chiller, means cost-efficiencies alone will not be sufficient to drive the uptake of more efficient chillers.

The Australian Building Codes Board recently introduced regulations to enforce the energy efficiency provisions for commercial buildings, and assessed the market failures in the associated RIS (ABCB 2006b). They state:

> *"Market forces are unable to deliver optimum outcomes due to split incentives (owners/builders incur costs while occupiers reap the benefits), lack of full information on which to make sound decisions, and because the energy users are not directly charged for the cost of the adverse environmental impacts of energy consumption, particularly climate change."* (page i)

The ABCB statement and justification for regulatory intervention supports the assessment of the market failures in the commercial building market.

To examine the degree of influence of the major market deficiencies, consideration needs to be given to the market characteristics of owner occupied commercial property vs tenanted property. Purchases of chillers by developers of tenanted property are likely to be influenced by capital cost of their purchases rather than the on-going energy costs as noted earlier. In this case the purchase decision is being made by a party who is not particularly concerned about the running costs of the chiller (i.e., there are split incentives).

The total value of the commercial property market likely to utilise chillers (Office and Retail) in Australia is $179 billion, of which the owner occupied component is estimated at $32 billion (Higgins 2007). This would suggest that some 82% of the market is occupied by tenants where the applicable market barrier is the split incentive. Therefore the alternative strategies will need to consider this market barrier as the dominant barrier to be addressed.

3 Objectives of Strategies

3.1 Objective

The objective of the proposed strategies for chillers is to bring about reductions in Australia's and New Zealand's greenhouse gas emissions below what they are otherwise projected to be (i.e. the "business-as-usual" case), in a manner that is in the broad community's best interests.

To be effective for manufacturers and suppliers the proposed strategy should be in accord with international test methods and marking requirements as these are internationally traded goods.

Within the objective, it must also provide a broad positive financial benefit to end consumers, without compromising product quality or functionality.

4 Proposed Strategies

The range of potential strategies considered for achieving the objective of reducing the power consumption of chillers including:

- Status Quo or business as usual;
- Voluntary efficiency standards;
- Voluntary certification program;
- Levies and emissions trading;
- Dis-endorsement labelling;
- Mandatory energy labelling
- Mandatory Energy Performance Standards.

These options will be discussed below.

4.1 Status Quo (BAU)

Net energy consumption from all types of chiller products in Australia is currently estimated to be approximately 4,900 GWh per annum, equivalent to annual greenhouse emissions of 5 Mt CO_2-e in 2006. Correspondingly the net energy consumption from all types of chiller products in New Zealand have been estimated to be approximately 790 GWh per annum, equivalent to annual greenhouse emissions of 550 kt CO_2-e in 2006.

If the current market and technology trends continue, the net energy resulting from the use of chillers is projected to grow to over 8,310 GWh in Australia and around 1,330 GWh in New Zealand by the year 2020. These estimated BAU projections of energy usage depend on assumptions and data regarding the sales, power consumption and usage characteristics of chillers. Detailed projections of sales are provided in Section 5.5, while Appendix 6 and Appendix 12 provide the power consumption and usage characteristics. Industry source noted that further technology improvements to chillers will have little effect on improving the efficiency, and that all improvements have now been extracted from these mature technologies. New types of chillers with improved efficiency are available that improve the part load performance. Industry reported that the improvement in efficiency of chillers sold has been relatively small for the last 7 years. However, in recognition of the probable impact of the BCA/NZBCA MEPS for new buildings in eliminating the worst performing chillers, some annual improvement in the efficiency of installed chillers has been assumed.

In summary, the BAU COP for chillers by category was assumed to improve by 0.25% pa over the period of the analysis (2000 – 2020), with the figures shown in Table 2 used for the BAU scenario. The BAU efficiency improvement is within the range of natural efficiency improvements used in previous air conditioning sector RIS studies in recent years. The suppliers consulted in preparing this RIS are shown in Section 6 and represent the vast majority of chillers sold in Australia and New Zealand.

Usage of chillers at various loadings is based on consultation with Australian / New Zealand suppliers listed in Section 6. Alternative analysis of the usage data is conducted to test the degree of sensitivity these inputs have on the RIS. The BAU scenario assumes that usage does not change over the forecast period and the sensitivity of this variable is tested in Section 5.4. As noted above, BAU efficiency is forecast to increase by 0.25% pa over the period 2000 – 2020.

Table 1, page 14, provides the estimated net energy consumption for all Australian states and territories, Australia as a whole, and New Zealand for the years 2000 to 2020 under the BAU conditions.

4.2 Voluntary Efficiency Standards

Voluntary efficiency standards are a policy option that encourages equipment suppliers and/or manufacturers to voluntarily meet certain minimum energy efficiency levels, i.e. in the absence of regulation.

This option can be effective when there are a relatively small number of suppliers with highly similar products and they are willing to agree to the introduction of the voluntary efficiency standards for a product. This may occur when the few suppliers perceive there will be advantages in meeting such standards in terms of public relations and brand positioning. However, when there are large numbers of suppliers it is more difficult to obtain agreement to the voluntary efficiency standards from a sufficient number of suppliers for the voluntary efficiency standards to have a significant impact on the energy efficiency of the products entering the market.

It is estimated that there are 15 importers and three local manufacturers of chillers serving the Australian market and 8 importers in New Zealand. Therefore to introduce voluntary efficiency standards, it would be necessary to convince the majority of importers of these chillers to voluntarily impose restrictions on the equipment they will import to Australia. Given that Australia will constitute a very small minority of these suppliers' overall market, it is not realistic to believe that these suppliers will agree to voluntary standards. Consultation with industry stakeholders from a wide range of supplier companies (both those that supply the larger chillers and those who supply smaller chillers) supported this view. The suppliers as a group (shown in Section 6) noted in the meetings during 2004 to 2007 that:

- Mandatory MEPS should be implemented for Australia
- A voluntary program might be effective in raising awareness for energy efficiency issues. However, it was generally felt that without code and legislative reinforcement there was no ongoing incentive to maintain compliance, especially from what is considered the "bottom end" of the chiller market place.

Compliance with a voluntary approach is an issue as the introduction of the voluntary efficiency standards could result in suppliers being required to decrease their model ranges to eliminate less efficient models, or to upgrade these models to meet the voluntary efficiency standards. There are few or no commercial incentives for suppliers to do this, especially as Australia and New Zealand are such a relatively small market, so it is unlikely that all suppliers would be willingly make these changes without significant government incentives. Also suppliers that agree to meet the standard may be placed at a commercial disadvantage compared to suppliers that do not participate, as non-participants might be able to sell their appliances at a price advantage, thus potentially increasing the net energy consumption of chillers.

There appear to be no international examples of voluntary energy efficiency standards relating to chillers.

Although in certain circumstances, voluntary agreements can be effective, as found by the World Energy Council in it's *Energy Efficiency: A Worldwide Review Indicators, Policies, Evaluation* (WEC 2004) The report found

> *"In certain conditions, voluntary agreements can be an effective alternative to minimum energy efficiency standards. Since they have the support of manufacturers, they can be implemented more rapidly than regulations. Nevertheless, their effectiveness is still dependent on the possibility of imposing precise requirements corresponding to genuine additional efforts from industry. To achieve this, the free flow of information should be ensured. Above all, the regulations must remain credible if negotiating power is to stay in the hands of the public authorities." P47*

The World Energy Council went on to conclude that results of past voluntary agreements are in many cases uncertain and that they are *"…more suited as complementary to other existing regulations, rather than being the prime policy instrument to address energy efficiency and climate change"*(WEC 2004, p67)

A detailed analysis of the cost and benefits of voluntary efficiency standards has not been undertaken due to the lack of information from industry on the costs and likely impacts of such a program and because such a voluntary program is considered unlikely to be effective.

4.3 Voluntary Certification Program

A voluntary electrical performance certification program involves suppliers submitting their products for objective testing and, if the products perform satisfactorily, then the products can be labelled as 'certified' to fulfil the required energy efficiency performance requirements or listed as certified products on a relevant website etc. The intention is that this provides information and encouragement for customers to purchase more efficient products and motivates suppliers to improve the efficiency of their products.

Internationally, manufacturers of chillers have participated in the testing and rating of their products by using standards such as Air-Conditoning and Refrigeration Institute (ARI) who represent the North American suppliers and EUROVENT, who represent the European air conditioning, ventilating and refrigeration manufacturers.

The purpose of these rating or "certification programmes" is to create a common set of criteria for rating products. Through specification of certified products, the engineer's tasks are made easier, since there is no need for carrying out detailed comparison and performance qualification testing. Consultants, specifiers and users can select products with the assurance that the catalogue data is accurate.

These international programs do not act as certification programs in the sense of signifying that the products have meet a specific minimum energy efficiency requirement. The program acts to test and rate the performance of the chillers against agreed international standards.

As the majority of chillers installed in Australia/New Zealand are imported, we can assume that these will have been "certified" as the chillers will have been made in or are to be sold in the European or USA markets. Consequently it might be possible to convince all chiller importers to use the "certified" ratings of the chillers to develop a voluntary certification program for the Australian and New Zealand market. "Certified" products could be listed on a website and an education campaign conducted in the industry to raise awareness of the certification program. For Australian manufacturers some method of testing and certifying their chillers would need to be developed but this is probably possible.

The difficulty with the voluntary certification program is that like other voluntary information-type programs, there is a tendency for only the better performing products to participate in the program in an attempt to gain a marketing advantage over cheaper and poorer performing products. There is no market advantage for less efficient products to participate in the program, or even for producers to participate who have products that vary from efficient to less efficient, so any program is likely to cover only a proportion of the chillers available.

Another difficulty for a voluntary certification program is that this type of program will work best in a market where consumers are actively looking for efficient products but, as previously discussed, the energy efficiency of chillers is unlikely to be the primary driver in the selection of most chillers according to chiller suppliers. Although there are voluntary building rating schemes operating in Australia (such as Green Star), the success of these programs are not yet assessed. Currently 38 projects have been Green Star certified, which represents only a fraction of the commercial sector. The RIS for the energy efficiency provisions in the BCA (ABCB 2006b, p6) also notes that energy efficiency is regarded to have, at most, a minor influence on the rents that can be charged. On the basis of this evidence, it is likely that there is no strong underlying market driver which a certification program can tap into and use to produce a market transformation towards the use of more efficient chillers.

There is also no evidence that voluntary certification programmes internationally are effective. In Europe the success of the voluntary EURVENT certification programme for chillers has not been assessed. While in the USA, the ARI certification program is used by most of the suppliers in the chiller market, as the USA enforces building code provisions (ASHREA 90.1) that require the suppliers of chillers to test and rate their products to the ARI standard. In addition, several USA electric utilities offer rebates for energy efficient chillers, when certified to ARI requirements. Hence, chiller suppliers participate in the USA certification program to enable their product to be considered under the mandatory building code and to obtain rebates for their customers where applicable. No such requirement is enforced in Australia or New Zealand.

4.4 Dis-endorsement Label

The principle of a dis-endorsement label is to highlight that a product is energy inefficient. Manufacturers and suppliers will not apply such a negative label on their products voluntarily, so this must be a mandatory scheme. Manufacturers and suppliers would be expected to strongly oppose the introduction of such a scheme.

A dis-endorsement label is very unlikely to be effective for chillers, as chillers are not a retail item but are sold on the basis of their technical specifications and price. Consequently the label would not be seen until the product is being installed, and it would only be seen by the installation contractor and probably not by the end-purchaser, the building owner or developer. The resulting impact of the dis-endorsement label scheme is therefore likely to be minimal.

The introduction of a dis-endorsement label program would therefore appear to be unjustified and inappropriate in Australia and New Zealand.

4.5 Levies and Emissions Trading

One way of increasing the uptake by the market of more energy efficient chillers is to increase the purchase cost or operating costs of the inefficient products from the consumer's perspective. This can be done by raising the price of the chillers via a levy or by raising the price of the energy the product consumes. Both options will be discussed.

Equipment Levy

The equipment levy involves imposing upon inefficient models a levy which would raise the prices of the chillers. The funds raised could be used to fund programs which would reduce the greenhouse impact of using the chillers. The revenue raised from the levy could be diverted to greenhouse-reduction strategies unrelated to the efficiency improvement of the chillers or used to subsidise the costs of more efficient models of chillers in order to reduce any cost differentials between these and inefficient models.

There are significant issues surrounding the measurement of chillers, the costs of collecting such a levy and the allocation of the resulting funds which would need to be addressed in order to implement this option. It is also unclear how such a levy scheme could be efficiently managed and whether the costs of implementing such as scheme could be justified in terms of its impact. It is also understood that the use of such levies are not currently government policy, so this option will not be considered further.

Electricity Levy

At present, electricity prices are sufficiently low that energy efficiency has not been a critical issue in the design of heating and cooling systems for buildings and in the selection of chillers. This is especially true when new buildings are being developed to be sold or for tenanted buildings. The imposition of a government levy on electricity prices or the introduction of emissions trading would raise the developers, building owners and tenants' consideration of the energy efficiency of buildings and hence chillers and might encourage the uptake of more efficient chillers.

A low level electricity levy is currently already applied in New Zealand. The revenue from this levy is presently used to fund the operations and functions of the Electricity Commission, including some targeted electricity efficiency research and capital upgrade projects. However, none of these projects currently relate to the use or efficiency of chillers.

Carbon Emissions Trading Scheme - Australia

In 2007, the Australian Government formally announced its intention to introduce a Carbon Pollution Reduction Scheme (CPRS) (previously known as the Emissions Trading Scheme) by 2010. Economic literature suggests such a scheme can be used as an effective policy tool for internalising the costs associated with greenhouse gas emissions. However, even under a CPRS, there may still be a role for complementary policies.

Energy efficiency measures have been proven in some circumstances as a cost-effective method for households and businesses to reduce energy consumption while delivering greenhouse gas abatement. All other things being equal, the increase in costs of energy resulting from a CPRS should encourage households and businesses to improve the efficiency of their energy use. However, in some instances, market failures and/or other factors may act to mitigate some of the impacts of a CPRS, and therefore complementary energy efficiency measures may be appropriate.

For example, the presence of split incentives (such as between building owners and tenants) may lessen the effectiveness of a CPRS in delivering an 'optimal' investment in energy efficiency in tenanted dwellings.

In other instances, the transactions costs of investing in energy efficiency may outweigh the marginal benefits of such investments, even in a CPRS environment. For example, the potential energy savings to consumers may be small, relative to the time and effort required to calculate the associated life cycle costs when purchasing a product. In this circumstance, it is possible that a CPRS will not deliver an optimal investment in energy efficiency. A similar situation can arise if there is imperfect information, such as a lack of comparative energy consumption data on energy bills.

Taking into account the above factors, in some situations it is possible that the increase in electricity prices induced by a CPRS may result in a relatively small rise in demand for energy efficient products. Therefore it is possible that the carbon abatement costs induced by complementary energy efficiency measures may be lower than those induced solely under a CPRS. In such cases, it may be beneficial to consider energy efficiency policies, including MEPS and energy labelling, in conjunction with a CPRS.

The nature of the CPRS and the impact on the costs and benefits of the proposed policy approach for chillers cannot be determined until the Government has decided operational details of the ETS and until modelling of future electricity prices is available. The impact of a CPRS on the RIS analysis is discussed in Section 5.6 and Appendix 7. However, it is unclear if an CPRS alone would impact on the energy efficiency of chillers. The energy price rises that might flow from the introduction of a CPRS are unlikely to quickly lead to purchasers and installers of chillers being concerned about the energy efficiency of chillers. Such energy price raises probably would encourage over time investment in energy efficiency actions in the owner-occupied building sector, but most chillers are used in the tenanted building sector. As previously noted, the lack of a robust economic link between the investment of purchasers/installers of chillers and the economic gains from improved energy efficiency for building tenants, would greatly weaken the impact of an CPRS on investment in efficient chillers, even if the CPRS did lead to significant energy price rises.

Hence it is concluded that even if the CPRS was to significantly increase energy prices; due to many commercial buildings being tenanted, this would not create any immediate motivation for developers/investors to purchase more efficient chillers. Consequently a CPRS on its own is unlikely to affect chiller energy performance or market take-up of efficient chillers, without other market change occurring.

As the Task Group in the *Report of the Task Group on Emissions Trading* (Australian Government 2007) noted regarding the emissions trading scheme:

> *"Emissions trading is not a panacea. A comprehensive response will involve complementary measures that address market failures not corrected by the emissions trading scheme. ... There will also be a continuing role for policies that improve information, awareness and adoption of energy-efficient vehicles, appliances and buildings." (p 12)*

New Zealand Emissions Trading Scheme

In September 2007, the New Zealand Government announced an in-principle decision to use an Emissions Trading Scheme as its core price-based measure to reduce greenhouse gas emissions and enhance forest carbon sinks.

The Government proposes to implement the scheme from 2008, with various sectors phased in over the years to 2013. It is proposed that the first sector included will be forestry, followed by liquid fossil fuels, then stationary energy and industrial processes, followed by agriculture, and waste. New Zealand units are expected to be the primary domestic unit of trade and the scheme would allow purchase from, and sale to, international trading markets.

Feedback from stakeholders and Maori will inform subsequent decisions on the design of the scheme and the ultimate form of legislation required to implement the scheme.

The scheme is one of a range of policies and measures to reduce domestic greenhouse gas emissions and contribute to sustainable outcomes for New Zealand. Together such measures are intended to bring New Zealand's net emissions below business-as-usual levels and comply with New Zealand's international obligations, including existing commitments under the Kyoto Protocol.

The scheme is intended to shift New Zealand's economy towards investing in and consuming goods and services with lower greenhouse gas emissions (e.g. investment in energy efficiency and renewable energy generation). This will be achieved by making the price of greenhouse gas emissions a factor in the decisions of both producers and consumers.

4.6 Mandatory Energy Labelling

Mandatory energy labelling requires the application and display of a comparative energy performance label on products and packaging. It is to provide consumers with a visual display of the performance of one product relative to another. Energy labelling requires the establishment of relative energy levels and a rating system.

As chillers are not sold to consumers but are a business product, sold on the basis of their technical specifications and price, energy labelling is highly unlikely to affect the market for more efficient chillers. Also the label would not be seen until the product is being installed, and it would only be seen by the installation contractor and probably not by the end-purchaser, the building owner or developer. The resulting impact of the mandatory energy labelling scheme is therefore likely to be minimal.

Mandatory Energy labelling for chillers therefore is not considered likely to influence the purchase decision of chillers and so this strategy is not assessed any further.

4.7 Mandatory Minimum Energy Performance Standards

Minimum Energy Performance Standards (MEPS) aim to remove the worst performing products from the marketplace, rather than promoting the best. In Australia and New Zealand, this is achieved by including the energy performance criteria within an Australian/New Zealand Standard which is mandated through legislation. A proposed MEPS that covers all chillers with capacity of $\geq$ 350 kWr is described in the following section.

As Australia and New Zealand suppliers source product that is typically rated under the USA/EUROVENT test method and the USA now have introduced the most stringent international MEPS levels, it is proposed to match the USA and Canada MEPS levels for chillers in Australia. Table 4 shows the proposed MEPS levels, based on the USA MEPS and taking into account the simplification of these levels to cover all air cooled and all water cooled chillers with capacities greater than or equal to 350 kWr.

The decision to apply the proposed MEPS to chillers capacity of ≥ 350 kWr was made in consultation with the Australian industry and takes into account the lack of local testing capacity for this segment of the market. No stakeholder has expressed reservations about the proposed introduction of MEPS for chillers capacity of ≥ 350 kWr and many are supportive of the introduction of the MEPS.

Further development of policy options for this smaller chiller market will be considered in 2008 and 2009 as greater testing capacity is established in the Australia/New Zealand region. Larger chillers are generally tested by the international overseas, which enables greater access to performance data and these units are typically tested for ARI or EUROVENT programs. The Australia/New Zealand local manufacturers do not currently have access to testing facilities and would incur significant costs to comply with a testing program if they have to send their models overseas for testing.

Table 4: Proposed Chiller MEPS Levels – Australia and New Zealand

Chiller Type	Capacity (kWr)	Minimum COP	Minimum IPLV
Air Cooled	< 350 kWr	Regulated in 2010	Regulated in 2010
	≥350 - ≤ 500 kWr	2.70	3.70
	>500 - ≤ 700 kWr	2.70	3.70
	>700 - ≤ 1000 kWr	2.70	4.10
	>1000 kWr	2.70	4.10
Water Cooled	< 350 kWr	Regulated in 2010	Regulated in 2010
	≥350 - ≤ 500 kWr	5.00	5.5
	>500 - ≤ 700 kWr	5.10	6.0
	>700 - ≤ 1000 kWr	5.50	6.2
	>1000 - < 1500 kWr	6.00	6.5
	>1500 kWr	6.20	6.5

Like the USA, the proposed MEPS levels apply to both the COP and the Integrated Part Load Value (IPLV).

Based on the USA and other countries such as Canada and Chinese Taipei, and as the market for Australian and New Zealand chillers is generally specified with the ARI, ASHRAE and EUROVENT standards, the Australian and New Zealand MEPS levels will ensure our product matches world best regulatory practice. The E3 Committee's operating instructions under The National Framework for Energy Efficiency are that Australia/New Zealand will set MEPS at stringency levels "to match world's best regulatory practice, but with a suitable time-lag to allow local industry to adapt", or to "lead the world with regulatory standards – where there is no significant manufacturing base and is supported by industry" (AGO 2007). In the case of chillers, it is appropriate that the MEPS will seek to match the stringency of world's best regulatory practice.

The USA have issued a revised ASHRAE 90.1-2004 which includes all the addenda issued since 1999 and revised code format. ASHRAE are again revising 90.1 standard and soon will issue a new ASHRAE Standard 90.1-2007. At this stage, the MEPS levels for chillers in the new ASHRAE 90.1-2007 are not known, but these levels could be introduced into the Australian/New Zealand Standard as the "High Efficiency" levels, similar to the levels specified for "Class A" Efficiency of air conditioners in the AS 3823.2. In addition, these high efficiency levels could form the basis of the revision to increase the stringency of the MEPS levels when the regulations are reviewed (usually after 4 years). The inclusions of the high efficiency levels will be reviewed with the appropriate standards committee as required.

4.8 Conclusions

The voluntary options presented in the earlier sections are either not effective or practical or else they are not appropriate. These alternative options are assessed as less effective at reducing GHG emissions from BAU. In addition, mandatory labelling is not a practical or appropriate for chillers.

The proposed MEPS regime for chillers is to be a mandatory scheme, which is in keeping with stakeholder feedback. When industry was consulted there was concern raised that a voluntary scheme would not be effective but a mandatory scheme produces a level playing field.

In conclusion, the most effective way to reduce GHG emissions caused by chillers is to introduce MEPS. This is the option that is subsequently assessed in this study in terms of costs, benefits and impacts on consumers, taxpayers and industry.

5 Cost-Benefit and Other Impacts

This section presents the costs, benefits and other impacts of the MEPS for chillers. Most of the assumptions that apply to Australia also apply to New Zealand as the products likely to be sold in NZ are similar to Australia. As such, results that are commonly applicable to both Australia and New Zealand do not contain a direct reference to either country. In other cases, results and discussions are provided concurrently for both countries as the analysis reflects the results based on differing conditions specific to each country. The product stock modelling framework is explained in Appendix 4: Stock and Sales.

5.1 Costs to the Taxpayer

The proposed MEPS program will impose costs on governments. Some of these are fixed and some vary from year to year. The government costs comprise:

- Administration of the program by government officials (salaries and overheads, attendance at E3 and Standards meetings etc);
- Cost of maintaining a registration and approval capability;
- Random check testing to protect the integrity of the program;
- Costs of producing leaflets and other consumer information; and
- Consultant costs for standards development, market research and analysis, Regulatory Impact Statements, etc.

The government costs have been estimated as follows, which are similar to the allocations made for other products regulated by E3:

- Salary and overheads for officials administering the program: $50,000 per year;
- Check testing, research and other costs underpinning the program: $75,000 per year, half of it borne by the Commonwealth and the other half by other jurisdictions in proportion to their population, in accordance with long-standing cost-sharing arrangements for E3 activities; and
- Education and promotional activities at $25,000 per year.

Hence total Australian government program costs are estimated to be $150,000 per annum. In addition, New Zealand government costs are estimated to be 25% of the total Australian government costs.

These costs have been included in the national cost-benefit analyses in later sections for both Australia and New Zealand.

5.2 Business Compliance Costs

Responsibility for compliance with the MEPS lies with the importer or supplier of the product. This analysis assumes that any increases in product design and construction costs will be passed on to customers in the form of higher purchase prices. The Business Cost Calculator (OBPR 2006) has been used as a basis to the calculation of the costs for compliance with the MEPS. The costs of compliance were identified as follows:

- Education – which involves maintaining awareness of legislation and regulations, and the costs of keeping abreast of changes to regulatory details.
- Permission – which involves applying for and maintaining permission for registration to conduct an activity, usually prior to commencing that activity.
- Record Keeping – which involves keeping statutory documents up-to-date.

The Purchase Cost category, which involves the costs of all materials, equipment, etc, purchased in order to comply with the regulation, was not included in the business compliance costs. This cost category was interpreted as the cost of design changes to the products to ensure that they meet the required power levels and these costs are explicitly included in the costs benefits analysis as increased purchase costs to the consumer.

Therefore the tasks, categories and costing assumptions are provided in Table 5.

Table 5: Business Cost Calculation Inputs

Category	Task	Cost Inputs	Source
Education	Train staff, keep up-to-date with regulations	80 hours/year per supplier	Estimated from other MEPS programs
Permission	Rating to EUROVENT or ARI	$500 per model supplied	Based on international sources
Permission	Complete MEPS registration	8 hours per model supplied	Estimated from other MEPS programs
Record Keeping	Maintain documents for 5 years	8 hours per 5 years per supplier	Estimated from other MEPS programs
Other inputs:		Staff costs $40/hr	*Australian Jobs 2006*

The total costs of business compliance for the MEPS are in proportion to the number of businesses importing/suppling chillers and the number of models supplied. Overall, some 350 unique models are estimated to be currently supplied from approximately 18 suppliers, or an average of approximately 20 models per supplier.

The Business Costs Calculator was used to determine the costs per business, and then these costs were allocated on a "per model" basis for the cost-benefit analysis. The RIS cost-benefit analysis models the costs on the basis of each model supplied to the market in a particular year, as this approach provides a greater certainty to the costing of MEPS. The total costs calculated are shown in Table 6.

Table 6: Business Compliance Costs for Chiller MEPS (AUD)

Category	Task	Costs / business	Costs / model
Education	Train staff, keep up-to-date with regulations	$3,200	$163
Permission	Rating to EUROVENT or ARI (proportion allocated to Australian supplier)	$9,833	$500
Permission	Complete MEPS registration	$6,293	$320
Record Keeping	Maintain documents for 5 years	$320	$16
Total		$19,647	$999

These costs represent approximately $354,000 to the Australian suppliers in the first year of MEPS, based on 18 chiller suppliers. This cost-benefit assumes that new models are introduced to the market each year and hence are required to be registered. Sensitivity analysis of these estimated costs shows that if these compliance cost increase by 100%, the effect on the cost-benefit is minimal. As the majority of importing companies already rate their chillers to ARI or EUROVENT, the permission cost is likely to be significantly lower than the amount estimated in Table 6. Appendix 13: Annual Cost Inputs for RIS Model, shows the annual cost inputs for the RIS analysis. New Zealand supplier compliance costs are in proportion on the basis of sales in New Zealand.

5.3 Industry, Competition and Trade Issues

Industry Issues

This section reviews the impacts of the proposal/s on suppliers. In the chiller product supply market, there are estimated to be approximately 18 suppliers; some are specific suppliers of particular product categories while others are multi-national air conditioning companies. The vast majority of chillers are imported into Australia/New Zealand. These importers and manufacturers vary in size, however all have some internal capacity to respond to the costs that the proposed regulations will place on them. According to industry representatives, almost all the chillers of ≥ 350 kWr capacity are imported. The majority of the chillers products are typically registered with the ARI or EUROVENT certification programmes and hence the costs of efficiency testing are already incorporated in the suppliers pricing structure. There are suppliers who are not registered in either program and they would have an increased cost to their business if they choose to join either program.

Most energy efficiency regulations envisage an increase in average equipment costs due to changes in the design of the product to improve the energy efficiency of the product. This is likely to be the case with chillers. Retail/contractor price increases due to the requirements of the chiller MEPS are modelled in the RIS and range from 12% – 22% for air cooled chillers and approximately 15% for water cooled chillers. These incremental price increases are modelled to remain constant for the analysis period. Table 7 presents the estimated incremental price increase due to the MEPS requirements by year for the base scenario modelled in the RIS, based on surveys of industry stakeholders listed in Section 6.

Table 7: Incremental Price Increase (AUD) Due to MEPS Requirements by Year

Category	2009	2010	2011	2012	2013	2014	2015	2020
Air Cooled >350 - < 500 kW	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000
Air Cooled >500 - < 700 kW	$18,000	$18,000	$18,000	$18,000	$18,000	$18,000	$18,000	$18,000
Air Cooled >700 - < 1000 kW	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000
Air Cooled >1000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000
Water Cooled >350 - < 500 kW	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000
Water Cooled >500 - < 700 kW	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000
Water Cooled >700 - < 1000 kW	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000
Water Cooled >1000 - < 1500 kW	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000
Water Cooled >1500	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000

Source: Chiller suppliers - confidential

The later sections examine the costs and benefits of the MEPS options from the perspective of consumers. It was assumed that all compliance costs incurred by suppliers are eventually passed on to buyers in the normal course of business. Hence, for the purposes of cost-benefit analysis, the cost impact on product suppliers as a group is neutral. The cost-benefit assessment provided in Section 5.4 assumes that the product suppliers recover the costs via an increase in the costs of the product to the consumer. As the benefits of the energy efficiency improvement accrue to the consumer, this approach allows for a consistent treatment of costs-benefits.

The supplier's ability to use internationally recognised testing standards and certification schemes reduces the need for testing of products for different regions.

Trade, GATT and TTMRA issues are discussed in detail in Appendix 8.

Competition

Implementation of the proposed MEPS requirements is unlikely to affect the competitiveness of one supplier over another. The proposed MEPS addresses the energy efficiency performance of the chiller, not the overall performance of the unit, so consumer choice will not be affected. Industry representatives have reported that chillers that meet the required MEPS are readily available; however the issue of compliance and testing has been raised as a possible impediment to supplying units. If a supplier does not currently have EUROVENT or ARI certification of their products, the supplier would be required to either seek certification to these schemes or provide a test report of the performance of the chiller to the Australian Standard (or ISO/ARI/EUROVENT equivalent). As no known testing facilities are currently available in Australia or New Zealand to test chillers of <350 kWr capacity, the chiller would need to be tested overseas, or in the affiliated supplier laboratories in other countries. This would incur additional costs for the supplier. However the industry has reported that the instance of these cases would be small.

As the proposed MEPS is being applied to chillers of greater than 350 kWr, there will be no impact on smaller chiller suppliers, who are mostly small importers and local manufacturers. In addition, small businesses do not purchase chillers greater than 350 kWr, hence there are no impacts on small business purchases.

It is suggested that the MEPS is implemented as early as possible, but not before October 2008, which provides 4 years since the announcement of the proposal to enable industry to comply with these levels. Government/industry consultation has suggested that a 4-year period is appropriate for MEPS notification, based on product development lifecycles (i.e., the time required to adjust product design to meet the new MEPS levels). The industry stakeholders have suggested that between 20 to 40% of the chillers currently sold in 2006 would not meet the required MEPS levels. However, the industry has reported that MEPS compliant chillers are available for use now and would be easily available by the suggested implementation date of October 2008.

The proposed MEPS does not penalise products with additional features, as the MEPS only affect the efficiency, which is not generally dependant on the features or other characteristics available in the product such as output capacity or water temperatures. Consequently, there is unlikely to be any significant impact on the availability and range of models and hence consumer choice in New Zealand and Australia.

The proposed introduction of MEPS in Australia and New Zealand, combined with other international programmes, will provide a spur for increased innovation and performance. As all importers will have the same requirements for their products, they will all be on an equal footing and still be able to compete in their normal market processes.

5.4 Consumer Costs and Benefits

The assessment of costs and benefits from the perspective of the consumer is examined in this section. The benefits to the consumer include the estimated electricity cost savings from a more energy efficient product, while the costs include the estimated incremental price increase due to suppliers meeting the MEPS requirements.

Consumer Perspective

Calculations of the cost-benefit performed with the RIS model are shown in Figure 9 for Australia and in Figure 10 for New Zealand. The undiscounted benefits peak at $71M for Australia and NZ$11M for New Zealand in 2020, while the highest costs are estimated in 2020 at $22M for Australia and NZ$5M for New Zealand.

Figure 9: Consumer Cost-Benefit of MEPS (Aus)

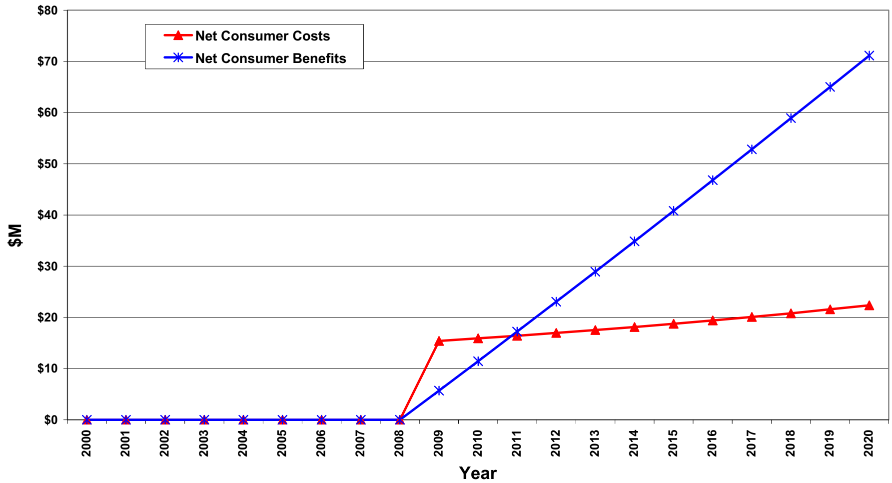
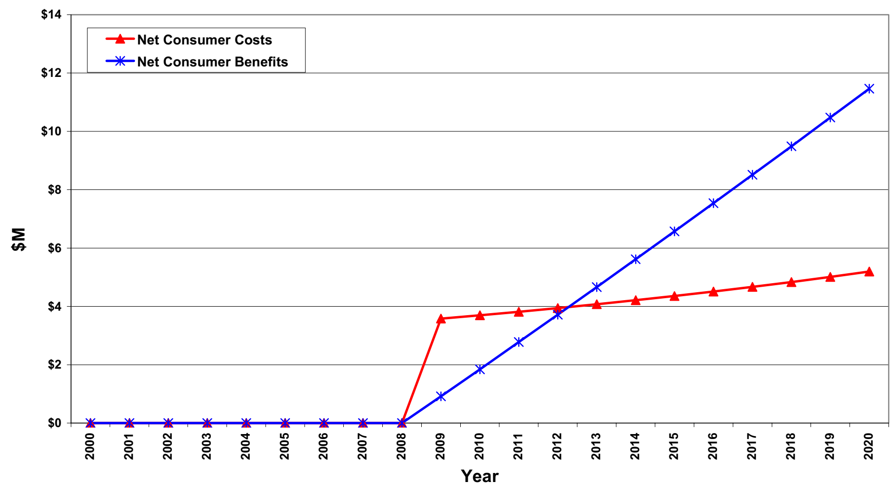


Figure 10: Consumer Cost-Benefit of MEPS (NZ)



The benefits increase from 2008 to 2020 in line with the increase of the MEPS compliant product in the overall stock of chillers. The consumer benefits continue to grow as a result of cohorts of new, more efficient products (compared to the BAU) coming into use each year.

As noted earlier in Section 5.3, the estimated cost increase due to the MEPS could be up to 22% in 2008. The net consumer costs show a gradual increase from 2008 to 2020 as more result of cohorts of new, more expensive but efficient products being sold each year. The data for New Zealand shows a similar result.

The individual consumer costs and benefits of the MEPS in 2008 are shown in Table 8. The present value of the benefits is discounted over an estimated average 15 service year life of the products (see Appendix 4).

Table 8: Present Value Costs and Savings – Chiller MEPS, 7.5% Disc Rate

Category	Incremental Price Increase	Estimated Annual Energy Savings (MWh/yr)	Energy Costs Savings/year[1]	Present Value Cost Savings (15yrs)[1]	Benefit Cost Ratio
Air Cooled >350 - < 500 kW	$15,000	31	$4,887	$68,187	5.5
Air Cooled >500 - < 700 kW	$18,000	52	$8,305	$115,878	7.7
Air Cooled >700 - < 1000 kW	$15,000	26	$4,230	$59,024	4.7
Air Cooled >1000	$20,000	49	$7,891	$110,114	6.6
Water Cooled >350 - < 500 kW	$10,000	16	$2,589	$36,119	4.3
Water Cooled >500 - < 700 kW	$10,000	40	$6,374	$88,941	10.7
Water Cooled >700 - < 1000 kW	$15,000	28	$4,544	$63,403	5.1
Water Cooled >1000 - < 1500 kW	$20,000	48	$7,611	$106,205	6.4
Water Cooled >1500	$30,000	32	$5,054	$70,520	2.8

1. The costs savings are based on an Australian and New Zealand average tariff of 16.0c/kWh.

As Table 8 demonstrates, the value of the benefits are substantially larger (by a factor of at least 2.8) compared to the costs regardless of the product category. Many of the product categories demonstrate benefits that are at least 4 times greater than the costs.

It is considered that small businesses do not purchase chillers (as they are usually installed in large commercial sector buildings) and hence no analysis is required of the specific impacts to small businesses.

Cost of Forgoing Product Features

The design of chillers are controlled by standards/specifications covering areas such as electrical safety, refrigerants and other performance issues. The MEPS does not affect the power consumption of various features of products and hence there is no forgoing of product features due to the MEPS. The improvement to energy efficiency required to meet the MEPS can easily be achieved by changes to the design of the product and will not result in the loss of product features. In fact many chillers already meet the proposed MEPS as demonstrated in the EUROVENT certification programme data (see Figure 8).

Distributional Impact

This section provides an analysis of impacts on consumers with respect to patterns of usage different to the base model used for the RIS analysis. These impacts are modelled on Australian data, which provides a more conservative assessment. The results are also applicable to New Zealand. Table 9 shows the impact for usage where the consumer reduces by 20% the time the chiller is used in the *low* usage scenario. Similarly, the *high* usage scenario increases the time the chiller is used by 20%. Full details of these scenarios are shown in Appendix 6, Table 27. Data for the base MEPS analysis is as per Table 8, which is the NPV analysis over 15 years at 7.5% real discount rate.

Table 9: Present Value Costs and Savings: Varying Usage - MEPS, 7.5% Disc Rate

Category	Usage Case	Estimated Annual Energy Savings (MWh/yr)	Present Value Cost Savings (15yrs)[1]	Benefit Cost Ratio
Air Cooled >350 - < 500 kW	Low	24	$54,550	3.6
Air Cooled >350 - < 500 kW	High	37	$81,824	5.5
Air Cooled >500 - < 700 kW	Low	42	$92,702	5.2
Air Cooled >500 - < 700 kW	High	62	$139,053	7.7
Air Cooled >700 - < 1000 kW	Low	21	$47,219	3.1
Air Cooled >700 - < 1000 kW	High	32	$70,828	4.7
Air Cooled >1000	Low	39	$88,091	4.4
Air Cooled >1000	High	59	$132,137	6.6
Water Cooled >350 - < 500 kW	Low	13	$28,895	2.9
Water Cooled >350 - < 500 kW	High	19	$43,343	4.3
Water Cooled >500 - < 700 kW	Low	32	$71,153	7.1
Water Cooled >500 - < 700 kW	High	48	$106,730	10.7
Water Cooled >700 - < 1000 kW	Low	23	$50,722	3.4
Water Cooled >700 - < 1000 kW	High	34	$76,084	5.1
Water Cooled >1000 - < 1500 kW	Low	38	$84,964	4.2
Water Cooled >1000 - < 1500 kW	High	57	$127,446	6.4
Water Cooled >1500	Low	25	$56,416	1.9
Water Cooled >1500	High	38	$84,624	2.8

1. The costs savings are based on an Australian and New Zealand average tariff of 16.0c/kWh.

In general, usage variation of +- 20% do not substantially affect the significance of the benefits to the users, with the lowest benefit is found for water cooled chillers of > 1500 kWr where the present value benefits are still almost 2 times the incremental cost in the low usage case. It is easily observed that low usage decreases the benefits to the consumer compared to the base scenario, while the high usage case increases the consumer benefit.

5.5 Impact on Energy Use and Greenhouse Gas Emissions

Sales Forecasts

Since the MEPS criteria apply only to new products entering the market, it will be a number of years before these measures impact on the stock of existing products to any major extent. Therefore two scenarios have been modelled in the RIS; a Base Sales scenario with product sales continuing to increase at a rate of approximately 3 – 4% pa and a Low Sales scenario with sales only increasing by 0.5 – 0.7% pa from 2008. Forecast sales of chillers to 2020 by category are shown in Figure 11 for Australia and in Figure 12 for New Zealand.

Annual sales by category of product are forecast from trends produced from estimates of sales reported by industry and AREMA. The historical and forecasts sales figures developed for the RIS take into account the mix of effectively competing technologies (air cooled and water cooled chillers). Recent trends show that the sales of air cooled chillers are increasing and will probably continue to increase over the next 10 to 15 years. Detailed assessment of the sales of chillers is provided in Appendix 4: Stock and Sales. The detailed values used for the following tables are also shown in Appendix 9: Detailed Sales & Stock by Chiller Category – Base Scenario.

Figure 11: Forecast Sales of Chillers - Base Sales Scenario Australia

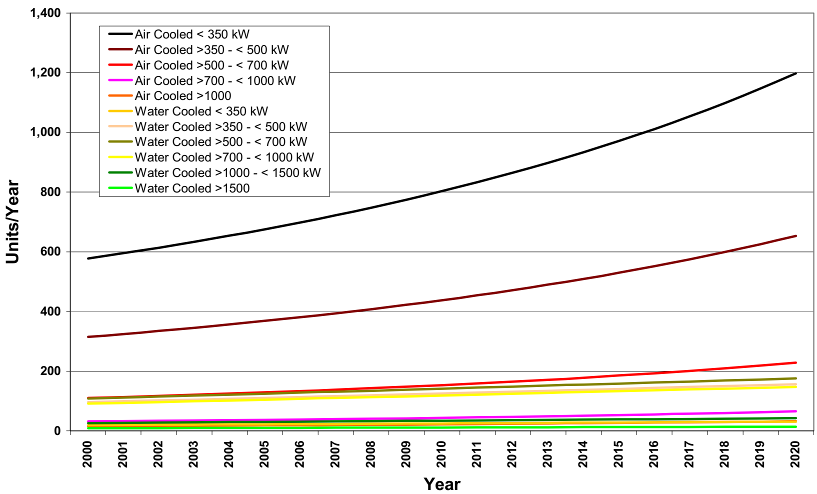
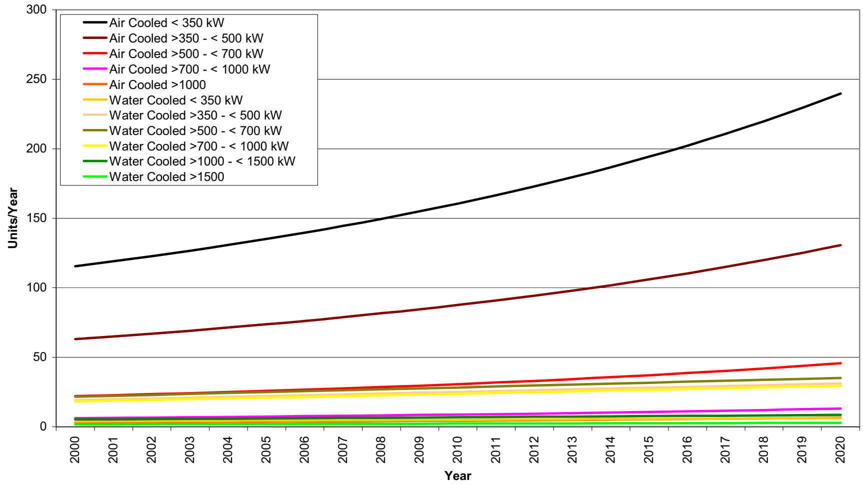


Figure 12: Forecast Sales of Chillers - Base Sales Scenario New Zealand



The current trends indicate that Base Sales scenario is more likely however many factors can influence these projections. If a slow down in the commercial building sector occurs, the sales growth would also reduce.

To simulate the impact of slowing in commercial sector growth, a forecast for chillers under a Low Sales scenario for Australia and New Zealand were undertaken and are shown in Figure 13 and Figure 14 respectively. It is considered unlikely that this scenario would develop given the historical sales of new product in Australia and New Zealand, so this low sales forecast scenario is utilised for sensitivity analysis of the RIS impact projections.

Figure 13: Forecast Sales of Chillers - Low Sales Scenario Australia

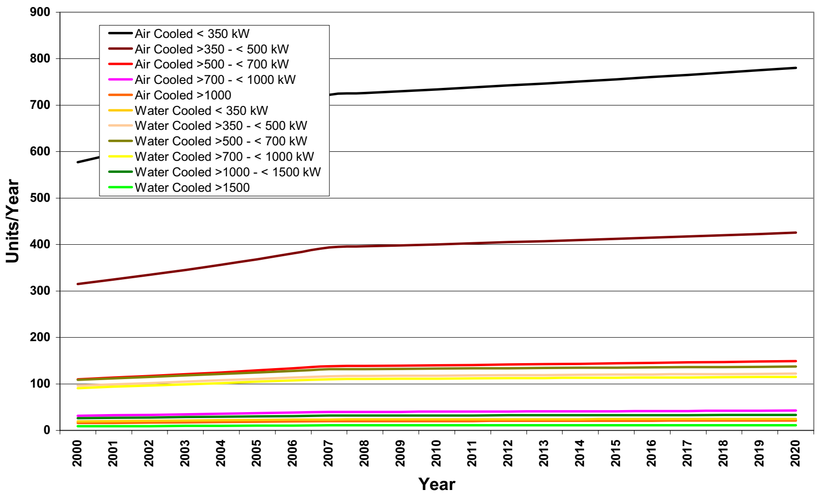
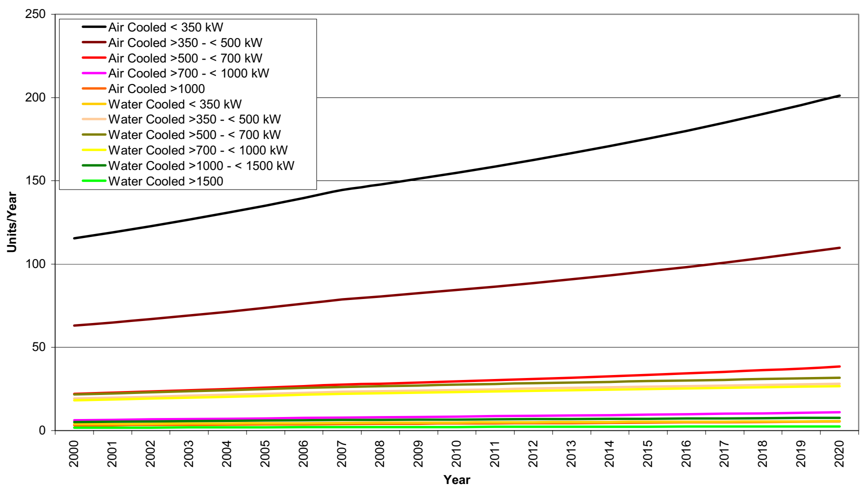


Figure 14: Forecast Sales of Chillers - Low Sales Scenario New Zealand



Energy and Greenhouse Impacts

The MEPS impact is based on an implementation date of October 2008; hence energy and greenhouse impacts are modelled to begin occurring in 2009. For the Base Sales scenario, the net energy impact of the proposed MEPS for each category of chillers is shown in Figure 15, for Australia and in Figure 16 for New Zealand. The estimated impact of MEPS is shown as the "MEPS" line compared to business as usual (BAU). Annual net energy savings are estimated at 446 GWh per year for Australia and 72 GWh per year for New Zealand by 2020 for all products as a result of the MEPS. The largest category is air cooled chillers of 350 – 500 kWr representing approximately 38% of the total net energy savings in both Australia and New Zealand.

Figure 15: Net Annual Energy - BAU and MEPS: Australia Base Sales Scenario

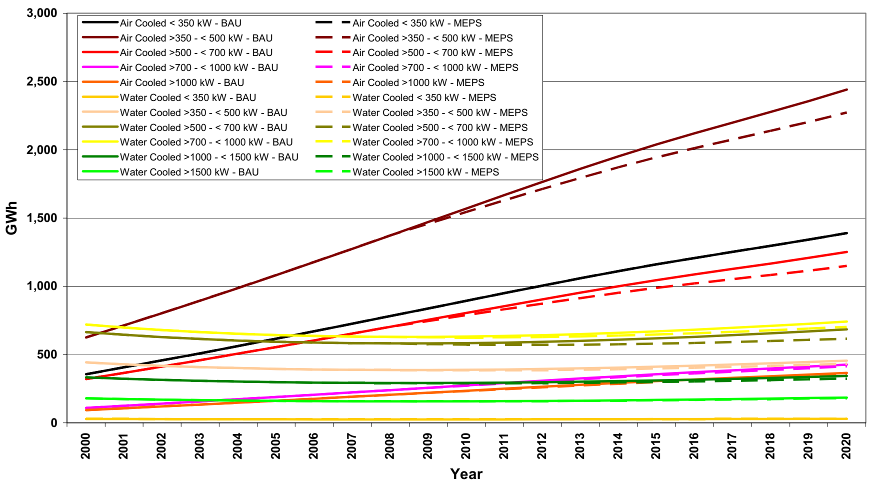
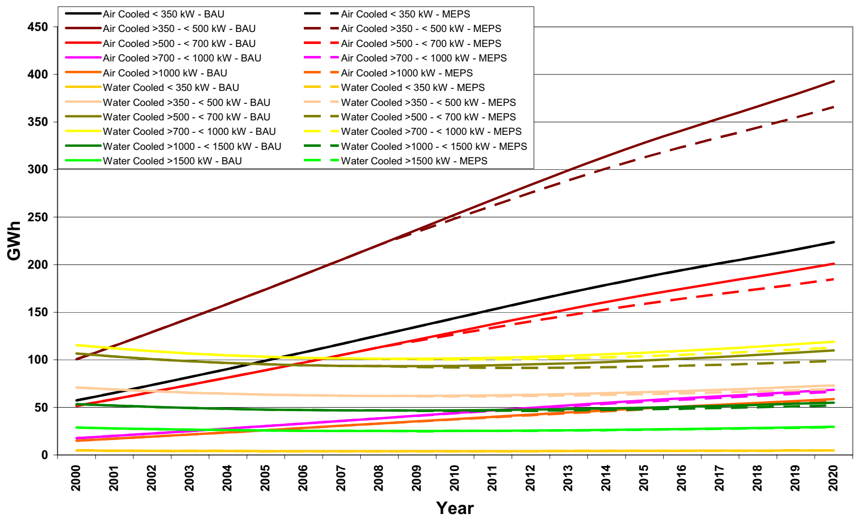


Figure 16: Net Annual Energy - BAU and MEPS: NZ Base Sales Scenario



The MEPS impact for the Low Sales scenario is shown in Figure 17, for Australia and in Figure 18 for New Zealand with total net energy savings of 373 GWh per year for Australia and 60 GWh per year for New Zealand by 2020.

Figure 17: Net Annual Energy - BAU and MEPS: Australia Low Sales Scenario

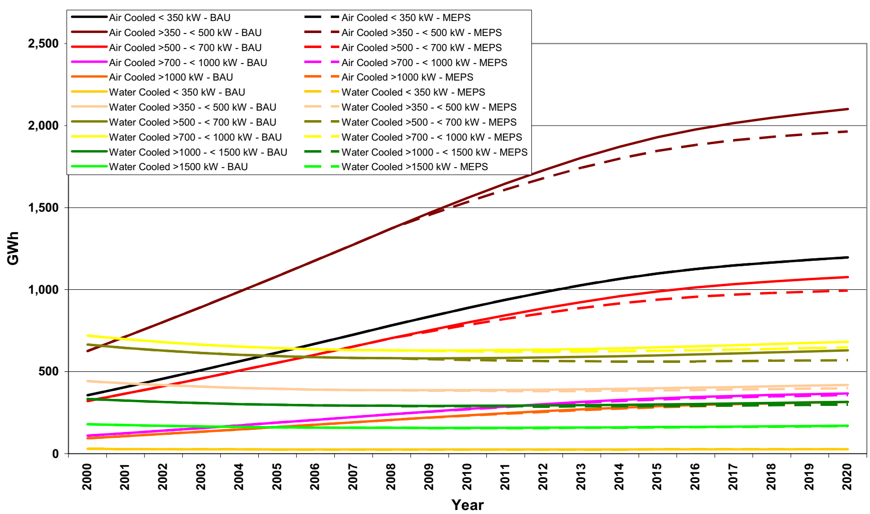
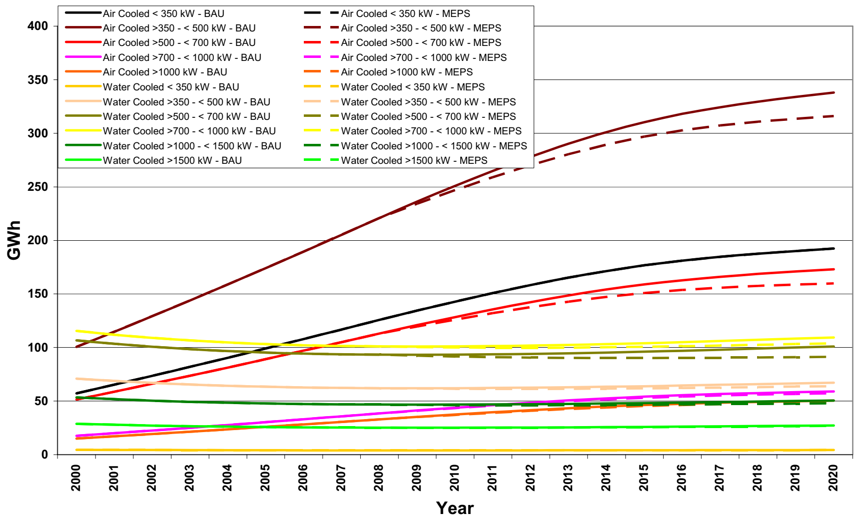


Figure 18: Net Annual Energy - BAU and MEPS: New Zealand Low Sales Scenario



For Australia the resulting estimated GHG emission reduction from the proposed MEPS is shown in Figure 19, with estimated GHG emission reductions for all chillers of 393 kt CO_2-e/yr under the Base Sales scenario in 2020. For New Zealand the resulting estimated GHG emission reduction from the MEPS for chillers is shown in Figure 20, with a 50 kt CO_2-e/yr emission reduction for the Base Sales scenario.

Figure 19: GHG Emissions - BAU and MEPS: Australia Base Sales Scenario

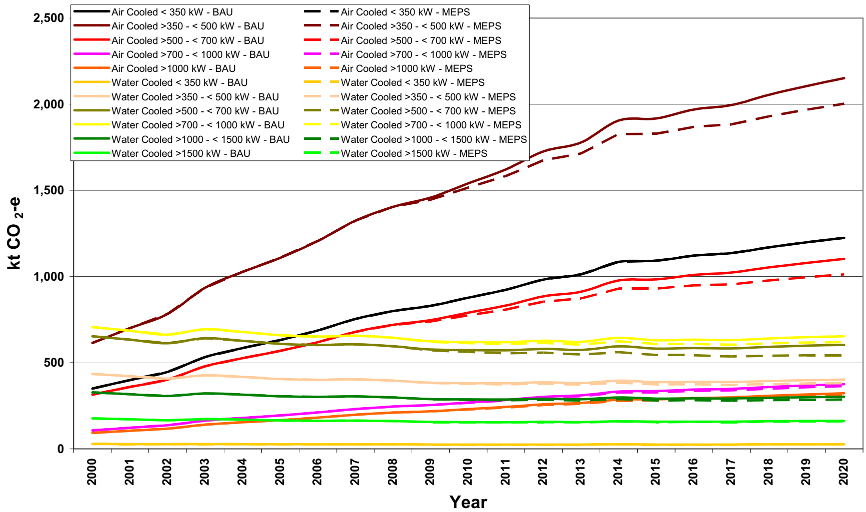


Figure 20: GHG Emissions - BAU and MEPS: NZ Base Sales Scenario

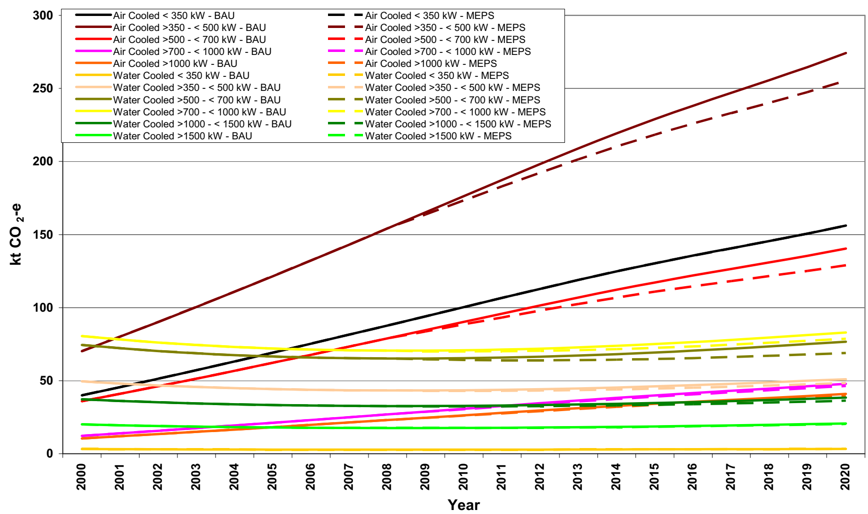


Figure 21 shows the resulting GHG emission reduction for the Low Sales scenario for Australia. It is estimated that greenhouse emissions would be approximately 64 kt CO_2-e lower in 2020 if the MEPS is implemented compared to BAU under this scenario. Figure 22 shows the resulting GHG emission reduction for the Low Sales scenario for New Zealand. It is estimated that greenhouse emissions would be approximately 8 kt CO_2-e lower in 2020 if the MEPS is implemented compared to BAU under this scenario.

Figure 21: GHG Emissions - BAU and MEPS: Australia Low Sales Scenario

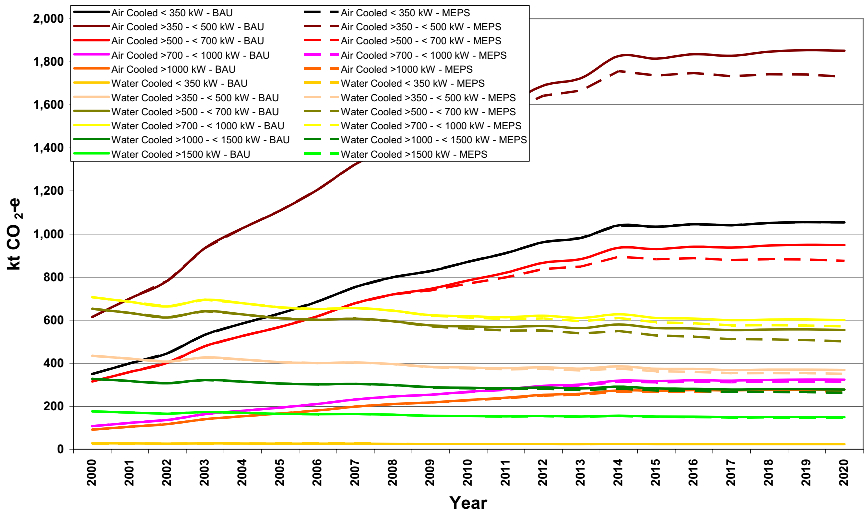
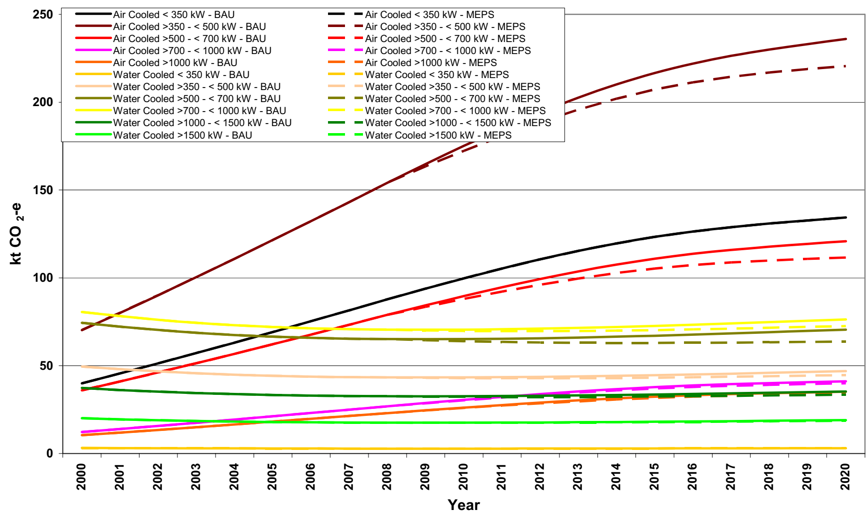


Figure 22: GHG Emissions - BAU and MEPS: NZ Low Sales Scenario



5.6 National and State Costs and Benefits

National and State Analysis - Australia

Table 10 shows the Net Present Value and Benefit Cost Ratios (BCR) for Australia for a range of real discount rates. The national perspective includes:

- **Costs:**
- to the consumer due to the incremental price increases of product due to the MEPS
- to the State and Federal government for implementing and administering the MEPS program
- to the product supply businesses for complying with the requirements of the MEPS program, i.e., testing, administration, training, etc
- **Benefits** to the nation due to the avoided electricity generation, distribution and transmission costs.

In terms of an approach for the cost-benefit analysis, it is necessary to do this from either a consumer or societal perspective, although the ratio between retail and resource costs will be much the same for both electricity prices and any incremental costs associated with the efficiency increase due to MEPS, so the cost/benefit outcomes will be similar.

Analysis from a consumer or product purchaser 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.

Analysis from societal or resource perspective, involves assessing the cost to the economy of manufacturing more efficient products using the marginal cost of resources diverted from other activities. Only the extra costs involved in the manufacturing and distribution process (i.e., extra materials, handling, storage costs) are counted and any benefits are valued at the marginal cost of electricity production rather than the retail price. Price components not related to costs, such as retail mark-ups and taxes are not included.

The dollar value of both costs and benefits will be lower from the resource perspective than from the consumer perspective, although if they both fall in the same proportion then the cost/benefits ratios will be much the same. Carrying out a separate cost/benefit analysis from the resource perspective is only necessary if the ratios of private to public costs are significantly different for costs and benefits.

For this analysis, a consumer or product purchaser perspective has been assumed as the available data corresponds to that perspective and this is the most readily available information. Retail mark-ups and taxes will be passed onto the consumer and this perspective will simplify the process (while still remaining appropriate), whereas a new set of factors and assumptions have to be introduced, particularly regarding manufacturing costs, if assessing from a resource perspective. The product purchaser approach is recommend for the development of RISs associated with the E3 programme (NAEEEP 2005). The impact of varying discount rates is very much more difficult to assess from a resource perspective.

Table 10 shows the Net Present Value and Benefit Cost Ratios (BCR) for Australia for a range of discount rates. All data tables are based on the incremental real price increase for chillers as per Table 7 for MEPS compliant product, the State and Federal program costs in Section 5.1 and business compliance costs in Section 5.2.

The provisional benefits under an emissions trading scheme (ETS) are discussed in Appendix 7. However, they are not included in the main analysis, as the Australian Government has yet to establish the details of how an ETS will operate or to undertake modelling of future electricity prices under emissions trading. This information will help determine the best approach to including the emissions abatement benefits under the ETS in the RIS.

Table 10: Financial Analysis – Australia Base Sales Growth for a Range of Discount Rates

	NPV Nil (0%)	NPV Low (5%)	NPV Med (7.5%)	NPV High (10%)
Total Costs	$229,674,675	$151,074,702	$124,708,096	$104,058,501
Total Benefits	$1,306,727,969	$898,320,576	$760,074,252	$651,040,787
Net Benefits	$1,077,053,294	$747,245,874	$635,366,156	$546,982,286
Benefit Cost Ratio	5.7	5.9	6.1	6.3

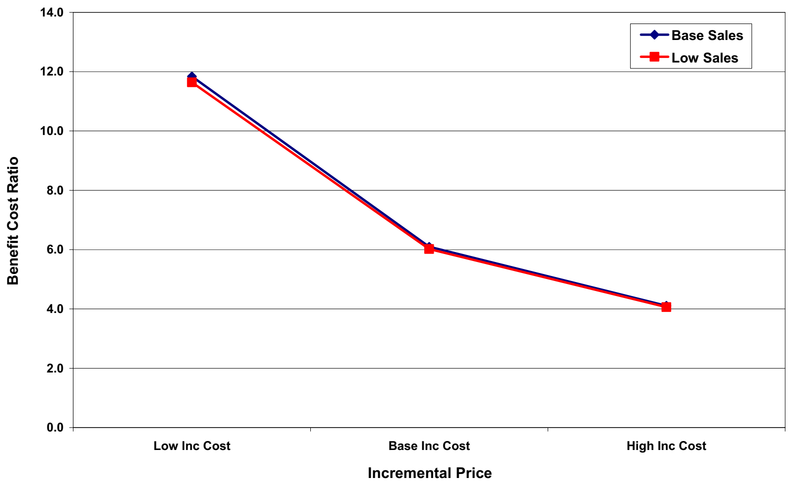
Table 11 presents the NPV benefits and costs of the proposed MEPS for the Low Sales scenario.

Table 11: Financial Analysis – Australia Low Sales Growth for a Range of Discount Rates

	NPV Nil (0%)	NPV Low (5%)	NPV Med (7.5%)	NPV High (10%)
Total Costs	$191,360,396	$127,951,863	$106,447,845	$89,488,500
Total Benefits	$1,098,371,285	$756,880,036	$640,999,929	$549,473,173
Net Benefits	$907,010,889	$628,928,173	$534,552,084	$459,984,673
Benefit Cost Ratio	5.7	5.9	6.0	6.1

To assess the potential sensitivity of the benefit-costs to the estimated incremental price increase for chillers due to the MEPS, a number of options were modelled. The incremental price increase of chillers was increased by 50% and decreased by 50%. Figure 23 shows the change in the national BCR if the price of MEPS-compliant product is up to 50% higher than the price increase estimated in Table 7. As the figure demonstrates, the net present benefits are still significantly higher than the costs under these conditions.

Figure 23: Benefit Cost Ratio as a Function of Incremental Price Increase (Australia)



The benefit-cost ratios for all the Australian states are shown in Table 12 under the Base Sales scenario. In all states the BCR is well above 3. The highest BCR occurs in the Northern Territory, where electricity prices are higher and hence provide greater consumer benefits. State/Territory program costs are apportioned by household numbers in each state.

Table 12: Benefit Cost Ratio for States by Discount Rate: Base Sales Scenario

State	NPV Nil (0%)	NPV Low (5%)	NPV Med (7.5%)	NPV High (10%)
NSW & ACT	6.1	6.4	6.5	6.7
NT	8.1	8.4	8.7	8.9
QLD	7.1	7.5	7.6	7.8
SA	4.6	4.8	4.9	5.0
TAS	3.4	3.5	3.6	3.7
VIC	4.6	4.8	4.9	5.0
WA	5.4	5.6	5.7	5.9

The benefit cost ratios for all the Australian states and territories are shown in Table 13 under the Low Sales scenario. Again, in all states the BCR is well above 5 and shows very little sensitivity to changes in sales growth.

Table 13: Benefit Cost Ratio for States by Discount Rate: Low Sales Scenario

State	NPV Nil (0%)	NPV Low (5%)	NPV Med (7.5%)	NPV High (10%)
NSW & ACT	6.1	6.3	6.4	6.6
NT	8.2	8.4	8.6	8.7
QLD	7.2	7.4	7.5	7.7
SA	4.6	4.8	4.9	4.9
TAS	3.4	3.5	3.6	3.6
VIC	4.6	4.8	4.9	4.9
WA	5.4	5.6	5.7	5.8

Figure 24 shows the forecast undiscounted net benefit by state/territory over the period 2000 to 2020 for the Base Sales scenario.

Figure 24: Annual Net Benefit $M: Base Sales Growth Scenario

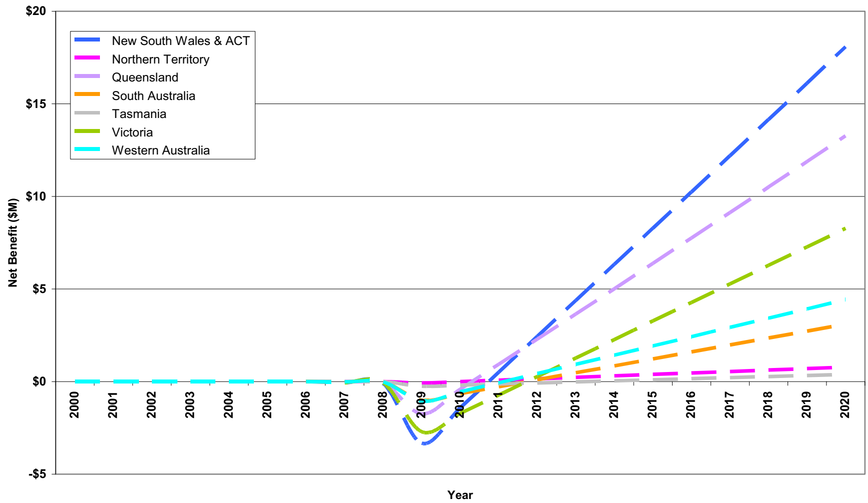
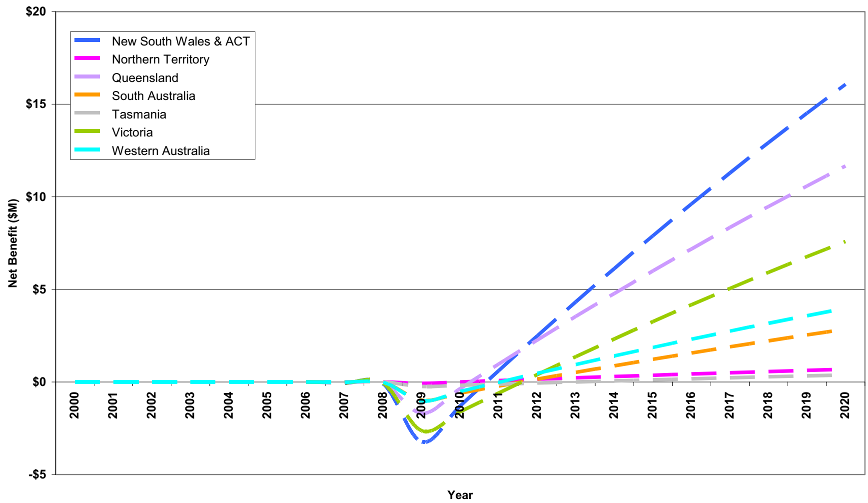


Figure 25 shows the forecast undiscounted net benefit by State over the period 2000 to 2020 for the Low Sales scenario.

Figure 25: Annual Net Benefit $M: Low Sales Growth Scenario



Analysis – New Zealand

The analysis of costs and benefits to New Zealand uses the same approach as for Australia. The New Zealand Government has announced an in-principle decision to use an Emissions Trading Scheme (ETS) as its core price-based measure to reduce greenhouse gas emissions. No account of this has been used in this analysis, as the New Zealand Government has yet to establish the details of how an ETS will operate. Once known, this information will help determine the best approach to including the emissions abatement benefits under the ETS in the RIS.

Table 14 shows the Net Present Value and Benefit Cost Ratios for New Zealand for a range of discount rates under Base Sales scenario. All data tables are based on the incremental real price increase for products as per Table 7 for MEPS compliant products. In addition, part of the program costs is apportioned to NZ in relation to the proportion of NZ sales of chillers to Australian sales. All values are expressed in NZ dollars, converted at 1.1NZD to 1 AUD.

Table 14: Financial Analysis – NZ Base Sales Scenario for a Range of Discount Rates

	NPV Nil (0%)	NPV Low (5%)	NPV Med (7.5%)	NPV High (10%)
Total Costs	$53,726,174	$35,345,189	$29,178,663	$24,348,914
Total Benefits	$210,514,826	$144,719,856	$122,448,209	$104,882,799
Net Benefits	$156,788,652	$109,374,666	$93,269,546	$80,533,884
Benefit Cost Ratio	3.9	4.1	4.2	4.3

Table 15 presents the NPV benefits and costs of the proposed MEPS for the Low Sales scenario for New Zealand.

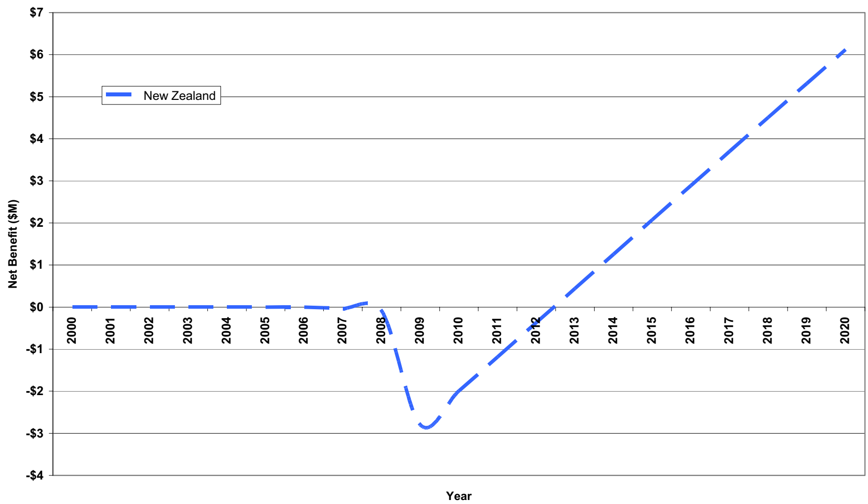
Table 15: Financial Analysis – NZ Low Sales Scenario for a Range of Discount Rates

	NPV Nil (0%)	NPV Low (5%)	NPV Med (7.5%)	NPV High (10%)
Total Costs	$44,821,936	$29,971,442	$24,934,981	$20,962,846
Total Benefits	$176,955,765	$121,938,696	$103,269,481	$88,523,802
Net Benefits	$132,133,829	$91,967,254	$78,334,500	$67,560,956
Benefit Cost Ratio	3.9	4.1	4.1	4.2

The benefit cost ratio under the Low Sales scenario is lower than the Base Sales scenario, but still higher than 3.9.

Figure 26 shows the forecast undiscounted net benefit for New Zealand over the period 2000 to 2020 for the Base Sales scenario.

Figure 26: NZ Annual Net Benefit NZ$M: Base Sales Growth Scenario



Summary Data for Alternative BAU Sales Scenarios

The impact of changes to the forecast sales of chillers is shown for the two scenarios in Table 16 for Australia and in Table 17 for New Zealand.

Table 16 Summary Data for Alternative BAU Sales Australia – 7.5% Discount Rate

Scenario	Base Sales	Low Sales
Energy Saved (cumulative)	2,862 GWh	2,521 GWh
GHG Emission Reduction (cumulative)	2.6 Mt CO_2-e	2.3 Mt CO_2-e
Total Benefit	$760M	$641M
Total Investment	$125M	$106M
Benefit Cost Ratio	6.1	6.0

Table 17 Summary Data for Alternative BAU Sales New Zealand – 5% Discount Rate

Scenario	Base Sales	Low Sales
Energy Saved (cumulative)	460 GWh	405 GWh
GHG Emission Reduction (cumulative)	321 kt CO_2-e	282.8 kt CO_2-e
Total Benefit	$145M	$122M
Total Investment	$35M	$30M
Benefit Cost Ratio	4.1	4.1

Note that NZ Govt requires analysis of alternative proposals with 5% discount rate

6 Consultations and Comments

The following consultations have been undertaken in relation to the policy development for chillers:

- ***Launch of MEPS Proposal – Chillers: October 2004.*** Almost 100 participants attended the Energy Efficiency Forum in October 2004 representing industry, regulators, Commonwealth and State/Territory government agencies, testing authorities, academia and consultants. The proposal provided details of the product description, efficiency and characteristics of new products, ownership trends, relevant Australian Standards, Australian and international policies for this product, potential MEPS levels, energy consumption, greenhouse emissions and potential savings. Detailed comments where sought from industry, however no formal submissions were made. The timeline for development of this policy option was explained and subsequently an Australian Standards working group was established to develop the technical requirements for both the testing standard and the MEPS for chillers.

- ***AREMA meeting – Chillers: December 2004.*** Again at a well attended industry forum, the proposed MEPS for chillers was explained. This presentation was made available to all that attended and requests for comment noted. Again, no formal comments were submitted, however the suppliers at the meeting supported the development of a MEPS for chillers.

- ***Annual National Air Conditioning & Energy Forum: September 2005***. The chiller MEPS proposal was discussed in detail at the National Air Conditioning forum in Sydney. Based on discussions with industry representatives and the USA Air Conditioning and Refrigeration Institute, broad agreement was reached on the use of ARI certification for the means of assessing the performance of chillers in the proposed MEPS program. During the forum, it was also decided to delay the implementation date of the MEPS from October 2007. Discussions continued during and after the forum with the ARI and Australian industry on the compliance methodology. Testing issues were also addressed at the conference and a broad cross-section of the industry was invited to participate in a Steering Committee to be established following the forum.

- ***MEPS Steering Committee: February 2006 - onwards.*** Further consultation between the chiller industry and government was conducted in a series of meetings during 2006 and 2007. Agreements were sought on the compliance pathways for suppliers to comply with the MEPS and the MEPS levels were refined to reflect the market conditions in Australia. Several meetings were held as follows:

- 13 February 2006 – Sydney
- 30 March 2006 – Melbourne
- 13 September 2006 – Sydney
- 18 October 2006 – Sydney

In these meetings, many topics were covered, including the MEPS levels by type/size of chiller, testing methods, rating and compliance pathways to use the ARI and EUROVENT certifications programmes, sales data for chillers by size/type, data on efficiency of chillers sold in Australia and the potential costs of implementation. Representatives from all the major chiller suppliers in Australia were present at many of the meetings and all received the meeting notes. The suppliers represented at these meetings and provided information on the market characteristics include:

Airwell
Boronia Technologies
Carrier
Cosair
ECP Australia Pty Ltd
Fluid Chillers Australia
Hitachi Australia Limited
Hirotec
Lu-ve
McQuay Australia Pty Ltd
Power Pax
Sharpen Engineering
Sharpe & Rendry
Trane Australia
York Australia

- ***Australian/New Zealand Standards Committee ME-086: Dec 2006 - onwards.*** To progress the development of the testing/rating and MEPS for chillers, a new committee of Standards Australia was established in the second half of 2006 called *Commercial Airconditioning Equipment*. This committee was tasked to develop the measurement and rating of system for chillers, which was based on the ISO standard PWD 19298-2, Liquid-chilling packages using the vapour compression cycle, Part 2: Method for testing for performance and the ARI550/590 standard. Several meetings were held in Sydney as follows:
- 21 December 2006
- 12 February 2007
- 14 March 2007
- 17 April 2007

- 22 May 2007
- 27 June 2007

The draft standards developed by this committee have now been published for public comment. These documents were published on 8 June 2007 and comment was required by 10 August 2007. The final standard is now under preparation.

- ***Commercial Chillers MEPS 2008 - Industry Government Roundtable - 6 June 2007.*** To further consult with the industry and suppliers of chillers, a roundtable meeting was held in Sydney to discuss the MEPS proposals. The meeting allowed for input on compliance pathways and other issues. Broad support for the MEPS was received. The meeting minutes were published on the Energy Rating website: http://www.energyrating.gov.au/forums-2007-chillers.html

- ***E3 Committee Cost-Benefit Analysis: Minimum Energy Performance Standards and Alternative Strategies for Chillers." August 2007*** - This proposal was released for public comment in Australia and New Zealand during August 2007. The document was advertised in the Australian and New Zealand press, asking for comments by 14 September 2007. One formal submission was received that dealt with formatting issues.

In addition, the key policy/technical documents were also available on the public website, www.energyrating.gov.au and public comments invited.

6.1 Summary of Comments: Consultation RIS

In December 2007, the MCE released a *Consultation RIS: Minimum Energy Performance Standards and Alternative Strategies for Chillers* seeking comments. Stakeholders were asked to comment on the proposed MEPS and the data and assumptions relating to the cost-benefit analysis. The document was advertised in the Australian and New Zealand press, asking for comments by 15 February 2008. Table 18 presents the short summary of the four submissions received and the responses to these comments.

Table 18: Summary of Comments and Responses to Consultative RIS for Chillers

Organisation	Comment Received	Response Summary
Carrier	State their support of MEPS but suggested the MEPS levels, particularly the IPLV values, be higher and be introduced in 2010.	The MEPS program is on schedule for introduction in 2008. The next round of MEPS levels will see the levels, as described in AS/NZS 4776.2 2008, to be above those suggested. Recommendation: Maintain the current MEPS program
McQuay (NZ)	Support for government initiative but concerned the actual way chillers are controlled is of greater importance.	The scope of the MEPS program is to establish a base line for the minimum amount of power a chiller can use at a predetermined set of conditions. How they are control is outside the scope of the MEPS program. Recommendation: Maintain the current MEPS program
Cook Industries (NZ)	In Submission 1 they expressed concern that the ARI and EUROVENT programs were not suitable and do not cover the range of chillers imported and manufactured in NZ	ARI and EUROVENT programs are globally acceptable for rating and certifying chillers. It is recognised that there are limitations to both programs and thus the option of testing in accordance with the standards is available. By limiting the program to chillers above 350 KWr it is felt the effect on local manufacturers will be minimised. Recommendation: Maintain the current MEPS program
Cook industries (NZ)	In submission 2 Accepted the need to reduce energy but pointed out that there are other areas that must be considered e.g., the building design, utilisation of cooling and heating and the design operation and maintenance of the air conditioning systems. Delay the implementation of the MEPS to April 2009	It is recognised that these are important issues in reducing energy but are outside the scope of the MEPS program. Recommendation: Maintain the current MEPS program

6.2 Responses to Comments: Consultation RIS

The comments from the stakeholders were considered and no change to the RIS is required. Two of the submissions from stakeholders addressed issues that were out of the scope of the proposed MEPS initiative. The remaining two submissions were considered and addressed issues that were raised in previous consultation. The submission suggesting higher MEPS levels had already been addressed by publishing higher efficiency levels in the Australian Standard and stating that these levels will be considered as future MEPS levels to be implemented after detailed consultation. The submission relating to the use of ARI and EUROVENT test methods has been addressed in the Standards Australia Committee.

7 Evaluation and Recommendations

7.1 Assessment

Reduce Greenhouse Gas Emissions Below Business-as-Usual

It is expected that, due to their voluntary nature, the non-mandatory policy alternatives will not reduce greenhouse emissions. This is supported by the industry who state that voluntary targets in this market would not provide sufficient incentive for acceptable levels of compliance, and overseas experience.

Based on the modelling of the MEPS, significant greenhouse gas emission reductions are possible.

Due to its non-voluntary nature, the MEPS option has the highest probability of reducing greenhouse gas emissions below business-as-usual with high benefit cost ratios for end consumers.

Addressing Market Failures

By requiring the removal of low efficiency product from the market, the MEPS will most effectively address market failures, so that the average lifetime costs of products are reduced. All other options rely on voluntary mechanisms and are not as effective in addressing this market failure.

MEPS will not effectively provide buyers with improved access to product performance information, nor will any of the other options, with the exception of mandatory labelling, which would not be effective in this market.

The MEPS option would clearly require importers and suppliers of chillers to provide complying equipment. This is not thought to involve negative impacts on suppliers as the volume of sales would not be substantially affected and compliance costs are low.

Conclusions

After consideration of the policy options it is concluded that:

- The MEPS option is likely to be effective in meeting all the stated objectives.
- None of the non-MEPS alternatives examined appear as effective in meeting all objectives. Some would be completely ineffective with regard to some objectives and some do not have industry support.
- Given that the proposal for MEPS has been in the public domain since October 2004 and the Australian/New Zealand Standard will be published in 2007, the program could be implemented in 2008.

7.2 Recommendations

It is recommended that the Ministerial Council on Energy (MCE) agree:

1. To implement mandatory energy performance standards for liquid-chilling packages using the vapour compression cycle in regulation.
2. That products covered by this RIS include all those chillers above 350 kWr output capacity included in the scope of AS/NZS 4776, Part 1.1.
3. To review chillers with an output capacity of less than 350 kWr, with a view to introducing MEPS for these products by 2010
4. To use the test method AS/NZS 4776.1.2 which specifies the method of testing liquid-chilling packages using the vapour compression cycle to verify the capacity, power and efficiency requirements at a specific set of conditions.
5. That liquid-chilling packages must meet or surpass the energy performance requirements that are proposed in this document and will be set down in Australian and New Zealand Standard AS/NZS 4776.2 (MEPS requirements for liquid-chilling packages using the vapour compression cycle).
6. That the amendments take effect not earlier than 1 October 2008.
7. To have all jurisdictions take the necessary administrative actions to ensure that the suite of regulations can take effect from not earlier than 1 October 2008.

8 Implementation and Review

General administrative arrangements

Australia has a national scheme for mandatory energy labelling and performance standards that relies on State and Territory legislation to give it legal effect. The jurisdictions have also agreed to a set of administrative guidelines. While not legally binding, they aim to promote a uniform approach, consistent outcomes and to minimise compliance costs. The E3 program released the latest guidelines in May 2005 (NAEEEC 2005). The key administrative arrangements are:

1. The technical details of the MEPS and labelling requirements are contained in Australia or Australian and New Zealand Standards that are incorporated by reference into the State and Territory legislation. These standards do not vary between States and Territories and are subject to unanimous approval by State and Territory regulatory bodies.

2. Changes to the technical detail in Standards are subject to transition periods that are negotiated between industry and government. State and Territory regulatory agencies and stakeholders have agreed that this type of transition arrangement minimises the cost of compliance and the confusion surrounding both the old and the new standards.

3. To minimise trade barriers, State and Territory regulatory agencies support a policy of adopting international standards wherever appropriate. E3 and Standards Australia actively support the development of international standards.

4. Where a product is not regulated for energy efficiency prior to the implementation of MEPS for the first time, products that were manufactured in Australia or imported before the MEPS implementation date may be sold without the need for any registration. Products that are manufactured in Australia or imported after the MEPS implementation date must hold a valid registration at the time of sale, which indicates compliance with the relevant MEPS requirements.

5. Grandfathering arrangements are adopted such that stocks of non-complying products that were imported or manufactured in Australia prior to the effective date of legislation affecting them can be sold for an indefinite period (i.e. products made in Australia or imported prior to the relevant MEPS date may be sold at any time into the future).

6. All States and Territories accept the registration of an appliance undertaken in another State or Territory. Where a regulatory agency has refused to register a model for energy efficiency labelling or MEPS, it will immediately inform all other States and Territories of the circumstances surrounding the refusal.

7. State and Territory regulatory agencies have set target time periods within which they aim to process applications.

8. Proposed changes in administrative and operating practice are subject to consultation between states.

Product-specific compliance and enforcement activities

The E3 program organises its compliance and enforcement activities as follows:

1. A check testing program is administered by the Department of Environment, Water, Heritage and the Arts

2. Checktesting is conducted in NATA accredited laboratories.

3. Equipment is selected for check testing on the basis of risk factors rather than randomly. The risk factors are as follows:
   - history of success and failure in check tests;
   - age of models, with newer models given greater attention, reflecting the prospect of longer life in the market;
   - high volume sales;
   - claims of high efficiency;
   - complaints.

4. In the event of failure to comply, there are several sanctions that may be utilised.
   - There is a 'shaming' option involving publication of failed brands or models in reports by agencies and/or the relevant Ministers.
   - Deregistration by the state and territory authorities, subject to show cause procedures. Subsequent sale of deregistered appliances would be a criminal offence. Re-registration of models that are subject to MEPS is subject to new registration tests.
   - Legal action by the ACCC.

5. Standard statistical criteria are applied to deal with normal variation in the performance of equipment selected for check testing. A sample of only one is selected initially, with a further sample of 3 selected if the first fails.

6. Laboratories that produce misleading tests results may also be denied further registration business.

7. Applicants that use laboratories for registration testing, whose products subsequently fail Checktesting, may be asked to ensure that future testing conducted in relation to their products is undertaken by a NATA accredited

laboratory or a laboratory accredited by a body with a mutual recognition agreement with NATA.

General monitoring and benchmarking of impacts and effectiveness

In the past the E3 program has periodically commissioned an omnibus evaluation of its impacts. The last of these was published in April 2005 (NAEEEC 2005b), titled W*hen you keep measuring it, you know even more about it: Projected impacts 2050-2020.* The general aims of such an exercise are to document expected impacts, estimate costs and benefits, and compare outcomes with earlier projections. It commits E3 to examination of the appliance register and store survey data, and comparative review of trends in appliance efficiency. . The program has since advised industry that the 2003 exercise was the last of the omnibus reviews and will be replaced by ad-hoc reviews. The first of these evaluated the impacts of MEPS and labelling of refrigerators and freezers (EnergyConsult 2006).

Over the past seven years, E3 has produced an annual "Achievements" report, the most recent reporting the 2006 position. These reports provide summary information such as achievements in the year, current and projected economic benefits, current and projected greenhouse gas reductions, compliance/enforcement issues, procedures and outcomes and Standards information. . The bi-annual standby store survey provides the E3 program with trend data and information on the energy consumption of products that are being sold in the market. This survey specifically targets set-top boxes and other consumer electronics, and will be used to monitor the general effectiveness of the MEPS over time

E3 holds an annual consultation forum and invites stakeholders to raise concerns about its operation and impacts. In addition, E3 also holds industry/stakeholder fora and conferences to discuss future directions for currently regulated products and products being considered for regulation.

Less frequently, E3 reviews program fundamentals. The most recent exercise of this kind was a major research-based review and scoping of future directions for a wide range of appliance efficiency labels in Australia and NZ (Winton 2003).

The program also takes occasional opportunities to benchmark its activities with programs in other countries.

Regulatory review

Review functions are not centralised: each State and Territory has its own arrangements for review. The 'subordinate legislation' acts in several states provide for the automatic revoking of regulations after 10 years. These states are Victoria, SA, Queensland and Tasmania. NSW requires that all regulations contain sunset clauses. The remaining jurisdictions have no general requirement but may include sunset clauses on a case-by-case basis.

All jurisdictions have some Parliamentary machinery for the systematic review of regulations, such as a 'Legislation Review Committee'. Arrangements for agency or inter-agency review are more variable. Only Victoria has a specific body charged with regulatory oversight, which is the Victorian Competition and Efficiency Commission. This work is undertaken by an inter-departmental committee in the NT. Otherwise, however, the review process uses a parliamentary secretariat to raise issues and solicit public comment.

Once the States and Territories agree to mandatory requirements, their removal in any one jurisdiction would undermine the effect in all other jurisdictions, because of the Mutual Recognition agreements between the States and Territories. Under the co-operative arrangements for the management of the Equipment Energy Efficiency Program, States advise and consult when the sunset of any of the provisions is impending. This gives the opportunity for revised cost-benefit analyses to be undertaken.

Information Specific to Chiller Requirements

Chiller MEPS would be implemented under the same State and Territory regulations as household appliance labelling and MEPS, and so subject to the same sunset provisions, if any.

As with the E3 adopted principles there should be a MEPS 'stability period', and a cost-benefit analysis would be undertaken before any revisions are proposed. The earliest possible timing of any change to the MEPS regulations discussed in this RIS would therefore depend on date of their implementation. If implemented in October 20008, the earliest possible revision would be October 2012.

In respect of revisions, it would be necessary to carry out a study well in advance of that time, so that adequate notice could be given to industry in the event that a change was justified. The study would typically be undertaken 18 - 24 months before a revision was proposed. The study would review and compare local and international trends in efficiency levels, international programs and harmonisation initiatives, possibly proposing more stringent MEPS, if sufficient evidence indicated such change was achievable and beneficial. Equally, the study could indicate that continuation of MEPS, with registration, may not be the most cost effective outcome for the community at large and hence recommend alternative options, including the removal of mandatory measures.

Therefore considering the E3 Committee principles and the State sunset requirements:

- the earliest a review would be undertaken would be 2010 (if changes were to be considered for implementation in October 2012).
- the latest a review to be undertaken would be in 2017, one year before the State sunset provisions.

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Appendix 2: Australian Energy Efficiency Policy Background

The Australian Government's initial response to concerns about the environmental, economic and social impacts of global warming was set out in the Prime Minister's statement of 20 November 1997, *Safeguarding the Future: Australia's Response to Climate Change*. The Prime Minister noted that the Government was seeking *"…realistic, cost-effective reductions in key sectors where emissions are high or growing strongly, while also fairly spreading the burden of action across the economy."* He also stated that the Government is "…*prepared to ask industry to do more than they would otherwise be prepared to do, that is, go beyond a 'no regrets'*[5]*, minimum cost approach where this is sensible in order to achieve effective and meaningful outcomes."* This "no regrets" test was a key part of the guidelines adopted by the Council of Australian Governments (COAG) in 1997 that any initiative proposed by the MCE, including standards and labelling measures under the Equipment Energy Efficiency Program, must meet.

In 1998 the Australian Government released *The National Greenhouse Strategy* (NGS) that was endorsed by the Australian Government and state and territory governments and committed them to an effective national greenhouse response. Progress under the NGS was reported to the Council of Australian Governments (CoAG). Many key elements of the NGS were implemented successfully, but, over time, the Australian Government identified a range of emerging climate change priorities that required attention at the federal government level. Similarly, there was acknowledgment that state and territory jurisdictional boundaries necessitated state/territory level climate change action plans and these were developed.

In 2004, the Australian Government released a new climate change strategy as articulated through its Energy White Paper, *Securing Australia's Future*, and the 2004-05 Environment Portfolio Budget. Some elements of the earlier NGS were included in the new strategy. As a critical element of the Australian Government's climate change strategy, the new energy policy represented the refinement of strategic themes pursued in relation to energy under the NGS, including energy market reform, the development of low-emissions and renewable technologies, and improvements to end-use energy efficiency.

Since that time, CoAG has remained the primary forum for progressing Australian, state and territory government collaboration on climate change issues requiring inter-jurisdictional attention. Significant progress has been made under the CoAG climate change agenda since CoAG's agreement in June 2005 to establish a new Senior Officials

[5] The Productivity Commission has defined "No regrets" policy options as measures that … *have net benefits (or at least no net cost) in addition to addressing the enhanced greenhouse effect. A more intuitive interpretation of 'no regrets' measures could be that they are actions which would still be considered worthwhile even in the absence of concerns about the potential adverse impact of global warming.* (PC 1997: page vii). This may involve imposing additional business costs on suppliers if the resulting more efficient products deliver a net benefit to the wider community.

Group to consider ways to further improve investment certainty for business, encourage renewable energy and enhance cooperation in areas such as technology development, energy efficiency and adaptation. This work culminated in the January 2006 CoAG climate change action plan. In addition, climate change issues requiring national coordination have been managed through a number of inter-governmental ministerial councils including the Ministerial Council on Energy.

The Australian Government's climate change strategy is the mechanism through which Australia will meet its international commitments as a party to the United Nations Framework Convention on Climate Change (UNFCCC). The Government has an overall target of limiting Australia's emissions in 2008-2012 to 108% of its 1990 emissions. This is a 30% reduction on the projected "business as usual" (BAU) outcomes in the absence of interventions.

Over 2006, the national policy debate over introducing a carbon price in Australia continued with the state and territory governments proposing an emissions trading scheme, and the Australian Government holding a nuclear energy enquiry and announcing its own emissions trading inquiry by the *Task Group on Emissions Trading*.

In 2007, emissions trading became a major new plank in the Australian Government's response to climate change. The Prime Minister, the Hon John Howard MP, announced in June 2007 that Australia will introduce a world-class domestic emissions trading system by 2012. Emissions trading will be the primary mechanism for achieving the long term emissions reduction goal, which will be set in 2008. It will have a strong economic foundation and take account of global developments while preserving the competitiveness of our trade exposed emissions intensive industries. Through emissions trading, the market will help Australia develop the most cost effective technologies for cutting greenhouse emissions.

Emissions trading will complement existing Government actions to reduce greenhouse gases. These include:

- improving end-use energy efficiency;
- investing in the new low emissions technologies Australia and the world will need in the future, including renewable energy technologies and clean coal;
- supporting world-class scientific research to continue to build our understanding of climate change and its potential impacts, particularly on our region; and
- assisting regions and industries to adapt to the impacts of climate change.

An emissions trading scheme will build on the success of past and ongoing measures. These measures include the *2004 Energy White Paper*, *2004-05 Climate Change Strategy*, earlier measures such as *Measures for a Better Environment* and *Safeguarding the Future*, as well as new programs announced in 2006-07.

Appendix 3: Review of International Approaches

USA

The regulatory framework for the US programs consists of the National Energy Policy and Conservation Act (NEPCA) of 1978 (and subsequent amendments), which requires comparative labelling for household appliances and packaging disclosure panels for certain classes of lighting; the National Appliance Energy Conservation Act (NAECA) of 1987 (and subsequent amendments), which requires MEPS for a range of household appliances; and the Energy Policy and Conservation Act (EPCAct) of 1992, which extended MEPS and labelling to certain classes of non-household products. This legislation requires the US Department of Energy (DOE) to set MEPS for a wide range of named products, plus any other products that consume more than a specified amount of energy.

While the USA has equipment based MEPS for many products under the Energy Policy Act of 1992, the efficiency of air conditioning chillers is regulated as part of State building codes. The ASHRAE Standard 90.1 (Energy Standard for Buildings Except for Low Rise Residential Buildings) specifies the test standards and MEPS levels for chillers and this standard then forms the technical basis for the all State building codes.

Testing Standard

The ASHRAE Standard 90.1 was approved by the ASHRAE and IESNA boards in 1993, and then reviewed every three years. It is intended to promote the application of cost-effective design practices and technologies that minimise energy consumption without sacrificing either the comfort or productivity of the occupants. This standard references ARI 550/590.

The test method applies to factory-made vapour compression refrigeration Water-Chilling Packages including one or more hermetic or open drive compressors. These Water-Chilling Packages include:

- Water-Cooled, Air-Cooled, or Evaporatively-Cooled Condensers,
- Air-Cooled or Water-Cooled Heat Reclaim Condensers,
- Packages supplied without a Condenser.

MEPS Levels

The Energy Policy and Conservation Act of 1992 (EPCAct 92) requires state and local governments to update their commercial building energy efficiency codes to be at least as stringent as ASHRAE Standard 90.1-1999 by 2004. To meet this requirement, almost all States have adopted ASHRAE 90.1-1999, eight have adopted 90.1-2001 and many have gone further and adopted ASHRAE 90.1-2004, including California, Iowa, New Jersey, Virginia, Vermont, Georgia, Utah and Ohio (http://www.energycodes.gov/). The chiller efficiency levels for ASHRAE 90.1-1999 through to 90.1-2004 are however the same. Table 19 summarises the requirements for Chillers in ASHRAE Standard 90.1-1999 to 2004.

Table 19: ASHRAE 90.1-1999, 2001 & 2004 Chiller Performance Standards

Vapour Compression Chillers	Capacity (kWR)	Min COP	Min IPLV
Air cooled, with Condenser	All Capacities	2.80	3.05
Air Cooled, without Condenser	All Capacities	3.10	3.45
Water cooled, Reciprocating	All Capacities	4.20	5.05
Water Cooled (Rotary Screw and Scroll)	< 528 kW	4.45	5.20
	>528 kW and < 1055 kW	4.90	5.60
	>1055 kW	5.50	6.15
Water Cooled, Centrifugal	< 528 kW	5.00	5.25
	> 528 kW and <1055 kW	5.55	5.90
	> 1055 kW	6.10	6.40

Canada

The Canadian economy is the eighth largest in the world (measured in US dollars at market exchange rates) after the US, Japan, Germany, the UK, France, China and Italy. It is highly integrated with the US economy, which absorbs over 85% of its exports. The Energy Efficiency Act passed in 1992 provides for the making and enforcement of regulations concerning minimum energy performance standards (MEPS) for energy-using products, as well as the labelling of energy-using products and the collection of data.

Canada has a MEPS program that covers air and water sourced heat pumps, commercial air conditioning chillers and dehumidifiers. A voluntary comparative labelling program for heat pumps also exists.

In 2004, Canada introduced a MEPS for chillers that are intended for application in the air conditioning of buildings. Products covered include vapour-compression chillers with a capacity less than 7 000kW with water condenser or less than 700kW with air condenser and absorption chillers up to 5 600kW. Energy efficiency was defined as COP and the Integrated Part Load Value (IPLV) for various size and technology combinations. The MEPS was implemented in October 2004 and will operate under the standard CSA-C743-02. This testing standard is equivalent to the American standard of ARI 550/590.

A key difference between the Canadian MEPS regulatory program and that of the USA is the regulation is on the water chillers themselves, as opposed to USA where the Building Codes are used to regulate the chillers to be installed in new buildings.

Testing Standard

The scope of Canadian Chiller Test Standard CSA-C743-02 is similar to ARI 550/590, and applies to:

- factory-designed and prefabricated absorption or vapour-compression refrigeration chillers equipped with centrifugal or rotary screw and positive displacement (reciprocating or scroll) compressors. The Standard applies to chillers having a cooling capacity under 5600 kW (1590 tons) and intended for application in air-conditioning systems for buildings.
- absorption chillers, single-effect indirect-fired by steam or hot water; double-effect, both indirect and direct-fired; and multiple-effect and multi-loop cycle absorption chiller/heater units. Water is the refrigerant and lithium bromide is the absorbent. It may also be used for rating gas-fired absorption chillers at the discretion of the user.
- hermetic and external-drive centrifugal or rotary-screw chillers with continuous capacity modulation, whether driven by an electric motor, steam turbine, or another prime mover, such as an internal combustion engine.
- hermetic and external-drive positive displacement (reciprocating or scroll) compressor equipped chillers, with either self-contained or remote condensers.
- positive displacement compressor heat reclaim chillers.

The Canadian Standard does not apply to

- absorption chillers with air-cooled condensers;
- liquid chillers for use with liquids other than water; and
- centrifugal or rotary screw heat reclaim chillers.

There are no labelling standards associated with air conditioning water chillers.

MEPS Levels

The MEPS levels are shown in Table 20. These MEPS are listed in CSA-C743-02, Section 6.

Table 20: Canada Minimum COP and IPLV of Packaged Water Chilling Packages

Type	Capacity Range, kW (tons)	COP	IPLV
Vapour Compression			
-- air-cooled with condenser	< 528 (150)	2.80	3.05
	>= 528 (150)	2.80	3.05
-- air-cooled without condenser	all	3.10	3.45
-- water-cooled, reciprocating	all	4.20	5.05
-- water-cooled, rotary screw, scroll	< 528 (150)	4.45	5.20
	>= 528 (150) and <= 1055 (300)	4.90	5.60
	>1055 (300)	5.50	6.15
-- water-cooled, centrifugal	< 528 (150)	5.00	5.25
	>= 528 (150) and <= 1055 (300)	5.55	5.90
	> 1055 (300)	6.10	6.40
Absorption			
-- single-effect absorption, air-cooled	all	0.60	N/A
-- single-effect absorption, water-cooled	all	0.70	N/A
-- double-effect absorption, indirect-fired	all	1.00	1.05
-- double-effect absorption, direct-fired	all	1.00	1.00

Chinese Taipei

The Energy Commission in the Ministry of Economic Affairs (MOEA) has developed MEPS for a number of products. In most cases the energy tests are detailed in Chinese National Standards (CNS) of Chinese Taipei, and the MEPS requirements are published by MOEA. The Bureau of Commodity Inspection and Quarantine is also involved in the implementation of the program.

Chinese Taipei introduced MEPS for water chillers in January 2003 with the second Phase of the regulations being introduced in January 2005. The regulations cover water cooled volumetric and centrifugal compressors, as well as air cooled chillers .

Testing Standard

Test standards are established in CNS 12575 for volumetric-type compressors (screw, scroll, piston, etc) and in CNS 12812 for centrifugal-type compressors. These standards reference test standards, ARI 550/590 and the Japanese Industrial Standard (JIS), as follows:

- B8613 - Chiller standard for displacement type motor compressor, evaporator, condenser, etc., and which have a cooling capacity of 420 kW; and
- B8621 - Centrifugal water chillers to be used for cooling or heating water having not less than 348.8 kW in refrigerating capacity.

MEPS Levels

The MEPS for commercial air conditioning chillers required different units to attain varying MEPS levels dependent upon the chiller type and capacity. The MEPS level for water cooled type volumetric compressors will increase in 2005.

The current MEPS levels are shown in Table 21.

Table 21 - Chinese Taipei MEPS for Commercial Air Conditioning Chillers

Chiller Type	Min COP 2003	Min COP 2005
Water Cooled Type, Volumetric Compressors		
Cooling Capacity < 150 RT	4.07	4.45
Cooling Capacity ≥ 150 RT< 500 RT	4.19	4.90
Cooling Capacity ≥ 500 RT	4.65	5.50
Water Cooled Type, Centrifugal Compressors		
Cooling Capacity < 150 RT	5.0	5.0
Cooling Capacity ≥ 150 RT, < 300 RT	5.55	5.55
Cooling Capacity ≥ 300 RT	6.10	6.10
Air Cooled Type, All	**2.79**	**2.79**

Note: Volumetric compressors are screw, scroll and reciprocating

Summary

The USA, Canada and Chinese Taipei all test chillers to ARI 550/590 or the equivalent. The MEPS levels of the USA and Canada are the most stringent international standards, with Chinese Taipei having come into line with these standards in 2005. The USA and Canadian MEPS is specified in terms of minimum Coefficient of Performance (COP) and Integrated Part Load Value (IPLV), while the Chinese Taipei is applied to the COP only.

The USA uses a building code (ASHRAE Standard 90.1) to enforce the MEPS for chillers and has had standards in place since 1993. The USA have required that state and local governments to update their commercial building energy efficiency codes to be at least as stringent as ASHRAE Standard 90.1-1999 by 2004. Many States have done this, and some have gone to 90.1.2004, but building codes are not mandatory in all States. By using the building code to regulate chillers, the regulation is restricted to the installation of chillers into new buildings and consequently does not affect the replacement market.

In comparison the Canadian and Chinese Taipei MEPS are applied to equipment sold in that country. These regulations therefore affect both replacement chillers and new installations.

Appendix 4: Stock and Sales

Chillers – Sales Trends

Sales by Category

The sales of air and water cooled chillers are function of economic growth and more specifically a result of business and industrial activity. The industry sources have suggested that the historically the sales of all types of chillers have increased steadily at an annual growth rate of around 3%. However there have been changes in proportion of technology and size in the annual sales. For example, historically water cooled chillers have been more popular than air cooled, especially in larger capacities. However, more recently due to increased concerns about legionnaire's disease and improvements in air cooled technology the sales of air cooled chillers significantly outnumbers the sales of water cooled chillers.

Annual sales by category of product are forecast from estimated values, as provided by industry sources, for the year 2000 by applying annual growth rate of 3%. The historical and forecasts sales figures developed for the RIS take into account the mix of two technologies and size categories. Using the 2000 estimates as reference point the historical and forecast values have been estimated. In doing so, assumptions have been implied to account for growing sales of air cooled chillers at the expense of water cooled counterparts.

The year 2000 estimates provide that of all new chillers sold 75% were air cooled and remaining 25% were water cooled. This demonstrates a significant shift from the historic trend, for only 46% of the existing stock of chillers were air cooled in the year 2000. While there has been a shift from one technology to another, the proportional shares by chiller capacity within each technology is estimated to have remained steady. A large proportion of air cooled chillers are of smaller capacities, while the reverse is applicable for water cooled chillers. Table 22 provides the market shares by technology and by cooling capacity in year 2000.

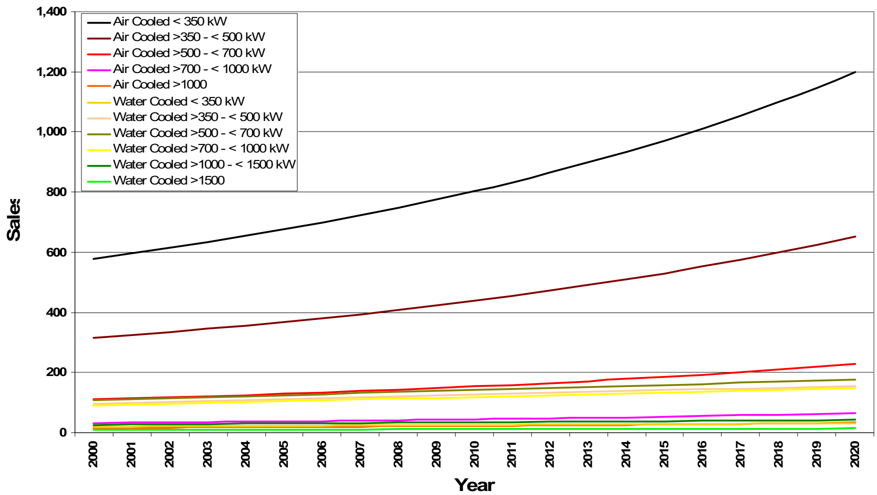
Table 22: Market Shares by technology and cooling capacities (2000)

Cooling Capacity (kW)	Market Share (Stock)			Market Share (Sales		
	% Air	% Water	All	% Air	% Water	All
< 350	55%	6%	28%	55%	6%	43%
>350-528	30%	28%	29%	30%	28%	29%
> 528-700	11%	31%	22%	11%	31%	16%
>700-1055	3%	26%	15%	3%	26%	9%
>1055-1500	2%	8%	5%	2%	8%	3%
>1500	0%	3%	1%	0%	3%	1%
All	46%	54%	100%	75%	25%	100%

In order to allow for shift in preference for air cooled technology offset was applied to general annual sales growth rate of 3% for all chillers. In case of air cooled chillers a +2% offset was applied to general 3% sales growth. In contrast a -2% offset was applied to general 3% annual sales growth rate of water cooled chillers.

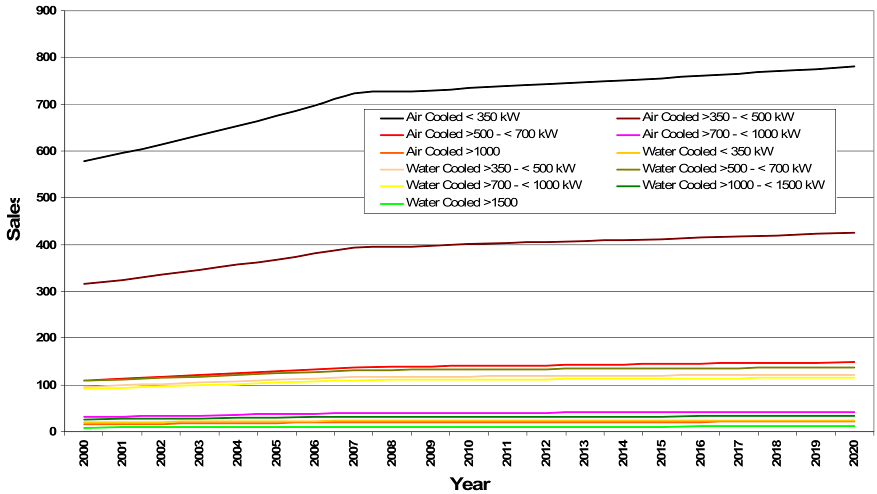
Figure 27 shows the resulting forecast sales of chillers to 2020 in Australia by category for the base sales scenario.

Figure 27: Forecast Sales of chillers - Base Sales Scenario Australia



The current trends indicate that Base Sales scenario is more likely however many factors can influence these projections. The competing Low sales scenario is shown in Figure 28. Please note that in both cases forecast values start from 2008.

Figure 28: Forecast Sales of chillers - Low Sales Scenario Australia



Similar forecasts and sales estimates were also made for the New Zealand market, based on the assumption that New Zealand market, both in terms of stock and sales, is about 20% of Australian market. Figure 29 and Figure 30 show the forecast sales of chillers to 2020 by category in New Zealand for the base and low sales scenarios respectively.

Figure 29: Forecast Sales of chillers - Base Sales Scenario New Zealand

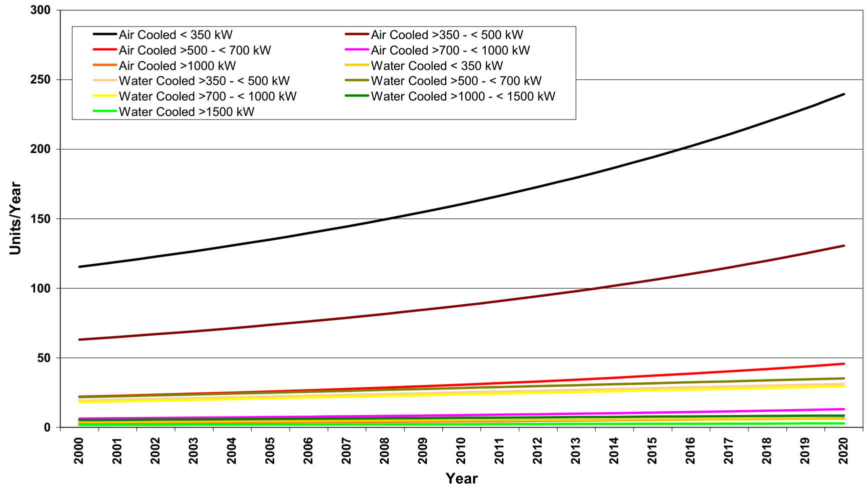
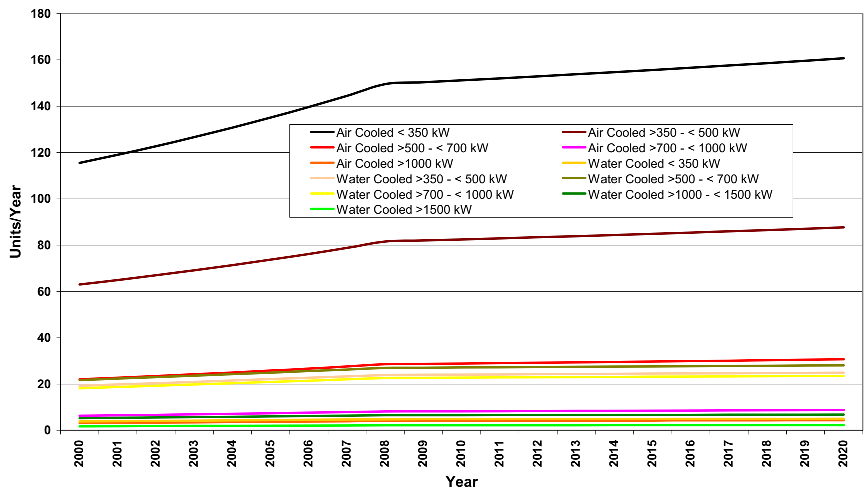


Figure 30: Forecast Sales of chillers - Low Sales Scenario New Zealand



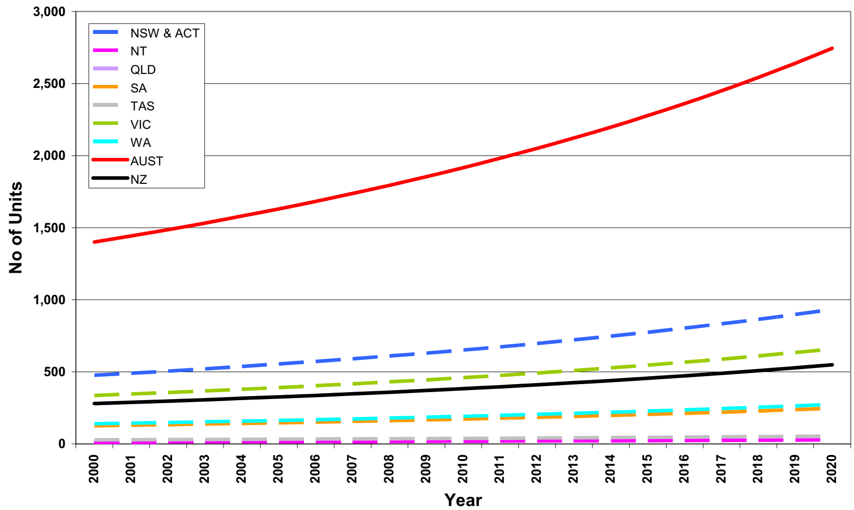
Sales by States and New Zealand

Based on the earlier forecasts of sales, the share of chiller sales by State/Territory for the period 2000 – 2020 are shown in Table 23 while Figure 31 graphically illustrates the sales trends. New Zealand sales are the total sales for New Zealand, where the Australian State and Territory data is based on estimates provided by industry sources.

Table 23: Total annual sales of chillers 2000-2020, by States, Australia as a whole and New Zealand – Base sales scenario

YEAR	NSW & ACT	NT	QLD	SA	TAS	VIC	WA	AUST	NZ
2000	476	14	280	126	28	336	140	**1,400**	**280**
2001	490	14	288	130	29	346	144	**1,442**	**288**
2002	505	15	297	134	30	357	149	**1,487**	**297**
2003	521	15	307	138	31	368	153	**1,533**	**307**
2004	537	16	316	142	32	379	158	**1,581**	**316**
2005	554	16	326	147	33	391	163	**1,631**	**326**
2006	572	17	337	151	34	404	168	**1,683**	**337**
2007	591	17	347	156	35	417	174	**1,737**	**347**
2008	610	18	359	161	36	431	179	**1,794**	**359**
2009	630	19	371	167	37	445	185	**1,854**	**371**
2010	652	19	383	172	38	460	192	**1,916**	**383**
2011	674	20	396	178	40	476	198	**1,982**	**396**
2012	697	21	410	185	41	492	205	**2,050**	**410**
2013	722	21	424	191	42	509	212	**2,122**	**424**
2014	747	22	440	198	44	528	220	**2,198**	**440**
2015	774	23	456	205	46	547	228	**2,278**	**456**
2016	803	24	472	213	47	567	236	**2,361**	**472**
2017	833	24	490	220	49	588	245	**2,450**	**490**
2018	865	25	509	229	51	610	254	**2,543**	**509**
2019	898	26	528	238	53	634	264	**2,642**	**528**
2020	934	27	549	247	55	659	275	**2,746**	**549**

Figure 31: Annual sales of chillers by State, Australia and NZ – Base sales scenario



Chillers – Stock Trends

Stock by Category

Chillers often have very long life. Typically chillers have a life span of between 10 and 20 years. Water cooled chillers are know to have longer life span than the air cooled types. The long life of chillers makes it complicated to estimate the number of chillers by their technology, cooling capacity, and age. Identifying the chillers by these three attributes is important from the point of view of having reliable estimates of energy consumption and GHG emissions, as older chillers are considered to be less efficient than new units.

Once again to estimate historic and forecast stock, the values for the year 2000 were used as reference. The estimated stock in 2000 and its breakdown by technology and cooling capacity were provided by the industry sources. It was estimated that in year 2000 around 15,000 chillers were operating in Australia. Of all the operating chillers 54% were estimated to be water cooled and remaining were the air cooled types. An estimated breakdown of air and water cooled chiller stock in 2000 has been shown in Table 22. The resulting breakdown was subjected to backwards distribution across 15 to 20 years on the basis of annual sales estimates and a survival function that reflects the life span of water and air cooled chillers. Consequently the year 2000 stock was broken down, first by technology and cooling capacity based on values in Table 22, followed by each category broken down into estimated number of units over past several years up to the maximum life of technology (15 years for air cooled and 20 years for water cooled). The resulting breakdown was subjected to appropriate "survival functions" to re-estimate the year 2000 stock. Please note the chillers stock re-estimated as above, now provides another level of breakdown i.e. the age of chillers, which when applied with relevant energy performance values, was used to estimate more reliable energy and GHG emission estimates.

Because of different operating behaviour and life spans, two different survival functions were generated for water and air cooled types. The survival functions shown in Figure 32 and Figure 33 provide a graphical view of the percentage of chillers (Rt) in useful service over the life in years from purchase (t).

Figure 32: Survival Function of water cooled chillers for Australia and New Zealand

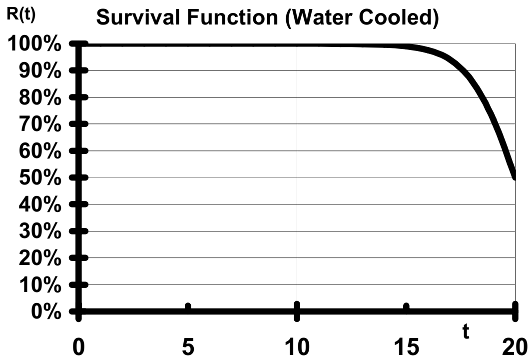
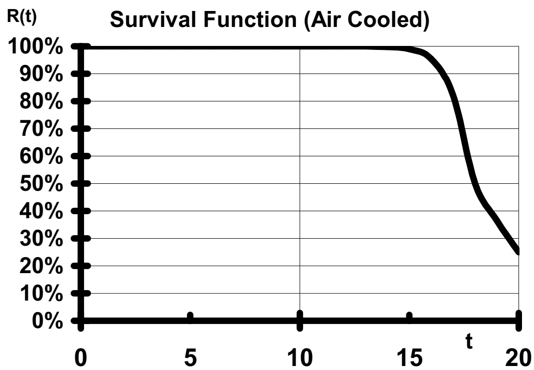


Figure 33: Survival Function of air cooled chillers for Australia and New Zealand



The resulting estimated stock of chillers by category for Australia over the period 2000 – 2020 is shown in Figure 34 for the base sales scenario and Figure 35 for the low sales scenario.

Figure 34: Forecast Stock of chillers - Base Sales Scenario Australia

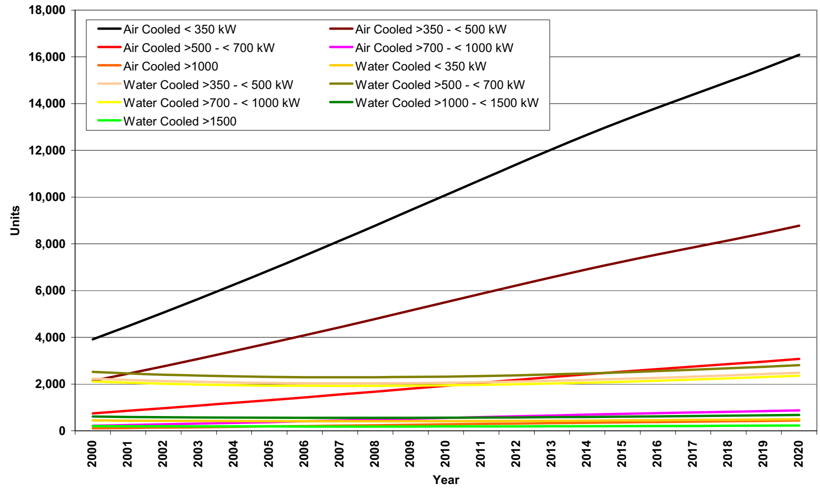
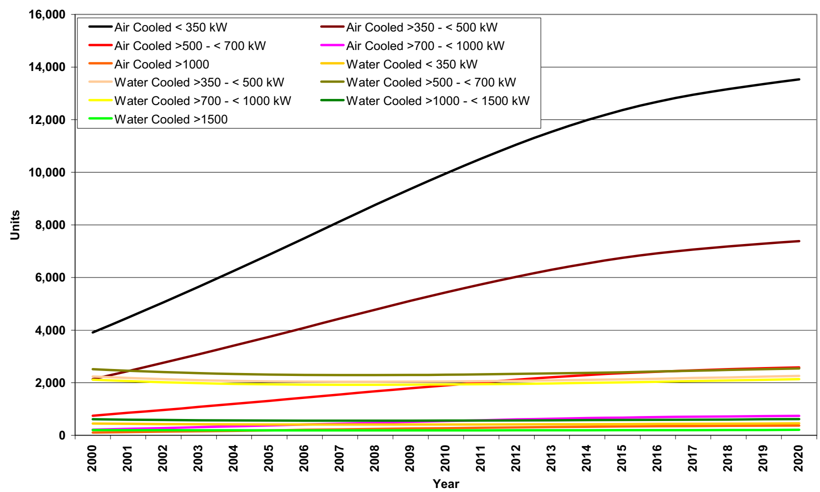


Figure 35: Forecast Stock of chillers - Low Sales Scenario Australia



Similarly in NZ, the stock of chillers by category for the period 2000 – 2020, for the base sales scenario is shown in Figure 36 and Figure 37 for the low sales scenario.

Figure 36: Forecast Stock of chillers - Base Sales Scenario New Zealand

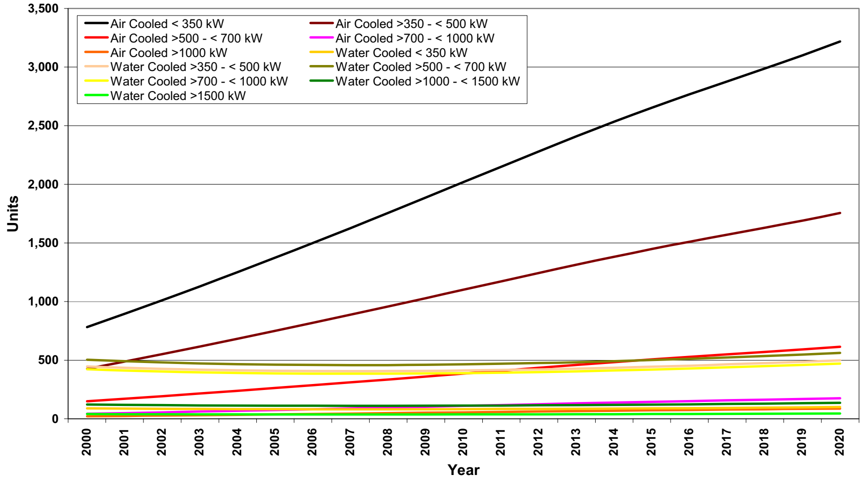
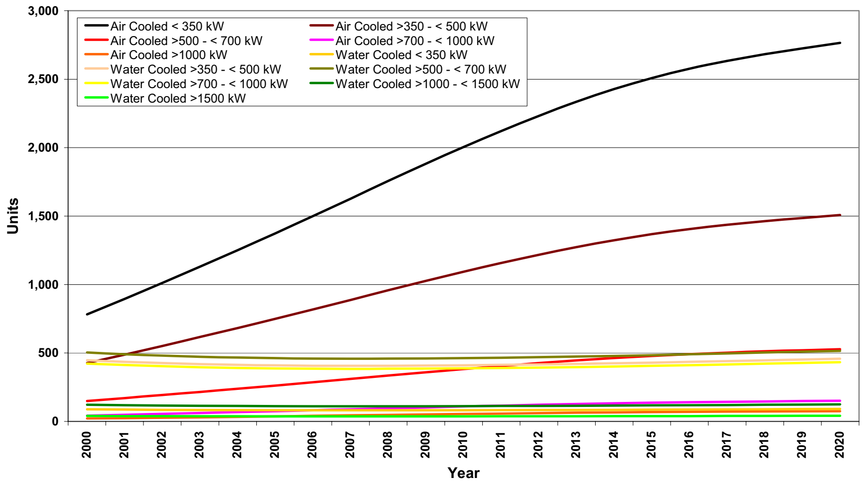


Figure 37: Forecast Stock of chillers - Low Sales Scenario New Zealand



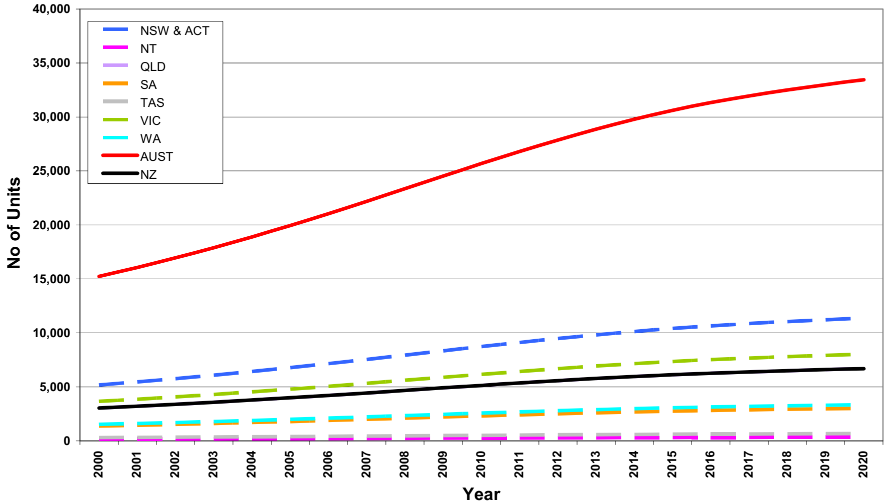
Stock by States and New Zealand

The estimates of chillers stock for the period between 2000 and 2020 by states, Australia as a whole and New Zealand are provided in Table 24 while Figure 38 shows the corresponding trend.

Table 24: Stock of chillers 2000-2020, by States, Australia as a whole and New Zealand (base sales scenario)

YEAR	NSW & ACT	NT	QLD	SA	TAS	VIC	WA	AUST	NZ
2000	5,178	152	3,046	1,371	305	3,655	1,523	**15,229**	**3,046**
2001	5,460	161	3,212	1,445	321	3,854	1,606	**16,059**	**3,212**
2002	5,762	169	3,389	1,525	339	4,067	1,695	**16,947**	**3,389**
2003	6,083	179	3,578	1,610	358	4,294	1,789	**17,892**	**3,578**
2004	6,423	189	3,778	1,700	378	4,534	1,889	**18,891**	**3,778**
2005	6,780	199	3,988	1,795	399	4,786	1,994	**19,942**	**3,988**
2006	7,154	210	4,208	1,894	421	5,050	2,104	**21,041**	**4,208**
2007	7,543	222	4,437	1,997	444	5,324	2,218	**22,185**	**4,437**
2008	7,945	234	4,674	2,103	467	5,609	2,337	**23,369**	**4,674**
2009	8,360	246	4,918	2,213	492	5,901	2,459	**24,589**	**4,918**
2010	8,785	258	5,168	2,326	517	6,202	2,584	**25,840**	**5,168**
2011	9,218	271	5,423	2,440	542	6,507	2,711	**27,113**	**5,423**
2012	9,656	284	5,680	2,556	568	6,816	2,840	**28,400**	**5,680**
2013	10,094	297	5,938	2,672	594	7,125	2,969	**29,688**	**5,938**
2014	10,526	310	6,192	2,786	619	7,430	3,096	**30,960**	**6,192**
2015	10,949	322	6,440	2,898	644	7,729	3,220	**32,202**	**6,440**
2016	11,359	334	6,681	3,007	668	8,018	3,341	**33,407**	**6,681**
2017	11,762	346	6,919	3,113	692	8,302	3,459	**34,594**	**6,919**
2018	12,168	358	7,158	3,221	716	8,590	3,579	**35,790**	**7,158**
2019	12,588	370	7,405	3,332	740	8,886	3,702	**37,023**	**7,405**
2020	13,028	383	7,664	3,449	766	9,196	3,832	**38,318**	**7,664**

Figure 38: Trend - Stock of chillers 2000 – 2020 by States, Australia as a whole and New Zealand (base sales scenario)



Appendix 5: Energy Prices and Factors

Table 25: Marginal Commercial Electricity Tariffs 2006-07

State	c/kWh Commercial
NSW	17
Victoria	17
Queensland	15
SA	16
WA	14
Tasmania	16
NT	15
ACT	19.0
Australia (weighted)	**16.0**
New Zealand	**16**

Source: Estimates from published electricity tariffs and *Guide to Preparing Regulation Impact Statements for the Appliance and Equipment Energy Efficiency Program* (NAEEEP 2005). All values include GST

Appendix 6: Calculation Methodology

The following Appendix describes the assumptions, data sources and calculation steps and methodology for this RIS.

This methodology and the assumptions made are the basis of the Costs, Benefits and Impacts of the proposal. As such, careful scrutiny and feedback is sought from stakeholders in this consultative phase.

Power and Usage

Energy used by chillers is a function of average electrical input power, number of operating units and average number of hours of operation. In turn the GHG emission is a function of energy consumption and generation mix by type of technology.

The number of operating units is a function of existing stock, replacements and new sales. Estimates of stock and sales were made for all Australia and New Zealand as detailed in Appendix 4: Stock and Sales. Combination of running stock and new sales were subjected to a "survival function" that reflected the life span of typical chillers. These sales, in combination with the survival function, were multiplied by BAU and MEPS average power input figures and corresponding average number of hours of operation for each category.

It is worth noting that chillers are known to operate at variable loads throughout a year. Therefore, the energy performance of chillers is often measured at Integrated Part-Load Value (IPLV). The loading values that are generally used to measure energy performance are 100%, 75%, 50% and 25%.

The input power to a chiller is a function of the commonly used coefficient of performance (COP) of the chiller. The COP and cooling capacity in kW are the commonly used technical attributes of chillers. The input power in kW can be calculated as;

$$\text{Input Power (kW)} = \frac{\text{Cooling Capacity (kWr)}}{COP}$$

The COP of a chiller varies by the value of its loading. Hence different values of COP, and consequently power input, need to be used for different IPLV loading values as above.

The industry consultation yielded estimated sets of net COPs under various IPLV loading conditions as above and estimated average times of operation, for current BAU operations and proposed MEPS requirements. The net IPLV COP is time weighted average of COPs at four IPLV loading intervals as above. This is illustrated as below;

Table 26: Example of calculation of NET IPLV COP

IPLV Loading Intervals	100%	75%	50%	25%
Proportional Operating Time	1%	42%	45%	12%
Corresponding COP	4.20	5.00	6.00	7.00

$$\text{Net IPLV COP} = 1\% \times 4.20 + 42\% \times 5.00 + 45\% \times 6.00 + 12\% \times 7.00 = 5.68$$

The BAU and MEPS average cooling capacities, COPs and input power for IPLV loading intervals for each category of chillers are shown in Appendix 12: To determine the total energy consumption, these values were multiplied by their respective usage characteristics as applicable to different states and New Zealand.

In order to estimate energy performance under BAU and MEPS situations, industry sources provided standard values for hours of operation of average chillers under four IPLV loading intervals as shown in Table 27. The actual average operating hours under four IPLV loading intervals varies because of different weather conditions. As such the average operating hours have been estimated separately for each state and for New Zealand. While these estimates are based on average number heating, cooling and neutral days, industry sources were consulted to verify the validity of these estimates. The estimated usage, applied to different categories of chillers, in each state is shown in Table 27 for the base case scenario. These average loading conditions and operating hours were the average weighted values according to the proportion of chillers sold in various commercial and industrial facilities.

The values for low and high usage scenarios were calculated by reducing or increasing the portion of Off period by 20% and distributing the difference across four categories of IPLV loading intervals according to their proportional share in base usage scenario.

Table 28 and Table 29 show the proportion of operating hours for low and high usage scenarios respectively.

Table 27: Proportion of IPLV loading intervals as percentage of total time (Base Usage Scenario)

IPLV Loads	NSW	NT	QLD	SA	TAS	VIC	WA	NZ
100%	4.5%	7.0%	7.0%	4.0%	3.5%	4.0%	4.5%	4.0%
75%	16.0%	20.1%	20.1%	12.0%	9.8%	12.0%	16.0%	12.0%
50%	1.0%	1.5%	1.5%	1.2%	1.0%	1.2%	1.0%	1.2%
25%	0.5%	0.0%	0.0%	0.3%	0.3%	0.3%	0.5%	0.3%
Off	78.0%	71.4%	71.4%	82.5%	85.4%	82.5%	78.0%	82.5%

Table 28: Proportion of IPLV loading intervals as percentage of total time (Low Usage Scenario)

IPLV Loads	NSW	NT	QLD	SA	TAS	VIC	WA	NZ
100%	3.6%	5.6%	5.6%	3.2%	2.8%	3.2%	3.6%	3.2%
75%	12.8%	16.1%	16.1%	9.6%	7.8%	9.6%	12.8%	9.6%
50%	0.8%	1.2%	1.2%	1.0%	0.8%	1.0%	0.8%	1.0%
25%	0.4%	0.0%	0.0%	0.2%	0.2%	0.2%	0.4%	0.2%
Off	82.4%	77.1%	77.1%	86.0%	88.3%	86.0%	82.4%	86.0%

Table 29: Proportion of IPLV loading intervals as percentage of total time (High Usage Scenario)

IPLV Loads	NSW	NT	QLD	SA	TAS	VIC	WA	NZ
100%	5.4%	8.4%	8.4%	4.8%	4.2%	4.8%	5.4%	4.8%
75%	19.2%	24.1%	24.1%	14.4%	11.8%	14.4%	19.2%	14.4%
50%	1.2%	1.8%	1.8%	1.4%	1.2%	1.4%	1.2%	1.4%
25%	0.6%	0.0%	0.0%	0.4%	0.4%	0.4%	0.6%	0.4%
Off	73.6%	65.7%	65.7%	79.0%	82.5%	79.0%	73.6%	79.0%

Energy and Greenhouse

Generally the sum of direct and indirect energy consumption is used to provide the net energy consumption used for all subsequent calculations. However, operation of chillers does not affect energy usage by other appliances. Consequently the indirect energy resulting due to the operation of chillers is either none or negligible.

The GHG emissions were estimated by using the State energy calculations combined with the Greenhouse Gas Emissions Factors in Appendix 10.

Cost-Benefits

The NPV benefits are calculated for each State using the avoided costs of electricity as shown in Appendix 5: Energy Prices and Factors multiplied by the energy savings calculated earlier. The incremental costs are based upon industry information and shown in Table 7. These costs are multiplied by the sales of product to obtain the customer costs. The sum of these customer costs, the supplier costs and government costs provide the total costs for the MEPS option. The energy cost savings post 2020 of cohorts of product installed up till 2020 under the MEPS scenario are included in the net benefits, as per the Guide to Preparing Regulatory Impact Statements (NAEEEP 2005)

Sensitivity Scenarios

To test the sensitivity of the analysis outputs, scenarios were developed as follows:

- Two sales scenarios were modelled. Base and Low Growth.
- Three usage scenarios were modelled – high, base and low Usage
- Several incremental cost scenarios were modelled as shown in Figure 23.

Appendix 7: ETS Provisional Benefits to be Included in Future

The potential impact of an Australian emissions trading scheme (ETS) on the benefit-cost ratio is assessed in this appendix. On 3 June 2007, the Prime Minister announced that Australia will implement a domestic emissions trading system beginning no later than 2012, and that the Government will set a national emissions target in 2008. However, with the change of Government in November 2007, the nature of the ETS and the timing of its introduction may be changed. Whatever the nature of any ETS, it has the potential to increase the national benefits from chiller MEPS due to the cost the ETS will imposed on greenhouse gas (GHG) emissions. Hence the RIS should take into account the increased benefits due to the avoided cost of carbon permits for electricity generators, which will result from the proposed MEPS reducing the consumption and generation of electricity at the margin.

These valuations are included as a trial in this RIS and will be included within the main analysis once the Australian Government has set out parameters for how the emissions trading scheme will operate and this RIS methodology has been trialled and reviewed.

A number of possible methodologies could be used to value the GHG emissions abatement, such as using a separate carbon price or using retail electricity tariffs that include the effects of the ETS. The most appropriate approach can be determined once the Government has made decisions on how the ETS will operate (which will clarify how a new MEPS and the ETS interact) and once modelling of future electricity prices under emissions trading is available.

In the interim, the MCE E3 Committee plans to use the valuation methodology discussed below, and to revisit the choice of methodology once more information is available. The approach essentially involves sensitivity testing of a range of plausible carbon prices.

The methodology values abatement at the shadow price of the carbon permit price on the basis that by introducing emissions trading the Government has placed a carbon constraint on the economy and created a market value for emission reductions (i.e., "commoditised" emissions). Abatement is also shown in tonnes of greenhouse gases for information. With an ETS operating in the economy, any new MEPS should have its abatement valued in terms of the counter-factual cost of achieving the same abatement through other measures in the ETS.

As this CBA is a partial equilibrium analysis, it values the costs and benefits of the proposed measure at the prevailing prices in the economy, assuming the impact of the measure has negligible impact on those prices. As already noted in Section 5.6, the MEPS will reduce the consumption of electricity at the margin and this reduction is valued at the avoided cost of electricity generation and transmission for the economy – hence it provides the basis of the national benefits.

Similarly, a partial equilibrium analysis takes the ETS cap as given, assuming any new individual MEPS will have negligible impact on the carbon market and cap. Therefore the GHG emissions reduction is valued at the expected prevailing carbon permit price. This implicitly recognises that the emissions avoided through the MEPS will obviate the need for an equivalent amount of abatement elsewhere in the economy. Using the same approach as for the avoided cost of electricity generation and transmission, the avoided cost of carbon permits is added to the national benefits.

The carbon prices for sensitivity analysis are shown at $0, $10 and $20/t CO_2-e from 2012 and Table 30 reports the effect of this on the CBA.

Although the future carbon price under the ETS is uncertain at present, emissions trading will mean the estimated benefits will always be higher than without emissions trading (i.e., the benefits will always be higher when the carbon price is above zero).

Table 30: Carbon Permit Sensitivity Analysis – Australia Base Sales Growth

$0/t CO_2-e Carbon Permit Price				
	NPV Nil (0%)	**NPV Low (5%)**	**NPV Med (7.5%)**	**NPV High (10%)**
Total Costs	$229,674,675	$151,074,702	$124,708,096	$104,058,501
Total Benefits	$1,306,727,969	$898,320,576	$760,074,252	$651,040,787
Net Benefits	$1,077,053,294	$747,245,874	$635,366,156	$546,982,286
Benefit Cost Ratio	5.7	5.9	6.1	6.3
Cumulative Mt CO_2-e Abatement (2012 -2020)	2.4			
Potential Carbon Permit Avoided Costs				
Additional Avoided Carbon Costs @ $10/t CO2-e from 2012	$24,304,059	$14,473,509	$11,331,923	$8,952,419
Additional Avoided Carbon Costs @ $20/t CO2-e from 2012	$48,608,118	$28,947,018	$22,663,846	$17,904,838
Changes to Benefit Cost Ratio				
BCR with @ $10/t CO_2-e from 2012	5.8	6.0	6.2	6.3
BCR with @ $20/t CO_2-e from 2012	5.9	6.1	6.3	6.4

As the table shows, a potential carbon permit price of $10/t CO_2-e would increase the BCR from 6.1 to 6.2; likewise the permit price of $20/t CO_2-e would increase the BCR to 6.3, at a discount rate of 7.5%.

The New Zealand Government has announced an in-principle decision to use an Emissions Trading Scheme (ETS) as its core price-based measure to reduce greenhouse gas emissions. No account of this has been used in this RIS, as the New Zealand Government has yet to establish the details of how an ETS will operate. Once known, this information will help determine the best approach to including the emissions abatement benefits under the ETS in the RIS.

Appendix 8: Trade, GATT and TTMRA Issues

Trade

Mandatory energy efficiency regulations apply to all products sold, whether locally manufactured or imported. Nevertheless it is useful for decision-makers to know whether the proposals are likely to impact on the balance between local manufacture and imports, e.g. by affecting one group of suppliers more than another.

There are local manufacturers of chiller products in Australia or New Zealand. However, almost all this product is of capacities of less than 350 kWr, hence it is considered that the impact on local products will be minimal. Where a local supplier does provide chillers of greater than 350 kWr that are required to be registered for MEPS, this supplier can either test the unit to the relevant Australian/New Zealand Standard or recognised international equivalent test and provide the details of their certification to the ARI or EUROVENT programmes. Industry representatives have reported that they currently have units available that meet the required MEPS and are registered to the ARI or EUROVENT programmes.

GATT issues

One of the requirements of the RIS is to demonstrate that the proposed test standards are compatible with the relevant international or internationally accepted standards and are consistent with Australia's international obligations under the General Agreement on Tariffs and Trade (GATT) Technical Barriers to Trade (GTBT) Agreement. The relevant part of the *GTBT Technical Regulations and Standards* is Article 2: *Preparation, Adoption and Application of Technical Regulations by Central Government Bodies*. These are addressed below.

As almost all of the products addressed in the study are currently imported, MEPS would not favour local supplies against imports.

It is a particular concern of the GTBT that where technical regulations are required and relevant international standards exist or their completion is imminent, members should use them, or the relevant parts of them, as a basis for their technical regulations. The energy test procedure adopted by the Australian/New Zealand Standard replicates the ISO test and is comparable to the ARI and EUROVENT certification programmes.

The GTBT urges GATT members to give positive consideration to accepting as equivalent the regulations of other Members, even if these regulations differ from their own, provided they are satisfied that these regulations adequately fulfil the objectives of their own regulations.

The design of the compliance program for the MEPS allows for the acceptance of the results of certifications to the ARI and EUROVENT programmes.

In summary, the proposed regulations are fully consistent with the GATT Technical Barriers to Trade Agreement, and follow international standards where possible.

TTMRA

The Trans-Tasman Mutual Recognition Agreement (TTMRA) states that any product that can be lawfully manufactured in or imported into either Australia or New Zealand may be lawfully sold in the other jurisdiction. If the two countries have different regulatory requirement for a given product, the less stringent requirement becomes the de facto level for both countries unless the one with the more stringent requirement obtains an exemption under TTMRA.

As the Australia-NZ appliance and equipment markets are closely integrated, TTMRA issues arise if one country proposes to implement a mandatory energy efficiency measure but the other does not, if the planned implementation dates are different, or even if the administrative approaches are different (for example, Australian governments may require products sold locally to be registered with regulators, whereas New Zealand may not, so changing administrative and compliance verification costs).

The TTMRA is an issue that may arise if New Zealand does not implement the MEPS requirements, in accordance with the Standard, at the same time as Australian states and territories. However, the Australian and New Zealand regulators are working together within the E3 Committee and hence this is not envisaged as an issue.

Appendix 9: Detailed Sales & Stock by Chiller Category – Base Scenario

Table 31: Annual Sales by Chiller Category for Australia & New Zealand: Base Sales Scenario

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Australia																					
Air Cooled < 350 kW	578	595	614	633	654	676	698	722	748	775	803	833	865	898	934	971	1,011	1,054	1,099	1,147	1,198
Air Cooled >350 - < 500 kW	315	325	335	345	357	368	381	394	408	423	438	454	472	490	509	530	552	575	599	626	654
Air Cooled >500 - < 700 kW	110	114	117	121	125	129	133	138	143	148	153	159	165	171	178	185	193	201	210	219	229
Air Cooled >700 - < 1000 kW	32	32	33	35	36	37	38	39	41	42	44	45	47	49	51	53	55	57	60	63	65
Air Cooled >1000 kW	16	16	17	17	18	18	19	20	20	21	22	23	24	24	25	26	28	29	30	31	33
Water Cooled < 350 kW	19	20	20	21	22	22	23	23	24	24	25	26	26	27	28	28	29	29	30	31	31
Water Cooled >350 - < 500 kW	96	99	102	105	108	111	114	117	120	122	125	129	132	135	138	141	144	147	150	153	156
Water Cooled >500 - < 700 kW	109	112	115	118	121	125	128	131	135	138	141	145	148	152	155	159	162	165	169	172	176
Water Cooled >700 - < 1000 kW	91	94	96	99	102	105	107	110	113	116	119	122	124	127	130	133	136	139	142	145	147
Water Cooled >1000 - < 1500 kW	26	27	28	29	29	30	31	32	33	33	34	35	36	37	38	38	39	40	41	42	43
Water Cooled >1500 kW	9	9	9	10	10	10	10	11	11	11	11	12	12	12	13	13	13	13	14	14	14
All	1,400	1,442	1,487	1,533	1,581	1,631	1,683	1,737	1,794	1,854	1,916	1,982	2,050	2,122	2,198	2,278	2,361	2,450	2,543	2,642	2,746
New Zealand																					
Air Cooled < 350 kW	116	119	123	127	131	135	140	144	150	155	161	167	173	180	187	194	202	211	220	229	240
Air Cooled >350 - < 500 kW	63	65	67	69	71	74	76	79	82	85	88	91	94	98	102	106	110	115	120	125	131
Air Cooled >500 - < 700 kW	22	23	23	24	25	26	27	28	29	30	31	32	33	34	36	37	39	40	42	44	46
Air Cooled >700 - < 1000 kW	6	6	7	7	7	7	8	8	8	8	9	9	9	10	10	11	11	11	12	13	13
Air Cooled >1000 kW	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	5	6	6	6	6	7
Water Cooled < 350 kW	4	4	4	4	4	4	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6
Water Cooled >350 - < 500 kW	19	20	20	21	22	22	23	23	24	24	25	26	26	27	28	28	29	29	30	31	31
Water Cooled >500 - < 700 kW	22	22	23	24	24	25	26	26	27	28	28	29	30	30	31	32	32	33	34	34	35
Water Cooled >700 - < 1000 kW	18	19	19	20	20	21	21	22	23	23	24	24	25	25	26	27	27	28	28	29	29
Water Cooled >1000 - < 1500 kW	5	5	6	6	6	6	6	6	7	7	7	7	7	7	8	8	8	8	8	8	9
Water Cooled >1500 kW	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
All	280	288	297	307	316	326	337	347	359	371	383	396	410	424	440	456	472	490	509	528	549

Table 32: Annual Stock by Chiller Category for Australia & New Zealand: Base Sales Scenario

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Australia																					
Air Cooled < 350 kW	3,910	4,477	5,057	5,650	6,255	6,872	7,499	8,137	8,783	9,436	10,093	10,750	11,404	12,047	12,671	13,269	13,838	14,387	14,935	15,497	16,093
Air Cooled >350 - < 500 kW	2,133	2,442	2,759	3,082	3,412	3,748	4,091	4,438	4,791	5,147	5,505	5,864	6,220	6,571	6,911	7,238	7,548	7,848	8,146	8,453	8,778
Air Cooled >500 - < 700 kW	746	855	965	1,079	1,194	1,312	1,432	1,553	1,677	1,801	1,927	2,052	2,177	2,300	2,419	2,533	2,642	2,747	2,851	2,959	3,072
Air Cooled >700 - < 1000 kW	213	244	276	308	341	375	409	444	479	515	551	586	622	657	691	724	755	785	815	845	878
Air Cooled >1000 kW	107	122	138	154	171	187	205	222	240	257	275	293	311	329	346	362	377	392	407	423	439
Water Cooled < 350 kW	447	435	426	419	414	410	407	406	407	409	412	416	422	428	436	444	454	464	475	487	498
Water Cooled >350 - < 500 kW	2,233	2,177	2,132	2,095	2,068	2,048	2,037	2,032	2,035	2,044	2,059	2,081	2,108	2,141	2,178	2,221	2,268	2,320	2,375	2,433	2,491
Water Cooled >500 - < 700 kW	2,517	2,455	2,403	2,362	2,331	2,309	2,296	2,291	2,294	2,304	2,322	2,346	2,376	2,413	2,456	2,504	2,557	2,615	2,677	2,742	2,808
Water Cooled >700 - < 1000 kW	2,111	2,059	2,016	1,981	1,955	1,937	1,925	1,921	1,924	1,932	1,947	1,967	1,993	2,024	2,060	2,100	2,144	2,193	2,245	2,300	2,355
Water Cooled >1000 - < 1500 kW	609	594	581	571	564	559	555	554	555	557	562	568	575	584	594	606	619	633	648	663	679
Water Cooled >1500 kW	203	198	194	190	188	186	185	185	185	186	187	189	192	195	198	202	206	211	216	221	226
All	15,229	16,059	16,947	17,892	18,891	19,942	21,041	22,185	23,369	24,589	25,840	27,113	28,400	29,688	30,960	32,202	33,407	34,594	35,790	37,023	38,318
New Zealand																					
Air Cooled < 350 kW	782	895	1,011	1,130	1,251	1,374	1,500	1,627	1,757	1,887	2,019	2,150	2,281	2,409	2,534	2,654	2,768	2,877	2,987	3,099	3,219
Air Cooled >350 - < 500 kW	427	488	552	616	682	750	818	888	958	1,029	1,101	1,173	1,244	1,314	1,382	1,448	1,510	1,570	1,629	1,691	1,756
Air Cooled >500 - < 700 kW	149	171	193	216	239	262	286	311	335	360	385	410	435	460	484	507	528	549	570	592	614
Air Cooled >700 - < 1000 kW	43	49	55	62	68	75	82	89	96	103	110	117	124	131	138	145	151	157	163	169	176
Air Cooled >1000 kW	21	24	28	31	34	37	41	44	48	51	55	59	62	66	69	72	75	78	81	85	88
Water Cooled < 350 kW	89	87	85	84	83	82	81	81	81	82	82	83	84	86	87	89	91	93	95	97	100
Water Cooled >350 - < 500 kW	447	435	426	419	414	410	407	406	407	409	412	416	422	428	436	444	454	464	475	487	498
Water Cooled >500 - < 700 kW	503	491	481	472	466	462	459	458	459	461	464	469	475	483	491	501	511	523	535	548	562
Water Cooled >700 - < 1000 kW	422	412	403	396	391	387	385	384	385	386	389	393	399	405	412	420	429	439	449	460	471
Water Cooled >1000 - < 1500 kW	122	119	116	114	113	112	111	111	111	111	112	114	115	117	119	121	124	127	130	133	136
Water Cooled >1500 kW	41	40	39	38	38	37	37	37	37	37	37	38	38	39	40	40	41	42	43	44	45
All	3,046	3,212	3,389	3,578	3,778	3,988	4,208	4,437	4,674	4,918	5,168	5,423	5,680	5,938	6,192	6,440	6,681	6,919	7,158	7,405	7,664

Appendix 10: Greenhouse Gas Emissions Factors

Table 33: Projected Marginal Emissions Factors: Electricity by State 2000-2020

Region	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
NSW+ ACT	0.950	0.950	0.958	1.018	1.027	1.021	1.031	1.039	1.018	0.987	0.975	0.963	0.965	0.945	0.961	0.919	0.910	0.883	0.888	0.881	0.866
VIC	0.008	0.008	0.008	0.754	0.757	0.760	0.760	0.764	0.770	0.769	0.775	0.779	0.727	0.732	0.735	0.739	0.743	0.747	0.750	0.752	0.754
Qld	1.053	1.053	1.035	1.021	0.991	1.020	0.994	1.022	0.979	0.935	0.935	0.929	0.932	0.901	0.929	0.912	0.901	0.894	0.874	0.864	0.869
SA	1.020	1.020	1.003	1.163	1.167	1.112	1.123	1.153	1.161	1.113	1.093	1.099	1.120	1.078	1.093	1.014	0.993	0.986	0.979	1.000	0.955
WA	0.651	0.651	0.663	0.840	0.769	0.769	0.902	1.007	1.024	1.033	0.998	0.993	1.000	1.016	1.005	1.038	0.984	0.965	0.954	0.966	0.976
NT	0.988	0.988	0.992	1.122	1.128	1.106	1.117	1.130	1.130	1.094	1.075	1.086	1.105	1.085	1.112	1.048	1.023	0.992	0.995	0.965	0.936
Tas	1.040	1.040	0.996	1.038	1.029	0.906	0.884	0.868	0.885	0.890	0.894	0.830	0.826	0.823	0.838	0.845	0.855	0.817	0.804	0.808	0.810
New Zealand	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698

Source: www.greenhouse.gov.au/ggap/round3/emission-factors.html: see separate emissions factor file for each State. Regional weightings by GWA All values state-wide average kg CO_2-e per kWh delivered, taking into account transmission and distribution losses (combustion emissions only). NZ Emissions updatedin Oct 2007

Appendix 11: Population and Household Numbers

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
NSW	HH ('000)	2465	2503	2541	2577	2605	2643	2682	2720	2758	2797	2836	2875	2914	2952	2991	3030	3068	3105	3143	3180
	Persons	6575	6634	6693	6752	6811	6869	6924	6978	7032	7087	7141	7192	7243	7294	7345	7396	7444	7492	7541	7589
VIC	HH ('000)	1812	1848	1883	1916	1946	1976	2006	2036	2066	2096	2127	2157	2187	2218	2248	2279	2309	2339	2368	2398
	Persons	4805	4858	4911	4965	5018	5071	5112	5154	5195	5237	5278	5317	5355	5394	5432	5471	5508	5544	5581	5618
QLD	HH ('000)	1404	1435	1471	1510	1544	1583	1623	1663	1704	1745	1787	1829	1872	1914	1958	2001	2045	2088	2132	2175
	Persons	3629	3703	3777	3851	3925	4000	4067	4134	4202	4269	4337	4403	4469	4535	4601	4667	4732	4798	4863	4928
SA	HH ('000)	610	618	626	634	642	649	656	663	670	677	684	690	697	704	710	717	723	729	735	741
	Persons	1512	1518	1524	1531	1537	1544	1548	1552	1556	1560	1565	1568	1571	1574	1577	1580	1583	1585	1587	1590
WA	HH ('000)	721	736	753	771	789	806	824	841	858	876	894	912	930	948	966	984	1001	1019	1037	1055
	Persons	1901	1928	1954	1980	2006	2033	2059	2084	2110	2136	2162	2187	2212	2237	2262	2287	2311	2335	2359	2384
TAS	HH ('000)	192	194	196	198	201	203	205	207	209	211	213	215	217	219	221	223	225	226	228	229
	Persons	472	473	474	475	476	477	477	477	477	478	478	478	478	478	478	477	477	476	476	475
NT	HH ('000)	61	62	63	64	66	67	68	70	71	72	73	75	76	77	78	80	81	82	83	84
	Persons	198	199	201	202	204	205	208	210	212	215	217	219	222	224	226	229	231	233	236	238
ACT	HH ('000)	120	122	124	127	128	130	132	134	136	138	140	142	144	146	148	150	151	153	155	157
	Persons	319	322	325	327	330	333	335	337	340	342	344	346	349	351	353	355	357	359	361	363
AUST	HH ('000)	7385	7518	7656	7797	7920	8057	8195	8333	8472	8612	8754	8895	9036	9177	9320	9461	9602	9741	9880	10019
	Persons	19411	19635	19859	20083	20307	20531	20729	20927	21125	21323	21522	21710	21898	22085	22273	22461	22642	22823	23004	23185
	Persons/HH	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3
NZ	HH ('000)	1441	1462	1483	1504	1526	1548	1566	1585	1603	1622	1641	1659	1677	1696	1714	1733	1750	1767	1784	1801
	Persons	3880	3925	3970	4016	4062	4109	4136	4164	4192	4220	4248	4274	4300	4326	4353	4379	4404	4429	4455	4480
	Persons/HH	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5
ANZ	HH ('000)	8826	8980	9139	9301	9446	9605	9761	9918	10075	10234	10395	10554	10713	10873	11034	11194	11352	11508	11664	11820
	Persons	23291	23559	23829	24098	24369	24640	24865	25091	25317	25543	25770	25983	26197	26412	26626	26840	27046	27252	27459	27665
	Persons/HH	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.3

Source: ABS 3236 Series III, Statistics New Zealand

Appendix 12: Cooling Capacity, BAU & MEPS COPs and Input Power by Chiller Categories

Chiller Category	Average Cooling Capacity (kW)	IPLV Load Interval	BAU COP	BAU Power Input (kW)	MEPS COP	MEPS Power Input (kW)
Air Cooled < 350 kW	132	100%	2.20	60.00	2.20	60.00
		75%	3.10	42.58	3.10	42.58
		50%	3.50	37.71	3.50	37.71
		25%	4.50	29.33	4.50	29.33
		Net	3.44	38.38	3.44	38.38
Air Cooled >350 - < 500 kW	425	100%	2.20	193.18	2.50	170.00
		75%	3.10	137.10	3.50	121.43
		50%	3.50	121.43	4.00	106.25
		25%	4.50	94.44	5.00	85.00
		Net	3.44	123.58	3.69	115.18
Air Cooled >500 - < 700 kW	610	100%	2.20	277.27	2.50	244.00
		75%	3.00	203.33	3.50	174.29
		50%	3.60	169.44	4.00	152.50
		25%	4.60	132.61	5.00	122.00
		Net	3.45	176.61	3.90	156.61
Air Cooled >700 - < 1000 kW	850	100%	2.60	326.92	2.80	303.57
		75%	3.50	242.86	3.70	229.73
		50%	4.00	212.50	4.45	191.01
		25%	5.40	157.41	5.90	144.07
		Net	3.94	215.52	4.29	198.02

Chiller Category	Average Cooling Capacity (kW)	IPLV Load Interval	BAU COP	BAU Power Input (kW)	MEPS COP	MEPS Power Input (kW)
Air Cooled >1000	1,450	100%	2.70	537.04	2.80	517.86
		75%	3.40	426.47	3.70	391.89
		50%	4.30	337.21	4.45	325.84
		25%	5.70	254.39	5.90	245.76
		Net	4.07	355.92	4.29	337.80
Water Cooled < 350 kW	132	100%	3.60	36.67	3.60	36.67
		75%	4.30	30.70	4.30	30.70
		50%	5.15	25.63	5.15	25.63
		25%	6.00	22.00	6.00	22.00
		Net	4.88	27.05	4.88	27.05
Water Cooled >350 - < 500 kW	425	100%	3.75	113.33	4.10	103.66
		75%	4.50	94.44	5.00	85.00
		50%	5.65	75.22	6.20	68.55
		25%	6.50	65.38	7.10	59.86
		Net	5.25	80.95	5.78	73.49
Water Cooled >500 - < 700 kW	610	100%	4.30	141.86	5.90	103.39
		75%	4.75	128.42	5.50	110.91
		50%	5.80	105.17	6.70	91.04
		25%	6.60	92.42	7.70	79.22
		Net	5.44	112.13	6.31	96.70
Water Cooled >700 - < 1000 kW	850	100%	4.60	184.78	5.10	166.67
		75%	5.15	165.05	5.70	149.12
		50%	6.20	137.10	6.90	123.19
		25%	7.00	121.43	7.90	107.59
		Net	5.84	145.57	6.50	130.81

Chiller Category	Average Cooling Capacity (kW)	IPLV Load Interval	BAU COP	BAU Power Input (kW)	MEPS COP	MEPS Power Input (kW)
Water Cooled >1000 - < 1500 kW	1,450	100%	5.10	284.31	5.70	254.39
		75%	5.40	268.52	6.00	241.67
		50%	6.50	223.08	7.20	201.39
		25%	7.40	195.82	8.30	174.70
		Net	6.13	236.44	6.81	212.80
Water Cooled >1500	2,500	100%	5.60	446.43	5.80	431.03
		75%	5.70	438.60	6.00	416.67
		50%	6.90	362.32	7.20	347.22
		25%	7.90	316.46	8.30	301.20
		Net	6.45	387.72	6.81	366.89

Appendix 13: Annual Cost Inputs for RIS Model

STB Category	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Costs to Government															
Establishment (Once Off)	$0	$0	$0	$0	$0	$0	$0	$70	$0	$0	$0	$0	$0	$0	$0
Maintenance/Yr	$0	$0	$0	$0	$0	$0	$0	$50	$50	$50	$50	$50	$50	$50	$50
Administration of Program	$0	$0	$0	$0	$0	$0	$0	$25	$25	$25	$25	$25	$25	$25	$25
Random Check/Testing/	$0	$0	$0	$0	$0	$0	$0	$0	$20	$20	$25	$25	$25	$25	$25
Consumer Information/Education/	$0	$0	$0	$0	$0	$0	$0	$25	$25	$25	$25	$25	$25	$25	$25
Misc (RIS, Market Research)r	$0	$0	$0	$0	$0	$0	$5	$10	$15	$20	$25	$25	$25	$25	$25
Subtotal Government	$0	$0	$0	$0	$0	$0	$5	$180	$135	$140	$150	$150	$150	$150	$150
Costs to Industry															
Total Cost of Testing	$0	$0	$0	$0	$0	$0	$0	$0	$177	$176	$170	$175	$175	$175	$175
Total Cost of Registration	$0	$0	$0	$0	$0	$0	$0	$0	$0	$165	$160	$164	$164	$164	$164
Subtotal Business	$0	$0	$0	$0	$0	$0	$0	$0	$177	$341	$330	$339	$339	$339	$339
Costs to Consumers															
Costs of Incremental Price Increase	$0	$0	$0	$0	$0	$0	$0	$0	$0	$15,401	$14,310	$13,300	$12,366	$11,502	$10,703
Total	$0	$0	$0	$0	$0	$0	$5	$180	$312	$15,882	$14,789	$13,789	$12,856	$11,992	$11,192

Annual non-discounted costs in thousands of dollars ($'000)

Appendix 14: Annual Benefit and Cost Data

Table 34: Annual Consumer Energy, Benefits and Costs by State for Australia & New Zealand: Base Sales Scenario

Year	Units	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Australia																						
BAU Energy use	GWh/yr	3872	4013	4169	4339	4523	4720	4928	5147	5376	5613	5858	6108	6361	6615	6865	7110	7347	7581	7816	8059	8313
With-program energy use	GWh/yr	3872	4013	4169	4339	4523	4720	4928	5147	5376	5578	5786	6000	6216	6433	6647	6854	7054	7250	7447	7651	7867
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	36	72	108	144	181	218	256	293	331	369	407	446
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	11.4	17.2	23.1	28.9	34.8	40.8	46.8	52.8	58.9	65.0	71.2
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	35	70	105	141	173	213	240	272	300	333	364	393
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.4	15.9	16.4	17.0	17.5	18.1	18.7	19.4	20.1	20.8	21.6	22.4
NSW&ACT																						
BAU Energy use	GWh/yr	1325	1373	1426	1484	1547	1614	1685	1760	1838	1919	2002	2088	2174	2261	2346	2430	2511	2590	2671	2754	2840
With-program energy use	GWh/yr	1325	1373	1426	1484	1547	1614	1685	1760	1838	1907	1978	2051	2125	2199	2272	2343	2411	2477	2545	2615	2688
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	12	24	37	49	62	74	87	100	113	126	139	152
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	4.2	6.3	8.4	10.5	12.7	14.8	17.0	19.2	21.4	23.6	25.8
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	12	24	35	48	58	72	80	91	100	112	122	132
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	5.4	5.6	5.8	6.0	6.2	6.4	6.6	6.8	7.1	7.3	7.6
NT																						
BAU Energy use	GWh/yr	51	53	55	58	60	63	65	68	71	75	78	81	85	88	91	95	98	101	104	107	110
With-program energy use	GWh/yr	51	53	55	58	60	63	65	68	71	74	77	80	83	85	88	91	94	96	99	102	105
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5	6
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.8	0.9	1.0
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	3	3	3	4	4	4
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
QLD																						
BAU Energy use	GWh/yr	1028	1065	1107	1152	1201	1254	1309	1368	1428	1492	1557	1623	1691	1758	1825	1890	1953	2015	2078	2142	2210
With-program energy use	GWh/yr	1028	1065	1107	1152	1201	1254	1309	1368	1428	1482	1538	1594	1652	1710	1767	1822	1875	1927	1979	2034	2091
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	10	19	29	39	48	58	68	78	88	98	109	119
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	2.9	4.3	5.8	7.3	8.7	10.2	11.7	13.2	14.8	16.3	17.8
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	9	18	27	36	44	54	62	70	79	86	94	103
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.9	4.0	4.2	4.3	4.5

Year	Units	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
SA																						
BAU Energy use	GWh/yr	280	290	301	314	327	341	356	372	389	406	424	442	460	478	497	514	531	548	565	583	601
With-program energy use	GWh/yr	280	290	301	314	327	341	356	372	389	403	418	434	450	465	481	496	510	524	539	553	569
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	3	5	8	10	13	16	18	21	24	27	29	32
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.8	1.2	1.7	2.1	2.5	3.0	3.4	3.8	4.3	4.7	5.2
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	3	6	9	12	14	17	19	21	24	26	29	31
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.9	1.9	2.0
TAS																						
BAU Energy use	GWh/yr	52	54	56	58	61	63	66	69	72	75	79	82	85	89	92	96	99	102	105	108	112
With-program energy use	GWh/yr	52	54	56	58	61	63	66	69	72	75	78	81	84	86	89	92	95	97	100	103	106
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5	6
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.6	0.7	0.8	0.8
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	4	4	4	5	5	6
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
VIC																						
BAU Energy use	GWh/yr	746	774	804	837	872	910	950	993	1037	1083	1130	1178	1227	1276	1324	1371	1417	1462	1508	1554	1603
With-program energy use	GWh/yr	746	774	804	837	872	910	950	993	1037	1076	1116	1157	1199	1241	1282	1322	1361	1398	1436	1476	1517
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	7	14	21	28	35	42	49	57	64	71	79	86
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.2	3.3	4.5	5.6	6.7	7.9	9.0	10.2	11.4	12.6	13.8
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	8	15	23	31	38	47	52	58	63	71	76	80
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	3.8	3.9	4.1	4.2	4.4	4.5	4.7	4.8	5.0	5.2	5.4
WA																						
BAU Energy use	GWh/yr	390	404	420	437	455	475	496	518	541	564	589	614	639	665	690	715	738	762	786	810	835
With-program energy use	GWh/yr	390	404	420	437	455	475	496	518	541	561	582	603	625	647	668	689	709	729	748	769	791
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	4	7	11	14	18	22	26	29	33	37	41	45
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.1	1.6	2.2	2.7	3.3	3.8	4.4	5.0	5.6	6.1	6.7
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	3	6	9	12	15	18	22	25	27	30	33	36
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.6	1.6	1.7	1.8	1.8	1.9	1.9	2.0	2.1	2.2	2.2
NZ																						
BAU Energy use	GWh/yr	622	645	670	697	727	758	792	827	864	902	941	982	1022	1063	1103	1143	1181	1218	1256	1295	1336
With-program energy use	GWh/yr	622	645	670	697	727	758	792	827	864	896	930	964	999	1034	1068	1102	1134	1165	1197	1230	1265
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	6	12	17	23	29	35	41	47	53	59	65	72
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.8	2.8	3.7	4.7	5.6	6.6	7.5	8.5	9.5	10.5	11.5
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	4	8	12	16	20	24	29	33	37	41	46	50
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	3.7	3.8	3.9	4.1	4.2	4.4	4.5	4.7	4.8	5.0	5.2

Table 35: Annual Consumer Energy, Benefits and Costs by State for Australia & New Zealand: Low Sales Scenario

Year	Units	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Australia																						
BAU Energy use	GWh/yr	3872	4013	4169	4339	4523	4720	4928	5147	5376	5603	5825	6040	6247	6441	6618	6776	6910	7025	7125	7215	7297
With-program energy use	GWh/yr	3872	4013	4169	4339	4523	4720	4928	5147	5376	5568	5756	5938	6112	6274	6420	6546	6650	6736	6807	6869	6924
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	35	69	102	135	167	199	229	260	289	318	346	373
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	11.0	16.3	21.6	26.7	31.7	36.6	41.4	46.1	50.7	55.2	59.6
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	34	68	99	132	160	194	216	241	262	287	309	329
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	15.1	15.1	15.2	15.3	15.4	15.4	15.5	15.6	15.7	15.8	15.9
NSW&ACT																						
BAU Energy use	GWh/yr	1325	1373	1426	1484	1547	1614	1685	1760	1838	1915	1991	2065	2135	2201	2262	2315	2361	2401	2435	2465	2494
With-program energy use	GWh/yr	1325	1373	1426	1484	1547	1614	1685	1760	1838	1903	1967	2030	2089	2144	2194	2237	2273	2302	2326	2347	2366
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	12	23	35	46	57	68	78	89	99	108	118	127
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	4.0	5.9	7.8	9.7	11.5	13.3	15.0	16.8	18.4	20.0	21.6
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	12	23	34	44	54	65	72	81	87	96	104	110
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	5.1	5.1	5.2	5.2	5.2	5.3	5.3	5.3	5.3	5.4	5.4
NT																						
BAU Energy use	GWh/yr	51	53	55	58	60	63	65	68	71	74	77	80	83	86	88	90	92	93	95	96	97
With-program energy use	GWh/yr	51	53	55	58	60	63	65	68	71	74	76	79	81	83	85	87	88	90	90	91	92
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3	3	4	4	5	5
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.8
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	3	3	3	3	4
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
QLD																						
BAU Energy use	GWh/yr	1028	1065	1107	1152	1201	1254	1309	1368	1428	1489	1548	1605	1660	1712	1759	1801	1837	1867	1894	1918	1940
With-program energy use	GWh/yr	1028	1065	1107	1152	1201	1254	1309	1368	1428	1479	1530	1578	1624	1667	1706	1740	1768	1790	1809	1826	1840
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	9	18	27	36	45	53	61	69	77	85	92	100
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	2.8	4.1	5.4	6.7	7.9	9.2	10.4	11.6	12.7	13.8	14.9
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	9	17	25	34	40	49	56	62	69	74	80	86
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	3.0	3.0	3.0	3.1	3.1	3.1	3.1	3.1	3.1	3.2	3.2

Year	Units	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
SA																						
BAU Energy use	GWh/yr	280	290	301	314	327	341	356	372	389	405	421	437	452	466	479	490	500	508	515	522	528
With-program energy use	GWh/yr	280	290	301	314	327	341	356	372	389	403	416	429	442	454	464	473	481	487	492	497	501
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	3	5	7	10	12	14	17	19	21	23	25	27
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.8	1.2	1.6	1.9	2.3	2.7	3.0	3.3	3.7	4.0	4.3
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	3	5	8	11	13	16	17	19	21	22	25	26
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
TAS																						
BAU Energy use	GWh/yr	52	54	56	58	61	63	66	69	72	75	78	81	84	87	89	91	93	94	96	97	98
With-program energy use	GWh/yr	52	54	56	58	61	63	66	69	72	75	77	80	82	84	86	88	89	91	91	92	93
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3	3	4	4	5	5
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3	3	4	4	4	5
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
VIC																						
BAU Energy use	GWh/yr	746	774	804	837	872	910	950	993	1037	1080	1123	1165	1205	1242	1277	1307	1333	1355	1374	1392	1408
With-program energy use	GWh/yr	746	774	804	837	872	910	950	993	1037	1074	1110	1145	1179	1210	1238	1263	1283	1299	1313	1325	1336
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	7	13	20	26	32	38	44	50	56	61	67	72
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.1	3.2	4.2	5.2	6.1	7.1	8.0	8.9	9.8	10.7	11.5
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	7	14	21	29	35	43	46	51	55	61	64	67
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	3.6	3.6	3.7	3.7	3.7	3.7	3.7	3.7	3.8	3.8	3.8
WA																						
BAU Energy use	GWh/yr	390	404	420	437	455	475	496	518	541	563	586	607	628	647	665	681	695	706	716	725	733
With-program energy use	GWh/yr	390	404	420	437	455	475	496	518	541	560	579	597	614	631	645	658	668	677	684	690	696
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	3	7	10	14	17	20	23	26	29	32	35	37
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	3.9	4.3	4.8	5.2	5.6
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	3	6	9	11	14	17	19	22	24	26	28	30
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6
NZ																						
BAU Energy use	GWh/yr	622	645	670	697	727	758	792	827	864	900	936	971	1004	1035	1064	1089	1111	1129	1145	1160	1173
With-program energy use	GWh/yr	622	645	670	697	727	758	792	827	864	895	925	954	982	1008	1032	1052	1069	1083	1094	1104	1113
Energy savings	GWh/yr	0	0	0	0	0	0	0	0	0	6	11	16	22	27	32	37	42	46	51	56	60
Value of energy saved	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.8	2.6	3.5	4.3	5.1	5.9	6.7	7.4	8.2	8.9	9.6
Emissions saved (marginal)	ktCO2-e	0	0	0	0	0	0	0	0	0	4	8	11	15	19	22	26	29	32	36	39	42
Additional appliance cost	$M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	3.5	3.5	3.5	3.6	3.6	3.6	3.6	3.6	3.6	3.7	3.7

ENDNOTES

1 Laid before the Legislative Assembly on . . .

2 The administering agency is the Department of Employment, Economic Development and Innovation.