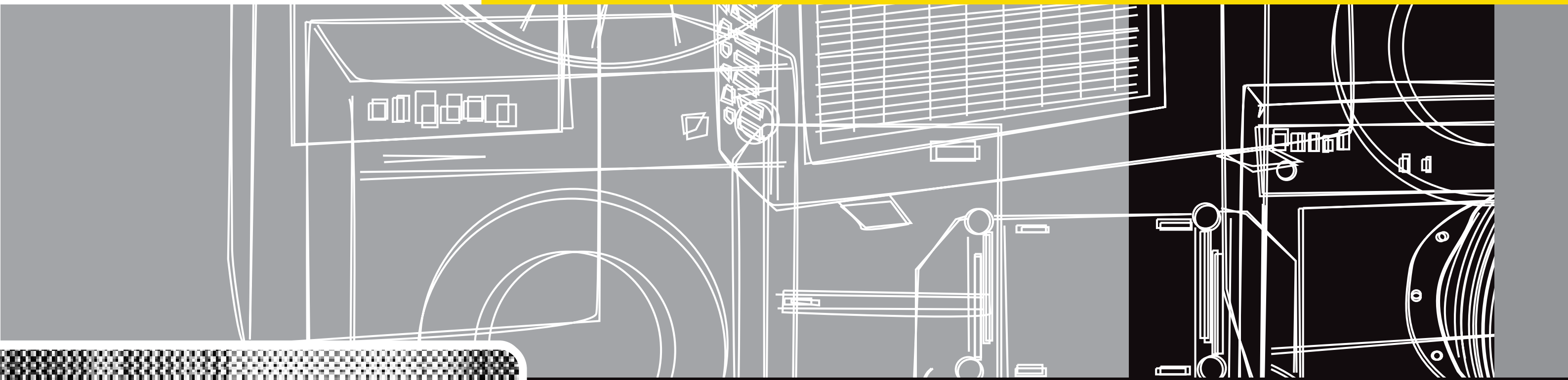
Report No: 2002/13

NATIONAL APPLIANCE AND EQUIPMENT ENERGY EFFICIENCY PROGRAM

ENERGY LABELLING OF DOMESTIC ELECTRIC STORAGE WATER HEATERS: OPTIONS



October 2002

PREPARED FOR THE NATIONAL APPLIANCE AND EQUIPMENT ENERGY EFFICIENCY COMMITTEE

BY

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Executive Summary

This report considers the case for introducing energy labelling for domestic electric storage water heaters, including solar-electric and heat pump types. It takes into account a range of issues, including:

- the range of water heater technologies and energy efficiencies;
- the impact of existing and proposed minimum energy performance standards (MEPS) regimes; and
- the way in which consumers, builders and other market intermediaries select energy forms and water heaters.

Electric storage water heaters are not at present subject to mandatory energy labelling in Australia, but they have been subject to MEPS since October 1999.

Conclusions

Mains Pressure Electric Storage Water Heaters

The development and publication of energy ratings for electric storage water heaters would involve negligible additional costs, since all necessary data are already collected and reported to the State regulators to demonstrate compliance with MEPS.

Therefore even moderate increases in the effectiveness of the National Appliance and Equipment Energy Efficiency Program would justify the implementation of an *energy rating* system, with the data published in ways that involve negligible cost – brochures and websites.

Although the level of buyer interest in and awareness of the relative energy efficiency of alternative electric water heater models is fairly low, the existence of an accessible rating scheme would assist those buyers who are interested, and indeed could stimulate buyer interest by revealing differences.

The way in which electric storage water heaters are purchased means that the benefits of mandatory physical labelling are unlikely to exceed the costs. Therefore, physical labelling should not be mandatory, but should be available as an option for suppliers.

There are already some differences in heat loss between electric water heater models, and the range of efficiencies for smaller water heaters is likely to widen considerably with the introduction of new models in the lead up to the implementation of revised MEPS levels in 2005.

The range of efficiencies for larger storage water heaters may also widen, depending on whether, how and when the current MEPS levels are revised.

Energy ratings will obviously assist buyers and intermediaries who are seeking to purchase, or advise on the purchase of, electric storage water heaters.

Energy ratings could also assist the electric water industry by:

- Assisting those suppliers who opt for sale-weighted MEPS targets to achieve their target, and hence avoid or reduce any penalties; and
- Allowing those approval authorities with sustainable energy or greenhouse guidelines to identify and permit the installation of more efficient electric storage water heaters, rather than to exclude all electric water heaters.

Solar Water Heaters (Electric Boosted) and Heat Pump Water Heaters

The development and publication of energy ratings for solar-electric and heat pump storage water heaters would involve negligible additional costs, since all necessary data are already collected for the purposes of calculating Renewable Energy Certificates under the Commonwealth Renewable Energy (Electricity) Act 2000.

Therefore even moderate increases in the effectiveness of the National Appliance and Equipment Energy Efficiency Program would justify the implementation of an *energy rating* system, with the data published in ways that involve negligible cost – brochures and websites.

The buyers of solar and heat pump water heaters tend to be more interested and involved in the purchase than the buyers of conventional electric storage water heaters. The existence of an accessible rating scheme would assist buyers, and indeed could stimulate buyer interest by revealing efficiency differences.

The way in which solar-electric and heat pump storage water heaters are purchased means that the benefits of mandatory physical labelling are unlikely to exceed the costs. Therefore, physical labelling should not be mandatory, but should be available as an option for suppliers.

There are already considerable differences in the energy efficiency of alternative models, as indicated by the wide range in attributable Renewable Energy Certificates (RECs) for models of similar storage capacity. However, the full extent of these differences is not apparent from the published RECs data, and would only become apparent if a systematic energy rating program were implemented.

Energy ratings will obviously assist buyers and intermediaries who are seeking to purchase, or advise on the purchase of, solar-electric and heat pump storage water heaters.

A Unified Rating?

A unified rating scheme would rate all conventional electric, solar-electric and heat pump storage water heaters on the same scale. The theoretical advantage of such a unified scale is that it could give undecided prospective purchasers two distinct types of information simultaneously:

- That solar and heat pump types are more “energy-efficient”; and
- That there is a range in efficiencies between models even of the same type.

However, the decision on energy type is usually taken prior to, and largely separately from, the choice of model. Buyers tend to regard conventional electric, solar-electric and heat pumps as distinct energy/technology options, rather than as alternative forms of electric water heating. The potential influence of a unified rating or label on energy type selection is likely to be low.

The use of a unified 6-star label would restrict the rating's potential value in influencing model choice: only half as many gradations would be available for each technology type than if separate scales were used. (Of course, a unified water heater label could be extended to 10 or even 12 stars, but this would make it visually distinct from other appliance labels.)

The difficulty of agreeing on a unified scale should not be underestimated. The pragmatic approach would be to use different technical bases for the two halves of the scale. If however it were considered necessary to devise a common determination of energy consumption related to a given water heater delivery task, then either physical testing or some form of simulation would be necessary for all water heater models.

The greenhouse impact of alternative energy/technology combinations is an important issue and one which should receive more attention in the product purchase decision than it does now. This is more effectively handled by means such as the www.energyrating.gov.au website, which could direct users to comparative information on the energy alternatives for water heating before directing them to separate rating lists for electric, gas and solar water heaters. A calculation option for the greenhouse gases emitted by each model when installed in different States could also appear next to its rating (similar to the energy cost calculation option that is already provided).

In conclusion, it is not necessary to aim for a unified labelling system encompassing both conventional electric storage water heaters and unconventional (solar or heat pump) models.

If the rating scales are kept separate it would be advisable to emphasise this visually, perhaps by using different graphic devices (eg "suns") for solar water heaters.

Recommendations

Mains Pressure Electric Storage Water Heaters:

It is recommended that the National Appliance and Equipment Energy Efficiency Committee:

1. Develop a six-star energy rating scale for electric storage water heaters, based on the ratio of tested heat loss to the maximum heat loss in the current (1999) MEPS level;

2. Using the registration data, rate all registered storage water heaters and publish the rating on the www.energyrating.gov.au website;

3. Encourage water heater manufacturers to include the energy rating in their brochures;

4. Encourage resellers, plumbers and installers to become familiar with the rating and to make use of it in their advice to water heater buyers;

5. Develop a format for a physical water heater label, similar to those used for other electrical appliances;

6. Amend regulations to make use of the physical label optional for electric storage water heaters, while proscribing energy labelling in any other format.

Solar Water Heaters (Electric Boosted) and Heat Pump Water Heaters

It is recommended that the National Appliance and Equipment Energy Efficiency Committee:

7. Develop a six-star energy rating scale for solar-electric and heat pump storage water heaters, based on the data used to calculate Renewable Energy Certificates (RECs), but also taking into account factors such as storage volume;

8. Add solar-electric and heat pump storage water heaters to the schedule of electrical appliances that must be registered for energy labelling purposes;

9. Using the registration data, rate all registered solar-electric and heat pump storage water heaters and publish the rating on the www.energyrating.gov.au website;

10. Encourage manufacturers to include the energy rating in their brochures;

11. Encourage resellers, plumbers and installers to become familiar with the rating and to make use of it in their advice to solar and heat pump water heater buyers;

12. Develop a format for a physical solar and heat pump water heater label, based on but visually different from those used for other electrical appliances;

13. Amend regulations to make use of the physical solar and heat pump water heater label optional, while proscribing energy labelling in any other format.

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1. Background

1.1 Objectives of this Paper

This report was commissioned by the Australian Greenhouse Office (AGO) on behalf of the National Appliance and Equipment Energy Efficiency Committee (NAEEEC).

The objective of the report is to consider the case for introducing energy labelling for domestic electric storage water heaters, including solar-electric and heat pump types, taking into account:

- the range of water heater technologies and energy efficiencies
- the impact of existing and proposed MEPS regimes
- the way in which consumers, builders and other market intermediaries select energy forms and water heaters
- a previous report on the issue by (EMTF 1997)
- the possible convergence of Australian and New Zealand water heater standards and markets
- the history of other Australian and New Zealand water heater programs, ie Water Mark in NZ and the AGA's gas water heater labelling.

The report makes recommendations regarding whether labelling should be introduced, and the possible types of labelling that might be considered (eg comparative star rating, or endorsement).

Electric storage water heaters are not at present subject to mandatory energy labelling in Australia, but they have been subject to mandatory minimum energy performance standards (MEPS) since October 1999.

1.2 The water heating market

1.2.1 Technologies

Types

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). This makes the water heating service offered by different water heaters easier to compare than other appliances which offer a wide range of cycles and options.

There are several combinations of energy types and technologies on the Australian market which can provide the 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 nearly all 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 are given in Appendix 1.[1]

Energy Efficiency

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 electric storage water heater 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* (Appendix 2).

At present, standing heat losses for all models are tested in order to determine whether they meet MEPS (see below), but the values are not made public. The range of efficiencies is narrow: nearly all electric storage water heater models have a heat loss close to the MEPS level. The water heater is not tested actually delivering water or

[1] In the remainder of this paper the only type of electric storage water heater considered for labelling is the mains pressure type. Low-pressure electric storage units, calorifiers and heat exchangers have very small market shares which Ellis (2001) concludes are likely to decline.

even connected to the water supply, but the standing heat loss value can be used to estimate electricity consumption in use (EMTF 1997).

The energy efficiency of a gas storage water heater depends on two main factors – the efficiency of the gas burner, and the rate at which the unit loses heat (as indicated by the gas consumption required to maintain a given temperature – the "maintenance rate"). The measurement of these factors is defined in the joint Australian Standard/Gas Code AS 4552–2000/AG 102–2000: *Gas Water Heaters*. The water heater is not tested actually delivering hot water, but the measured parameters are used to estimate an annual gas consumption under a standard water heater delivery task.

At present, the burner efficiency and maintenance rate for every model is tested to determine whether the model meet MEPS (see below), but the values are not made public. The estimated annual gas consumption calculated from the values is made public, and is used to determine its gas label rating. The range of efficiencies is reasonably wide, with models rated from 1 to 5 stars on the market.

Determining the energy efficiency of a solar water heater is even more complex, because it involves the most factors: the characteristics of the collector panels, the interaction between the solar and backup energy inputs (which vary with energy tariffs and draw-off regimes), the conversion efficiency of the backup energy (gas or electric) and the heat loss from the storage tank.

The method of calculating the energy consumption of solar water heaters and heat pumps is set out in AS4234-1994 *Solar Water Heaters (Domestic) and Heat Pumps – Calculation of Energy Consumption*. The Standard uses a simulation program (TRNSYS) to calculate the boost energy required at any location in Australia, using the key physical parameters of the water heater and stored data on the solar availability and temperatures at various locations, merged into four geographical zones.

The Commonwealth Renewable Energy (Electricity) Act 2000 requires electricity retailers and other liable parties to source specified percentages of their energy purchases from approved "renewable" sources of electricity. Solar and heat pump water heaters have been included in the list of eligible renewable sources, and although they produce no electricity, the nominal renewable energy output for each model is defined as the amount of electricity displaced, ie:

KWh saved = (kWh that would be consumed by a conventional continuous-tariff electric storage system) – (kWh that would be consumed by that model of solar water heater or heat pump in the same location, also connected to a continuous-tariff)

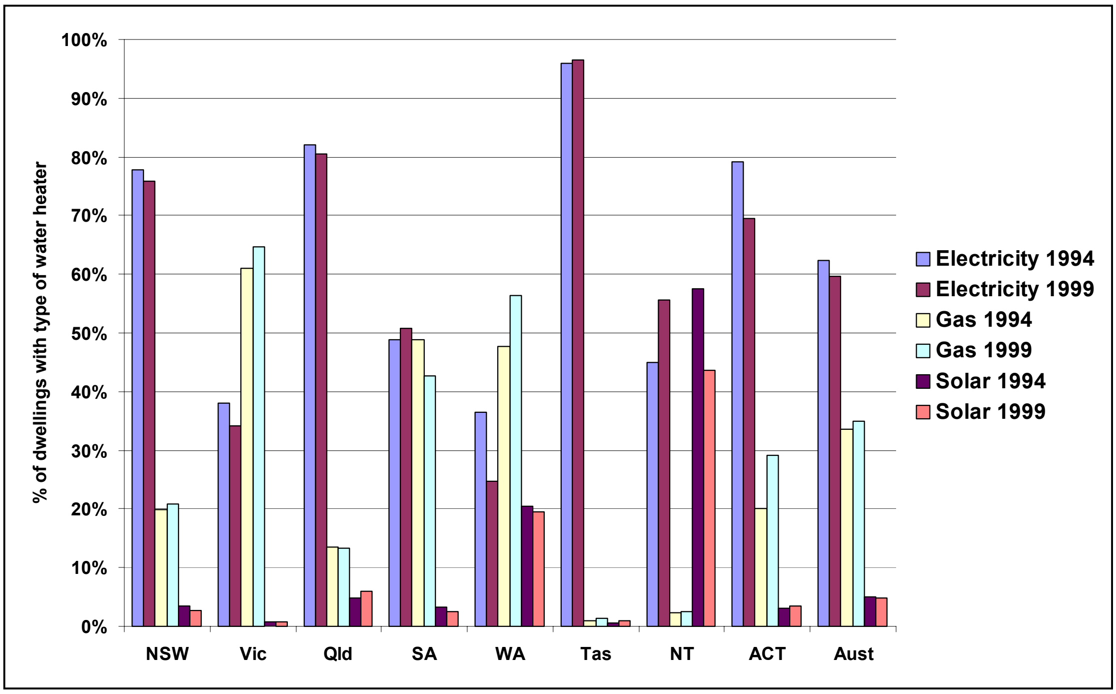
The kWh saved over a nominal 10 year operating life represents the total "renewable electricity" that the model is deemed to supply, and hence the number of Renewable Energy Certificates (RECs) that may be issued for each model installed. The Renewable Energy (Electricity) Regulations 2001 (updated 15 March 2002) list the RECs values for each of 221 solar water heater and heat pump models. Four values are given for each model, corresponding to four geographical zones. These RECs ratings represent in effect an energy efficiency rating for every model of solar and heat pump water heater on the Australian market.

The range of solar water heater efficiencies is fairly wide, with a ratio of about 2 to 1 between the highest and lowest number of RECs for models of about 200 litres capacity.

1.2.2 Stocks and Sales

The majority of Australian households use electricity to heat water, although the proportion is declining. The ABS survey *Environmental Issues* (Cat 4602.0, 1999) estimated that 59.6% of households used electricity as their primary form of water heating in 1999, down from 62.4% in 1994 (Figure 1). The gas share increased from 33.6% in 1994 to 35.0% in 1999, and the solar share remained virtually unchanged at 4.8%. The great majority of gas water heaters use natural gas, but about 3% use LPG.

Figure 1 Installed water heaters by energy type: 1994 and 1999



According to a commercial monitoring company, BIS Shrapnel, about three quarters of gas water heaters are of the storage type, and one quarter instantaneous, but the latter have a much higher share of the new gas water heater market (Table 1). The fact that the market share of electric water heaters is less than the share in the current stock is consistent with the declining stock share observed by the ABS.

Table 1 Estimated stock share and market share by water heater type

Type	Share of households using as main water heater (a)	Share of sales, 2000 (b)
Electric – Storage	59.6%	48%
Gas – Storage	26.9%	29%
Gas – Instantaneous	8.4%	18%
Solar	4.8%	5%

(a) ABS Cat 4602.0 (b) Ellis (2002)

1.2.3 Energy and Emissions

Water heating accounts for the second highest share of energy use in the Residential sector, after space heating, and the second highest share of emissions, after appliances. In 1999 water heating accounted for about 27% of Residential sector emissions, compared with 42% for electrical appliances and 20% for space heating and cooling (GWA 2002).

The energy delivered to water heaters is used in the following ways:

- For all gas and LPG water heaters, some energy is lost during combustion;
- For all forms of storage water heaters (electric, gas or LPG) there are heat losses from the storage vessel;
- The balance of energy is delivered from the water heater as “useful” hot water, although a proportion of this is lost from pipework before reaching the draw-off point.

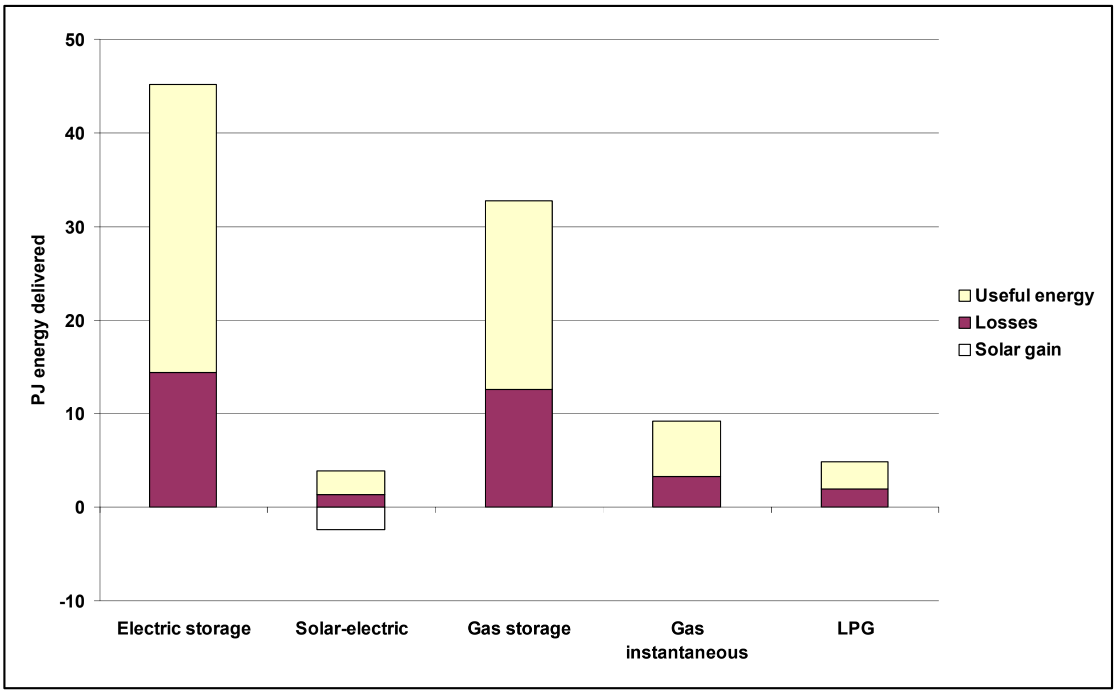
Table 2 and Figure 2 indicate the amount of energy lost and delivered as useful energy for each water heater type, and Figure 3 the associated emissions. Solar gain is indicated as a negative energy input, since it reduces fossil fuel delivered. The solar contribution to solar-electric water heating was about 61% of energy delivered (2.36/(1.29+2.57)). Electric storage water heaters accounted for about 49% of useful hot water, but for nearly 79% of water heating emissions. The high emissions-intensity of electric water heating compared with all other types is indicated in Table 2. Gas and LPG water heaters had a significantly lower emissions-intensity than solar-electric.

Table 2 Water heaters: Energy delivered, lost and used, 1999

	Solar gain PJ	Losses PJ	Useful PJ	Delivered Fossil PJ	Useful/ delivered	Emissions Gg CO_2-e	kg CO_2-e/ useful MJ
Electric storage		14.43	30.75	45.18	68.1%	13238(a)	0.43
Solar-electric	-2.36	1.29	2.57	1.50	170.7%	438	0.17
Gas storage		12.61	20.14	32.75	61.5%	2150	0.11
Gas instantaneous		3.24	6.01	9.25	65.0%	614	0.10
LPG		1.99	2.89	4.88	59.1%	345	0.12
	-2.36	33.57	62.35	93.56	66.6%	16785	0.27

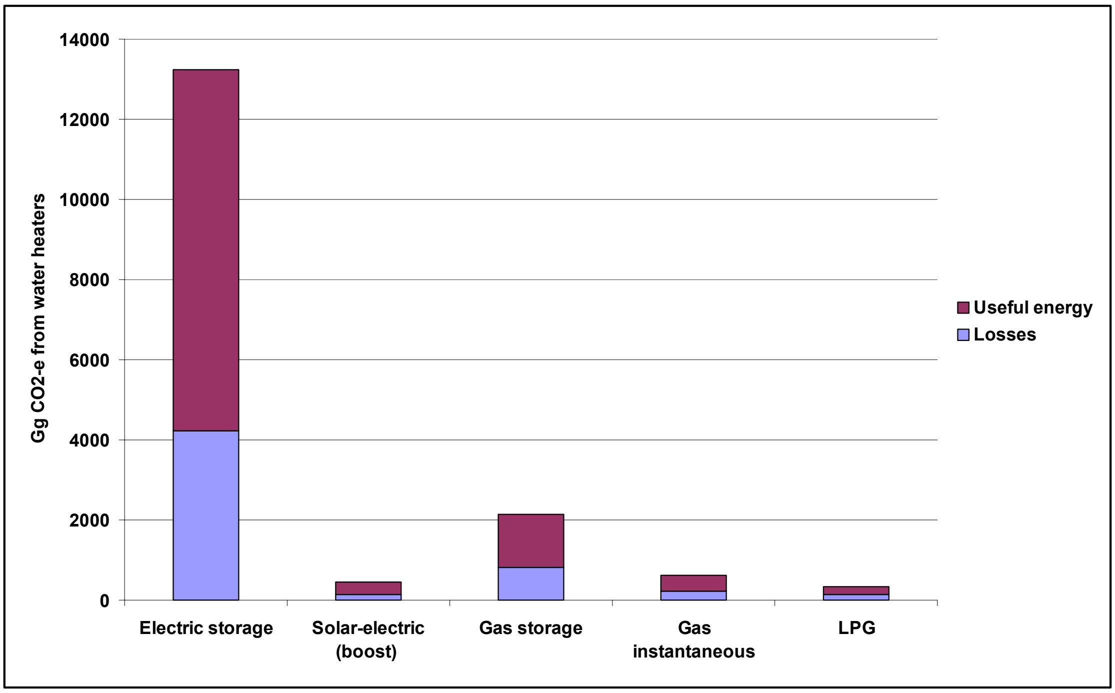
Source: GWA (2002) Low pressure storage types account for about 540 Gg CO_2-e (Ellis 2001)

Figure 2 Energy use in water heaters, Residential sector 1999



Source: GWA (2002)

Figure 3 Emissions from water heaters, Residential sector 1999



Source: GWA (2002)

1.3 Purchase Patterns

1.3.1 The Selection Process

Virtually every dwelling in Australia has at least one water heater, and many have more than one, to serve bathrooms that may be far apart or that have been built or modernised at different times. There are two distinct modes of water heater selection:

- At the time of dwelling construction (or renovation); and
- At the time of replacement of a failed water heater.

The range of options considered by purchasers is usually wider at the time of construction than at the time of replacement. Water heater failures tend to be unforseen and catastrophic (unlike appliances such as refrigerators, which often deteriorate gradually and which are often replaced for reasons of appearance or utility rather than actual failure). Most householders have a very low tolerance for going without hot water. Apart from the cost of time and inconvenience in researching options, there may well be additional monetary costs in changing water heater types:

- The cost of connection to gas, if this is not already connected to the dwelling (in the case of shifting from electric to gas);
- The costs of additional plumbing and wiring, if the water heater is to be relocated from the previous position (even if it is of the same energy form).

Some dwellings do not in fact have the full range of water heater options available. There may be no gas supply in the street, or (in the case of flats) no access to roof space suitable for a solar unit, or to wall space suitable for an external gas unit. Some flats have electric water heaters built into cupboards, and installation of a larger unit (eg off peak rather than day-rate electric) would require rebuilding of the cupboard.

For these reasons, the most common replacement option tends to be the most familiar and the cheapest: a water heater of the same energy form and tariff, installed in the same location. Therefore the choice of water heater made at the time of construction often constrains the choice at each replacement for the remainder of the life of that dwelling. However, some degrees of freedom still remain.

1.3.2 Choice of Energy Form

At the time of construction, the choice of energy form is often made by the builder, especially if the dwelling is built speculatively, without an identified first occupant.

The factors influencing the builder include:

- Whether reticulated natural gas is available – if not, then the decision defaults to electric only;
- If gas is available, the incentives that the gas supplier may be offering to offset the additional cost of connecting to it;

- Incentives that the electricity suppliers might be offering (eg to cover the additional costs of connecting to off-peak, which involves additional wiring and a larger water heater);
- Any other incentives (eg the value of RECs for installing solar water heaters);
- The marketing benefits of have gas or solar water heaters;
- The marketing benefits of installing more energy efficient appliances (eg higher star rated gas water heaters);
- The requirements of building approval authorities. In some jurisdictions, local authorities have begun to encourage "low-energy" or "low-greenhouse" design. This usually concentrates on minimising heating and cooling energy demand, but has also started to prefer certain water heater types, eg solar-electric, heat pump and sometimes gas rather than electric, although the criteria are sometimes inconsistent.

However, the over-riding choice consideration for most builders is to minimise the net capital cost. This does not necessarily mean the cheapest option – which is almost always an electric storage water heater - but the one which is cheapest after all incentives are taken into account, and satisfies any approval requirements. Running costs rarely influence the choice where only the builder is involved.

If the initial occupant is involved in the decision, then it is more likely that running cost or environmental performance will become a choice factor, but only if the householder:

- places a value on running cost and/or environmental performance;
- is aware that different options have different running cost and/or environmental characteristics;
- can readily obtain information about the various energy types and models on offer;
- has access to capital (or cashbacks or incentives) to cover any differences in cost, in the event that the option with lower lifetime cost has a higher initial cost.

At the time of replacement the householder is more likely to be aware of the running costs of alternative options, but will be under pressure of time to make a quick decision. Plumbers and energy suppliers tend to be the main sources of external advice at times of replacing water heaters. The choice tends to be limited to what the plumber recommends, or can obtain quickly. In some cases the energy supplier can have an important influence: the gas utilities in particular have developed methods of enabling a same-day installation of a gas water heater in a dwelling not connected to gas, and running it off a cylinder of compressed natural gas until the connection can done.

1.3.3 Model Choice

In water heaters the main choice usually concerns energy type – eg between electric, gas or solar. The next level of choice is configuration, location or tariff class:

- For gas, whether indoor or outdoor, storage or instantaneous;
- For electric, whether continuous, restricted off peak or extended off peak tariff (and hence size and location);
- For solar, whether close-coupled or other configuration and electricity tariff class (or, rarely, whether to have gas boost).

The choice between comparable models may well be the last factor in the decision process, and it is often made on cost grounds. Builders and plumbers will usually prefer the cheapest model. However, some buyers may wish to compare the energy efficiency of different water heater models through their own research, or request this information from the builders, plumbers or energy suppliers.

Of course, the water heater selection process does not always flow linearly from energy type to configuration to model. For example, there is no electric counterpart to the gas instantaneous water heater, and the Japanese-made models introduced in the 1980s had electronic temperature controls not then available on any other type of water heater (they have only recently been introduced for electric types). Furthermore their energy efficiency was high, with some models rating 6 stars on the gas label scale. Some householders chose gas specifically in order to have the advantages of these models - an example of model and configuration choice driving energy choice.

1.3.4 Options for Market Intervention

Energy accounts for a higher share of the lifetime cost for electric storage water heaters than for almost any other common household appliance. The net present value of energy consumed over the lifetime of a day-rate electric storage water heater accounts for about 80% of the ownership cost (GWA 2001). By contrast, the energy share of total cost is about 50% for gas and off-peak electric water heaters – about the same ratio as for refrigerators. The energy share of lifetime cost is only about 20% for solar water heaters, since they have much higher capital costs and lower running costs.

Given the importance of energy costs in water heater selection, it would be expected that intending buyers would seek out information about the running costs of water heaters and act on that information.

This does not often happen, for the following reasons:

- Many decisions are made by builders and owners of rental properties, who are concerned only with capital cost, since the operating costs will be borne by others (the so-called “split incentives”, or “landlord-tenant” problem);
- Consistent and objective information about the comparative running costs of different energy types is not always readily accessible at the time the decision need to be made;
- Consistent and objective information about the relative energy efficiency of different models of the same energy form is only available for gas water heaters, and even there the label information is not readily accessible, since – unlike appliance purchases - few customers bother to visit a showroom to select a water heater;
- Electric storage water heaters are nearly all built to the same heat loss standard, so there is little point in comparative efficiency labelling.

Some of these factors are evidence of market failure or information failure. Other factors in water heater purchase – notably the high value placed on quick replacement – are not market failures as such but accurately reflect the high value that householders place on an uninterrupted supply of hot water.

The objective of the National Appliance and Equipment Energy Efficiency Program is to identify and overcome these imperfections in energy product markets. The main measures used are energy labelling and MEPS.

Energy Labelling

Energy labelling is a means of indicating the energy consumption or energy efficiency of a product according to some standard criteria. The label can indicate the relative efficiency of the product in relation to some selected reference point (as is the case for gas water heaters) or in relation to the actual range of models on the market. These are called comparative labels.

Alternatively, "endorsement" labels can indicate whether a product meets certain criteria (eg Energy Star standby power consumption), or is among the most efficient 10% of all models.

Comparative labels can use a range of graphical device such as a star rating scale, a bar with pointer, classification numbers or letters. Endorsement labels need only contain the logo of the endorsing program or authority.

Labelling does not only involve physical labels fixed to products. Indeed, the information may be better conveyed in other ways such as websites or brochures, especially for products such as water heaters which are often purchased without a showroom visit.

MEPS

As for labelling, there several possible approaches to MEPS. "Low level" MEPS are set to exclude the least efficient segment (typically a quarter to a third) of the models on the market. This is the approach that has been taken for gas water heaters and for the 1999 MEPS for refrigerators. The levels are determined by analysis of what is on the market.

"High level" MEPS are set at a level that very few or no models can achieve at the time the MEPS levels are announced, but suppliers are given sufficient lead time (typically 3 to 4 years) to redesign their models. This is the approach that was been taken for the 1999 MEPS for electric water heaters, and it will be also applied to the next round of refrigerator MEPS, due 2005.

In addition, a MEPS level may be "absolute" in that no product that exceeds it may be sold, or "sales-weighted", so that some products with lower energy efficiency may be sold, provided that sufficient products with higher efficiency are sold so that the weighted average meets or exceeds the given MEPS level.

The Appropriateness of Labelling and MEPS

Energy labelling and MEPS have separate but complementary functions within an energy efficiency program. Labelling is intended to steer potential buyers to the more efficient products on the market, and enable them to avoid the less efficient. This of course feeds back to suppliers, who gain a commercial advantage from offering more efficient products and from withdrawing their less efficient ones. Labelling works best when there is a range of efficiencies on the market, and where buyers are directly involved in the decision process.

Labelling is less effective where all products are essentially built to the same energy standard, and so have the same rating, and where intermediaries like builders or plumbers have a major influence on the purchase decision. Nevertheless, the introduction of labelling can itself raise awareness of energy efficiency among suppliers and potential buyers, even if the market was not energy-aware beforehand.

Table 3 indicates the typical mix of measures to suit the market conditions for household electric and gas appliances. Where the efficiency range is narrow, and/or intermediary influence is high, MEPS is generally the more effective measure, while for products with wider efficiency range and/or more direct purchasing by end users, labelling is usually more effective. However, technologies and markets evolve, and the mix of measures needs to be reviewed regularly: for example, the main NAEEEP efficiency driver for refrigerators and freezers after 2005 will be high level MEPS, because of the policy commitment to match world's best practice energy efficency levels.

Table 3 Typical mix of measures to suit initial market conditions; household appliances

Efficiency Range	Intermediary influence	Example	Primary measure	Secondary measure
Wide	Low	Electric - RF,FZ,DW,WM,AC Gas – Flued space heaters	Labelling	Low-level MEPS
Narrow	High	Electric – water heaters	High-level MEPS	None
Wide	High	Gas – water heaters, ducted heaters	Medium-level MEPS	Labelling
Narrow	Low	Gas – Unflued space heaters Electric – Clothes dryers	Low-level MEPS	Labelling

The design of the label and the comparative rating scales should relate to the way buyers are likely to select the product, and on the condition of the market. If buyers and suppliers respond to labelling, then models will come to be bunched at the top of the star rating scale, and labelling effectiveness will fall unless the scales are revised. A list of the rating of every model on the market is enough to allow a judgement of the potential effectiveness of labelling.

MEPS levels on the other hand are influenced more by technical considerations and cost-benefit analyses. In order to set optimum MEPS levels it is necessary to have data on model sales and on the general cost and efficiency implications of various technologies and options.

Because of these differences in approach, it is not essential to formally connect label scales to MEPS levels, although it is necessary to be aware of how the two interact. There is no point in setting label scales so that every MEPS-complying product scores 5 stars.

2. Water Heater Energy Programs

2.1 Australia

2.1.1 MEPS

Electric

In the early 1990s the Australian and New Zealand Minerals and Energy Council (ANZMEC) commissioned a study on the benefits and costs of implementing MEPS for household electrical appliances in Australia.[2] The recommendations concerning electric storage water heaters were that:

- "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 Appendix 2). The regulations under State and Territory energy labelling legislation were amended to make compliance with AS1056.1 mandatory, with effect from the same date. These maximum heat loss values are known as the "1999 MEPS levels".

[2] At the time, the maximum heat loss levels for unvented storage water heaters were equivalent to those specified in Column 3 of Table 9 in Appendix 2.

In 2001 the NAEEEC commissioned a Regulatory Impact Statement on the costs and benefits of increasing the stringency of the 1999 MEPS for smaller electric water heaters (GWA 2001). The RIS 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 January 2005.

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 allow the option of "sales-weighted" compliance, for water heaters of 50 litres delivery volume only. Suppliers who take this option could continue to sell water heaters which meet the current (ie 1999) MEPS level up to 1 January 2010, so long as the sales-weighted average heat loss of all their sales of 50 litre models over the 5 years to 1 January 2010 is no higher than the revised (ie 2005) MEPS level for 50 litre delivery water heaters.

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.

The Australian MEPS levels for main pressure electric storage water heaters of 80 litres and above currently represent "world's best practice". New US MEPS levels announced in January 2001 to take effect in January 2004 will be more stringent: about 30% less heat loss for 80 litre models, and then converging to the present Australian levels, so that there is little difference for 250 litre models (EES 2001). This could trigger a review of the Australian MEPS regime for larger electric storage water heaters.

MEPS limiting maximum standing heat loss are also planned for a number of miscellaneous electric water heater types, which have much lower market shares than the main pressure storage types: low pressure storage types, electric boosted solar types and calorifiers and heat exchangers (in which the supply water is passed through a cylinder of hot water from which it picks up heat) (NAEEEC 2002).

Gas

The joint Australian Standard and Gas Code for gas water heaters (AS4552-2000 AG102-2000) contains minimum values for the thermal efficiency of burners in storage and instantaneous water heaters, and maximum values for the rate of gas consumption required to maintain the temperature of stored water in storage heaters (the “maintenance rate”).

These values have effectively become MEPS levels because gas utilities and regulators will only allow the connection of products that have the approval of the Australian Gas Association (AGA), and compliance with the relevant Codes is a condition of approval.

A recent study has reviewed the MEPS levels for gas water heaters and other gas appliances (Ellis 2002).

2.1.2 Labelling

Gas

A form of gas appliance labelling was introduced by the Gas and Fuel Corporation of Victoria (GFCV) in 1981, when the first “high efficiency” balanced fuel gas storage water heaters (SWH) came on to the market. In fact, the scheme was largely designed to create market interest in the new products, which were distinguished in GFCV showrooms with an “E” label.

In 1985 the AGA took control of the program and devised a scheme whereby products could carry “20%”, “30%” or “40%” labels to indicate the extent to which they consumed less gas than the maximum specified in Australian Gas Standard AG102. In 1988 the AGA adopted the current six star rating label design, largely for visual consistency with the electrical appliance label which was introduced in late 1986.

The label rating is based on comparison with the annual gas consumption of a reference water heater with a storage volume of 140 litres and a burner rating of 30MJ/hr, and which just complies with the AG102 limits of 70% thermal efficiency and 1.14 MJ/hr maintenance rate). The delivery task is the equivalent of raising 200 litres per day from 15ºC to 60ºC (ie a useful energy output of 13,760 MJ/yr) while the water heater stands in an ambient air temperature of 20ºC. Under these conditions the reference model would consume 28,900 MJ of gas, giving a task efficiency of 47.6%.

The star rating scale is based on 7% intervals: units consuming between 100% and 93% of the energy of the reference get one star, those consuming between 86% and 93% get 2 stars and so on (see Table 4). The formula allows the calculation of fractional (ie decimal) stars, but these were not reported before 1999.

The star ratings for instantaneous water heaters are related to the same reference. Because there are no losses from stored water, and for units with electronic ignition no pilot losses, instantaneous water heaters (IWH) generally achieve a higher star rating than a storage water heater (SWH) unit with comparable burner and heat transfer efficiency.

Table 4 AGA Energy Efficiency Ratings - Water Heaters

Star rating	Max MJ/yr (a)	% of reference	Task efficiency for storage water heater
1	28900	93 - 100%	47.6 - 51.1%
2	26880	86 - 92.9%	51.2 - 55.3 %
3	24850	79 - 85.9%	55.4 - 60.2%
4	22830	72 - 78.9%	60.3 - 66.0%
5	20810	65 - 71.9%	66.1 - 73.1%
6	18790	Less than 65%	73.2% or more

Source: derived by author from AGA data
(a) To deliver 13760 MJ of useful energy in hot water

Until the mid 1990s the suppliers of gas appliances were able to choose whether to label their products, and only the more efficient were labelled. Although the AGA acquired information about product efficiency as part of the approval process, the information was not widely disseminated. Furthermore there was at first no general obligation to actually affix labels, although for a time the GFCV made it a condition of display in its showrooms.

In March 1993 the AGA decided to make it a condition of appliance approval that the energy rating be calculated and that the labels be affixed to all water heaters produced. Labelling became effectively mandatory by 1995, by which time all pre-existing registrations had to be renewed.

From 1989 the star rating of most products was published in the AGA and ALPGA *Directory of Certified Gas Appliances and Components*, but this was intended largely for the use of AGA and ALPGA members.[3]

A recent study has reviewed the operation and effectiveness of labelling levels for gas water heater and other gas appliances (Ellis 2002).

Electric

Electric water heaters have never been energy labelled in Australia, but labelling has been considered from time to time. In deciding to proceed with MEPS for electric storage water heaters in March 1995, the Australian Minerals and Energy Council requested its Energy Management Task Force (EMTF) to investigate the feasibility and cost effectiveness of energy labelling. The EMTF set up a Joint Working Party with representatives of the industry, Standards Australia and the Australian Consumers Association. The Joint Working Party reported in October 1997 (EMTF 1997).

The Working Party summarised its approach as follows:

> Energy consumption of water heaters could be measured for different units by considering their static efficiency (generally heat losses), their task efficiency (when delivering hot water) or a combination of the two. While a test based on standing heat loss would be relatively straightforward (and less costly), it would not be truly representative of actual in-use performance. Further, a heat loss test

[3] From January 2000 the *Directory* became publicly accessible via the AGA website, but the format has not changed.

is unlikely to provide reasonable differentiation between models. Usually there are only two models in each of the eight sizes on the Australian market and it is generally accepted that manufacturers aim for the heat loss of every unit to be within 0.2 kWh/day of the relevant AS1056.1 limit. It is doubted whether labelling based on heat loss would provide sufficient encouragement to manufacturers to differentiate their product from competitors on that basis.

A more realistic indicator of actual in-use energy consumption would be to take into account hot water delivered.

The study uses formulae to estimate the in-use energy consumption for two standard delivery tasks (37.7 MJ/day and 20 MJ/day hot water) at two operating temperatures. The MJ/litres/day values are higher at the lower delivery (since standing heat losses account for a higher share of total energy) and at the higher temperatures (since heat loss is proportional to temperature difference). Water heaters with heat loss corresponding to the 1999 MEPS level, 10% lower and 20% lower were considered (see Appendix 3).

Heat loss is a relatively small share of total energy delivered in use, ranging from 8% to 29% of the energy delivered in all the scenarios modelled in Appendix 3, and task efficiency (the proportion of energy delivered as hot water) ranged from 71% to 92%. An energy rating approach which concentrates on task efficiency will compress the apparent difference between units. Although there was a 3.5 to 1 (29/8) ratio between the extremes of energy lost as heat, there was only a 1.3 to 1 (92/71) ratio between the extremes of task efficiency. Clearly, labelling on heat loss would have more impact on buyers than labelling on task efficiency, because the range of values is wider.

The Joint Working Group's conclusion that a rating approach based on standing heat loss alone would be any less "truly representative of actual in-use performance" than one based on task efficiency is questionable. Users will have different and varying daily usage cycles and therefore different task efficiencies, and the only certainty is that a more highly insulated water heater (as indicated by a lower standing heat loss) will have lower heat losses in use. The actual kWh/day lost will in most cases be somewhat lower than the AS1056.1 kWh/24 hr loss, but the ranking of units, form highest to lowest loss, should be the same in use as in the test laboratory.

The assumptions about the water heater market which the Joint Working Group embodied in its study may no longer apply. There now does appear to be a divergence in heat losses of different models and the proposed revision of MEPS levels for smaller water heaters is likely to widen the range even further (see Section 3). This would make a labelling approach based on standing heat loss alone more effective.

The conclusion of the Joint Working Party were as follows:

The Working Party's analysis indicates that energy labelling for water heaters would not be cost effective. Because of the peculiar nature of the water heater market, the estimated savings resulting from the introduction of labelling are estimated to be about $140,000 p.a. This saving is significantly outweighed by the estimated costs, with the cost of labels alone estimated to be about

$330,000 p.a. In these circumstances, even a simple labelling scheme based on standing heat loss using the result of MEPS testing could not be justified.

However, the Working Party did not consider a low-cost energy rating scheme that did not involve actual labels on every product. A scheme of this type is proposed in Section 3 of this report.

Solar

As with electric water heaters, labelling for solar-electric water heaters has been proposed from time to time, but not implemented. Solar-gas water heaters are labelled, and they are arguably disadvantaged because of this. The standard on which the AGA labelling program is based (AS4552-2000/AG102-2000) does not allow for the solar input. Therefore the solar-gas water heaters are tested as if they were conventional storage water heaters, with only the burner efficiency and the maintenance rate taken into account. The solar water heaters listed in the AGA directory are all rated between 1 and 4 stars, whereas the conventional gas water heaters are rated between 1 and 5 stars.

This approach fails both tests of the effectiveness of solar water heater labelling:

- It fails to indicate that a gas-boosted solar water heater will use substantially less gas than a conventional water heater in use (in fact, it suggests the opposite); and
- it also fails to indicate the ranking of energy efficiency between solar-gas models, since it tests only the gas part of the system, not the whole; a system which gets the lowest rating on the AGA test could conceivably get the highest rating if tested with solar input.

It has been suggested that the AGA energy test could be revised to give a better representation of the performance of solar-gas products (Ellis 2002).

Both solar-electric and solar-gas models are given a form of energy rating by the number of Renewable Energy Certificates (RECs) assigned to them in the Renewable Energy (Electricity) Regulations. The potential for this to be used as a basis for a full energy rating are discussed in Section 3.

2.2 Overseas

2.2.1 New Zealand

New Zealand had a voluntary energy labelling program for electric storage water heaters in the 1990s. 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).[4]

There is no MEPS or labelling requirement for gas water heaters, but as most units sold are imported from Australia, the AGA MEPS and labelling requirements impact on the NZ market.

MEPS for electric storage water heaters in under consideration. 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 5 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 9). The NZ efficiency standard is equivalent to between 47% and 61% of the current Australian MEPS level.

Table 5 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.

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 electric storage water heaters sold in NZ (and all small water heaters) have heat losses well in excess of the standard.

For some years, consideration has been given to making the standard mandatory, at least for new installations if not for all installations. MEPS could be enforced for new installations by amending the New Zealand Building Code to require new electric water

[4] 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.

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 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.[5]

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 water heaters have yet been passed.

2.2.2 Other

In other countries with energy efficiency programs covering storage water heaters, the emphasis is on MEPS rather than labelling (Table 6). The USA is the only OECD country with mandatory energy labelling for storage water heaters (electric, gas and oil). The European Union is considering energy labelling for water heaters, but no firm plans have been made yet.

Table 6 Other Water Heater Energy Labelling and MEPS Programs

	USA		Canada		Europe		UK	
	MEPS	Label	MEPS	Label	MEPS	Label	MEPS	Label
Storage	Yes	Man(a)	Yes	Vol(b)	Yes	No	Yes	No
Instantaneous	Yes	No	No	No	Yes	No	Yes	No

Source: EES (2001) (a) Comparative label (b) Endorsement label

5 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.

3. Labelling Options

3.1 Potential Benefits and Costs

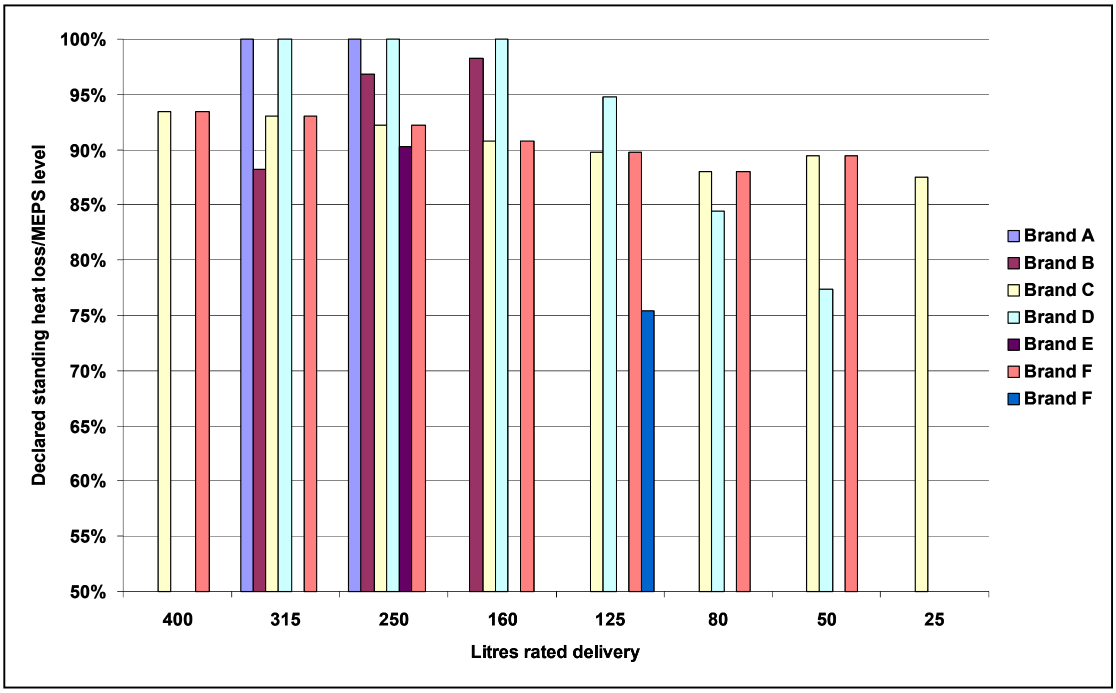
The main issues with regard to labelling electric storage, solar-electric and heat pump water heaters are:

- Is it likely to increase the effectiveness of the NAEEEP?
- Is the measure practical?
- Are the benefits likely to exceed the costs?

3.1.1 Electric Storage Water Heaters

There is little point in developing a label for products that are all close to the same level of energy efficiency. This has historically been the case with electric storage water heaters, but there are now signs of divergence. The website www.energyrating.gov.au lists the details of all appliance models registered for energy labelling and MEPS, including electric storage water heaters. There are 55 models listed, of which 28 are distinct models.[6] The ratio of the registered heat loss of each model to its MEPS level (the "MEPS ratio") is illustrated in Figure 4.

Figure 4 Electric Storage Water Heaters –Heat Loss compared with MEPS



[6] The rest are either left/right hand variants or (in the case of Vulcan and Rheem) rebadged variants from the same manufacturer. Each supplier makes only one model of each capacity, except that Rheem offers two 125 litre models.

For the six size categories where there are models with different MEPS ratios, the difference between the highest and lowest MEPS ratio varies from about 4 percentage points to over 19. There would be an even wider range of efficiency levels on the market if either of the following events occurred:

- "sales-weighted" MEPS were introduced for electric water heaters of 50 litre delivery, as has been recommended in the RIS on small water heater MEPS (GWA 2001); or

- the New Zealand Government were to adopt the heat loss levels in NZS4305:1996 *Energy Efficiency – Domestic Type Hot Water Systems* as MEPS, and water heaters meeting this MEPS level were to appear on the Australian market.

Either of these events would introduce a number of models of significantly lower heat loss than the AS1056 limit. For a supplier to achieve a "sales-weighted" MEPS corresponding to a heat loss 30% lower than the 1999 MEPS level, while continuing to sell small numbers of the current model, it would have to introduce a new model with a heat loss which may be *more than* 30% below the 1999 level – how much more depends on the heat loss of its current model.

It would then have to ensure that the sales of the new model were high enough to achieve the sales-weighted target, so that it did not incur penalties. It would do this through controlling the pricing differential, promotion and availability of the two models. The supplier would be greatly assisted in this objective if buyers were able to identify the more efficient models by means of a reliable, government-endorsed energy label.

The heat loss levels in NZS4305:1996 are about 50% below the 1999 Australian MEPS levels, although there is some debate about the equivalence of the test method. There are no mains pressure storage models on the market meeting the NZS4305 levels, but they would have be introduced if NZ adopted these levels for MEPS.

Given these possibilities, there may well be up to four distinct efficiency levels on the market, at least in the 50 litre class for which the sales-weighted MEPS option has been proposed:

- The current model, which those suppliers who opt for a "sales-weighted" MEPS target could retain on the market until January 2010;

- The new models which those suppliers who opt for a sales-weighted MEPS target would have to introduce, as early as possible: these would have to have a heat loss in the range 35%-40% below the 1999 MEPS levels;

- The new models which those suppliers who did *not* opt for a "sales-weighted" MEPS target would have to introduce in January 2005: these would have to have a heat loss 30% below the 1999 MEPS levels;

- Models meeting NZS4305; these would have a heat loss about 50% below the 1999 MEPS levels.

The existence of a comparative energy labelling program would allow buyers to readily compare the heat loss of these models, and could provide an incentive for suppliers to introduce the more efficient types earlier than otherwise. Both outcomes would accelerate the rate of energy and greenhouse savings from the introduction of MEPS, and so enhance the effectiveness of the NAEEEP.

If no supplier opted for a sales-weighted MEPS target in Australia, and NZS4305 were not adopted as a NZ MEPS level, then the current range of small water heater models would need to be replaced, by January 2005, with new models with 30% lower heat loss. Even though all the new models are likely to have similar heat losses, the existence of a labelling program could motivate some suppliers to bring forward the date of introduction of their new models in order to gain a commercial advantage. Again, this outcome would accelerate the rate of energy and greenhouse savings from the introduction of MEPS, and so enhance the effectiveness of the NAEEEP. Labelling would need to be mandatory, so that the less efficient models could also be readily identified.

For the time being, it is only possible to speculate on the effects of labelling on the smaller water hater market, because there are no firm proposals for revising the MEPS levels for larger models. If sales-weighted MEPS options were adopted for large water heaters as well, the same arguments for labelling would also apply. Indeed, the existence of optional labelling could lead to the introduction of large water heater models with lower heat loss than the 1999 MEPS even before more stringent MEPS levels are considered.

Buyers – including institutional buyers such as housing authorities - are the most obvious target group for electric storage water heater labelling. However, building approval authorities may also be interested. Labelling would allow then to easily differentiate electric water heater models by efficiency level, so rather than excluding or penalising all electric water heaters in design guides they could treat the more efficient models more favourably.

Labelling Options

The existing 6 star label rating scale could be readily adopted for electric storage water heaters, using the same principle as the gas water heater labelling scale: the number of stars indicates the percentage reduction band compared with the MEPS level.

Table 7 illustrates two possible scales. On Scale A, models meeting the current (1999) MEPS level would rate 1 star. Small water heaters meeting the proposed Australian 2005 MEPS would rate 4 stars, and those meeting the proposed NZ MEPS would rate 5 or 6 stars. On Scale B, small water heaters meeting the proposed Australian 2005 MEPS would rate only 3 stars, but a fourth star would be more easily achievable for a supplier that took the sale-weighted MEPS option and needed a better-than-MEPS model to achieve it. This scale would give such a model a competitive edge over a 3 star just-complying model. The lowest MEPS ratio of any model on the market today is 75.4%, and this model would rate 3 stars on either scale.

Because MEPS options for large water heaters have not yet been proposed, the effect of these scales following a revision of MEPS is less clear. The introduction of the 1999 MEPS forced a greater heat loss reduction for large electric storage water heaters than for small ones. It is possible that the cost-effective scope for further reduction may be of the order of about 20-25% rather than 30% as for smaller water heaters. If so, scale B would obviously be more favourable, since 5% less reduction in heat loss would be required for any given star rating.

Table 7 Possible star rating scales for electric storage water heaters

	% of current AS1056 heat loss	
Star rating	Scale A	Scale B
1	>90-100%	>95-100%
2	>80-90%	>85-95%
3	>70-80%	>75-85%
4	>60-70%	>65-75%
5	>50-60%	>55-65%
6	<50%	<55%

Energy labelling need not involve a physical label attached to every unit. The proportion of buyers who take the trouble to inspect actual models of electric storage water heaters in a showroom before purchase is very low. The least costly ways of conveying the label rating would include:

- Manufacturer brochures and websites
- Brochures produced by government energy agencies and energy utilities
- The www.energyrating.gov.au website.

Calculating a label rating at the time of MEPS registration and then adding the rating to websites would involve negligible cost.

Some suppliers may wish to attach a label to their products, and if so there should be an obligation to use a prescribed format, which could be similar to the label used for all other electrical appliances.

3.1.2 Solar and Heat Pump Water Heaters

There is already an energy efficiency labelling system for solar water heaters. The issue is how to make it more accessible, more informative and more effective. The number of RECs attributable to each model indicates its energy efficiency. For models with the same capacity (in litres), the higher the number of RECs the less the amount of boost energy needed. The Renewable Energy (Electricity) Regulations list the number of RECs attributable to each registered solar water heater model in each of the four geographic zones, but give none of the other data that a prospective buyer would need: the storage volume, the configuration (eg whether close coupled or floor-standing tank) or the number of collectors. The only guidance that the Regulations give is to divide water heaters into “large” and “small” categories.

Table 8 indicates the range of the number of RECs attributable to large and small solar water heaters. It is not possible to identify the storage capacity of each model from the list in the Regulations, although the model number designations given some indication of size. "Large" appears to cover everything from 200 litre tanks with a single panel collector up to 630 litre tanks with 4 collectors. For a prospective buyer, a more useful indicator of comparative efficiency for would be RECs per litre of storage volume.

Table 8 Number of RECs attributable to solar water heaters

Type	Number of models		Zone 1	Zone 2	Zone 3	Zone 4
Large systems	167	Lowest no. of RECs	17	18	17	13
		Highest no. of RECs	64	62	64	52
Small systems	54	Lowest no. of RECs	12	13	12	9
		Highest no. of RECs	22	21	23	20

Source: Renewable Energy (Electricity) Regulations 2001 No 2 as amended

It would be a relatively simple matter to load all of the RECs ratings, as well as the base data used to calculate the ratings, on to the www.energyrating.gov.au website. The site could also provide a star rating based on RECs/litre stored. The lowest RECs/litre value could be set at one star, with the highest at 5 stars.

Unlike electric storage water heaters, where all models must be registered for MEPS, there is no obligation on solar water heater suppliers to register their models with the Office of the Renewable Energy Regulator (ORER). However, there is a strong commercial incentive for suppliers: models can only produce RECs if they are registered, and their associated RECs are calculated in accordance with the approved methodology.

If solar water heater were to be labelled, it would be necessary to obtain the same data as are currently provided to ORER. ORER cannot release the data without the approval of the product supplier. The most efficient way to ensure coverage would be to bring solar water heaters directly within the framework of energy labelling, by adding them to the list of products that must be registered for labelling (but not MEPS).

In this case the energy labelling need not involve a physical label attached to every unit. The proportion of solar water heater buyers who take the trouble to inspect actual models in a showroom before purchase is very low. The least costly ways of conveying the label rating would include:

- Manufacturer brochures and websites
- Brochures produced by government energy agencies and energy utilities
- The www.energyrating.gov.au website

Since the same data are required as for ORER, requiring registration of each model would involve negligible cost.

Registration should be mandatory rather than optional, so that interested buyers can identify the less efficient models as well as the more efficient ones. Some suppliers may wish to attach a label to their products, and if so there should be an obligation to use a prescribed format, which could be similar to the label used for all other electrical appliances.

3.2 Conclusions

Mains Pressure Electric Storage Water Heaters:

The development and publication of energy ratings for electric storage water heaters would involve negligible additional costs, since all necessary data are already collected and reported to the State regulators to demonstrate compliance with MEPS.

Therefore even moderate increases in the effectiveness of the National Appliance and Equipment Energy Efficiency Program would justify the implementation of an *energy rating* system, with the data published in ways that involve negligible cost – brochures and websites.

Although the level of buyer interest in and awareness of the relative energy efficiency of alternative electric water heater models is fairly low, the existence of an accessible rating scheme would assist those buyers who are interested, and indeed could stimulate buyer interest by revealing differences.

The way in which electric storage water heaters are purchased means that the benefits of mandatory physical labelling are unlikely to exceed the costs. Therefore, physical labelling should not be mandatory, but should be available as an option for suppliers.

There are already some differences in heat loss between electric water heater models, and the range of efficiencies for smaller water heaters is likely to widen considerably with the introduction of new models in the lead up to the implementation of revised MEPS levels in 2005.

The range of efficiencies for larger storage water heaters may also widen, depending on whether, how and when the current MEPS levels are revised.

Energy ratings will obviously assist buyers and intermediaries who are seeking to purchase, or advise on the purchase of, electric storage water heaters.

Energy ratings could also assist the electric water industry by:

- Assisting those suppliers who opt for sale-weighted MEPS targets to achieve their target, and hence avoid or reduce any penalties; and
- Allowing those approval authorities with sustainable energy or greenhouse guidelines to identify and permit the installation of more efficient electric storage water heaters, rather than to exclude all electric water heaters.

Solar Water Heaters (Electric Boosted) and Heat Pump Water Heaters

The development and publication of energy ratings for solar-electric and heat pump storage water heaters would involve negligible additional costs, since all necessary data are already collected and reported to the Office of the Renewable Energy Regulator.

Therefore even moderate increases in the effectiveness of the National Appliance and Equipment Energy Efficiency Program would justify the implementation of an *energy rating* system, with the data published in ways that involve negligible cost – brochures and websites.

The buyers of solar water and heat pump heaters tend to be more interested and involved in the purchase than the buyers of conventional electric storage water heaters. The existence of an accessible rating scheme would assist buyers, and indeed could stimulate buyer interest by revealing efficiency differences.

The way in which solar-electric and heat pump storage water heaters are purchased means that the benefits of mandatory physical labelling are unlikely to exceed the benefits. Therefore, physical labelling should not be mandatory, but should be available as an option for suppliers.

There are already considerable differences in the energy efficiency of alternative models, and indicated by the wide range in attributable RECs for models of similar storage capacity. However, the full extent of these differences is not apparent from the published RECs data, and would only become apparent if a systematic energy rating program were implemented.

Energy ratings will obviously assist buyers and intermediaries who are seeking to purchase, or advise on the purchase of, solar-electric and heat pump storage water heaters.

A Unified Rating?

A unified rating scheme would rate all conventional electric, solar-electric and heat pump storage water heaters on the same scale. For example:

- a conventional electric unit with a heat loss of 75-100% of the MEPS level might rate 1 star;
- a conventional electric unit with a heat loss of 50-75% of the MEPS level might rate 2 stars;
- a conventional electric unit with a heat loss of less than 50% of the MEPS level might rate 3 stars;
- a solar or heat pump unit with a renewable energy contribution of less than 50% might rate 4 stars
- a solar or heat pump unit with a renewable energy contribution of 50-75% might rate 5 stars
- a solar or heat pump unit with a renewable energy contribution of more than 75% might rate 6 stars.

The theoretical advantage of such a unified scale is that it could give prospective purchasers who have not decided between conventional electric, solar-electric or heat pump two distinct types of information at the same time:

- That solar and heat pump types are more "energy-efficient"
- That there is a range in efficiencies between models even of the same type.

However, the decision on energy type is often taken prior to, and largely separately from, the choice of model. Buyers tend to regard conventional electric, solar-electric and heat pumps as distinct energy/technology options, rather than as alternative forms of electric water heating. The potential influence of a unified label on energy form selection is likely to be low.

The use of a unified 6-star label would restrict the rating's potential value in influencing model choice: only half as many gradations would be available for each technology type than if separate scales were used. (Of course, a unified water heater label could be extended to 10 or even 12 stars, but this would make it visually distinct from other appliance labels.)

The difficulty of agreeing on a unified scale should not be underestimated. The pragmatic approach would be to use different technical bases for the two halves of the scale – as in the example above. If however it were considered necessary to devise a common determination of energy consumption for a given water heater delivery task, then either physical testing or some form of simulation would be necessary for all conventional water heater models. As this is not carried out at present – only standing heat loss is reported – it would require additional cost.

A further complication for a unified scale is existence of the gas water heater label. If buyers became accustomed to interpreting a unified electric water heater rating as an indication of relative energy efficiency across energy/technology types, they may begin to apply the same assumptions to the gas water heater label, on which an energy-efficient conventional gas unit can rate 6 stars.[7] This would make it visually equivalent to an efficient solar-electric on a unified 6 gradation scale. This may well be desirable as a reasonably accurate indication of the similar *greenhouse* impact of the two alternatives, but would introduce a further layer of meaning and potential controversy.

The greenhouse impact of alternative energy/technology combinations is an important issue and one which should receive more attention in the product purchase decision than it does now. This is more effectively handled by means such as the structure of the www.energyrating.gov.au website, which should direct users to comparative information on the energy alternatives for water heating before directing them to separate rating lists for electric, gas and solar water heaters. A calculation option for the greenhouse gases emitted by each model when installed in different States could also appear next to its rating (similar to the energy cost calculation option that is already provided).

[7] The gas label does not at present handle solar-gas units effectively. A recent study has recommended that this be rectified (Ellis 2002).

In conclusion, it is not necessary to aim for a unified labelling system encompassing both conventional electric storage water heaters and unconventional solar or heat pump models, for the following reasons:

- Energy type choice is made earlier in the search process than model type;
- It would compromise the effectiveness of the label for model choice.
- There is already general awareness that solar is "more efficient" than conventional electric, and solar has been and continues to be heavily promoted by special government incentives, and now by the value of RECs. Any additional raising of awareness of solar from a unified label is likely to be negligible.

If the rating scales are kept separate it would be advisable to emphasise this visually, perhaps by using different graphic devices (eg "suns") for solar water heaters. Otherwise, some users may get the impression that there are no energy efficiency differences between a four star electric storage water heater and a four star solar-electric water heater.

3.3 Recommendations

Mains Pressure Electric Storage Water Heaters:

It is recommended that the National Appliance and Equipment Energy Efficiency Committee:

1. Develop a six-star energy rating scale for electric storage water heaters, based on the ratio of tested heat loss to the maximum heat loss in the current (1999) MEPS level;

2. Using the registration data, rate all registered storage water heaters and publish the rating on the www.energyrating.gov.au website;

3. Encourage water heater manufacturers to include the energy rating in their brochures;

4. Encourage resellers, plumbers and installers to become familiar with the rating and to make use of it in their advice to water heater buyers;

5. Develop a format for a physical water heater label, similar to those used for other electrical appliances;

6. Amend regulations to make use of the physical label optional for electric storage water heaters, while proscribing energy labelling in any other format.

Solar Water Heaters (Electric Boosted) and Heat Pump Water Heaters

It is recommended that the National Appliance and Equipment Energy Efficiency Committee:

7. Develop a six-star energy rating scale for solar-electric and heat pump storage water heaters, based on the formula used to calculate Renewable Energy Certificates (RECs), but also taking into account factors such as storage volume;

8. Add solar-electric and heat pump storage water heaters to the schedule of electrical appliances that must be registered for energy labelling purposes;

9. Using the registration data, rate all registered solar-electric and heat pump storage water heaters and publish the rating on the www.energyrating.gov.au website;

10. Encourage manufacturers to include the energy rating in their brochures;

11. Encourage resellers, plumbers and installers to become familiar with the rating and to make use of it in their advice to solar and heat pump water heater buyers;

12. Develop a format for a physical solar and heat pump water heater label, based on but visually different from those used for other electrical appliances;

13. Amend regulations to make use of the physical solar and heat pump water heater label optional, while proscribing energy labelling in any other format.

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Appendix 1. Storage Water Heater Technology and MEPS

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 2. Current MEPS levels for Electric Storage Water Heaters

AS 1056 publishes the maximum rates of heat which water heaters should achieve (Table 9). 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.

Table 9 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	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.

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.

Appendix 3. Estimated in-use energy consumption, selected electric storage water heaters

125 litre; cont

Temp	Delivery	Efficiency	MEPS		MEPS - 10%		MEPS - 20%		Heat loss/total energy		
Dec C	litres/day	98%	kWh/24hr	kWh/yr	kWh/24hr	kWh/yr	kWh/24hr	kWh/yr	MEPS	MEPS-10%	MEPS-20%
60	200	3906	1.95	4401	1.76	4349	1.56	4249	11.3%	10.2%	8.1%
60	106	2072	1.95	2578	1.76	2526	1.56	2474	19.6%	18.0%	16.2%
70	164	3906	1.95	4553	1.76	4489	1.56	4424	14.2%	13.0%	11.7%
70	87	2072	1.95	2719	1.76	2655	1.56	2590	23.8%	22.0%	20.0%
kWh/yr loss (MEPS)			kWh/yr loss (MEPS-10%)			kWh/yr loss (MEPS-20%)			Heat loss/total energy		
AS1056	Actual	Actual/AS	AS1056	Actual	Actual/AS	AS1056	Actual	Actual/AS	MEPS	MEPS-10%	MEPS-20%
712	495	70%	641	443	69%	569	343	60%	88.7%	89.8%	91.9%
712	506	71%	641	454	71%	569	402	71%	80.4%	82.0%	83.8%
712	647	91%	641	583	91%	569	518	91%	85.8%	87.0%	88.3%
712	647	91%	641	583	91%	569	518	91%	76.2%	78.0%	80.0%

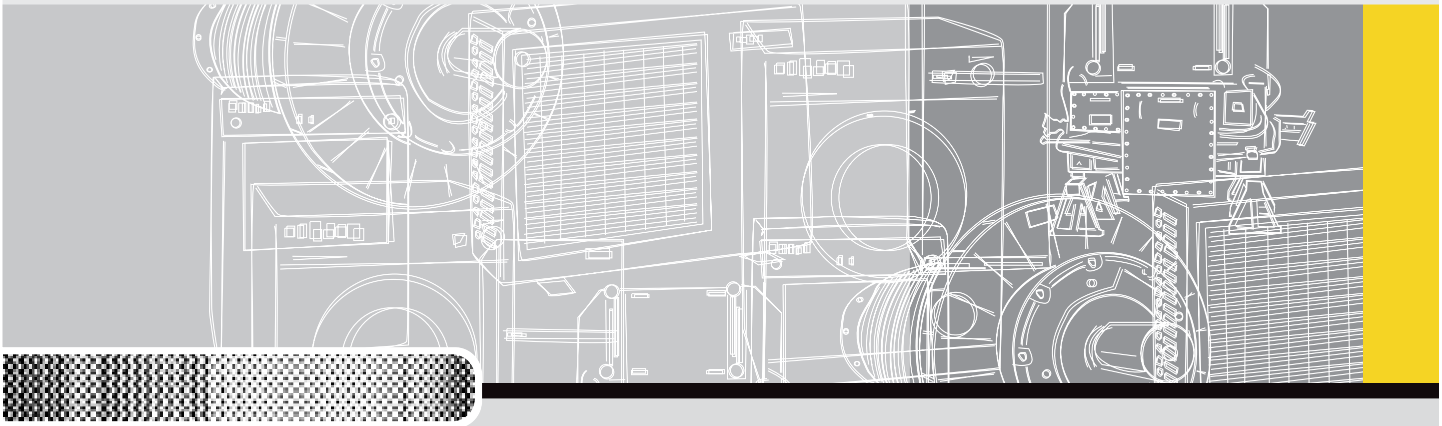
250 litre; off peak

Temp	Delivery	Efficiency	MEPS		MEPS - 10%		MEPS - 20%		Heat loss/total energy		
Dec C	litres/day	98%	kWh/24hr	kWh/yr	kWh/24hr	kWh/yr	kWh/24hr	kWh/yr	MEPS	MEPS-10%	MEPS-20%
60	200	3906	2.58	4348	2.32	4308	2.06	4255	10.2%	9.3%	8.2%
60	106	2072	2.58	2618	2.32	2565	2.06	2511	20.9%	19.2%	17.5%
70	164	3906	2.58	4487	2.32	4437	2.06	4371	13.0%	12.0%	10.6%
70	87	2072	2.58	2769	2.32	2703	2.06	2636	25.2%	23.3%	21.4%
kWh/yr loss (MEPS)			kWh/yr loss (MEPS-10%)			kWh/yr loss (MEPS-20%)			Heat loss/total energy		
AS1056	Actual	Actual/AS	AS1056	Actual	Actual/AS	AS1056	Actual	Actual/AS	MEPS	MEPS-10%	MEPS-20%
942	442	47%	848	402	47%	753	349	46%	89.8%	90.7%	91.8%
942	546	58%	848	493	58%	753	439	58%	79.1%	80.8%	82.5%
942	581	62%	848	531	63%	753	465	62%	87.0%	88.0%	89.4%
942	697	74%	848	631	74%	753	564	75%	74.8%	76.7%	78.6%

315 litre; off peak

Temp	Delivery	Efficiency	MEPS		MEPS - 10%		MEPS - 20%		Heat loss/total energy		
Dec C	litres/day	98%	kWh/24hr	kWh/yr	kWh/24hr	kWh/yr	kWh/24hr	kWh/yr	MEPS	MEPS-10%	MEPS-20%
60	200	3906	3.06	4494	2.75	4308	2.45	4255	13.1%	9.3%	8.2%
60	106	2072	3.06	2750	2.75	2648	2.45	2618	24.7%	21.8%	20.9%
70	164	3906	3.06	4670	2.75	4587	2.45	4504	16.4%	14.9%	13.3%
70	87	2072	3.06	2935	2.75	2852	2.45	2769	29.4%	27.3%	25.2%
kWh/yr loss (MEPS)			kWh/yr loss (MEPS-10%)			kWh/yr loss (MEPS-20%)			Heat loss/total energy		
AS1056	Actual	Actual/AS	AS1056	Actual	Actual/AS	AS1056	Actual	Actual/AS	MEPS	MEPS-10%	MEPS-20%
1117	588	53%	1005	402	40%	894	349	39%	86.9%	90.7%	91.8%
1117	678	61%	1005	576	57%	894	546	61%	75.3%	78.2%	79.1%
1117	764	68%	1005	681	68%	894	598	67%	83.6%	85.1%	86.7%
1117	863	77%	1005	780	78%	894	697	78%	70.6%	72.7%	74.8%

Source: Derived from EMTF (1997)



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