DRAFT FOR PUBLIC COMMENT

REGULATORY IMPACT STATEMENT:

Revised Minimum Energy Performance Standards and Alternative Strategies for SMALL ELECTRIC STORAGE WATER HEATERS

Prepared for the Australian Greenhouse Office

by

George Wilkenfeld and Associates Pty Ltd

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GEORGE WILKENFELD AND ASSOCIATES Pty Ltd
ENERGY POLICY AND PLANNING CONSULTANTS
92 Spencer Road, Killara NSW 2071 Sydney Australia
Tel (+61 2) 9418 2405 Fax (+612) 9418 2406 e-mail: geosanna@ozemail.com.au

Executive Summary

Electric water heating accounts for about 28% of national household electricity use and about 2% of commercial sector electricity use. Electric water heating is the largest single source of greenhouse gas emissions in the residential sector.

The energy used by electric water heaters is made up of two distinct components:

- The heat lost through the walls and fittings of hot water storage vessels; this is known as “standing heat loss”; and
- The useful energy in the hot water drawn off from the water heaters.

Useful energy is largely determined by the hot water demand, whereas the heat loss is determined by the design of the water heater itself and how and where it is installed.

There are three main groups of electric storage water heaters:
1. Conventional storage water heaters with a water delivery of less than 80 litres (“small water heaters”);
2. Conventional storage water heaters with a water delivery of 80 litres or more (“large water heaters”); and
3. Unconventional electric water heaters, ie solar water heaters with electric boosting and heat pump water heaters.

It is estimated that about 32% of the energy used by small electric water heaters and 20% of the energy used by large electric water heaters was lost in 2000. Heat losses alone from small electric water heaters accounted for 1,115 GWh of delivered electricity, costing users $134 million. The associated greenhouse gas emissions totalled over 1.1 Mt CO_2-e. The electricity consumption and costs of these heat losses are projected to increase by more than 37% by 2010, and the associated greenhouse gas emissions by more than 27% (ie less than the growth in electricity use because the greenhouse-intensity of electricity supply is projected to fall).

The water heater market interposes several intermediaries between the decision-maker who selects the water heater and the householder who bears the running costs. The original choice of water heater is often made by the builder or plumber. Subsequent decisions about water heater replacement are usually made by the building owner in the case of rental accommodation. Where homeowners make their own replacement choices, decisions are often made under time pressure and with limited information. Options that are cost-effective over the lifetime of the water heater are either passed up, or simply not available – eg all electric water heater models are designed to the same heat loss level. Minimum energy performance standards (MEPS) for water heaters addresses these market failures directly.

In 1996, the Australian and New Zealand Minerals and Energy Council (ANZMEC) decided to adopt MEPS for electric storage water heaters. These took effect in October 1999. The MEPS levels are expressed as maximum standing heat losses in Australian Standard AS1056.1 *Storage Water Heaters: General Requirements.* MEPS are given effect in each State and Territory by the same regulations which govern appliance energy labelling.

The National Greenhouse Strategy states that “improvements in the energy efficiency of domestic appliances and commercial and industrial equipment will be promoted by extending and enhancing the effectiveness of existing energy labelling and minimum energy performance standards [MEPS] programs.” (NGS 1998). A high priority in the work program of the National Appliance and Equipment Energy Efficiency Committee is to “commence negotiation to increase MEPS levels for refrigerators, freezers and electric water heaters for implementation in 2004” (NAEEEC 1999).

The prospect of revising the MEPS levels for small electric storage water heaters was first formally discussed between government and the industry in 1996, when the 1999 MEPS levels were adopted. It was agreed that the 1999 MEPS levels would not be revised before 2004 at the earliest.

The Proposal

Small electric water heaters represent the most expensive way to heat water. Although they are cheapest to purchase, they incur the highest running costs, both for useful energy and to cover heat losses. There is still considerable technical scope for reducing heat losses below the 1999 MEPS levels, both through thicker insulation and other means.

This document considers options for increasing the stringency of MEPS for small electric storage water heaters. Six MEPS options have been modelled:

1. Equivalent to 20% reduction in maximum standing heat loss. This is considered the least improvement for which it is worthwhile to change product design;
2. Equivalent to 30% reduction in maximum standing heat loss;
3. Equivalent to 40% reduction in maximum standing heat loss;
4. Equivalent to 50% reduction in maximum standing heat loss;
5. As for option 1, but with a further step to option 3 heat loss level in October 2007;
6. As for option 1, but with a further step to option 4 heat loss level in October 2007.

The two step options may offer more flexibility for manufacturers to address the issues of changing foaming agents.

Regulatory Impact Statement

The Council of Australian Governments (COAG) requires that proposals of this type be subject to a Regulatory Impact Statement (RIS).[1] The present RIS estimates the

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[1] The COAG Guidelines state that:
“The purpose of preparing a regulation impact statement (RIS) is to draw conclusions on whether regulation is necessary, and if so, on what the most efficient regulatory approach might be. Completion of a RIS should ensure that new or amended regulatory proposals are subject to proper analysis and scrutiny as to their necessity, efficiency and net impact on community welfare. Governments should then be able to make well-based decisions. The process emphasises the importance of identifying the effects on groups who will be affected by changes in the regulatory environment, and consideration of alternatives to the proposed regulation.
Impact assessment is a two step process: first, identifying the need for regulation; and second, quantifying the potential benefits and costs of different methods of regulation. In demonstrating the need for the regulation, the RIS should show that an economic or social problem exists, define an

benefits, costs and other impacts of the proposal, assesses the likelihood of the proposal meeting its objective, and considers a range of alternatives to the proposal.

The objective of the proposed regulation is to bring about reductions in Australia's greenhouse gas emissions from the use of electric water heaters below what they are otherwise projected to be (ie the "business as usual" case) in a manner that is in the community's best interests. The following alternative options are considered:

1. Status quo (termed business as usual, or BAU);
2. Revised MEPS (see the 6 options above);
3. Voluntary MEPS, where industry is given incentive, but not compelled to adhere to the proposed revised levels;
4. Another regulatory option involving a levy imposed upon inefficient equipment to fund programs to redress the greenhouse impact of equipment energy use;
5. A levy on electricity reflecting the impact it has on greenhouse gas emissions.

In addition to assessing whether the alternatives would meet the objective of reducing greenhouse gas emissions, they were also reviewed in light of the following criteria:

1. Does the option address market failures, so that the average lifetime costs of water heating are reduced, when both capital and energy costs are taken into account?
2. Does the option minimise negative impacts on product quality and function?
3. Does the option minimise negative impacts on manufacturers and suppliers?
4. Is the option consistent with other national policy objectives, including in this case reduction in the emissions of ozone depleting substances and the objectives of the National Appliance and Equipment Energy Efficiency Program to match "world best practice" standards?

Benefits and Costs

Detailed cost-benefit modelling was carried out for the 6 MEPS options. Table S1 summarises the projected reductions in electricity use and greenhouse emissions. The financial benefit is the value of the electricity that would be saved (Table S2). No monetary value is given to greenhouse gas reductions (illustrated in Figure S1).

Table S1 Projected energy and greenhouse savings, 2000-2020

MEPS option	Total GWh saved, 2000-2020	Total kt CO_2-e saved, 2000-2020	Avg kt CO_2-e saved/yr 2008-12	Avg reduction below BAU 2008-12
1. 20% reduction	4220	3980	211	13.1%
2. 30% reduction	6331	5970	317	19.6%
3. 40% reduction	8441	7960	423	26.2%
4. 50% reduction	10551	9950	528	32.7%
5. 20% then to 40%	7417	6974	319	19.7%
6. 20% then to 50%	9015	8470	372	23.1%

Note: All energy and greenhouse estimates refer to heat loss only, and exclude the energy delivered as useful hot water.

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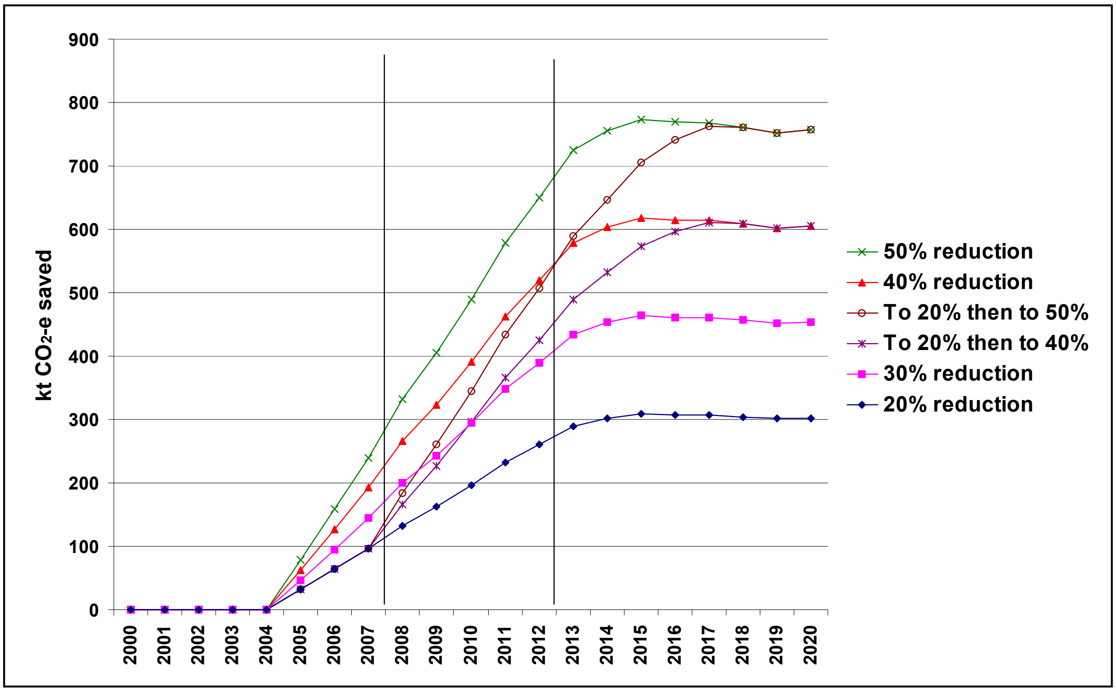
objective for regulatory intervention, and show that alternative mechanisms for achieving the stated objective are not practicable or more efficient" (COAG 1997).

Figure S1. Projected greenhouse savings from MEPS options, 2000-2020



The financial cost is made up of the following components:

- The increase in the average purchase price of small electric water heaters, due to increased material content and the capital costs of retooling. These are incurred by manufacturers, but are passed on (with retail markup) to buyers. Although there are many technical pathways to achieve heat loss reductions, one pathway – increasing the thickness of insulation – is used as a proxy to calculate costs.
- The costs of altering some of the enclosures in which small water heaters are now installed, to accommodate larger units than otherwise. The number of installations where this is likely to occur, and the average costs of the alterations, are estimated from surveys commissioned by the AGO, using information provided by the industry.

Table S2 indicates the projected costs and benefits.

Table S2. Projected national costs and benefits, MEPS options

MEPS option	NPV purchase costs $M	% of enclosures changed	NPV enclosure costs $M	NPV total capital costs $M	NPV energy costs $M	Capital cost increase $M	Energy saving $M	Net benefit $M	Benefit/ cost
BAU	$407.3	NA	NA	$407.3	$1,358.7				
20% reduction	$441.3	1%	$2.8	$444.1	$1,192.8	$36.8	$166.0	$129.2	4.5
30% reduction	$451.0	2%	$5.5	$456.5	$1,109.8	$49.3	$248.9	$199.7	5.1
40% reduction	$464.5	4%	$11.1	$475.6	$1,026.8	$68.3	$331.9	$263.6	4.9
50% reduction	$484.7	8%	$22.2	$506.8	$943.9	$99.6	$414.9	$315.3	4.2
20% then to 40%	$458.9	1-4%	$7.9	$466.9	$1,077.0	$59.6	$281.8	$222.2	4.7
20% then to 50%	$473.0	1-8%	$14.8	$487.9	$1,019.1	$80.6	$339.6	$259.1	4.2

All Net Present Values at mid 2001, at 10% discount rate.

The projected benefit/cost ratio is highest (5.1) with a 30% reduction in heat loss, but the net national benefit is highest ($315 million net present value at 10% discount rate) if 50% heat loss reduction is achieved in one step. These projections have been tested for sensitivity to a range of assumptions regarding material costs, discount rates, water heater service life and enclosure alteration costs.

Supplier and Trade issues

There are two major manufacturers of small mains pressure electric storage water heaters in Australia: Southcorp (Rheem and Vulcan Brands) and GWA International (Dux brand). Edwards Energy Systems also makes a small water heater. There are negligible imports, and limited exports. The adoption of more stringent MEPS is not likely to either increase or reduce the number of suppliers, or have any significant effect on price competition. Manufacturers were able to implement the 1999 MEPS levels with price increases (as was expected) and without disruption to the market.

The current MEPS regime is not inconsistent with the GATT *Technical Barriers to Trade* Agreement, and there is no reason why more stringent MEPS would be so.

Assessment

Reduce greenhouse emissions below business as usual

An increase in the stringency of mandatory MEPS is the only measure for which the extent of likely reduction in standing heat loss, and hence greenhouse gas emissions can be quantified.

Address market failures

An increases in the stringency of MEPS would address the market's lack of concern with operating costs by enforcing investment in more efficient products so that the total life cycle cost of electric water heating would be lower than otherwise, irrespective of whether users change their purchase behaviour.

A mandatory efficiency-related levy on water heaters could in theory address market failure by making the more efficient water heaters cheaper than the less efficient, and so encourage their purchase by all buyers, including those concerned exclusively with capital cost. However, there are two critical objections to this:

- It requires that there be a range in product energy efficiency, from high to low. All of the small water heater models offered by the two major suppliers are designed to the current MEPS level; and
- there is no obvious legal or taxation mechanism by which the measure could be implemented.

An emissions-related levy on electricity prices would be less effective than the efficiency-related levy on appliances, since it addresses running costs rather than capital costs. It would have economy-wide implications that are beyond the scope of the present analysis. Given that any decision to implement such a levy would need to be taken at the highest levels of Government, it is not considered a direct alternative to the proposal..

Minimise negative impact on product quality

An increase in the stringency of MEPS is not expected to have any significant effect on product quality or function (ie apart from energy-efficiency). However, such an increase will lead to additional costs to some users who will in future wish to replace an existing small electric water heater, and find that none of the models then on the market will fit in the existing water heater enclosure.

The number of such users will depend on the extent to which MEPS levels are made more stringent, and the extent to which manufacturers meet them through increases in insulation and through the other technical options available.

Minimise negative impact on suppliers

More stringent MEPS would clearly require suppliers to re-engineer their products to reduce heat loss, at about the time they will also need to re-engineer products and manufacturing processes to change to non-HCFC foaming agents. While these changes would impose additional costs, these would be recoverable in higher prices. Planning the changes jointly would allow costs to be minimised.

The other options would have lower costs for suppliers to the extent that they were less effective in bringing about the outcome of lower heat loss. At the extreme, the voluntary MEPS option would have least impact on suppliers because it is unlikely that any would take it up.

Conclusions [Draft]

After consideration of the option of more stringent mandatory MEPS and other alternatives, it is concluded that:

1. More stringent MEPS is likely to be effective in meeting the objectives stated for the regulation: reductions in greenhouse gas emissions and reduced life cycle costs to users.

2. None of the alternatives examined appear as effective as MEPS in meeting all objectives, some would be ineffective with regard to some objectives, and some appear to be far more difficult or costly to implement.

3. The costs of more stringent MEPS levels have been modelled as if the necessary heat loss reduction were achieved solely through increasing the insulation thickness of water heaters. However, other – and possibly cheaper - technical options could achieve some or all of the heat loss reduction required.

4. The projected costs and benefits are relatively insensitive to assumptions about average service life and discount rate. All options would remain cost-effective at much higher material costs and enclosure rebuilding costs (ie where larger units no longer fit in existing enclosures).

5. Of the six modelled MEPS options, the one which gives the highest ratio of benefits to costs (5.1) is Option 2 (30% reduction in heat loss).

6. The option with the highest net benefits and greenhouse savings is the most stringent: Option 4 (50% reduction in standing heat loss in a single step). This also leads to the greatest increase in total water heater costs, with about four fifths of the increase coming from higher manufacturing costs and one fifth from the cost of changing enclosures to accommodate larger water heaters.

7. Option 2 (30% reduction in heat loss) corresponds to the most stringent mandatory MEPS for small water heaters currently in force (in Germany and Switzerland) and so would be consistent with the ANZMEC policy to match "world's best practice."

8. The net benefits of higher MEPS levels for small electric water heaters would most likely flow disproportionately to households who rent, occupy smaller dwellings and, on the whole, have lower incomes.

9. The timing of the proposed change in MEPS would coincide with the change to new foam blowing agents. While this will most likely reduce the insulation performance of the foam, this could be compensated with other technical options, and all options should still be feasible.

10. The total costs of changing both foaming agents and heat loss levels would be minimised if each manufacturer were able to plan for them in an integrated manner.

11. The greater the volume of insulation foam that will be required, the greater the exposure to uncertainties regarding foam availability, cost and characteristics. The higher MEPS levels (Options 3 and 4) would require significant increases in foam volume, which would magnify the uncertainty, although the risks from foam uncertainty could be reduced by a two-step approach (Options 5 and 6). The lower MEPS levels (Options 1 and 2) could be achieved with much less change in dimensions – minimal change on some models.

12. A "sales-weighted target" approach (in which some higher heat loss units could be sold provided that enough lower heat loss units were also sold) could give suppliers greater flexibility to address the dimensional constraint issue than a strict MEPS regime (in which every unit sold would have to meet the nominated MEPS level).

Recommendations [Draft]

It is recommended that:

1. States and Territories implement more stringent mandatory MEPS for storage water heaters of less than 80 litres delivery (as defined in AS1056.1 *Storage Water Heaters Part 1: General requirements*).

2. The MEPS levels be set at 30% of the current maximum standing heat loss in AS1056.1-1991, to be achieved in a single step.

3. The scope of AS1056.1-1991 should be expanded to cover water heaters of delivery smaller than 25 litres (the current limit).

4. The mode of implementation be through the existing regulations governing appliance energy labelling and MEPS in each State and Territory.

5. The revised MEPS levels take effect on 1 October 2004.

6. ANZMEC agree to the development of a joint Australian and New Zealand standard for heat loss testing, to eventually supersede the existing Australian Standard and New Zealand Standard.

7. State and Territory governments consider the possibility of a "sales-weighted target", under which suppliers who wished to do so could continue to sell water heaters which meet the 1999 MEPS level after October 2004, so long as the average heat loss of all their sales of models of each delivery capacity in each 12 month period is no higher than the MEPS level for models of that capacity.

8. If such an approach is implemented, supplier participation should be voluntary and subject to agreement to pay fines in the event of failure to meet the agreed targets. Such fines should be high enough to provide an incentive to meet targets and should reflect the value of electricity savings to small water heater buyers.

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Contents

Glossary

AEEMA	Australian Electrical and Electronics Manufacturers Association
AGO	Australian Greenhouse Office
ANZMEC	Australian and New Zealand Minerals and Energy Council
APEC	Asia-Pacific Economic Cooperation
AS/NZS	Australian Standard/New Zealand Standard
BAU	Business as usual
CFC	Chlorofluorocarbon
COAG	Council of Australian Governments
DISR	Department of Industry, Science and Resources
EC	Council of the European Union
GATT	General Agreement on Tariffs and Trade
GWP	Global warming potential
HCFC	hydrochlorofluorocarbon
HFC	hydrofluorocarbon
HLF	Heat loss factor (ratio of proposed maximum heat loss to current maximum heat loss)
HWS	Hot water system
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronic Engineers (USA)
IPCC	Intergovernmental Panel on Climate Change
LP	Low pressure
MEPS	Minimum energy performance standards
MP	Mains pressure
NAEEEC	National Appliance and Equipment Energy Efficiency Committee
NGGI	National Greenhouse Gas Inventory
NGS	National Greenhouse Strategy
ODP	Ozone depleting potential
OP	Off-peak (electricity tariff)
PRV	Pressure relief valve
RIS	Regulatory Impact Statement
SWH	Storage water heater
T&PRV	Temperature and pressure relief valve
TTMRA	Trans-Tasman Mutual Recognition Agreement
UNFCCC	United Nations Framework Convention on Climate Change

1. The Problem

COAG Guidelines:

- ***Statement of the problem:*** *why is government action being considered in the first place? What is the problem being addressed? For example, this should state the market failure that the proposal seeks to remedy.*

1.1 Energy-Related Greenhouse Gas Emissions

In recognition of the risks and costs of climate change, the Australian government is cooperating with other countries on a global strategy to reduce greenhouse gas emissions below what they would otherwise be. The Commonwealth, State and Territory governments have adopted a National Greenhouse Strategy to give effect to this objective (NGS 1998).

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

The Kyoto Protocol to the UNFCCC was agreed in December 1997, but has yet to be ratified by its signatories, which include Australia. If ratified, it would place a legally binding obligation on Annex I countries to limit their average annual greenhouse gas emissions during the “first commitment period” 2008 – 2012 to agreed targets, expressed as a proportion of their 1990 emissions. Australia’s target would be 108% of its 1990 emissions. While this is higher than the average for Annex 1 countries, it is nevertheless challenging, representing a reduction of more than 20% compared with business-as-usual projections (NGS 1998).

Table 1 summarises Australia’s greenhouse gas emissions in 1990 and 1999, the latest year for which a national greenhouse gas inventory (NGGI) has been prepared. Net emissions increased by 17.4% over the period, and the energy sector accounted for nearly all of this increase.[2] The energy sector accounted for nearly all of the growth in national emissions, and electricity generation emissions represented nearly two thirds of the increase in energy emissions. The next highest contributor was road transport (19% of the total increase in energy emissions).

ABARE (1999) projects total electricity use to increase by a further 21% between 1999 and 2010, the mid-point of the Kyoto protocol commitment period. Electricity use in agriculture, mining and manufacturing is projected to increase by 22%, commercial sector electricity use by 32%, and residential electricity use by 9%. Slowing, and ultimately reversing the growth in electricity-related emissions is thus a high priority in Australia’s greenhouse gas reduction strategy.

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[2] By convention, emissions from land use change are reported separately. These were substantially lower in 1999 than in 1990.

Table 1 Change in Greenhouse Gas Emissions, 1990 to 1999

	1990 Mt CO_2-e	1999 Mt CO_2-e	Change 1990 to 99 Mt CO_2-e	Change 1990 to 99 %	% of Energy Sector change
1A Fuel Combustion	270.0	333.7	63.8	23.6%	98.0%
1A1 Energy Industries	142.3	188.8	46.5	32.7%	71.5%
Electricity generation	129.1	171.8	42.7	33.1%	65.7%
Other	13.2	16.9	3.8	28.6%	5.8%
1A2 Manufacturing & Construction	50.3	52.0	1.7	3.4%	2.6%
1A3 Transport	61.5	73.9	12.4	20.3%	19.1%
Road	54.8	66.6	11.8	21.5%	18.2%
Other	6.6	7.3	0.6	9.6%	1.0%
1A4 Small combustion	14.2	16.7	2.5	17.5%	3.8%
1A5 Other	1.7	2.3	0.6	38.3%	1.0%
1B Fugitive	29.5	30.8	1.3	4.4%	2.0%
Solid Fuels	15.9	18.3	2.4	15.3%	3.7%
Oil and Natural Gas	13.6	12.5	-1.1	-8.3%	-1.7%
Sector 1. All Energy (sum of 1A, 1B)	299.5	364.6	65.1	21.7%	100.0%
Sector 2. Industrial Processes	12.0	9.6	-2.4	-19.9%	
Sector 4. Agriculture	91.2	93.8	2.7	2.9%	
Sector 5 (part). Forestry and Other (a)	-27.3	-25.9	1.4	-5.1%	
Sector 6. Waste	14.9	16.0	1.1	7.6%	
Gross emissions	417.6	484.1	66.5	15.9%	
Net emissions	390.3	458.2	67.9	17.4%	

Source: AGO 2001c (a) Land use change excluded. Sector 3, Solvent and Other Product Use, contains only indirect greenhouse gases that fall outside the scope of the Kyoto Protocol.

1.2 Contribution of Electric Water Heaters to Emissions

The National Greenhouse Gas Inventory does not indicate directly the contribution of economic sectors (eg the commercial or manufacturing sectors) or end uses (eg water heating) to national greenhouse gas emissions. Further analysis is required, especially the allocation of electricity use to sectors, end uses and technology types.

Most of the energy consumption for electric water heating occurs in the residential sector, with the rest in the commercial and manufacturing sectors.[3] EES (1999) and EMET (1999) are the most detailed recent studies of energy use in the residential and the commercial sectors respectively.

Table 2 summarises estimated energy use for all purposes in the residential and commercial sectors in 2000 and 2010. In 2000, electric water heating accounted for about 28.1% of household electricity use and 2.1% of commercial sector electricity use – a total of 48.4 PJ (13,450 GWh). It is projected that the energy consumed by

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[3] The water heaters covered in this RIS are of the type designed to deliver water at 70-80°C for general kitchen, bathroom and laundry purposes in households and in commercial establishments. It does not cover products intended to supply super-heated water or steam for industrial purposes.

electric water heating will fall by about 4% between 2000 and 2010, largely because of the shift to gas water heating which is discussed later in this RIS. Even so, electric water heating is projected to remain the largest single source of greenhouse gas emissions in the residential sector (see Table 3).

Table 2 Estimated end uses of residential and commercial energy, 2000 and 2010

	2000 Res	2000 Com	2000 Tot	2010 Res	2010 Com	2010 Tot	Change
HVAC (a) - electric	8.4	83.3	91.7	9.1	110.3	119.4	30.3%
Heating - fuels	121.8	65.0	186.8	143.3	85.5	228.8	22.5%
Water heating – electric	45.5	2.9	48.4	42.6	4.0	46.6	-3.8%
Water heating - fuels	44.6	2.3	46.9	54.1	2.8	56.9	21.3%
Cooking - electric	8.3	1.0	9.3	9.8	1.3	11.1	20.0%
Cooking - fuels	6.9	6.9	13.8	8.2	8.5	16.7	20.5%
Lighting	15.8	35.3	51.1	17.7	52.5	70.2	37.5%
Appliances, other (b)	84.2	18.3	102.5	94.5	24.0	118.5	15.6%
Total	335.5	214.9	550.4	379.3	288.9	668.2	21.4%
Electricity	162.2	140.3	302.5	173.7	191.7	365.4	20.8%
Fuels	173.3	74.6	247.9	205.6	97.2	302.8	22.1%
WH/total energy	26.9%	2.4%	17.3%	25.5%	2.4%	15.5%	
Elect WH/tot elect	28.1%	2.1%	16.0%	24.5%	2.1%	12.7%	

All values PJ. Extracted from EMET (1999), EES (1999) (a) Heating, ventilation and air conditioning. (b) Comprises a large number of products and technology types.

Table 3 Estimated greenhouse gas emissions by residential and commercial energy use, 2000 and 2010

	2000 Res	2000 Com	2000 Tot	2010 Res	2010 Com	2010 Tot	Change
HVAC (a) - electric	2.3	24.4	26.7	2.4	32.4	34.8	30.2%
Heating - fuels	5.6	4.1	9.7	6.5	5.3	11.8	21.7%
Water heating – electric	12.4	0.9	13.3	10.9	1.2	12.1	-9.0%
Water heating - fuels	2.8	0.2	3.0	3.4	0.2	3.6	21.1%
Cooking - electric	2.4	0.3	2.7	2.7	0.4	3.1	14.0%
Cooking - fuels	0.4	0.5	0.9	0.5	0.5	1.1	16.9%
Lighting	4.6	10.5	15.1	4.8	15.7	20.5	35.8%
Appliances, other	24.2	5.4	29.6	25.7	7.1	32.8	10.7%
Total	54.7	46.2	101.0	56.9	62.8	119.7	18.5%
Electricity	45.9	41.4	87.3	46.2	56.7	102.9	17.8%
Fuels	8.9	4.8	13.7	10.4	6.1	16.5	20.4%
WH/total energy	27.7%	2.2%	16.1%	25.3%	2.2%	13.1%	
Elect WH/tot elect	27.0%	2.1%	15.2%	23.6%	2.1%	11.7%	

All values Mt CO_2-e. Extracted from EMET (1999), EES (1999) (a) Heating, ventilation and air conditioning.

There are three distinct groups of electric storage water heaters:[4]

1. Conventional storage water heaters with a water delivery of less than 80 litres ("small water heaters");
2. Conventional storage water heaters with a water delivery of 80 litres or more ("large water heaters"); and

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[4] Storage water heaters account for the great majority of electric water heaters. Non-storage instantaneous water heaters account for a negligible share of electric water heating energy.

3. Unconventional electric water heaters, ie solar water heaters with electric boosting and heat pump water heaters.

It is projected that the shift from electric to gas water heating currently under way will impact on large water heaters but not on small ones, because small water heaters are more likely to be installed in locations where gas is not available, space is restricted, flue access is unavailable, hot water demand is moderate and/or minimising initial capital cost is the dominant decision factor (see following section). As the average number of persons per household declines, the market for small electric water heaters will grow. Therefore energy use by small electric water heaters is projected to increase by more than 41% between 2000 and 2010, whereas energy use by large electric water heaters is projected to fall by nearly 20% - due to both declining market share and to the impact of MEPS, which took effect in October 1999 (see following section).

The energy used by electric water heaters is made up of two distinct components:

- The heat lost through the walls and fittings of hot water storage vessels; this is known as “standing heat loss”;
- The useful energy (UE) in the hot water drawn off from the water heaters: most of this is delivered to the draw-off point (eg shower head or faucet), but some of this is lost from pipes between the water heater and the point of draw-off.

Useful energy is largely determined by the hot water demand, whereas the heat loss is determined by the design of the water heater itself and how and where it is installed. Table 4 disaggregates the electricity consumed by small and large water heaters into useful energy and energy losses (energy use by unconventional water heaters is included with large water heaters). It is estimated that about 32% of the energy used by small electric water heaters and 20% of the energy used by large electric water heaters was lost in 2000. It is estimated that by 2010, losses for small water heaters will increase by about 37%, but losses for large water heaters will fall by about 44%.

Table 4 Components of annual electric water heater energy use, 2000 and 2010

	2000 Res	2000 Com	2000 Tot	2010 Res	2010 Com	2010 Tot	Change
Small WH - useful	7.7	0.8	8.5	10.9	1.4	12.2	43.6%
Small WH - losses	3.6	0.4	4.0	4.9	0.6	5.5	37.1%
Small WH - total	**11.4**	**1.2**	**12.5**	**15.8**	**2.0**	**17.7**	**41.5%**
Large WH - useful	27.3	1.5	28.8	23.1	1.8	24.8	-13.7%
Large WH - losses	6.8	0.3	7.1	3.8	0.2	4.0	-43.9%
Large WH - Total	**34.1**	**1.7**	**35.9**	**26.8**	**2.0**	**28.8**	**-19.6%**
Total useful energy	35.0	2.3	37.3	34.0	3.1	37.1	-0.6%
Total heat losses	10.5	0.6	11.1	8.6	0.8	9.5	-14.6%
Total water heating	**45.5**	**2.9**	**48.4**	**42.6**	**4.0**	**46.6**	**-3.8%**
% heat loss	23.0%	21.8%	22.9%	20.3%	21.0%	20.4%	

All values PJ. Author estimates for total stock, based on ES (1999)

Table 5 indicates that in 2000, small water heaters consumed about 3,484 GWh of electricity, with a value of $420 million, and caused the emission of 3.6 million tonnes CO_2-equivalent. This greenhouse impact was equivalent to all of cooking and greater than the greenhouse impact of all water heating by natural gas and other fuels (see Table 3).

Heat losses alone from small electric water heaters accounted for 1,115 GWh of delivered electricity in 2000, costing $ 134 million. The associated greenhouse gas emissions totalled over 1.1 Mt CO_2-e. The electricity consumption and costs of these heat losses are projected to increase by more than 37% by 2010, and the associated greenhouse gas emissions by more than 27% (ie less than the growth in electricity use because the greenhouse-intensity of electricity supply is projected to fall).

Table 5 Annual electricity consumption, energy costs and greenhouse gas emissions for small electric water heaters, 2000 and 2010

	2000 Res	2000 Com	2000 Tot	2010 Res	2010 Com	2010 Tot	Change
	GWh electricity consumed (a)			GWh electricity consumed (a)			
Useful energy	2149	220	2369	3021	381	3402	43.6%
Standing heat loss	1011	104	1115	1357	171	1528	37.1%
Total energy	3160	324	3484	4378	552	4930	41.5%
	$M electricity cost (a)			$M electricity cost (a)			
Useful energy	$ 256	$ 30	$ 285	$ 360	$ 51	$ 411	44.0%
Standing heat loss	$ 120	$ 14	$ 134	$ 162	$ 23	$ 185	37.5%
Total energy	$ 376	$ 44	$ 420	$ 521	$ 75	$ 596	41.9%
	kt CO_2-e emissions (a)			kt CO_2-e emissions (a)			
Useful energy	2224	228	2451	2906	366	3272	33.5%
Standing heat loss	1046	107	1154	1306	165	1470	27.4%
Total energy	3270	335	3605	4211	531	4743	31.6%

Author estimates for total stock, based on ES (1999). Cost/benefit analyses cover only stock installed after 2000

1.3 Water Heater Technology and Energy Efficiency

Water heater technology

Unlike the range of cycles and options provided by some other appliances, the energy service provided by water heaters is very simple: the supply of hot water at the water heater outlet, whence it can be distributed by a system of pipes to a number of draw-off points. (In older installations the heater outlet was often the only draw-off point - the typical "sink" or "bath" heater - but this is now uncommon).

There is a wide range of fuel types and technologies on the Australian market which can provide this basic service, and their present market shares are largely a result of historical water heater and energy prices, the promotional efforts of the various utilities, and the consolidation of manufacturing. The main types on the market are:

- **electric storage:** an insulated tank of water is kept at a preset temperature (typically 60-80°C) by one or more electric resistance elements. These come on when the tank temperature drops below the thermostat set point, as occurs when hot water is drawn off and replaced by cold, or heat is lost by conduction through the tank walls and the pipe connections;

- **electric instantaneous:** an electric resistance element heats cold water as required; there is no store of hot water kept ready for use;

- **electric heat pump:** performs a task comparable with that of the conventional electric storage type, except that the water is heated by a heat pump which concentrates ambient energy, on the same principle as a reverse cycle air conditioner. Electricity is required to power the pump which circulates the heat exchange fluid, but not for resistance heating;

- **gas storage:** this operates on the same principle as the conventional electric storage, except that the water is heated by a gas burner;

- **gas instantaneous:** a gas burner heats the incoming cold water as required;

- **solar:** water is passed through rooftop collectors where it is heated by solar energy, and stored in an insulated tank ready for use. In most parts of Australia, the tank would need to be impractically large and/or highly insulated to provide for all hot water use at the times of the night or the year when solar input is insufficient. Therefore most units have an electric resistance element to provide "boost" energy at those times. Gas boosted systems are also available.

Each type of water heater has its particular energy efficiency, cost and technological characteristics. For example, the energy input rates of storage heaters can be smaller, since the stored hot water provides a time buffer. Storage water heaters are divided into a number of important subgroups, differentiated by the pressure at which the water is stored, and the energy type. Further details re given in Appendix 3.

Energy efficiency levels

The efficiency of energy transfer from the electric resistance heating element immersed in a storage water heater is close to 100%. Therefore the effective energy efficiency of a given model is determined almost entirely by the rate at which it loses heat. The established method for determining this rate is the standing heat loss test in Australian Standard AS1056.1 *Storage Water Heaters: General Requirements.*

AS 1056 also publishes the maximum rates of heat which water heaters should achieve (Table 6). These heat loss rates vary with the size of the water heater, as measured by its “hot water delivery” – the volume of water that can be drawn off before the water temperature falls below a specified level. In practice, the delivery volume is 5 to 6 litres less than the actual storage volume.

AS 1056 specifies maximum heat loss levels for three types of storage water heaters: “unvented” (ie mains pressure), “vented without attached feed tank” and “with attached feed tank.” The two latter groups of values apply to low pressure units only, since mains pressure units have neither vents nor feed tanks.

As with any other aspect of Australian Standards, the heat loss levels in AS1056 are advisory only, unless backed by regulation or unless the supplier wishes to voluntarily use the Standards Australia compliance mark. Since 1 October 1999, it has been mandatory for unvented water heaters sold in Australia to comply with the maximum heat loss requirements in Column 2 (see following section).

Table 6 Electric Water Heaters – Maximum Heat Loss

1	2	3	4
Hot water delivery	**Maximum heat loss, Kwh/24 hr (a)**		
	Water heaters without attached feed tank		**Water heaters with attached feed tank**
L	**Unvented (b)**	**Vented**	
25 (c)	1.4	1.4	—
31.5	1.5	1.5	—
40	1.6	1.6	—
50	1.7	1.7	—
63	1.9	1.9	—
80	1.47	2.1	—
100	1.61	2.3	2.6
125	1.75	2.5	2.8
160	1.96	2.8	3.1
200	2.17	3.1	3.4
250	2.38	3.4	3.7
315	2.66	3.8	4.1
400	2.87	4.1	4.4
500	3.15	4.5	4.8
630	3.43	4.9	5.2

Source: AS1056.1-1991 Storage Water Heaters Part 1: General requirements, Amendment No 3. Published 5 August 1996. (a) These values apply to water heaters with a single heating unit and may be increased by 0.2 kWh/24 h for each additional heating unit. (b) the values in Column 3 may be used instead of the values in Column 2 for unvented water heaters without an attached feed tank that are manufactured in Australia before 1 October 1999 or imported before 1 October 1999. The values for unvented water heaters without an attached feed tank may be increased by 0.2 kWh/24 h for each temperature/pressure relief valve mounted on a hot-water fitting, but not for any valve mounted on a cold-water fitting. (c) Existing 18 litre delivery models are outside scope of current standard.

Previous and Current MEPS

In the early 1990s the Australian and New Zealand Minerals and Energy Council (ANZMEC) commissioned a study on the benefits and costs of implementing minimum energy performance standards (MEPS) for household electrical appliances in Australia. At the time, the maximum heat loss levels for unvented storage water heaters were equivalent to those specified in Column 3 of Table 6.

The findings and recommendations concerning electric storage water heaters, which are reproduced at Appendix 3 of this RIS, included the following:

> "It is recommended that the following minimum energy performance standards be adopted for electric storage water heaters:
>
> - the standing heat loss as measured in accordance with AS1056.1 shall be no greater than 55% of the corresponding standing heat loss, for models of 80 litres delivery or more (as defined in AS1056.1); and
> - the standing heat loss as measured in accordance with AS1056.1 shall be no greater than 70% of the corresponding standing heat loss, for models of less than 80 litres delivery (as defined in AS1056.1);
> - the ratios of new to existing heat loss limits should be based on the total heat loss of a single-element water heater with a hot-side temperature and pressure relief valve; the new limits should be global limits, without additional allowance for extra elements or valves. This will give additional incentive for innovative design." (GWA et al 1993)

Discussions between the water heater industry and ANZMEC led to the following agreement:

- The MEPS level for models of 80 litres delivery or more would be 70% of the then maximum heat loss in AS1056.1, rather than the 55% recommended;
- The MEPS level for models of less than 80 litres delivery would be 100% of the then maximum heat loss in AS1056.1, rather than the 70% recommended – this still represented a more stringent requirement, since prior to the agreement most small water heater models had a higher heat loss than the maximum in AS1056.1;
- The MEPS levels would take effect for products manufactured or imported after 1 October 1999; and
- The MEPS levels would not be increased before 1 October 2004 at the earliest.

The revised MEPS levels were given effect by amending AS1056.1 in August 1996 so that the maximum heat losses for 80 litres and over became 70% of the previous values, to take effect October 1999 (see Table 6). The regulations under State and Territory energy labelling legislation were amended to make compliance with AS1056.1 mandatory, with effect from the same date (see example, Appendix 1). These maximum heat loss values are known as the "1999 MEPS levels".

Scope for Further Efficiency Increases

There is still considerable technical scope for reducing heat losses below the 1999 MEPS levels. A study commissioned by the AGO (EP et al 2000) considered improvement options for smaller water heaters within the following constraints:

- allowing for a reduction in the insulation value of blown polyurethane foam insulation, as would occur once the manufacturers phase out low-ozone-depleting hydrofluorocarbon (HCFC) foam blowing agents in favour of zero-ozone-depleting foaming agents such as cyclopentane or hydrofluorocarbons (HFCs)[5];
- maintaining the external rectilinear dimensions of the water heater (ie allowing a prismatic casing rather than a cylindrical one, but within the same height and width).

The measures examined (by computer simulation), and the impact of each measure on reducing standing heat loss, are summarised in Table 7. The study found that even within the dimensional constraint, and allowing for a more conductive foam, it would be possible to reduce the standing heat loss of a 50 litre delivery water heater to about 1.2 kWh per 24 hrs, or 30% below the 1999 MEPS level. If the option of changing the outer casing plan from round to square were excluded, it would still be possible to achieve a reduction in heat loss of 21%.

Table 7 Combined heat loss savings from potential design changes to small electric water heater, within the dimensional constraint.

Possible Modification	**Loss, Wh/24h**	**Additional Saving, Wh/24h**	**% reduction**
Starting point (a)	**1,985**	NA	NA
Insulate anode access cover	18 (c)	10	0.5%
Insulate element access cover	20 (c)	66	3.3%
Insulate T&P valve (or make from stainless steel) (b)	132 (c)	42	2.2%
PVC inlet and outlet connections (b)	75 (c)	48	2.5%
Relocate polyester compression wad	153 (c)	80	4.1%
Change outer casing to square in plan	968 (c)	357	17.4%
Reshape tank bottom like tank top	483 (c)	180	9.4%
All measures combined	**1,202**	**783**	**39.4%**

Source: EP et al (2000). (a) Based on a 1999 MEPS-compliant 50 litre delivery model with 25mm of foam in the walls, but with a less insulating blowing agent. (b) Reduction when tested to AS1056, ie with fittings disconnected. Actual savings greater when water heater is connected to conductive pipes. (c) Heat loss from this element before modification.

It follows from the EP *et al* analysis that for the particular water heater model studied

- heat losses of significantly greater than 20% could be achieved without changing cabinet shape, the foam thickness or the foam conductivity,
- if less insulating foams are adopted the heat loss reduction should still be above 20%;

---

[5] The use of the highly ozone-depleting CFC-11 was phased out in the mid 1990s.

- relaxation of the constraint on cabinet shape and foam thickness would allow the achievement of heat loss reductions of significantly greater then 50%, even with less insulating foams.

However, the results of the study should be treated with caution. Some of the measures proposed may have safety implications, and some measures that could be applied to this particular model are already incorporated into other water heater models, so the further scope for heat loss reduction in those models is less.

Laboratory and in-use heat loss

The Energy Test

The standing heat loss test in AS1056 is carried out with the water in the storage tank maintained at a constant temperature of 75°C over a 24 hr period in a test room maintained at 20°C (with tolerances for both set out in the Standard). The inlet and outlet pipes are disconnected, and the sockets are plugged with 12.5 mm of hair felt insulation or equivalent. The temperature and pressure relief valve (T&PRV) is fitted, but without a drain line.

As the energy test does not replicate actual conditions of installation and use, it is necessary to consider what effect these may have on actual energy performance.

In-use energy performance

EP et al (2000) found that pipes running upwards from the water heater allow the water in the pipe to convect and increase the effective conductivity of the copper pipe. Each upward 12.5 mm pipe connection added 20.6% relative to the heat losses of the disconnected tank. Pipes running horizontally or downward from the container (or incorporating a convection trap, ie running downward first before changing direction) add 14.8%. These values increase if the water heater is installed in an exposed location. Thus, the worst case for an internally installed unit is for two upward pipe connections and one downward (dry) drain from the T&PRV, for a total additional loss of around 55%. This situation is representative of the common past practice of installing under a suspended timber floor. Insulating those pipes (or substituting a PVC pipe in the case of the drain) reduces these additional heat losses by about half.

Standing heat loss tests are generally carried out with new water heaters, in which the insulation foam is at its optimum performance. Over time the blowing agent tends to migrate out from the foam, to be replaced with air which has a lower insulating value. The rate of degradation depends on many factors including the foam cell structure and the airtightness of the metal casing around the foam. Consequently any apparent performance difference between foams when tested new tends to decrease over time.

As no hot water is drawn off during the standing heat loss test, it is possible to maintain a steady water temperature of 75°C and a constant differential of 55°C between the water and the air in the test room. In actual use however, hot water is drawn off constantly and is replaced by cold water. As reheat is not instantaneous, the average temperature of the stored water is lower than the thermostat setting, so the average standing heat loss would be lower than under test conditions, even if the ambient temperature remained at 20°C. The difference is greatest with water heaters connected to off-peak tariffs, since reheat is often delayed for several hours after draw-off and the tank may become stratified, with a large temperature difference from top to bottom. With water heaters connected to the continuous tariff (which includes all smaller water heaters) reheat commences immediately draw-off begins and there is less stratification, so average storage temperature is closer to the thermostat setting.

In actual installations, the ambient temperature around the water heater is not likely to be a constant 20°C, or even an average of 20°C. Mains pressure water heaters are often installed outside or in ventilated sub-floor spaces, where the combined effects of low temperature and high air movement could increase heat loss. Conversely, they may be installed in cupboards, where temperatures could well rise above 20°C and so reduce heat loss. Table 8 illustrates these effects. For an enclosure where average temperature is 30°C, standing heat loss would be 18% lower than in the standard test, but with pipes connected it would be 33% higher.

Table 8 Effect of enclosure and exposure on heat loss

Enclosure temp	% of (disconnected) standing heat loss	% of (disconnected) standing heat loss (when connected)
15°C	109%	NA
20°C	100%	NA
25°C	91%	NA
30°C	82%	133%
35°C	73%	NA
Outdoor – Brisbane (a)	110%	NA
Outdoor – Melbourne (a)	120%	NA

Source: EP et al (2000) (a) mean wind speed of 2 m/s.

In summary, some aspects of actual water heater installation and use will increase heat losses when compared with the AS1056 test, while others will reduce it. Installation in an enclosure, and reduced average water storage temperature due to drawoffs, will lead to *lower* in-use losses. On the other hand, the connection of pipes, installation in an exposed location, and – over time – degradation of insulation performance – will lead to *higher* in-use losses. In the absence of detailed information on the circumstances of water heater installation and on hot water use, the AS1056 heat loss will be used as a reasonable proxy for heat loss in the field.

There are many other measures that could be taken to reduce water heating energy demand. These include:

- locating the water heater closer to the main draw-off points to reduce pipe losses;
- locating the water heater indoors or in a sheltered location to reduce heat loss;
- better installation practices – heat traps on connections to the water heater and insulation of pipes;
- reducing the demand for hot water through installation of low-flow shower heads and faucets, and more water-efficient clothes washers and dishwashers;
- reducing the demand for hot water by washing clothes in cold water;
- wrapping existing water heaters with flexible insulation to reduce heat loss.

These measures are being promoted by a number of State and Commonwealth agencies, with the aim of minimising energy use, water use and greenhouse gas emissions. They are independent of the proposals considered this RIS, in that the energy savings from reducing the standing heat loss of new small electric water heaters would be additional to the savings from these programs.

1.4 The water heater market

Product Supply

Manufacturers

The electric storage water heater (SWH) market is now dominated by mains pressure (MP) systems, which account for well over 95% of sales nationally. There is still a large installed stock of low pressure (LP) units, because of their longevity, but comparatively few new ones are sold. The only significant remaining LP markets are parts of Victoria, SA and WA, where the water supply is low pressure and/or poor water quality shortens the service life of main pressure units.

Southcorp Australia Pty Ltd, which manufactures Rheem and Vulcan brand SWHs in Sydney, has the largest share of the MP market. The next largest supplier is GWA International, which manufactures Dux brand SWHs in Moss Vale. Both companies make a full range of electric SWHs, from small to large, with a large number of element sizes and configurations. All small water heaters are designed for connection to single phase electricity supply, and for use on continuous tariff. Edwards Energy Systems in Perth offers a range of stainless steel electric water heaters, including one small model. The main characteristics of the current small models, and the estimated weighted averages for sales in 2000, are summarised in Table 9. Other SWH suppliers such as Beasley offer a limited number of MP models in the larger sizes

Table 9 Characteristics of small electric water heaters on the market, 2001

Brand	Model	Delivery litres	Storage litres	Height mm	Diameter mm	Heat loss kWh/24hr(a)	Retail $
Rheem	111025	18	25	400	385	1.0(a)	375
Rheem	111050	50	56	670	415	1.7(a)	390
Vulcan	50L	50	56	668	385	1.7(a)	380
Edwards	DES50	50	56	702	470	1.2(b)	680
Dux	25 VI	25	30	420	405	1.4(a)	360
Dux	50 VI	50	55	675	405	1.7(a)	370
Weighted(c)		37	43	558	397	1.4	377

Source: Manufacturer catalogues and sales departments; (a) Assuming heat loss just meets AS1056.1 (b) Author estimate based on wall thickness derived from dimensional analysis. (c) Weighted averages from author's estimate of market share by company and product size, 2000.

For purposes of cost-benefit analysis, the average service life of small water heaters is estimated at 9 years, allowing for both technical failures and early retirement of serviceable units due to building renovations. (The cost-benefit analysis in Chapter 4 includes a test of sensitivity to service life assumptions).

Rheem, Vulcan and Dux offer two quality grades in their larger water heaters - 5 and 10 years' warranty respectively - but only one quality grade, with 5 years' warranty, for the smaller models. Edwards uses a stainless steel tank (reflected by the higher price) and offers a 10 year warranty for all models.

Market Size

In 1999 there were about 7.14 million water heaters installed in Australian dwellings (an average of 1.01 per dwelling) and an unknown number of domestic-style units in commercial and institutional use. Figure 1 illustrates the share of household water heaters by type in 1994 and in 1999. It indicates that:

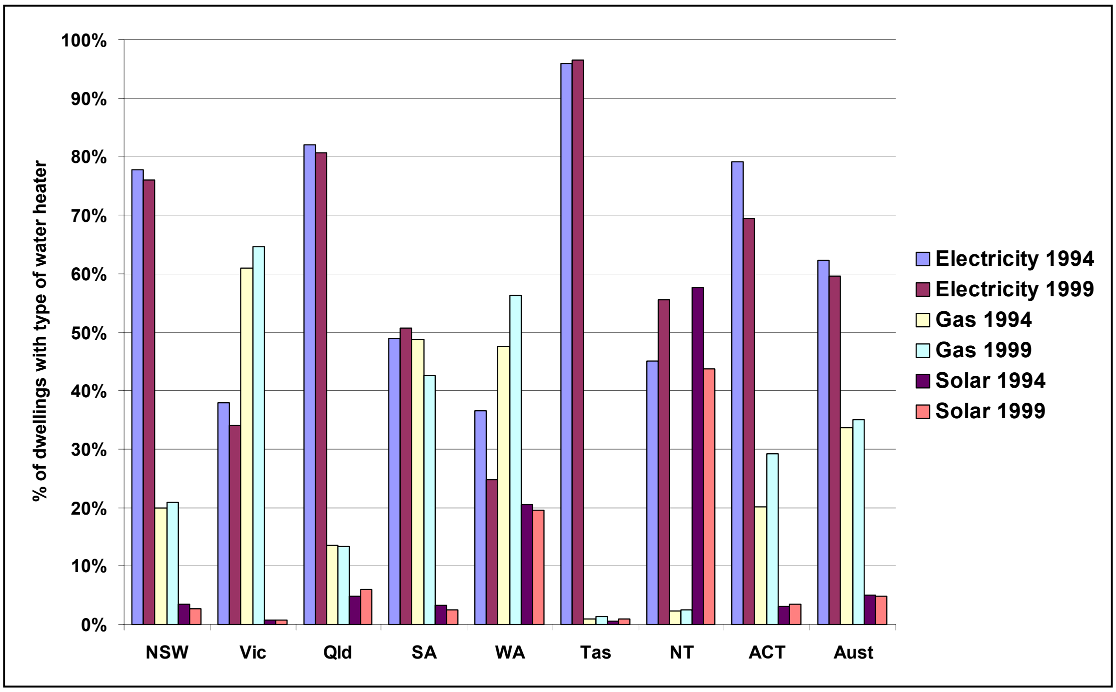
- On a national basis, the electric share of total water heaters installed declined from 62.4% to 59.6% between 1994 and 1999, the gas share increased from 33.6% to 35.0% and the solar share remained virtually unchanged at 4.9%;

- The shift from electric to gas was most marked in the ACT, WA and Victoria;

- The electric water heater share increased in the NT (where electricity took market share from solar), SA (where electricity took market share from gas) and Tasmania (where there is no natural gas supply).

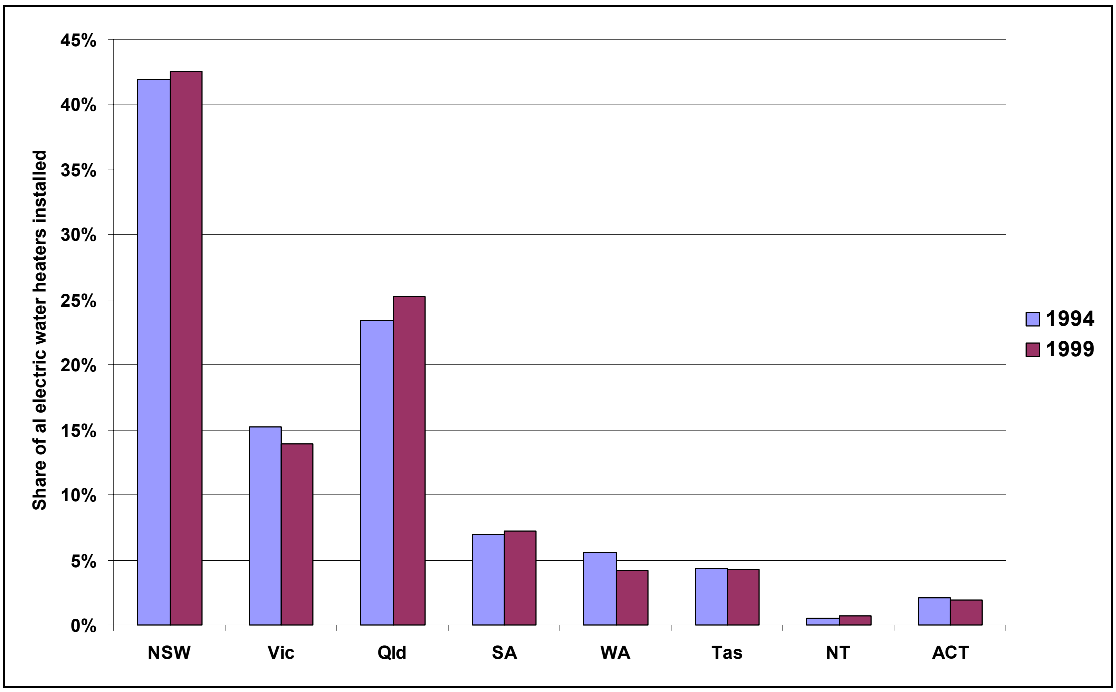
Figure 2 illustrates the distribution of electric water heaters by jurisdiction. NSW and Queensland between them have over 70% of the household electric water heater stock

Figure 1 Share of household water heaters by energy type, 1994 and 1999



Source: Environmental Issues, March 1999, ABS Catalogue 4602.0

Figure 2 Share of household electric water heater stock by jurisdiction, 1994 and 1999



Source: Environmental Issues, March 1999, ABS Catalogue 4602.0

Figure 3 Historical and projected annual sales of electric and gas water heaters

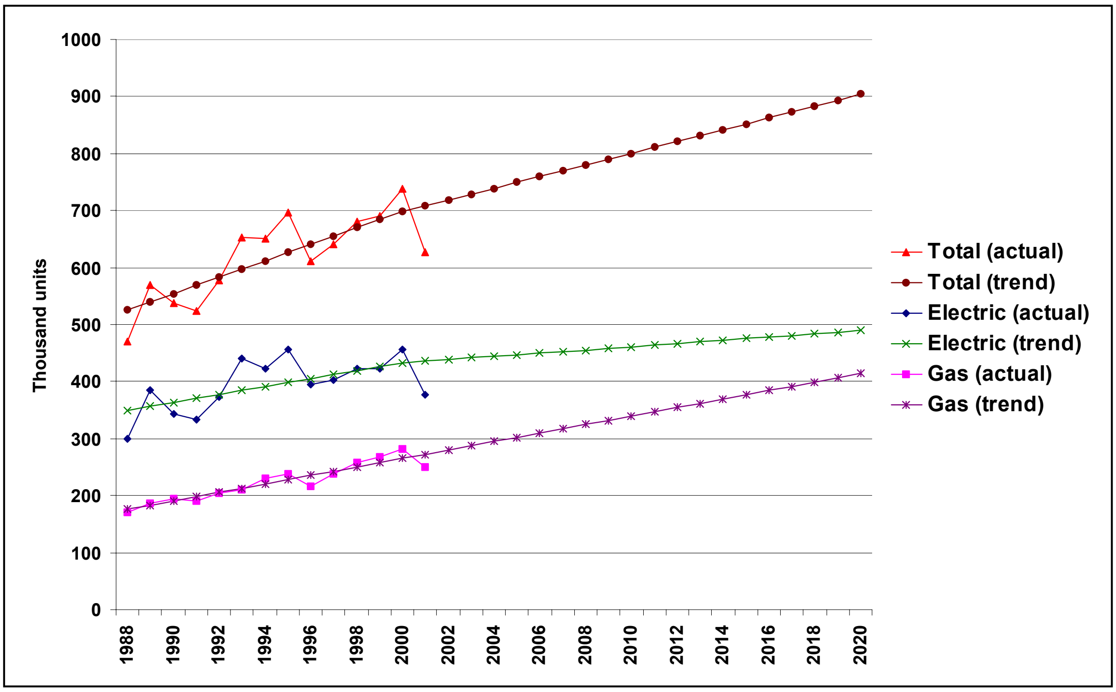


Figure 4 Projected annual sales of small electric water heaters by jurisdiction

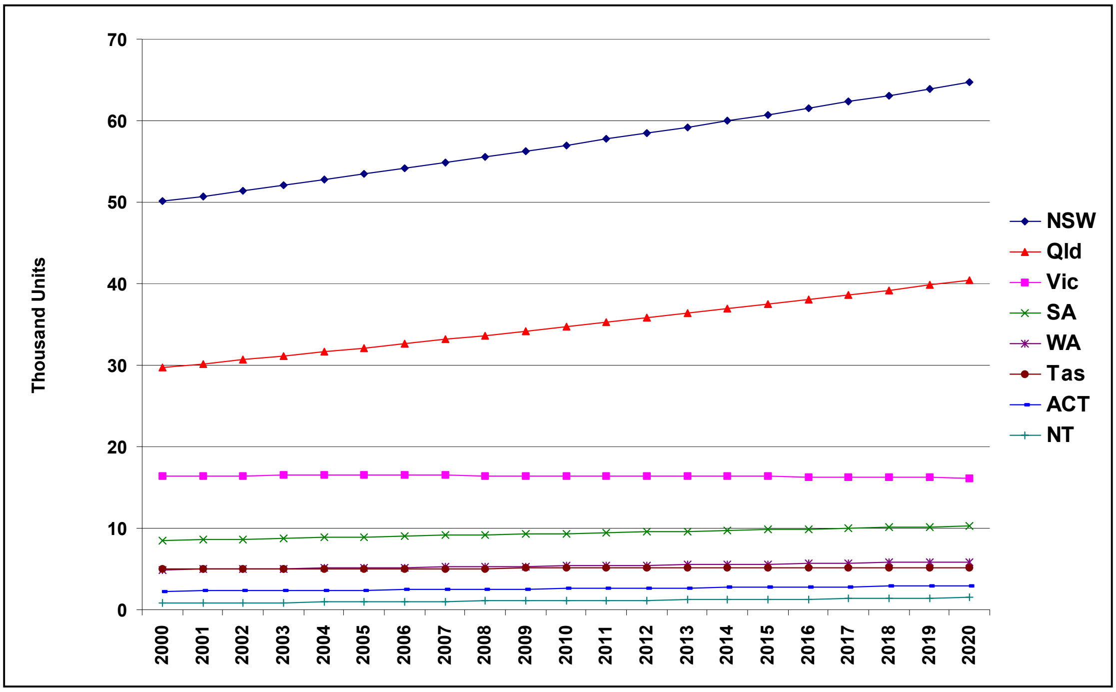


Figure 3 illustrates the historical trend in gas and electric water heater sales between 1998 and 2000, and a trend projection based on the regression line, which smooths out the year to year fluctuations caused by the variability of the housing market.
It is estimated that in 2000 the trend sales of gas and electric water heaters totalled about 700,000 units (62% electric, 38% gas). This covers units intended for non-household as well as household use. Total sales are projected to reach about 900,000 units per annum by 2020 (54% electric, 46% gas). It is estimated that small water heaters accounted for about 26% of electric water heaters sales in 2000, and that this will increase to 30% by 2020. Projected sales of small water heaters by jurisdiction are illustrated in Figure 4.

Product selection

Life Cycle Costs

Small electric water heaters are the most expensive way to heat water. Although they are cheapest to purchase, they incur the highest running costs, both for useful energy and to cover heat losses. Table 10 summarises the life cycle costs of obtaining the same amount of daily hot water for 9 years from a small continuous tariff electric SWH and by four alternatives: a gas instantaneous water heater (a more likely direct competitor than gas storage for small electric water heaters), electric off-peak 1 (restricted hours), electric off-peak 2 (extended hours) and solar with off-peak 2 boost. The table indicates that, for the continuous electric water heater:

- the life cycle costs are the highest (apart from unsubsidised solar)
- energy costs represent about 82% of the life cycle cost

- the net present value of energy losses alone exceeds the capital cost of the water heater
- The least costly option (off-peak 1) costs about one-third less.

The costs and cost components are illustrated in Figure 5.

Table 10 Typical life cycle costs for alternative means of water heating

Water heater type and tariff	Purchase	Install-ation	Energy cost (a)	Total life cycle cost	Energy/ total cost	Heat loss cost (d)
Continuous (50 litre) – new/same location	$ 375	$ 150	$2,440	$ 2,965	82%	$ 425
Continuous – relocation (b)	$ 375	$ 500	$2,440	$ 3,315	74%	$ 425
Gas instantaneous – existing gas connection	$ 870	$ 300	$1,040	$ 2,210	47%	
Gas instantaneous - new gas connection	$ 870	$ 600	$1,040	$ 2,510	41%	
Off-peak 1 (250 litre)	$ 780	$ 250	$963	$ 1,993	48%	$ 203
Off-peak 2 (160 litre)	$ 670	$ 250	$1,562	$ 2,482	63%	$ 294
Solar/Off-peak 2 (subsidised) (c)	$ 1,500	$ 500	$642	$ 2,642	24%	
Solar/Off-peak 2 (no subsidy)	$ 2,000	$ 500	$642	$ 3,142	20%	

(a) Net present value of energy costs over 9 years, at 10% discount rate, for supplying 150 litres of hot water per day. (b) Where replacement cannot be installed in same location, and either the enclosure has to be altered or the unit relocated. (c) $500 minimum government subsidy available in NSW, Queensland and Victoria; higher subsidy available in some cases. (d) NPV of 9 years of standing heat losses from water heater (excluding fittings and pipework).

User concern with energy efficiency

Small electric SWH tend to be purchased in preference to other types when minimising capital cost is the main concern in the initial purchase decision, when access to space outside the dwelling is difficult and when the purchase price and the running costs are borne by different parties (ie there are “split incentives”).

The most common applications for small electric SWH are:

- New townhouses and apartments, where the developer wishes to minimise costs;
- Rental accommodation, where the landlord wishes to minimise costs;
- Apartments where space is limited;
- Remote bathrooms in larger houses, where pipe runs from the main water heater are excessive;
- Those commercial and institutional kitchens and bathrooms where hot water requirements are modest and space is limited.

There is a strong inverse correlation between dwelling size and tendency to rent. Table 11 indicates that in 1999 over 69% of flats were rented, compared with 18% of separate houses. There is also a correlation between household income and tendency to rent. The ABS reports that in 1999, the median weekly income of owning households was $ 823, compared with $ 612 for renting households *(Australian Housing Survey 1999*, ABS Catalogue 4182.0). Adjusted for differences in average size of owning and renting households, this was equivalent to $ 304 and $ 255 per capita respectively.

Figure 5 Typical life cycle costs for alternative means of water heating

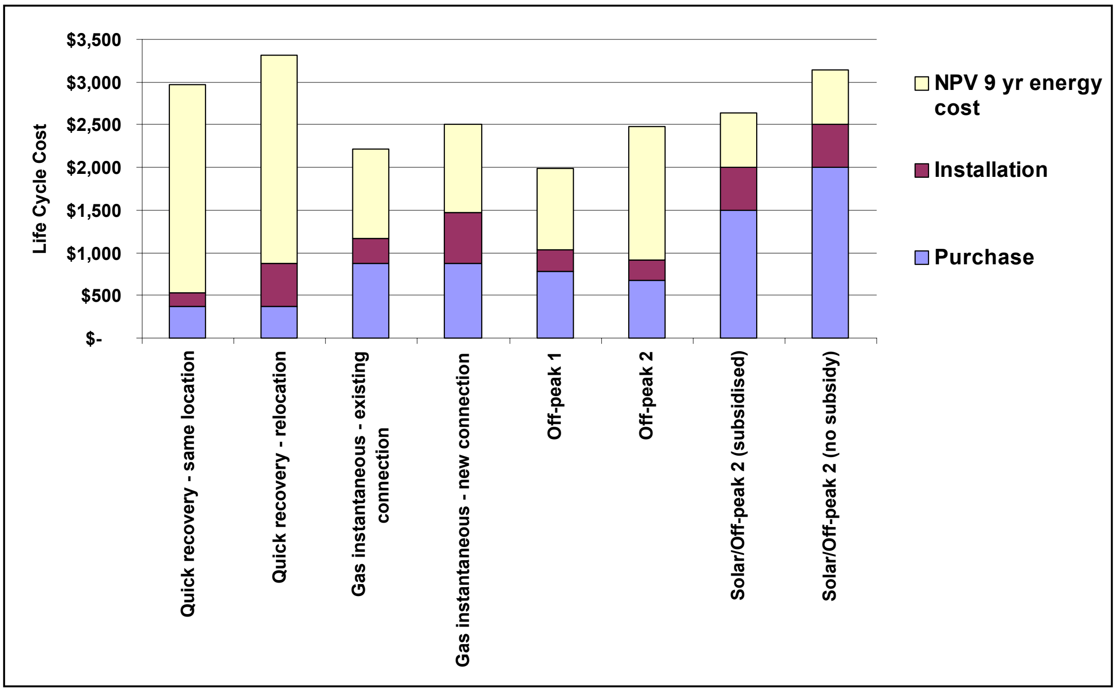


Table 11 Dwelling type by tenure

Dwelling type	Owned(a)	Rented(b)	Other(c)	Total	% rented
Separate house	4535.8	1049.3	150.2	5735.3	18.3%
Semi-detached	275.6	347.4	18.5	641.5	54.2%
Flat	221.7	553.9	22.9	798.5	69.4%
Other	NA	NA	NA	41.6	NA
All types	5033.1	1950.6	191.6	7216.9	27.2%

Source: Australian Housing Survey 1999, ABS Catalogue 4182.0 All values thousands (a) Includes owner with mortgage. (b) Includes both private landlord and housing authority. (c) Includes rent-free tenure.

While these data are not conclusive, they suggest that small electric water heaters are likely to be installed in rental accommodation, where decisions about the choice of water heater are not made by the resident who pays the energy bills, and where the resident is likely to have a lower income. In other words, the mode of water heating with the highest energy and life cycle costs tend to be imposed on the lowest income groups.

Of course, many householders do purchase their own water heaters, if not at the time of first moving in (when the water heater is the one chosen by the builder, the landlord or the previous occupant), then at the time when the water heater fails and needs replacement. The selection of the replacement is often made under severe time pressure (nobody wants to go without hot water for any longer than necessary) and without visiting a showroom to inspect alternatives. For these reasons the most common replacement is another water heater of the same type, and in the same location (GWA et al 1993).

Where running costs do enter the decision process, it is usually in the form of technology type (eg gas vs conventional electric vs solar vs heat pump) and tariff selection (eg off-peak vs continuous tariff electricity). Only then does the comparative energy efficiency of alternative models of the same energy type become a factor. For gas water heaters, there are two distinct technology types (storage and instantaneous) and many efficiency levels within each type, so choice is both worthwhile and possible because of gas appliance labelling, which was introduced by the gas industry in the early 1980s. Electric SWHs on the other hand, are nearly all built to the maximum heat loss levels in AS1056.1, and labelling would reveal no significant efficiency difference between models.[6] This was one of the main reasons for ANZMEC's 1996 decision to proceed with MEPS for electric water heaters.

Historically, MEPS has been the main driver of improvement in the energy efficiency of electric water heaters. In the mid 1980s more stringent MEPS levels were enforced by the energy utilities, mainly out of concern with off-peak water heater service quality (which affected competition with gas) and energy retention (which affected the economics of electricity supply). The further increase in MEPS levels in 1999 was prompted by ANZMEC. These changes are illustrated in Table 12.

Given the weakness of buyer interest in greater energy efficiency, it is likely that any further increases in water heater energy efficiency will depend on further changes in MEPS levels.

Table 12 Reductions in water heater heat loss levels since 1986

Date	**AS1056.1 maximum standing heat loss, hWh/24 h**		
	50 l delivery	**160 l delivery**	**250 l delivery**
Pre-June 1986	2.3	3.4	3.7
From June 1986	1.7	2.7	3.4
From October 1999 (MEPS)	1.7(a)	1.96	2.38

(a) No change, but compliance mandatory for first time

The Dimensional Constraint Issue

Magnitude of the issue

In 1993, the major objection by water heater suppliers to increasing MEPS levels for small water heaters was the argument that increasing the external dimensions of new products would make it difficult to replace those existing water heaters installed in confined enclosures, when they reach the end of their service lives.

There are two approaches to reduce standing losses from electric storage water heaters:

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[6] The recently introduced Edwards 50 litre delivery model appears to be an exception. It has a wall insulation thickness of about 50 mm compared with 20-30mm for other small water heaters, suggesting a heat loss of 30-40% less than the AS1056 level. However, the price premium is about $300, which is more than twice the NPV of the heat loss reduction, even over a longer than average service life.

a) Increasing the insulation thickness; and
b) All those measures which do not affect insulation thickness.

The potential for (b) has been estimated at about 20% in at least one current model (see Table 7). The potential for (a) is limited by economic and practical considerations, not technical ones. The approach – or combination of the two approaches – which manufacturers will follow to achieve any given MEPS level is up to them. However, it is likely that if MEPS require a heat loss reduction of more than 20%, it will be achieved with some increase in insulation, and the more stringent the MEPS requirement, the greater the likely insulation increase.

If all water heater models increase in external volume, then when some existing units reach the end of their service life, it may be impossible to install their replacements in the same location. The options would then be:

1. Rebuilding the enclosure;
2. Locating the replacement small electric water heater in a different place; and/or
3. Adopting a different energy form (eg gas or off-peak electric).

Each of these options would impose additional capital costs beyond the "direct replacement" option, ie installing a new small electric storage water heater in the same location. However, option 3 may actually be cost-effective for the user if the subsequent reduction in running costs were large enough.

Information about the magnitude of the dimensional constraint issue has only recently become available. In 1999 the AGO commissioned Taylor Nelson Soffres (TNS) to research the proportion of installations where a larger water heater would not fit, the options available in such cases and the costs (TNS 1999). On the basis of 250 household visits by plumbers in mid 1999 (50 in each mainland State capital) the study concluded that

> "…if 80 mm (3 inches) of insulation were added around small water heaters (under 80 litres), approximately:
>
> - 31% of small water heaters would no longer fit in the current space
> - the cost is estimated at $350 per small electric hot water heater to alter and relocate it" (TNS 1999).

However, there were several methodological problems with the survey. The main problem was inconsistency in the interpretation of the dimensional constraint by different plumbers. It was discovered after the survey that some marked a location as constrained if *any* of the clearances around or above the water heater was less than 80mm, whereas others correctly interpreted the constraint as whether a water heater of 80mm greater diameter and 80mm greater height could be installed. This resulted in a significant overestimate of the number of constrained locations.

The nomination of a single size increment also limited the value of the survey. Most of the MEPS options considered in this RIS could be achieved with increments of less than 80mm. Table 13 indicates that a 30% reduction in heat loss (the MEPS level recommended in 1993) could be accommodated with a 50 mm increment, even assuming that only the technical approach used is thicker insulation – ie the other options in Table 7 are ignored. Only at 50% heat loss – the most stringent MEPS option considered in this RIS – is the increment likely to exceed 80mm.[7]

Table 13 Indicative size increases to accommodate thicker insulation

	Standing heat loss compared with AS1056.1-1991				
	100%	**80%**	**70%**	**60%**	**50%**
Thickness of wall insulation	25	44	50	58	70
Increase in wall thickness(a)	NA	19	25	33	45
Increase in cabinet diameter and height	NA	37	50	67	90

(a) Assuming that heat loss through insulated walls and ends accounts for about 70% of initial standing heat loss, and reduction in heat loss is achieved solely through increasing the insulation thickness.

Consequently, the AGO commissioned a follow-up survey, which was completed in August 2000 (TNS 2000). The owners of the Sydney, Melbourne and Brisbane installations that were originally found to be constrained were re-contacted. Of these, 12% had changed water heaters (suggesting that about 1 in 8 of the original water heaters had been removed in the year since the original survey, reasonably consistent with a mean service life of 9 years), 20% did not answer or refused, and 68% consented to a revisit.

In the end, only 3 installations were found to be unable to accommodate a water heater of 20mm extra diameter and height. Unlike the first survey, plumbers were asked to measure the available space in detail. Table 14 summarises the results.

Table 14 Average clearances around existing water heaters

Dimension	Mean mm
Clearance above the water heater	401
Clearance below the water heater (including false bottom)	259
Clearance on the right of water heater	149
Clearance on the left of water heater	294
Clearance at the back of water heater	55
Clearance at the front of water heater	254
Height of water heater	653
Diameter of water heater	356

Source: TNS (2000)

Figure 6 combines the findings of both surveys. It indicates that for every 2120 instances where a small electric water heater is initially installed, only 26 (2%) would eventually face a situation where, if the owner wished to replace with another small electric, there would be difficulties if the replacement was more than 20mm larger. The proportion with difficulties at other specified increments is not known. The proportion with difficulties at 80mm is somewhat less than the reported 18% (376/2120) – for reasons given earlier, this value was significantly over-estimated in the original survey.

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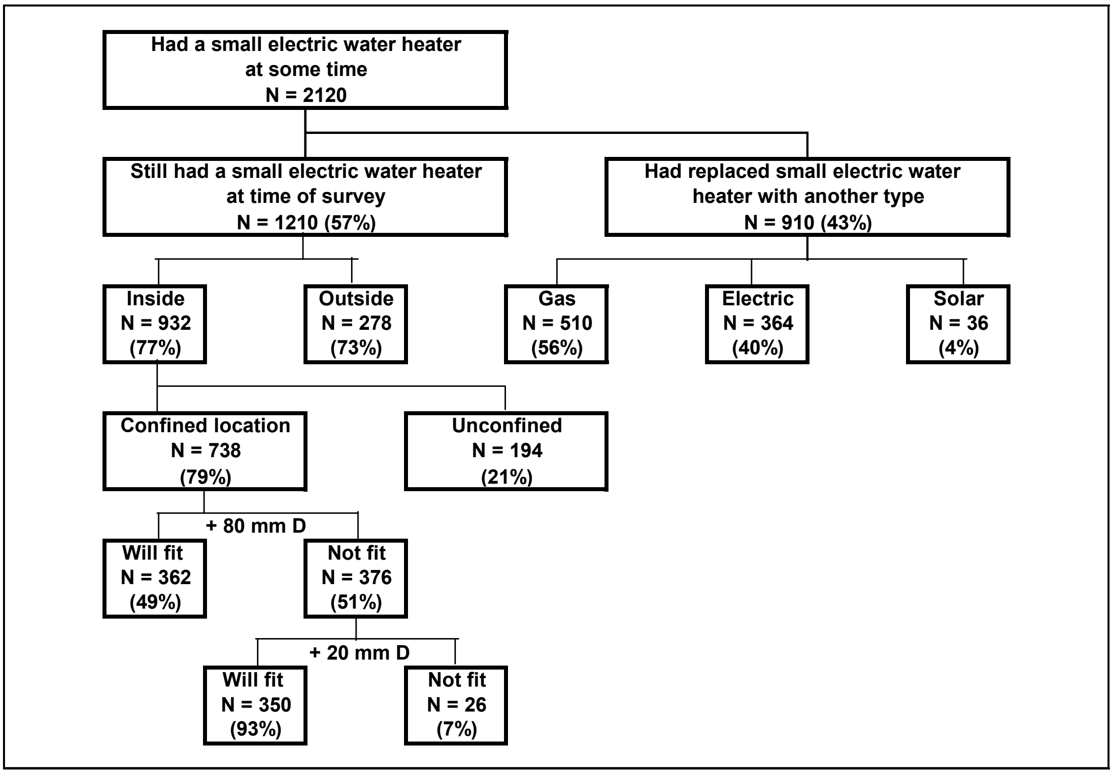
[7] These estimates are consistent with the actual increments in foam thickness that were necessary to meet the more MEPS levels for larger water heaters that took effect in 1999.

However, it is likely that nearly all the small water heaters measured pre-date the 1999 MEPS, when manufacturers increased insulation to ensure that models which had not previously met the AS1056 heat loss levels now did so. The average water heater diameter reported in Table 14 was 356mm. The smallest of the water heaters now available has a diameter of 385mm (see Table 9). Therefore in an unknown proportion of installations (perhaps 2-4%) there will be a problem accommodating even a current model, let alone a model meeting a higher MEPS level. This reduces rather than increases the enclosure alteration costs from further MEPS increases. If relocation or alteration is required in any case to accommodate current water heaters, then the marginal cost of accommodating a still larger water heater meeting a higher than current MEP level is likely to be small.

Figure 6 Small electric water heater replacements and dimensional constraints



Source: Author estimates based on TNS (1999, 2000)

If the existing enclosure cannot accommodate the smallest of the small electric water heaters available at the time of failure, then some owners would have the options of replacement with different type of water heater, in a different location. Because the life cycle costs of *all* alternatives are lower (see Table 10) a forced change would in fact make the owner better off.

Some owners will not be able to replace with a different type, because they do not have access to a natural gas supply, to a suitable location outside or on the wall of the dwelling, or – in the case of solar - access to a suitable roof. Many flats will be in this situation. In these cases the only options will be alteration to the enclosure or relocation within the dwelling. The costs of these actions are taken into account in the cost-benefit analysis.

A possible flexibility mechanism

The water heater industry advises that a high proportion of likely problem installations are located in older apartment buildings in inner Sydney and the Gold Coast. The industry has indicated that even if MEPS levels for small water heaters were increased, it would prefer to be able to continue to manufacture a limited number of the current 50 litre models to alleviate the difficulties faced by water heater replacement buyers in these areas. The number of problem installations will decline over time, as individual apartments are renovated and, ultimately, the buildings are demolished. The manufacturers would decide the point at which it were no longer economic to offer two 50 litre models (an "old" model at the 1999 MEPS heat loss level and a "new" model with lower heat loss) and would then drop the old model.

Without safeguards, however, such an arrangement could undermine the objective of MEPS. The manufacturing setup costs of the old model have already been incurred, and the material costs would be less than the more highly insulated new model, so the old model would in normal circumstances sell for less. Given that the small electric SWH market is driven by first cost, the great majority of buyers would then prefer the old model to the new, even though the life cycle cost of the new model would be lower. Therefore the national energy cost and greenhouse savings would be reduced, and the average life cycle costs to electric water heater buyers would be higher than if all units met the MEP level.

However, if suppliers were to price the old models at a sufficient premium to the new models, the market would prefer the new models in all cases except where the water heater location is within a constrained enclosure, the costs of enclosure change are much higher than the survey average (about $350) and alternative fuel/technology combinations are not available. Alternatively, if the number of old units produced each year were limited, scarcity would drive up their price.

Government has no direct means of control over the pricing or production of water heaters (see Chapter 3). Even if the numbers of "old" models needed each year could be determined – and this would require considerable additional survey work – there would be no means for governments to ensure that production volumes were limited to those numbers, or that the units produced were in fact directed to the problem installations. However, the water heater industry could be given the incentive to manage the issue itself, without compromising the overall objectives of MEPS, in the following way.

Suppliers could agree to mix the sales of old and new 50 litre units each year to achieve a "target" sales-weighted average heat loss (or lower), rather than a MEPS level that would apply to every unit produced. For example, if the target heat loss level for 50 litre units were 1.19 kWh/24 hrs (30% lower than the "old" MEPS level of 1.70 kWh/24 hrs) and suppliers wished to be able to make up 10% of their sales from old units, they could so provided that the heat loss of the other 90% sold were no higher than 1.134 kWh/24 hrs to compensate.

Suppliers would need to report sales of each model to government (directly or through a reliable intermediary) and to pay a fine in the event that the sales-weighted average heat loss exceeded the target level. For example, if a supplier sold 50,000 units in a year, and old models accounted for 16% (8,000 units) instead of the intended 10% (5,000 units) the sales-weighted heat loss would be 1.224 kWh/24 hrs instead of the target 1.190. The total additional heat loss from that cohort would be (50,000 x 0.034 x 365) = 620,500 kWh per year, or 620.5 MWh per year for the life of that cohort.

The appropriate penalty might be the value of the additional electricity cost imposed on the purchasers of those 50,000 water heaters over their expected 9 year service life. At an average tariff of 11.43 c/kWh (Table 18) this would be $638,300. It would be administratively simpler to pay the full amount in the year the water heaters are installed: at a 10% discount rate, the NPV would be $ 408,400. This amounts to $136 for each of the *extra* 3,000 "old" water heater units sold. The proceeds from the fine could be applied to energy efficiency programs targeting hot water use.

Suppliers would have an incentive to avoid fines of this magnitude by physically limiting their production of "old" units, or price them to recover the value of the fines, so making them less attractive to the market. They would also have an incentive to carefully consider the actual demand for "old" units in the first place, since the higher the projected market share the lower the heat loss limits must be for the "new" units. Once "old" models are removed from the market, the sales-weighted heat loss would automatically become the heat loss of the "new" models. As this would be lower than the target heat loss, the total energy and greenhouse reductions thereafter would be greater than if the target heat loss had been adopted as a universal MEPS level.

The advantage of this arrangement would be to give greater flexibility for suppliers to overcome the dimensional constraint issue, without involving government in production and pricing issues. At the same time there would be inbuilt incentives to limit the sales of "old" units. The key elements for its success would be

1. legally binding agreements between government and participating suppliers
2. a market monitoring system; and
3. fines high enough to give the appropriate signals and incentives.

There should be no obligation to participate. One supplier might take advantage of the flexibility arrangements to supply the perceived problem market, while another might simply adopt the target heat loss value as a universal MEPS level and so avoid exposure to the risk of fines, but give up a (declining) market niche to competitors. This may lead to a wider range of models appearing on the market, and increase – to a limited extent - the scope for price competition among the suppliers.

2. Objectives of the Regulation

COAG Guidelines:

- ***Objective:*** *the objective which the regulation is intended to fulfil must be stated in relation to the problem. The objectives of a regulation are the outcomes, goals, standards or targets which governments seek to attain to correct the problem.*

2.1 Objective

The primary objective of the proposed regulation is to bring about reductions in Australia's greenhouse gas emissions from the use of small electric storage water heaters, below what they are otherwise projected to be (ie the "business as usual" case) in a manner that is in the community's best interests.

2.2 Assessment Criteria

The primary assessment criterion is the extent to which an option meets the primary objective.

The following secondary assessment criteria have been adopted:

1. Does the option address market failures, so that the average lifetime costs of obtaining hot water from small electric storage water heaters are reduced, when both capital and energy costs are taken into account?

2. Does the option minimise negative impacts on product quality and function?

3. Does the option minimise negative impacts on manufacturers and suppliers?

4. Is the option consistent with other national policy objectives, including in this case reduction in the emissions of ozone depleting substances and the objectives of the National Appliance and Equipment Energy Efficiency Program to match "world best practice" standards?

3. Proposed Regulation and Alternatives

COAG Guidelines:

- ***Statement of the proposed regulation and alternatives:*** *this should describe the proposed regulation and distinct alternatives in sufficient detail to allow comparative assessment and evaluation in the rest of the RIS.*

The following options for achieving the objectives were considered.

1. Status quo (termed business as usual, or BAU): maintaining the MEPS levels introduced in October 1999;

2. The proposed regulation: an increase in the stringency of the existing MEPS levels, effective October 2004);

3. Voluntary MEPS;

4. Another regulatory option involving a levy imposed upon inefficient equipment to fund programs to redress the greenhouse impact of equipment energy use;

5. A levy on electricity reflecting the impact it has on greenhouse gas emissions abatement.

The following sections describe the options in more detail, and assess the non-MEPS options (4 and 5). The MEPS options (2 and 3) have been subject to detailed cost-benefit analysis, which is reported in the next chapter.

3.1 Status quo (BAU)

Improvements in energy efficiency are not likely to take place in the absence of any market intervention, for the reasons set out in the preceding chapter.

A "BAU" water heater energy use projection has been developed for each State and Territory, taking into account the projected sales of electric water heaters and the market share of different sizes.

The Status Quo option would, by definition, fail to meet the objective of the regulation. There would be no reduction in Australia's greenhouse gas emissions below the BAU case, and there would be no correction of identified market failures. On the other hand, there would be no negative impact on product quality or function, or negative impacts on manufacturers and suppliers.

3.2 Mandatory MEPS

The proposal is to increase the stringency of the existing MEPS levels for small electric water heaters (delivery less than 80 litres). This would be put into effect by revising the maximum standing heat loss values in Clause 2.4 of Australian Standard

AS 1056.1-1991 *Storage water heaters Part 1: General Requirements*. This is the same mechanism as was used to implement the 1999 water heater MEPS levels.[8] Existing State and Territory energy labelling and MEPS regulations enforce compliance with this clause (see example, Appendix 1).

The revised MEPS levels have yet to be determined. The selection of MEPS levels will be informed by the cost-benefit and other analyses in the present RIS.

The National Greenhouse Strategy states that "improvements in the energy efficiency of domestic appliances and commercial and industrial equipment will be promoted by extending and enhancing the effectiveness of existing energy labelling and minimum energy performance standards [MEPS] programs. This will be pursued by … developing minimum energy performance standards for a broader range of new appliances and equipment" (NGS 1998).

A high priority in the work program of the National Appliance and Equipment Energy Efficiency Committee is to "commence negotiation to increase MEPS levels for refrigerators, freezers and electric water heaters for implementation in 2004" (NAEEEC 1999).

When the water heater industry and ANZMEC agreed to the implementation of MEPS for these products in October 1999, it was understood that the levels would be reviewed regularly, but MEPS levels would not be changed before October 2004 at the earliest. It was also understood that there would be at least three years notice of the revised MEPS levels proposed for adoption.

3.3 Voluntary MEPS

Under a voluntary MEPS regime, water heater suppliers would be encouraged to meet more stringent MEPS voluntarily, ie in the absence of regulation. This would require them to incur the costs of changing at least part of their model range. Otherwise, "voluntary MEPS" is in effect "business as usual".

Suppliers would presumably only incur these costs if there were commercial incentive for them to do so. Whether such incentive exists or could be created is considered in Chapter 4.

3.4 Equipment levy

Another option involves "a levy imposed upon inefficient appliances to fund programs to redress the greenhouse impact of equipment energy use." Two variations of this option have been considered:

a) the proceeds from the levy are diverted to greenhouse-reduction strategies unrelated to water heater efficiency (ie the levy is "revenue-positive"); or

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[8] In 1996 Standards Australia issued the new heat loss levels as Amendment No 3 to AS1056.1-1991, with a footnote that the levels would take effect from 1 October 1999. The date of the main Standard was not changed.

b) the proceeds are used to subsidise the costs of more efficient water heaters – if and when these are introduced - so that any cost differentials between these and the standard efficiency water heaters are narrowed or eliminated (ie the levy is "revenue-neutral").

The flexibility mechanism proposed by the industry itself as a means of addressing the dimensional constraint issue within an overall MEPS framework may lead to a voluntary form of (b) above. However, the issue considered here is the scope for a mandatory levy as an alternative to MEPS.

Raising and disbursing the levy

A threshold question for both the "revenue-neutral" and "revenue-positive" options is whether the Commonwealth or State tax regimes could support the raising of the levy. The recent abolition of wholesale sales tax, which could be levied at different rates, in favour of a single-rate GST, removed the most likely vehicle for imposing a levy.

Once funds were raised, then under a "revenue-positive" option they would be applied to a greenhouse reduction activity determined by government – perhaps under competitive project bidding such as the AGO's current Greenhouse Gas Abatement Program (GGAP). The "revenue-neutral" option would be more complex, in that it would require

- the presence on the market of electric storage water heaters of different efficiency levels; and
- a mechanism for applying the funds raised to the desired objective of narrowing the cost differential between more efficient and less efficient water heaters.

Possible approaches include:

- payments to manufacturers (or importers) according to a formula based on sales and efficiency;
- rebates direct to the purchasers of energy-efficient water heaters.

Where a supplier offered water heaters across a range of efficiencies, it may be largely unaffected by the levy (ie its required contribution to revenues may be close to it nominal receipt of benefits). Alternatively, where a supplier is a net recipient it may use the revenues to support product prices in ways that conflict with the objectives of the levy. The only way to ensure that the funds are actually applied to the purchase price of the more efficient water heaters would be to offer rebates direct to purchasers. However, this would create the following difficulties:

- high fixed costs to establish a publicity, verification and payment infrastructure;
- administrative and transaction costs would probably be high in relation to the value of each payment to buyers;
- "free riders": a large number of buyers who would have bought the more efficient water heaters in any case will claim payments.

Conclusions

There are no readily apparent means for raising the proposed levy. While expert legal advise would need to be obtained, it is not likely that differential taxation rates can be implemented under existing Commonwealth or State taxation or licencing laws. A levy would only become feasible if general provisions were introduced to enable import duties and other tax rates to be linked to specific product characteristics, in this case energy efficiency.

The product registration, check testing and ongoing administrative costs to business and government would be no less than under mandatory MEPS.

In the “revenue-positive” case, where the funds raised by the levy were applied to greenhouse gas reduction programs outside the water heating sphere, there is no evidence that potential greenhouse gas reductions from other possible application of the funds would be more cost-effective, or even equally cost-effective, to water heater MEPS.

In the “revenue-neutral” case, where the funds raised were to be applied to reducing the cost differential between more- and less-efficient water heaters, it is first necessary that the more efficient models be introduced to the market, but it would still be difficult and/or administratively costly to ensure that payments to water heater suppliers and/or purchasers were targeted as intended.

If the framework could be established, a “revenue-neutral” levy would act as a form of MEPS in which regulations would enforce the payment of the levy rather than prescribe characteristics to be met for lawful sale. Suppliers would be free to sell water heaters less efficient than the reference level, but each sale would carry a financial cost. With a mandatory MEPS regime, suppliers who sell non-compliant products are subject to financial penalty under the regulations. The main difference is that the levy would provide an in-built mechanism for scaling the penalty to the extent by which MEPS is exceeded, whereas the existing regulations do not. However, if such a feature is considered desirable it may be more straightforward to incorporate it into the regulations than to establish a levy regime.

The proposed levy, even if legally feasible, appears to offer no cost savings, no greater greenhouse gas reductions (in fact, probably less greenhouse gas reductions) and probably higher lifetime appliance costs to purchasers, compared with mandatory MEPS. Some form of levy *in association with* MEPS may produce greater energy savings, but more information about the form and design of a levy proposal would be necessary in order to form a judgement.

3.5 Electricity levy

At present, the electricity prices faced by consumers reflect – however imperfectly - the cost of the capital invested in the electricity generation and distribution system, operating and maintenance costs, and taxes (now including GST). They may also reflect the costs of controlling pollutants such as oxides of nitrogen and sulphur (NOx and SOx), for which emissions standards are currently in force in some areas. They do not reflect the value of greenhouse gas emissions, or rather they implicitly assign a value of zero to such emissions. In other words, greenhouse costs are not internalised in the electricity price.

It may be possible to introduce a levy on the price of electricity to reflect the cost of greenhouse gas emissions from the production and combustion of the fuels used to generate it – in effect, a carbon tax. Alternatively, if a cap and trade emissions permit scheme were implemented, electricity generators and other major emitters would have to obtain sufficient permits to cover their emissions. Some of these may be obtained free (ie by "grandfathering") and some may have to be purchased, but if there is an open market then all permits will ultimately have the same monetary value. The permit value would thus be reflected in the price of electricity and all greenhouse-intensive goods and services. The effect of a permit trading scheme would be similar to a carbon tax in its pervasiveness, but the magnitude of the electricity price impact would vary with the market price of permits.

The decision to introduce an electricity levy or an emissions trading scheme is a matter for the highest levels of Commonwealth, State and Territory Government. In that respect the options are not direct alternatives to the proposed mandatory MEPS regime.

However, the matter raises the following issues for consideration:

1. If an electricity levy were introduced, would market failures be corrected to the extent that higher MEPS levels were no longer necessary?

2. Alternatively, if the price of electricity reflected a value for emissions higher than zero, what would be the impact on the cost-effectiveness of higher MEPS levels?

4. Costs, Benefits and Other Impacts

COAG Guidelines:

- ***Costs and benefits:*** *there should be an outline of the costs and benefits of the proposal(s) being considered. This should include direct and indirect economic and social costs and benefits. There should also be analysis of distinct alternatives (including ' do nothing') to the proposed regulation.*

The major economic benefit of more stringent MEPS is the value of the electricity saved. The major economic cost is the increase in the average price of water heaters, and the possible costs of accommodating larger water heaters. This chapter summarises the cost-benefit modelling carried out to estimate these benefits and costs.

A reduction in electricity consumption would also produce social benefits in the form of lower greenhouse gas emissions. These are estimated, but not given monetary value. The economic costs and benefits are likely to be passed on to the household and business users of electric storage water heaters, but there will also be impacts on the manufacturers, importers and exporters of water heaters. These are also covered.

4.1 Benefits and Costs of Mandatory MEPS

Options

Six MEPS options have been modelled (summarised in Table 15):

1. Equivalent to 20% reduction in maximum standing heat loss. This is considered the least improvement for which it is worthwhile to change product design;
2. Equivalent to 30% reduction in maximum standing heat loss;
3. Equivalent to 40% reduction in maximum standing heat loss;
4. Equivalent to 50% reduction in maximum standing heat loss (equivalent to the New Zealand advisory standard for water heaters);
5. As for option 1, but with a further step to option 3 heat loss level in October 2007;
6. As for option 1, but with a further step to option 4 heat loss level in October 2007.

The two step options may offer more flexibility for manufacturers to address the issues of changing foaming agents and dimensional constraints in some installations.

Table 15 MEPS options considered

MEPS option	Maximum standing heat loss kWh/24 hr		
	18 l delivery(a)	25 l delivery	50 l delivery
AS1056.1	1.00	1.40	1.70
1. 20% reduction	0.80	1.12	1.36
2. 30% reduction	0.70	0.98	1.19
3. 40% reduction	0.60	0.84	1.02
4. 50% reduction	0.50	0.70	0.85

(a) At present AS1056.1 does not cover units less than 25 litre delivery. It is assumed that scope will be extended to smaller units.

Modelling Approach

The business-as-usual (BAU) case is modelled as follows:

1. The number of small electric storage water heaters projected to be sold in each State in each year from 2000 to 2020 is projected (see Figure 4). Each year's sales is termed a "cohort";
2. The projected total heat loss from water heaters sold between 2000 and 2020 is calculated, using the numbers sold, the weighted average heat loss with the existing (1999) MEPS levels (see Table 9) and the cohort survival rate. It is assumed that each year's cohort of new water heaters has a 100% survival rate up to the year before the average service life (ie to year 7 for an average service life of 8 years), then two thirds survive in the eighth year, one third in the ninth year and none in the tenth year;
3. The value of the energy lost by the water heaters in each year is calculated, using the marginal household day-rate electricity tariffs in each State and Territory (see Table 18);
4. The capital costs of water heater sales in each year is calculated, using the average values in Table 9;
5. The net present value (NPV) at mid 2001 of the projected capital costs and energy costs is calculated, using a discount rate of 10%;
6. The greenhouse emissions from generating the electricity associated with the water heater heat losses is calculated, using the marginal greenhouse intensity coefficients in Appendix 3.

After the baseline is established, steps 2 to 6 are repeated for each of the 6 MEPS options. The energy consumption, energy costs, capital costs and greenhouse gas emissions under each of the 6 options is then compared with the BAU baseline, to calculate the NPV of the energy cost savings (the benefit), the NPV of the capital cost increments (the costs), the benefit/cost ratios and the greenhouse gas reductions.

It is only necessary to model the energy use of the *new* water heaters entering service after the new MEPS levels implemented, not the energy consumption of the whole stock. The energy consumption of models installed prior to changes in the MEPS regime will not be affected by those changes, and so can be excluded from the analysis. However, if an 8 year service life is assumed, the stock will be composed entirely of compliant models by the 10th year after new MEPS levels are introduced.

Similarly, it is only necessary to model heat losses, not the total energy used by electric water heaters, since hot water consumption will not be affected by MEPS. Any energy savings from changes in water heater installation practice or reductions in hot water use would be additional to and independent of the heat loss savings achieved through changes in the design of the water heaters themselves.

Costs of reducing heat loss

There are many technical options available to manufacturers for meeting any given reduction in standing heat loss (EP et al 2000). For simplicity, costs have been calculated as if only one technical approach is used - increasing the insulation thickness. This approach was used in GWA et al (1993). The costs are calculated as follows:

1. The insulation foam volume and steel cabinet surface area of each of the water heater models in Table 9 is calculated, from the manufacturer's specifications (using the difference between external cabinet volume and water storage – not delivery - volume as the proxy for insulation volume);

2. The insulation thickness is increased by the dimensions in Table 13, to match the more stringent heat loss levels under each of the MEPS options;

3. For each MEPS option, the following values are calculated:

   - the additional cost of foam, calculated from the increase in foam volume and the unit cost of foam (see costs in Table 16)
   - the additional cost of steel, calculated from the increase in steel surface area and unit cost of steel (see Table 16)
   - the additional cost of packaging, calculated from the increase in carton surface area and the unit cost of packaging (see Table 16)
   - the additional cost of fittings, calculated from the increase in the fitting lengths and an assumed standard cost per total length of fittings (Table 16);
   - the additional costs of warehousing and transport, calculated from the increase in carton volume and the estimated unit costs in Table 16.

For the most stringent MEPS level, about 71% of the cost increase is due to more insulation, 8% to more steel, 2% to packaging, 18% to longer fittings and less than 1% each to transport and storage. The sensitivity of the costs and benefits to higher material cost assumptions is examined later in this chapter. in the sensitivity tests

Table 16 Estimated material and other cost components

Element	Units	Unit cost
Insulation foam	$/litre	$ 0.75 (a)
Colourbond steel	$\$/m^2$	$ 10.00 (a)
Carton packaging	$\$/m^2$	$ 2.00 (b)
Fittings (length)	$ for 25mm	$ 5.00 (b)
Storage	$\$/m^3$	$ 4.00 (b)
Transport	$\$/m^3$	$ 6.00 (b)
Manufacturer markup		1.3 (b)
Retail markup		1.3 (b)

(a) From EP et al (2000). (b) Author estimates, based on GWA et al (1993)

4. The once-off capital costs of changing dies and machine settings are calculated as $500,000 per model affected, irrespective of the MEPS increment. As there are 6

separate models (Table 9), the total capital cost, incurred during 2004 for an October 2004 implementation date would be $3 M. It is assumed that this capital impost is recovered from the units sold in the 3 years after MEPS (equivalent to $7.94 per unit, plus retail markup) and then dropped. For MEPS Options 5 and 6, there would be a further capital cost of $3 M in 2007. Again, it is assumed that these costs are recovered from all water heaters sold in the following 3 years (equivalent to $7.68 per unit) and then dropped.

5. The additional material and capital costs incurred by manufacturers are marked up by a factor of 1.3 in the wholesale price, and by a further factor of 1.3 in the retail price (which includes GST, as do the energy tariffs used to estimate savings); ie a total markup factor of 1.7.

Table 17 summarises the costs for successive MEPS levels as well as the benefits in terms of expected electricity savings, at the national weighted average tariff of 11.43 c/kWh. During the 3 years while the capital cost of the changeover is recovered, the benefit/cost ratio from the perspective of the user ranges from 1.9 (for 20% reduction in heat loss) to 2.3 (for 40% reduction). After the capital cost is recovered, the benefit/cost ratios increase, to between 2.5 and 2.7. The relationship between heat loss reductions and increases in water heater price is illustrated in Figure 7.

Table 17 Estimated costs associated with reducing heat loss

	Current	**20% reduction**	**30% reduction**	**40% reduction**	**50% reduction**
Specified material and service costs (with wholesale and retail markup)	$ 62.0	$ 96.4	$ 108.8	$ 126.2	$ 152.0
Capital impost (for 3 yrs after changeover)	$ -	$ 10.3	$ 10.3	$ 10.3	$ 10.3
Total cost impact on retail price	$ 62.0	$ 106.7	$ 119.1	$ 136.5	$ 162.3
Average retail price	$ 375.5	$ 420.2	$ 432.6	$ 450.0	$ 475.8
Cost increase (including capital impost)		$ 44.7	$ 57.1	$ 74.5	$ 100.3
		11.9%	15.2%	19.8%	26.7%
NPV of savings over 9 years, 10% discount	NA	$ 85.0	$ 127.6	$ 170.1	$ 212.6
Benefit/cost ratio (with capital impost)		1.9	2.2	2.3	2.1
Cost increase (without capital impost)	NA	$ 34.3	$ 46.8	$ 64.1	$ 90.0
		9.1%	12.5%	17.1%	24.0%
Benefit/cost ratio (without capital impost)		2.5	2.7	2.7	2.4

Cost of overcoming dimensional constraints

The number of installations where enclosure alterations or relocations will be necessary above the number that would be necessary in any case to accommodate water heaters meeting the 1999 MEPS levels are estimated as follows:

- For the 20% heat loss reduction level (MEPS option 1): 1% of new water heaters in the first year (2005), (0.95 x 1)% in the second year, (0.95 x 0.95 x 1)% in the third year and so on. The proportion is expected to fall because as soon as MEPS are announced, builders, plumbers and renovating householders can make allowance for future changes when they design or install water heater enclosures;

- For the 30% heat loss reduction level (MEPS option 2): 2% of new water heaters in 2005, (0.95 x 2)% in the second year, (0.95 x 0.95 x 2)% in the third year and so on;
- For the 40% heat loss reduction level (MEPS option 3): 4% of new water heaters in 2005, (0.95 x 4)% in the second year, (0.95 x 0.95 x 4)% in the third year and so on;
- For the 50% heat loss reduction level (MEPS option 2): 8% of new water heaters in 2005, (0.95 x 8)% in the second year, (0.95 x 0.95 x 8)% in the third year and so on;
- For the stepped heat loss reduction (MEPS options 5 and 6): the same number of affected installations as in Option 1 for the period 2004-06, then the same number as in option 3 and 4 respectively for the period in 2007 and subsequently.

The projected number of units affected is illustrated in Figure 8. The estimated cost per enclosure change is $350 (TNS 1999). It is possible that the costs of overcoming dimensional constraints will deter some householders from replacing an existing new small electric water heater with a new one, and they will opt to change systems. In that case they will be better off financially, since benefits will exceed costs from an individual perspective (see Table 10), and the net economic benefit of the MEPS program as a whole would *increase*. The net greenhouse impact from water heaters changes would range from a large reduction - if the transfer was to gas, LPG, solar or heat pump - to a small increase, if the transfer was to off-peak, where heat losses are somewhat higher. These effects are expected to be marginal, and have not been explicitly modelled.

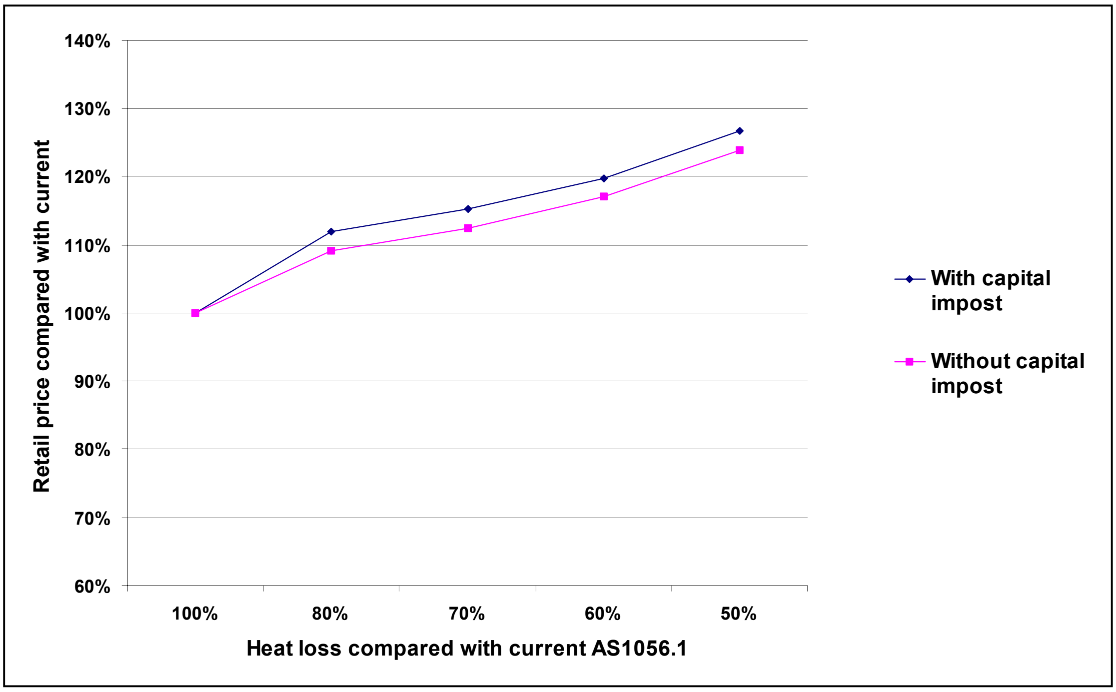
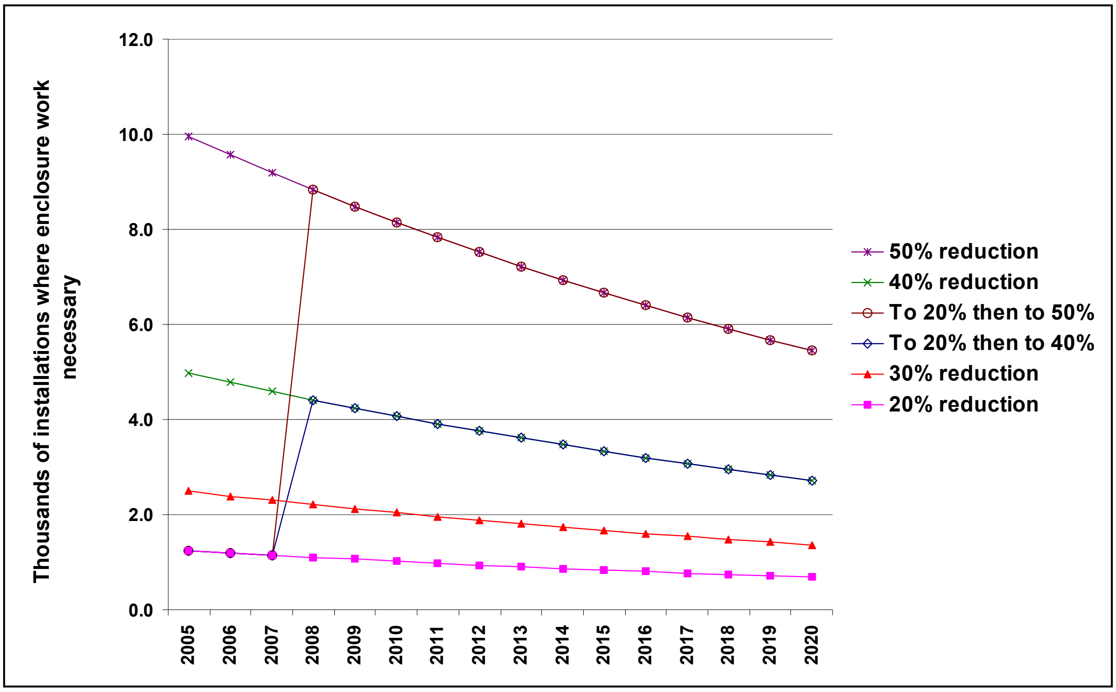


Figure 7 Projected relationship between heat loss and water heater price

Figure 8 Projected number of installations where enclosure work is necessary



Flexibility mechanism

Adoption of the flexibility mechanism to address the dimensional constraint issue outlined in Chapter 1 would affect the costs and benefits of any given MEPS level in the following ways, assuming that the suppliers participating in the program were able to meet their sales-weighted heat loss targets, and the "old" water heaters sold were successfully directed to the installations with the highest costs of enclosure change:

- Since the average standing heat loss would be the same the maximum heat loss under a strict MEPS regime (ie one in which every unit must comply) the total projected energy savings and hence benefits would be the same in the early years, but higher in later years once the "old" units were removed from the market;

- The average price of water heaters to users will be higher than under a strict MEPS regime. "New" models will need to have a lower heat loss and hence higher material costs, and suppliers will probably increase the price of "old" models as a way of limited demand for them (otherwise they will incur fines). The net increase in average price will depend on whether the suppliers retain the additional revenues from the "old" units as increased profit or apply them to reducing the price of "new" units.

- The number, extent and hence total costs of enclosure modifications will be less than under a strict MEPS regime. Whether or not this saving to users exceeds any additional costs of water heaters depends on the ability of water heater suppliers to target the old units to the installations with the highest costs of enclosure change.

At best, the flexibility arrangement would transfer income from the suppliers of enclosure alteration and water heater relocation services, and the suppliers of other fuel/technology combinations who may benefit from shifts, to the suppliers of small electric water heaters. These suppliers would be in a position to decide whether to return the additional income to buyers (as a reduction in the price of "new" small water heater units) or to increase profits.

If a supplier mis-judged the demand for old units and had to pay fines, it may be in a position to subsequently recover these in the pricing of all water heaters, given the small number of suppliers and the limited competition in the Australian market.

Thus while adoption of the proposed flexibility mechanism may reduce costs for a small number of users, the overall reduction in benefit to other users may well be greater. Without access to detailed information about the problem cases which the industry is proposing to address through this flexibility measure, it is not possible to model the costs and benefits separately. Therefore the following analysis deals only with a strict MEPS regime, in which all units must meet the nominated MEPS level.

National Benefits and Costs

Electricity Prices

Table 18 summarises the electricity prices used in the cost-benefit analysis. The marginal tariffs (ie excluding any initial standing charges, high-cost or low-cost blocks) were taken from the sole or the largest electricity retailer in each State and Territory in late 2000.[9]

The AGO projects that wholesale prices in the national electricity market will fall over the next 20 years (except in Victoria) (AGO personal communication, April 2000). However, wholesale prices (including transmission costs) account for only about 30% of the retail price – the other 70% represents distribution and retail costs. As the residential part the retail market is deregulated, remaining price controls will be removed, and retail margins are more likely to increase than to decrease. Given the range of upward and downward price pressures, it has been assumed that tariffs remain constant in real terms throughout the projection period. In any case, the projected cost-benefit calculations are much less sensitive to electricity price assumptions than to water heater capital cost assumptions, since capital costs are incurred at the time of installation whereas energy costs are incurred progressively over the service life, and subject to greater time discounting.

It is estimated that in 2000 about 90% of the energy loss from small electric water heaters occurred in the residential sectors, and 10% in the commercial sector (Table 4). Therefore the electricity price is weighted 90% to the residential tariff and 10% to the business tariff. The nationally weighted average cost in 2000 was 11.43 c/kWh.

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[9] General business tariffs were used: there are so many business price structures available, including time of use and maximum demand, that is impossible to estimate marginal business electricity prices in any other way. Most data sources reporting "business" electricity prices (eg ESAA) report average rather than marginal prices, and amalgamate commercial and industrial sector prices.

This varies slightly over the projection period with changes in the share of the national water heater stock installed in each jurisdiction.

Table 18 Marginal electricity prices

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	**National**
Residential c/kWh	10.4	14.0	10.4	14.3	13.9	8.4	14.2	9.2	
Business c/kWh	13.5	14.3	11.5	14.0	14.0	12.5	16.3	14.9	
Weighted c/kWh	10.71	14.03	10.48	14.23	13.95	8.84	14.41	9.81	**11.43**

Projected Energy and Greenhouse Reductions

Figure 9 illustrates the projected electrical energy supplied to cover heat lost from the small electric water heaters installed new in Australia from 2000 to 2020, under business-as-usual (BAU) assumptions and under each of the five MEPS options. It is estimated that about 2.77 million units will be installed over that period (Figure 4). Note that this is energy represents heat losses only, not the total electricity consumed by small water heaters, since the electricity embodied in the useful hot water delivered from water heaters is not affected by MEPS. The first part of the projection curve rise steeply as additional and ever larger cohorts of new water heaters are added in each successive year. After the eighth year (corresponding to the average service life of the water heaters) the energy saved each year by the retirement of previous cohorts largely offsets the energy added by new cohorts, and the growth in total consumption is much slower.

Figure 10 illustrates the energy savings under each MEPS option – in effect the difference between the BAU trend line and the trend line for that MEPS option in Figure 9. Savings commence in fiscal year 2005, the first year in which water heaters affected by revised MEPS levels are sold. Figure 11 shows the BAU heat-loss related greenhouse gas emissions by State and Territory and Figure 12 shows the projected national savings in greenhouse gas emissions (calculated using the greenhouse coefficients in Appendix 4).

Table 19 Projected energy and greenhouse savings, 2000-2020

MEPS option	**Total GWh saved, 2000-2020**	**Total kt CO_2-e saved, 2000-2020**	**Avg kt CO_2-e saved/yr 2008-12**	**Avg reduction below BAU 2008-12**
1. 20% reduction	4220	3596	196	13.1%
2. 30% reduction	6331	5394	295	19.7%
3. 40% reduction	8441	7192	393	26.2%
4. 50% reduction	10551	8990	491	32.8%
5. 20% then to 40%	7417	6288	296	19.8%
6. 20% then to 50%	9015	7634	346	23.1%

Note: All energy and greenhouse estimates refer to heat loss only, and exclude the energy delivered as useful hot water.

Table 19 summarises the projected energy and greenhouse savings over the entire projection period, and the average annual reduction in greenhouse gas emissions in the period 2008-2012, the First Commitment Period under the Kyoto Protocol. It is projected that the average emissions reduction during this period will range from 196 kt CO_2-e per year (13.1% below BAU) under the least stringent MEPS option, to 491 kt CO_2-e per year (32.8% below BAU) under the most stringent MEPS option.

Figure 9 Projected energy losses from small electric SWH installed 2000-2020

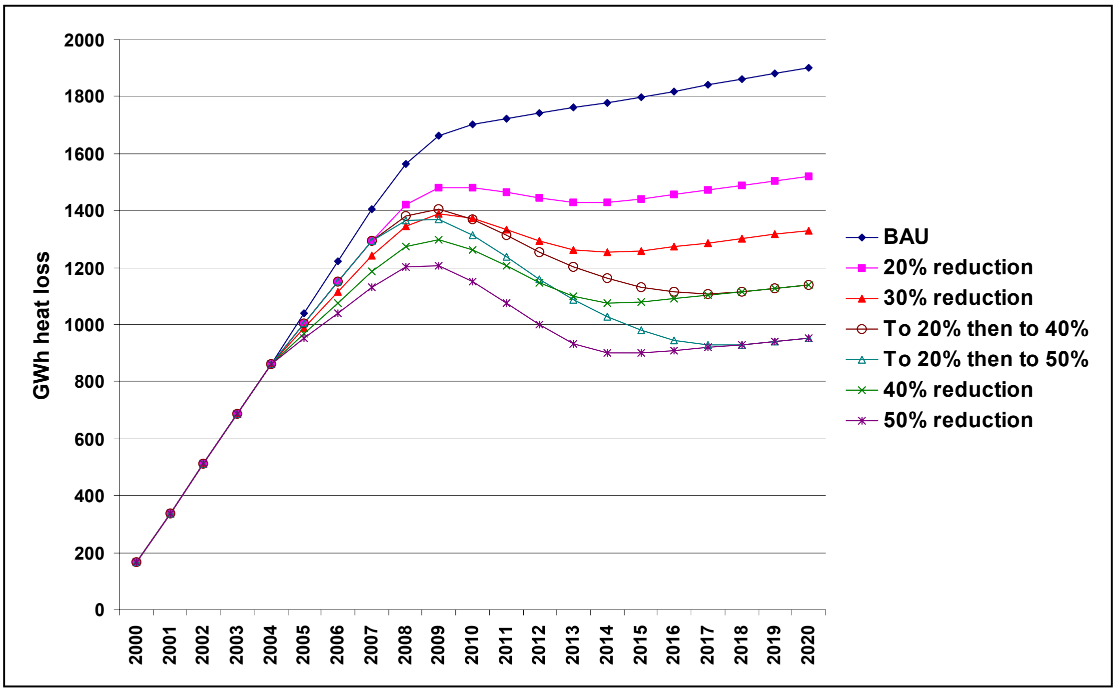


Figure 10 Projected energy savings from MEPS options, 2000-2020

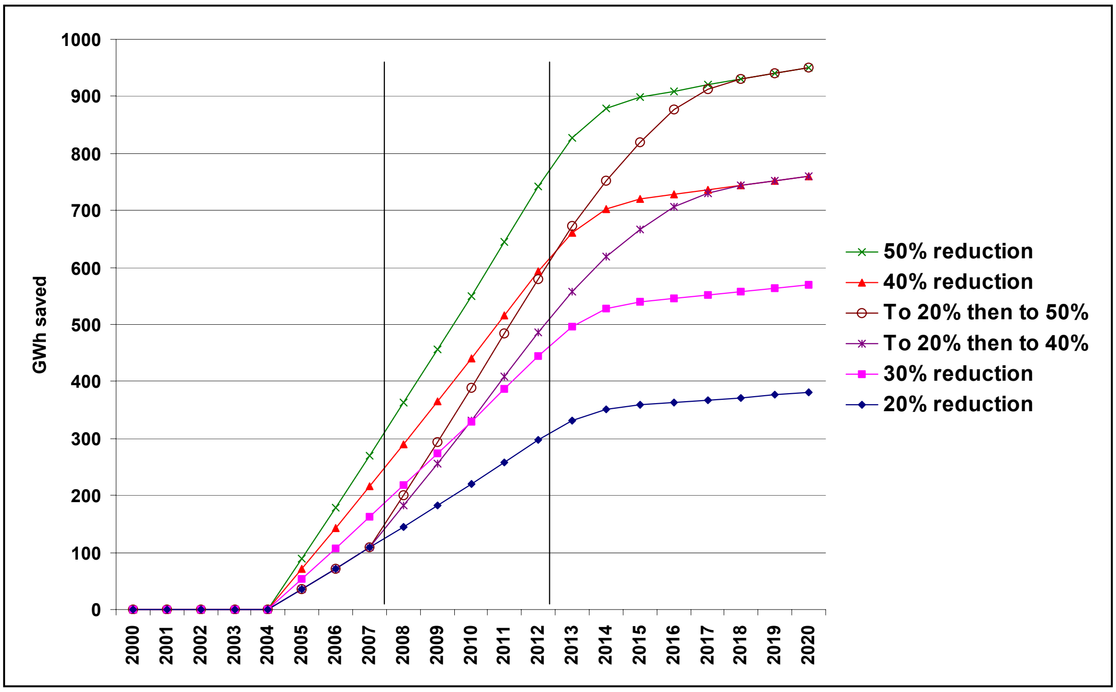
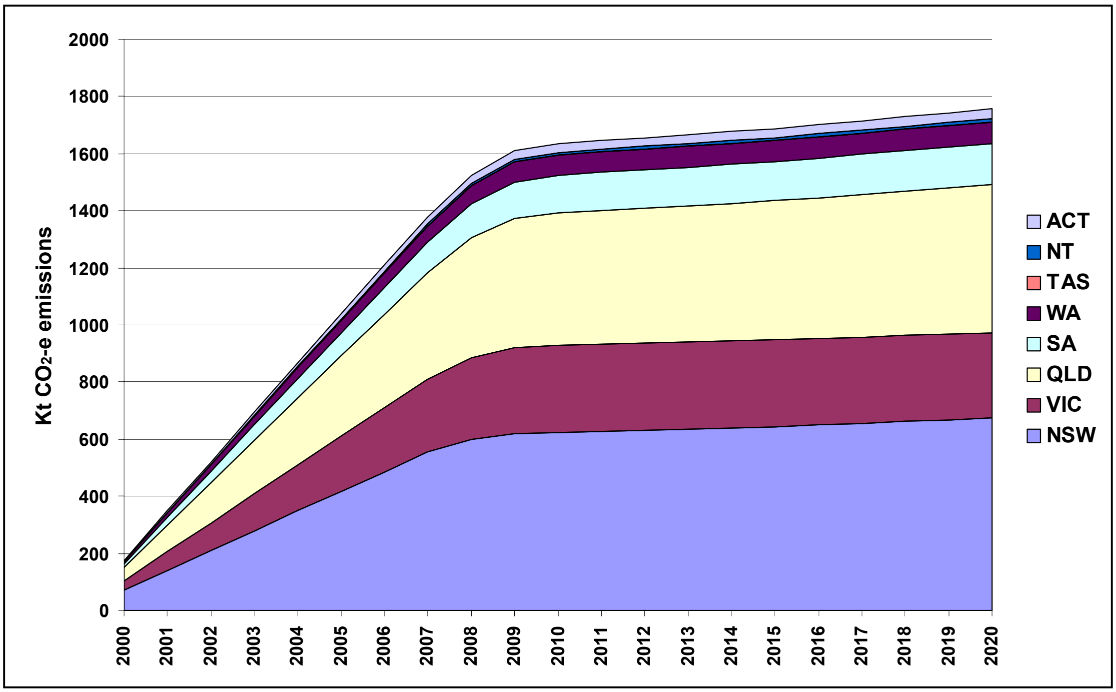
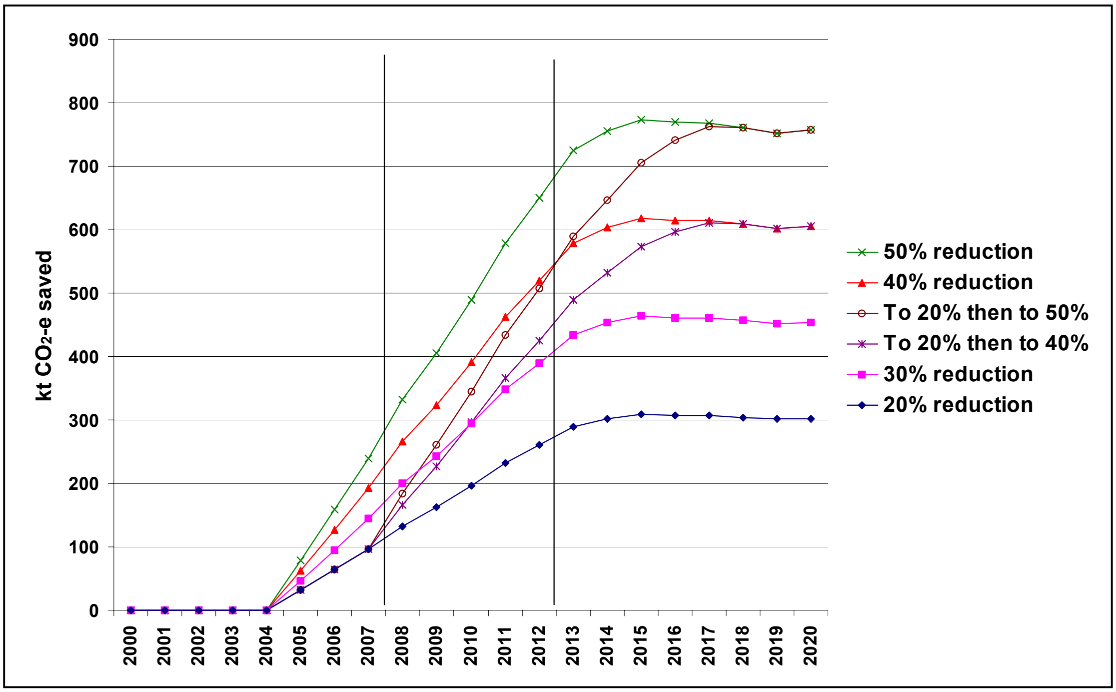


Figure 11 Projected BAU greenhouse gas emissions from heat loss of small electric SWH sold in 2000 and later, State and Territory



Calculated using average greenhouse coefficients (see Appendix 4)

Figure 12 Projected annual greenhouse savings from MEPS options, 2000-2020



Calculated using marginal greenhouse coefficients (see Appendix 4)

Costs and Benefits

The projected national costs and benefits of the six MEPS options are summarised in Table 20. The benefits come from the electricity costs savings only. No value has been given to greenhouse gas emission savings. The costs are the sum of increases in the purchase price of water heaters due to the higher material costs and the capital costs of retooling, and the costs of altering enclosures to accommodate larger water heaters. The latter could rise to nearly a fifth of the total national cost in the 50% heat loss reduction option. There are no additional program costs, since the testing and administrative infrastructure already exists.

The highest benefit/cost ratio is 5.1, for the 30% heat loss reduction option, and the lowest is 4.2, for the 50% heat loss reduction option. The net benefit increases with the heat loss reduction, reaching $ 315.3 million for the 50% heat loss reduction option. Figure 13 shows the benefit/cost ratio for each State and Territory. As expected, the ratios are highest in the jurisdictions with the highest electricity tariffs (Victoria, SA, WA and NT). All options ate highly cost-effective in all jurisdictions.

Given that benefits exceed costs in each scenario, the greenhouse gas reductions would be gained at no cost.

Table 20 Projected national costs and benefits, MEPS options

MEPS option	NPV purchase costs $M	% of enclosures changed	NPV enclosure costs $M	NPV total capital costs $M	NPV energy costs $M	Capital cost increase $M	Energy saving $M	Net benefit $M	Benefit/ cost
BAU	$407.3	NA	NA	$407.3	$1,358.7				
20% reduction	$441.3	1%	$2.8	$444.1	$1,192.8	$36.8	$166.0	$129.2	4.5
30% reduction	$451.0	2%	$5.5	$456.5	$1,109.8	$49.3	$248.9	$199.7	5.1
40% reduction	$464.5	4%	$11.1	$475.6	$1,026.8	$68.3	$331.9	$263.6	4.9
50% reduction	$484.7	8%	$22.2	$506.8	$943.9	$99.6	$414.9	$315.3	4.2
20% then to 40%	$458.9	1-4%	$7.9	$466.9	$1,077.0	$59.6	$281.8	$222.2	4.7
20% then to 50%	$473.0	1-8%	$14.8	$487.9	$1,019.1	$80.6	$339.6	$259.1	4.2

All Net Present Values at mid 2001, at 10% discount rate.

Sensitivity tests

The projected costs and benefits have been tested for sensitivity to a number of key assumptions.

Service life: an average service life of 9 years has been used. The impacts of service lives of 8 and 10 years is illustrated in Figure 14. The shorter the service life, the lower the lifetime energy savings for the same purchase price increment, so the lower the overall benefit/cost ratio. However, the benefit/cost projections are relatively insensitive to service life assumptions.

Material costs: the impact of assuming higher material costs – up to 7 times the values in Table 16 – are illustrated in Figure 15. All options remain cost-effective up to 5 times the material costs assumptions, but none are-cost effective at 7 times.

Enclosure alteration rates: the impact of assuming alteration rates of twice and three times the base assumption are illustrated in Figure 20. The extreme assumption is that enclosure alteration rates would be 3% for Option 1, 6% for Option 2, 12% for Option 3 and 24% for Option 4. Option 1 is least sensitive, and Option 4 most sensitive. However, even at three times the enclosure costs all options are highly cost-effective.

Figure 13 Projected costs and benefits by State and Territory, MEPS options

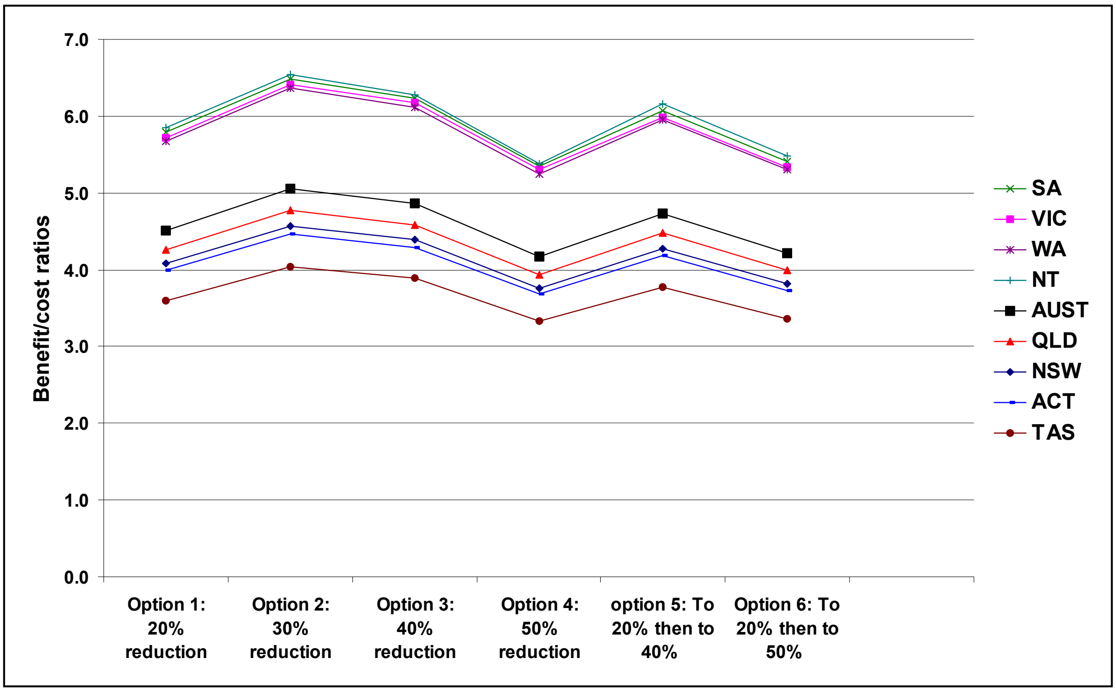


Figure 14 Sensitivity of national benefit/cost ratios to service life assumptions

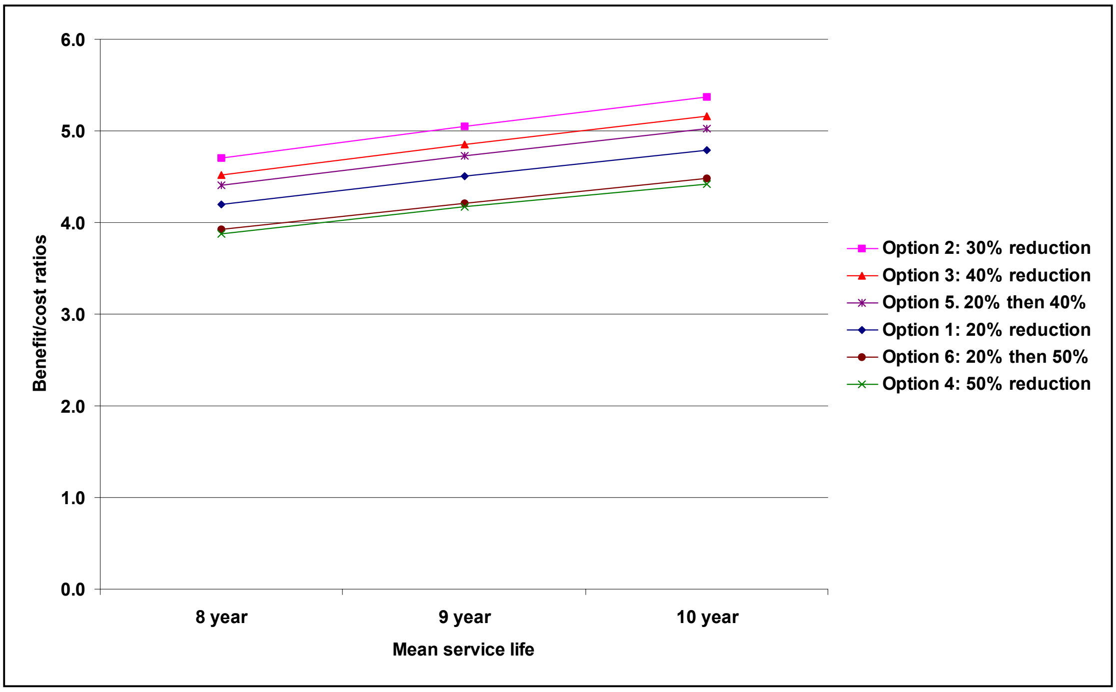
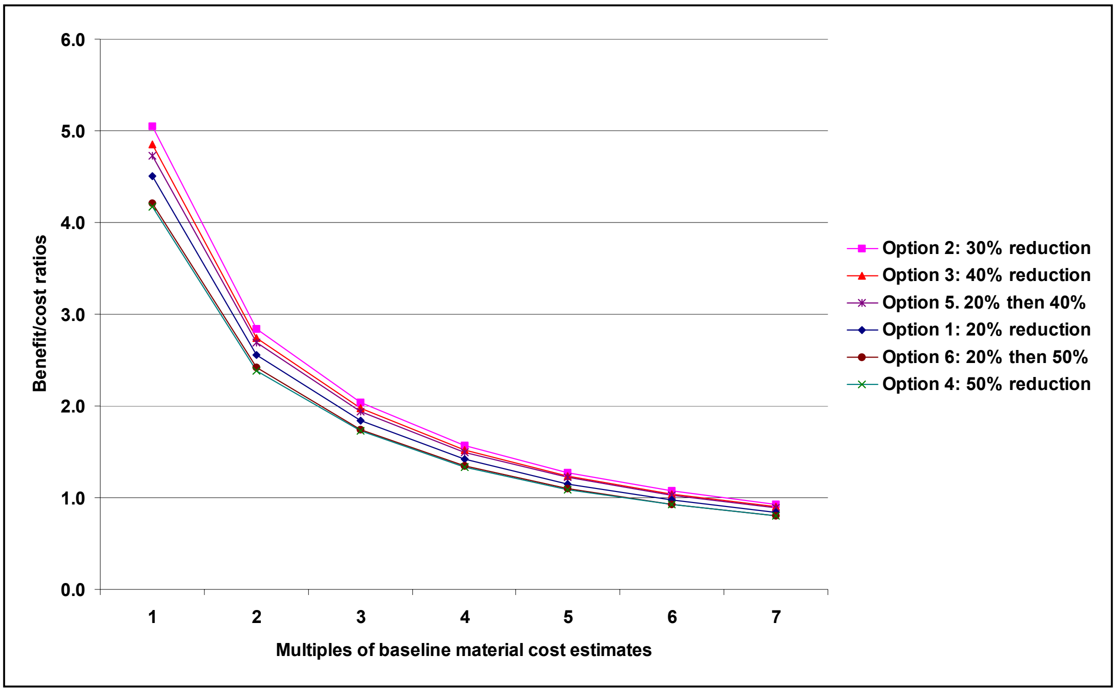
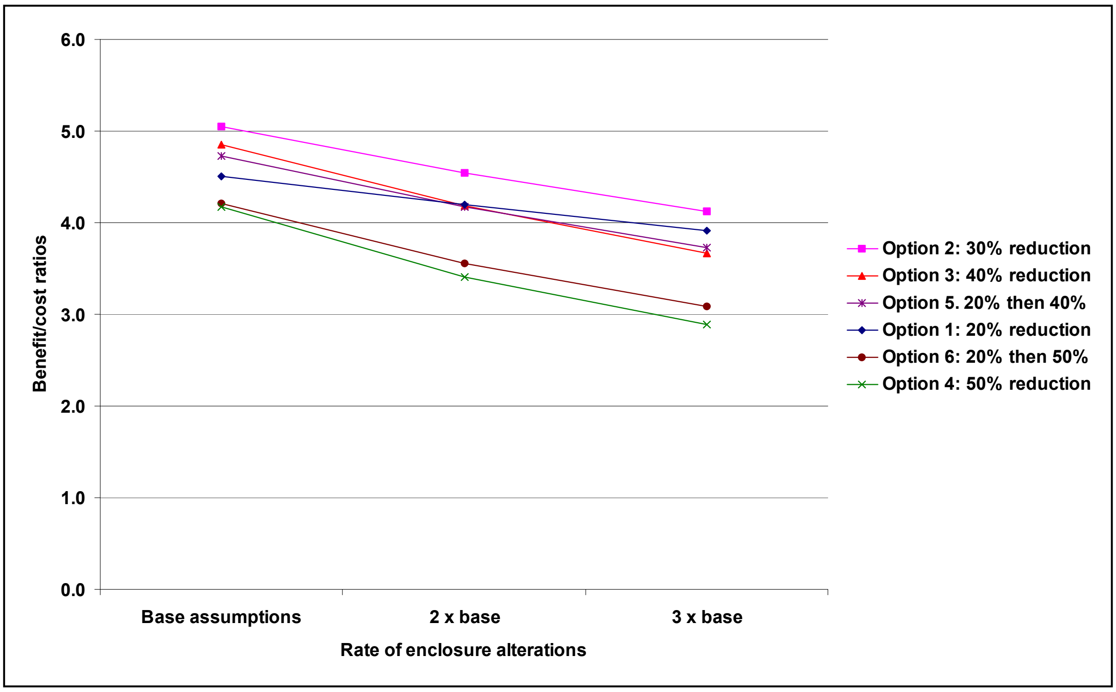


Figure 15 Sensitivity of national benefit/cost ratios to material cost assumptions

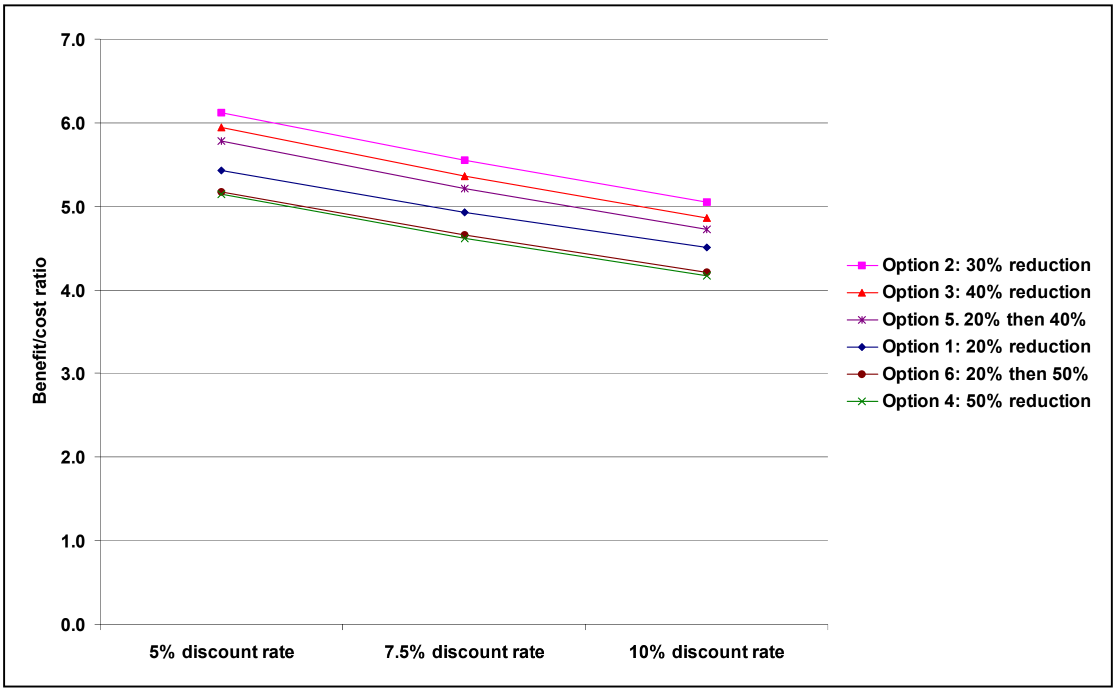


16 Sensitivity of national benefit/cost ratios to enclosure alteration rates



Finally, the influence of the selected discount rate is illustrated in Figure 17. The value of the future stream of electricity savings is more heavily discounted than the capital costs, which are incurred in one lump. Hence the higher the discount rate, the lower the benefit/cost ratio. At a 5 % discount rate, the benefit/cost ratio of Option 2 is 6.1, whereas at 10% it is 5.1. .

Figure 17 Sensitivity of national benefit/cost ratios to discount rates



4.2 Industry, Competition and Trade Issues

Industry issues

Supplier competition

At present there are two major manufacturers of small mains pressure electric water heaters in Australia and New Zealand: Southcorp (manufacturing in Australia and New Zealand) and Dux (manufacturing in Australia only). The third Australian supplier, Edwards, has a relatively small market share. These manufacturers (and others) have successfully adjusted their larger water heater ranges to increased MEPS levels in the past. Changes in MEPS levels for smaller models are unlikely to lead to new suppliers entering the market, or to the departure any of the present suppliers.

The introduction of more stringent MEPS levels will require manufacturers to make a once-only change to the tooling and production lines for each model: $500,000 has been allowed in the cost-benefit analysis for each of the 6 models currently on the market.[10] All else being equal, suppliers with a smaller number of annual sales per model may be at a disadvantage, since the capital cost impact per unit sold will be somewhat higher. However, the dimensional relationships between models is also a factor: where two models share the same diameter and end details, most of the cost of the changeover can be shared.

On balance, the introduction of higher MEPS levels is not likely to increase or decrease the number of suppliers, or the price competition between them.

Montreal Protocol issues

As required under the Commonwealth Ozone Protection Act 1989, which gave effect to Australia's ratification of the Montreal Protocol on Substances that Deplete the Ozone Layer, the appliance industry phased out the use of CFCs as refrigerants and as foaming agents by 1996. The industry is at present in a transitional period in which a range of substances including HFCs, HCFCs and hydrocarbons is being used.

HFCs have zero Ozone Depleting Potential (ODP), whereas HCFCs have ODPs in the range 2 – 15% of that of CFC-11, and so will have to be phased out. The import, export and manufacture of HCFCs has been controlled under the Ozone Protection Act and Customs (Prohibited Imports) Regulations since 1996.[11]

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[10] This is probably an overestimate: the Edwards model already appears to have a substantially lower heat loss than 1999 MEPS level, so full retooling would not be necessary.

[11] HCFC suppliers and users must be licenced and licensees must not import or manufacture HCFCs unless they hold a quota allocated under the Act. The HCFC quota system sets a maximum annual limit on the quantity of HCFCs that may be imported under an individual licence. For 2000-01 the total annual limit on HCFCs to be imported is 220 ODP tonnes. In 2002-03 the annual limit will be reduced to 190 ODP tonnes. Quota allocations for 2002-03 will be based on a licensee's regulated activity in 2000. (Source: HCFC Environment Australia *Licence Application Form*, at http://www.environment.gov.au/epg/ozone/Drafting/downloads/hcfcapplicationdownload.htm)

The current target date for HCFC phaseout in Australia is 2020.[12] However, this may be brought forward partly as a consequence of policy decisions in the USA, where the manufacture of HCFC-141b, the preferred HCFC foam blowing agent, will cease in 2003 (Table 21).

Table 21 Montreal Protocol and US Schedules for HCFC Phaseout

Montreal Protocol		**United States**	
Year by which Developed Countries Must Achieve % Reduction in Consumption	% Reduction in Consumption Using the Cap as a Baseline	Year to be Implemented	Implementation of HCFC Phaseout through Clean Air Act Regulations
2004	35.0%	2003	No production and no importing of HCFC-141b
2010	65.0%	2010	2010 No production and no importing of HCFC-142b and HCFC-22, except for use in equipment manufactured before 1/1/2010 (so no production or importing for NEW equipment that uses these refrigerants)
2015	90.0%	2015	No production and no importing of any HCFCs, except for use as refrigerants in equipment manufactured before 1/1/2020
2020	99.5%	2020	No production and no importing of any HCFCs

Source: US Environmental Protection Agency, www.epa.gov/ozone/title6/phaseout/hcfc.html

Australian water heater manufacturers will have to decide on a non-HCFC foam blowing agent within the next two years. The Global Warming Potential (GWP) of the substance may also be a factor in the decision. For example, HFC-134a has a zero ODP but a GWP that is 1300 times as great as CO_2 (mass for mass over a 100-year time scale). Hydrocarbons such as cyclopentane have zero ODP as well as zero GWP, but have lower insulating performance than HFC-134a.

It is important that each supplier be given the opportunity to integrate its planning for new blowing agents and for revised MEPS levels. Depending on the technical approach it decides to follow, the least costly transition path may be for both changes to be accommodated in one step, so only one redesign and retooling is necessary per model. An implementation date of October 2004 for revised MEPS levels would be consistent with the foaming agent changeover schedule that suppliers are likely to follow. Alternatively, a two-step MEPS approach (20% heat loss reduction in 2004 and a further step in 2007) may give suppliers the opportunity to make changes not involving the thickness or composition of the insulation foam in the first step, and allow a further three years for foam development before the second step.

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[12] *Review of the National Ozone Protection Program*, Australian and New Zealand Environment and Conservation Council, January 2000.

Manufacturers have indicated that they could accommodate MEPS increments of up to 30% in a single step at the same time as switching foams. They have also indicated that on present information October 2004 should be an achievable timeframe, subject to review in case of major unforseen problems in the availability of the replacement foams or in the adaptation of their foam blowing equipment.

Trade

GATT issues

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

The regulations would apply equally to imports and locally manufactured products, and so do not discriminate against imports.

It is a particular concern of the GTBT that where technical regulations are required and relevant international standards exist or their completion is imminent, Members should use them, or the relevant parts of them, as a basis for their technical regulations. Unlike products such as fluorescent lamps, air conditioners or electric motors, where there is considerable international trade and a degree of convergence on international standards, there are no accepted international test standards for electric water heater heat loss.

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

There would be scope for accepting the results of water heater tests conducted in other countries provided that AS1056 were used as the basis of testing. However, there is no scope for accepting a water heater that may comply with MEPS in its country of origin (eg in the EU) unless it also complies with Australian MEPS levels. The GATT does not prevent countries from setting MEPS levels according to their own requirements, costs and benefits.

In summary, water heater MEPS are not inconsistent with the GATT *Technical Barriers to Trade* Agreement.

International Standards

In 1999 ANZMEC agreed that Australia would "match the best MEPS levels of our trading partners after taking account of test method differences and other differences (eg climate, marketing and consumer preference variations)" and that this policy covered "any product regulated by mandatory labelling or MEPS programs in other developed countries" (NAEEEP 2001b). Therefore, when considering a revised MEPS level for small electric water heaters it is necessary to review the relevant standards for these products elsewhere.

New Zealand

There are no imports to Australia of small electric water heaters within the scope of this RIS. There are some exports to Papua New Guinea, Fiji and other Pacific Islands. Although there is no actual trade in small water heaters, there are several links between the Australian and New Zealand markets.[13] Rheem New Zealand, which commenced water heater manufacture in Wellington in 1969, was the first overseas venture of Rheem Australia.[14] Rheem NZ makes a different range of MP water heaters from Rheem Australia. The two small NZ models (24 litres and 44 litres storage) are for indoor installation only (they are finished in galvanised steel, not weatherproof colourbond) and are not sold in Australia.

Unlike household appliances, which are now covered by joint Australian and New Zealand standards, there are separate water heater heat loss test standards in Australia (AS1056) and New Zealand (NZS4602). There are slight differences in the test procedures, but tests carried out on the same units using the two standards have returned very similar results (EP et al 2000).

NZS4305:1996 *Energy Efficiency – Domestic Type Hot Water Systems* sets out efficiency standards for both gas and electric water heaters. For small electric water heaters of 90 litres storage (not delivery) and less, the maximum permitted standing heat loss over 24 hrs is determined by the formula:

$$0.0084\,L + 0.40$$

Table 22 compares, for the same size water heaters, the maximum standing heat loss specified in NZS4305 and measured in accordance with NZS4602 with the maximum heat loss specified and measured in accordance with AS1056 (see Table 6). The NZ efficiency standard is equivalent to between 47% and 61% of the current Australian MEPS level. For the most popular sizes (25 and 50 litres delivery) this corresponds to MEPS option 4 in Table 15 (a heat loss of 50% below current Australian MEPS).

Table 22 Australian and New Zealand heat loss standards, small electric water heaters

Delivery litres(a)	Storage litres(b)	AS1056.1 heat loss kWh/24h(c)	NZS4602 heat loss kWh/24h	NZ/Aust heat loss
18	25	1.0	0.61	61%
25	30	1.4	0.65	47%
50	56	1.7	0.87	51%

(a) AS1056 relates heat loss to delivery volume. (b) NZS4602 and NZS4305 relate heat loss to storage volume. (c) Excludes 0.2 kWh/24h allowance for hot-side temperature and pressure relief valve.

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[13] There is trade in the larger sizes, mostly exports from Australia to New Zealand.

[14] Rheem's parent company, Southcorp, now has water heater manufacturing operations in the USA, China and Italy as well as Australia and New Zealand.

However, it should be noted that while the Australian standard is a legally binding MEPS since October 1999, the NZ efficiency standard is not. In fact, many large water heaters sold in NZ (and all small water heaters) have heat losses well in excess of the standard. In 1991 the then Electricity Development Association (EDA) of NZ introduced the WaterMark label to indicate which models met the heat loss levels in the NZ standard (designated WaterMark "A" grade) and which had a higher heat loss ("B" grade – there were also "C" and "D" grades but these were no longer manufactured).[15]

For some years, consideration has been given to making the standard mandatory. In July 1996 the then Minister for Energy announced the decision to implement legislation providing for the introduction of MEPS for some categories of appliances and equipment:

> "Initially performance standards are likely to be introduced for domestic electric storage hot water cylinders, fluorescent lamps and fluorescent ballasts for office lighting. More analysis into the possible introduction of standards for electric motors and domestic refrigerators and freezers will also be undertaken" (*Media Release* 10 July 1996).

No target implementation date was mentioned, but the Minister indicated that "standards would be developed in full consultation with the relevant industries, and that appropriate lead times would be provided before implementation to allow suppliers to quit existing stocks of non-complying product."[16] The Minister also noted the increasing use of MEPS internationally, and stated that "New Zealand officials will work closely with their Australian counterparts to achieve harmonisation of standards between our two countries where possible."

The former government reiterated the intention to implement MEPS in its climate change policy, which stated that EECA will:

> "Develop the technical basis for the new minimum energy performance standards (MEPS) covering fluorescent lamps and ballasts, and domestic hot water cylinders" and
>
> investigate the case for MEPS for further product classes, including domestic refrigerators/freezers and three-phase induction motors" (Ministry for the Environment, November 1999).

The policy also confirmed an earlier decision to amend the New Zealand Building Code to require new electric water heaters to comply with the heat loss limits in the NZ standard. This would oblige the dwelling owner (ie the builder in the case of

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[15] The EDA WaterMark should not be confused with the Watermark logo which appears on some Australian water heaters, indicating compliance with AS3498, *Authorisation requirements for plumbing products – Water heaters and hot-water storage tanks.* These requirements relate to materials and safety. The EDA no longer exists and the NZ WaterMark label has fallen into disuse.

[16] A note issued by the Chief Executive of EECA on 11 July 1996, *Minimum Energy Performance Standards: Selected Questions and Answers*, stated that "it is expected that it will be 1998 before the first MEPS will take effect."

speculative or project housing) to install MEPS-compliant water heaters at the time of construction or refurbishment, and could function as a de-facto form of general water heater MEPS.[17]

The present NZ Government has taken up the implementation of MEPS for a range of products, including storage water heaters, and the NZ Parliament has passed enabling legislation analogous to the legislation under which labelling and MEPS are implemented in Australian States and Territories. However, no regulations giving effect to MEPS for the targeted products (analogous to the example in Appendix 1 of this RIS) have yet been passed. Therefore NZ does not yet have MEPS for small electric water heaters, and neither MEPS levels nor implementation timetables have been set.

The Trans-Tasman Mutual Recognition Agreement (TTMRA) states that any product that can be lawfully manufactured in or imported into either Australia or New Zealand may be lawfully sold in the other jurisdiction. If the two countries have different MEPS requirement for a given product, the less stringent requirement (which may be no MEPS at all) becomes the defacto level for both countries unless the one with the more stringent requirement obtains an exemption under TTMRA. In theory, a company could import NZ-manufactured water heaters which fail to meet even today's Australian MEPS. This has not occurred, partly because of historical differences in product ranges. If NZ should implement more stringent MEPS than Australia, Australian products could still continue to be exported because of TTMRA.

It would clearly be less disruptive for both suppliers and buyers for any MEPS regimes which Australia and New Zealand might adopt to be harmonised. In the case of water heaters, this would be accomplished if a single standing heat loss test procedure were developed – ideally as a joint AS/NZS standard - and the identical standing heat loss levels were adopted in both countries, for larger as well as smaller water heaters. This would enable suppliers to make the same models for both the Australian and NZ markets, and so lead to greater economies of scale in manufacturing.

Canada

The permitted heat loss in Canada is lower but is measured at a lower standard hot water temperature (Table 23). Canada is changing to the USA Energy Factor method to eliminate the implied trade barrier in having differing testing standards.

United States of America

The MEPS level adopted in the USA in 1980 is indicated in Table 23. In 1998, the US Department of Energy decided not to proceed with revised minimum performance standard for small water heaters (under 20 US gallons, or 75.7 litres) because of:

- Absence of data to determine the appropriate daily hot water consumption; and

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[17] It would be lawful to sell non-compliant water heaters, but effectively unlawful to install them if the Building Code required replacement water heater installations to be brought up to present safety standards, including the installation of a tempering valve and the use of a water heater complying with all aspects of the NZ standard, including the heat losses. This would make water heater replacements subject to the Building Code even if no other construction took place.

- DOE's need to develop and evaluate the stand-by loss procedure.

Daily hot water consumption is significant because the US water heater standards are expressed in terms of an Energy Factor - a measure of water heater efficiency over a 24 hour period under standard service conditions of temperature, connection and draw off. By contrast. the Australian and New Zealand standards are expressed in terms of standing heat loss only, and so are independent of any assumptions about daily usage.

In 1999 the American Society of Heating, Refrigeration and Airconditioning Engineers, ASHRAE (1999) published an advisory minimum Energy Factor formula for electric water heaters not larger than 12 kW: 0.93 – 0.005V (V = volume in litres).

In 2001 the US government rejected the adoption of the ASHRAE value as a MEPS level because it would lead to increased energy consumption compared with the existing standard.[18]

European Union

The countries of the European Union have widely varying mandatory standards. The Swiss and German standards are significantly more stringent than current Australian MEPS for tanks sizes up to about 90 litres. French standards are slightly more stringent than Australian MEPS for tanks sizes up to about 70 litres. The British requirements are very low by world standards.

The EU is currently considering common MEPS levels, which would be close to the current German/Swiss levels (EES et al 2001). The heat loss test is similar to the AS1056 but is done with a temperature difference of only 45°C and the container volume rather than rated delivery defines tank size (Table 23).

The average heat loss for EU models of 50 L container capacity is about 0.880 kWh/24h. They have insulation thicknesses of between 64 and 93 mm. Several German manufacturers offer models with heat losses 33% lower than the standard (EP et al 2000).

Table 23 Indicative standard heat loss for selected countries

Country	Nominal Size (L)(a)	Temp. Diff. (°C)	Target Losses (kWh/24h)	Status
Australia	50 delivery	55	1.700	Mandatory; excludes allowance of 0.2 kWh/24h for the T&P valve
Canada	55	45	1.728	Mandatory in some provinces, moving to Energy Factor rating to conform with USA
Switzerland Germany	55	45	0.938	Mandatory; likely to become EU standard
New Zealand	55	55.6	0.862	Advisory
USA (1980)	55	44.4	1.032	ASHRAE recommendation is $5.9 + 5.3\sqrt{V}$ watts for units over 12 kW; smaller units target an Energy Factor of $\geq 0.93 - 0.005V$ (volume in litres)
USA (AHRAE)	55	38.9	1.085	

Source: EP et al 2000. (a) Storage or recoverable storage volumes unless otherwise stated.

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[18] 10CFR Pt 431 Part X, published in *Federal Register* 12 January 2001.

Comparison

Table 23 compares the heat loss standards under the various test regimes, for a small water heater roughly equivalent to an Australian 50 litre delivery model. Table 24 presents the data scaled to the Australian test temperature difference, for those countries where tests are based on standing heat loss alone, and so are independent of hot water usage. (It would be misleading to scale the US values without making additional assumptions about daily draw-off patterns).

For 50 litre water heaters:

- Swiss and German mandatory MEPS levels require are about 33% lower heat loss than current Australian levels;

- Canadian MEPS levels require about 24% higher heat loss than current Australian levels;

- New Zealand advisory standards require about 50% lower heat loss than current Australian levels.

For purposes of matching "world's best practice", the benchmark should be the Swiss and German MEPS. Although New Zealand has the most stringent advisory heat loss standards for small water heaters, they are not mandatory MEPS levels and no models that actually meet the standard have yet been produced.

Table 24 Standard heat loss for selected countries adjusted to Australian test

	Temperature Difference in test (ºC)	Heat loss kWh/24 hrs (a)	Adjusted kWh/24 hrs (b)	% of Australian heat loss
Australia (1999)	55.0	1.700	1.700	100%
Canada (Mandatory)	45.0	1.728	2.112	124%
Switzerland and Germany (Mandatory)	45.0	0.938	1.146	67%
New Zealand (Advisory)	55.6	0.862	0.853	50%

Based on Table 23. All unit approximate 50 litres delivery. (a) As tested. (b) Scaled to temperature difference of 55ºC.

Conclusions with Regard to Competition

The revision of small mains pressure electric water heater MEPS, and the level adopted, would inevitably have some impact on individual suppliers, but is not likely to greatly effect the degree of competition between suppliers.

Because there are only three manufacturers of small mains pressure electric water heaters in Australia and New Zealand, and negligible trade in these products, it is difficult to speculate on the effects of MEPS on competition without analysing the likely commercial strategies of each supplier under different MEPS regimes.

However, the suppliers responded to the 1999 increase in MEPS levels without apparent commercial cost, and were able to pass the costs on to customers. Therefore the adoption of more stringent MEPS levels would be within the normal business environment and need not reduce competition.

If the adoption of more stringent MEPS levels in Australia were coordinated with similar proposals in New Zealand, manufacturers could achieve greater economies of scale by being able to supply the same models to both markets. Customers could benefit, to a limited extent, through increased choice or lower prices. The impact of the proposed regulations on suppliers is likely to be moderate overall.

4.3 Voluntary MEPS

Under a voluntary MEPS regime, water heater manufacturers would voluntarily incur the costs of introducing models that achieve lower heat losses than currently required. In theory, they could also retain the existing models to minimise the instances where enclosures need to be modified. However, given the relatively small Australian market and the economics of water heater manufacture, maintaining a larger number of models is not likely to be economic in the longer term.

Suppliers would presumably only introduce lower heat loss models if there were commercial incentive for them to do so. Such incentive might perhaps come from an industry association. If membership of, or product approval by the association were a commercial necessity, and the association perceived adoption of more stringent heat loss standards to be in the collective interest of all its members, it may be feasible for the association to urge or require members to adopt such standards. These conditions have never been present in the electric water heater industry (which is covered by AEEMA). They were once but are no longer present in the electricity supply industry, which in the past was able to enforce technical standards on water heater suppliers (as the Australian Gas Association is still able to do, albeit to a lesser extent than formerly).

Another commercial incentive for voluntary action could be the aim to increase the average price of water heaters, manufacturer revenues and profitability. The average price of electric water heaters increased following the adoption of the current MEPS levels. While it is not possible to assess whether this led to an increase in manufacturer profitability, there is no indication of any adverse effect.[19] Further price increases are expected from the introduction of more stringent MEPS; this would in

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[19] For example, Southcorp reports revenues and Earnings Before Interest and Tax (EBIT) for the water heater division as a whole, not on a country basis. Up to the 1999 financial year, the water heater division was part of the appliances division, but the other appliance operations were divested in early 1999. The division's ratio of EBIT to revenues was 4.0% in financial year 1997, 5.6% in 1998, 7.0% in 1999, 15.4% in 2000 (the financial year in which the current water heater MEPS took effect), and 11.2% in the first half of 2001. Although this reflects many market factors including some outside Australia, there is no evidence of financial penalty from the introduction of MEPS. Comparable financial information for Dux's parent company GWA International was not available.

effect enable the water heater manufacturers to capture more of the value of the water heating energy service business from the electricity suppliers.

More stringent heat loss levels would most likely be in the longer term commercial interests of the two water heater manufacturers, but only if they took concerted action. If only one moved, others would have a price advantage which could be readily exploited to gain market share, since consumers are more concerned with first cost than life cycle cost. Coordination of changes to standards by what is in effect a duple could be construed as collusive behaviour by the ACCC, even though – as the present RIS demonstrates - the public interest would be served.

Voluntary compliance might be commercially advantageous for suppliers if buyers thought that lower heat loss was a desirable product attribute. However, since water heater buyers as a group give energy efficiency a low priority, a proprietary “energy efficiency mark”, or use of the Standards Australia compliance mark, would have little value to customers unless it were very heavily promoted.

There have been instances of successful introduction of compliance marks with the support of government or other agencies. The US Environment Protection Agency introduced the *Energy Star* label, initially for office equipment, in the early 1990s. The label now has high recognition in the USA and low to moderate recognition in Australia (GWA et al 1996). Most office equipment suppliers have products that qualify for the label. However, the greatest force for compliance was the decision of the US Government, the single largest corporate purchaser of office equipment in the world, to give tender preference to qualifying products, so establishing a form of “Government MEPS”. This is clearly only feasible for products where government represents a large proportion of the market. This is not the case with water heaters.

To sum up, it appears that the chances of a successful voluntary implementation of more stringent MEPS appears remote. Furthermore, the outcome would be uncertain for several years, so the risk that the program would fail to contribute sufficiently to national greenhouse gas reduction objectives would be high.

5. Consultation

COAG Guidelines:

- ***Consultation:*** *a RIS must outline who has been or will be consulted, and who will be affected by the proposed action. On a case by case basis, this may involve consultation between departments, with interest groups, with other levels of government and with the community generally.*
- ***Review:*** *there should be consideration of how the regulation will be monitored for amendment or removal. Increasingly, sunset provisions are regarded as an appropriate way of ensuring regulatory action remains justified in changing circumstances.*

5.1 Consultations

The issues related to MEPS for electric storage water heaters have received considerable exposure over the last seven years.

Chronology of Previous Reports and Consultations

July 1993	Electric storage water heaters identified as one of the product types suitable for MEPS, in GWA et al (1993)
1993-1995	Several meetings held between representatives of the water heater industry, Commonwealth and State governments and electricity suppliers, to discuss MEPS issues related to water heaters
1995	ANZMEC agrees to implement MEPS for electric storage water heaters, commencing October 1999 (more stringent for larger than for smaller) and to further consider smaller water heaters following discussions with industry and completion of any necessary research
February 1999	RIS on mandatory labelling and MEPS for household electrical appliances, including water heaters, completed .
July 1999	TNS (1999) report on dimensional constraint issues for smaller electric storage water heaters.
October 1999	Water heater MEPS come into force
March 2000	Initial discussions between representatives of AGO, NSW government and water heater industry re smaller electric storage water heater MEPS proposals
May 2000	EP et al (2000) report on technical options to increase efficiency of smaller electric storage water heaters
June 2000	Issues paper prepared (GWA 2000a)
August 2000	TNS (2000) further report on dimensional constraint issues for smaller electric storage water heaters
May 2001	Consultations with water heater manufacturers
June 2001	Draft Regulatory Impact Statement released for public comment

Proposed public consultations

The following further consultations are planned:

- AGO will send out copies of this draft RIS to known interested parties, advertise its availability, and hold public meetings in Sydney and Melbourne (and possibly Perth, Adelaide and/or Brisbane, if there is demand), at which the consultant will make presentations;

- Written comments will be invited;

- The AGO will review and address written comments received, propose responses, and revise the final RIS if necessary.

5.2 Comments on draft RIS

[This section will address comments received on the draft RIS received during the consultation period]

6. Evaluation and Recommendations

COAG Guidelines:

- ***Evaluation:*** *there should be an evaluation of the relative impacts of the proposal and any alternatives, to show that the desired policy objective cannot be achieved at a lower cost to business and the community at large.*

6.1 Assessment

A summary assessment of the alternatives considered in this RIS against the objectives of the proposal to raise mandatory MEPS levels is given in Table 26. (Note that this the proposal is called the *higher* MEPS option because electric storage water heaters are already subject to MEPS).

Reduce greenhouse emissions below business as usual

The higher MEPS option is the only one for which the extent of likely reduction in standing heat loss, and hence greenhouse gas emissions can be quantified, and the one where reductions have the highest probability of occurring.

Address market failures

The higher MEPS option would address the market's lack of concern with operating costs by enforcing investment in more efficient products so that the total life cycle cost of electric water heaters to users would be lower than otherwise, irrespective of whether they changed their purchase behaviour.

A mandatory efficiency-related levy on water heaters could in theory address market failure by making more efficient water heaters cheaper than the less efficient, and so encourage their purchase by all buyers, including those concerned exclusively with capital cost. However, there are two critical objections to this:

- It requires that there be a range in product energy efficiency, from high to low. There are only 6 small water heater models on the Australian market, and all but one (which is a premium cost product because of its materials) are designed to the current MEPS level; and
- there is no obvious legal or taxation mechanism.

An emissions-related levy on electricity prices would be less effective than the efficiency-related levy on appliances, since it addresses running costs rather than capital costs, and water heater buyers are less concerned with running cost than with purchase price. It would have economy-wide implications that are beyond the scope of the present analysis. Given that any decision to implement such a levy would need to be taken at the highest levels of Government, it is not considered a direct alternative to the proposed regulation.

Minimise negative impact on product quality

The higher MEPS option is not expected to have any significant effect on product quality or function (ie apart from energy efficiency).

However, the higher MEPS option will lead to additional costs to some users who wish to replace an existing small electric water heater and find that none of the models on the market will fit in the existing enclosure.

The number of such users will depend on the stringency of the higher MEPS, and the extent to which manufacturers meet it through increases in insulation and through the other technical options have been shown to be available.

The number of buyers faced with the expense of overcoming dimensional constraints could be reduced if suppliers were able to continue to supply current models for some time after introducing new, more highly insulated models.

Minimise negative impacts on suppliers

The mandatory higher MEPS option would clearly require suppliers to re-engineer their products to reduce heat loss, at about the time they will need to re-engineer products and manufacturing processes to change to non-HCFC foaming agents. While these changes would impose additional costs, these would be recoverable in higher prices. Allowing each supplier to plan for coordination of the changes would allow costs to be minimised.

The other options would have lower costs for suppliers to the extent that they were less effective in bringing about the outcome of lower heat loss. At the extreme, the voluntary MEPS option would have least impact on suppliers because it is unlikely that any would take it up.

Preferred MEPS level

While mandatory MEPS is the preferred measure, selection of the preferred MEPS option of the six summarised in Table 25 requires consideration of several criteria.

Benefit/Cost ratio: Option 2 (30% of current heat loss) shows the highest benefit/cost ratio.

Net benefit: According to Layard (1972), where public policy options have similar practicability and risk, yet are mutually exclusive, the preferred option is the one with the highest net benefit, provided that benefits exceed costs. This would indicate that Option 4 (50% of current heat loss, in one step), the most stringent option tested, is the preferred option.

MEPS levels for similar products in other countries: Applying the principle adopted by ANZMEC – matching but not exceeding the most stringent MEPS levels in force elsewhere – would indicate Option 2 (30% of current heat loss). This would roughly align Australian MEPS with the German and Swiss MEPS levels, which appear set to become EU wide.

Risk: The higher the MEPS levels, the more risk there is from two issues: foaming agents and dimensional constraints. The greater the volume of insulation foam that will be required, the greater the exposure to uncertainties regarding foam availability, cost and characteristics. Dealing with these uncertainties within the timeframe (ie before October 2004) will be unavoidable in any case, because HCFC replacements will need to be found irrespective of MEPS, but the higher MEPS levels (Options 3 and 4) would require significant increases in foam volume, which would magnify the uncertainty. The lower MEPS levels (Options 1 and 2) could be achieved with much less change in dimensions – minimal change on some models - even with new foams.

The risks from foam uncertainty could be reduced by a two-step approach (Options 5 and 6).

The higher the MEPS level, the greater the likely increase in water heater dimensions, and hence the greater the risk that some householders will face high costs and delays when attempting to replace their existing small water heaters when they fail. The total number of expected cases and the average additional cost in each case have been factored into the national cost-benefit analysis. However, at higher MEPS levels the number of high-cost cases will increase.

The risks to those householders could be reduced without forgoing the national benefits of a given MEPS level by allowing suppliers to continue to sell limited number of "old" units, provided they sell enough "new" units so that the sales average meets the agreed target value. This would introduce additional risks to water heater buyers stemming from the ability of suppliers to estimate the number of old units needed and to target them to the high-cost installation cases, but this additional risk could be controlled to some extent if the suppliers were willing to enter into enforceable arrangements, with defined payments for non-performance.

Such arrangements would most likely be unnecessary under Option 1, but valuable under Option 4. With regard to Options 2 and 3, the costs and complexities of the national administrative arrangements will need to be considered against the likely benefits to a limited and declining number of buyers.

On balance Option 2 (30% heat loss) is recommended as the MEPS level. This option has the highest benefit/cost ratio (although not the highest net benefit), matches international best practice, and limits the exposure to risks from changes in foaming agents and from dimensional constraints. A single step change which meets both MEPS objectives and Ozone Depletion reduction objectives appears feasible. The dimensional constraint issue may be modest enough not to require the introduction of flexibility mechanisms (ie sales-weighted targets) but these should be considered.

Table 25 compares the water heater MEPS options covered in this RIS with current MEPS proposals for three other products: packaged air conditioners, electric motors and fluorescent lamp ballasts. The preferred water heater option (Option 2: MEPS at 50% of current heat loss, in one step) is considerably higher in net benefit value and similar in projected greenhouse gas savings to electric motors, although lower in net benefit and projected greenhouse savings than packaged air conditioners or fluorescent lamp ballasts.

Table 25 Summary of water heater scenarios and comparison with other products

Option	Change in water heater heat loss level	NPV of costs $M(a)	NPV of benefits $M(a)	Net benefits $M(a)	benefits /costs	CO_2-e saving Mt (f)
1	20% reduction, effective October 2004	37	166	129	4.5	0.21
2	**30% reduction, effective October 2004**	**49**	**249**	**200**	**5.1**	**0.32**
3	40% reduction, effective October 2004	68	332	264	4.9	0.42
4	50% reduction, effective October 2004	100	415	315	4.2	0.53
5	20% reduction, effective October 2004, then further 25% effective October 2007 (ie heat loss will then be 40% below present level)	60	282	222	4.7	0.32
6	20% reduction, effective October 2004, then further 38% effective October 2007 (ie heat loss will then be 50% below present level)	81	340	259	4.2	0.37
Range of above		37-100	166-415	129-315	4.2-5.1	0.21-0.53
Proposed MEPS for 3-phase electric motors (b)		92	165	73	1.8	0.33
Proposed MEPS for airconditioners & heat pumps (c)		78	480	402	6.2	0.53
Range of 2 recommended MEPS scenarios for fluorescent lamp ballasts (d)		132-152	549-623	416-471	4.1	0.63-0.72
Mandatory energy labelling and MEPS for household appliances (including 1999 water heater MEPS) (e)		670	1286	616	1.9	2.0

(a) Net Present Value of costs and benefits compared with BAU case, at 10% discount rate. (b) GWA 2000b (c) GWA 2000c (d) GWA 2001 (e) GWA 1999: NPV in this study are at 8% discount rate (f) Average annual reduction below BAU during Kyoto Protocol commitment period. Calculated using marginal greenhouse coefficients (for water heaters) and average greenhouse coefficients for other products. For most States, marginal coefficients are about 10% lower than average coefficients (see Appendix 4).

Conclusions [Draft]

After consideration of the option of more stringent mandatory MEPS and other alternatives, it is concluded that:

1. More stringent MEPS is likely to be effective in meeting the objectives stated for the regulation: reductions in greenhouse gas emissions and reduced life cycle costs to users.

2. None of the alternatives examined appear as effective as MEPS in meeting all objectives, some would be ineffective with regard to some objectives, and some appear to be far more difficult or costly to implement.

3. The costs of more stringent MEPS levels have been modelled as if the necessary heat loss reduction were achieved solely through increasing the insulation thickness of water heaters. However, other – and possibly cheaper - technical options could achieve some or all of the heat loss reduction required.

4. The projected costs and benefits are relatively insensitive to assumptions about average service life and discount rate. All options would remain cost-effective at much higher material costs and enclosure rebuilding costs (ie where larger units no longer fit in existing enclosures).

5. Of the six modelled MEPS options, the one which gives the highest ratio of benefits to costs (5.1) is Option 2 (30% reduction in heat loss).

6. The option with the highest net benefits and greenhouse savings is the most stringent: Option 4 (50% reduction in standing heat loss in a single step). This also leads to the greatest increase in total water heater costs, with about four fifths of the increase coming from higher manufacturing costs and one fifth from the cost of changing enclosures to accommodate larger water heaters.

7. Option 2 (30% reduction in heat loss) corresponds to the most stringent mandatory MEPS for small water heaters currently in force (in Germany and Switzerland) and so would be consistent with the ANZMEC policy to match "world's best practice."

8. The net benefits of higher MEPS levels for small electric water heaters would most likely flow disproportionately to households who rent, occupy smaller dwellings and, on the whole, have lower incomes.

9. The timing of the proposed change in MEPS would coincide with the change to new foam blowing agents. While this will most likely reduce the insulation performance of the foam, this could be compensated with other technical options, and all options should still be feasible.

10. The total costs of changing both foaming agents and heat loss levels would be minimised if each manufacturer were able to plan for them in an integrated manner.

11. The greater the volume of insulation foam that will be required, the greater the exposure to uncertainties regarding foam availability, cost and characteristics. The higher MEPS levels (Options 3 and 4) would require significant increases in foam volume, which would magnify the uncertainty, although the risks from foam uncertainty could be reduced by a two-step approach (Options 5 and 6). The lower MEPS levels (Options 1 and 2) could be achieved with much less change in dimensions – minimal change on some models.

12. A "sales-weighted target" approach (in which some higher heat loss units could be sold provided that enough lower heat loss units were also sold) could give suppliers greater flexibility to address the dimensional constraint issue than a strict MEPS regime (in which every unit sold would have to meet the nominated MEPS level).

6.2 Recommendations [Draft]

It is recommended that:

1. States and Territories implement more stringent mandatory MEPS for storage water heaters of less than 80 litres delivery (as defined in AS1056.1 *Storage Water Heaters Part 1: General requirements*).

2. The MEPS levels be set at 30% of the current maximum standing heat loss in AS1056.1-1991, to be achieved in a single step.

3. The scope of AS1056.1-1991 should be expanded to cover water heaters of delivery smaller than 25 litres (the current limit).

4. The mode of implementation be through the existing regulations governing appliance energy labelling and MEPS in each State and Territory.

5. The revised MEPS levels take effect on 1 October 2004.

6. ANZMEC agree to the development of a joint Australian and New Zealand standard for heat loss testing, to eventually supersede the existing Australian Standard and New Zealand Standard.

7. State and Territory governments consider the possibility of a "sales-weighted target", under which suppliers who wished to do so could continue to sell water heaters which meet the 1999 MEPS level after October 2004, so long as the average heat loss of all their sales of models of each delivery capacity in each 12 month period is no higher than the MEPS level for models of that capacity.

8. If such an approach is implemented, supplier participation should be voluntary and subject to agreement to pay fines in the event of failure to meet the agreed targets. Such fines should be high enough to provide an incentive to meet targets and should reflect the value of electricity savings to small water heater buyers.

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Table 26 Assessment of alternatives against objectives

Objective and assessment criteria	A. Status quo	B. Mandatory MEPS	C. Voluntary MEPS	D. Levy on Inefficient Appliances	E. Levy on electricity
Objective: Reduce emissions below BAU	No	Significant reduction projected	Extent of reduction uncertain – most likely zero	Extent of reduction uncertain – if funds raised go to other programs, they are not likely to be as effective as MEPS	Extent of any reduction uncertain
Address market failures	No	Yes – projected to reduce life cycle costs of water heating	Fails to address market failure; relies on raising consumer and supplier concern with energy	May address market failure, but large price differentials would be necessary to affect purchase decisions	Large electricity price increase necessary to affect purchase decisions
Minimise negative impact on product quality or function	No effect	No effect	No effect	No effect	No effect
Minimise negative impacts on suppliers	No effect	Most suppliers will have some non-complying models, so costs are fairly widely distributed. MEPS-complying products already available. Range of supplier responses possible. 2003 start may be less disruptive	Would minimise supplier costs, since suppliers not likely to opt in	Supplier costs no less than for mandatory MEPS. Administrative costs likely to be higher	Would minimise supplier costs
Other issues		Some existing water heaters are installed in confined enclosures, which will require modification to accommodate larger units	True voluntary MEPS has not been successfully introduced anywhere in the world	No readily apparent legal means of raising the levy. At best, would be a form of non-mandatory MEPS with higher costs	Not a true alternative – decision does not rest with ANZMEC

7. Review

An increase in the stringency of water heater MEPS would be implemented under the same State and Territory regulations as existing MEPS, and so subject to the same sunset provisions, if any. Victoria and SA have general sunset provisions applying to their labelling/MEPS regulations as a whole, while NSW has sunset provisions applying to the inclusion of some (but not all) items scheduled.

Once the States and Territories agree to mandatory requirements, their removal in any one jurisdictions would undermine the effect in all other jurisdictions, because of the Mutual Recognition agreements between the States and Territories (GWA 1999a). Under the cooperative arrangements for the management of the National Appliance and Equipment Energy Efficiency Program, States advise and consult when the sunset of any of the provisions is impending. This gives the opportunity for fresh cost-benefit analyses to be undertaken.

The Australian Standards called up in State and Territory labelling MEPS regulations are also subject to regular review. The arrangements between the Commonwealth, State and Territory governments and Standards Australia provide that the revision of any Standards called up in energy labelling and MEPS regulations are subject to the approval of the governments.

Therefore any proposal to make the MEPS in AS1056.1 *Storage Water Heaters Part 1: General requirements* either more or less stringent would need the cooperation of both the Standards bodies and of the regulators.

NAEEEC has adopted the principles that there should be a MEPS “stability period” of at least 4 years, and that a cost-benefit analysis would be undertaken before any revisions are proposed (NAEEEC 1999). The earliest possible timing of any change to the MEPS regulations discussed in this RIS would therefore depend on date of their implementation. If they are implemented in one step October 2004, the earliest possible revision would be October 2008. If there is a second step in October 2007, stability would be guaranteed until October 2011. It would be necessary to carry out a study well in advance of any proposed revision, so that adequate notice could be given to industry in the event that a change were justified.

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Appendix 1 Extract from Typical State Regulations

NSW Electricity Safety Act (1945)
Electricity Safety (Equipment Efficiency) Regulation 1999

Part 2 Standards

5 Minimum standards

(1) An electrical article listed in Schedule 2 must comply with the performance criteria set out in Part 2 of the relevant standard when tested, in accordance with Part 1 of that standard, by an accredited laboratory.

(2) An electrical article listed in Schedule 3 must comply with the energy efficiency requirements set out in the relevant standard.

(3) In this clause, accredited laboratory means a laboratory:

(a) accredited by the National Association of Testing Authorities, or

(b) approved by the Corporation.

Part 4 Labelling of electrical articles

15 Electrical articles to be appropriately labelled when sold

(1) A person must not sell an electrical article listed in Schedule 2 unless an approved energy efficiency label is displayed on the article in accordance with Part 2 of the relevant standard. Maximum penalty: 20 penalty units.

(2) In the case of an air conditioner that is sold in a package, the approved energy efficiency label may instead be displayed on the package.

(3) This clause applies in respect of the sale of new articles, whether by wholesale or retail, but does not apply to the sale of second-hand articles.

SCHEDULE

(Clauses 7 and 19)

Item	Fee
For registration of an electrical article	$150
For transfer of registration of an electrical article	$50
For provision of an extract from the Register	$50

{tc \l 2 ""}Schedule 2 Standards for electrical articles that require registration and labelling

Article: (Clause 5 (1))

Relevant standard:

Clothes washing machine Australian/New Zealand Standard, "Performance of household electrical appliances Clothes washing machines Part 1: Energy consumption and performance", AS/NZS 2040.1:1998, and Australian/New Zealand Standard, "Performance of household electrical appliances Clothes washing machines Part 2: Energy labelling requirements", AS/NZS 2040.2:1998.

Dishwasher Australian/New Zealand Standard, "Performance of household electrical appliances Dishwashers Part 1: Energy consumption and performance", AS/NZS 2007.1:1998, and Australian/New Zealand Standard, "Performance of household electrical appliances Dishwashers Part 2: Energy labelling requirements", AS/NZS 2007.2:1998.

Refrigerating appliance Australian/New Zealand Standard, "Performance of household electrical appliances Refrigerating appliances Part 1: Energy consumption and performance", AS/NZS 4474.1:1997, and Australian/New Zealand Standard, "Performance of household electrical appliances Refrigerating appliances Part 2: Energy labelling and minimum energy performance standard requirements", AS/NZS 4474.2:1997.

Room airconditioner Australian/New Zealand Standard, "Performance of household electrical appliances Room airconditioners Part 1.1: Non-ducted airconditioners and heat pumps Testing and rating for performance", AS/NZS 3823.1.1:1998, and Australian/New Zealand Standard, "Performance of household electrical appliances Room airconditioners Part 2: Energy labelling requirements", AS/NZS 3823.2:1998.

Rotary clothes dryers Australian/New Zealand Standard, "Performance of household electrical appliances Rotary clothes dryers Part 1: Energy consumption and performance", AS/NZS 2442.1:1996, and Australian/New Zealand Standard, "Performance of household electrical appliances Rotary clothes dryers Part 2: Energy labelling requirements", AS/NZS 2442.2:1996.

{tc \l 2 ""}Schedule 3 Standards for electrical articles that require registration only

Article: (Clause 5 (2))

Relevant standard:

Storage water heater unvented without an attached feed tank Australian Standard, "Storage water heaters Part 1: General requirements", AS 1056.1:1991, Clause 2.4 "Thermal Insulation".

Appendix 2 Extract from Executive Summary and Recommendations *Benefits and Costs of Implementing Minimum Energy Performance Standards for Household Electrical Appliances in Australia* (GWA et al (1993)

Water Heaters

There is considerable scope to improve the energy-efficiency with which household hot water service is provided, through more efficient hot water use at outlets and by appliances, better matching of heat storage to demand, changes in installation practices, and changes in temperature settings, sizing and selection practices.

Most of the above measures require changes in behaviour rather than technology, or changes in the efficiency of hot water use. They fall outside the scope of MEPS, which must be capable of application to the product itself. The only area of greater energy-efficiency clearly within the scope of MEPS, and independent of changes in the behaviour of householders or others, is a *reduction in water heater standing heat loss,* as defined in AS1056.

Existing standing heat loss limits are already incorporated into AS1056. There is no direct obligation on manufacturers to adopt these standards, unless they wish the product to carry the Australian Standard "tick" label. Nevertheless, the heat loss limits are given quasi-mandatory force by the insistence of most electricity utilities that only water heaters which comply with them may be connected to off-peak tariffs.

The impact of two distinct *limit* MEPS levels for water heaters was examined:

- if the allowable heat loss as measured by AS 1056 were reduced by 30% for each size of water heater; this is expressed as a "heat loss factor " (HLF) of 0.7. It was estimated that this would reduce the sales-weighted heat loss of new electric storage water heaters by 62 GWh per annum (about 5% of the consumption without MEPS);

- if the allowable heat loss as measured by AS 1056 were reduced by 45% for each size of water heater; this is expressed as a HLF of 0.55. It was estimated that this would reduce the sales-weighted heat loss of new electric storage water heaters by 99 GWh per annum (about 8% of the consumption without MEPS).

A 10% to 15% improvement in the average water-efficiency of dishwashers and clothes washers could reduce household hot water demand by an additional 2 to 4%. Showers account for about half of all household hot water use. Even at half the theoretical savings, a low flow shower head would remain the single most cost-effective energy-efficiency measure available in most Australian households, and would be far greater than the savings available from water heater MEPS alone.

There would be considerable benefit in terms of both water-efficiency and energy-efficiency in a coordinated program of standards for household water-using appliances and fittings, as well as for water heaters themselves. Unless these are considered together, the benefits and costs cannot be adequately valued and assigned. However, the evaluation of such a co-ordinated program of standards is beyond the scope of the present study.

It would be cost-effective to achieve an average HLF of 0.7 in OP water heaters as a group provided that not more than $ 51 were added to their average purchase price, and an average HLF of.0.55 provided that not more than $ 84 were added to their average purchase price. The analysis for a specific 250 litre model suggests that this is achievable for both MEPS levels, even allowing for a deterioration in performance and an increase in price for CFC-free insulation foam. It would increase the retail price by 6 to 15%.

Off-peak water heaters present the most severe test of cost-effectiveness, since the additional material volumes are high and the value to the consumer of saved energy are low. The cost-effectiveness limits of $ 122 and $ 185 for continuous water heaters (at average HLFs of 0.7 and.0.55 respectively) are almost certain to be met. However, the geometry of smaller continuous electric water heaters, and the need to retain products in the model range suitable for replacement installations in cupboards, means that it would be difficult for smaller models to meet the more stringent heat loss limit.

Realisation if the savings theoretically available from user-adjustable thermostats (UATs) would depend on user behaviour. This falls outside the scope of MEPS, which should ensure energy savings independently of user behaviour (though UATs may be desirable in order to enable users to make energy savings and reduce the risk of scalds).

Experience with energy labelling in Australia and New Zealand suggests that energy labelling of water heaters will not be effective on its own in eliminating poor energy performers, or in encouraging the introduction of more energy-efficient products. However, labelling may have other benefits to consumers and could co-exist with MEPS.

Recommendations: Water Heaters

1. It is recommended that the following minimum energy performance standards be adopted for electric storage water heaters:

- the standing heat loss as measured in accordance with AS1056.1 shall be no greater than.55% of the corresponding standing heat loss, for models of 80 litres delivery or more (as defined in AS1056.1); and
- the standing heat loss as measured in accordance with AS1056.1 shall be no greater than.70% of the corresponding standing heat loss, for models of less than 80 litres delivery (as defined in AS1056.1);
- the ratios of new to existing heat loss limits should be based on the total heat loss of a single-element water heater with a hot-side temperature and pressure relief valve; the new limits should be global limits, without additional allowance for extra elements or valves. This will give additional incentive for innovative design.

2. It is recommended that ANZMEC, in co-operation with the water heater industry, review the recommended MEPS levels in the latter half of 1993, by which time the industry should be in a position to assess the properties and costs of the CFC-free insulation materials which will be used as permanent replacements for those existing

materials which contain CFCs. The objective of the review should be to verify or revise the recommended MEPS levels in the light of the costs and properties of the new materials, not to reopen issues of whether MEPS are to be adopted, or their timing. The review should take place no later than the end of 1993, to allow the water heater industry time to adjust to the final MEPS standards which may be adopted.

3. It is recommended that ANZMEC Ministers approach the Federal and State Ministers responsible for the management of water resources and for the operation of the metropolitan water authorities, with a view to exploring the potential for an integrated system of water- and energy-efficiency standards for all household fittings and appliances which use or heat hot water.

Appendix 3 Storage Water Heater Technology and Energy Tariffs

Pressure

The two pressure classes are "mains pressure" (MP) and "low pressure" (LP). (The "mains pressure" designation actually covers a range of design pressures, from about 850 to 1400 kPa, and in areas where supply pressure could exceed the design pressure, reducing valves have to be installed). MP tanks are generally installed at floor level, inside or outside the dwelling. Because the hot water is at or near mains pressure it can be used at several outlets simultaneously, and the mixing of hot and cold is easier. MP water heaters have no feed tank

In LP water heaters the pressure is reduced by a cistern-operated feed tank or a valve, and the hot water is stored in the main tank at atmospheric pressure. "Side-fed" LP tanks are generally installed in the roof space to give sufficient head for satisfactory water pressure at the outlets. Even so, the unit must be located near the main draw-off points. It is often difficult to serve more than one outlet at a time, and the balancing of LP hot supply and MP cold supply can be a problem. In the "cistern-fed" LP configuration, there is a cistern in the roof and the main tank is located at floor level.

LP tanks are relatively simple to fabricate, and used to be the most common type until about 25 years ago. As MP tanks came to be manufactured in large quantities, their quality became more consistent and their price declined. LP tanks now tend to be installed only in areas without reticulated water supply. However, their remaining advantage over MP tanks is their far longer service life: 30 years or more, compared with about 8-10 years for MP (even less in areas of poor water quality, such as Adelaide).

Energy Type

The different types of energy used in storage systems are natural gas, liquefied petroleum gas (LPG), continuous supply electricity, and restricted supply ("off-peak") electricity. Each of these types interacts with the water heater in different ways: in this respect, continuous electricity has more in common with gas than with restricted supply electricity. In storage heaters which are gas-fired or "continuous" electric (sometimes called "quick recovery"), reheat begins as soon as a draw-off commences.

In "off-peak" (OP) water heaters, reheat can take place only during the restricted periods when the utility make electricity supply available to the element. This may be for as little as 6-8 hours during the night ("restricted OP"), or for as long as 16-18 hours ("extended OP"): ie, supply may be available at all times except during the hours of peak demand on the electricity system. The more restricted the hours of electricity supply, the larger the water storage needed. For example, a four-person household which would be adequately supplied by a gas-fired or continuous electric water heater of about 125 litres storage capacity, might require a tank of 160 litres on extended OP, and 250 or even 315 litres on restricted OP.

The larger the tank, the higher the costs of manufacturing it , transporting it, and of accommodating it within or outside the dwelling. There are also additional costs associated with installing separate off-peak electricity meters and wiring circuits.

Therefore the capital cost of an off-peak hot water system is higher than the cost of an equivalent continuous electric system.

The great advantage of OP water heaters is access to lower electricity tariffs. The marginal cost to produce and distribute an additional kWh of electricity is highest during peak demand periods and lowest during the night, when most of the demand can be met by the lowest cost base load power stations. The electricity utilities signal these costs in their tariff structures: the restricted hours OP tariff is typically about a third of the continuous tariff, and the extended hours OP tariff is about two thirds. However, the utilities also specify the minimum size of water heater that may be connected to these tariffs, for two related reasons:

- so the heat storage capacity of the water heater is adequate to maintain hot water supply during the periods when reheat is denied (the gas utilities exploited this risk in their advertising, by noting that gas hot water is “unlimited”); and

- so the water heater can absorb enough heat to function as a significant energy sink during periods when power supply prices are low, so the utility maximises the profit margin on the tariff.

The minimum size for connection to the restricted hours OP tariff is generally 250 litres, and the minimum for the extended hours OP tariff is generally 160 litres. Small electric water heaters (less than 80 litres) can only be connected to the continuous tariff.

Appendix 4 Greenhouse Gas Emissions

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

- average intensity: total annual emissions divided by total annaual 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 trend 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.

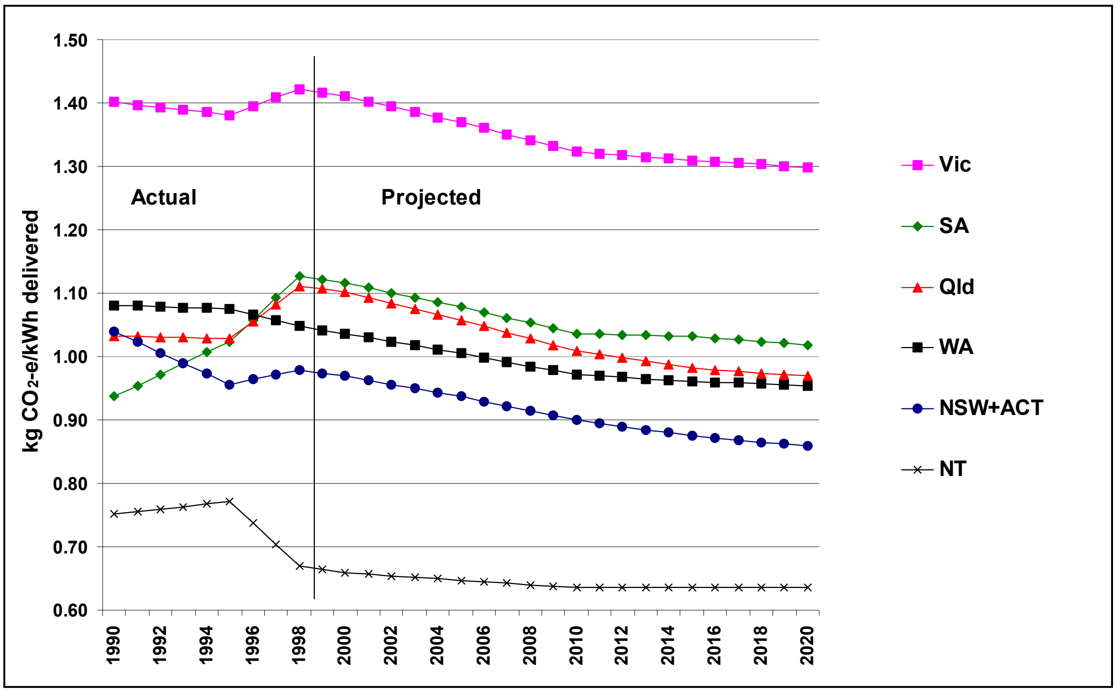
However, when estimating the emissions associated with existing electricity uses which are more or less continuous (as distinct from time-controlled loads such as off-peak water heating, or seasonal loads such as airconditioning) any ranking of loads in priority order would be arbitrary. Therefore, it is more appropriate to use average rather than marginal coefficients when estimating the share of national emissions associated with electric water heating in 2000.

The average electricity system CO_2–e intensities used in the RIS, illustrated in Figure 18, are taken from GWA (2000a). The intensities are projected to decline due to an eventual preference for natural gas, and the impacts of two Commonwealth initiatives, the “2% renewables” measure and power station efficiency standards.

The marginal electricity system CO_2–e intensities used in the RIS, illustrated in Figure 19 were supplied by the AGO (personal communication, April 2000). These embody specific assumptions about the scheduling of future generation and transmissions projects. For example, the projected completion of Basslink in 2003 would harmonise the marginal coefficient for Tasmania and Victoria, and both would converge to the intensity of natural gas generation.

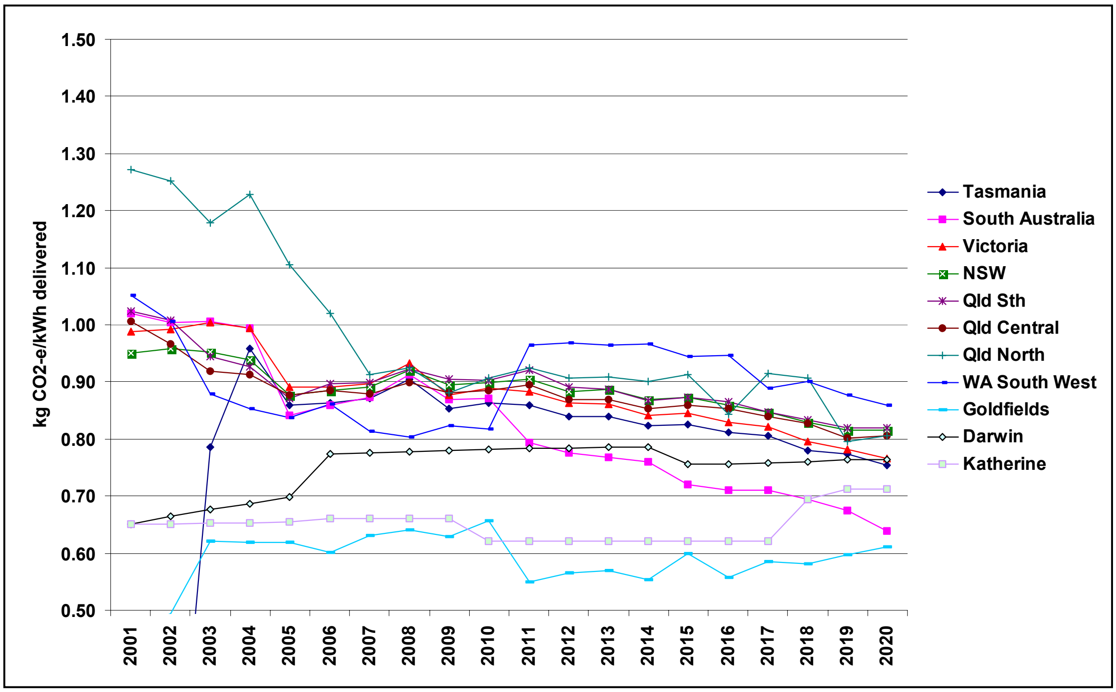
In order to derive a single marginal State coefficient for household electricity use, the three Queensland zone coefficients supplied by AGO were weighted on the basis of population in 200 as follows: 80% south Queensland, 8% central Queensland, 12% north Queensland. The WA coefficient was weighted 98% southwest WA and 2% Goldfields. The NT coefficient was weighted 90% Darwin and 10% Katherine. The weighted coefficients are illustrated in Figure 20.

Figure 18 Projected average emissions-intensity of electricity supply by State, 1990-2020



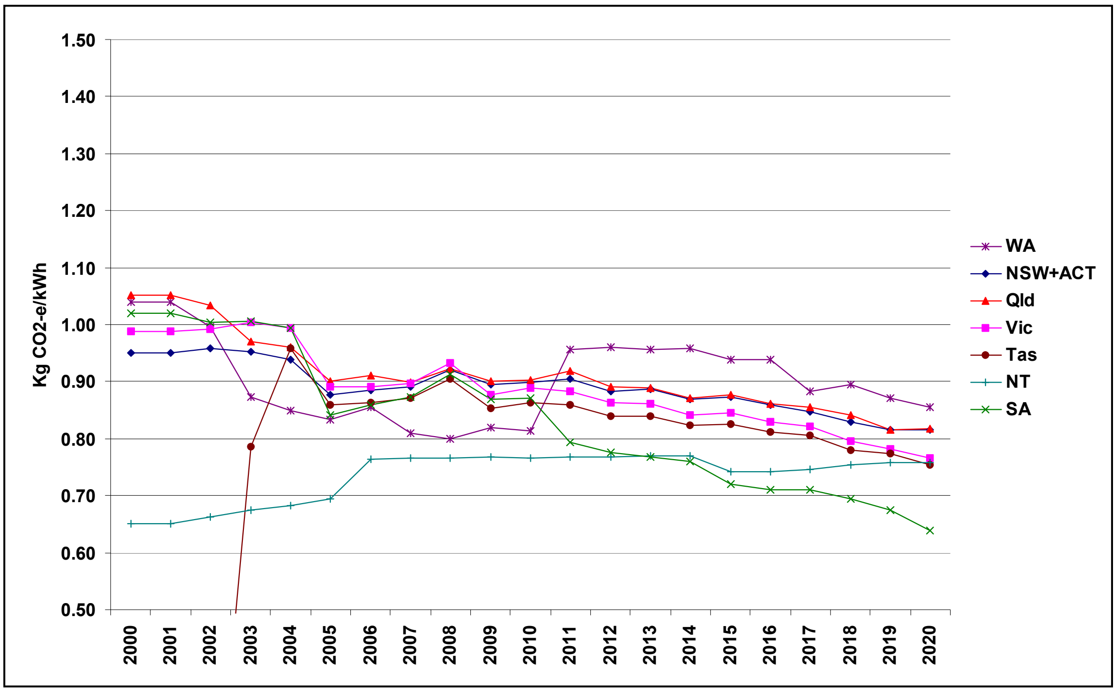
Source: GWA 2000a

Figure 19 Projected marginal emissions-intensity of electricity supply by State (sub zones), 2001-2020



Source: AGO (personal communication, April 2001)

Figure 20 Projected marginal emissions-intensity of electricity supply by State (weighted averages), 2000-2020



Appendix 5 Details of material quantity and cost estimates

Model	100% heat loss - Base							80% heat loss							70% heat loss						
Litres delivery	Height mm	Diameter mm	Ext vol litres	Foam litres	m^2 metal surface	m^2 carton surface	m^3 carton volume	Height mm	Diameter mm	Ext vol litres	Foam litres	m^2 metal surface	m^2 carton surface	m^3 carton volume	Height mm	Diameter mm	Ext vol litres	Foam litres	m^2 metal surface	m^2 carton surface	m^3 carton volume
A 18	400	385	46.6	21.6	0.72	0.91	0.059	437	422	61.3	36.3	0.86	1.10	0.078	450	435	66.8	41.8	0.91	1.16	0.085
B 50	670	415	90.6	34.6	1.14	1.46	0.115	707	452	113.7	57.7	1.33	1.69	0.145	720	465	122.2	66.2	1.39	1.77	0.156
C 50	668	385	77.8	21.8	1.04	1.33	0.099	705	422	98.9	42.9	1.22	1.55	0.126	718	435	106.6	50.6	1.28	1.63	0.136
D 25	420	405	54.1	24.1	0.79	1.01	0.069	457	442	70.3	40.3	0.94	1.20	0.090	470	455	76.4	46.4	1.00	1.27	0.097
E 50	675	405	87.0	32.0	1.12	1.42	0.111	712	442	109.5	54.5	1.30	1.65	0.139	725	455	117.8	62.8	1.36	1.73	0.150
Avg	557	394	68.4	25.5	0.94	1.19	0.087	595	431	87.5	44.5	1.10	1.40	0.111	607	444	94.5	51.5	1.16	1.48	0.120
Litres delivery	**100% heat loss - Base**							**80% heat loss**							**70% heat loss**						
	Foam $	Metal $	Carton $	Fittings $	Storage $	Transport $	Total $	Foam	Metal	Carton	Fittings	Storage	Transport	Total	Foam	Metal	Carton	Fittings	Storage	Transport	Total
A 18	16.17	7.17	1.82	5.00	0.24	0.36	30.76	27.22	8.61	2.19	8.74	0.31	0.47	47.55	31.37	9.12	2.32	9.99	0.34	0.51	53.65
B 50	25.97	11.44	2.91	5.00	0.46	0.69	46.48	43.29	13.27	3.38	8.74	0.58	0.87	70.13	49.65	13.91	3.54	9.99	0.62	0.93	78.65
C 50	16.32	10.41	2.65	5.00	0.40	0.59	35.37	32.14	12.16	3.10	8.74	0.50	0.76	57.40	37.98	12.78	3.25	9.99	0.54	0.81	65.36
D 25	18.08	7.92	2.02	5.00	0.28	0.41	33.71	30.24	9.43	2.40	8.74	0.36	0.54	51.71	34.78	9.97	2.54	9.99	0.39	0.58	58.24
E 50	23.97	11.16	2.84	5.00	0.44	0.66	44.08	40.89	12.98	3.30	8.74	0.56	0.84	67.30	47.11	13.61	3.47	9.99	0.60	0.90	75.68
Avg	19.09	9.36	2.38	5.00	0.35	0.52	36.70	33.36	11.01	2.80	8.74	0.45	0.67	57.03	38.65	11.59	2.95	9.99	0.48	0.72	64.38
	Material and service costs with manufacturer markup						47.71	Material and service costs with manufacturer markup						74.13	Material and service costs with manufacturer markup						$ 83.69
								Retooling cost (2004 – 2007 only)						7.94	Retooling cost (2004 – 2007 only)						7.94
	With retail markup						62.03	Material and capital costs impact on retail price						106.70	Material and capital costs impact on retail price						119.13
	Base retail price						375.50	Base retail price						420.17	Base retail price						432.60
								Increase in retail price (2004 –2007)					11.9%	44.67	Increase in retail price (2004 – 2007)					15.2%	57.10
								Increase in retail price (after 2007)					9.1%	34.35	Increase in retail price (after 2007)					12.5%	46.78

Model	60% heat loss							50% heat loss						
Litres delivery	Height mm	Diameter mm	Ext vol litres	Foam litres	m^2 metal surface	m^2 carton surface	m^3 carton volume	Height mm	Diameter mm	Ext vol litres	Foam litres	m^2 metal surface	m^2 carton surface	m^3 carton volume
A 18	467	452	74.7	49.7	0.98	1.25	0.095	490	475	86.8	61.8	1.08	1.38	0.110
B 50	737	482	134.1	78.1	1.48	1.88	0.171	760	505	152.1	96.1	1.61	2.04	0.194
C 50	735	452	117.6	61.6	1.36	1.73	0.150	758	475	134.2	78.2	1.48	1.89	0.171
D 25	487	472	85.0	55.0	1.07	1.36	0.108	510	495	98.1	68.1	1.18	1.50	0.125
E 50	742	472	129.5	74.5	1.45	1.84	0.165	765	495	147.1	92.1	1.57	2.00	0.187
Avg	624	461	104.5	61.5	1.24	1.58	0.133	647	484	119.6	76.6	1.35	1.72	0.152
Litres delivery	**60% heat loss**							**50% heat loss**						
	Foam $	Metal $	Carton $	Fittings $	Storage $	Transport $	Total $	Foam	Metal	Carton	Fittings	Storage	Transport	Total
A 18	37.29	9.82	2.50	11.66	0.38	0.57	62.21	46.32	10.85	2.76	13.99	0.44	0.66	75.02
B 50	58.61	14.79	3.77	11.66	0.68	1.02	90.52	72.08	16.06	4.09	13.99	0.77	1.16	108.15
C 50	46.22	13.62	3.47	11.66	0.60	0.90	76.47	58.66	14.85	3.78	13.99	0.68	1.03	92.99
D 25	41.23	10.70	2.72	11.66	0.43	0.65	67.39	51.05	11.77	3.00	13.99	0.50	0.75	81.05
E 50	55.88	14.48	3.69	11.66	0.66	0.99	87.35	69.08	15.74	4.01	13.99	0.75	1.12	104.69
Avg	46.13	12.38	3.15	11.66	0.53	0.80	74.65	57.46	13.54	3.45	13.99	0.61	0.91	89.95
	Material and service costs with manufacturer markup						97.05	Material and service costs with manufacturer markup						116.94
	Retooling cost (2004 – 2007 only)						7.94	Retooling cost (2004 – 2007 only)						7.94
	Material and capital costs impact on retail price						136.49	Material and capital costs impact on retail price						162.34
	Base retail price						449.96	Base retail price						475.81
	Increase in retail price (2004 – 2007)					19.8%	74.46	Increase in retail price (2004 – 2007)					26.7%	100.31
	Increase in retail price (after 2007)					17.1%	64.19	Increase in retail price (after 2007)					24.0%	89.99