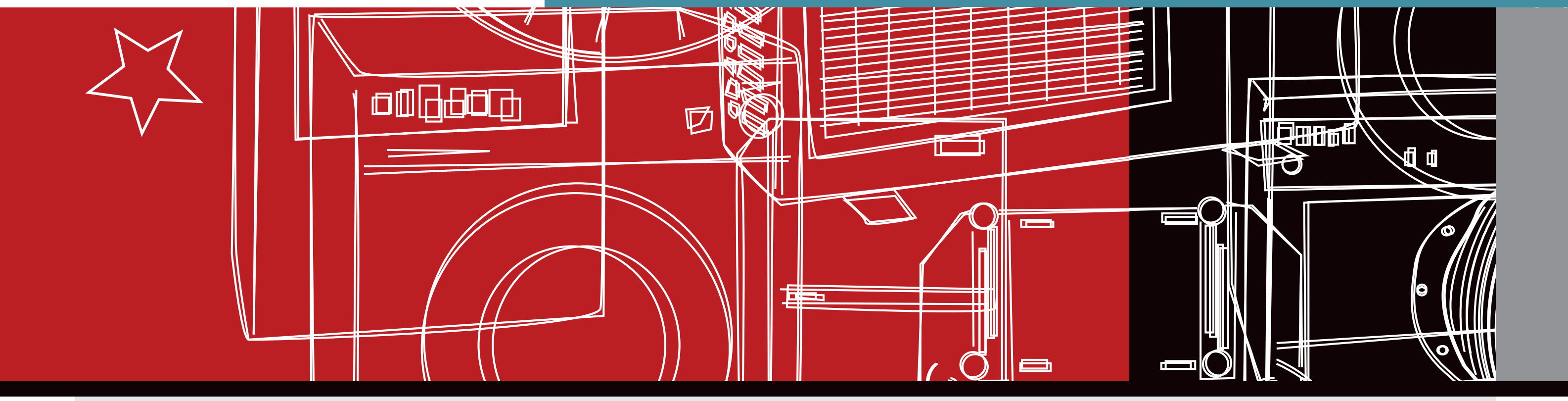
Report No: 2005/05

NATIONAL APPLIANCE AND EQUIPMENT
ENERGY EFFICIENCY PROGRAM

WHEN YOU KEEP MEASURING IT, YOU KNOW EVEN MORE ABOUT IT!



PROJECTED IMPACTS 2005-2020

AN INITIATIVE OF THE MINISTERIAL COUNCIL ON ENERGY
FORMING PART OF THE AUSTRALIAN NATIONAL FRAMEWORK
FOR ENERGY EFFICIENCY AND NEW ZEALAND NATIONAL ENERGY
EFFICIENCY AND CONSERVATION STRATEGY

April 2005

EXPLANATORY NOTE:

The quote, "When you keep measuring it, you know even more about it" continues the theme of the last projections for NAEEEP, "When you measure it, you know something about it!"

ABBREVIATIONS

ANZ	Australian and New Zealand
AS	Australian Standard
AS/NZS	Joint Australian and New Zealand Standard
BAU	Business as Usual
CO_2-e	Carbon dioxide equivalent
COP	Coefficient of Performance
EER	Energy Efficiency Ratio
HE	High Efficiency
MCE	Ministerial Council on Energy
MEPS	Minimum Energy Performance Standards
GAEEEP	Gas Appliance and Equipment Energy Program
NAEEEP	National Appliance and Equipment Energy Program
NAEEEC	National Appliance and Equipment Energy Efficiency Committee
NFEE	National Framework for Energy Efficiency
PAC	Packaged Air Conditioner
RIS	Regulatory Impact Statement

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PROJECTED IMPACTS 2005 - 2020

This summary presents the main findings of a study projecting the impacts of the National Appliance and Equipment Energy Efficiency Program (NAEEEP) over the period 2005–20. The complete study by George Wilkenfeld and Associates, *When you keep measuring it,you know even more about it!* follows the summary.

NAEEEP is a collection of coordinated end-use energy efficiency programs that deliver economic and environmental benefits to the community. It focuses on programs that require a nationally consistent framework to improve energy efficiency and reduce greenhouse emissions from household appliances and equipment and commercial and industrial equipment.

The study continues the approach first adopted five years ago in 2000 to aggregate projections of the various measures within the national program. This is the third such study following a second study in 2003. It maintains the same forward time horizon of previous reports (projecting forward 16 years) to aid with comparisons.

NAEEEP aims to improve the uptake of energy efficient equipment in Australia at rates beyond what the market would otherwise deliver. The projected benefits do not include business-as-usual efficiency improvements that would otherwise have occurred. This aggregation study places all projections within a common framework and allows the impact of individual measures to be compared with the whole and with comparable product measures.

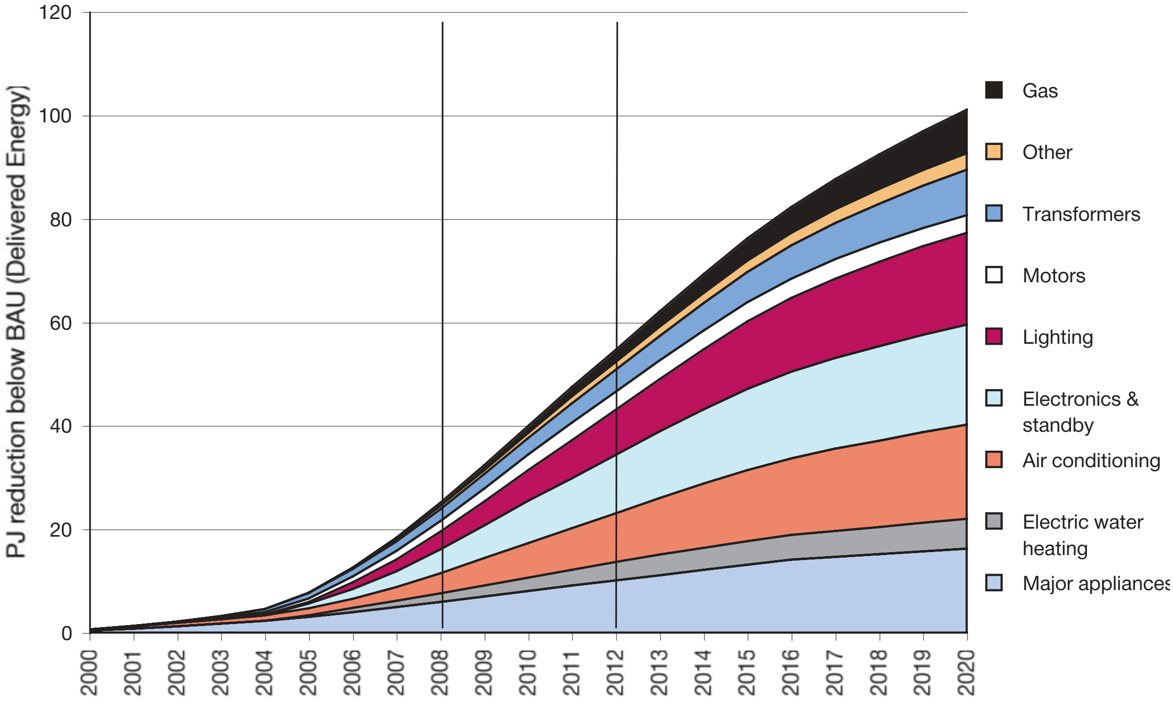
The main regulatory tools are energy labelling and minimum energy performance standards (MEPS) for a wide range of household, commercial and industrial appliances and equipment. The projection covers all measures included in the latest NAEEEP work program approved by the Ministerial Council on Energy in December 2004 for release in 2005. The work plan covers the period 2005–06 to 2007–08.

As with all previous projection studies, some measures have been incorporated into regulation, some are at advanced stages of development with stakeholders working toward target implementation dates, and some have only been announced as probabilities. Over time, these aggregate studies also demonstrate that the preliminary estimates allocated to potential measures at early stages of regulatory development have withstood the closer scrutiny of more formal and rigorous regulatory impact assessments incorporated into later studies.

DELIVERED ENERGY CONSUMPTION

The combined impacts of NAEEEP on delivered energy consumption in Australia are shown in Figure 1. Savings are projected to reach over 100 PJ a year by 2020. While other sectors are also contributing to the program's impact, technologies that are contributing most to savings are electronics and standby (20%), major appliances (18%), air conditioning (18%) and lighting (17%).

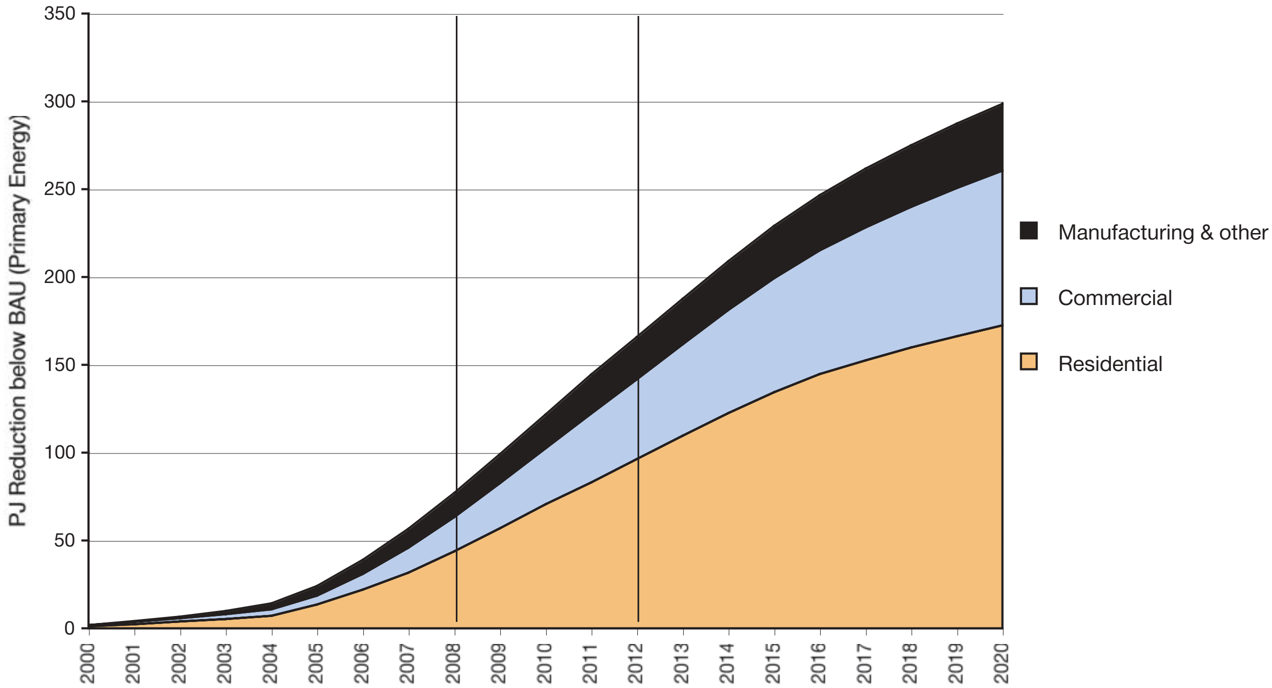
Figure 1: projected impact of NAEEEP on delivered energy, Australia



PRIMARY ENERGY DEMAND

The majority of NAEEEP energy savings are from displaced electricity generation. The Gas Equipment and Appliance Energy Efficiency Program (GAEEEP) within the NAEEEP also contributes savings. For each unit of electricity delivered, more than three times as much primary energy must be consumed, so this multiplies the energy impact of NAEEEP at the national level. The impact on primary energy demand is shown in Figure 2. Savings are projected to reach nearly 300 PJ a year by 2020, nearly 58% of this in the residential sector, 28% in the commercial sector and 14% from other sectors.

Figure 2: projected impact of NAEEEP on primary energy, Australia



REDUCTIONS IN GREENHOUSE

The reductions in greenhouse gas emissions associated with these energy savings, and comparisons with those estimated in the preceding studies, are shown in Figure 3.

It is estimated that NAEEEP will reduce greenhouse gas emissions by more than 204 Mt CO_2-e from 2005–20. The average combined impact in each of the five years of the Kyoto Protocol commitment period (2008–12) is projected to be 9.6 Mt CO_2-e reduction below business-as-usual. By 2020, the reduction is projected to reach 20.9 Mt CO_2-e a year.

These estimates are significantly higher than the equivalent estimates in previous studies because of the expanded scope of the NAEEEP. For the period common to all three studies (2003–15), the first study estimated a greenhouse gas reduction of 69.5 Mt CO_2-e, the second estimated 91.2 Mt and the third (present) study estimates 107.1 Mt, more than 54% higher than the first.

For the 16-year period 2005–20, the second study estimated an impact of 160.8 Mt, whereas the present study estimates 204.3 Mt or 27% more. The projected annual impacts of NAEEEP during each of the five years of the Kyoto Protocol commitment period has increased by more than 52% from 6.3 to 9.6 Mt CO_2-e a year (all values Australia only).

For the first time New Zealand has agreed to a common future work plan with Australia. The projected emissions impacts in the states and territories and in New Zealand is shown in Figure 4. It is projected that if all NAEEEP programs are implemented in New Zealand to the same extent as in Australia, New Zealand greenhouse gas emissions over the period 2005–20 will be 23.7 Mt CO_2-e lower than without NAEEEP programs. The average reduction in each of the five years of the Kyoto Protocol commitment period would be about 1.1 Mt CO_2-e.

Figure 3: Projected impact of NAEEEP on greenhouse gas emissions, Australia

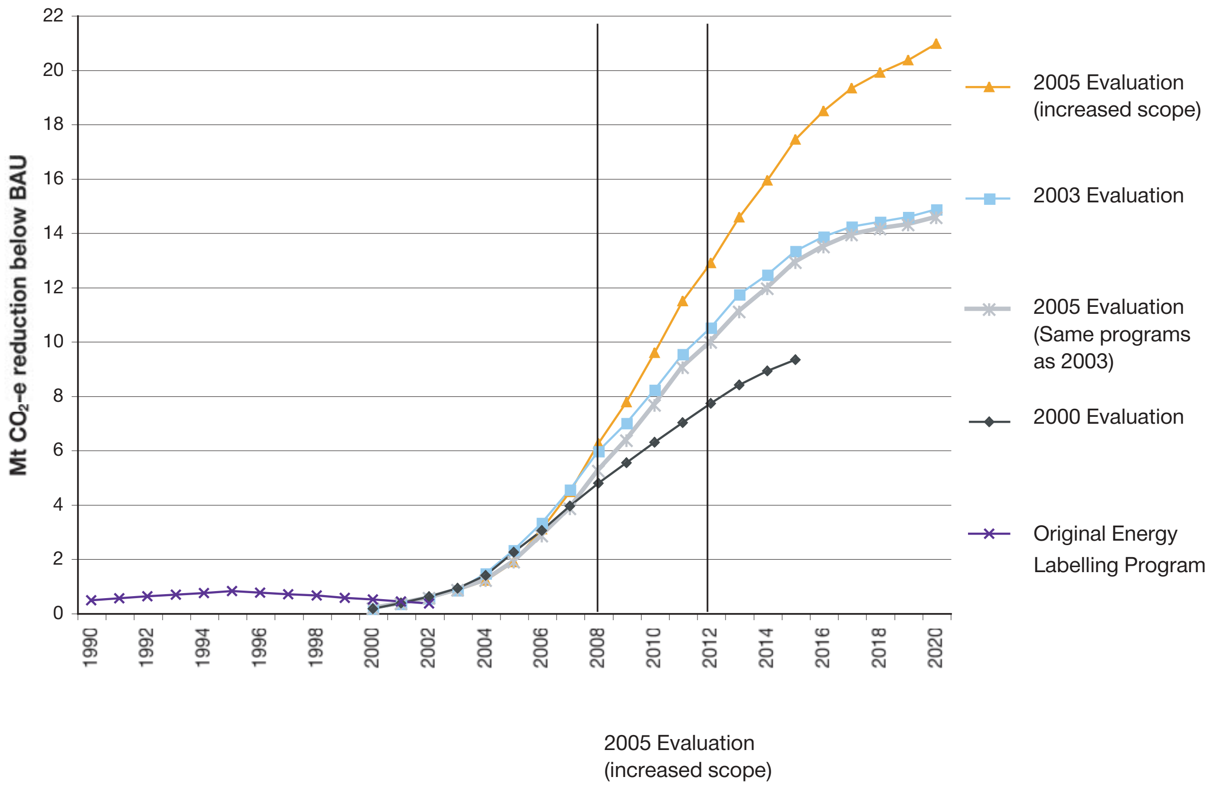
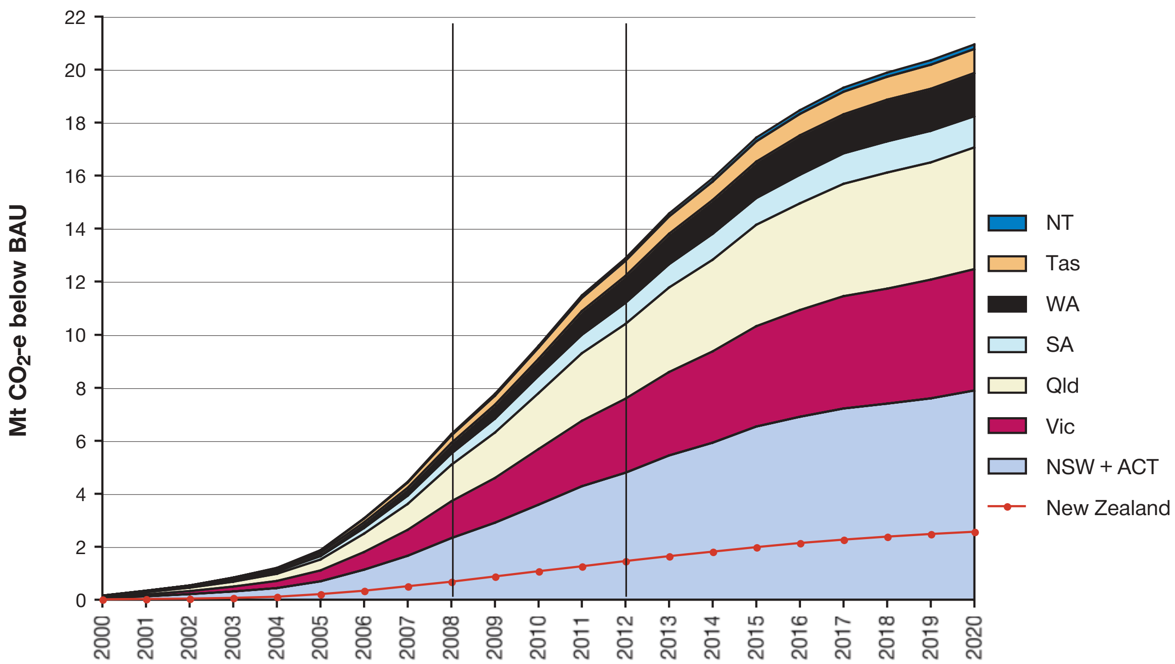


Figure 4: Projected impact of NAEEEP on greenhouse gas emissions by region



MONETARY BENEFITS

The monetary benefits and costs of all NAEEEP programs have also been calculated across the complete suite of measures. Cost data for programs in the early stages of development are preliminary only, and conservative assumptions have been used (that is, the costs are at the higher end rather than the lower end of industry provided data). Nevertheless, the estimated cost-effectiveness of NAEEEP is still a healthy 1.7, well over the break-even point of 1.0, even using the high discount rate of 10%.

Scenario modelling shows that even if the most pessimistic cost assumptions are adopted, the program remains beneficial to the wider community. Table S1 shows that for each tonne of emissions saved, there is a net benefit – or 'negative cost' – of $23 to the Australian community.

Table S1 Summary of Estimate Benefits and Costs, Australia Only

	Period	Benefit/cost ratio			$ cost per tonne CO_2-e saved		
		0% discount rate	5% discount rate	10% discount rate	0% discount rate	5% discount rate	10% discount rate
NAEEEP 2000 (first study)	2000-15	3.5	2.9	2.4	-$135	-$62	-$31
NAEEEP 2003 (second study)	2003-18	3.1	2.7	2.4	-$84	-$47	-$28
NAEEEP 2003 (second study)(a)	2005-20	3.7	3.2	2.9	-$109	-$62	-$37
NAEEEP 2005 (third study–current)	2005-20	2.3	2.0	1.7	-$81	-$43	-$23

Note: *Negative values for costs indicate net benefits per tonne avoided. (a) Although the length of the accumulation period is the same (16 years) shifting the starting point for the NPV calculations by two years changes the values.*

CONTENTS – MAIN REPORT

BACKGROUND

1.1 SCOPE

This study presents an overview of the projected impacts of the National Appliance and Equipment Energy Efficiency Program (NAEEEP) on national energy use and greenhouse gas emissions in the period 2005 to 2020, and the estimated monetary costs and benefits of achieving those impacts.

It covers programs and measures which have already been implemented as well as those which form part of the NAEEEP Work Program for the triennium just beginning, 2005-07.[1] The scope of the Work Program has still to be finalised, and the present study is based on the description in the November Draft of the *Appliance and Equipment Energy Efficiency Package* of the National Framework for Energy Efficiency (NFEE Stage One Implementation Plan (NFEE 2004).

As well as the projected impacts on electricity consumption, it also covers the impacts of the Gas Appliance Energy Efficiency Program (GAEEEP), which Ministers have agreed should be incorporated into the NAEEEP.

The NAEEEP comprises both mandatory and voluntary energy efficiency programs. Most of the impacts come from programs such as mandatory energy labelling (eg the 'star' rating label for electrical appliances) and minimum energy performance standards (MEPS). The MEPS and energy labelling requirements form part of the relevant Australian or joint Australian and New Zealand product standard, and are given mandatory effect by State, Territory and New Zealand legislation.

Significant impacts are also projected for voluntary information measures which enable product suppliers and consumers to identify exceptionally energy efficiency products, or those capable of lower energy consumption. These measures include:

- the 'Energy Star' endorsement label for office equipment and home entertainment products. This generally indicates that energy consumption in standby mode can be set to below a defined threshold, and that the default product settings make use of the low-energy mode. Energy Star criteria apply internationally, are controlled by the US Environmental Protection Agency and are revised at infrequent intervals;
- the 'The Top Energy Saver Award' (TESAW) endorsement label for products which are the most energy-efficient of their type available on the Australian and New Zealand (ANZ) market in a given year. TESAW criteria are revised annually by the NAEEEC;
- the 'High Efficiency' (HE) designation available to products which exceed current MEPS levels by a specified margin. HE criteria are included in the relevant A/NZ product standards, and generally foreshadow the revised MEPS that may be adopted after the conclusion of the stability period for the current MEPS level, as agreed with industry (subject to a Regulation Impact Statement and the agreement of Energy Ministers).

Increasingly, products with significant national energy use are becoming subject to a wide range of mandatory and optional measures designed to influence different groups of specifies and purchasers. NAEEEC determines the optimum mix of measures for each product type after market analysis and consumer research. NAEEEC has also, from time to time, concluded after analysis that the benefits of implementing measures for certain product types is not likely to exceed the costs for the present.[2]

1 *The NAEEEP work programs generally cover periods of three calendar years. The first triennium was 1999-2001, the second 2002-04 and the third 2005-07.*

2 *This conclusion has been reached for Evaporative Coolers, Industrial Boilers and Wine Storage Cabinets.*

1.2 PROGRAMS COVERED

The study updates previous set of projections, published in March 2000 (NAEEEP 2000) and in January 2003 (NAEEEP 2003). The first study covered the period 2000 to 2015, whereas the second study and the present one cover the period 2000 to 2020.

The products, programs and measures covered by this study (summarised in Table 1) include the following:

- all NAEEEP programs and measures which have already been implemented,
- all NAEEEP programs and measures for which there are committed implementation dates; and
- all NAEEEP programs to be finalised during the next triennium (2005-07) and for which product profiles have been published.

This includes all programs accepted for implementation in both Australia and New Zealand in the *Appliance and Equipment Energy Efficiency Package* (NFEE 2004) but not all of the additional measures proposed by New Zealand (see Table 2).

The estimates of the Australian and New Zealand impacts for the measures listed in Table 1 are based on published studies and Regulation Impact Statements. Most of the studies cover Australia only, and the impacts have been extrapolated to New Zealand using assumptions explained later. No impacts have been included for some of the additional New Zealand measures listed in Table 2, because there are no estimates of impacts available, and because it has yet to be determined whether the measures will be implemented in both countries or in New Zealand only.

Programs 1 to 15 in Table 1 largely correspond to Programs 1 to 16 in Table 1 of the previous study (NAEEEP 2003), except for the following minor changes:

- The order of programs has been changed slightly to group similar measures;
- The MEPS and energy labelling of small water heaters, formerly two programs, has been combined into one, since the measures were dealt with in an integrated manner in the one RIS (GWA 2003).

Programs 16 to 27 are new programs not included in the previous projections.

1.3 SOURCE OF ESTIMATES

The study draws on the cost-benefit and impact estimates generally published at two key stages in the development of a measure:

- When a product plan is released by NAEEEC; and
- When a Regulatory Impact Statement (RIS) is published on a specific proposal for a mandatory measure.

The product plan explains the reasons to include (and in some cases, exclude) certain products within the scope of the NAEEEP and usually contains a preliminary impact estimate. The RIS is prepared at a later stage, after a draft Australian Standard containing actual proposed MEPS levels and/or or label designs and algorithms has been published. The cost-benefit analyses included in RISs are more comprehensive and detailed than the preliminary estimates in the product plans.

Many of the products and measures covered in the previous study (NAEEEP 2003) have since advanced from preliminary consideration to product plan, or from product plan to RIS. Therefore many of the estimates in the present study are based on revised calculations, or on data and modelling not available to the previous study. In some cases this has led to a reduction in projected estimates and in other cases an increase.

Some impact projections have been adjusted for changes in the timing of program implementation. In a few cases the original modelling did not extend to 2020, and a decay function has been added to simulate a gradual reduction in impact after the peak impact year identified in the modelling. This would correspond to a continuing background improvement in energy efficiency, and a reducing margin over time between the efficiency levels prompted by the measure, and business as usual (BAU).

All modelling has been re-based to common discount rates, energy prices and greenhouse gas intensity values for electricity and gas delivered. This has been done by re-running the original models (where these are in GWA's possession) or by extrapolating from the published reports.

Table 1 Summary of equipment types and program elements covered

Program number	Products covered	Measure	Commencement (actual or projected)	Source of data and modelling	Compared with previous study
1	Refrigerators, freezers, dishwashers, single phase air conditioners, clothes washers, clothes dryers	Mandatory appliance labelling and revised labelling	1986 1999 (revised label)	RIS (GWA 1999, 1999a)	Unchanged
	Refrigerators, freezers, electric storage water heaters	Initial MEPS	1999		Unchanged
2	Refrigerators, freezers	Revision of MEPS levels	2005	RIS (GWA 2001b)	Unchanged
3	Single phase airconditioners	Initial MEPS; Accelerated & Enhanced MEPS	2004, 2006, 2007	NAEEEP (2002d), RIS (Syneca 2004b)	Increased
4	Packaged (3 phase) air conditioners	Initial MEPS	2001	RIS (GWA 2000a)	Unchanged
5	Packaged (3 phase) air conditioners	Revision of MEPS levels	2007	NAEEEP (2002c)	Unchanged
6	Fluorescent Lamp Ballasts	Initial MEPS	2003	RIS (GWA 2001)	Unchanged
7	Linear fluorescent lamps	Initial MEPS (efficacy standards)	2007	RIS (MEA 2003)	Reduced
8	Electricity Distribution Transformers	Initial MEPS	2004	RIS (GWA 2002)	Unchanged
9	Commercial refrigeration, icemakers and storage bins	Initial MEPS	2004, 2006	RIS (MEA 2004, NAEEEP (2004c)	Reduced
10	Small electric storage water heaters	Revision of MEPS levels, with LE/HE labelling	2005	RIS (GWA 2003)	Unchanged
11	Electric motors	Initial MEPS	2001	RIS (GWA 2000)	Unchanged
12	Electric motors	Revision of MEPS levels	2006	RIS (Syneca 2003)	Increased
13	Large electric storage water heaters	Revision of MEPS levels	2005	NAEEEP (2001d)	Unchanged
14	Miscellaneous electric water heaters	Initial MEPS	2005	RIS (Syneca 2004a)	Reduced
15	Standby	One Watt program for standby consumption	2004	NAEEEP (2002b)	Delayed 2 yrs
16	All lamps, lighting transformers, fittings	'Greenlights' measures	2005	NAEEEP (2004a)	New program
17	Televisions – On-mode	MEPS and labelling	2006	NAEEEP (2004b)	New program
18	Water dispensers	MEPS	2007	NAEEEP (2004d)	New program
19	Chillers	MEPS	2007	NAEEEP (2004e)	New program
20	Close Control Air Conditioners	MEPS	2007	NAEEEP (2004f)	New program
21	Heating mode of ACs - household	Information and MEPS	2006	NAEEEP (2004g)	New program
22	Heating mode of PACs - business	Information and MEPS	2006	NAEEEP (2004g)	New program
23	Swimming pool equipment	Information and MEPS	2006	NAEEEP (2004h)	New program
24	Gas Water Heaters (GAEEEP)	MEPS and labelling	2005	GWA (2004a)	New program
25	Gas Space Heaters (GAEEEP)	MEPS and labelling	2005	GWA (2004a)	New program
26	Gas savings from water efficiency labelling	Energy impact of water efficiency labelling	2005	RIS (GWA 2004b)	New program
27	Electricity savings from water efficiency labelling	Energy impact of water efficiency labelling	2005	RIS (GWA 2004b)	New program

Table 2 Additional products recommended for inclusion in New Zealand *Appliance and Equipment Energy Efficiency Forward Programme 2004-05*

Sector	Product	Measure to be investigated	Covering in this study
Residential	Incandescent lamps	MEPS and/or labelling	Covered (Program 16)
	Dehumidifiers	MEPS and/or labelling	Not covered
	Gas water heaters	MEPS and/or labelling	Covered (Program 24)
	Gas space heaters	MEPS and/or labelling	Covered (Program 25)
	Solid fuel space heaters	MEPS and/or labelling	Not covered
	Solar water heaters	MEPS for storage tank; labelling for whole system	Not covered
	Two-stroke engines	Public education, emission controls, MEPS and/or labelling	Not covered
Commercial	Commercial lighting	MEPS and/or labelling	Covered (Program 16)
Industry & Agriculture	Motor rewinds (service)	Quality controls	Not covered
	Dairy water heaters	MEPS and/or labelling	Not covered
Non-energy using products	Water heater cylinder wraps	MEPS and/or labelling	Not covered
	Building insulation	MEPS and/or labelling	Not covered
	Windows	MEPS and/or labelling	Not covered

Source: NFEE (2004) and EECA (2004)

1.4 COSTS AND BENEFITS

The net present value (NPV) of the costs and benefits of each proposed or implemented measure is calculated using the following assumptions:

- The NPV for all programs is calculated with reference to the same point in time - the beginning of 2005;
- The monetary benefit of each program is calculated as the NPV of the energy consumption avoided over the 16 year period 2005-2020, using the marginal electricity and gas tariffs in Appendix 1;
- The cost of each program is the NPV of the projected increases in capital costs brought about by the measure, for products sold and installed up to 2020;
- NPV is calculated using 0%, 5% and 10% discount rates.
- NPV is calculated from the perspective of the product 'end user', ie the party which ultimately bears the capital costs as well as the running costs. Manufacturers, retailers and parties purchasing on behalf of the end user (eg developers, builders or plumbers) are considered intermediaries who pass on the costs to the end user.[3] The contribution of intermediaries to market failure is often the main rationale for the decision to implement mandatory programs.

For programs where RISs have been completed, the projected impact on product prices is taken from the RIS. Where only a product profile has been completed, but not a full RIS, the increase in product price is calculated as follows:

- The NPV of the projected reduction in energy consumption is calculated, using the marginal tariffs in Appendix 1;
- The average capital cost of new products sold is increased so that the NPV of all product sales up to 2020 matches the NPV of the value of energy saved (at a discount rate of 10%).

3 *The impacts on intermediaries is nevertheless one of the key issues considered in RISs. If suppliers in a given market vary greatly in their ability to pass on the costs associated with mandatory measures, there may be disproportionate impacts on particular companies and possibly a reduction in supplier or price competition.*

In other words, it is assumed that the benefit/cost ratio is 1.0 at a discount rate of 10% (making it typically about 1.2 at 5% discount and 1.5 undiscounted). This introduces a conservative bias into the estimate, since all completed RISs have found benefit/cost ratios well over 1.0 at 10% discount rate. Consequently the monetary benefits per tonne of greenhouse emissions saved by the NAEEEP as a whole are somewhat lower in the present analysis than in the previous analysis: $23/tonne CO_2-e at a 10% discount rate, compared with a previous value of $37/tonne.[4] However, this value still indicates that there is a large net benefit associated with the greenhouse gas reduction from NAEEEEP programs, in contrast with other means of reducing emissions, such as renewable electricity production, which involve a significant cost.

For products installed in air-conditioned spaces (as are the majority of lamps, fluorescent lamp ballasts and office equipment), projected reductions in airconditioning energy ('indirect savings') as well as direct energy savings from greater energy-efficiency are taken into account.

Greenhouse impacts are quantified using the marginal greenhouse gas coefficients in Appendix 1. No monetary value is given to greenhouse emissions avoided.

4 *Another way to express this benefit is that the monetary cost per tonne of emissions saved by the NAEEEP is -$27, compared with a previous estimate of -$35. By contrast the cost per tonne of emission saved by measures such as renewable energy is a positive value.*

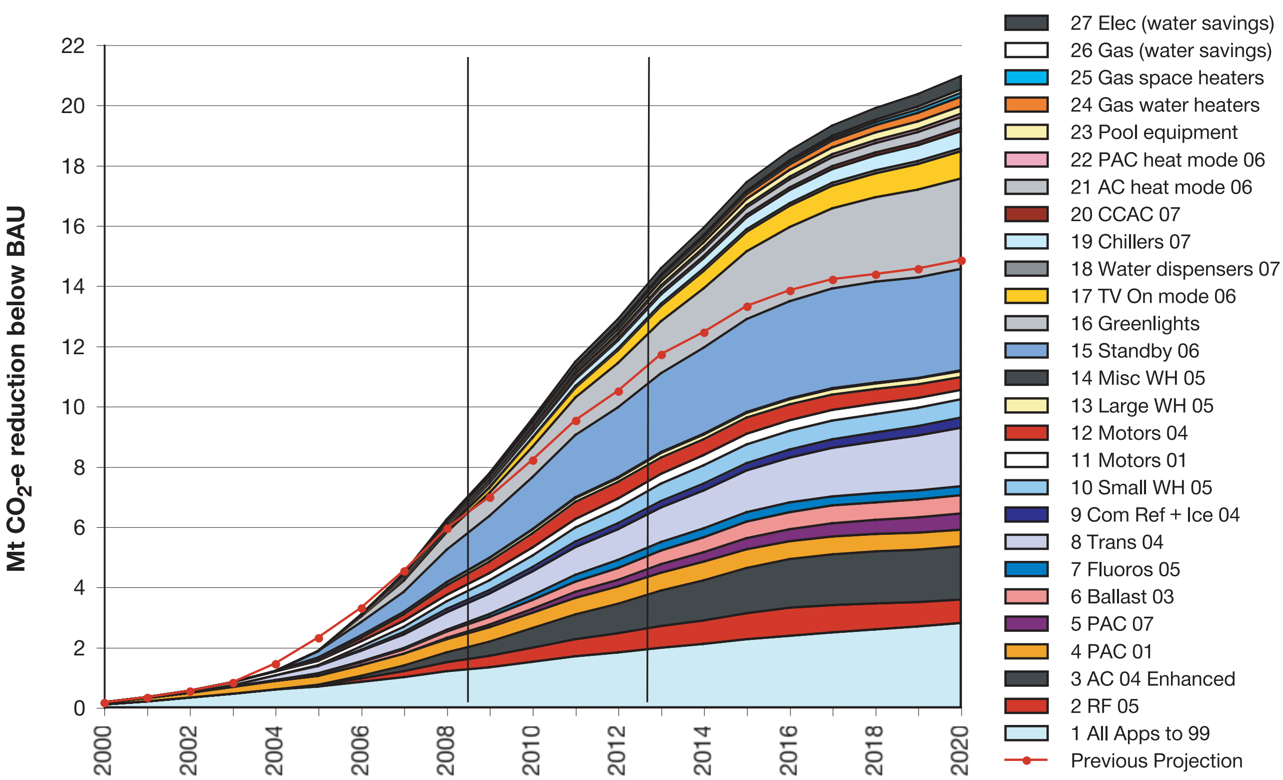
2 INDIVIDUAL MEASURES

2.1 OVERVIEW OF IMPACTS

The combined projected impacts of the measures listed in Table 1 are illustrated in Figure 1. Measures numbered 1 to 15 correspond to those covered in the previous NAEEEEP Combined Impacts study. In several cases the projected impacts have been revised, so the total is somewhat less than the previous total for the same group of measures, which is illustrated by the red 'Previous Projection' line in Figure 1. However, new programs (numbered 16 to 27) more than make up for any reductions in projected impact.

The following sections discuss each measure in detail, list the sources of the impact projections and highlight where previous projections have been revised. Measures are grouped by sector, but Standby is treated separately because of the diversity of devices and programs covered, and the fact that impacts are spread across sectors.

Figure 1 Overview of projected greenhouse gas reductions from NAEEEP measures, Australia 2000 - 2020



5 *NAEEEP Combined Projections 2004 V1.xls*

2.2 HOUSEHOLD APPLIANCES

REFRIGERATORS AND MAJOR APPLIANCES

ALL MEASURES TO 1999

In 1999 the NAEEEC considered the impacts of:

- implementing a nationally uniform mandatory energy labelling program (ie rectifying the inconsistencies between the separate State-based programs, and extending sunset provisions where these applied);
- revising the energy label design and the supporting Standards and algorithms; and
- proceeding with the implementation of MEPS for refrigerators, freezers and electric storage water heaters, as had been agreed by the Australian Minerals and Energy Council (AMEC) in 1995.

Energy Ministers agreed to implement the measures following the completion of the required RISs (GWA 1999, 1999a). The first round of MEPS for refrigerators, freezers and electric storage water heaters took effect in October 1999, and the new energy label was phased in during 2000. The projected impacts of those measures – indicated on Figure 1 as 'Program 1 All Apps to 99 ' – are taken directly from the RISs. The estimates are unchanged from the previous NAEEEP projections.

REFRIGERATORS AND FREEZERS – ADDITIONAL MEASURES

In 1999 Energy Ministers agreed that Australia would match the most stringent MEPS levels of Australia's trading partners after taking into account any differences in test methods, climate and consumer preferences (NAEEEP 2001a). The first application of this policy was to the review of MEPS for refrigerators and freezers. In 1997 the US Department of Energy published revised MEPS levels for implementation in 2001. These represented a 30% reduction in energy from the 1993 US MEPS levels, which were already more stringent than the 1999 Australian levels.

In 1999 and 2000, a NAEEEC working group drawn from industry, government and consumer bodies developed a consensus position on new MEPS levels for Australia that would be comparable to the 2001 US MEPS levels. These levels were analysed in a RIS (GWA 2001b) and are due to be implemented in 2005. The projected impacts – indicated on Figure 1 as 'Program 2 RF 05' – are taken directly from the RIS. The estimates are unchanged from the previous NAEEEP projections.

AIR CONDITIONER MEPS

COOLING MODE MEPS

In 2001 NAEEEC commissioned a review of the case for MEPS for those appliances which are currently energy labelled but not subject to MEPS (NAEEEP 2001h). The review recommended that MEPS be implemented for single phase airconditioners. In September 2002 NAEEEC released a plan for air conditioners which proposed MEPS in two stages. The first stage, to take effect in 2004, would remove the least efficient products, and the second stage, to take effect in 2007, would closely match the Taiwanese MEPS which took effect in 2001 (NAEEEP 2002d).

In June 2004 the Air Conditioning and Refrigeration Equipment Manufacturers Association of Australia (AREMA) agreed to bring forward the implementation of the second stage from October 2007 to April 2006 (APEC 2004). A further proposal for a third stage MEPS increment in 2007 has now been investigated in a RIS (Syneca 2004a). This would bring local MEPS levels up to the Korean level, which is world's best regulatory practice for single phase ACS.

The impacts of the original two-phase MEPS proposal (Phase 1 in 2004, Phase 2 in 2007) have been revised upward to reflect the fact that the growth in air conditioner ownership since 1999 has been much higher than previously projected, and combined with the proposal to bring forward the second phase and to add a third, more stringent phase. The entire MEPS program for single phase air conditioners is shown at Figure 1 as 'Program 3 AC 04 Enhanced'. The impacts of accelerating phase 2 and adding phase 3 are taken directly from the RIS (Syneca 2004b, plus personal communication with author).

HEATING MODE MEASURES

The MEPS proposals above refer only to air conditioner performance in cooling mode. Air conditioners are increasingly being used as the main form of home heating in winter, so their heating capability and energy efficiency are also matters of concern.

The energy label indicates heating energy efficiency at a relatively moderate outside temperature of 7°C dry-bulb (corresponding to ISO condition H1).

However, some models may be incapable of satisfactory heating operation at the very low winter temperatures which occur in some parts of Australia and New Zealand. Performance at these temperatures would be better indicated by testing the unit at 2°C (ISO Condition H2) or even -7°C (Condition H3).

Thus, while the proposed cooling mode MEPS will ensure a high level of energy efficiency when cooling, they would not by themselves ensure a high level of energy efficiency on heating, although there is usually some correspondence between the two.

If heating efficency is a concern the buyer can consult the energy label, but at present the information is only relevant for moderate winter conditions. For some buyers, who intend to use the air conditioner for heating in very cold climates, the present energy labelling system does not give useful information because it does not indicate the heating performance at a low temperature.

The issues are canvassed in the NAEEEP discussion paper *Minimum Energy Performance Standards: Heat Pumps* (NAEEEP 2004g). It is questionable whether it would be cost-effective to require all AC models to meet minimum heating performance criteria and energy efficiency levels at H1, let alone at lower temperatures, or whether it would be preferable to change the labelling system to enable the identification of models which are designed to operate at low temperatures.

The optimum approach has yet to be determined. For the purpose of this study, it is assumed that measures will be implemented in 2006 (whether labelling, MEPS or some combination) and that they will lead to a reduction in heating energy demand 20% as great as the reduction in cooling energy demand from cooling mode MEPS. These reductions are indicated at Figure 1 as 'Program 22 AC Heat Mode 06'.

WATER HEATING

ELECTRIC STORAGE WATER HEATERS

Electric storage water heaters were divided into two categories for the purpose of MEPS implementation in 1999: larger units (delivery rating of 80 litres and above) and smaller (delivery rating less than 80 litres). For larger water heaters, the 1999 MEPS specified that standing heat losses should be no higher than 70% of the maximum levels previously specified in the Australian Standard AS1056.1. For smaller water heaters, the 1999 MEPS specified that standing heat losses should be no higher than 100% of the maximum levels previously specified in the Australian Standard – this still represented a more stringent requirement, since prior to the implementation of MEPS most small water heater models had a higher heat loss than the maximum in AS1056.1. It was agreed that MEPS levels would not be revised before October 2004.

A RIS prepared in 2001 recommended that the MEPS levels for small electric water heaters be made more stringent, by reducing the maximum standing heat loss specified in AS1056.1 by 30% from the beginning of 2005 (GWA 2001a). The RIS was subsequently revised in the light of the New Zealand Government's decision to implement a MEPS level for small water heaters that corresponds to a 45-50% reduction in standing heat loss (GWA 2003).

Part of the revised proposal is that suppliers may choose to continue to sell some models with heat loss exceeding the MEPS level, provided that the weighted average heat loss of all their sales meets the MEPS level. This would mean that, for the first time, there would electric water heaters with significantly different heat losses on the market concurrently, so there would be scope for energy labelling. The potential for water heater labelling to increase buyer preference for the lower heat loss models, and therefore to accelerate the rate of reduction in sales-weighted heat loss, has now been included in the Small Electric Storage Water Heater impact estimates (Program 10 Small WH 05 Figure 1). The impact estimates are unchanged since the previous study, except that the MEPS and label impacts previously reported separately have been combined.

The NAEEEC plan for larger mains pressure electric storage water heaters (NAEEEP 2001d) states that:

- Tank sizes of 80 litres to 250 litres: NAEEEC proposes to review MEPS levels for these products with a view to matching US MEPS levels for 2004 (or developing a proposal with industry that is equivalent). NAEEEC will propose amending the Australian Standard to reflect the improved stringency levels.
- Tank sizes over 250 litres: NAEEEC does not propose any change to the existing MEPS levels, which will be maintained.

The estimated energy savings – indicated at Figure 1 as 'Program 13 Large WH 05' – are unchanged from the previous study.

In 2001 NAEEEC published a plan for miscellaneous electric water heaters (NAEEEP 2001e), which proposed that low pressure storage, electric-boosted solar, calorifier and heat exchange water heaters - the products which compete most directly with mains pressure electric storage water - should meet the same MEPS levels from 2006. These proposals have now been subject to an RIS, which recommended that the heat loss standards apply, from October 2005, to low pressure storage, calorifier and heat exchange types but not to solar-boosted (Syneca 2004a).

The estimated energy savings - indicated at Figure 1 as 'Program 14 Misc WH 05' - are derived from the RIS. They are somewhat lower than the corresponding projections in the previous study, partly because of the exclusion of solar water heaters and partly because of a more accurate assessment of the (declining) market share of other types.

ELECTRICALLY HEATED WATER

The Commonwealth is proposing to implement a mandatory Water Efficiency Labelling Scheme (WELS) for shower heads, toilets, clothes washers, dishwashers, taps and urinals. Legislation embodying the proposal passed the House of Representatives in 2004 but stopped in the Senate due to the prorogation of the Parliament. It is expected that the legislation will soon be reintroduced and that the program will be implemented in 2005 under the direction of the Department of the Environment and Heritage.

As the program is projected to lead to significant savings in the demand for hot water, the energy requirement for water heating will be reduced. The RIS for the program (GWA 2004b) estimated the reductions in both electricity and gas for water heating energy. Although WELS is not strictly speaking part of the NAEEEP, the two programs are closely linked by common technical standards. The electricity savings have been included in the present study at Figure 1 as 'Program 27 Elec (water savings)' in order to complete the estimates of reductions in the energy demand for water heating, both from reduced heat losses and from reduced demand for hot water.

TELEVISION – ON MODE

In October 2004 NAEEEC published a proposal to implement MEPS and energy labelling for television sets (NAEEEP 2004b). The first stage MEPS would be introduced in 2006 and would affect about 30% of the models on the market today. The second stage would be implemented later, to align with proposed European Union (EU), Japanese and Chinese MEPS levels.

It is proposed that the MEPS levels be based on the Energy Efficiency Index (EEI) developed in Europe, which reflects both on-mode energy and standby energy. It is also proposed that TV labelling use a common EEI measure across technologies – cathode ray tube (CRT), liquid crystal display (LCD), plasma and projection – so that buyers are informed of the inherent differences in energy efficiency.

The product profile (NAEEEP 2004b) estimates the impacts of the proposals on the energy consumption and greenhouse gas emissions of new CRT TVs, which will continue to represent the great majority of sales, although the market shares of the other technologies is increasing. The energy impacts include both on-mode and standby energy savings for CRTs only. In the present study these estimates are used as a proxy for on-mode savings from all TV types (see 'Program 17 TV On Mode 06' – Figure 1). The standby-mode energy savings from all types of TVs are counted in the Standby estimates (see later section). This will tend to reduce double-counting, although more refined estimates will be made once the proposals are subject to RIS.

SWIMMING POOL EQUIPMENT

In October 2004 the NAEEEC published a review of the energy consumption of swimming pool and spa pool equipment, including water circulation pumps, chlorinator calls, solar pool heater pumps, electric and gas pool and spa heaters, timers and controllers.

The study recommended that a range of energy efficiency measures be investigated, including MEPS, mandatory labelling, voluntary labelling, inclusion in the NAEEEP standby strategy and a Pool Energy and Water Rating Scheme. These might target motors (which are generally too small to be covered by the current 3-phase electric motor MEPS), motor-pump assemblies and other elements of pool equipment. As the measures are only at a preliminary stage, the impact projection is based on an assumption of a 10% reduction in the electricity consumption of pool equipment (see 'Program 23 Pool equipment' – Figure 1).

GAS APPLIANCES

The objective of putting in place a gas appliance and equipment energy efficiency program (GAEEEP) as a joint government-industry partnership, modelled on the national appliance and equipment energy efficiency program for electrical appliances (NAEEEP), has been approved in principle by senior government officials, by representatives of gas appliance suppliers and by other gas industry stakeholders (SEAV 2003).

The Standing Committee of Officials (SCO), which reports to the Ministerial Council for Energy (MCE), has requested that a Strategic Plan be prepared and submitted for SCO's consideration by December 2004. It is envisaged that the Plan will look forward about ten years, with a detailed work program for the first three to four years.

WATER HEATERS

Increasing the efficiency of gas water heaters will be the first priority of GAEEEP. The measures to be investigated include enhancing the effectiveness of the existing gas appliance labelling program for water heaters, and increasing the stringency of MEPS for gas water heaters, which have not been reviewed since 1983. A recent review (MEA 2002) found that the MEPS levels for water heater are less stringent than those applying in some other countries (although the differences in test procedures make direct comparison difficult).

A preliminary estimate of the impact of increasing the average energy efficiency of new gas water heaters by measures affecting the design and market mix of gas water heaters, taken from GWA (2004b) is indicated as 'Program 24 Gas Water Heaters' at Figure 1.

The reduction in the demand for hot water from the proposed Water Efficiency Labelling Scheme (WELS) was discussed earlier. These changes are largely independent of the design and energy efficiency of the water heaters themselves. The specific impact on gas consumption for water heating is indicated as 'Program 26 Gas (water savings)' at Figure 1.

SPACE HEATERS

A preliminary estimate of the impact of increasing the average energy efficiency of new gas space heaters by measures affecting the design and market mix of gas space heaters, taken from GWA (2004b) is indicated as 'Program 25 Gas Water Heaters' at Figure 1.

2.3 COMMERCIAL SECTOR

PACKAGED AIR CONDITIONERS

Packaged airconditioners (PACs) are defined as those taking three-phase electricity supply. They include unitary, split and multi-split configurations, and both cooling-only and cooling and heating ('heat pump') models. Most are used in the commercial sector, although some are also being installed in larger dwellings.

In the late 1990s NAEEEP developed a set of recommended MEPS levels for PACs with cooling capacities up to 65 kW. Following the completion of a RIS (GWA 2002a), ANZMEC decided to implement MEPS commencing October 2001. The MEPS levels are expressed as minimum Energy Efficiency Ratio (EER) values for cooling in Australian and New Zealand Standard AS/NZS 3823.

Energy labelling is voluntary for three-phase PACs, but if the supplier elects to label then the label must conform to the same requirements as the mandatory energy label for single-phase airconditioners.

The estimated energy savings - indicated at Figure 1 as 'Program 6 PAC 01' - are derived from the RIS, and have not been revised since the previous analysis. The impact of optional energy labelling has not been estimated.

PACKAGED AIR CONDITIONER MEPS REVISION

COOLING MODE MEPS

NAEEEC proposes to increase the MEPS levels for three-phase PACs from mid 2007 (NAEEEP 2002d). The proposed levels are based on those which took effect in the US in October 2003 (for products up to 19 kW) and October 2004 (for products over 19 kW).

The projected energy savings - indicated at Figure 1 as 'Program 5 PAC 07' – have not been revised since the previous analysis. A draft RIS completed since then (Syneca 2003b) projected significantly lower energy savings, but the original estimates have been retained to take into account the fact that estimates of air conditioning growth rates have been revised upward.

HEATING MODE MEPS

As for the heating mode of single-phase air conditioners (discussed earlier) it is assumed that labelling, MEPS or some combination of measures will be implemented in 2006, leading to a small reduction in heating energy demand. This is estimated to be 10% as great as the reduction in cooling energy demand from cooling mode MEPS. This is a lower than the ratio assumed for single phase air conditioners (20%), since a higher proportion of packaged air conditioner operation is in cooling mode. PACs operate for longer hours during summer, and even in winter most commercial facilities generate so much heat from occupants and lighting that relatively little additional heating is required. The reductions are indicated at Figure 1 as 'Program 24 PAC Heat Mode 06'.

CHILLERS

Chillers provide chilled water for space cooling equipment in large buildings, They are typically the most energy-intensive single item of space conditioning equipment in a large commercial building. Commercial water chillers were among the products identified in 2003 for possible efficiency regulation, and NAEEEC published a detailed product profile in October 2004 (NAEEEP 2004e).

Commercial chillers generally range from less than 100 kW to over 2000 kW in cooling capacity. The value of the Australian air conditioning water chiller market is estimated at AU$60 – 70 million per year. The vast majority are imported, although some smaller sized models are assembled in Australia. Electricity consumption by chillers was estimated at over 1,900 GWh in 2003.

There are no energy efficiency standards for chillers in Australia, as there are in many of the countries form which chillers are sourced, including the USA, Canada and Chinese Taipei. Preliminary research of the Australian market indicates that chillers sold in Australia are generally of lower efficiency than the countries where regulation applies.

An Australian chiller energy test standard could be developed fairly quickly, based on the US Air-Conditioning and Refrigeration Institute (ARI) Standard 550/590 -2003 *Water Chilling Packages using the Vapour Compression Cycle*, which operates as a de facto international test standard in this field.

NAEEEC proposes to introduce minimum energy performance MEPS regulations factory-designed and prefabricated vapour-compression chillers that have a cooling capacity of up to 7000 kW (2000 tons) if equipped with a water-cooled condenser, and up to 700 kW (200 tons) if equipped with an air-cooled condenser, to take effect in October 2007. The proposed levels are similar to those implemented in the USA and Canada in October 2004, and which are to be implemented in Taipei in 2005.

The test standards to be developed to support MEPS would also designate High Efficiency criteria, about 15% more energy efficient than the MEPS levels.

The projected energy and greenhouse savings from MEPS for chillers are indicated as 'Program 21 Chillers 07' at Figure 1. These projections are taken directly from NAEEEP (2004e).

CLOSE CONTROL AIR CONDITIONERS

'Close control air conditioners' are central air conditioner specifically designed for use in data processing areas. They are also called 'computer room' or 'process' air conditioners. Because they are intended to cool equipment rather than people, they are specifically designed to remove a higher ratio of sensible heat to latent heat than general duty air conditioners. They typically maintain an internal temperatures of about 22°C and a relative humidity of about 52 percent, 365 days a year. Each installation is typically served by at least two units, one on duty and one on standby. The very long average hours of operation per unit, and the demanding cooling task, means that the energy savings from even minor increases in energy efficiency can be substantial.

Approximately 500 close control air conditioners are sold per annum, with an average cooling output capacity of 40 kW. This represents 10-15% of the market for packaged air conditioners of that capacity range. Almost all close control air conditioners are imported.

Internationally, the Californian Energy Commission (CEC) is the only jurisdiction that regulates the energy efficiency of close control air conditioners. The USA Department of Energy has assessed that product as not being a 'covered' under the Energy Policy and Conservation Act (EPCA), primarily due to its exclusion from the de-facto USA building code – ASHRAE Standard 90.1. However, ASHRAE has developed a specific test standard for computer room air conditioners under Standard 127-2001.

The CEC's MEPS for computer room air conditioners have been in place since 1998 and regularly made more stringent, with the next increase due in 2006. The 2004 CEC MEPS for computer room air conditioners will be effectively more stringent than the 2004 USA Federal MEPS for general commercial unitary air conditioners.

A recent NAEEEP review (NAEEEP 2004f) recommended that MEPS for close control air conditioners should be considered in the proposed 2007 MEPS for three phase air conditioners. The MEPS levels should be equivalent to those which took effect in California in 2004.

The projected energy and greenhouse savings from close control air conditioners are indicated as 'Program 22 CCAC 07' at Figure 1. These projections are taken directly from NAEEEP (2004f).

FLUORESCENT LAMP BALLASTS

Following the completion of a RIS to determine the most cost-effective level of MEPS for fluorescent lamp ballasts (GWA 2001), MEPS were implemented in 2003 to would exclude the most common ('C type') ferro-magnetic ballasts, which use about 9W during operation. The highest–loss ballast ferro-magnetic ballasts now permitted on the Australian market are B2 (about 5.5 W during operation).

The RIS also recommended that governments re-examine, no later than the end of 2005, the costs and benefits of revising the MEPS levels and other options for further increasing the energy efficiency of ballasts. This timing would be consistent with the European Commission's intentions to review MEPS levels at that time, with the possibility that ferro-magnetic ballasts could be excluded from the market entirely, in favour of electronic ballasts.

The estimated energy savings from ballasts MEPS - indicated at Figure 1 as 'Program 7 Ballast 03' - are derived from the RIS (GWA 2001), and are unchanged from the previous study. The potential impact of increasing the stringency of ballast MEPS has not been considered.

LAMP EFFICACY STANDARDS

The energy efficiency of lamps is generally measured in terms of 'efficacy' which is defined as light output (in lumens) per watt of electricity consumed, under standard operating conditions.

A RIS prepared in 2003 (MEA 2003) recommended efficacy standards which can only be met by triphosphor-coated lamps, and so effectively exclude the less efficient halophosphate types. Efficacy levels are specified for lamps when new (nominally at 100 hrs operation) and 'maintained' (nominally at 5,000 hrs operation), to guard against excessive degradation in use. The MEPS took effect in 2004.

The New Zealand government had previously implemented its own MEPS levels for linear fluorescent lamps in mid 2002, but these have now been replaced by the revised joint ANZ MEPS regime, with only minor changes in impact.

The energy and greenhouse impacts of this measure depend on a large number of assumptions about:

- The rate at which T8 and T5 would gain market share even in the absence of MEPS (ie efficacy standards);
- The relative T8 and T5 shares of the post-MEPS market;
- The rate at which the gains in efficacy are translated into energy savings as distinct from (possibly unwanted) increases in light output. This depends on the response of the designers of new lighting installation to the higher efficacies of the triphosphor lamps, and the extent to which potential gains in existing luminaires are realised (eg by omitting every fourth lamp when replacing with higher efficacy lamps).

Estimates of savings are very sensitive to these assumptions. The RIS (MEA 2003) projected much higher BAU takeup of triphosphor and hence lower energy savings from MEPS than previously estimated. The more recent, lower projections have been used in the present study. They are indicated at Figure 1 as 'Program 13 Lamps 07'.

GREENLIGHT AUSTRALIA PLAN

The purpose of the Greenlight Australia plan is to provide a framework for reducing energy consumption from Australian lighting over the period 2005-2015. In October 2004 NAEEEP published a discussion paper as a precursor to the plan (NAEEEP 2004a). It states:

> *Greenlight Australia is being developed at a time when many other countries are also launching policies aimed at increasing lighting efficiency. This provides an opportunity to closely align requirements in Australia with those of our major trading partners.*

The Greenlight Australia plan will cover the major lighting technologies, with the exception of low pressure sodium and induction lighting. Given the size of the Australian lamp market, the plan will not consider options which rely on driving new development in lamp technology. However lamp substitution and technical development of control equipment and luminaires are included, as is improved lighting design.

The plan will cover lighting in the residential, commercial, industrial and public lighting sectors, but not vehicular, indicator and special use lighting. The possible types of intervention include MEPS, labelling, mandatory information disclosure, information provision, education and training, demonstration projects, bulk procurement and product subsidies. The Greenlight Australia plan proposes 'an aim of reducing lighting energy consumption by between 15 and 25% over the period 2005-2015'. For the present study, a more conservative projection of a 12% reduction in commercial sector lighting energy only by 2020 rather than 2015 has been used. Even so, the program still has the highest projected energy savings of all the new initiatives (see 'Program 17 Greenlights' – Figure 1).

REFRIGERATED CABINETS AND ICEMAKERS

In 2001 NAEEEC signalled its intention to develop MEPS for selected commercial refrigeration products including supermarket display cabinets, refrigerated vending machines, icemakers and ice storage bins (NAEEEP 2001j,k). The proposals covered both remote configurations (where the compressor is at a distance from the refrigeration unit) and self-contained units.

The development of MEPS for commercial refrigeration cabinets and for icemakers and ice storage units was subsequently separated. A RIS completed in early 2004 (MEA 2004) recommended that MEPS for commercial refrigeration cabinets commence in October 2004, and that the levels should be reviewed no later than 2008.

In October 2004 NAEEEC published a product plan (NAEEEP 2004c) stating its intention to introduce efficiency regulations for ice makers and ice storage bins, with key components as follows:

- minimum energy performance standards (MEPS) should be implemented for commercial ice makers with an ice harvest rate up to 2,500 kg/24hrs, applying to all new products sold from October 2006;
- ice maker MEPS should be equivalent to those due for implementation in California from 1/1/2006;
- factory-made ice storage bins should also be regulated for heat loss by MEPS;
- potable water consumption of ice makers should not exceed 22.5 litres/10 kg ice (27 gals/100 lbs), but no limits should be set for condenser water consumption;
- 'High Efficiency' levels should be set for promoting the best performing ice makers, and consideration should be given to establishing a similar High Efficiency category for ice storage bins once further data becomes available;
- An additional requirement for High Efficiency products should be that potable water consumption will not exceed 12 litres/10 kg ice (15 gals/100 lbs) for all ice makers;
- High Efficiency levels should be used as the basis for stage 2 MEPS levels, proposed for introduction no later than October 2010;
- MEPS and High Efficiency levels should be published in a new Australian Standard based on the ARI 810 and ARI 820 test methods. Once published, the Australian test methods should be proposed as the new ISO international test methods.

The combined impacts of the MEPS for refrigerated cabinets implemented in 2004 and of the MEPS for icemakers and ice storage cabinets proposed for 2005 are indicated at Figure 1 as 'Program 10 Com Ref + Ice 04'. The projections for refrigerated cabinets are taken direct from the RIS (MEA 2004) and those for icemakers and ice storage cabinets direct from NAEEEP (2004c).

WATER DISPENSERS

Many commercial premises have chilled drinking water dispensers and boiling water dispensers for making beverages. These functions are increasingly being combined in the one unit, and such units are beginning to enter the household market as well. Energy use can be reduced significantly by measures such as integrated time clocks to switch the units off when buildings are unoccupied (or after a preset period from last use), and by improved thermal insulation, especially for boiling water units.

In October 2004 NAEEEC published a product plan (NAEEEP 2004d) stating its intention to introduce efficiency regulations for chilled water dispensers and boiling water units dispensers, with key components as follows:

- minimum energy performance standards (MEPS) should be implemented for water dispensers based on maintenance energy consumption, commencing not earlier than October 2007;
- a specific test method should be developed by the Standards Australia Working Group for inclusion as a part of the Electric Water Heater Standard AS/NZS1056. The test method for maintenance energy consumption should allow for the use of timeclocks and similar devices, where they are factory-fitted. This test method should be proposed as a new ISO/IEC international test method.
- the proposed MEPS levels for chilled and combined boiling and water dispensers should be equivalent to the ENERGY STAR criteria in force since 2000, with the proposed MEPS levels for boiling water heaters also set at competitive levels;
- these actual levels should be confirmed by further product testing by the AGO and industry over the next 12 months, in particular to explore whether further categories need to be added;
- a category of 'High Efficiency' products should be established in the relevant Standard, such that only products which meet these specified performance standards can be promoted as 'high efficiency' products.
- 'High Efficiency' levels should be used as the basis for stage 2 MEPS levels, proposed for introduction no later than October 2011.

The projected energy impacts of MEPS for boiling water and chilled water dispensers, taken directly from NAEEEP (2004d) are indicated as 'Program 19 Water Dispensers 07' at Figure 1.

2.4 INDUSTRIAL PRODUCTS

MOTORS

Three-phase cage induction electric motors account for the great majority of electricity use by electric motors in the commercial and industrial sectors. MEPS for 2, 4, 6 and 8-pole motors with rated outputs from 0.73 kW to 185 kW were implemented in October 2001. The MEPS levels are expressed in AS 1359.5 as minimum energy efficiency values which must be achieved at either 100% or 75% of rated load.

Energy labelling is not required, but if the supplier elects to designate a motor as 'High Efficiency' (HE) then it must meet a higher level of efficiency, also specified in AS 1359.5. The HE levels corresponded approximately with the US motor MEPS levels in force at the time, and were intended to form the basis of higher MEPS levels in due course.

Following a the completion of a RIS in 2003 (Syneca 2003) the more stringent MEPS, based largely on the original HE levels, were implemented in October 2004.

The projected energy impacts of the first round of MEPS for electric motors, taken from the RIS (GWA 2000) are indicated as 'Program 12 Motors 01' at Figure 1. They are unchanged from the previous study. The projected impact of the second round of MEPS (Program 13 Motors 04) is taken from the RIS (Syneca 2003), and are somewhat higher than those previously estimated.

ELECTRICITY DISTRIBUTION TRANSFORMERS

Minimum energy performance standards for electricity distribution transformers of up to 2500 kVA capacity came into effect in October 2004. The MEPS apply to both oil-filled and dry-type transformers. The projected impacts are taken directly from the RIS on the proposal (GWA 2002) and are unchanged from the previous study. They are indicated at Figure 1 as 'Program 9 Trans 04'.

2.5 STANDBY

ONE WATT STRATEGY

Standby power is the energy used by an appliance while plugged in but not performing its central function. In 2000, standby power accounted for up to 11.6% of Australia's household energy consumption. In 2002 the appliances in the average Australian household consumed about 90W (790 kWh per year) on standby (Figure 2). Although the standby consumption of many devices is projected to fall due to BAU efficiency improvements, new devices with significant standby use are being introduced all the time.

In August 2000, Australian governments agreed to adopt the "one-watt" plan endorsed by a number of developed countries and trading blocs. This calls on the reduction of standby power consumption of individual products to less than one watt. In 2002 NAEEEC published a plan covering a range of voluntary and mandatory measures to address standby – including voluntary labelling, product surveys, industry wide agreements, MEPS and mandatory labelling (NAEEEP 2002f). These measures were to have commenced in 2004.

Figure 3 illustrates the projected total impact of measures on standby energy consumption projected in the NAEEEP (2002f). The blue line in Figure 4 illustrates the annual reductions in standby energy use corresponding to the divergence of trendlines in Figure 3.

DETAILED STANDBY MEASURES

In 2004 NAEEEP published detailed proposals to address the standby energy consumption of a number of specific products, with impact estimates. The products covered are listed in Table 3, and the impact estimates are illustrated in Figure 3. Comparing the sum of these estimates with previous total estimates of standby energy savings (the blue line in Figure 4) leads to the following conclusions:

- The previous estimate of the magnitude of standby energy savings appears reasonably robust, given the number of energy-intensive products for which detailed estimates are still to be developed (see Table 3), but:
- The timing of program implementation and hence the development of savings is running about one year later than previously thought. The estimate of savings has been adjusted accordingly (to the red line in Figure 4).

Figure 2 Average standby power consumption per household

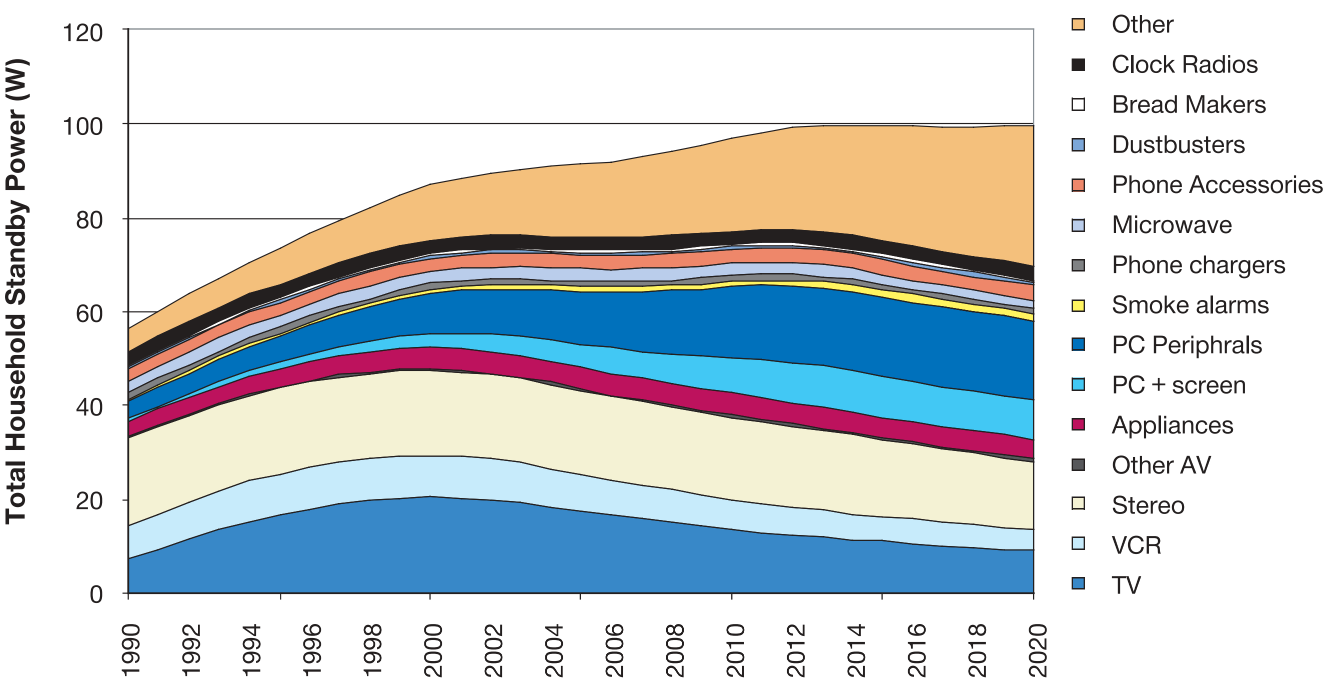


Figure 3 Projected impact of 'One Watt' program on standby energy use

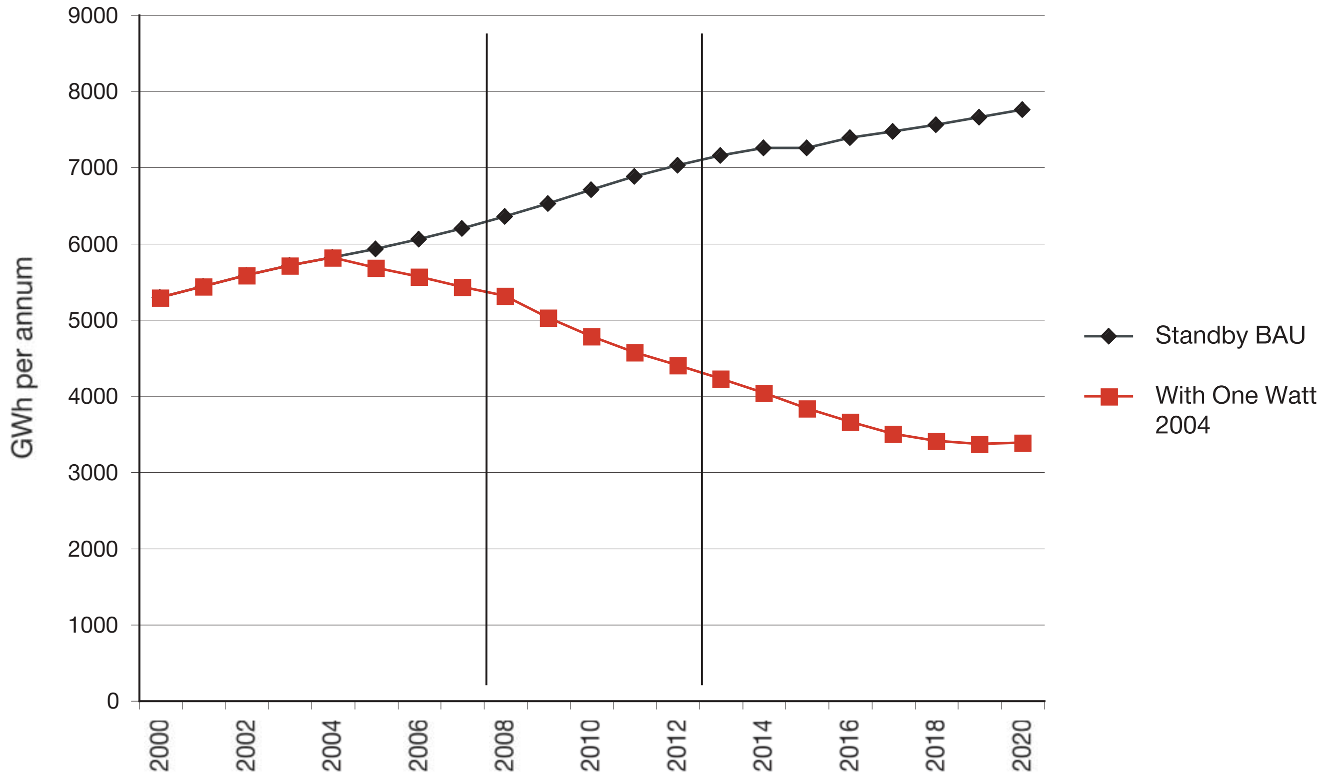


Figure 4 Composition of projected 'One Watt' standby energy savings

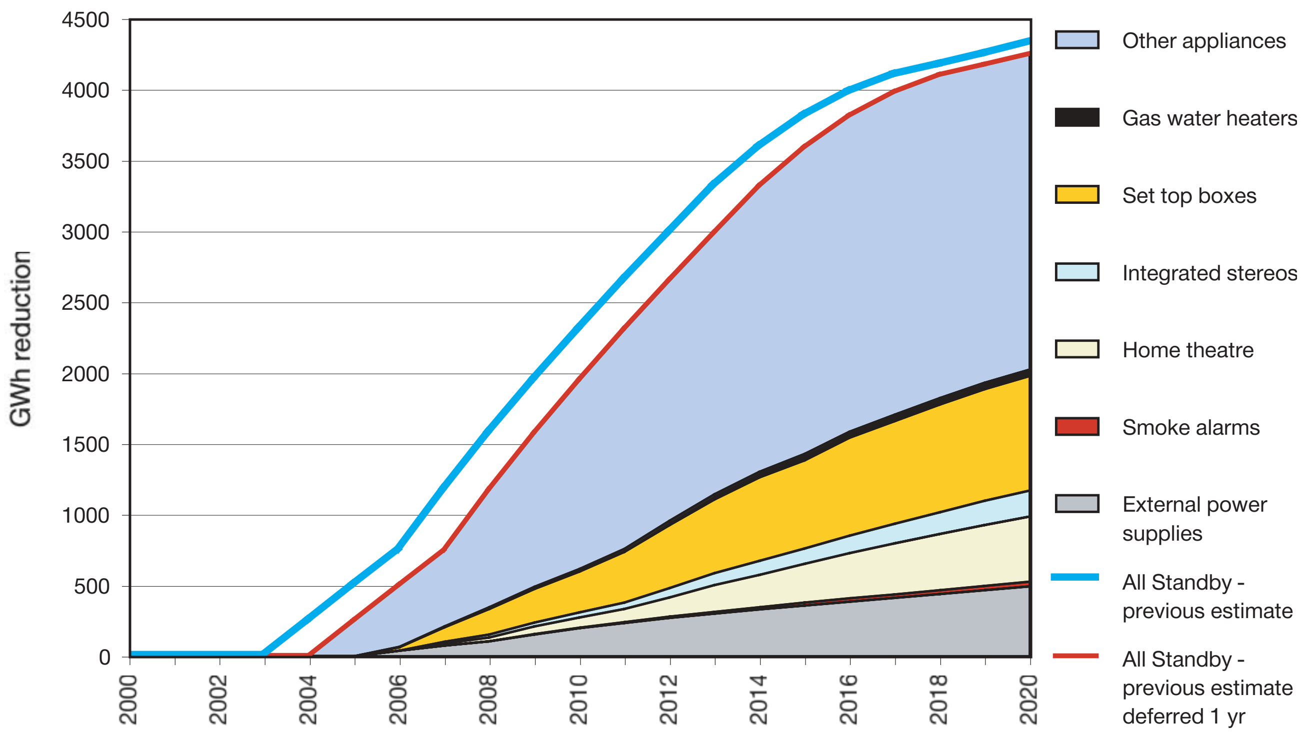


Table 3 Standby estimates for various products

Status	Product	NAEEEP Reference
Standby impacts quantified in Figure 4	Integrated stereos	2004/01
	Home theatre equipment	2004/02
	Set top boxes (all types)	2004/03, 2004/08
	Instantaneous gas water heaters	2004/04
	Smoke alarms	2004/05
	External power supplies	2004/07
Standby impacts not yet quantified – included in ‘Other Appliances’ Figure 4	Computers & monitors	2004/06
	Major appliances (eg dishwasher)	2002/12
	Minor appliances (eg microwave)	2002/12
	Image recorders (DVDs, VCRs)	2003/01
	Televisions	2004/11

The product-specific savings quantified to date amount to about 30% of the total projected impact of the standby program as a whole.

Given the high degree of interaction between electronic products (eg external power supplies, computers and monitors) and the fact that many product types are used in both commercial and household applications, there is some uncertainty about the magnitude of energy savings, and the proportion of the savings to be assigned to various sectors. For the time being all standby energy savings are assigned to households.

3 PROJECTIONS

3.1 ENERGY AND GREENHOUSE IMPACTS

RESIDENTIAL SECTOR

Figure 5 illustrates the estimated impact of NAEEEP measures on the latest projections of residential sector electricity consumption published by the Australian Bureau of Agricultural and Resource Economics (ABARE 2004). It is assumed that the impacts of energy labelling and the first round of MEPS in 1999 have now been taken into account in ABARE's energy modelling, and that the 'BAU' trend line includes the effect of these measures. It is estimated that NAEEEP measures will reduce residential sector electricity consumption by about 18% below what it would otherwise be by 2017, and this percentage reduction will remain until 2020. However, assuming that some of the reductions have already been taken into account in ABARE's projections, the additional reductions are of the order of 16% by 2017.

It is projected that NAEEEP residential sector measures will reduce national greenhouse emissions by about 117.5 Mt CO_2-e over the period 2005 to 2020 (Figure 6). The average reduction during the Kyoto commitment period (2008-12) is projected to be 5.5 Mt CO_2-e per annum.

About 36% of the cumulative reduction in residential sector emissions is projected to come from measures targeting standby and electronic equipment, 33% from major appliances (including water heater MEPS to 1999), 16% from air conditioners and 11% from electric water heating (Figure 7). Gas appliances are projected to contribute only about 3% of the savings, due to the lower greenhouse gas-intensity of natural gas.

Figure 5 Projected electricity consumption of residential sector with and without NAEEEP measures

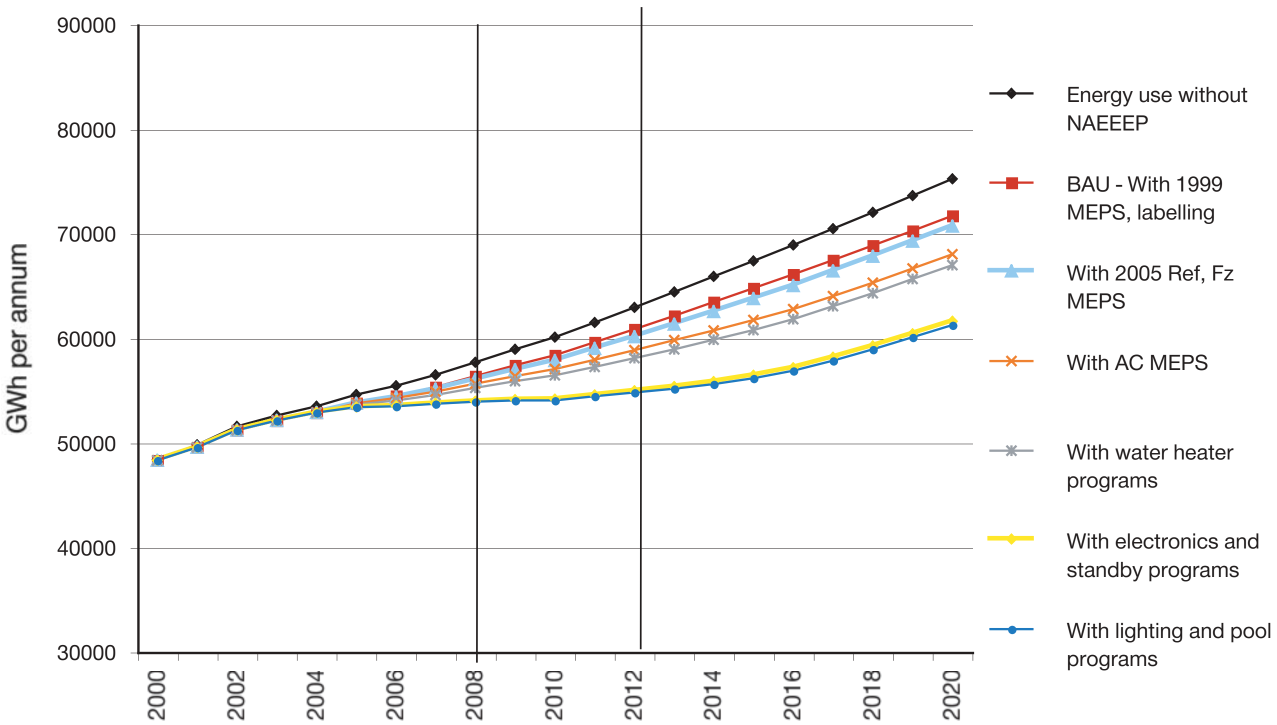


Figure 6 Projected impact of household sector measures on emissions

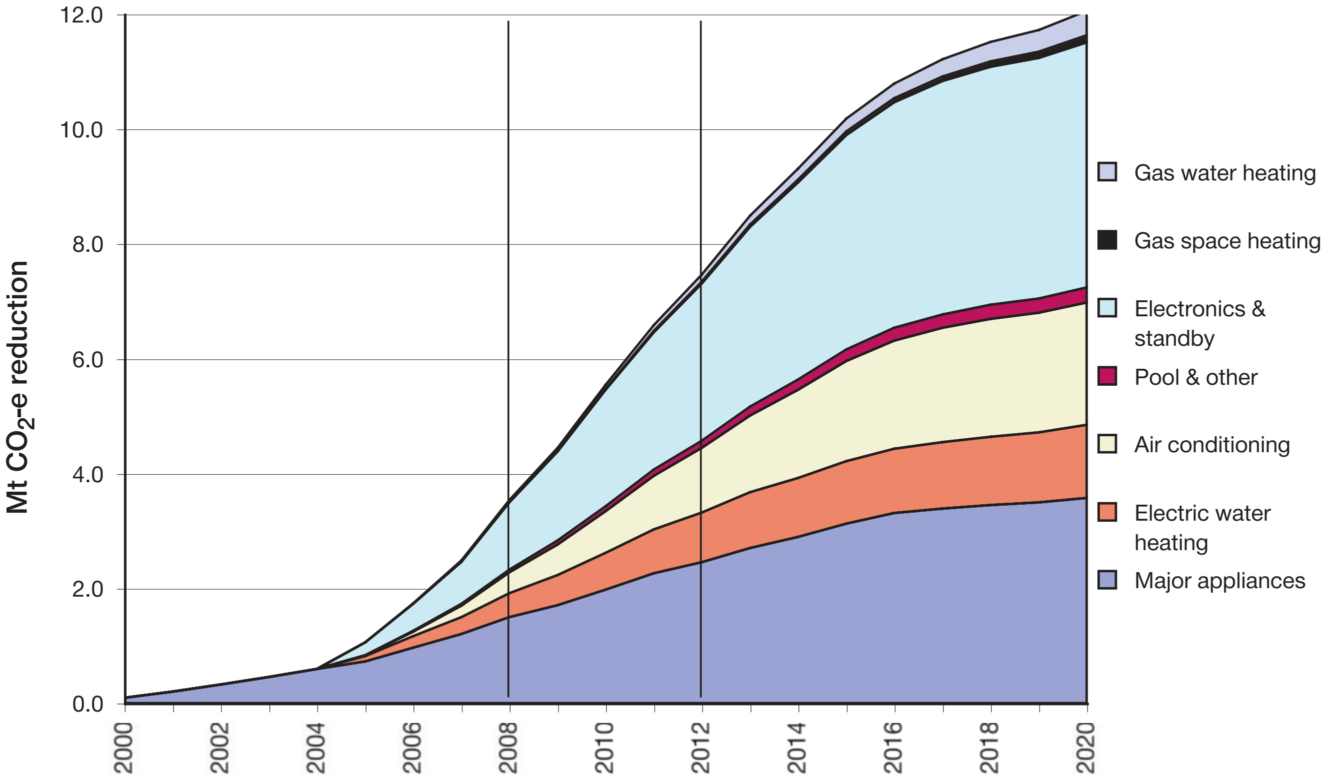
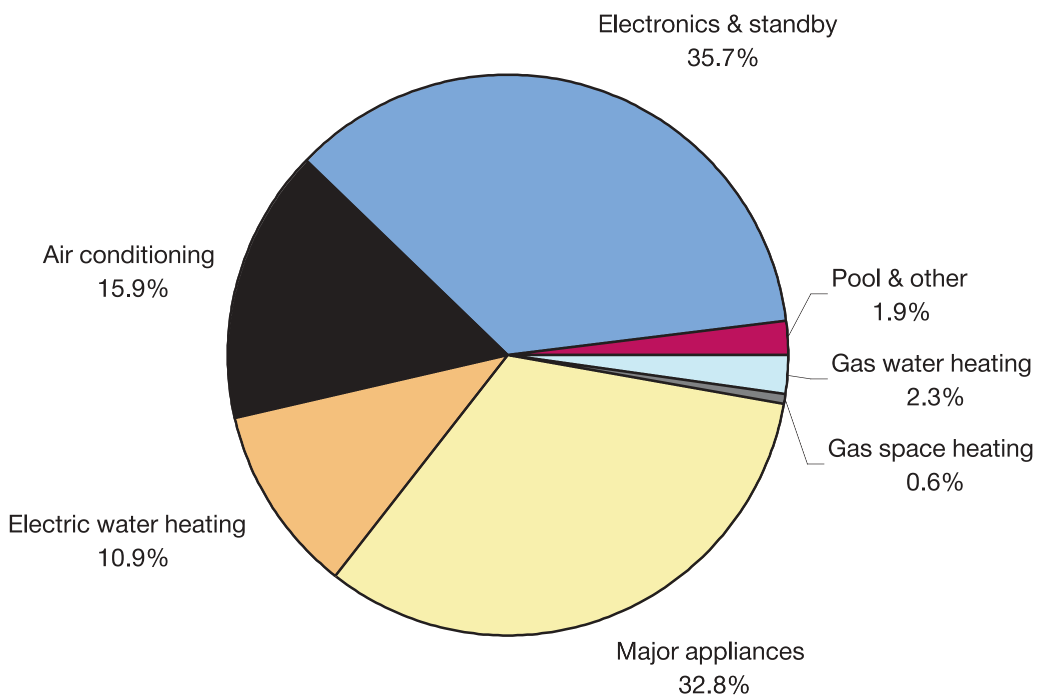


Figure 7 Contribution to emissions reductions, Residential sector 2005-2020



COMMERCIAL SECTOR

The impact of NAEEEP measures on projected electricity consumption in the commercial and services sector is shown in Figure 8. This is drawn to the same scale as the residential sector projection (Figure 5) to illustrate the higher rate of electricity growth projected for this sector. It is estimated NAEEEP measures will reduce commercial sector electricity consumption by about 9% below what it would be without the measures by 2017, and this percentage reduction will remain to 2020.

NAEEEP commercial sector measures are estimated to reduce national greenhouse emissions by about 57.5 Mt CO_2-e over the period 2005 to 2020 (Figure 6). The average reduction during the Kyoto commitment period (2008-12) is projected to be 2.6 Mt CO_2-e per annum. About 62% of the cumulative greenhouse reductions between 2005 and 2020 are projected to come from lighting, 32% from air conditioning and 7% from commercial refrigerators and icemakers.

MANUFACTURING AND OTHER

The Manufacturing sector has a lower level of NAEEEP coverage than other sectors, partly because the Program's focus on this sector is more recent, and partly because a high ratio of the sector's energy is used in unique, purpose-engineered equipment rather than in mass-produced products (GWA 2004c). At present the only mandatory measure impacting on manufacturing is MEPS and optional 'High Efficiency' labelling for electric motors, which are projected to lead to 11.2 Mt CO_2-e reductions between 2005 and 2020.

The energy savings from MEPS for electricity distribution transformers accrue to all electricity users, and it is impossible to allocate the savings between end use sectors. Cumulative emissions reductions are projected to reach 17.4 Mt CO_2-e by 2020.

Figure 8 Projected electricity consumption of commercial sector with and without NAEEEP measures

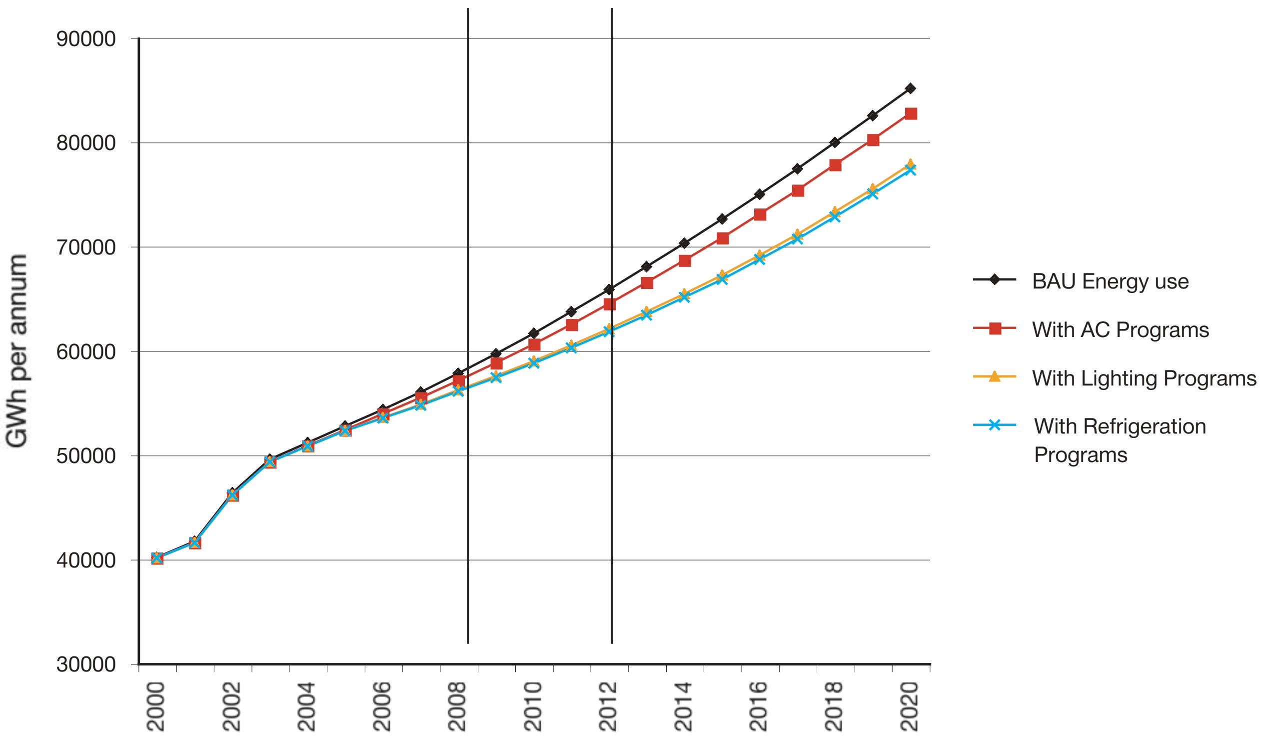
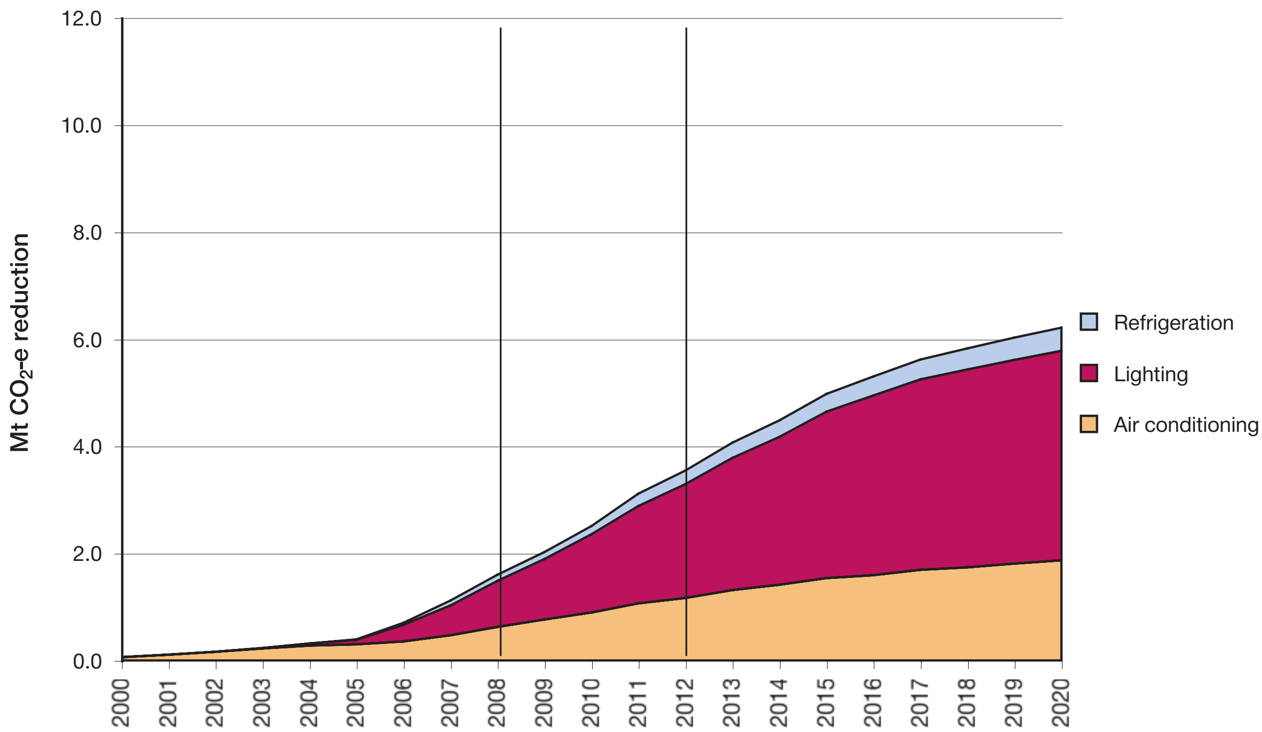


Figure 9 Projected impact of commercial sector measures on emissions



ALL MEASURES

ENERGY IMPACTS

The reductions in delivered energy from NAEEEP programs are shown by sector in Figure 10, and by main technology group in Figure 11. Delivered energy savings are projected to reach 100 PJ/yr by 2020. Over 59% of the cumulative energy savings to 2020 are estimated to come from the residential sector, 27% from the commercial sector and 13% from other sectors. The technologies contributing most to savings are electronics and standby (20%) major appliances (18%), air conditioning (18%) and lighting (17%).

Energy prices and greenhouse gas emission have generally been used as the means to normalise the financial and environmental impacts of different energy forms. Another way to compare different energy forms is on the basis of the Primary Energy (PE) required to supply the delivered energy (DE). The higher the PE/DE ratio, the more primary energy is used in producing, transmitting and converting energy to the form and location of its use. The calculated Australian average PE ratios for electricity and natural gas are summarised in Table 4. Each PJ of end use electricity is equivalent to 3.12 PJ PE (taking into account that about 5.25% of the primary energy use in electricity generation is renewable, mainly hydro). Each PJ of natural gas supplied via the low pressure network is equivalent to 1.13 PJ PE.

Table 4 Primary Energy (PE) Ratios

		PJ/PJ (a)
Electricity		3.12
Natural gas	Low pressure supply	1.13
	High pressure supply	1.11

Source: GWA (2004c) (a) PJ Primary energy (fossil fuel only)/PJ delivered energy

Figure 10 Projected impact of NAEEEP on delivered energy by sector, Australia

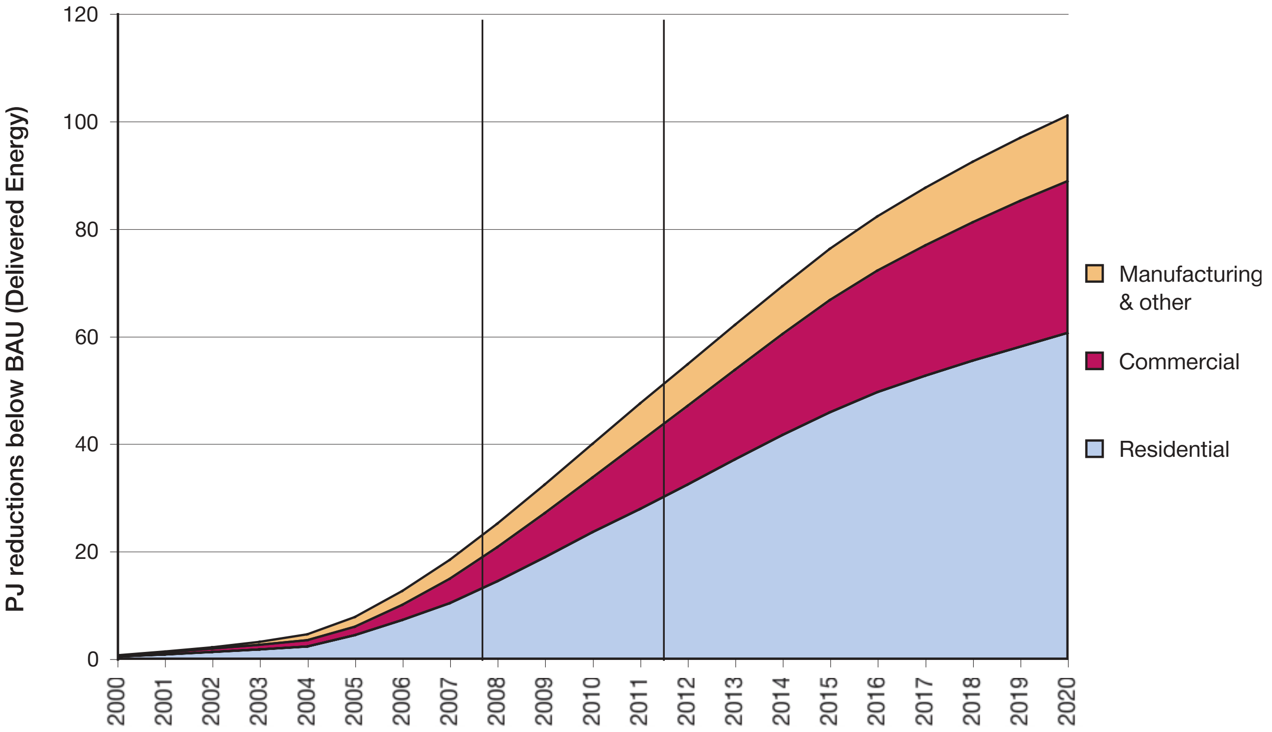


Figure 11 Projected impact of NAEEEP on delivered energy by technology type, Australia

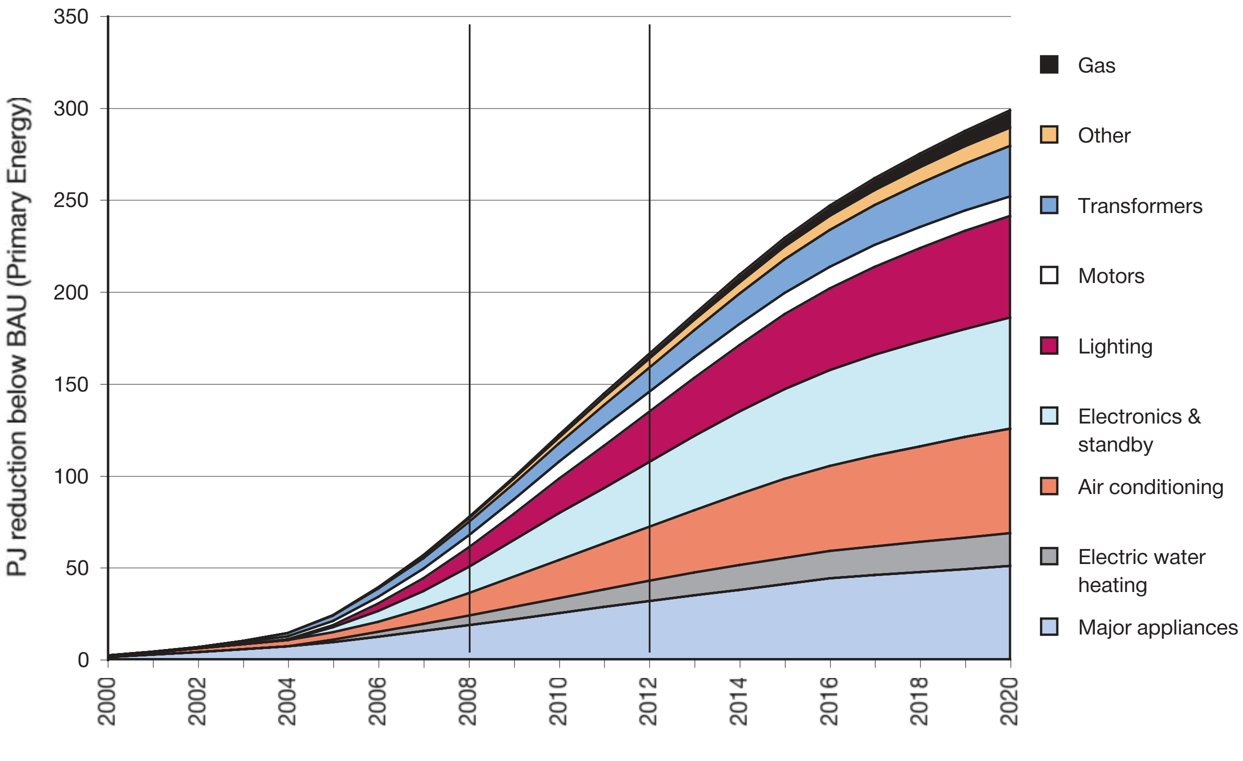


Figure 12 Projected impact of NAEEEP on delivered energy by sector, Australia

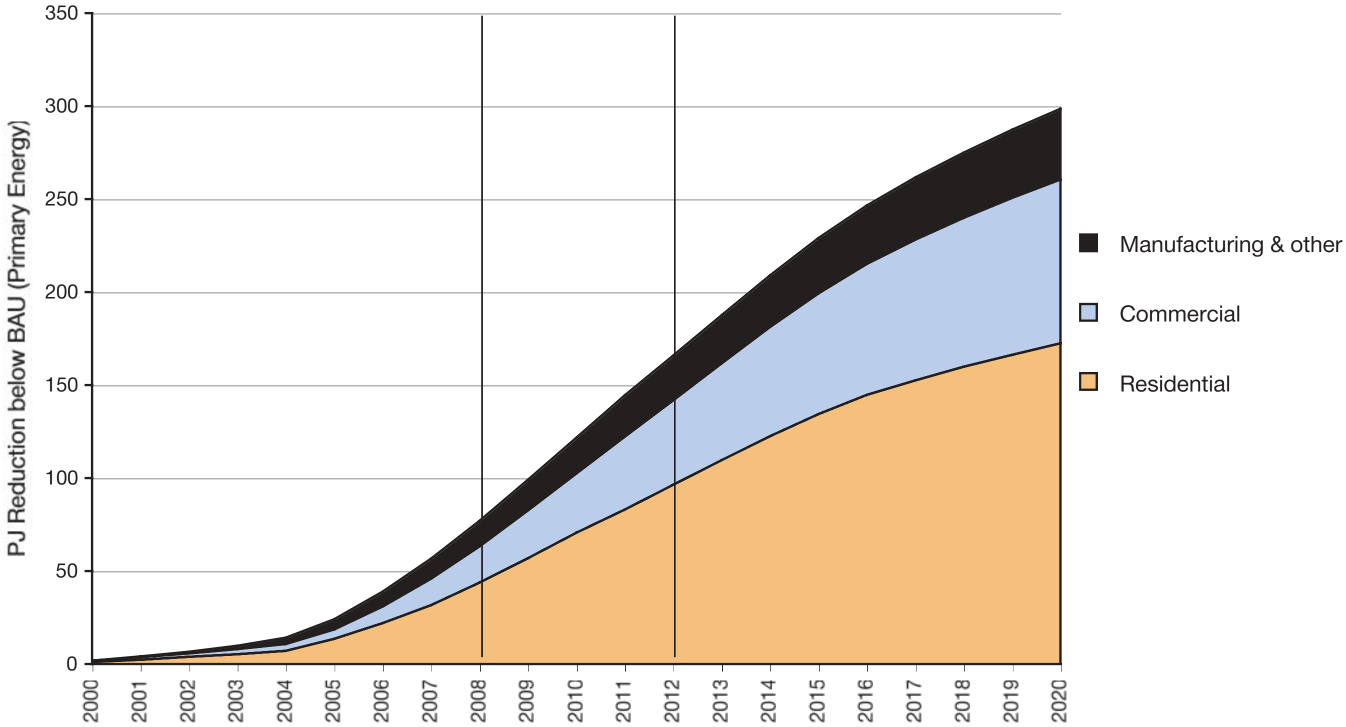


Figure 13 Projected greenhouse gas reductions by technology group

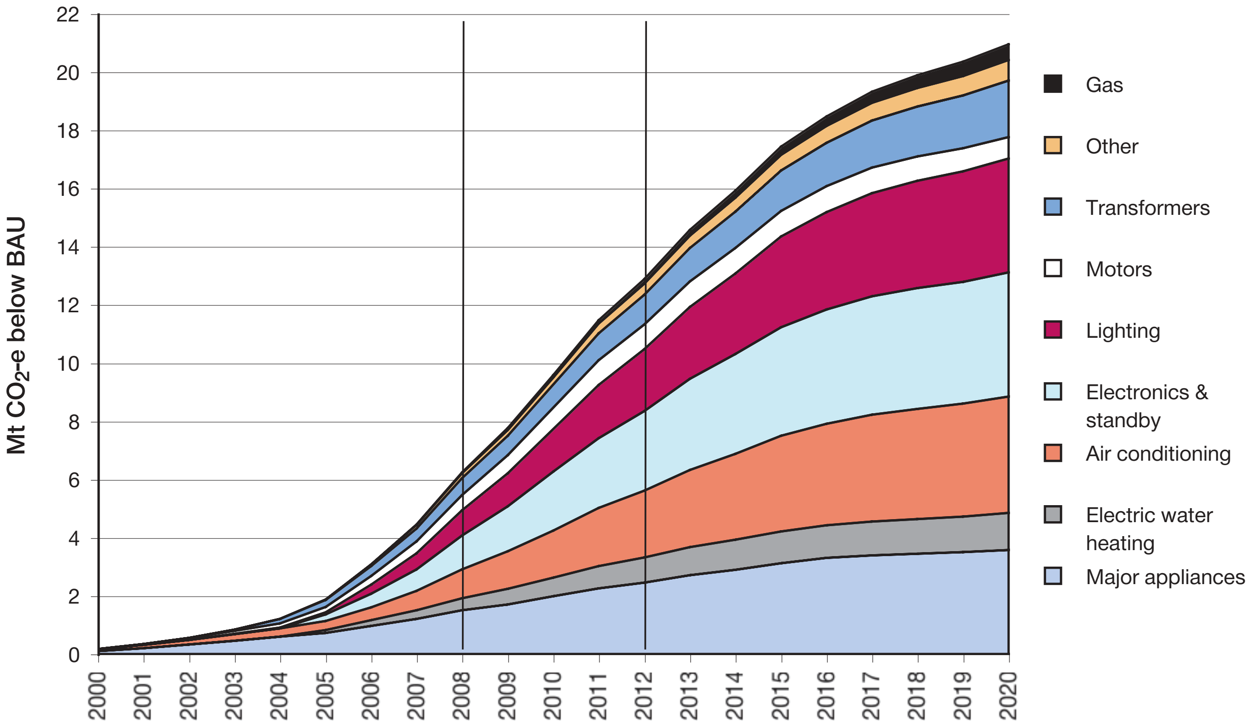


Figure 12 shows the projected impact of the NAEEEP on Primary Energy consumption in Australia. The savings are projected to reach nearly 300 PJ/yr by 2020. Because some of the energy savings in the residential sector are gas, which has a much lower PE ratio than electricity, the residential share of Primary Energy savings (about 58%) is somewhat lower than the sector's share of Delivered Energy saving (about 59%), but otherwise the breakdown by sector and technology type is similar.

GREENHOUSE IMPACTS

The combined projected greenhouse gas impacts of all programs covered in this study is illustrated in Figure 13. It is estimated that the programs will reduce greenhouse gas emissions by nearly 204 Mt CO_2-e over the period 2005-2020. The impact of each measure builds up over time as new products replace the existing stock, so the earlier the date of implementation the greater the impact during the Kyoto Protocol Commitment Period. The average combined impact in each of the 5 years of the Commitment Period (2008 – 2012) is projected to be about 9.6 Mt CO_2-e reduction below BAU. By 2020 the impact is projected to reach 20.9 Mt CO_2-e per annum.

COMPARISON WITH PREVIOUS ESTIMATES

Table 5 and Figure 14 compare the projections in the present analysis with the estimates completed five years ago (NAEEEP 2000) and two years ago (NAEEEP 2003). The first study only covered the period 2003 – 2015, whereas the two more recent studies cover 2000 – 2020. For the period common to all three studies (2003 – 2015) the first study estimated a greenhouse gas reduction of 69.5 Mt CO_2-e, the second study estimated 91.2 Mt and the third (present) study estimates 107.1 Mt, more than 54% higher than the first. For the 16 year period 2005-2020, the second study estimated an impact of 160.8 Mt, whereas the present study estimates 204.3 Mt, or 27% higher. The projected annual impacts of the NAEEEP during each of the 5 years of the Kyoto commitment period has increased by over 52%, from 6.3 to 9.6 Mt CO_2-e per annum.

The main reason for the progressive increase in impact estimates is due to the greater coverage and scope of the NAEEEP. Not only have the estimates increased, but the degree of confidence in them has also increased, as more research has been carried out on product markets and technologies and on the performance of NAEEEP programs as they are implemented. This has not always led to

Figure 14 Comparison of NAEEEP impact projections: 2000, 2003 and 2005

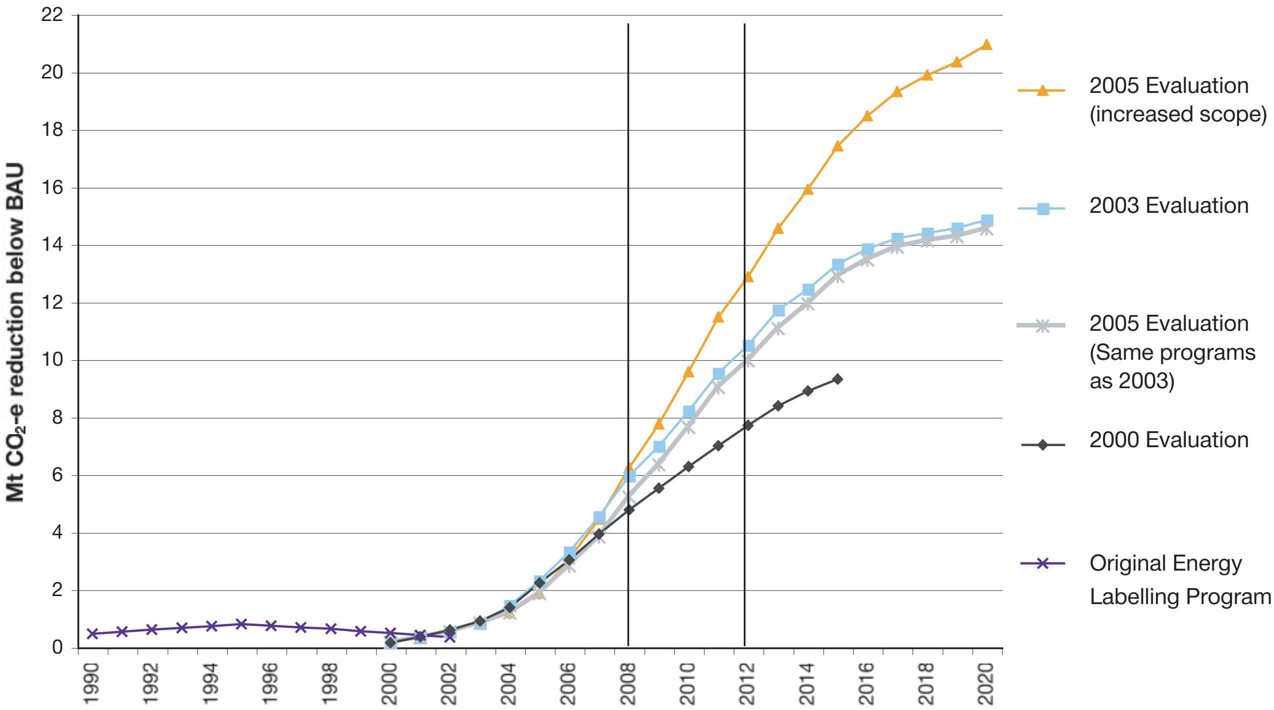


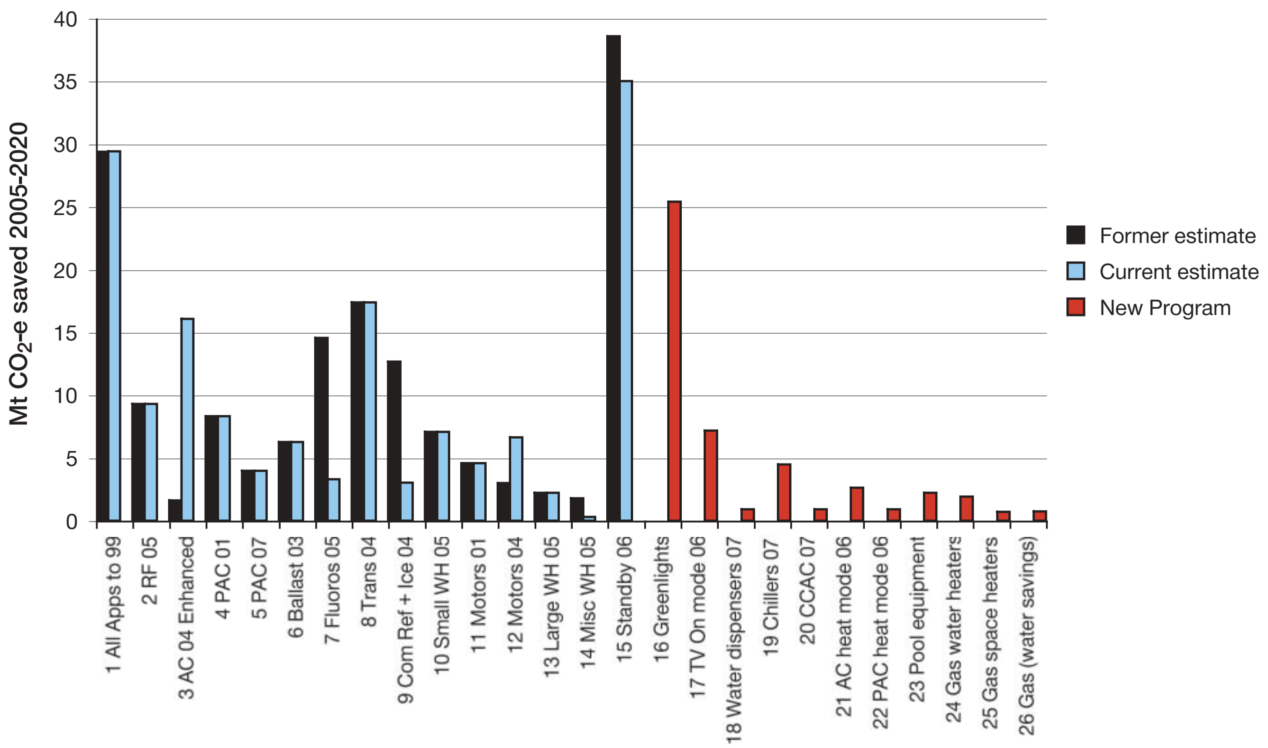
Table 5 Comparison of NAEEEP impact projections: 2000, 2003 and 2005

	2003-15 Mt CO_2-e	Change on previous	2005-20 Mt CO_2-e	Change on previous	Avg 08-12 Mt CO_2-e	Change on previous
NAEEEP 2000 (First study)	69.5	NA	NA	NA	6.3	NA
NAEEEP 2003 (Second study)	91.2	+31%	160.8	NA	8.2	+30%
NAEEEP 2005 (Third study – this one)	107.1	+17%	204.3	+27%	9.6	+17%

an increase in the estimates for individual programs – as Figure 14 shows, the aggregate estimate of the impact of the same group of measures has actually fallen slightly.

The extent of revision of the estimates of impacts of specific programs and the magnitude of the new programs added is illustrated in Figure 15. There have been major upward revisions in the estimated impact of programs targeting single phase air conditioners and three-phase motors. This was counterbalanced by reductions in estimates for fluorescent lamps, commercial refrigeration, miscellaneous electric water heaters and standby energy programs (the last due to a slight delay in implementation rather than any reduction in the estimate of ultimate impacts). The reason for these revisions are discussed in the detailed description of each measures in Section 2. About half the impact of the new measures is expected to come from the Greenlights program.

Figure 15 Revision of specific program estimates



3.2 COSTS AND BENEFITS

The aggregate benefits of the NAEEEP in terms of the net present value (NPV) of the energy saved, and the aggregate costs in terms of the net present value of increased product prices, are summarised in Table 6 and Table 7. The aggregate NPV of net benefits from 2005 to 2020 is $16.6 Billion (undiscounted), based on energy savings alone, without assigning any monetary value to the greenhouse gas reductions. The net benefit at 5% discount rate is $8.8 Billion and $4.8 Billion at 10% discount (Figure 16).

Programs 1 to 15 are relatively well developed, with most the subject of completed Regulation Impact Statements, so there is reasonable confidence in the projection of costs and benefits. For programs 16 to 25 however only product profiles have been completed, but not full RISs. For those programs the increase in product price is estimated as follows:

- The NPV of the projected reduction in energy consumption is calculated, using the marginal tariffs in Appendix 1;
- The average capital cost of new products sold is increased so that the NPV of all product sales up to 2020 matches the NPV of the value of energy saved (at a discount rate of 10%).

In other words, it is assumed that the benefit/cost ratio is 1.0 at a discount rate of 10% (making it typically about 1.2 at 5% discount and 1.5 undiscounted). This implies that the programs just break even from the consumers' perspective, and introduces a conservative bias into the estimate, since all completed RISs have found benefit/cost ratios well over 1.0 at 10% discount rate. Because the estimate of benefits is more conservative than in the previous study the monetary benefits per tonne of greenhouse emissions are somewhat lower: $23/tonne CO_2-e at a 10% discount rate, compared with a previous value of $37/tonne (Table 6). However, the fact that the cost value is still negative indicates that there still is a large net *benefit* associated with the greenhouse gas reductions from NAEEEEP programs, in contrast with other means of reducing emissions, such as renewable electricity production, which involve a significant cost.

Table 6 Summary of costs and benefits, and comparison with previous studies

	Period	Benefit/cost ratio			$ cost per tonne CO_2-e saved		
		0% discount rate	5% discount rate	10% discount rate	0% discount rate	5% discount rate	10% discount rate
NAEEEP 2000 (First study)	2000-15	3.5	2.9	2.4	- $135	- $62	- $31
NAEEEP 2003 (Second study)	2003-18	3.1	2.7	2.4	- $84	- $47	- $28
NAEEEP 2003 (Second study)(a)	2005-20	3.7	3.2	2.9	- $109	- $62	- $37
NAEEEP 2005 (Third study – this one)	2005-20	2.3	2.0	1.7	- $81	- $43	- $23

Note: Negative values for costs indicates net benefits per tonne avoided. (a) Although the length of the accumulation period is the same (16 years) shifting the starting point for the NPV calculations by two years changes the values.

Figure 16 Projected net savings by product type, Australia 2005-2020

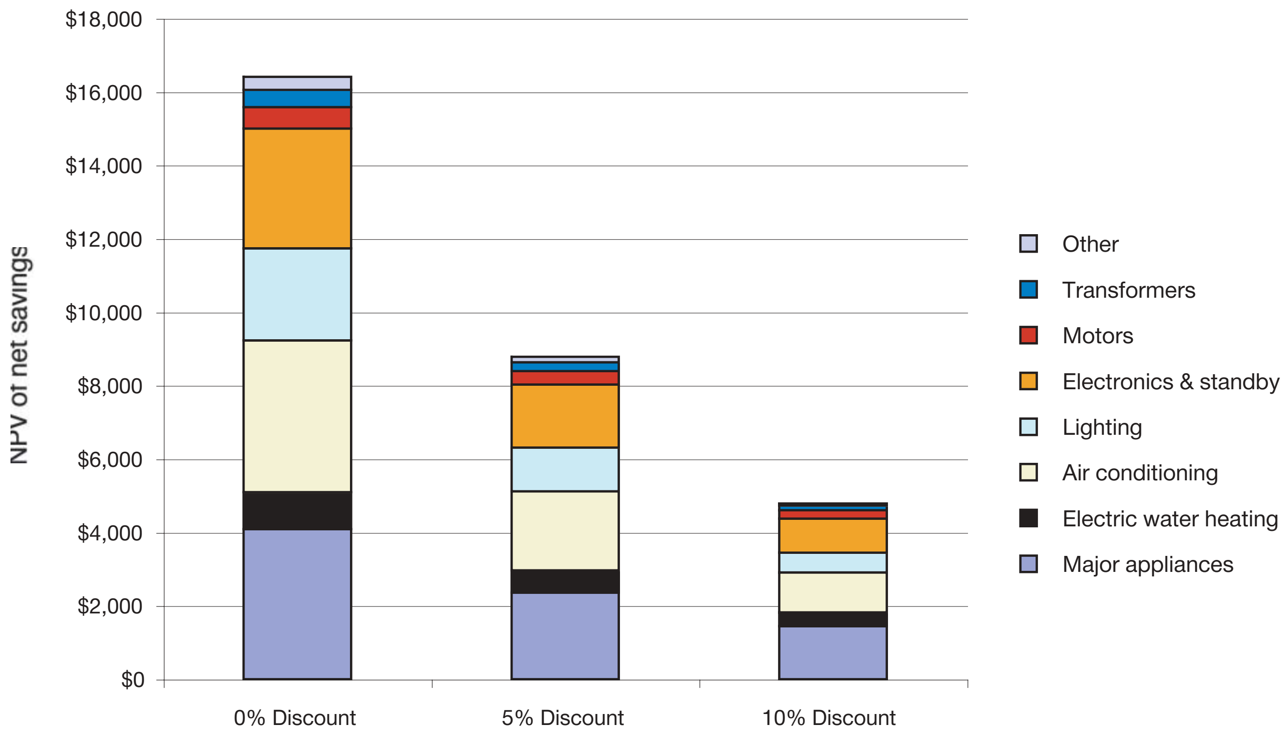


Table 7 Estimated costs and benefits, Individual NAEEEP programs

Measure	Projected Mt CO_2-e Reduction 2005-20	0% Discount rate					5% Discount rate					10% Discount rate				
		Saving $M	Cost $M	Net benefit $M	Benefit/ Cost	NPV (benefit) $/tonne	Saving $M	Cost $M	Net benefit $M	Benefit/ Cost	NPV (benefit) $/tonne	Saving $M	Cost $M	Net benefit $M	Benefit/ Cost	NPV (benefit) $/tonne
1 All Apps to 99	29.4	$4,497	$1,340	$3,157	3.4	107	$2,779	$921	$1,858	3.0	63	$1,832	$674	$1,158	2.7	39
2 RF 05	9.3	$1,295	$368	$926	3.5	99	$780	$275	$505	2.8	54	$497	$212	$285	2.3	31
3 AC 04 Enhanced	16.1	$2,480	$641	$1,839	3.9	114	$1,438	$641	$797	2.2	50	$879	$641	$238	1.4	15
4 PAC 01	8.3	$1,446	$42	$1,403	34.0	168	$937	$28	$909	33.0	109	$647	$20	$627	32.0	75
5 PAC 07	4.0	$707	$156	$551	4.5	138	$460	$113	$348	4.1	87	$313	$85	$228	3.7	57
6 Ballast 03	6.3	$1,096	$75	$1,021	14.6	163	$660	$75	$585	8.8	93	$422	$51	$371	8.3	59
7 Fluoros 05	3.3	$578	$107	$471	5.4	143	$344	$70	$274	4.9	83	$215	$49	$167	4.4	51
8 Trans 04	17.4	$1,015	$556	$459	1.8	26	$610	$369	$241	1.7	14	$390	$261	$129	1.5	7
9 Com Ref + Ice 04	3.0	$535	$298	$237	1.8	78	$318	$204	$115	1.6	38	$201	$148	$54	1.4	18
10 Small WH 05	7.1	$1,083	$259	$825	4.2	116	$659	$167	$492	3.9	69	$425	$115	$309	3.7	44
11 Motors 01	4.6	$430	$212	$218	2.0	47	$274	$139	$136	2.0	30	$186	$97	$89	1.9	19
12 Motors 04	6.6	$620	$254	$365	2.4	55	$390	$166	$224	2.3	34	$259	$116	$143	2.2	22
13 Large WH 05	2.2	$390	$216	$174	1.8	78	$245	$147	$98	1.7	44	$164	$106	$58	1.5	26
14 Misc WH 05	0.3	$29	$12	$17	2.4	55	$18	$8	$10	2.2	31	$11	$6	$6	2.0	18
15 Standby 06	35.0	$5,371	$2,458	$2,913	2.2	83	$3,213	$1,602	$1,611	2.0	46	$2,035	$1,110	$926	1.8	26
16 Greenlights	25.4	$4,488	$3,477	$1,011	1.3	40	$2,597	$2,273	$324	1.1	13	$1,588	$1,588	$0	1.0(a)	0
17 TV On mode 06	7.2	$1,108	$750	$359	1.5	50	$635	$522	$113	1.2	16	$383	$383	$0	1.0(a)	0
18 Water dispensers 07	0.9	$158	$108	$50	1.5	56	$90	$75	$16	1.2	18	$54	$54	$0	1.0(a)	0
19 Chillers 07	4.5	$793	$524	$269	1.5	60	$455	$370	$85	1.2	19	$276	$275	$0	1.0(a)	0
20 CCAC 07	0.9	$159	$128	$31	1.2	34	$92	$82	$10	1.1	11	$56	$56	-$0	1.0(a)	0
21 AC heat mode 06	2.6	$408	$374	$34	1.1	13	$253	$242	$11	1.0	4	$165	$164	$0	1.0(a)	0
22 PAC heat mode 06	0.9	$163	$156	$6	1.0	7	$104	$103	$2	1.0	2	$71	$71	$0	1.0(a)	0
23 Pool equipment	1.6	$343	$267	$77	1.3	34	$198	$174	$25	1.1	11	$121	$121	$0	1.0(a)	0
24 Gas water heaters	1.9	$371	$259	$112	1.4	58	$206	$171	$35	1.2	18	$121	$121	$0	1.0(a)	0
25 Gas space heaters	0.7	$134	$92	$42	1.5	58	$74	$61	$13	1.2	18	$43	$43	$0	1.0(a)	0
26 Gas (water)	0.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA(b)	NA
27 Elec (water)	3.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA(b)	NA
Total	**203.7**	**$29,694**	**$13,129**	**$16,565**	**2.3**	**81**	**$17,830**	**$8,996**	**$8,834**	**2.0**	**43**	**$11,357**	**$6,568**	**$4,788**	**1.7**	**23**

(a) *Not possible to reliably assess costs at this stage, so NPV costs have been set to equal to NPV benefits at discount rate of 10% (a) Monetary benefits and costs are separately accounted to Water Efficiency Labelling Program. All values are for Australia only.*

3.3 IMPACTS BY REGION

GREENHOUSE GAS REDUCTIONS

The projected greenhouse gas emission reductions for Australian States and Territories, and for New Zealand, are illustrated in Figure 17. For each NAEEEP residential sector program, the national electricity savings estimates are allocated to regions according to each region's share of national electricity consumption, and for commercial sector programs the allocation follows each region's share of national commercial sector electricity consumption. The greenhouse savings are then calculated from the electricity savings, using the marginal coefficients in Appendix 1.

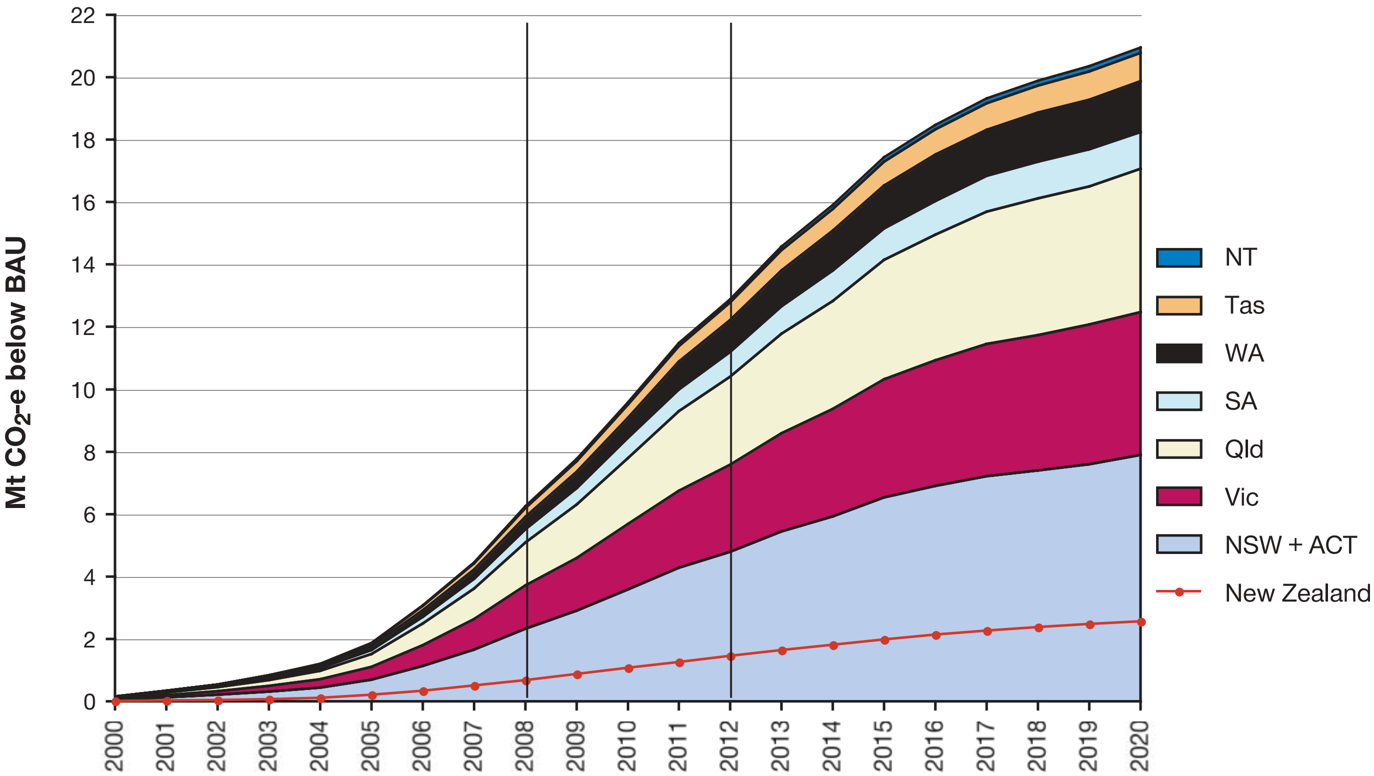
The energy impacts of each program in New Zealand in each year are calculated using the following formula:

NZ impact = Australian impact x population ratio x climate ratio x ownership ratio

Where:

- Population ratio is the ratio of projected NZ population to projected Australian population, based on published forecasts (the value is actually close to 0.20 in all years of the period);
- Climate ratio represent the higher energy required for heating applications and lower energy required for cooling applications due to NZ's cooler climate; and
- Ownership ratio indicated the relative ownership rate of that appliance or end use technology in New Zealand; eg a ratio of 0.5 indicates that the product is half as likely to be present in NZ homes as in Australian homes.

Figure 17 Projected greenhouse impacts by State, Territory and New Zealand



The estimated climate and ownership ratios relevant to each NAEEEP program as indicated in Table 8.

The greenhouse impacts for New Zealand are then calculated using the marginal coefficients in Appendix 1. It is projected that if all NAEEEP programs were implemented in New Zealand to the same extent as in Australia, New Zealand greenhouse gas emissions over the period 2005-2020 would be 23.7 Mt CO_2-e lower than without the NAEEEP programs. The average reduction in each of the five years of the Kyoto Protocol commitment period (2008-2012) would be 1.1 Mt CO_2-e.

Table 8 Estimated climate and ownership ratios for New Zealand

	Program	Climate ratio	Ownership ratio
1	Household appliances - 1999 MEPS, Mandatory & Enhanced Labelling	0.9	0.9
2	Household refrigerators and freezers - 2005 MEPS	0.9	0.9
3	Household airconditioners - 2004-07 MEPS (revised estimate)	0.7	0.5
4	Packaged air airconditioners - 2001 MEPS	0.7	0.6
5	Packaged air airconditioners - 2007 MEPS	0.7	0.6
6	Ballasts (business use) - 2003 MEPS	1.0	0.9
7	Triphosphor Lamps - 2005 MEPS	1.0	0.9
8	Transformers - 2004 MEPS	1.0	1.0
9	Commercial Refrigeration - 2006 MEPS	0.9	0.8
10	Small Electric Water heaters - 2005 MEPS & Info	1.1	1.2
11	Electric motors - 2001 MEPS	1.0	0.8
12	Electric motors - 2006 MEPS	1.0	0.8
13	Large Electric water heaters - 2005 MEPS	1.1	1.0
14	Miscellaneous electric water heaters - 2005 MEPS	1.1	1.0
15	Standby - One Watt Program (delayed)	1.0	0.9
16	Greenlights - all measures	1.0	0.9
17	Televisions - on mode	1.0	0.8
18	Water dispensers	1.0	0.8
19	Chillers	0.9	0.6
20	Close Control Air Conditioners	0.9	1.0
21	Heating mode of ACs - household	1.4	1.0
22	Heating mode of PACs - business	1.4	0.5
23	Swimming pool equipment	1.0	0.4
24	Gas Water Heaters (GAEEEP)	1.1	0.3
25	Gas Space Heaters (GAEEEP)	1.4	0.3
26	Gas savings from water efficiency labelling	1.1	1.0
27	Electricity savings from water efficiency labelling	1.1	1.0

BENEFIT/COST RATIOS

The cost-effectiveness of NAEEEP programs varies from region to region according to local energy prices as well as local climatic factors. For example, a NAEEEP program which increases the efficiency of air conditioner cooling mode will be more cost-effective in regions with higher summer average temperatures, and in regions with higher electricity prices.

Figure 18 gives a preliminary indication of the cost-effectiveness of the NAEEEP as a whole for different States and Territories and for New Zealand, under the range of discount rates. The estimate is preliminary only, since it assumes that higher product costs are distributed more or less according to population, whereas buyers in different regions may prefer different product types and hence incur different additional cost due to MEPS. the regions where the NAEEEP appears most cost-effective are those where electricity prices are highest. In all regions however the benefit/cost ratio is well above 1.0, even at a 10% discount rate.

The energy and greenhouse impacts, benefits and costs for each region are summarised in Table 9.

Figure 18 Estimated Benefit/Cost ratios by region

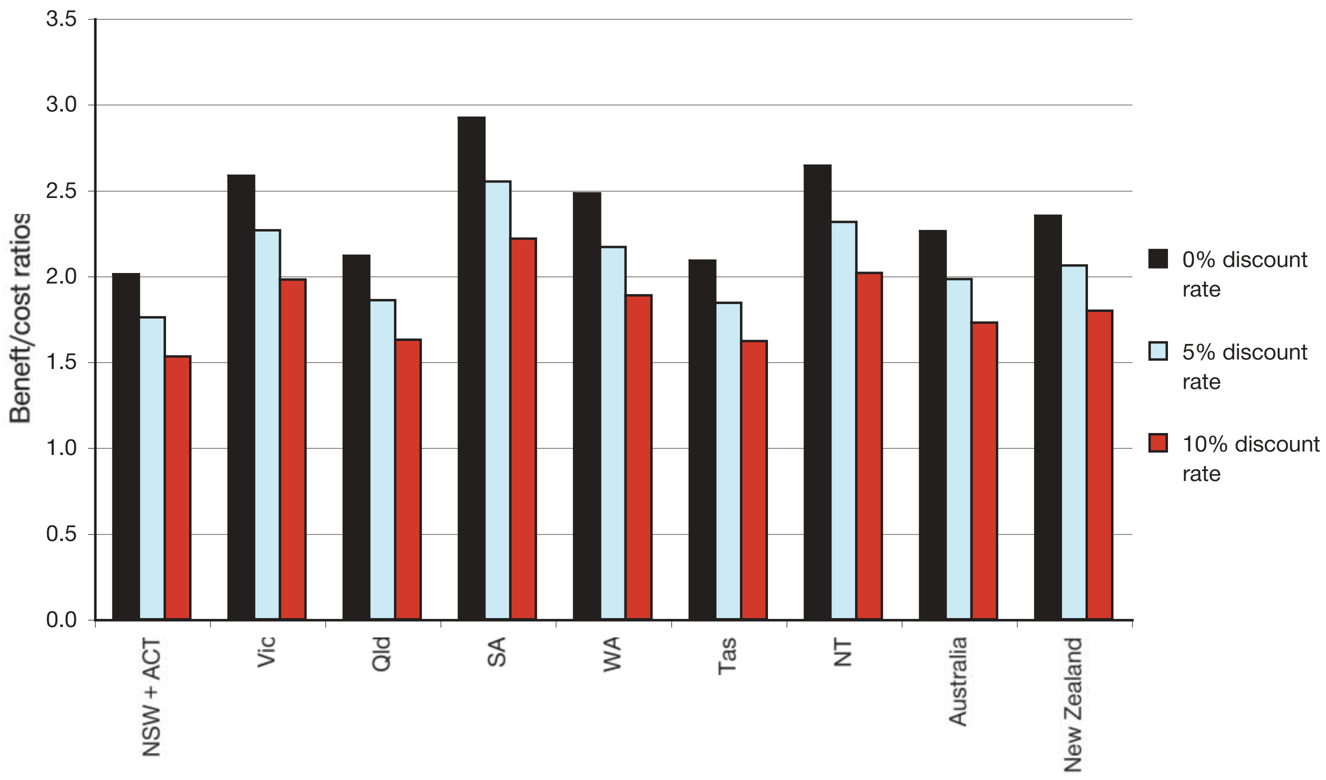


Table 9 Summary of impacts by region

Ragion	Sector	PJ energy saved		Mt CO2-e saved		$M impacts (0% discount rate)(c)				$M impacts (5% discount rate)(c)				$M impacts (10% discount rate)(c)			
		2005-20	2020	2005-20	2020	Saving	Cost	Benefit	B/C ratio	Saving	Cost	Benefit	B/C ratio	Saving	Cost	Benefit	B/C ratio
NSW + ACT (a)	Res	203.2	22.3	46.7	4.8	$5,857	$2,779	$3,078	2.1	$3,512	$1,948	$1,564	1.8	$2,234	$1,460	$773	1.5
	Comm	83.3	9.6	19.8	2.2	$3,890	$2,070	$1,820	1.9	$2,341	$1,381	$959	1.7	$1,494	$976	$518	1.5
	Other	41.2	4.1	9.9	0.9												
	Total	327.7	36.0	76.4	7.9	$9,747	$4,850	$4,898	2.0	$5,852	$3,329	$2,523	1.8	$3,728	$2,436	$1,292	1.5
Vic	Res	131.3	15.8	25.3	2.6	$4,344	$1,452	$2,891	3.0	$2,604	$1,018	$1,586	2.6	$1,656	$763	$893	2.2
	Comm	54.7	6.3	12.6	1.3	$2,918	$1,359	$1,559	2.1	$1,756	$907	$849	1.9	$1,121	$640	$480	1.7
	Other	27.0	2.7	6.3	0.6												
	Total	213.0	24.8	44.2	4.5	$7,262	$2,811	$4,450	2.6	$4,360	$1,925	$2,436	2.3	$2,777	$1,404	$1,374	2.0
Qld	Res	100.9	11.0	23.6	2.4	$3,130	$1,406	$1,724	2.2	$1,876	$985	$891	1.9	$1,193	$739	$455	1.6
	Comm	59.5	6.9	14.3	1.6	$2,978	$1,480	$1,499	2.0	$1,792	$987	$805	1.8	$1,144	$697	$447	1.6
	Other	29.4	3.0	7.1	0.7												
	Total	189.8	20.8	45.0	4.6	$6,108	$2,885	$3,223	2.1	$3,669	$1,972	$1,696	1.9	$2,338	$1,436	$901	1.6
SA	Res	40.0	4.4	7.8	0.7	$1,840	$534	$1,306	3.4	$1,103	$374	$729	3.0	$702	$280	$421	2.5
	Comm	14.6	1.7	3.0	0.3	$781	$364	$418	2.1	$470	$243	$227	1.9	$300	$172	$129	1.7
	Other	7.2	0.7	1.5	0.1												
	Total	61.9	6.9	12.3	1.2	$2,621	$897	$1,724	2.9	$1,573	$617	$957	2.6	$1,002	$452	$550	2.2
WA	Res	41.9	4.7	9.7	1.0	$1,544	$547	$997	2.8	$926	$383	$542	2.4	$589	$287	$301	2.0
	Comm	16.0	1.8	4.0	0.4	$798	$397	$402	2.0	$480	$265	$216	1.8	$307	$187	$120	1.6
	Other	7.9	0.8	2.0	0.2												
	Total	65.7	7.3	15.7	1.6	$2,342	$944	$1,399	2.5	$1,406	$648	$758	2.2	$895	$474	$421	1.9
Tas	Res	17.5	1.9	4.0	0.4	$606	$253	$353	2.4	$363	$177	$186	2.1	$231	$133	$98	1.7
	Comm	14.9	1.7	3.4	0.4	$697	$371	$326	1.9	$420	$248	$172	1.7	$268	$175	$93	1.5
	Other	7.4	0.7	1.7	0.2												
	Total	39.8	4.3	9.1	0.9	$1,303	$624	$679	2.1	$783	$425	$358	1.8	$499	$308	$191	1.6
NT	Res	4.6	0.5	0.9	0.1	$189	$64	$125	2.9	$113	$45	$68	2.5	$72	$34	$38	2.1
	Comm	2.1	0.2	0.4	0.1	$121	$53	$68	2.3	$73	$35	$37	2.1	$46	$25	$21	1.9
	Other	1.1	0.1	0.2	0.0												
	Total	7.8	0.9	1.6	0.2	$310	$117	$192	2.6	$186	$80	$106	2.3	$118	$59	$60	2.0
Australia	Res	539.4	60.6	118.1	12.1	$17,510	$7,036	$10,474	2.5	$10,498	$4,931	$5,567	2.1	$6,677	$3,697	$2,980	1.8
	Comm	245.1	28.2	57.5	6.2	$12,184	$6,093	$6,091	2.0	$7,332	$4,066	$3,267	1.8	$4,680	$2,872	$1,808	1.6
	Other	121.3	12.2	28.6	2.7												
	Total	905.8	101.0	204.3	21.0	$29,694	$13,129	$16,565	2.3	$17,830	$8,996	$8,834	2.0	$11,357	$6,568	$4,788	1.7
New Zealand (b)	Res	86.4	9.4	13.8	1.5	$2,551	$992	$1,559	2.6	$1,529	$695	$834	2.2	$973	$521	$451	1.9
	Comm	37.1	4.3	6.2	0.7	$1,832	$872	$960	2.1	$1,102	$582	$521	1.9	$704	$411	$293	1.7
	Other	22.4	2.3	3.7	0.4												
	Total	145.9	16.0	23.7	2.6	$4,383	$1,864	$2,518	2.4	$2,632	$1,277	$1,354	2.1	$1,676	$932	$744	1.8

(a) Data not sufficiently detailed to distinguish between NSW and ACT (b) New Zealand values estimates only based on ratios in Table 8 and ratios between NZ and Australian average energy prices and greenhouse gas intensities. (c) $M costs and benefits for Commercial sector and Other sectors are combined.

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APPENDIX 1 INPUT FACTORS

ENERGY PRICES

The value of energy savings is calculated using the marginal energy prices in Table 10.

Table 10 Projected Marginal Energy Tariffs, 2005-2020

	c/kWh Household	c/kWh Commercial	c/kWh Industrial	C/MJ Natural gas (household)
NSW	11.0	14.0	7.2	1.42
Victoria	15.6	16.0	7.8	1.00
Queensland	11.6	15.0	8.5	1.41
SA	18.0	16.0	8.5	1.17
WA	14.7	15.0	10.7	1.26
Tasmania	12.5	14.0	4.6	1.40
NT	15.4	17.0	14.5	1.17
ACT	9.2	14.9	7.2	1.37
Australia (weighted)	13.0	14.9	8.0	1.14
New Zealand	12.0 (a)	16.0	9.0	1.40

Source: Estimates in RISs, except (a) Advised by NZ Ministry for Environment, November 2003.

GREENHOUSE GAS EMISSIONS

There are two ways of calculating the greenhouse gas intensity of electricity systems:

- average intensity: total annual emissions divided by total annual electricity produced, sent out, or delivered; and
- marginal intensity: the additional emissions that would be created (or avoided) by adding or saving an additional kWh.

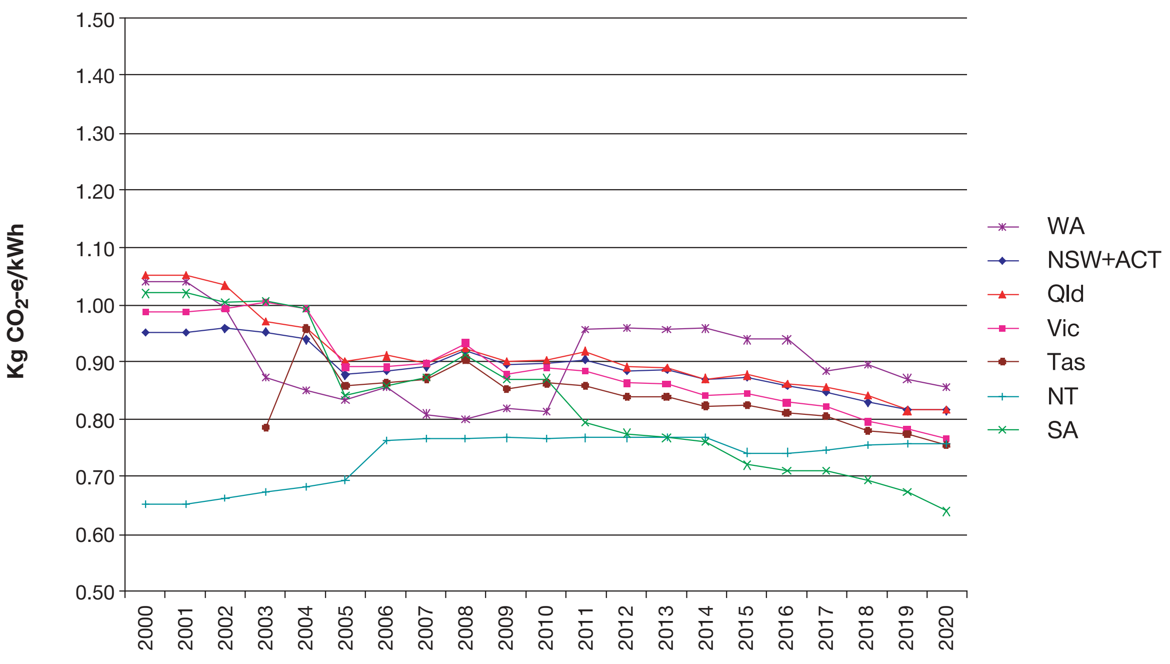
Both intensity measures vary over time, but the marginal intensity takes into account the merit order of generators. In Australia, the base electricity load is met by coal-fired power stations (which are the cheapest – so long as greenhouse emissions costs are externalised - and the most CO_2-intensive) while intermediate and peak loads are met by more expensive but less CO_2-intensive natural gas and zero-intensity hydro. Thus a measure that reduces overall electricity demand – such as MEPS - will tend to reduce the operation of power stations that are less CO_2-intensive than the average; ie the CO_2-intensity per kWh avoided should be calculated using the marginal coefficients.

The marginal electricity system CO_2–e intensities for Australia used in the RIS, illustrated in Figure 19 were supplied by the AGO (personal communication, April 2000). The marginal coefficient for New Zealand (0.600 kg/kWh in all years) was supplied by the NZ Ministry for Environment (personal communication, November 2003). These embody specific assumptions about the scheduling of future generation and transmissions projects. For example, the completion of Basslink will harmonise the marginal coefficient for Tasmania and Victoria, and both will converge to the intensity of natural gas generation. The marginal coefficients for natural gas are illustrated in Table 11.

Table 11 Marginal greenhouse gas coefficients, natural gas (all years)

	kt CO_2-e/PJ
NSW	72.0
VIC	64.2
QLD	74.8
SA	74.5
WA	62.7
TAS	NA
NT	53.4
ACT	72.0
Australia (weighted)	**66.2**
New Zealand	**60.0**

Figure 19 Projected marginal emissions-intensity of electricity supply by State 2000-2020



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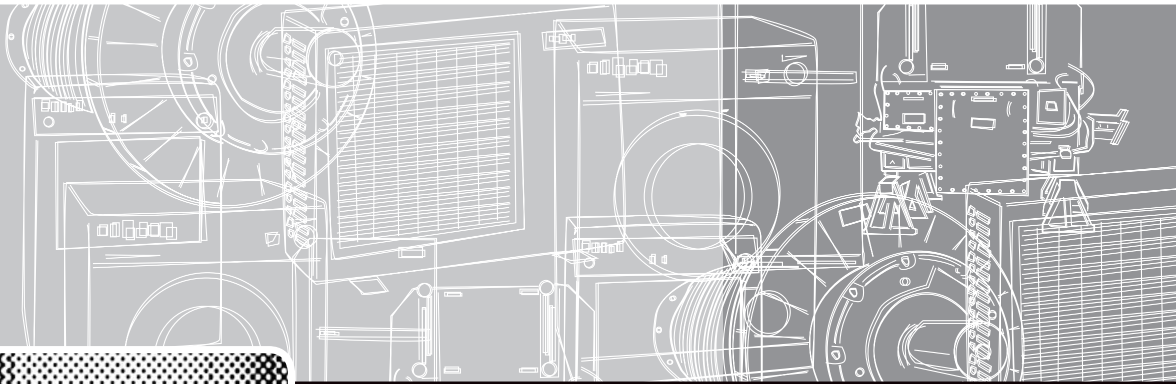

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