

# Minimum Energy Performance Standards for Airconditioners

## *Regulatory Impact Statement*

Draft Report – August 25, 2003

Prepared for  
Australian Greenhouse Office

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## Abbreviations

AGO	Australian Greenhouse Office
AREMA	Australian Refrigeration Equipment Manufacturers Association
AS/NZS	Australian Standard/New Zealand Standard
BAU	business as usual
COAG	Council of Australian Governments
COP	coefficient of performance
DoE	(US) Department of Energy
DPIE	Department of Primary Industries and Energy
E2G2	Working Group for Energy Efficiency and Greenhouse Gas
EER	energy efficiency ratio
EES	Energy Efficient Strategies Pty Ltd
ESSA	Energy Supply Association of Australia
GWA	George Wilkenfield and Associates
HVAC	heating, ventilation and air conditioning
kW	kilowatts
LBNL	Lawrence Berkeley National Laboratories
LCC	life cycle cost
MCE	Ministerial Council on Energy
MEPS	minimum energy performance standards
MT CO <sub>2</sub> -e	Mega tonnes of greenhouse emissions, measured as equivalent units of carbon dioxide
NAEEEC	National Appliance and Equipment Energy Efficiency Committee
NAEEEP	National Appliance and Equipment Energy Efficiency Program
NATA	National Association of Testing Authorities
NGS	National Greenhouse Strategy
PJ	petajoules
RIS	Regulatory Impact Statement
UNSW	University of New South Wales

## Executive summary

This is a regulatory impact statement for proposed changes to minimum energy performance standards (MEPS) for airconditioners falling within the scope of the joint Australian New Zealand Standard AS/NZS 3823. These are airconditioners of the refrigerative type with a cooling capacity of up to 65kW. They may be configured for cooling only or with a reverse cycle capability to provide both cooling and heating services. The revised Standard will be given legal effect under State and Territory legislation.

### **The problem**

The proposal is an element of the National Appliance and Equipment Energy Efficiency Program (NAEEEP), which is jointly managed and funded by the Commonwealth, State and Territory governments. NAEEEP is part of the National Greenhouse Strategy and targets the energy efficiency of consumer appliances, industrial and commercial equipment.

Electrical cooling and heating equipment are major contributors to greenhouse gas emissions, accounting for an estimated 4.4% of total emissions in 2000, increasing from 3.5% in 1990 and projected to increase to 5.6% in 2010. The airconditioners targeted by the regulation contribute more than half of these emissions.

### **The objective**

The proposal would substantially complete NAEEEP's strategy for airconditioners, which includes energy labelling, alignment of Australia's testing arrangements with international test procedures, registration and associated product databases, and a preliminary round of MEPS that have applied to three-phase airconditioners since October 2001.

NAEEEP has followed a policy of adopting 'world's best regulatory practice'. This involves setting MEPS at levels broadly comparable with the most demanding MEPS adopted by Australia's trading partners, but following that lead with a lag of several years. Given Australia's status as a large net importer of electrical appliances and equipment, it is considered inappropriate to take the lead or to otherwise adopt standards that put Australia significantly at odds with its trading partners. Taiwan and the US have provided the lead for airconditioners.

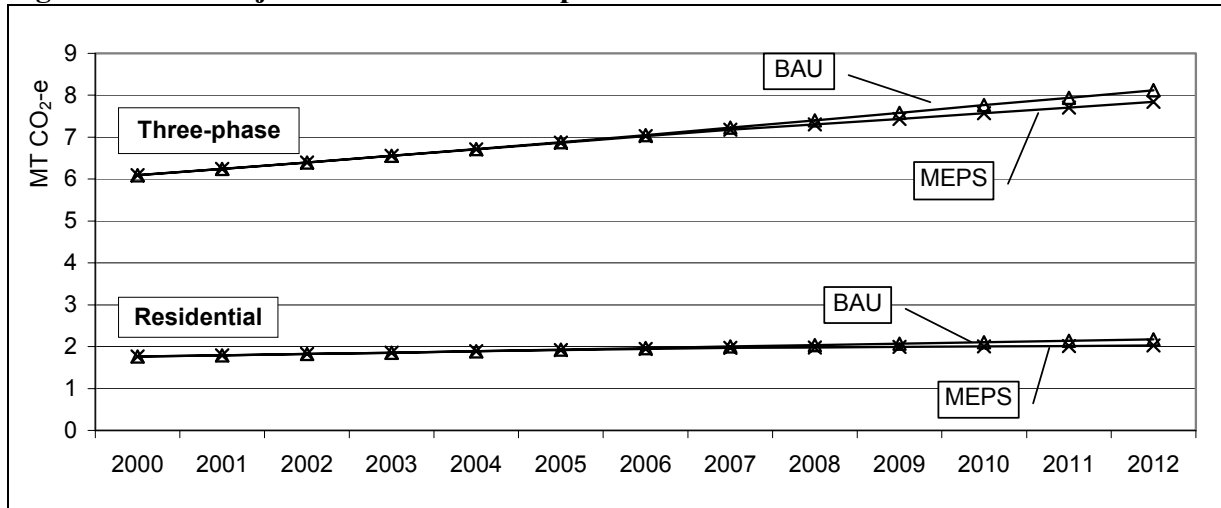
### **The proposal**

The adoption of world's best regulatory practice will require about 85% of existing models to be either withdrawn from the Australian market or redesigned. About 75% of existing models that take a three-phase power supply are affected. However a proportion of the three-phase models were eliminated by the interim MEPS introduced in October 2001. A two stage process is also proposed for models taking single-phase power supply, with the interim MEPS introduced in 2004 and a further increase in 2007. Of the existing models, 13% fail the 2004 MEPS and 89% fail the 2007 MEPS.

Figure 1 indicates the expected impact on greenhouse emissions through to 2008 – 2012, which is the first commitment period under international arrangements to reduce greenhouse emissions. Emissions from residential units (mainly single-phase) and three-phase units are reduced by 4.8% and 2.5% respectively in 2010. The percentage contribution would continue to grow beyond the projection period, since the changeover to more efficient units would be incomplete at that stage.

It is assumed that requirements beyond 2012 will be subject to a further review of regulatory options. NAEEEP has signalled to industry that further increases are likely in 2012.

**Figure 1: Projected emissions - comparison of BAU and MEPS**



The additional production costs have been estimated at an average of about 1.5% of the purchase price. Including one-off costs such as redesign and retesting, and the value of energy savings, the key findings of the cost benefit analysis are as follows:

- The present value (in 2003) of future benefits to residential users is estimated at \$37M assuming a discount rate of 10% and at \$137M for a discount rate of 0%. The baseline estimate is \$69M for a discount rate of 5%.
- The present value of future benefits to users of three-phase airconditioners are estimated at \$118M, \$501M and \$235M for discount rates of 10%, 0% and 5% respectively.
- The baseline estimates of the benefit/cost ratios are 3.0 and 10.3 for residential and three-phase airconditioners respectively.

The effect of the proposals on taxpayers is minimal. Apart from some increase in the level of check-testing, the resources required for administration and enforcement are already committed under previous arrangements.

### Other options

Minimum levels of energy efficiency could be further increased either by raising the MEPS requirements or by accelerating their introduction. However the relatively easy gains have been captured by the current proposal and the further cost increases cannot be determined with reasonable confidence. There would also be increasing concerns about adverse impacts on those who use airconditioners sparingly (and therefore save little from increased efficiency), and the difficult position of suppliers in a small market that would be somewhat at odds with the trading partners that supply most Australian products.

### Recommendations (draft)

It is recommended that:

- 1 States and Territories implement the proposed mandatory minimum energy performance standards.
- 2 Existing State and Territory regulations governing appliance energy labelling and MEPS be amended to implement the proposed standards.

# 1 The context for regulation

The regulatory proposal set out in this regulatory impact statement (RIS) is part of the National Appliance and Equipment Energy Efficiency Program (NAEEEP), which is an element of the National Greenhouse Strategy (NGS). This section explains that policy context.

## 1.1 National Greenhouse Strategy

The Australian Government's response to concerns about the environmental, economic and social impacts of global warming was enunciated in the Prime Minister's statement of November 20, 1997, *Safeguarding the Future: Australia's Response to Climate Change*. In the statement the Prime Minister announced a package of measures to reduce Australia's greenhouse gas emissions designed to ensure Australia plays its part in the global effort to reduce greenhouse gas emissions while protecting the Australian economy.

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"<sup>1</sup>, minimum cost approach where this is sensible in order to achieve effective and meaningful outcomes*.

The NGS was subsequently endorsed by the Commonwealth, States and Territories as a commitment by governments to an effective national greenhouse response.

*The Strategy maintains a comprehensive approach to tackling greenhouse issues. The range of actions it encompasses reflects the wide-ranging causes of the enhanced greenhouse effect and the pervasive nature of its potential impacts on all aspects of Australian life and the economy. (NGS 1998)*

The NGS is also the mechanism through which Australia will meet its international commitments as a party to the *United Nations Framework Convention on Climate Change*. The Australian government has announced its intention to meet an overall target by 2008-2012 of 108% of its 1990 emissions which is, in effect, a 30% reduction on the projected business-as-usual scenario (where no interventions occur).

## 1.2 Nationally Consistent Energy Efficiency Program

The proposed regulation is an element of the National Appliance and Equipment Energy Efficiency Program (NAEEEP). NAEEEP is part of the National Greenhouse Strategy and targets the energy efficiency of consumer appliances, industrial and commercial equipment. The main tools of the Program are mandatory energy efficiency labelling and minimum energy performance standards, and voluntary measures including endorsement labelling, training and support to promote the best available products.

NAEEEP's governance structure is as follows:

- The Program is the direct responsibility of the National Appliance and Equipment Energy Efficiency Committee (NAEEEC), which comprises officials from the Commonwealth, State and Territory government agencies, together with

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<sup>1</sup> No regrets in this context means imposing additional business costs on suppliers because the resulting more efficient products deliver a net benefit to the wider community.

representatives from New Zealand, responsible for implementing product energy efficiency initiatives in those jurisdictions.

- NAEEEC reports through the Working Group for Energy Efficiency and Greenhouse Gas (E2G2) to the Ministerial Council on Energy (MCE), which is made up of the Ministers with portfolio responsibility for implementation of the National Greenhouse Strategy in this field.
- MCE has charged E2G2 to manage overall policy and budget of the national program.

NAEEEP relies on State and Territory legislation to give it legal effect. This use of state and territory laws involves using the relevant Australian Standard for the specific product type. For example, a 2003 revision of Australian and New Zealand Standard AS/NZS 3823, *Performance of household electrical appliances – airconditioners and heat pumps*, sets out the proposed MEPS for airconditioners. It is this standard that will be called up by State and Territory legislation. These arrangements are further explained in chapter 7, dealing with implementation of the proposals.

### 1.3 NAEEEP's policy framework

The broad policy directions of NAEEEP were reviewed in 1998-99 and again in 2000-01, with recommendations brought together in two 'Future Directions' documents (NAEEEC 1999 and NAEEEC 2001). The MCE subsequently endorsed certain changes, with the result that NAEEEP operates with the authority of the MCE with respect to broad policy objectives. These relate to product coverage, communication, and procedures and timetable for products proposed for regulation.

#### **Product coverage**

Any type of consumer appliance, industrial or commercial equipment is eligible for inclusion in NAEEEP, provided it is identified as a likely contributor to growth in energy demand or greenhouse gas emissions. The selection criteria include potential for greenhouse or energy savings, environmental impact of the fuel type, opportunity to influence purchase, market barriers, access to testing facilities, and administrative complexity. The measures adopted by NAEEEP are subject to a community cost benefit analysis and consideration of whether the measures are generally acceptable to the community.

#### **Communication**

NAEEEC develops its product strategies through a transparent planning process, including by providing stakeholders with formal opportunities for providing comment and feedback.

#### **Procedures and timetable**

In respect of any proposal to implement Minimum Energy Performance Standard (MEPS), a significant initiative in recent years has been the decision by MCE to match the best MEPS level of Australia's trading partners, after taking account of differences in test methods and other relevant differences such as climate or consumer preferences. The explicit adoption of 'world's best regulatory practice' focuses attention on specific options, provides stakeholders with confidence that proposed MEPS are technically feasible, and thereby avoids the long and many-sided debates about technical options that have characterised the development process in the past.

Related to that, NAEEEP uses the standards machinery that is familiar to industry. Labelling and standards requirements are implemented in Australian and New Zealand Standards, and developed in consultation with, and using the consultative machinery of, Standards Australia. On occasion, this has required the development of a new standard, for example, to harmonise Australian testing standards with testing procedures commonly used by trading partners.

NAEEEP has adopted a standard legislative timetable, designed to implement any proposed MEPS within 3 to 5 years, giving industry some certainty about the process while also providing industry with adequate notice of new MEPS.

## 1.4 Contribution of airconditioners to greenhouse emissions

Estimates of the greenhouse contribution of electrical heating, ventilation and airconditioning (HVAC) equipment can be obtained from two studies commissioned by the Australian Greenhouse Office (AGO), *Australian Residential Building Sector Greenhouse Gas Emissions 1990 – 2010* (EES 1999) and *Baseline Study of Greenhouse Gas Emissions from the Commercial Buildings Sector with Projections to Year 2010* (EMET & Solarch, 1999). The estimates are based on “business as usual” (BAU) assumptions, including the effects of all energy efficiency programs in place by 1999.

GWA (2000) has summarised the key findings – see table 1.1.

- Electrical HVAC equipment accounted for 4.5% of total emissions in 2000, increasing from 3.7% in 1990 and projected to increase to 5.4% in 2010.
- Residential sector emissions are small relative to the commercial sector; the split is roughly 10% residential and 90% commercial.
- The residential contribution is expected to increase by 14% in the 20 years to 2010, whereas the commercial contribution is projected to increase by 66% over the same period. This reflects projected strong growth of the services sector of the economy.
- There are significant omissions from the electrical HVAC estimates provided in table 1.1. Specifically, the commercial building sector has been defined to exclude airconditioned space in non-service sectors – that is, excluding agriculture, mining, manufacturing, electricity generation, transport and construction.

**TABLE 1.1: PROJECTED ENERGY USE AND GREENHOUSE EMISSIONS DUE TO ELECTRICAL HVAC EQUIPMENT: 1990, 2000 AND 2008-2012**

	<i>Residential</i>	<i>Commercial</i>	<i>Total</i>
<b>Energy use (PJ)</b>			
1990	7.1	59.4	66.5
2000	8.4	83.3	91.7
2010	9.1	110.3	119.4
<b>Greenhouse emissions (Mt CO<sub>2</sub>-e)</b>			
1990	2.1	17.6	19.7
2000	2.3	22.8	25.1
2010	2.4	29.1	31.5
<b>Greenhouse emissions (% of total emissions)</b>			
1990	0.4%	3.3%	3.7%
2000	0.4%	4.1%	4.5%
2010	0.4%	5.0%	5.4%
<b>Greenhouse emissions (% of 1990 level)</b>			
1990	100.0%	100.0%	100.0%
2000	109.5%	129.8%	127.7%
2010	114.3%	165.6%	160.1%

Source: GWA 2000 (drawing on EES 1999 and EMET et al, 1999), but with the commercial estimates for greenhouse emissions adjusted by applying the same greenhouse intensity assumptions as used for the residential estimates.

Airconditioners and heat pumps (hereafter referred to simply as ‘airconditioners<sup>2</sup>’) are only a subset of the electrical HVAC equipment that accounts for the emissions reported in table 1.1.

<sup>2</sup> The airconditioners that will be subject to the proposed MEPS are of the vapour compression type. They can be designed as ‘cooling only’ devices that pump heat out of a building, or they can be configured for a ‘reverse cycle’ that allows the equipment to be used for either cooling or heating. The latter are often referred to as ‘heat pumps’, distinguishing the reverse cycle equipment from the cooling-only airconditioners. We refer to both as airconditioners.

In the residential sector, for example, the emission estimates include contributions from electric resistance heaters and evaporative coolers. In the commercial sector, the proposed MEPS will not apply to the purpose built installations that serve larger buildings, generally incorporating central cooling towers.

## 1.5 Market failure

Evidence of market failure (and the implicit scope for cost-effective reductions in greenhouse emissions) is strongly suggested by market observations such as the following:

- There are large gaps between the energy efficiency of the least efficient and the most efficient appliances on the market. Variations of 20-30% are readily observed in the Australian market, even putting aside the extremes of high and low efficiency. Even more energy efficient product is available overseas.
- There is expert evidence that the energy efficiency of many airconditioners could be considerably improved at little or no cost to suppliers and hence consumers.
- Marketing sources report that energy efficiency is often not a primary or even a significant consideration in consumer purchases. The apparent lack of concern is at odds with the fact that energy costs contribute significantly to the 'whole of life' costs of using an appliance.
- The cost effectiveness of regulatory measures to promote energy efficiency has been demonstrated across a range of appliances and equipment in a many countries, including for airconditioners.

The continued commercial success of inefficient appliances can be traced to the fact that reliable information about the value of investments in energy efficiency is unavailable or expensive to obtain. Furthermore, most people have a poor understanding of the contributions of different appliances to their total energy bill. They are therefore not well placed to assess investments in energy efficiency.

Even where the appliance or equipment selection is effectively delegated to experts – for example, to the building designers who specify the HVAC equipment – those experts are not systematically rewarded for energy efficient designs if the ultimate users (owners and renters) fail to appreciate the value of the investment. The perverse result is that small savings in capital costs may be preferred to large savings in energy costs.

## 2 The objective

This chapter explains the objectives of the regulations, firstly in terms of completing NAEEEC's strategy for airconditioners (section 2.1), much of which has already been implemented, and secondly, in terms of the formal objectives against which the proposal is assessed in this RIS (section 2.2).

### 2.1 NAEEEC's airconditioner strategy

#### Existing measures

The proposed regulations will substantially complete NAEEEP's package of airconditioner measures. The following elements of the strategy have already been implemented through successive amendments to Australian and New Zealand Standard AS/NZS 3823:

- NAEEEC's energy efficiency labelling scheme (the 'star' scheme) is mandatory for residential airconditioners taking single-phase power. It has been in place nationally for 10 years (in some states for much longer) and remains the cornerstone of the national program.
- Suppliers of three-phase units have had the option of labelling since October 2001. However all of the conditions apply if that option is taken, including the requirement for product testing. Marketing laws cover instances where suppliers inadvertently or intentionally label inaccurately.
- The regulation of performance standards for airconditioners commenced in October 2001 on a national scale, starting with airconditioners taking three-phase supply. This work was completed under the previous policy regime, that is, prior to the MCE decision to accelerate the development process by focusing on world's best regulatory practice. These airconditioners account for about 75% of the energy consumed by the targeted airconditioners.
- AS/NZS 3823 also requires:
  - all statements about cooling and heating capacity, energy consumption and energy efficiency to be consistent;
  - the values to be determined under the test conditions specified in Part 1;
  - products to meet requirements of the maximum cooling test in Part 1;
  - products to be registered with a State or Territory energy agency;
  - statements about cooling and heating capacity, energy consumption and energy efficiency to be subject to check testing, using the procedure specified in Part 2.
- Australian test standards have been aligned with overseas testing procedures – specifically, ISO5151:1994 and ISO1325.3:1995. This will avoid the costs of duplicate tests, since many supplier countries also have testing requirements as part of their MEPS arrangements.

Outside the Standards process, NAEEEC also works in partnership with stakeholder groups to introduce programs that encourage market transformation by promoting highly efficient equipment.

#### Development of new measures to complete the strategy

The proposed new regulation implements the following final elements of an overall strategy that will see the industry through to 2012, again via amendments to AS/NZS 3823:

- It will extend MEPS coverage to the remaining 25% of the airconditioner market (single-phase airconditioners) from July 2004.

- It provides for increased MEPS stringency for both single-phase and three-phase airconditioners from July 2007.
- The new Standard includes the definition of 'high efficiency' airconditioners for the first time.
- The registration testing requirements have been reduced, reducing business costs.

To determine the proposed MEPS, NAEEEC has followed the MCE policy directive to explore levels that are commensurate with MEPS adopted by Australia's trading partners. By contrast, the 2001 MEPS were completed using a market regression analysis because negotiations were well advanced when MCE made the policy change. The aim of the 2001 MEPS was to retire 40% of the models available on the market at a set time. This regulatory proposal moves away from that analysis of the Australian marketplace to use international developments as the driver for regulatory proposals. Given Australia's status as a large net importer of electrical appliances and equipment, NAEEEC considers that it could be excessively costly to adopt standards that put Australia significantly at odds with major trading partners.

Accordingly, NAEEEC described the development of the proposals as follows.

*NAEEEC commissioned consultants to examine international developments. ...The results were tested with key representatives from industry and other stakeholder groups and the outcome of this process is reported in this public profile.*

*In general, USA MEPS being implemented in 2003/4 were considered the basis for MEPS proposed for Australia for three-phase airconditioners while the Taiwanese MEPS levels implemented in 2001 were considered the basis for MEPS proposed for Australia for single-phase airconditioners. These were chosen after detailed comparison of testing methods and comparison with Australian products showed they were the most stringent currently or proposed by the major trading partners. Although Japan has proposed more stringent levels for certain sizes of single-phase airconditioners, they are based on a sales weighted average efficiency and not directly translatable to Australian conditions. They do, however, establish that more efficient product will be readily available. (NAEEEC 2002)*

Given an appropriate lead from a trading partner, the strategy is to match international best practice within a few years of the leading country. Note the meaning of 'best practice' in this context. It is best practice in terms of regulation, eliminating the least efficient models, not best practice in terms of leading the process of technological development. However, in instances where Australia matches regulation in some countries like the USA or Japan, it will in effect require MEPS levels that match best available technology because that is the legislative mandate in those countries.

The selection of a leading country for three-phase airconditioners is straightforward, since the USA is the only one of Australia's major trading partners to adopt MEPS for the larger (commercial) airconditioners. In broad terms, NAEEEC's proposal for July 2007 is to adopt MEPS levels that will apply in the USA from October 2003 for smaller commercial units and from October 2004 for larger commercial units. . The outcome of adopting the USA levels is that about 75% of models on the market in 2003 would not be able to be reregistered in 2007.

A number of Australia's trading partners have adopted MEPS or MEPS-like arrangements for single-phase air conditioners. NAEEEC's consultants (EnergyConsult 2002) provided comparisons for existing MEPS in the USA, Chinese Taipei, Japan, Korea and China. The most stringent of these, Chinese Taipei (Taiwan), provides the lead for the proposed regulation. The outcome of adopting the Chinese Taipei levels is that about 90% of models on the market in 2003 would not be able to be reregistered in 2007.

A further element of the new regulation is to require three-phase appliances designated as *high efficiency* to comply with specific efficiency requirements that are set higher than the mandatory requirements that apply to all appliances. This is a form of energy labelling, designed to ensure that the designation of *high efficiency* retains a well-defined meaning for users and is not diluted to the point where any unit that is marginally better than the MEPS can be marketed as highly efficient.

The high efficiency category also has a role in signalling NAEEEC's intentions beyond 2007, which it does in two ways:

- First, NAEEEC has indicated to industry that, after 2007, there would be no further increases in MEPS until at least 2012, to allow industry time to recoup costs.
- Second, NAEEEC commits to industry that any future MEPS commencing not earlier than 2012 would not exceed the standard for high efficiency appliances applicable from 2007. Industry has a clear view of the regulatory timetable for developments well into the next decade.

In respect of single-phase airconditioners, NAEEEC proposes to reduce the requirement for physical testing of each registration to only one unit. Currently, physical tests need to be carried out on three units for each registration. This system brings single-phase registration more into line with three-phase registrations where suppliers declare the efficiency of units without necessarily supplying any supporting data at the time of registration.

### **Options considered in the previous RIS**

In selecting to expand the ambit of regulation to complete the airconditioner strategy, NAEEEC has implicitly rejected a number of alternative approaches. Specifically, the previous RIS (GWA 2000) discusses the following alternatives:

- *Targeted regulation* was considered. This is a minimalist option, doing without various supporting provisions in the regulation, such as registration requirements, check testing and the maximum cooling test. (The latter is designed to eliminate certain design options that allow airconditioners to comply with the MEPS in a test situation but to under-perform in actual use.)
- A *voluntary MEPS regime* would encourage product suppliers to meet certain minimum energy efficiency levels, but without sanctions for non-compliance.
- A *levy imposed upon inefficient products* was also considered. The revenues would be used to fund programs to redress the greenhouse impact of equipment energy use, and the scheme might be revenue neutral or revenue positive.
- An *electricity levy* to reflect the costs of greenhouse gas emissions could be considered or, alternatively, some form of tradeable permits scheme.

These options are given further consideration in chapters 3 and 4, dealing with feasible alternatives to the proposals and the assessment of their impact.

## **2.2 Objectives against which the proposed regulation is assessed**

The objective of the proposed regulation is to reduce Australia's greenhouse gas emissions from the use of airconditioners, subject to the following constraints:

- The measures need to be cost-effective for the broad community of users of airconditioners.
- The measures need to be efficiently designed, minimising adverse impacts on manufacturers and suppliers, and minimising adverse impacts on product quality and function.

- The measures need to be clear and comprehensive, minimising potential for confusion or ambiguity for users and suppliers.

Cost-effectiveness is interpreted in terms of the interests of the broad community of users.

### 3 Options

NAEEEC’s options finalising the airconditioner strategy are explained here under seven headings. The first two deal with the options of either implementing the proposed regulation or maintaining the existing regulatory position. The remainder deal a series of options that depart from the proposal in some significant respect.

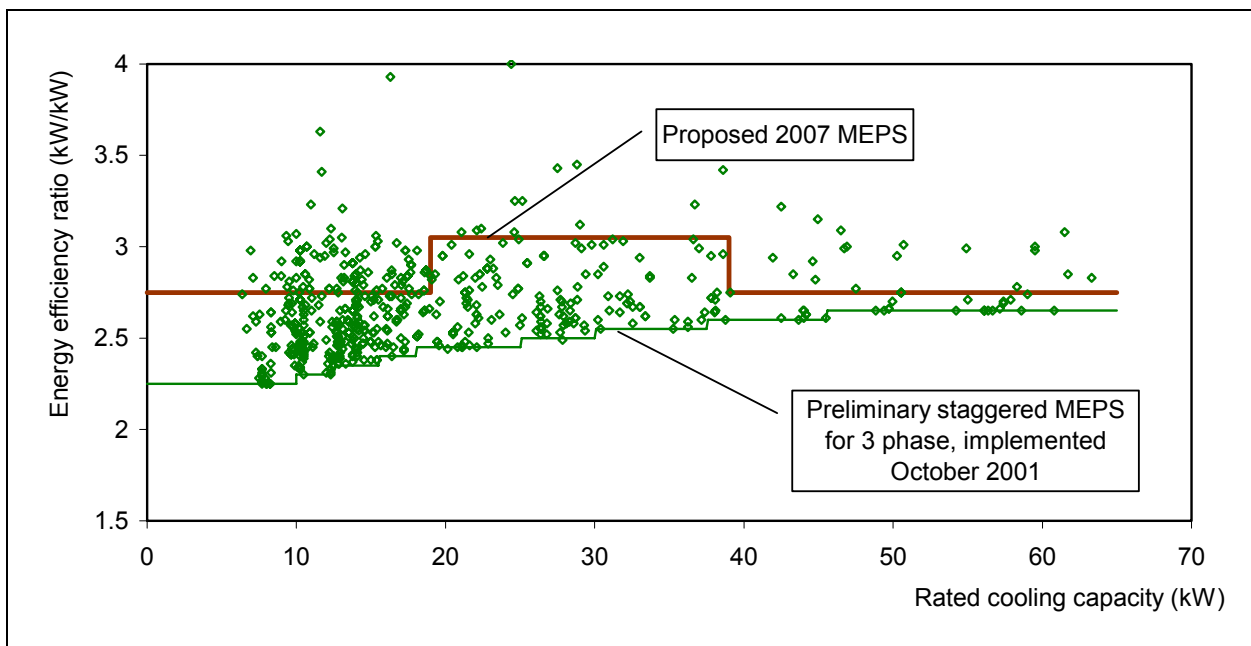
#### 3.1 The proposed regulation

The existing and proposed MEPS are summarised in figures 3.1 and 3.2 for three-phase and single-phase airconditioners respectively. These show the MEPS against scatter diagrams representing the approximately 2,200 airconditioners that were registered in 2003. Each point in the scatter represents the combination of capacity (kW of output power) and energy efficiency ratio (EER) of an airconditioner registered on the database. See appendix 1 for an explanation of the technical background and related terminology.

Tables 3.1 and 3.2 report the impact of the MEPS on the airconditioner models registered in 2003, for three-phase and single-phase airconditioners respectively. These are the proportions of existing models that would not comply with the 2007 MEPS. Note that both the figures and the tables somewhat overstate the impact of the MEPS, since normal processes of efficiency improvement in the period to 2007 would have eliminated some part of the product range anyway. Also note the difference in the horizontal scales used in figures 3.1 and 3.2. Three-phase airconditioners range in size up to 75 kW, whereas single-phase units are mainly of capacity less than 10 kW.

The preliminary MEPS for three-phase airconditioners was introduced in October 2001. As shown in figure 3.1, it is a staggered arrangement with progressively more demanding MEPS applied to larger airconditioners. The 2007 MEPS provides for more uniform MEPS, generally requiring a minimum EER of 2.75, with the exception of units in the capacity range of 19-39

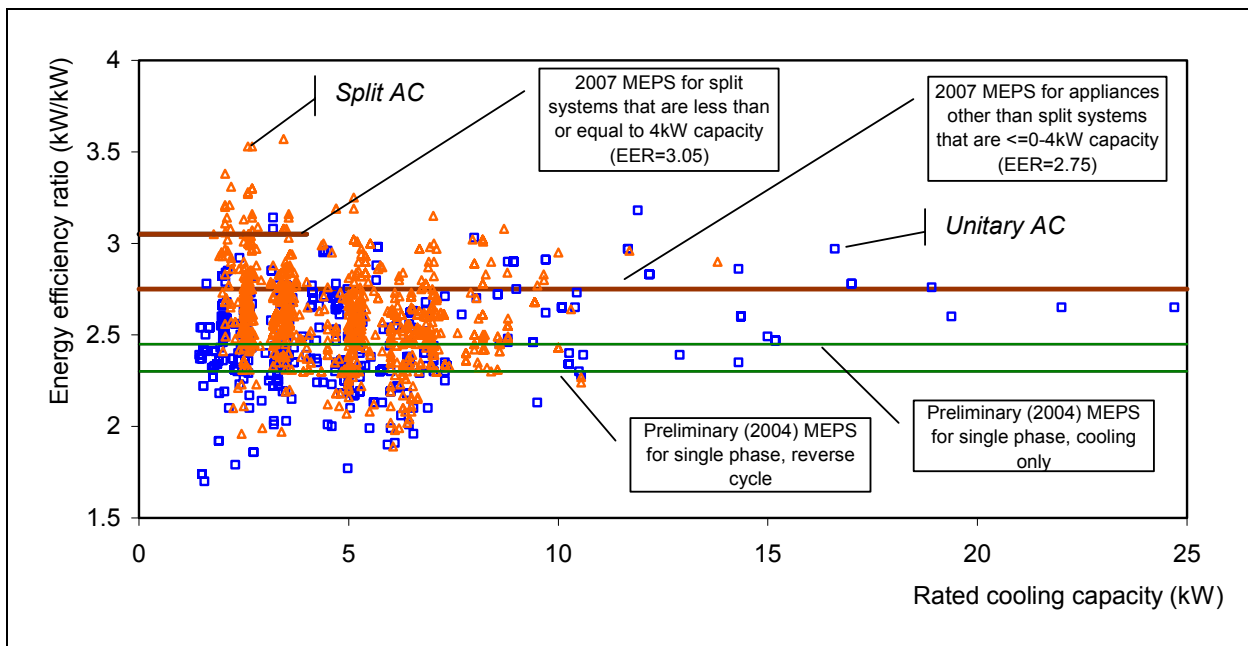
**FIGURE 3.1 THREE-PHASE UNITS - CAPACITY AND EER, COMPARED WITH PROPOSED MEPS**



**TABLE 3.1: PROPORTION OF THREE-PHASE MODELS REGISTERED IN 2003 THAT WOULD NOT COMPLY WITH THE 2007 MEPS**

Capacity (kW)	Cooling only			Reverse cycle			Total		
	Split	Unitary	Total	Split	Unitary	Total	Split	Unitary	Total
4-8	Na	100%	100%	80%	94%	91%	80%	94%	91%
8-19	45%	70%	63%	60%	73%	68%	57%	72%	67%
19-39	100%	87%	88%	95%	91%	93%	95%	91%	92%
39+	Na	56%	56%	20%	66%	54%	20%	63%	54%
<b>Total</b>	<b>52%</b>	<b>74%</b>	<b>69%</b>	<b>67%</b>	<b>78%</b>	<b>75%</b>	<b>65%</b>	<b>77%</b>	<b>74%</b>

**FIGURE 3.2 SINGLE-PHASE UNITS - CAPACITY AND EER, COMPARED WITH PROPOSED MEPS**



**TABLE 3.2: PROPORTION OF SINGLE-PHASE MODELS REGISTERED IN 2003 THAT WOULD NOT COMPLY WITH THE 2007 MEPS**

Capacity (kW)	Cooling only			Reverse cycle			Total		
	Split	Unitary	Total	Split	Unitary	Total	Split	Unitary	Total
0-2	86%	89%	89%	100%	100%	100%	91%	91%	91%
2-4	86%	92%	89%	95%	92%	94%	92%	92%	92%
4-8	88%	93%	90%	86%	94%	88%	87%	94%	89%
8-19	81%	50%	66%	73%	73%	73%	75%	66%	70%
19-25	Na	na	na	na	100%	100%	na	100%	100%
<b>Total</b>	<b>87%</b>	<b>89%</b>	<b>87%</b>	<b>89%</b>	<b>90%</b>	<b>90%</b>	<b>88%</b>	<b>90%</b>	<b>89%</b>

kW where the minimum EER is 3.05. This is reflected in the capacity distribution of models affected by the regulation, falling disproportionately on the smallest three-phase models that are lightly regulated at present and on models in the range 19-39kW – see table 3.1. Overall, three-quarters of currently registered models would not comply with the 2007 MEPS.

Currently, single-phase airconditioners are not subject to MEPS. The proposal is to introduce preliminary MEPS in 2004 but with a further increase to the proposed 2007 MEPS. Figure 3.2 shows both proposals with significant differences by type of air conditioner, as follows:

- The preliminary MEPS are set higher for cooling only models than for reverse cycle models (EER of 2.45 and 2.30 respectively).
- The 2007 MEPS distinguish between split and unitary models. While the general requirement is a minimum EER of 2.75, a more demanding requirement is proposed for the smaller split systems with capacity in the range 0-4 kW. (Split models and unitary models are presented in figure 3.2 as small triangles and rectangles respectively. Again, the technical background is explained in appendix 1.)

About 13% of the currently registered single-phase models would not comply with the preliminary 2004 MEPS. The impact varies little between cooling only and reverse cycle models, despite the difference in the preliminary MEPS. Turning to the 2007 MEPS, about 90% of the currently registered single-phase models would not comply - see table 3.2. Again there is little systematic difference between the impact on split and unitary models despite the difference in MEPS.

Overall, the adoption of world's best regulatory practice in 2007 would affect about 85% of the models that suppliers have registered with the AGO in 2003. The impact on single-phase units is considerably higher than for three-phase units. This outcome is to be expected as the introduction of the preliminary three-phase MEPS in 2001 has already eliminated many of the inefficient products within the three-phase range. Otherwise there are no significant patterns evident in the data; the impact of the proposal appears to be evenly distributed across the range of registered models.

This relatively uniform distribution of the impact reflects the fact that the levels specified by MEPS have been set consistent with the ease with which efficiencies can be achieved in different sectors of the market. This is largely related to the trade-off between physical size and energy efficiency. *For a given output capacity*, there is more efficient heat transfer from the increased surface areas available to units that are physically larger. Hence, higher standards can be imposed where the physical size of the unit is less constrained, as in the case of small split units where part of the unit is outside the building and out of sight.

## 3.2 The business as usual option

The proposed regulation is effectively defined by figures 3.1 and 3.2 and tables 3.1 and 3.2. However this is only one of the options to be considered. One alternative to that is to maintain the existing regulatory position. This is the *status quo* or business as usual (BAU) option. This option would preserve the elements of the airconditioner strategy that are already in place but the proposals to expand coverage and increase stringency would not occur. Specifically, the efficiency of three-phase airconditioners would continue to be constrained by the 2001 MEPS, with the minimum levels of efficiency increasing with the size of the unit. Most of the smaller airconditioners, being single-phase, would not be required to achieve a minimum level of efficiency.

The outlook is not one of zero efficiency gain under the BAU option. Long term trend increases in the energy efficiency of airconditioners have been documented in US studies (DoE 1997). In the previous RIS (GWA 2000) it was assumed that the heating and cooling requirements of buildings would decrease at 0.25% per year due to the combined effect of better designed buildings and gains in the energy efficiency of airconditioning equipment. In earlier projections of residential energy demand, EES (EES 1999) put the projected efficiency gains for various types of airconditioners in the range 0.2-0.5% per year. For the purposes of assessing the impact of the proposal relative to the BAU scenario, it has been assumed in this RIS that product energy efficiency improves at 0.4% per year under BAU conditions.

Over time, BAU improvements have implications for the continued impact of NAEEEC's energy efficiency strategies. Given sufficient time, for example, the star ratings used in energy labelling schemes would no longer reflect the range of available product; they would all be 6-star. And all airconditioners would eventually comply with the proposed MEPS through BAU efficiency gains. It follows that energy efficiency strategies need periodic adjustment. Otherwise the capacity to drive efficiency gains faster than market delivered improvements is diluted over time. NAEEEC's policy in that respect is to stay aligned with world's best regulatory practice.

### 3.3 Option of a minimalist regulation

The Australian Standard (AS/NZS 3823 series) contains a number of provisions other than the specific MEPS, but which support the MEPS. One option is to preserve the core of the proposed regulation (MEPS) but to do without one or more of the supporting provisions. The aim would be to adopt a minimalist regulation.

The supporting provisions relate to the practicalities of testing, registration and labelling – as follows:

- *Maximum cooling test:* The purpose of the maximum cooling test is to ensure that products are not engineered so as to obtain a high rating on the energy efficiency test at the cost of a reduction in maximum performance, which buyers will not be aware of until after purchase. It is considered that this offers important protection for consumers at a cost that is not excessive.
- *Registration:* The state regulatory authorities have opted to require registration of airconditioners falling within the scope of the AS/NZS 3823 series. The Standard specifies the form of application, including any test data that may be required.
- *Check testing procedure:* NAEEEC funds a check testing program for the purposes of monitoring and enforcement. The Standard specifies the number of units to be tested and the tolerances that will be allowed in test results.
- *Permanent marking:* The compliance plate that is fixed to every unit must include the additional information that the unit complies with the MEPS.
- *Performance simulation option for three-phase units:* Suppliers of three-phase airconditioners have the option of using a simulation test rather than a physical test, in recognition of certain constraints on the availability of suitable laboratory facilities in Australia.
- *Separate requirements for three-phase units designated as high efficiency:* It is proposed that three-phase models designated as *high efficiency* will need to achieve efficiency levels that are clearly higher than the mandatory MEPS. Specifically, three-phase units in the range 19-39 kW must achieve an EER of 3.65 to be designated as high efficiency, which is 0.6 greater than the mandatory requirement of 3.05. All other three-phase high efficiency units must achieve an ERR of 3.35, which is 0.6 higher than the general requirement of 2.75.

Most of these are not practical options for the purposes of this RIS. For single-phase airconditioners, the maximum cooling test, registration and check testing procedures<sup>3</sup> are required for the purposes of the pre-existing labelling requirements and are part of the BAU option. The only new requirement is the need for a statement of MEPS compliance on the compliance plate. This is a negligible cost since the compliance plate itself is required under other regulations.

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<sup>3</sup> As noted in chapter 2, NAEEEC proposes to reduce the requirement for physical testing of each registration to only one unit. Currently, physical tests need to be carried out on three units for each registration of a single-phase model. This change brings single-phase registration more into line with three-phase registrations where suppliers declare the efficiency of units without necessarily supplying any supporting data at the time of registration.

For three-phase airconditioners, all but the high efficiency measures are also part of the BAU scenario. They were introduced for the purposes of the 2001 MEPS and were assessed in the earlier RIS (GWA 2000). These supports were found to be highly cost efficient, particularly in terms of improving the information base, analytical and monitoring capacities of the regulatory authorities, and addressing the significant risks of non-compliance in the absence of these provisions. With the exception of the high efficiency requirements these options are not considered further in this RIS.

The high efficiency provisions are addressed but in the context of the ‘leadership’ option that follows.

### 3.4 The leadership option

The MCE has adopted a policy of following world’s best regulatory practice. An obvious alternative is for Australia to take the lead itself and set the pace for the rest of the world. It is convenient to pose this issue in terms of the appropriate status of airconditioners that would qualify as high efficiency units under the proposal. The proposal is not to require suppliers to deliver these levels of efficiency but simply to refrain from describing their products as highly efficient unless they do. The leadership option would be to raise the mandatory 2007 MEPS to the high efficiency level, or at least significantly higher than is proposed currently. While the higher standards have been defined only for three-phase units, similar high standards could be devised for single-phase models and adopted as MEPS. The further percentage increase in efficiency for three-phase airconditioners is about 20%. All but a handful of the airconditioner models that are currently registered would fail to comply with such standards.

Weaker variations on this option would involve maintaining the policy of following world’s best regulatory practice but to follow more closely. For example, the lag might be reduced by a year or two.

The general effect of either leading or following more closely is to raise the MEPS trajectory relative to what is proposed, affecting the stringency of the regulation. Since stringency is obviously a key dimension of the proposed regulation, this option is specifically addressed in chapter 4.

### 3.5 Less stringent options

Another alternative is to adopt a less demanding target than world’s best regulatory practice. As discussed already, world’s best practice was identified by NAEEEEC’s consultants (EnergyConsult 2002), who provided comparisons for existing MEPS in the USA, Chinese Taipei, Japan, Korea and China. Two other countries were also considered but put aside due to differences in testing procedures that prevented direct comparison (Philippines) and lack of coverage (Singapore).

The first point to make about this comparison is that it provides a snapshot of an options menu that is not static. All of these countries are on rolling programs of increasing MEPS, but moving to different timetables. Over the longer term it will be seen that different countries take the lead at different times. Importantly, NAEEEEC’s strategy is *not* to follow each new leader as it emerges. Rather, NAEEEEC plans to revise MEPS at periodic intervals, taking a lead that is appropriate at that time. In that way Australia joins the rolling program of increasing MEPS, moving closer to the front when MEPS are revised, but slipping back through the pack during intervening periods. Over the long haul the effect will be for Australia to broadly keep pace with its reference group. And it is this *group* that matters in terms of representing Australia’s suppliers, not the particular country that happens to provide the lead from time to time.

The second point to make is the menu often offers very little choice. Typically, one or two MEPS are clearly outdated and are due for revision. For example, many of the Chinese MEPS

were last revised in 1989 and one US MEPS was last revised in 1992. Other MEPS are future industry targets and are not appropriate models for Australia; the Japanese 'Top Runner' scheme takes this form. The result is that the differences between the practical options within the reference group members are not always significant, and certainly not in terms of the data that is available to discriminate between costs and benefits of those options. Generally the difference is than 7%. At the present time the choice is usually between Korea, Chinese Taipei and the US. While Korea is less demanding just at present, its timetable for revisions may take it ahead of Chinese Taipei within the next year or two.

Overall it is not feasible identify a less stringent targeting policy that is amenable to meaningful analysis. The options in respect of stringency are adequately addressed in terms of the appropriate lag between the lead country and Australia.

### 3.6 Option of reduced government role in regulation

The proposal is that the minimum energy efficiency of airconditioners be subject to explicit government regulation. That is one form of regulation. ORR (1998) identifies a spectrum of regulatory approaches with explicit government regulation at one end of the spectrum and self-regulation at the other at one end of the spectrum. Intermediate forms of regulation (quasi-regulation and co-regulation) are also identified. The differences can be summarised as follows:

- Self-regulation requires that the industry has a viable industry association with broad coverage and that members are sufficiently 'of like mind' that they will voluntarily adhere to a code of conduct devised by the members. Minimal sanctions such as loss of membership or peer disapproval are all that is required to ensure broad compliance. The government role is reduced to facilitation and advice.
- Self-regulation merges into quasi-regulation, the latter distinguished by a stronger role for government in endorsing industry codes, providing technical guidance, or entering into government-industry agreements.
- Co-regulation describes the further stage where government provides some form of legislative underpinning for industry codes and standards. This may involve delegating regulatory powers to industry, enforcement of undertakings to comply with codes, or providing a fall-back position of explicit regulation in the event that industry fails to self-regulate.

These options have been addressed in the previous RIS (GWA 2000) under the heading of 'Voluntary MEPS', referring mainly to the option of self-regulation. Various difficulties were identified. The key difficulty is that the industry association (AREMA) represents the larger and medium suppliers only and is not broadly representative of the industry. The preconditions in terms of trust and confidence simply do not exist in the industry. It was determined from an early stage (mid 1990s) that AREMA was not a suitable vehicle for developing an energy efficiency code and that it would need to be developed as a government rather than an AREMA program. This consideration is fatal to options for quasi-regulation and co-regulation as well, both of which would promote AREMA as the *de facto* industry regulator. GWA further identified the following considerations:

- Users are too numerous and diverse to provide the institutional structure that would be required to impose standards on suppliers.
- Governments could adopt efficiency standards for their own purposes but comprise too small a market to provide effective leadership to the market as a whole.
- All APEC countries other than Japan have used explicit regulation to impose MEPS. Japan is recognised as a special case in terms of the close relationships between government and industry, industry's willingness to provide governments with confidential information, and the effectiveness of informal sanctions.

In terms of ORR's checklist for assessing regulatory options (ORR 1998: Box D.2), it is also apparent that government is the active party. Government is responding to a significant public issue; it is convinced of the need for action; and it needs to ensure that there are specific achievements against the criteria of cost-effectiveness set out in the National Greenhouse Strategy. Overall, therefore, industry as a whole is neither strongly motivated nor well structured to take the initiative.

The earlier RIS applies specifically to three-phase airconditioners. If anything, however, self-regulation and the intermediate forms of regulation would prove even more problematic in the case of single-phase airconditioners. The main issue is that AREMA would be even less representative of the suppliers of smaller airconditioners, who are more numerous than the suppliers of three-phase units. And consumers are even more fragmented and naïve.

Accordingly, this RIS gives no further consideration to options for reducing the government role in the regulation of the energy efficiency of airconditioners.

### **3.7 Option of using alternative instruments**

ORR also identifies a number of alternative instruments that might be used instead of regulation. These include information and education campaigns; labelling requirements; taxes, subsidies and user charges; and tradable property rights.

The information, education and labelling options are not given further consideration in this RIS. As discussed in chapter 2, the airconditioner strategy already includes initiatives of this kind, organized around the energy labelling (star-rating) scheme. Airconditioners of less than 7.5 kW capacity have been included in this scheme for 10 years<sup>4</sup>. Nevertheless, NAEEEC considers that significant opportunities for cost-effective increases in energy efficiency remain. This basic proposition is assessed in chapter 4.

The previous RIS also briefly considered the options for market based instruments – specifically, levies on the use of energy or on the use of inefficient equipment. However, these are major policy issues for the highest level of governments. They would not be decided by NAEEEC or even necessarily by MCE. Nor would they be decided in relation to specific items of equipment such as airconditioners, since such schemes would apply to inefficient equipment generally or to the use of energy generally. They were rejected in the previous RIS and no longer represent realistic alternatives that could be considered by MCE. Accordingly, these options are not further considered in this RIS.

### **3.8 Conclusion**

Based on the above analysis, three options require detailed consideration. First, there is the BAU option which would leave the airconditioner strategy to continue as present. The second option is the proposed MEPS. The final option is for Australia to follow the international lead more closely and possibly to take a leading role itself in setting MEPS.

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<sup>4</sup> The criterion for labelling has recently been altered from a capacity-based rule (<7.5 kW) to a rule based on the type of power supply. Specifically, labelling now is required only of single-phase models. These dominate the range of smaller models.

## 4 Impacts analysis

This chapter reports assessments of the impact of the proposed regulation on energy use and greenhouse emissions, users, suppliers and governments. These are brought together in an assessment of national costs and benefits. Appendix 2 documents the key modelling assumptions that are not otherwise given in detail in this chapter.

Impacts have been assessed with reference to two previous modelling exercises commissioned by the AGO. One provides projections for greenhouse emissions from the residential building sector (EES 1999), which would account for the majority of single-phase units and a proportion of the three-phase units. The other is the report on options for an energy efficiency program for packaged air conditioners (Unisearch 1998) which also provided the basis for the earlier RIS for the interim MEPS for three-phase airconditioners (GWA 2000). These studies provide estimates of both the energy used and the number and characteristics of the airconditioners involved. The former is essential to the estimation of benefits. The latter is essential to the estimation of costs. AGO will revise the residential projections in 2004.

The two models overlap to some extent, since both include three-phase airconditioners that are used in residential buildings. These would be larger units used in the ducted systems that account for about 10% of the residential market. On the other hand, neither model includes single-phase airconditioners that are used in the commercial sector, for example, the room airconditioners used by motels and by small retail businesses. This is a significant omission and, on balance, the sum of the residential and three-phase sectors is likely to provide an underestimate of airconditioner use.

### 4.1 Impact on energy use and greenhouse emissions

Figures 4.1 and 4.2 report estimates of the energy savings and reductions in greenhouse emissions generated by the proposed regulation. The time profile of the projections reflects the following assumptions:

- The proposed 2007 MEPS are implemented from 1 July 2007 but assumed to become fully effective from July 2008, since suppliers are given one year to clear stock acquired before July 2007.
- The 2007 MEPS are assumed to terminate in July 2012, at which point there would be a further increase in the MEPS or at least some further decision about the level of MEPS. Beyond 2012, therefore, there is no addition to the stock of airconditioners that are required to comply with the 2007 MEPS.
- The stock of 2007 compliant airconditioners continues to deliver energy savings for the life of the last cohort of units that is installed in 2012. Assuming average asset lives of 10 years and 15 years, for residential and three-phase units respectively, the energy savings continue to accumulate until 2021 and 2026.
- It is also assumed that suppliers anticipate the introduction of MEPS by starting to phase out non-compliant units in the period before the introduction of MEPS. In the case of single-phase airconditioners, the phase out is accelerated by the introduction of preliminary MEPS in 2004.

Total reductions in energy use and greenhouse emissions are 1,560 GWh and 1.5 MTCO<sub>2</sub>-e respectively for residential airconditioners<sup>5</sup>. The corresponding estimates for three-phase

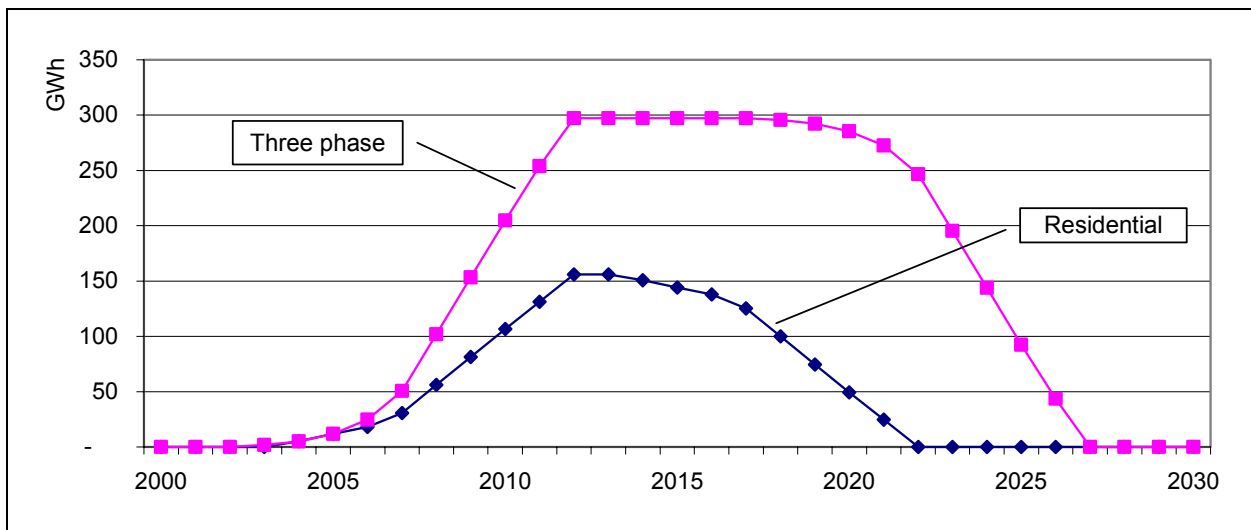
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<sup>5</sup> The relationship between energy savings and reductions in greenhouse emissions is determined by reference to projections for 'greenhouse gas coefficients' for electricity. For consistency with the underlying models, the

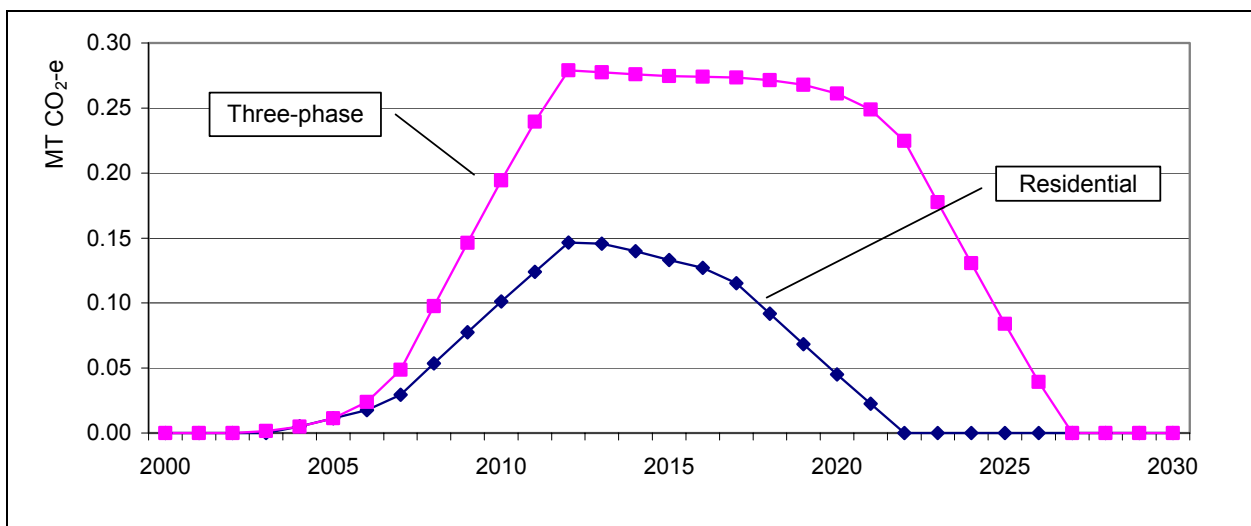
airconditioners are 4,460 GWh and 4.1 MTCO<sub>2</sub>-e. In 2010, the savings represent 4.8% of the emissions from the targeted airconditioners in the residential sector, and 2.5% from the three-phase airconditioners. Including the single-phase units in the commercial sector, which have not been explicitly modelled, it is reasonable to expect that the proposals will reduce greenhouse emissions by about 4% in 2010. (The period from 2008 to 2012 is the first commitment period under international arrangements to reduce greenhouse emissions.)

Importantly, the transition to more efficient airconditioners would be incomplete in 2010. The savings would continue to increase to about 10% of the total energy consumed under BAU conditions if the regulation is maintained beyond 2012. In the longer term, however, it is increasingly difficult to know how the regulation would differ from the normal processes of technological change and efficiency improvement.

**FIGURE 4.1: ENERGY SAVINGS DUE TO THE PROPOSAL – 2000 TO 2030**



**FIGURE 4.2: EMISSIONS REDUCTION (MT CO<sub>2</sub>-E) DUE TO THE MEPS – 2000 TO 2030**



coefficients used by EES for the residential building sector (EES 1999) have been adopted. The coefficient is 0.99 kg CO<sub>2</sub>-e per kWh in 2000, declining to 0.95 kg CO<sub>2</sub>-e per kWh in 2010, and is weighted to reflect interstate differences. The trend reduction in the greenhouse intensity of electricity generation reflects expected changes in the fuel mix (using gas and renewables instead of coal) and is assumed to continue at a somewhat slower rate beyond 2010.

## 4.2 Impact on users

### Total benefits

The present value of the energy savings presented in figure 4.1 is \$102M for the residential sector and \$261M for the three-phase sector, assuming a discount rate of 5% and an average marginal tariff of 12 cents/kWh. This is a conservative assumption. In 2003, the population-weighted average marginal tariff charged to residential consumers was 12.7 cents/kWh. For small to medium sized commercial customers the corresponding average was 12.2 cents/kWh. (The raw tariff data are drawn from the annual ESSA publication, *Energy Prices in Australia: 2002/03.*)

This baseline estimate is presented in table 4.2 together with alternative estimates generated by varying a number of assumptions, as follows.

First, while the discount rate of 5% is commonly used in public policy analysis, it is important to note that the discount rate has a major effect on the estimated value of energy savings that accrue in the medium to longer term.

Second, assumptions about the size of the efficiency upgrade are critical. One possibility is that units of borderline quality replace the models that currently fail to comply. That is, the replacements only just comply with the 2007 MEPS. At the other extreme, the replacement units may be broadly representative of the models of similar size and functionality that currently comply with the MEPS. While neither of these extremes is likely, the two cases put logical boundaries on the size of the efficiency improvement that may be anticipated. The baseline has been set half way between the extremes reported in the table.

It should be noted that the ideal of estimating efficiency on a sales-weighted basis cannot be fully implemented. Instead, the available data allow the sales to be disaggregated into 11 broad groups of airconditioners. Single-phase airconditioners comprise one group and there are 10 groups of three-phase airconditioners distinguished by cooling capacity. Within each group, all models have been given equal weight in the efficiency estimates. This would not be a significant source of error, however, given the reasonable expectation that the number of models is highly correlated with the volume of sales. Also, a large proportion of the registered models do not comply; it is not as though the specific characteristics of a minority of airconditioners are being inferred from the characteristics of a much larger population.

**TABLE 4.1: BENEFIT ESTIMATES – BASELINE AND SELECTED VARIATIONS**

	Cumulative energy savings (GWh)		Present value (\$M, 2003)	
	Residential	Three-phase	Residential	Three-phase
Baseline	1,560	4,459	102	261
Discount rate				
0%	1,560	4,459	187	535
10%	1,560	4,459	59	138
Quality of upgrade				
av. of complying models	1,794	5,849	118	342
borderline compliance	1,317	2,973	87	174
Implementation (+/- 1 year)				
+1 year	1,762	5,218	117	312
-1 year	1,306	3,681	84	210

Third, the implementation date is also a critical variable. The estimates in table 4.2 indicate that a delay of 1 year reduces benefits to the residential and three-phase users by \$18M and \$51M respectively.

The benefits estimates vary proportionally with certain other assumptions. These include assumptions about the price of energy, the number of new airconditioners that are purchased over the period to 2012, and the degree of effectiveness in enforcing the MEPS. It has been assumed for the baseline that enforcement is 97.5% effective.

Other assumptions are less critical. For example, variations in the assumptions about asset lives has a less than proportional effect on benefit estimates, reflecting the impact of the discount rate on medium to long term energy savings. Nor are the estimates sensitive to assumptions about the ongoing rate of efficiency improvement under BAU conditions.

### **Total costs of the proposal**

The purchase price of airconditioners may rise for several reasons, as follows:

- Reduced competition amongst suppliers may lead to higher market prices.
- The increased technological requirements of more efficient equipment may require imports to be sourced from countries with higher wages structures.
- There may be additional resource costs that are passed onto consumers, including the up-front costs of redesign and retesting and the increases in ongoing manufacturing costs.

### **Reduced competition**

The proposed MEPS pose no significant threat to the quality of supplier competition in the market for airconditioners. Relevant considerations are as follows:

- There is vigorous supplier competition in the market for air conditioners. Over 105 brands are registered with the AGO, with an average of 20 models each.
- The 30 largest brands, accounting for 75% of the registered models, tend to have a high proportion of models that would not comply with the 2007 MEPS. Typically, no more than 20% of these models would already comply with the 2007 MEPS. By contrast, many of the smaller brands have a higher proportion of models that already comply. On the assumption that the large players are best placed to respond to the MEPS requirements, it seems unlikely that there will be any significant reduction in the number of competitive players in the market.
- Industry sources have also indicated directly that the MEPS will not adversely affect the ability of existing suppliers to continue operating in the industry. The main stipulation for individual suppliers is that they continue to compete on a level playing field; they expressed no concerns in that respect.

The earlier RIS for the preliminary three-phase MEPS (GWA 2000) also made the point that MEPS may increase the quality of competition, by reducing the scope for misleading efficiency claims and thereby reducing the search and information costs of users.

### **Changes in the sources of supply**

In discussions with suppliers, it was often mentioned that many manufacturing operations had shifted to low wage countries over the last decade. Relevant analysis is reported in table 4.2, confirming that a large number of models are supplied by low-wage countries such as China, Korea, Malaysia and Thailand. These four countries contribute 75% of the single-phase models and 32% of the three-phase models.

It is conceivable that compliance with the technical demands of the proposed MEPS will require some reorientation of supply towards higher wage countries, causing upwards pressure on prices. Note that the lowest rates of non-compliance occur in higher-wage countries – such as the USA, Japan, Italy and New Zealand – although these account for a relatively small proportion of the available models.

However suppliers expressed no concern that the trend to low-wage manufacture has been impeded or reversed in response to the MEPS, or MEPS-like arrangements, that have been adopted by many countries. It is apparent from table 4.2 that low-wage countries are already producing a proportion of the models that comply with the MEPS. In many cases a multinational company owns the low-wage manufacturing operation but maintains its R&D and design capabilities in the home country.

The airconditioner strategy actually facilitates trade in one respect. Specifically, Australian test standards have been aligned with overseas testing procedures, reducing the duplication of tests in supplier countries that must comply with a variety of other MEPS arrangements.

Overall, it is considered that the introduction of Australian MEPS will have no significant effect on trade patterns.

**TABLE 4.2: SOURCES OF SUPPLY, RANKED BY DEGREE OF COMPLIANCE WITH PROPOSED 2007 MEPS**

Source	<i>Single-phase</i>		Source	<i>Three-phase</i>	
	<i>% of models not complying with 2007 MEPS</i>	<i>Number of models</i>		<i>% of models not complying with 2007 MEPS</i>	<i>Number of models</i>
New Zealand	10%	10	Italy	0%	3
Japan / Thailand	68%	25	New Zealand	34%	35
Malaysia	71%	119	USA	43%	14
Taiwan	87%	46	Thailand	65%	155
Japan	87%	71	Taiwan	67%	18
Korea	88%	244	France	75%	16
Thailand	89%	352	Korea	78%	9
Italy	94%	17	Malaysia	85%	82
China	94%	392	Japan / Thailand	86%	14
Singapore	97%	33	Japan	90%	42
China / Israel	100%	3	China	100%	6
France / Israel	100%	8	China / Thailand	100%	3
Indonesia	100%	2	Saudi Arabia	100%	3
Israel	100%	23	Taiwan / Malaysia	100%	1
Saudi Arabia	100%	15			
Taiwan / Malaysia	100%	3			
Thailand / Taiwan	100%	1			

### Costs of redesign and retesting

It is expected that the energy efficiency gains will be obtained derived largely from the improved performance of components, notably compressors and heat exchangers, and possibly by using new refrigerants that provide opportunities for improved energy performance. These components are readily available. Nevertheless suppliers will need to research the options, and often changes will need to be made to the layout of the unit to accommodate different components. Redesign would also be required to accommodate the new refrigerants, since these operate at pressures that are too high for many existing units. Overall, the size and weight of airconditioning units will tend to increase.

The costs of redesign and retesting were originally assessed by Unisearch (1998) and those estimates were subsequently adopted in the earlier RIS (GWA 2000), but with reference to three-phase models only. The cost was put at \$100,000 for each model that failed to comply with the requirements, including the costs of registration tests and the check testing regime. The total cost was estimated at \$15.5M.

These are generous allowances for the costs of redesign, and alternative assumptions have been adopted for this RIS. The main departure from the previous estimate is in relation to the number of failing models that will be redesigned, as follows:

- A small proportion of non-complying models would achieve the required MEPS under BAU improvements in efficiency. This has been put at 5%.
- Based on an examination of the physical dimensions and performance characteristics of the registered models, it is estimated that 20% of the registered models are duplicates of other models (for the purpose of energy efficiency and compliance with MEPS) and would not need to be separately engineered.
- Given the rapid turnover of models (reported to be 2-3 years on average), the AGO register accumulates a number of models that have been withdrawn from the market. Others are close to the end of their market life and will be withdrawn entirely rather than be redesigned to meet the MEPS. It is assumed that 33% of the single-phase models and 10% of the three-phase models can be ignored for these reasons.
- It is further assumed that the market for 33% of models will simply be transferred to existing models that are available overseas but not yet in Australia. Some may need to be tested under Australian conditions but there will be no costs of redesign.

It is also reasonable to expect that suppliers respond to the regulation by bringing forward engineering costs that would have been incurred under BAU conditions, albeit over a much longer period into the future. It is therefore assumed that the redesign costs would otherwise have been incurred over the subsequent 10 years, and that suppliers get some relief from the pressure to innovate over that period.

The estimated unit cost of redesigning a three-phase model (\$100,000/model) also seems generous. Typically, airconditioner models are designed as one of a family of models with many design features in common. It is reasonable to expect that there will be considerable economies in the design process, not only within a family of models but also across families within the same brand or company. There is also likely to be a degree of reverse engineering as suppliers copy from each other. Nevertheless the assumption of \$100,000 per three-phase model has been retained, but without inflation adjustment. This figure is also taken to include the costs of designing and printing new marketing brochures and the like, where there have been significant changes to the product range. Based on industry consultations, a lower estimate has been adopted for single-phase units – at \$25,000/model.

On these assumptions, about 200 three-phase models would need to be redesigned at a cost of \$100,000 each. The corresponding estimates for single-phase models are 440 and \$25,000. The total redesign costs are \$31M<sup>6</sup>. However, allowing for the displacement of future design costs that would be incurred under BAU conditions, the net cost in present value terms is \$7.1M – see the first line in table 4.3.

**TABLE 4.3: ESTIMATED NET COST OF REDESIGN AND RETESTING (\$M) – PRESENT VALUES**

	Single-phase	Three-phase	Total
Cost of bringing design costs forward	2.5	4.6	7.1
Cost of bringing testing costs forward	0.6	0.3	0.8
Saving from amended registration requirements	-10.3	0.0	-10.3
Net impact	-7.2	4.8	-2.4

<sup>6</sup> The cost for three-phase models (\$20M) is actually somewhat higher than the earlier estimates by Unisearch and GWA, reflecting the increase in registrations and the larger proportion of models that would fail to comply with the more demanding 2007 MEPS.

There will also be additional testing and registration costs, which have been separately modelled and reported in table 4.3. At least one firm is constructing its own testing facility, and it is understood that other manufacturers may also be considering a more hands-on role for testing. For example, it is reported that some suppliers use the physical test results for one model to ‘calibrate’<sup>7</sup> the simulation software to estimate EER values for the remainder of the model range. This not only saves money for suppliers but also provides some relief in terms of the throughput capacity of the two NATA accredited testing facilities in Australia.

Based on industry consultation, it is assumed that the test costs are \$2,500 per model for both single-phase and three-phase units. (While costs of physical tests for three-phase units would generally be higher than for single-phase units, suppliers have the option of using a simulation test rather than a physical test for three-phase units.) The additional cost is only \$0.8M. This is a small item because the proposed regulation does not introduce new testing requirements; testing is already required under BAU conditions. The only effect of the regulation is to bring forward the future stream of testing costs by about 1.5 years – assuming an average model life of 3 years.

These additional costs are effectively negated by the savings that will accrue to suppliers from NAEDEC’s decision to reduce the number of single-phase units that will need to be tested for registration purposes – from three units to one unit per model. The present value of the savings over the period to 2012 is about \$10M – see table 4.3. This assumes an average model life of 3 years and testing costs of \$2,500 each. Taking this saving into account, there is a net reduction of design and testing costs of \$2.4M.

Two final points should be noted. First, while the estimates are based on indications provided by suppliers wherever possible, suppliers were generally unable to provide hard cost data. Nor was it possible to isolate the particular effect of the earlier MEPS on the demand for the testing facilities of the UNSW testing laboratory, except to note that there was an increase in demand, particularly of the last minute variety around the time that the MEPS were implemented<sup>8</sup>.

Second, there is uncertainty about the extent to which these costs will be passed onto users. In a highly competitive market such as that for airconditioners, it is conceivable that suppliers may not be able to pass one-off costs onto users. They may be forced to absorb such costs, at least in part, rather than raise prices relative to their competitors. Further, to the extent that suppliers are not Australian-owned, the costs would be borne by foreign shareholders. Arguably, such costs could be ignored for the purposes of a cost benefit analysis of impacts on Australians.

### **Ongoing manufacturing costs**

It is reasonable to expect that more efficient units will be more costly to manufacture. For example, suppliers indicated that increased efficiency has implications for the size of units and the amount of material used, reflecting the fact that heat transfer is facilitated by increased surface area. When those options have been exhausted, however, further increments in energy efficiency may more costly.

The UNSW testing laboratory also indicated that substantial energy savings could be achieved by very simple design changes in the case of larger split units in the range 15kW to 20KW. For example, the outside condenser coil in these units is often kept small for aesthetic reasons and market acceptance. Enlarging the coil would increase costs only to the extent of the additional coil material (since the manufacturing process itself would remain largely unchanged), and the resultant cost increase is estimated to be minimal. However, such modifications may not always be sufficient to achieve the proposed MEPS.

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<sup>7</sup> Part 3 of AS 3823 contains default values for the key performance parameters that may be used in the simulation if no model-specific data are available. However, the default parameter values have been chosen to give a conservative result, and a compliant unit may actually be shown to fail in the simulation.

<sup>8</sup> E. Leonardi: pers. comm.

Ongoing costs were originally assessed by Unisearch (1998) and a similar framework was adopted by GWA (2000) – again, for three-phase units only. Specifically, Unisearch and GWA put the ongoing costs at \$50/unit and \$100/unit respectively, but with those costs expressed relative to the sum of all airconditioner sales, including both complying and non-complying models. Given that about a third of the sales comprised non-complying units, the implied estimates of the increase in costs *per non-complying unit* are \$150 and \$300 respectively. GWA reports that the \$300 estimate is about 6% of the average retail price, which means that Unisearch puts the increase at 3%. The other key difference between the two estimates is that only GWA is referring to additional production costs, that is, the costs of better materials and components. Unisearch refers to the \$50/unit as the costs of administration, labelling and information activities of both industry and government.

Engineering studies contained in the following reports from the US Department of Energy (DoE) have also been examined for the current RIS.

DoE (1997), *Technical Support Document for Energy Conservation Standards for Room Air Conditioners*, prepared for DoE by LBNL.

DoE (2002), *Technical Support Document: Energy Efficiency Standards for Consumer Product - Residential Central Air Conditioners and Heat Pumps*, prepared for DoE by staff of Arthur D Little Inc. & LBNL.

DoE (2003), *National Energy Savings Spreadsheet: Commercial Unitary Air Conditioner and Heat Pumps*, downloaded from the following website in June 2003.  
[www.eere.energy.gov/buildings/appliance\\_standards/commercial/ac\\_hp.html](http://www.eere.energy.gov/buildings/appliance_standards/commercial/ac_hp.html)

Estimates of the relationship between efficiency and manufacturing costs have been extracted from these studies and are summarised in a series of charts presented in appendix 3. Note that the data have been normalised to present costs as unity (1.0) for equipment with an EER of 2.75. The pattern is that significant improvements in energy efficiency can be achieved at relatively low cost, but that subsequent improvements are achieved at progressively higher marginal cost.

DoE estimates that the increase in manufacturing costs is generally in the range of 3-4%. But there are important exceptions. The figures indicate that manufacturing costs would increase by 15-20% for large (6-10kW) single-phase units. On the other hand, the cost of improving three-phase units in the 20-30kW range is put at zero.

The estimates of ongoing costs that have been adopted for this RIS depart significantly from these estimates. To explain, it is important to understand that the available estimates have been generated by reverse engineering a sample of low efficiency airconditioners, thereby identifying the most cost-effective design changes that will achieve the desired improvements in energy efficiency. Many of the design changes under consideration have two effects. They not only increase energy efficiency, they also increase the output power of the unit<sup>9</sup>. That is, for a given input power, the more efficient unit has a greater cooling capacity. Because the unit is fundamentally changed by reverse engineering and redesign, some adjustments are needed in order to compare like with like.

One adjustment is to allow for the cost savings that could be had by reducing the input power, restoring the cooling capacity of the unit to its original level. For example, a smaller compressor could be used. Alternatively, if the other parts of the design are left unchanged the resulting higher capacity of the unit could be expected to have a higher market value, since consumers are willing to pay more for units with greater capacity. The supplier recoups some

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<sup>9</sup> 'Energy' and 'power' are related but different concepts. Energy refers to the total amount of electricity used to complete a particular task such as cooling a given area to a specified temperature. The power of the unit is the rate at which energy can be used.

of the cost of increased efficiency in both cases, either by reducing the input power of the unit or by marketing the unit in a higher capacity range.

Multiple regression analysis undertaken for this RIS suggests that the savings on input power are very significant in explaining the variation in the price of airconditioners. As would be expected, the price of a unit is positively related to both its input power and energy efficiency. More importantly, however, airconditioner prices are little affected by an increase in energy efficiency *if matched with an offsetting reduction in input power that leaves the cooling capacity unchanged*. This indicates that consumers are prepared to pay for energy efficiency – but only to the extent that it increases the capacity of the airconditioner, and not for additional benefits in the form of reduced energy bills.

Responding to these market signals, suppliers would be concerned only with minimising the capital costs of airconditioners. They would equalise the marginal capital costs of increasing input power and energy efficiency, paying little attention to the impact of higher energy efficiency on life cycle costs. The range of designs observed in the market would be such that the cost of providing improved energy efficiency is largely offset by the reduced cost associated with reductions in input power.

It is also significant that the US estimates are for manufacturing costs only and that manufacturing costs account for about 40% of the final purchase price. The percentage impact of increased efficiency is therefore reduced by at least half when expressed in terms of the final purchase price.

On the above analysis, it is apparent that the proportional changes in final purchase prices tend to be overstated by the raw data on manufacturing costs that emerges from reverse engineering studies. Taking all of the evidence together, the baseline assessment for this RIS is that the proposed MEPS will add on average 1.5% to the final purchase price of airconditioners that fail to comply with the 2007 MEPS. In terms of the two modelling exercises that are available, this indicates additional costs with a present value of \$41M for the residential sector and \$21M for the users of three-phase units.

### **Total net benefits of the proposal**

Table 4.4 presents the resulting estimates of net benefits. The baseline estimate suggests a very large payoff to MEPS, with most of the gains accruing to the users of three-phase units, the majority of whom would be commercial users. The larger ratio of benefits to cost in the commercial sector reflects the following factors:

- Commercial units are used much more intensively than residential units. Commercial workspaces tend to be enclosed and require intensive conditioning.
- Commercial units are much cheaper per unit of capacity, which translates into a smaller increase in cost required to achieve a given efficiency gain.
- Commercial units also have longer working lives in which to deliver the benefits of increased energy efficiency.

As indicated earlier, an important group of users are missing from these estimates, comprising commercial users of single-phase airconditioners. The benefit/cost ratio for that group would fall between the ratios for the residential and three-phase users. The average increase in costs would be similar to that of residential users but the average benefits would be greater, reflecting the more intensive use by commercial users.

The decision to reduce the number of models that must be tested for registration of single phase models makes a significant contribution to the outcome. Without those savings, which are estimated at \$10M, the baseline cost/benefit ratio for the residential sector is reduced to 2.3.

The assessment of the increase in manufacturing costs is obviously critical, particularly for the residential sector. For a discount rate of 5%, a doubling of the estimate for ongoing residential costs – from 1.5% to 3% of the market price – would reduce the benefit/cost ratio to 1.4 and there would be rather less confidence that the proposal is cost-effective. On the other hand, there is also the prospect that improvements in the energy efficiency of residential air conditioners is very close to a free lunch, on the assumption that increases in energy efficiency are virtually paid for by savings arising from reductions in input power. It is not possible to further reduce the uncertainties with the available data.

There is much greater certainty about the cost-effectiveness of the measures for three-phase airconditioners. The benefit/cost ratio would be about 4.0 even with a three-fold increase in the estimate of on-going costs.

**TABLE 4.4: ESTIMATED COSTS AND BENEFITS TO USERS (PRESENT VALUES, \$M)**

<i>Discount rate</i>	<i>Residential</i>			<i>Three-phase</i>		
	<i>0%</i>	<i>5% (baseline)</i>	<i>10%</i>	<i>0%</i>	<i>5% (baseline)</i>	<i>10%</i>
Total benefits	187	<b>102</b>	59	535	<b>261</b>	138
Total costs	51	<b>34</b>	22	34	<b>25</b>	20
<i>Design &amp; testing costs</i>	-7	<b>-7</b>	-7	5	<b>5</b>	5
<i>Manufacturing costs</i>	58	<b>41</b>	30	29	<b>21</b>	15
Net present value	137	<b>69</b>	37	501	<b>235</b>	118
Benefit/cost ratio	3.7	<b>3.0</b>	2.6	15.7	<b>10.3</b>	7.0

Note:

\* The once-only costs are the costs of redesign and retesting, which have been separately assessed for single-phase and three-phase models. 90% of the former and 10% of the latter have been assigned to the residential sector.

### 4.3 Equity considerations

Expected increases in the market price of residential airconditioners would not have significant adverse equity implications. Based on the assessments provided above, the increase in price would be on the order of \$50-\$100 at most, and would not be a significant impediment to the purchase of a long-lived asset such as an airconditioner. The increase in price is such that any adverse effect on sales, which are currently growing strongly, can be safely ignored. Most likely, cash-constrained buyers would purchase an airconditioner of marginally smaller capacity than otherwise, with costs substantially borne as some reduction in the functional value of the airconditioner in operation.

It should also be kept in mind that, while total net benefits of the proposal may be positive, the benefits will be distributed unevenly between users, depending on the type of airconditioner used, the cost of energy and, most importantly, the intensity of use. Based on US assessments, a minority of low-intensity users will be worse off, at least in certain stages of the life cycle when dwellings are unoccupied for a large portion of the day, or where energy is particularly cheap. Specifically, the investment in energy efficiency becomes borderline when the number of duty hours falls below 150 hours per year, or three hours per week, compared with an estimated average of 400 hours per year.

In the residential sector, the big winners are retired persons and families with young children who use space conditioning equipment more intensively. However, these differences will tend to average out over the life-cycle.

Lack of data on ownership patterns and user behaviour prevent more detailed quantitative assessment of these impacts.

## 4.4 Impact on government

The impact of the proposals on the taxpayer will be minimal. Not only is NAEEEP a relatively inexpensive program from the viewpoint of taxpayers, the majority of these costs would be incurred under BAU conditions. Once the proposed measures have been developed and implemented, there are few additional costs that can be attributed to the proposal.

On the first point the ongoing costs of administering the MEPS initiative are of the order of \$2M per year at most. This allows for the equivalent of two full-time staff member in each of the regulatory authorities of the larger states, a somewhat smaller resource commitment from the smaller states, and ongoing work by AGO staff at the national level.

On the second point, the ongoing program of registration, monitoring and check testing would be required for the purposes of the labelling program for single-phase units and the existing MEPS for three-phase airconditioners. The more demanding nature of the MEPS may justify some increase in the tempo of check-testing, at least for a period. However the additional costs would be less than \$100,000 and can be safely ignored for the purposes of the RIS.

## 4.5 Impact on suppliers

Suppliers have two broad options for each model of airconditioner that does not comply with the proposed regulation: it can be redesigned or withdrawn from sale. Each supplier must also make a decision about the scale of their business in the wake of the regulation, the ultimate choice is to abandon the business altogether.

A sample of registered suppliers was surveyed to determine likely responses to the proposed regulation.

### **Adjustments to the range of models**

It is apparent a number of models will be withdrawn from the market. Most will simply be replaced by other models. This may take the form of increased sales of registered models that already comply or the introduction of new models to the Australian market that are, at most, minor modifications of existing models that are sold elsewhere. A number of importers indicated that they would simply respecify their requirements from an existing supplier or change their supplier. They did not anticipate any significant difficulty in finding suppliers that could satisfy the proposed requirements.

However, some models cannot be replaced with comparable product. Two examples were provided. First, models with simple mechanical controls probably cannot remain in the market, since one of the most cost-effective ways to improve energy efficiency is to adopt electronic controls. Second, one supplier indicated that it is not feasible to improve the energy efficiency of some units without increasing the physical dimensions considerably, and that the larger units could not be physically accommodated in some situations. Other suppliers also mentioned the trade-off between energy efficiency and physical size, but only in the context of consumer preferences rather than the potential loss of sales.

Models that are not withdrawn will need to be redesigned in some significant fashion. This generally occurs where a supplier is tied to a particular manufacturing operation, either because they own the operation or because their supply options are constrained by the need to maintain a particular look or style across their product range. One Australian manufacturer indicated that the redesign costs would be significant and posed a threat to the product range. However, that was not the general supplier response. Others made the point that, given the small size of the Australian market, there was no scope to develop models specifically for Australia. However it is generally considered that, provided there is a level playing field, the cost of redesign and retesting could be absorbed by the market.

Overall, the airconditioner market in Australia is extremely competitive, with a wide range of models in each segment. If individual models are discontinued as a result of MEPS then the market will adjust to fill the gaps. It is difficult to imagine that market forces will fail to ensure that there will be relatively small loss of choice of models over the longer term, or that prices will rise to any marked extent, or functionality and other features will suffer.

### **Impacts on employment and profitability**

The proposal is not expected to significantly affect the level of demand, which is expected to continue its strong growth over recent years. Similarly, there is no expectation that the proposals are any threat to employment in the supplier industry.

The quality of supplier planning will have a major effect on the relative success of suppliers in adjusting to the new market regime. It is apparent from industry consultations that this is somewhat variable; some are much further advanced than others. However, reasonable advance notice has been provided to all. NAEEEEC commenced work on the proposals in early 2002, starting with a series of industry meetings. This led to the release of an industry consultation document (NAEEEEC 2002), asking for comments to be received by 1 November 2002. Standards Australia issued a revised draft of Part 2 of AS/NZS 3823 on 6 March 2003, asking for comment by 8 May 2003. Further details of the consultation process are provided in chapter 5.

## **4.6 National costs and benefits**

This section presents estimates of costs and benefits from a national perspective, bringing together all of the costs and benefits falling on all parties – that is, suppliers, users and taxpayers. However, the national assessment is not necessarily the simple sum of the costs and benefits presented above, for several reasons. These relate to the avoidable cost of electricity, the discount rate, and the possibility that that some of the costs will fall on the foreign owners of manufacturing operations.

### **Avoidable cost of electricity**

The cost of electricity consists of the cost of electricity generation (including the energy lost as heat in transmission and distribution), the cost of network services (poles, wires and substations for transmission and distribution of electricity) and the market costs associated with functions such as metering, billing and advertising. These costs are recovered in the tariffs charged to users and users rightly look to the tariff schedules to determine the value of energy savings. However some of these costs are not avoidable. That is, they cannot be reduced by energy saving measures. Market costs are the obvious but relatively minor example, since market costs generally account for less than 5% of average costs.

Less obviously, the large fixed costs of providing network services means that the marginal cost of providing additional network capacity is considerably less than the average costs. Based on a recent report to the Australian Building Codes Board<sup>10</sup> (ABCB), the marginal network cost of a general increase in energy use might be reasonably put at about 30% of average network costs, although considerable uncertainty attaches to any such estimate. This is a more serious consideration since network costs account for about 70% of the average residential and small to medium commercial tariffs. If 70% of those costs are unavoidable, it follows that about half of the average cost of electricity is unavoidable ( $70\% * 70\% = 49\%$ ).

However a further adjustment is required. Because network capacity is designed to cope with peak loads, the avoided network costs associated with any particular measure depends on the extent to which the measures reduce the peak load on the network. Some measures would have little or no impact on peak loads and would generate no such savings. Airconditioners are at the opposite extreme. In terms of the proportion of its energy that an appliance uses when the

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<sup>10</sup> Atech (2003), *A Financial Analysis Procedure for Energy Efficiency in Buildings*, Report to the Australian Building Codes Board

network is under peak load, airconditioners have a peak load factor that is 3-4 times greater than the average load profile that networks must accommodate<sup>11</sup>.

It follows that, whereas the network savings associated with proportional reductions in all loads would be equal to about 30% of average costs, the network savings associated with more efficient airconditioners would be in the range 90 – 120% - that is, 3 to 4 times 30%. Note the possibility that reduction in network costs associated with more efficient airconditioners may actually *exceed* the average cost of network services.

Given these particular circumstances arising from the peak load demands of air conditioners, it is reasonable to regard the marginal tariff as a conservative estimate of the avoided cost of electricity. This is particularly so given that generation costs are also increase under peak loads, which means that airconditioners incur higher-than-average generation costs as well. Accordingly, the average electricity tariff as has been retained as a reasonable estimate of the avoided costs of supplying the energy used by airconditioners.

### **Discount rate**

NAEEEC has established a practice of calculating present values at *real pre-tax discount rates* of 0%, 5% and 10%. That convention has been followed in the analysis of consumer impacts, presented in section 4.2 above. A different approach has been adopted by the ABCB, adopting a *nominal post-tax discount rate* of 7%. There are two key differences between the approaches:

- The post-tax approach treats the flow of revenue from an energy conservation measure as taxable company income after allowing for depreciation allowances. This provides a direct link with observed market rates of return on assets, since post-tax income is the focus of share market valuations. To cover the tax, pre-tax discount rates are necessarily higher than post-tax discount rates.
- Nominal rates are higher than real rates because they include an inflationary factor.

However it is possible to calculate the real pre-tax discount rate that is the equivalent of any given nominal post-tax rate. In this case, the ABCB's nominal post-tax rate of 7% equates to a real pre-tax rate of 6.3%. This is a relatively low rate, reflecting a judgement that investments in the energy efficiency of buildings will be somewhat insulated from cyclical fluctuations in economic activity, and are therefore relatively low risk.

### **Costs and benefits accruing to foreign shareholders**

In highly competitive markets such as that for airconditioners, it is possible that some of the costs of structural change (redesign and retesting costs) will be absorbed by suppliers rather than passed onto consumers. Given the heavy reliance on imports, this means that part of such costs will be carried by the owners of foreign-owned companies and may be excluded from a national assessment of costs and benefits. To roughly allow for this possibility these costs have been reduced by half.

For consistency benefits following from the proposal to reduce testing requirements are also reduced be half.

### **Findings**

The results of this analysis are presented in table 4.5. The very minor impacts on government have been excluded. Compared with the baseline assessment presented in table 4.4, which is from the user perspective, the key differences are as follows:

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<sup>11</sup>This estimate reflects parameters developed by the Lawrence Berkeley National Laboratories (LBNL) and presented in a report to the US Department of Energy - LBNL (1997). The discussion there is in terms of the Conservation Load Factors of different appliances, and variations in the amount of energy that must be saved to reduce peak loads by 1 kW.

- The benefit cost ratio for the residential sector is somewhat reduced, being the combined effect a higher discount rate and the allocation to foreign owners of part of the cost savings arising from the proposed relaxation of testing requirements.
- The benefit cost ratio for the three phase sector is unchanged. The adverse effect of the discount rate is offset by the allocation to foreign of cost increases associated with the initial costs of redesign and testing.

Overall the national perspective is not very different to the user perspective. The main reason is that the value of energy savings is approximated by the electricity tariff. This is not generally the case in industries with large fixed costs but reflects the above average share of energy savings that will occur in peak periods.

**TABLE 4.5: NATIONAL ASSESSMENT OF COSTS AND BENEFITS (\$M)**

	Residential	Three-phase
<i>Discount rate</i>	6.3%	6.3%
Benefits (present value, \$M)	88	219
Costs (present value, \$M)	34	21
Once-only costs	-4	2
Ongoing costs	38	19
Net present value (\$M)	55	198
<b>Benefit cost ratio</b>	<b>2.6</b>	<b>10.3</b>

## 4.7 Assessment of more stringent MEPS

Minimum levels of energy efficiency could be further increased either by raising the MEPS requirements or by accelerating their introduction. In terms of the NAEËEC strategy of following the best practice lead of trading partners, acceleration means a reduced gap between introduction overseas and introduction in Australia. In the case of three-phase units, for example, the proposed gap for three-phase units is 3 to 4 years. Substantial energy savings are at stake, with a value of the order of \$70M per year. Taken further, the option of more stringent MEPS entails Australia undertaking to lead the process of MEPS-setting amongst its trading partners.

Data inadequacies mean that it is not possible to assert confidently that the more stringent options will be cost effective. The main problem is that, while we can be confident that most of the increases in energy efficiency required by the proposal occur along the flat portion of the cost curve, further increases in the MEPS level may take the industry into the region of increasing marginal costs – see appendix 3. The degree of cost increase at the margin cannot be determined with reasonable confidence from the available (mainly US) estimates.

More stringent requirements will also increase the proportion of low-intensity users who are worse off.

For suppliers, the main concerns are access to product in the longer term and the adequacy of adjustment time in the short term. Regarding access to product, Australia's status as a large net importer of airconditioners means that we cannot stray far from overseas MEPS without threatening to compromise the range of products that is readily available. Industry has emphasised that the Australian market is not sufficiently large to justify special designs.

A further concern is the adequacy of the lead time provided to suppliers. Certainly, the proposal may err on the generous side for many suppliers. Based on industry discussions, many suppliers tend not to use all of the available time. Regardless of how long the lead time, their response is still of the 'last minute' variety. However the requirements are variable, depending on how closely the supplier is tied to a specific manufacturing operation. At one

end of the spectrum, for example, many importers consider that they can readily obtain complying models within a short period and would need no more than one year's notice to adjust their supplier relationships. At the other end of the spectrum, Australian manufacturers may need to withdraw some models from the market, redesign others, and possibly make significant changes to production facilities.

Between these extremes are suppliers that, while not being manufacturers themselves, cannot quickly change from one manufacturer to another. For example, the MEPS requirement may create gaps in their product line that cannot be readily filled by another manufacturer without disturbing the uniformity of the product line in terms of particular aesthetic and functional characteristics that are not readily replicated.

Based on the industry interviews conducted for this RIS, suppliers generally consider that 2-3 years lead time is the minimum requirement for making the required adjustments, commensurate with the normal product lifecycle. The proposal is to provide 3-4 years for the 2007 MEPS and 1-2 years for the less demanding interim MEPS for single-phase airconditioners. However, the proposal to retire older, less efficient models in 2004 has been discussed with key industry representatives for several years and all suppliers were informed of government intentions in 2002.

## 5 Consultation

The issues related to energy efficiency programs for air conditioners generally, and MEPS in particular, have received considerable exposure over the last 9 years.

### Chronology of previous reports and consultations

The following provides the history of the consultative process leading up to the introduction of the preliminary MEPS for three-phase airconditioners in October 2001.

April 1994	Packaged air conditioners identified as one of the products potentially suitable for MEPS and/or labelling, in <i>Energetics 1994</i> .
March 1995	DPIE holds meeting in Sydney to discuss issues related to air conditioners. Attended by representatives of AREMA, 4 suppliers electricity utilities, professional and standards associations and governments.
February 1996	Unisearch organises meeting in Sydney to discuss proposed MEPS program. Principles of "low-level" MEPS discussed, but actual levels not yet determined. Attended by representatives of AREMA, 19 suppliers (out of 65 invited).
March 1996	Unisearch reports to DPIE on changes affecting the air conditioner market since 1994, and on feedback from industry meetings.
June 1998	Unisearch reports to DPIE on energy efficiency program for air conditioners, including recommended MEPS levels and information disclosure provisions.
November 1999	Mechlab reports to AGO on proposals for revision of AS3823 Part 2 and a new Part 3 to give effect to recommended MEPS levels and option of computer simulation testing.
March 2000	Standards Australia issues drafts of new AS/NZS 3823 Part 1.2, revised AS/NZS 3823 Part 2, new AS/NZS 3823 Part 3. Comment period closed 30 April 2000.
March 2000	Before preparing the draft RIS, GWA presents issues paper (GWA 2000) to a steering group comprising members of AREMA.
August 2000	Preliminary draft RIS circulated to AREMA members. GWA presents preliminary findings at AREMA meeting

Subsequently, NAEEEC commenced work on the proposals for new single-phase MEPS for 2004 and revised MEPS for 2007, starting with a series of industry meetings, listed below. This led to the release of an industry consultation document (NAEEEC 2002), asking for comments to be received by 1 November 2002. Standards Australia issued a revised draft of Part 2 of AS/NZS 3823 on 6 March 2003, asking for comment by 8 May 2003. There have been a further round of phone interviews with a sample of 11 suppliers for the purposes of drafting this RIS.

27 March, 2002	Seminar on MEPS, <i>Air Conditioning, Refrigeration and Building Services Exhibition</i> , Sydney Convention and Exhibition Centre
30 May 2002	Presentation to AREMA general meeting, Sydney
5 June 2002	Air Conditioner MEPS Steering Committee Meeting, Sydney

16 August 2002	Three phase airconditioners – Potential MEPS 2007 <i>Being Part Of The Solution</i> , Conference, Sydney
31 October 2002	MEPS Training Future Directions, Sydney
25 March 2003	NAEEEC Forum, Melbourne

### **Proposed consultations**

The following further consultations are planned between early September and mid October and mid November.

- The AGO will send out copies the draft RIS to known interested parties, advertise its availability, and hold public meetings in Sydney, Melbourne and Auckland (and possibly other localities if there is demand).
- Written comments will be received until <<...>>
- NAEEEC will report the content of the comments to MCE and revise the final RIS as appropriate.

## 6 Conclusion and recommended option

### 6.1 Assessment against objectives

The key findings of the RIS can be stated as follows:

- During the first commitment period under international arrangements to reduce greenhouse emissions (2008-2012), the proposed regulations are expected to reduce energy use and greenhouse emissions by 4.8% for residential airconditioners and by 2.5% for three-phase airconditioners. The total reduction in greenhouse emissions over the life of airconditioners affected by the regulation is equivalent to 6 MT of carbon dioxide.
- The transition to more efficient airconditioners would be incomplete in 2010. The savings would continue to increase to about 10% of the total energy consumed under BAU conditions if the regulation is maintained beyond 2012. (It is assumed for the purposes of the RIS that the regulation will be reviewed in 2012 and subject to a fresh determination at that time.)
- The present value (in 2003) of future benefits to residential users is estimated at \$37M assuming a discount rate of 10% and at \$137M for a discount rate of 0%. The baseline estimate is \$69M for a discount rate of 5%.
- The present value of future benefits to users of three-phase airconditioners are estimated at \$118M, \$501M and \$235M for discount rates of 10%, 0% and 5% respectively.
- The baseline estimates of the benefit/cost ratios are 3.0 and 10.3 for residential and three-phase airconditioners respectively.
- The effect of the proposals on taxpayers is minimal. Apart from some increase in the level of check-testing, the resources required for administration and enforcement are already committed under previous arrangements.
- The average rise in the price of airconditioners has been put at only 1.5% and is not expected to have a significant effect on the level of demand for airconditioners.

The option of further increasing the stringency of the energy standards has been considered. Overall, it is considered that, given the broad policy framework provided by the NGS, the minimum level of energy efficiency cannot be safely increased, or more rapidly increased, beyond that contained in the proposal. A more aggressive approach poses significant risks for both suppliers and users.

Table 6.1 provides a summary comparison of the options against the objectives of the regulation.

### 6.2 Recommendations [Draft]

It is recommended that:

1. States and Territories implement the proposed mandatory minimum energy performance standards.
2. Existing State and Territory regulations governing appliance energy labelling and MEPS be amended to implement the proposed standards.

**TABLE 6.1 ASSESSMENT SUMMARY**

<i>Objective</i>	<i>BAU option</i>	<i>Proposed MEPS</i>	<i>More stringent or accelerated MEPS</i>
Reduction in greenhouse emissions	Improvement dependent on trend improvements in energy efficiency (0.4%/year) plus evolution of more energy efficient building stock, eg, due to energy efficiency measures in the Building Code of Australia.	Greenhouse emissions from the targeted airconditioners will be reduced by about 4% in 2010.	More rapid reduction in green house emissions could be achieved. The savings could be increased to 6% of BAU emissions by 2010.
Cost effective for users	Most users continue to minimise capital costs, but largely ignoring the potential to reduce life-cycle costs by improving energy efficiency.	Total benefits exceed total costs by a significant margin. But there would be some losers amongst those with low energy costs or who use airconditioners sparingly.	It is not possible to be confident that further increases in MEPS would be cost efficient at this stage. The proportion of losers would increase and the range of complying product would be reduced.
Minimise adverse effects on manufacturers and suppliers	The business as usual scenario for suppliers is for continued healthy growth of demand for airconditioners	Suppliers may not be able to pass some fixed costs on redesign and retesting onto users. These are one-off costs about which the industry seems to be little concerned.	Given Australia's status as a large net importer of airconditioners, there would be significant additional costs if Australia attempted to take the lead in setting MEPS on trading partners.
Minimise potential for confusion or ambiguity	No confusion or ambiguity	While suppliers are generally aware of the proposals and find them clear and comprehensive, there are some exceptions. It is part of the pattern that some suppliers do not plan adequately for changes and are caught up in a last minute rush to redesign and retest.	The redesign and retesting processes would need to be accelerated considerably, imposing a significant extra burden on the management team. More complex design problems would need to be overcome.

## 7 Implementation and review

The national legislative scheme for mandatory energy labeling and performance standards relies on State and Territory legislation to give it legal effect. This creates some potential for inconsistencies in the operations of the various regulatory agencies, creating additional costs and inconvenience to industry. NAEEEEC published a set of administrative guidelines to minimize those risks (NAEEEC 2000). The Guidelines are not legally binding but they are intended as a guide for State and Territory regulatory agencies to facilitate uniform and consistent practice among the States and Territories, delivering consistent outcomes for all affected products irrespective of the product or jurisdiction.

Key elements of the scheme are as follows:

- The technical details of the MEPS are contained in Australian Standards that are incorporated by reference into the State and Territory legislation. These Standards do not vary between States. The format and content of Australian Standards are also familiar industry, as are the operations of Standards Australia.
- Changes to the technical detail in Standards are subject to transition periods that are negotiated between industry and government.
- To minimize trade barriers, State and Territory regulatory agencies support a policy of adopting international standards wherever appropriate.
- Grandfathering arrangements are adopted, allowing reasonable time for the phase out of non-complying stock.
- All States and Territories accept the registration of an appliance undertaken in another State.
- State and Territory regulatory agencies have set target time periods within which they aim to process applications.
- Proposed changes in administrative and operating practice are subject to consultation between states.
- It is proposed that after October 2004, appliance registration testing must be conducted by a laboratory accredited by the National Analytical Testing Authority (NATA).
- Compliance monitoring takes the form of a program of check testing by accredited laboratories.
- 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 from third parties.
- There are several sanctions. There is a shaming option involving publication of failed brands or models in the AGO annual report. The second option is deregistration by the state 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. The third option involves legal action by the ACCC but is highly unlikely.

- 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.)
- Laboratories that produce misleading tests results may also be denied further registration business.
- In due course the introduction of more stringent MEPS will also be handled nationally. That is likely to be in 2012. Further increases in the stringency level at that time will be subject to the same processes of industry consultation and a RIS.
- NAEEEEC holds a consultation forum each year, providing an opportunity for stakeholders to raise concerns about the operation of the Standards or the Guidelines.

The check-testing and sanctions regime is obviously critical. Currently, check-testing expenditure (on all products) is running at about \$350,000 per year, and accounts for about 25% of NAEEEEC's budget. The 2002 program included 160 laboratory tests, 126 tests as part of the standards development program and 34 as part of the enforcement program. There were 12 instances where the claimed energy efficiency was not supported by testing conducted at NATA accredited laboratories. State regulators subsequently deregistered six products, negotiated acceptable outcomes including re-labelling of another four products. Several three-phase air conditioners were found to be non-compliant with MEPS.

Discussions with industry indicate that the check-testing and sanctions regime is adequate, provided it is adequately resourced. The commercial consequences of loss of reputation are considered to be serious. More generally, industry had no adverse comment on the regime for implementation and review of the MEPS.

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## APPENDIX 1: TECHNICAL BACKGROUND & TABULATION OF MEPS LEVELS

### Technical terms

The *capacity* of an airconditioner is measured as the number of kilowatts (kW) of *output power* in the cooling cycle, which is the rate of cooling achieved in the conditioned space under certain standard conditions. The efficiency of an airconditioner is measured as a ratio of output power to *input power*, which is the rate at which energy is used by the compressor and fans that drive the airconditioner. This ratio is also measured in the cooling mode under certain standard conditions and is known as the *energy efficiency ratio* (EER). EERs are typically greater than 2; they can range up to 4.

Note that the power output is a multiple of the input power, which means that heat pumps provide more energy than they use. This reflects the fact that heat pumps *move* energy in and out of the conditioned space, using refrigerants; they do not *generate* heat in the same manner as a gas or electric resistance heater.

An airconditioner is generally more efficient in the heating or reverse cycle configuration than in the cooling configuration. The ratio of power output to power input in the heating cycle is referred to as the *coefficient of performance* (COP). However, the analysis can be conducted almost entirely in terms of the EER, with some adjustment of averages to allow for a proportion of heating activity and the difference in energy efficiency.

The proposal also distinguishes between airconditioners taking *single-phase* and *three-phase* power. Most of the smaller airconditioners are single-phase but there are limits to the capacity of equipment that can be supplied by a single-phase. The larger units are three-phase, although innovations such as the use of rotary compressors, inverters and electronic controls have expanded the capacity of equipment that can be supplied by single-phase.

The distinction between *unitary* and *split* systems is also significant. Split systems have the compressor and one heat exchanger in one box, normally located outside the building, and the other heat exchanger in another box inside the building. Unitary systems have all elements in one box. They may be installed in a wall or window so that one heat exchanger communicates with the inside and the other with the outside. Or the conditioned air may be pumped into the building via ductwork.

### Proposed MEPS for single-phase airconditioners

Type	Minimum cooling EER	
	from 1 July 2004	from 1 July 2007
	<u>Unitary air conditioners</u>	
Cooling only	2.45	2.75
Reverse cycle	2.30	2.75
	<u>Split airconditioners</u>	
Cooling only	2.45	3.05 (<4kW) & 2.75 (4kW+)
Reverse cycle	2.30	3.05 (<4kW) & 2.75 (4kW+)

**Existing and proposed MEPS for three-phase airconditioners**

<i>Cooling Capacity (kW)</i>	<i>Minimum cooling EER from 2001</i>	<i>Cooling Capacity (kW)</i>	<i>Minimum cooling EER for 2007</i>
7.6-10.0	2.25	< 19kW	2.75
10.1-12.5	2.30	19 – 39kW	3.05
12.6-15.5	2.35	39 – 65kW	2.75
15.6-18.0	2.40		
18.1-25.0	2.45		
25.1-30.0	2.50		
30.1-37.5	2.55		
37.6-45.0	2.60		
45.1-65.0	2.65		

**Mandatory and ‘high efficiency’ MEPS for three-phase units from 1 July 2007**

<i>Output capacity</i>	<i>Mandatory MEPS – all appliances</i>	<i>Conditional MEPS – high efficiency appliances</i>
< 19kW	2.75	3.35
19 - 39kW	3.05	3.65
> 39kW	2.75	3.35

## APPENDIX 2: COST BENEFIT ASSUMPTIONS

The financial life cycle cost (LCC) is the sum of the capital, maintenance and energy costs incurred over the life of the unit. There are also non-financial costs associated with the size, noise, functions and aesthetics of the unit. Of these, only impacts on the capital and energy costs have been explicitly modelled.

The main challenge is the variety of circumstances for individual users, depending on the type of unit, its capacity, the life of the unit, the intensity of use over the life of the unit, and the cost of energy. It is inevitable that the analysis is conducted in terms of average users and that those averages will hide considerable variation in outcomes.

It should also be noted that the cost benefit models are not designed to track the fluctuations in building activity on a year-to-year basis. It is assumed that demand follows a smooth growth path. Given the significant periodic cycle in building activity, this means that sales estimates depart significantly from actual sales on a year-to-year basis. Taking the period as a whole, however, total sales that are affected by the MEPS reflect the underlying trends in market penetration and growth.

### Residential

The key quantitative assumptions for the baseline assessment of the residential impacts are set out in table A.1. They have been derived as follows:

- The estimates of *total sales* of airconditioners over the relevant period are consistent with AGO projections for the stock of residential airconditioners (EES 1999) and the assumption that the average life of an airconditioner is 10 years.
- The *sales of upgraded units* have estimated on the basis of the following assumptions:
  - The proportion of upgraded units is equal to the proportion of registered models that, under business as usual (BAU) conditions, would not comply with the MEPS.
  - Energy efficiency improves at 0.4%/year under BAU conditions, which means that the proportion of complying models increases over time.
  - The regulation is not assumed to be 100% effective. It is assumed that 2.5% of the units targeted for upgrading continue to be non-compliant. This estimate is based on NAEEEEC's experience with the check testing. While the testing regime typically finds that 5-10% of units fail, the program targets brands and supplier that are assessed as 'at-risk'. A failure rate of 5-10% is not considered representative of the market as a whole. In terms of sales, an allowance of 2.5% is considered a high end estimate.
  - The regulation has a significant impact prior to 1 July 2007, which is the commencement date for the 2007 MEPS. This is partly because suppliers need to adjust their product range before the MEPS commences and partly because the interim 4004 MEPS requires that the adjustment be commenced somewhat earlier than would otherwise be the case. For modelling purposes it is assumed that the interim MEPS effectively achieves 20% compliance with the 2007 MEPS.
- The average *output capacity* is that assumed for the AGO projections.
- The *hours of operation* have not been explicitly reported for the AGO projections. Instead these have been set at a level that generates estimates of the total energy used by refrigerative airconditioners that are consistent with the AGO projections for the amount of electricity used for space heating and cooling. We say 'consistent with' rather than 'equal to' because the AGO projections include the energy used by evaporative airconditioners and resistance heaters. Overall, it is assumed that the airconditioners subject to the MEPS account for about 82% of the total electricity used for space heating and cooling.
- Upgraded cohorts have lower than average EERs under BAU conditions, resulting in higher than average higher energy consumption. The average *pre-MEPS EER* is taken to

be the average EER of non-complying models. As shown in table A.1, this rises under the influence of background increases in energy efficiency. The *post-MEPS EER* is set as the midpoint between the average EER of borderline units (ie, that only just comply with the MEPS) and the average EER of complying models.

- The EERs reported in table A.1 is for the cooling cycle, which somewhat underestimates the efficiency of reverse cycle units, since reverse cycle units are more efficient in the *heating cycle* than in the cooling cycle. It is generally assumed that the difference is about 0.4 and that measures to improve energy efficiency have the same proportional effect in the heating mode as in the cooling mode. And, since the energy savings have been estimated in average and proportional terms, it is not necessary to explicitly model the difference.
- The *average price of electricity* a state-weighted average of marginal residential electricity tariffs, with weights set equal to state shares of the electricity used for space heating and cooling.
- The *average life* of airconditioners is taken from the AGO projections. The *average price* of airconditioners has been determined with reference to industry sources. Note that this is not the price of an airconditioner of average capacity, which would be about \$1,600 rather than the nominated figure of \$1,910. It is the average price per registered model, which is the appropriate basis from which to calculate the increase in costs under the proposal.
- The *percentage increase in cost* of upgraded units has been determined conservatively with reference to a series of engineering studies commissioned by the US department of energy. As discussed in section 4, the increase in cost has been put at an average of 1.5% for non-complying units.

**TABLE A2.1 COST-BENEFIT ASSUMPTIONS FOR THE RESIDENTIAL BASELINE**

Year	Sales ('000)		Average characteristics of upgraded cohorts			
	Total residential market	Upgraded cohorts	Output capacity (kW)	Annual duty hours	EER, pre-MEPS	EER, post-MEPS
2000	319	0	4.06	400	2.49	2.89
2001	328	0	4.08	400	2.50	2.89
2002	338	0	4.09	400	2.50	2.89
2003	348	0	4.10	400	2.51	2.90
2004	357	63	4.12	400	2.52	2.90
2005	368	102	4.13	400	2.53	2.90
2006	377	139	4.15	400	2.53	2.89
2007	388	178	4.17	400	2.54	2.89
2008	398	297	4.19	400	2.55	2.89
2009	409	302	4.20	400	2.55	2.90
2010	419	305	4.22	400	2.56	2.90
2011	430	306	4.24	400	2.57	2.89
2012	441	309	4.25	400	2.57	2.90
Average price of electricity, ex GST (cents/kWh)					12.0	
Average asset life (years)					10	
Average price of air conditioning unit, ex GST (\$)					1,910	
Average increase in price due to MEPS (%)					1.5%	

### Three-phase

The three-phase cost-benefit model is similar to the residential model but uses information about the distribution of output capacity to weight raw estimates of average efficiency, capacity and cost. This is essential given that the interim three-phase MEPS are more demanding for units of greater capacity, which means that the 2007 MEPS will require

relatively small efficiency improvements from the larger units. The larger units therefore need to be weighted according to their significance in terms of energy used and total sales.

The key quantitative assumptions for the baseline assessment of the impacts on the three-phase sector are set out in table A.2.

- The estimates of *total sales* of airconditioners is consistent with industry reports of total sales in the late 1990s reported in the RIS for the interim three-phase MEPS (GWA 2000), AGO projections for growth of commercial HVAC demand (EMET 1999) and an average asset life of 15 years, which is generally assumed.
- The *sales of upgraded units* have been estimated with reference to the proportion of registered models that, under business as usual (BAU) conditions, would not comply with the MEPS – but weighted to allow for the differential impact of the interim MEPS on rates of non-compliance for larger units. Assumptions regarding the BAU improvement in efficiency, program effectiveness and improvements prior to the 2007 deadline, are the same as for the residential model.
- The average *output capacity* is the sales weighted average of upgraded units, allowing for the fact that the proportion of non-complying units varies significantly by size. The weights are taken from sales data reported in the earlier RIS (GWA 2000).
- The average *hours of operation* are also derived from the data reported in the earlier RIS, comprising average hours of operation and estimates of the distribution by size of units. Note that these are cooling hours. To allow for additional savings during the heating cycle, total energy savings have been calculated as cooling savings plus 33%.
- The *pre-MEPS EER* is taken to be the average EER of non-complying models. The *post-MEPS EER* is set as the midpoint between the average EER of borderline units (ie, that only just comply with the MEPS) and the average EER of complying models. Both are weighted to reflect the variations in energy use and non-compliance rates by the size of airconditioners.

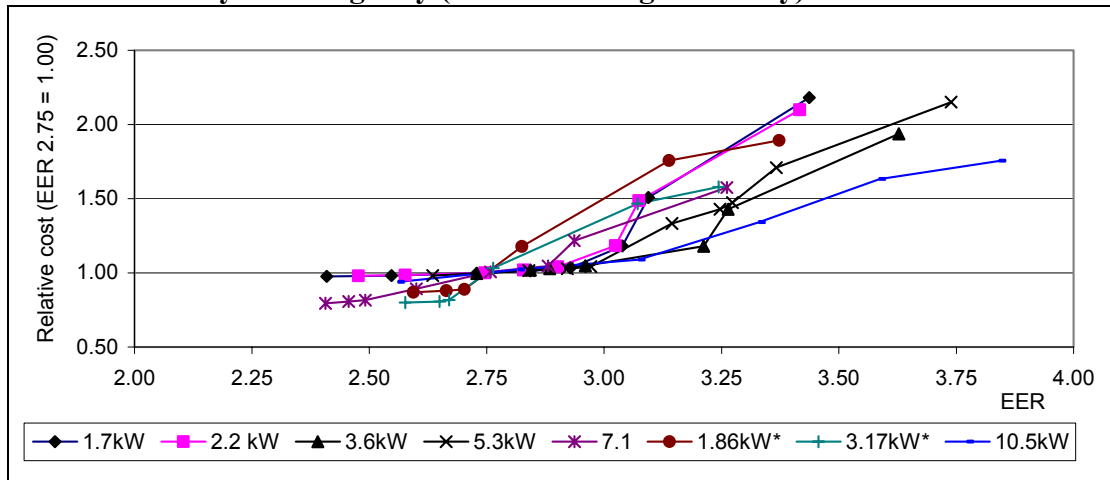
**TABLE A2.2 COST-BENEFIT ASSUMPTIONS FOR THE THREE-PHASE BASELINE**

Year	Sales ('000)		Average characteristics of upgraded cohorts			
	Total three-phase market	Upgraded cohort	Output capacity (kW)	Annual duty hours (cooling)	EER, pre-MEPS	EER, post-MEPS
2000	60	0	16.7	1365	2.59	2.93
2001	62	0	16.8	1370	2.60	2.93
2002	64	3	16.7	1372	2.61	2.93
2003	66	3	16.6	1372	2.61	2.92
2004	68	5	16.7	1377	2.62	2.92
2005	70	10	16.8	1377	2.63	2.92
2006	73	21	16.7	1383	2.63	2.92
2007	75	43	16.5	1386	2.64	2.92
2008	78	43	16.5	1389	2.65	2.93
2009	80	44	16.6	1393	2.66	2.93
2010	83	44	16.6	1391	2.66	2.93
2011	85	44	16.3	1389	2.66	2.93
2012	88	41	15.5	1412	2.66	2.92
Average price of electricity, ex GST (cents/kWh)					12.0	
Average asset life (years)					15	
Average price of air conditioning unit, ex GST (\$)					7,081	
Average increase in price due to MEPS (\$)					1.5%	

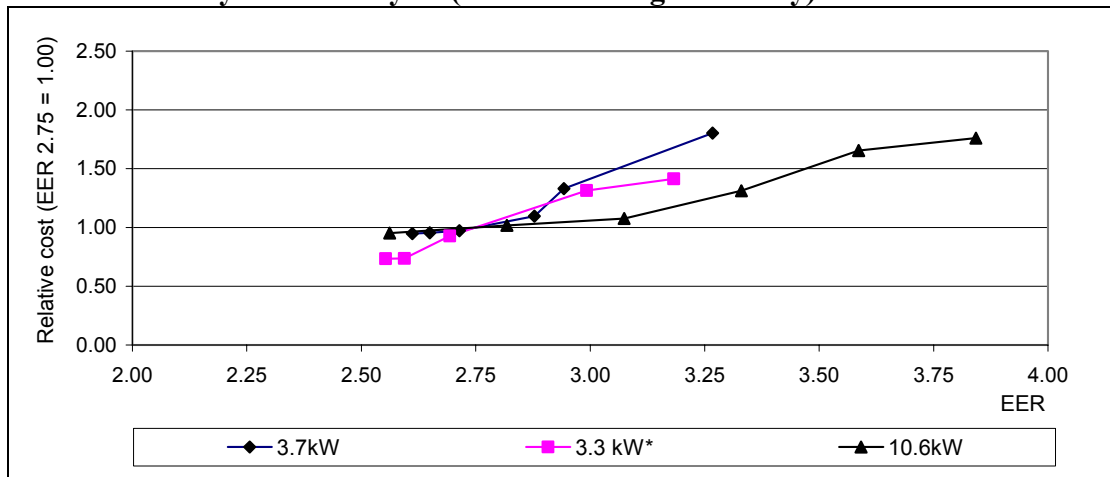
- The *average price of electricity* a state-weighted average of marginal residential electricity tariffs, with weights set equal to state shares of the electricity used for space heating and cooling.
- The *average life* of airconditioners is taken from the AGO projections. The *average price* of airconditioners has been determined with reference to industry sources, also weighted to reflect the differential impact of the measures by size of airconditioner.
- The *percentage increase in cost* of upgraded units has been determined conservatively with reference to a series of engineering studies commissioned by the US department of energy. As discussed in section 4, the increase in cost has been put at an average of 1.5% for non-complying units.

**APPENDIX 3: US ESTIMATES OF THE EFFICIENCY-COST RELATIONSHIP**

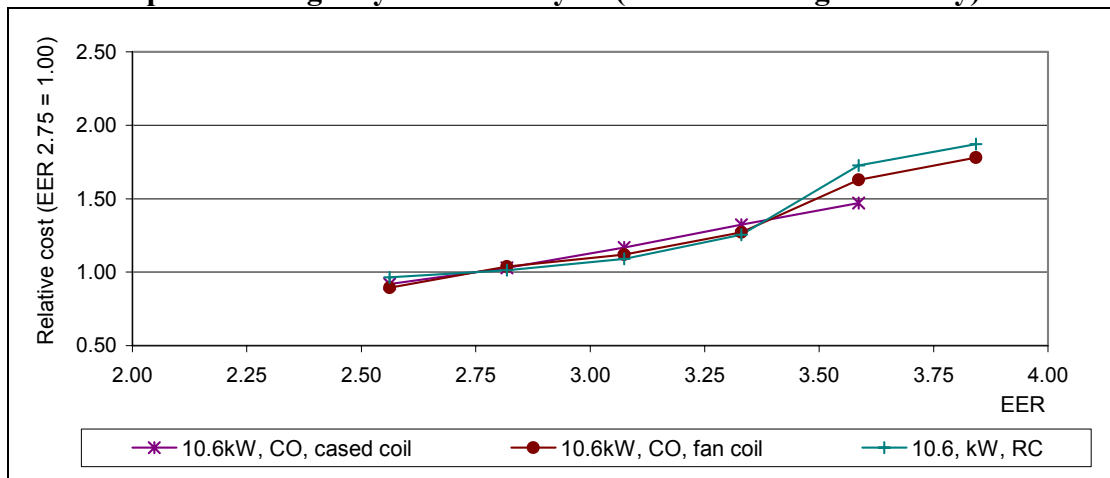
**Residential - unitary – cooling only (manufacturing costs only)**



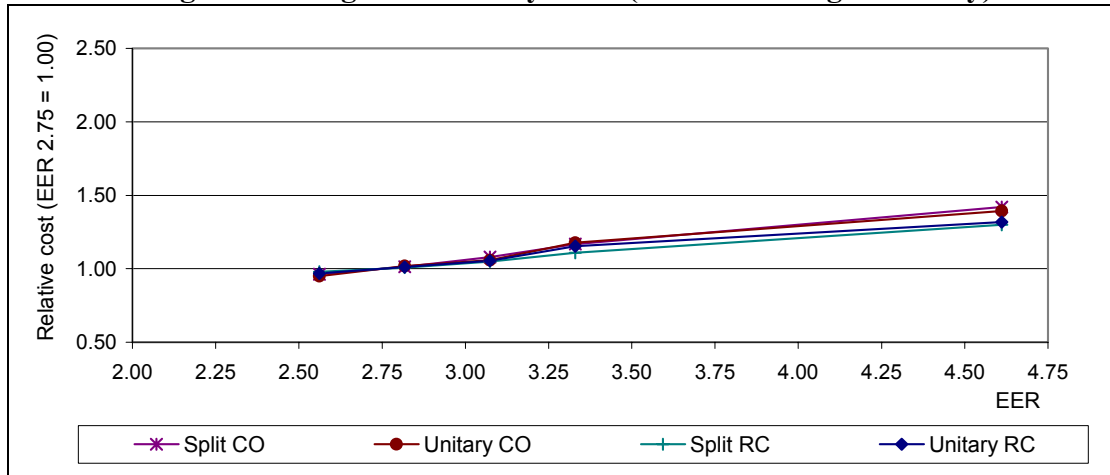
**Residential - unitary – reverse cycle (manufacturing costs only)**



**Residential - split – cooling only & reverse cycle (manufacturing costs only)**



**Residential - weighted average of ducted systems (manufacturing costs only)**



**Commercial systems (manufacturing costs only)**

