Energy Labelling of Gas Water Heaters: Maximising the Potential Benefits

Report to the

Australian Greenhouse Office

By

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Summary

The Study

The purpose of this study is to review the effectiveness and further potential of the Australian Gas Association (AGA) energy labelling program for gas water heaters, using the best available information.

Energy labelling works best for those appliances where there is a range of efficiencies on the market, and this is the case with gas water heaters. The gas appliance labelling program differs from electrical appliance labelling in that it is administered by the industry body rather than by government. Another key difference is that electric appliance labelling has always been mandatory, whereas gas labelling was effectively optional until the mid 1990s.

The gas label has not been as well supported by other information media as the electric label, although this is changing. Since 1989 the star rating of most products has been published in the AGA *Directory of Certified Gas Appliances and Components*, but this was intended largely for industry use (the Directory has been accessible at the AGA internet site since January 2000). While Energy Efficiency Victoria provides information on the higher-rated water heaters in a leaflet and on its internet site, there are no brochures or internet sites designed to assist consumers to search through and rank all appliances by energy efficiency, as there are for electrical appliances.

This study reviews the trends in the efficiency of gas water heaters listed in the *Directory,* projects the trends on a "business as usual" (BAU) basis and estimates the energy and greenhouse savings available from enhancing the effectiveness of gas water heater labelling towards "Medium" and "High" efficiency outcomes.

The study's conclusions are limited by the lack of information about the sales-weighted average star rating of gas water heaters sold. A partial sales-weighted analysis has been attempted, but this appears to give no better indication of trends in sales-weighted efficiency than does an analysis of the model register (a finding which has been confirmed by the suppliers). This underlines the importance of establishing a monitoring system to track gas water heater efficiency and to provide a baseline for assessing the future impact of labelling.

Figure A illustrates the projected reductions in greenhouse emissions below the "business as usual" trend based on preliminary assumptions about the market impact of enhanced gas water heater labelling. The calculation takes into account the projected sales and estimated mean service life of all gas water heaters sold between 2000 and 2015, and is calibrated to actual household gas consumption as distinct from the values used on the water heater label. It shows that:

- the greenhouse reductions peak in 2012 and decline thereafter – in effect, the enhancement of labelling brings forward efficiency increases that would take place later;

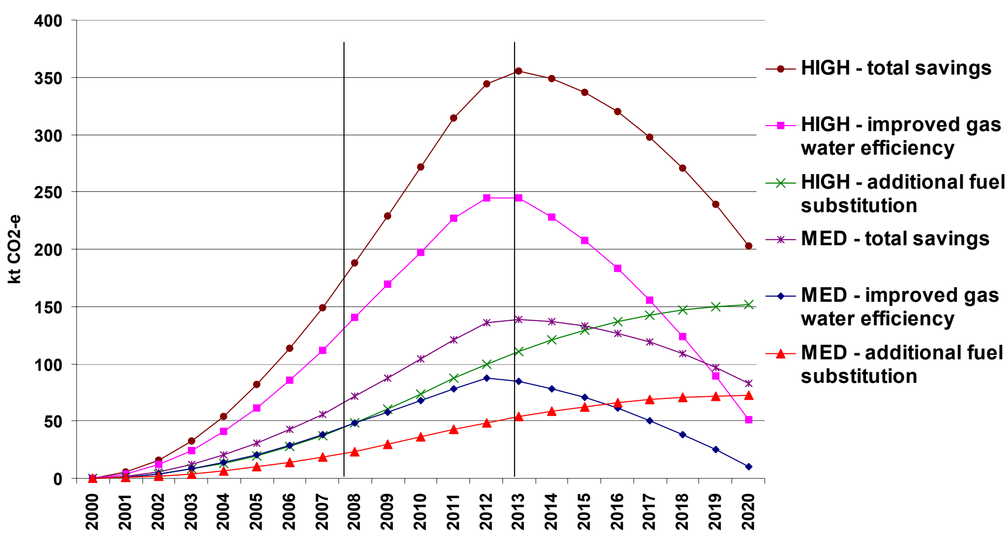
- in the Medium scenario, greenhouse reductions from greater gas water heater efficiency would reach about 90 kt CO_2-e (0.09 Mt CO_2-e) by 2012, and average 70 kt/yr (0.07 Mt/yr) during the Kyoto commitment period;

- in the High scenario, greenhouse reductions from greater gas water heater efficiency would reach about 250 kt CO_2-e (0.25 Mt CO_2-e) by 2012, and average 200 kt/yr (0.20 Mt/yr) during the Kyoto commitment period;

- substitution of gas for electric water heating beyond what is already projected in the BAU case could produce an extra 50 kt CO_2-e/yr savings by 2012 in the Medium case and 110 kt CO_2-e in the High case. These reductions would continue to increase, since the substitutions are not just brought forward but are additional to what would otherwise have occurred

- the projected impacts of the two effects combined average about 0.10 Mt CO_2-e/yr during the Kyoto commitment period in the Medium case and 0.27 Mt CO_2-e/yr under the High case.

Figure A. Emissions saved for gas water heaters sold 2000 - 2015



Conclusions and Recommendations

Maximising the effectiveness of gas water heater labelling could bring greenhouse benefits in two ways:

- Increasing the sales-weighted energy efficiency of new gas water heaters compared to what it would otherwise be; and

- Assisting gas to gain market share from more greenhouse-intensive forms of water heating (and possibly cooking and space heating as well, once gas-connection is established).

While there has been an increase in the average efficiency of registered gas water heater models since the start of labelling, the extent to which this been a consequence of labelling is not known; nor is the effectiveness of labelling in influencing purchase behaviour.

It is recommended that:

1. A market monitoring system be established so that sales-weighted efficiency trends can be tracked in future, as for electric appliances;

2. Consumer tracking surveys be established to monitor awareness and comprehension by appliance purchasers of gas labels and related communications (these could be combined with tracking surveys for electric labels, which are expected to commence in advance of the relaunch of the electric label);

3. Supporting communications for gas water heater labelling (internet sites and perhaps leaflets) listing all products, not just the most efficient, should be established nationally;

4. The internet communications for gas water heaters (and perhaps other gas appliances, subject to review) should be integrated with those for electric appliances at the energyrating.gov.au site, by
   a. adding a searchable gas water heater listing to the energyrating site;
   b. linking to the site from the AGA and gas utility sites;
   c. requiring that the gas label state the site address (as the new electrical label does);

5. The supplementary communications for gas water heaters (eg the preliminaries to the listings on the energyrating website) should carry messages related to:
   a. greenhouse implications of choice of energy form (with solar/gas treated as a form distinct from gas);
   b. category choice (ie instantaneous vs storage, outdoor vs indoor);
   c. energy value (ie "less than 3 stars poor, 3 and 4 acceptable, 5 and 6 good").

The label itself does not appear to need major revision at this stage. Judging by consumer research on the electrical label, the star rating format has wide recognition and acceptance, and there appears no reason to consider the format of the other known gas water labels, that of the USA, or the proposed European label. As yet there is no bunching at the top of the star scale, as there was for electrical appliances. However, the following minor change should be considered (apart from the addition of an internet address):

6. The textual and graphical presentation of stars should be limited to half star steps (as in the new electrical labels) rather than decimal or angular increments.

1. Background

1.1 Gas Water Heater Labelling

The purpose of this study is to review the effectiveness and further potential of the Australian Gas Association (AGA) energy labelling program for to gas water heaters, using the best available information.[1]

The overall objectives of appliance energy labelling (electric or gas) are to:

1. Enable appliance buyers to identify the more efficient of the models on the market;
2. By making the information readily available, encourage buyers to seek out the more efficient; and
3. By stimulating customer demand for more efficient products, increase the incentive for suppliers to introduce and market more efficient products.

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)[2]. 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 1). 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

[1] There is also labelling for gas space heaters and central heaters, but these are not covered in this study.
[2] A unit with these characteristics actually existed, but no longer appears to be on the market (Personal communication, Mr C Wealthy, AGA, May 1994).

rating than a storage water heater (SWH) unit with comparable burner and heat transfer efficiency. As a result, the average star rating for IWH models is higher than for SWH models, and the highest rating on the register (5.6 stars, although 6.4.stars have been reported in the past) is for an IWH. The highest rated SWH is 5.2.

Table 1 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

Energy labelling works best for those appliances where there is a range of efficiencies on the market. This is the case with gas water heaters, but not electric water heaters, which are virtually all designed to a uniform heat loss standard. For this reason, governments have decided not to implement energy labelling for electric water heaters but to proceed straight to Minimum Energy Performance Standards, which took effect in October 1999.

The gas appliance labelling program differs from electrical appliance labelling in that it is administered by the industry body. This is possible because of the high degree of integration in the gas industry: membership of the AGA comprises most gas retailers, distributors, gas appliance manufacturers and importers. Historically, the utilities would not connect equipment unless it met AGA safety, performance and labelling standards.[3] In the electricity industry the utilities, appliance manufacturers and importers all have separate associations, and product standards are generally controlled by Standards Australia. Consequently, governments have had to provide the general regulatory framework for labelling.

Another key difference is that electric appliance labelling has always been mandatory, whereas gas labelling was optional until the mid 1990s. The electrical appliance labelling regulations require registration of energy ratings for all models of the prescribed types (refrigerators, freezers, dishwashers, clothes washers, clothes dryers and air conditioners) and that all products of the correct label affixed when displayed or offered for sale. This increases the effectiveness of the program because all consumers who enter a showroom have access to the label information, and are able to identify less efficient as well as more efficient appliances.

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

[3] Following the reform of the gas industry in some States, Gas Technical Regulators rather than utilities now have jurisdiction over product approvals process.

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.[4] The AGA has not so far produced any counterparts of the electrical appliance information leaflets or internet sites designed to assist consumers to search through and rank appliances by energy efficiency. While Energy Efficiency Victoria (EEV) provides information on the most highly rated has water heaters in a leaflet and on its internet site, there are no brochures or internet sites designed to assist consumers to search through and rank all appliances by energy efficiency, as there are for electrical appliances.

The main elements of the gas and electric labelling programs are compared in Table 2.

Table 2 Elements of gas and electric labelling programs

	Gas Water Heaters	Electric Appliances
Registration of product energy consumption and star ratings	Effectively mandatory since 1995	Mandatory since start of program in 1986
Labelling of products	Effectively mandatory since 1995; GFCV enforced labelling at point of display in early 1990s	Mandatory since start of program in 1986
Publication of comparative leaflets for public use (as distinct from industry use)	Energy Efficiency Victoria (EEV) only agency with list of gas WH models (only 4 and 5 star models listed)	State energy agencies and electricity utilities have published many editions for each product; DPIE published list of all products in 1992 and 1993
Internet site with comprehensive, searchable lists	Directory on AGA site, January 2000; not searchable EEV site has list of 5* products	NetEnergy site launched 1997, energyrating.gov.au address to be on all labels from mid 2000
Monitoring of model-weighted efficiency	No	Since 1996 (using GfK sales data)
Consumer awareness surveys	No	Regular up to 1993
Inclusion of ratings in supplier brochures	Some	Some

Gas appliance energy labelling has not been subject to the same degree of public review as has electric appliance labelling, partly because it has been managed largely within an industry framework rather than a government-industry-consumer framework. It is not known whether the lack of a universal labelling requirement

[4] It is noted that from January 2000 the *Directory* became publicly accessible via the AGA website, but the format has not changed.

before 1995 and the lower accessibility of customer information leaflets have reduced the impact of gas appliance labelling in comparison with that of electric appliance labelling. In fact, there has been very little review to date of the effectiveness of the gas appliance labelling program

The only known reviews, prepared by the GFCV in 1990 and 1991, concluded that over half the SWHs sold annually in Victoria were then of the "high efficiency" type (ie rated three stars or higher) and that the savings realised through market penetration by such appliances by 2000 would be equivalent to 5% of annual Victorian household sector gas demand (GFCV 1990). However, the GFCV was more active in promotion of gas labelling than other utilities, so it would be misleading to extrapolate these savings estimates nationally.

In September 1991 the Council of Australian and New Zealand Minerals and Energy Ministers (ANZMEC) resolved that "the progress of the Australian gas industry in implementing effective appliance energy labelling programs for its major energy consuming appliances be reviewed in mid-1993 in order to determine whether government involvement is required" (GWA 1994). Between May and September 1993 ANZMEC's Energy Management Task Force (EMTF) requested information from AGA concerning both impact indicators (eg the reduction in gas consumption or increase in appliance efficiency as a result of the program) and intermediate indicators (eg the level of public awareness of the gas appliance label or the proportion of displayed product carrying a label). The material made available by the AGA at the time did not allow a clear assessment to be made.

1.2 The Present Study

The aim of this study is to review the main issues concerning gas water heater labelling and to assess the potential for maximising the program's energy saving and greenhouse gas emission reduction benefits. It relies on information in the public domain.[5]

The following approach was planned:

1. Review the present status of the gas water heater market with regard to:
   - annual gas water heater sales, and gas share of water heater market;
   - distribution of water heater models on the market by efficiency level;
   - distribution of sales by efficiency level.

2. Establish the present status of the gas water heater labelling program with regard to:
   - annual cost to suppliers: eg testing (in so far as this is additional to what is required for AGA product approval) label fixing, promotion etc;
   - administrative, compliance testing and program support infrastructure and its annual costs.

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[5] The AGA's assistance in obtaining access to previous editions of the AGA *Directory* is gratefully acknowledged.

3. Review information regarding the effectiveness of the program, eg:
   - historical rates of change in model efficiency distribution;
   - historical change in distribution of sales by efficiency level;
   - trends in consumer awareness of gas labelling (using data collected as a byproduct of reviews of electric appliance labelling).

4. Develop a computer model capable of modelling:
   - the lifetime gas consumption of all new gas water heaters;
   - the impact on lifetime water heater gas consumption and greenhouse gas emissions of increases in sales-weighted energy efficiency under two scenarios, corresponding to medium and maximum increases in the effectiveness of gas water heater labelling;
   – the costs (increased average water heaters purchase price) and benefits (value of gas saved, value of CO_2 saved) of the BAU scenario and the two increased effectiveness scenarios;
   - the additional greenhouse benefits of potential increases in gas water heater penetration and capture of cooking and space heating load from electricity;
   - greenhouse savings, and monetary costs and benefits, of pursuing the medium and maximum effectiveness outcomes compared with the BAU case.

5. Discuss what changes or enhancements in the present program may be necessary to achieve the "enhanced effectiveness" scenarios, including:
   - label format changes
   - program support (guides, directories, advertising etc)
   - retail staff training
   - intermediaries program (targeting builders, plumbers etc).

6. Review the gas water heater labelling program in the USA (the only country presently known to have efficiency labelling for gas water heaters) and assess whether aspects of the approach may be relevant in Australia.

7. Analyse the interaction of gas water heater labelling and other energy efficiency programs affecting gas water heaters, principally minimum energy performance standards (at the current and possibly increased levels).

After discussions with the Gas Water Heater Group in October 1999 it was decided to proceed largely on the basis of information in the public domain rather than proprietary sales and other data. This constrained the analysis to some extent, although the conclusions are still considered reasonably robust.

The remainder of this chapter discusses the available information on the consumer awareness of the gas water heater label.

Chapter 2 presents an analysis of the gas water heater market and analyses trends in the reported energy efficiency of registered gas WH models beginning in 1987, when the AGA first published such information in the Directory.

Chapter 3 presents the modelling of potential energy and greenhouse reductions though enhancing the effectiveness of gas water heater labelling.

Chapter 4 presents the conclusions, and discusses non-quantifiable issues such as label format, information content and program emphasis.

1.3 Buyer Response

Assessing the effect of energy labelling on appliance buyers is difficult because of the complex relationship between the fixed characteristics of the program (eg the label format), the compliance levels (eg the proportion of display products labelled) and the resources expended on the promotional and buyer response. However, it is possible to build up a picture of buyer response by monitoring the following factors over time, using market research techniques. Unfortunately, there seems to have been no continuous monitoring of awareness and behaviour of gas appliance buyers, and only limited "snapshot" data are available.

1. Priority given to energy use in appliance choice. For consumers who are unconcerned with energy use, there is no point in energy labels. The appearance of the label on products itself helps promote this concern (for cost and/or environmental reasons). When recent and intending electrical appliance buyers were surveyed in 1993 on the ranking they gave to star rating in their purchase criteria, the average ranking when unprompted was 11th. However, when the interviewer "prompted" them by reminding them about energy labelling (as the label itself would prompt them in the showroom) the average ranking increased to 4th (GWA et al 1993b). A similar study in 1998 found that appliance buyers (prompted with a list of criteria) rated "energy efficiency" as the 5th most important criterion, closely behind (1) appropriate size to fit available space, (2) warranty/guarantee, (3) appropriate size/capacity for application and (4) value for money (Artcraft 1998).

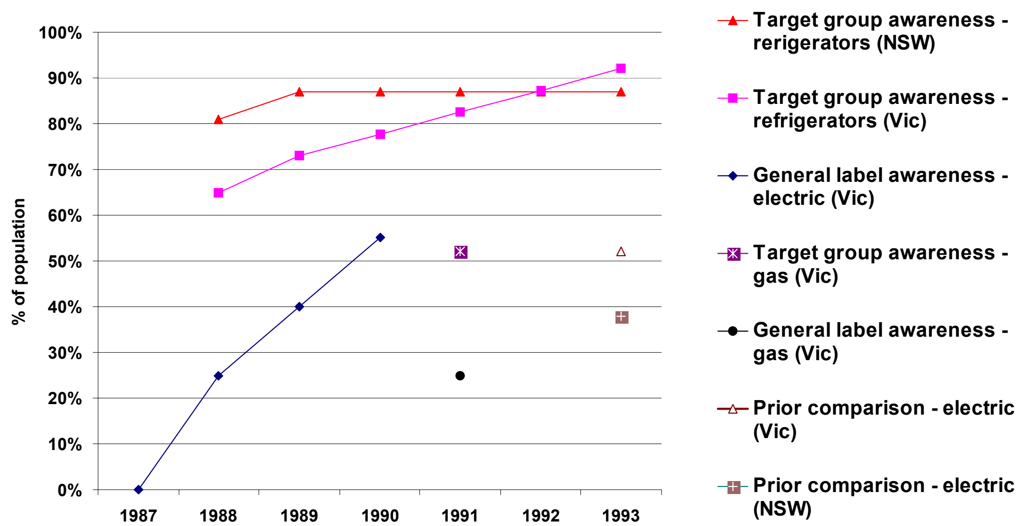
2. General awareness of energy labelling among the public. Figure 1 shows trends in awareness of labels in Victoria and NSW between 1987 and 1993, compiled from a number of surveys (Wilkenfeld, 1997: some points interpolated). In Victoria, general public awareness of the electric appliances had energy labels went from 0 in 1987, the year of introduction, to 51% in 1990. In 1991, the GFCV found that general public awareness of gas labels was only 25%.

3. Target group awareness. Whatever the level of general public awareness, it is more important that people who are actually in the process of buying an appliance are aware of the energy label. Figure 1 shows that in 1988 awareness among recent and intending refrigerator buyers in NSW was 82% (within 2 years of the introduction if labelling in that State) and in Victoria it was 65% (within a year of introduction in that State). By the time of the latest known survey, in 1993, 91% of Victorian appliance buyers and 87% of NSW buyers were label aware. (The fact that awareness in Victoria overtook NSW is almost certainly due to the higher level of publicity support given to energy labelling in that State in the period 1989 to 1993). In 1991, the GFCV found that awareness of the gas label among recent and intending gas water heater and space heater buyers was 51%, significantly lower than the value for electric appliance buyers.

4. Stated propensity to use the label in the purchase decision. When surveyed in 1993, some 52% of recent and intending electrical appliance buyers in Victoria *said* that they has used or intended to use the information on the energy label in making their purchase. In NSW it was 38% (Figure 1). There is no comparable information for gas labels.

5. Extent of actual use. There have been no market surveys in Australia of the actual extent of use of labels. This is logistically difficult since it requires researchers to ask buyers a number of key questions at, or very soon after the time of purchase, before recall fades and post-justification sets in: eg when did energy became an explicit factor in the search process, what specific models were shortlisted and their price, star rating and other important features? Such information could in theory be obtained through simulated shopping experiments, but for practical purposes, it is not directly measurable.

Figure 1 Consumer research findings: electric and gas appliance labelling, 1987 to 1993



While data are limited, this analysis suggests that the impact of gas labels on appliance buyers was somewhat lower than the impact of electric labels. This may be partly explained by the fact that one of the gas appliance types labelled was water heaters, which are often purchased sight unseen (rather than from a showroom), and under time pressure. The GFCV reported:

> "Generally speaking the label is less effective for hot water service sales than it is for space heater sales largely because hot water service buyers more often tend to be replacing a unit that was broken down, and often do not shop around for their new appliance" (GFCV 1991).

However, this finding is limited to one State only, based on research which pre-dates major changes such as community concern about climate change (which could well have increased interest in the has water heater label) or the withdrawal of the GFCV from gas appliance marketing (which could well have decreased interest).

New consumer research is necessary in order to assess the present impact of gas appliance energy labels on buyers, and to gather information which could be used to enhance the impact of labelling. Alternatively, if the impact is low, this may support a case for other measures to improve average product energy efficiency, such as more stringent Minimum Energy Performance Standards (MEPS).

2. Market analysis

2.1 Base Data

This analysis is based on the *Australian Gas Association Directory of Certified Gas Appliances and Components*. This lists all storage and instantaneous water heaters for which approval certificates are current.

The data are ordered by approval certificate number. Each certificate generally covers several models, which may differ by delivery capacity (eg 90 litres, 135 litres etc), whether designed for indoor or outdoor installation and in some cases by the rated energy efficiency.

Information about energy efficiency first appeared in the AGA directory in 1987. The amount of data on each model and the number of models for which the data are given have both increased over time (see Table 3). Until recently the AGA allowed models to be registered without testing or calculation of their energy consumption. These models were given a default star rating of 1.

The analysis covered all gas storage and instantaneous water heater models listed, from March 1987 to January 1999 inclusive. Two registers are published in most years, but only the first one published each year was used.

Table 3 Presentation of energy data in AGA Directory

Period	Energy Efficiency Data
1987,1988	Some models rated as 20%, 30% or 40% less energy than the reference model
1989-93	Most models have star rating (integer only)
1994-98	Most models have star rating (integer), annual MJ use and "label shading"
1999 on	Most models have star rating (decimal), annual MJ use and "label shading"

The analysis required that each model be allocated a decimal star rating, eg 4.3. Decimal ratings were first published in 1999. However, many of the models on the market in 1999 retained the same MJ value as in earlier years, so the integer star ratings in the earlier years (eg 4) were converted to the decimal star rating (eg 4.3) that applied in 1999.

In the case of models that dropped out of the market before 1999 but for which there were earlier MJ values, the decimal star rating was calculated from the MJ values. (The 1999 star values were also cross-checked with the MJ, and corrected if the calculated value deviated by more than 0.1 from the published value).

2.2 Number of Models

Before any analysis could be carried out, it was necessary to separate each distinct model from the registration data. There were 32 storage water heaters registrations current in January 1999, but 62 distinct models were identified.[6] In all, there were 103 distinct storage models on the market for some or all the period 1987-1999. MJ values and/or calculated star ratings were published for 86 of these. The other 17 were marked "not tested" and so were given a default rating of 1 star (15 of these were from the one manufacturer, Edwards, and were removed in 1999). The 16 instantaneous models that were marked "not tested" came from a wider range of suppliers.

Table 4 summarises the number and average star rating of the storage type models in the data set, and Table 5 summarises the number and average star rating of instantaneous types.

Table 4 Number of storage models on market, 1987-99

Brand	Number of models on market, 1987-99	Models tested	Model-weighted average star rating (all models)[1]	Model-weighted average star rating (tested models only)[1,2]
Aquamax	7	7	4.9	4.9
Beasley	3	3	3.3	3.3
Braemar	6	4	1.5	4.0
Dux	11	9	3.0	3.6
Edwards	16	1	1.6	5.0
Servgas	3	3	2.3	2.3
Solahart	2	2	4.2	4.2
Rheem	42	39	2.7	2.8
Vulcan	14	14	3.4	3.4
Total	**104**	**82**	**2.7**	**3.1**

(1). Calculate average of model decimal star ratings in each year for which that brand has models on the market, then average those values. (2). Untested default 1-star models excluded from calculations.

Table 5 Number of instantaneous models on market, 1987-99

Brand	Number of models on market, 1987-99	Models tested	Model-weighted average star rating (all models)[1]	Model-weighted average star rating (tested models only)[1,2]
Chaffoteaux	6	6	4.4	4.4
Bosch	35	29	3.5	3.8
Bosch/Harman	8	5	4.2	5.5
Cascade	2	2	5.6	5.6
D & S	1	1	4.4	4.4
Everdure	5	1	1.8	2.9
Heatmaster/Leblanc	2	2	3.6	3.6
Paloma	1	1	4.3	4.3
Raytherm/Hurricane	1	0	1.0	NA
Rinnai	13	13	4.8	4.8
Sylber Electra	1	0	1.0	NA
Vaillant	29	19	2.7	3.4
Total	**104**	**86**	**3.1**	**3.8**

(1). Calculate average of model decimal star ratings in each year for which that brand has models on the market, then average those values. (2). Untested default 1-star models excluded from calculations.

[6] This task was carried out by Energy Efficient Strategies, with fine tuning of the data by GWA.

There were 50 storage models on the market in 1987; 58 were added between 1987 and 1999 and 46 were dropped. Of the 50 storage models on the register in 1987, nearly half were still there in 1999, with the same star rating.[7] This suggests high model longevity and a relatively low rate of technological change. By contrast, the instantaneous model listings showed a higher rate of change (see Table 6). More models were added and more were dropped. Only three models (about one ninth of the 1987 registrations) were still there in 1999.

Table 6 Models added and removed, 1987-99

	Storage	Instantaneous
Models on register in 1987	50	26
Models added	58	80
Models dropped	46	67
Models on register in 1999	62	39
Models remaining throughout period	24	3

2.3 Trends in Model Efficiency

About one in six models on the register in the early part of the period were marked as "untested" and given a default rating of one star. The presence of models with one star would have had an effect on label-aware water heater buyers, since the models would have been perceived as less efficient (whether or not they actually were) and would have shown the models with more stars to greater advantage. However, the presence of untested models complicates the tracking of real change in the market, since taking these models as actual one-star would most likely exaggerate the apparent rate of increase in model average efficiency. If the objective is to track the *actual* efficiency trend then untested models need to be excluded.[8]

The following analyses are presented with untested models excluded, unless otherwise stated. The proportion not tested was low at first, increased in the early 1990s and then declined over time, such that by 1999 there were actual results for nearly all the models on register. Figure 2 illustrates the trends in the number of storage models on the register and the number of models added and retired in each year of the period. Figure 3 shows the same trends for instantaneous models.

Care was taken to ensure that some models which changed distributors or brands but otherwise remained the same were treated as the one continuing model. In two cases what was apparently the same storage model changed energy ratings from one year to the next, indicating technical revisions. These were treated as new models.

[7] Apparently a few models remained on the register for some time after they ceased production, but it is impossible to take this into account without details from the suppliers..
[8] For storage water heaters, the untested models are largely quarantined to one manufacturer with a modest market share, so exclusion would have little impact on the market analysis. For instantaneous water heaters the impact may be somewhat higher.

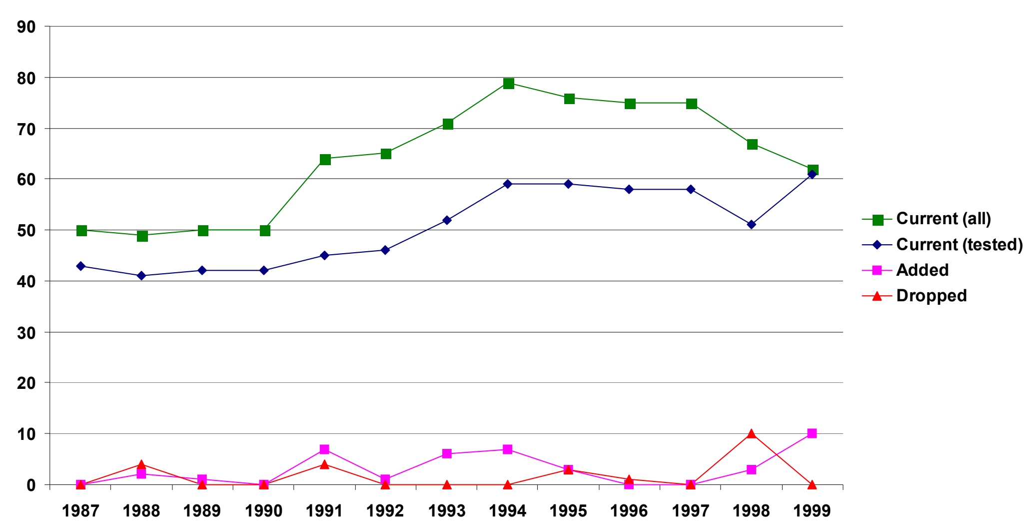


Fig 2. Gas storage water heaters - number of models on register (tested models only)

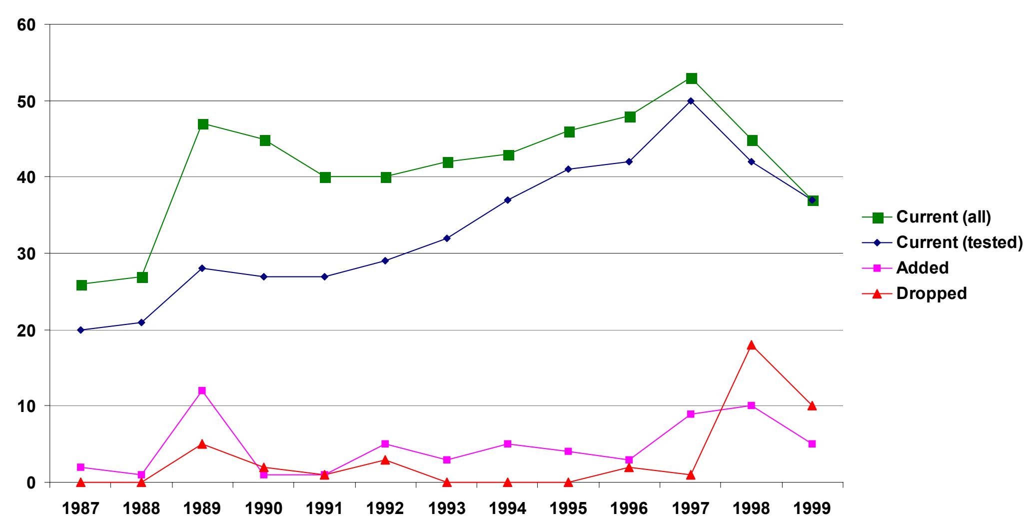


Figure 3. Gas Instantaneous Water Heaters - Number of Models on Register (tested models only)

Figures 4 and 5 illustrate the following data, for tested models only:

- The lowest and highest star ratings on the register in each year;
- The average star rating for models on the register in each year;
- The average star rating of new models added each year (no value if no new models).
- The time-weighted average star rating for all models on the register and for all new models introduced over the period (eg a 4.3 star model on the register for 5 years would contribute 21.5 star-model-years). There are plotted as horizontal

lines, and give the most direct indication of whether the model range is becoming more or less efficient.

If the star ratings for new models were consistently higher than the model average it would indicate that suppliers were introducing more efficient models. This appears to be the case. For storage types the average rating for all models was 3.07, but the average for new models was 3.23, a difference of 0.16. Efficiency for instantaneous types was higher overall and also increased at a higher rate: the average rating for all models was 3.81 and the average for new models was 4.12, a difference of 0.31.

Fig 4. Gas storage water heaters - average star ratings (tested models only)

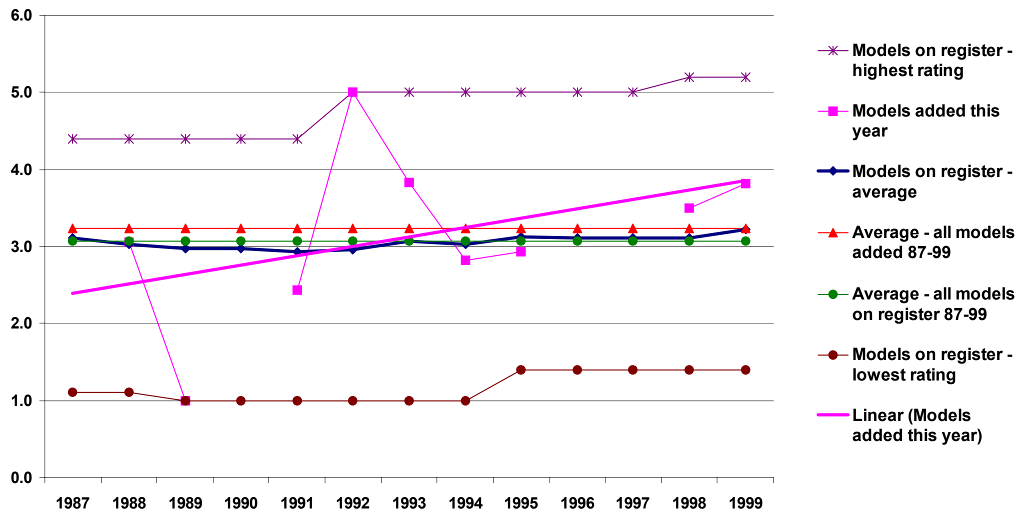


Figure 5. Gas instantaneous water heaters - Average star ratings (tested models only)

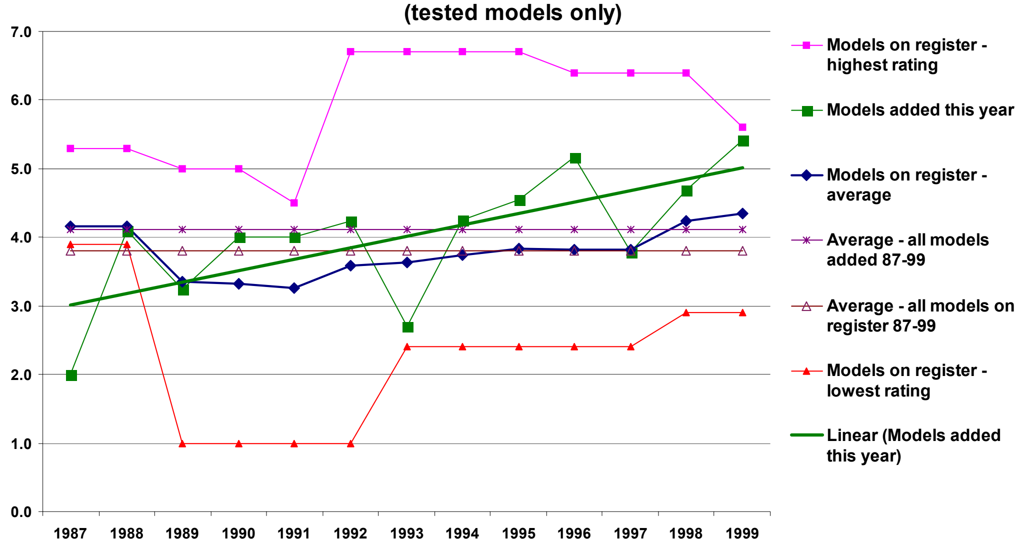


Figure 6 illustrates both water heater types on the same graph. The linear trend lines indicate that the model average efficiency of instantaneous water heaters was about 0.6 star rating higher than the average for storage water heaters in 1987, and this efficiency advantage increased to about 0.9 stars by 1999 (untested models excluded).

There is also an efficiency difference between outdoor and indoor models. Figure 7 shows that about half of instantaneous models are designed for outdoor installation, as are two thirds of storage models. The number of outdoor models had been rising.

Figure 6. Model average star ratings, gas water heaters

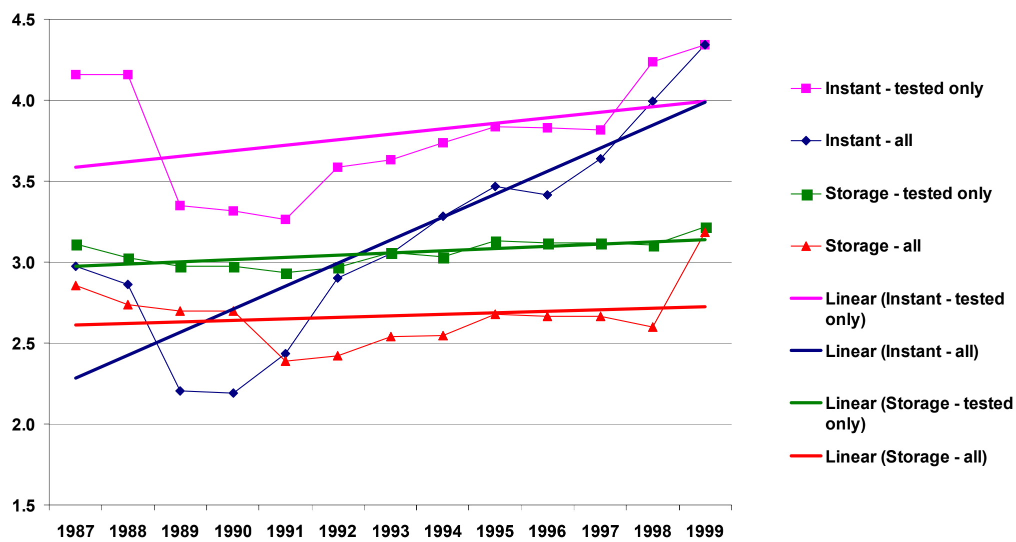


Figure 7. Number of indoor and outdoor models on the register, 1987 - 1999

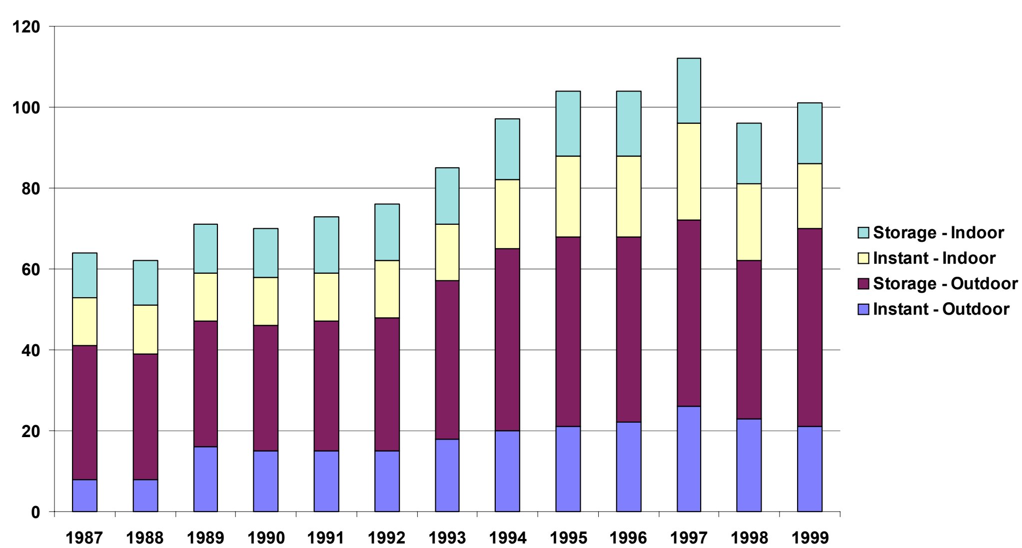
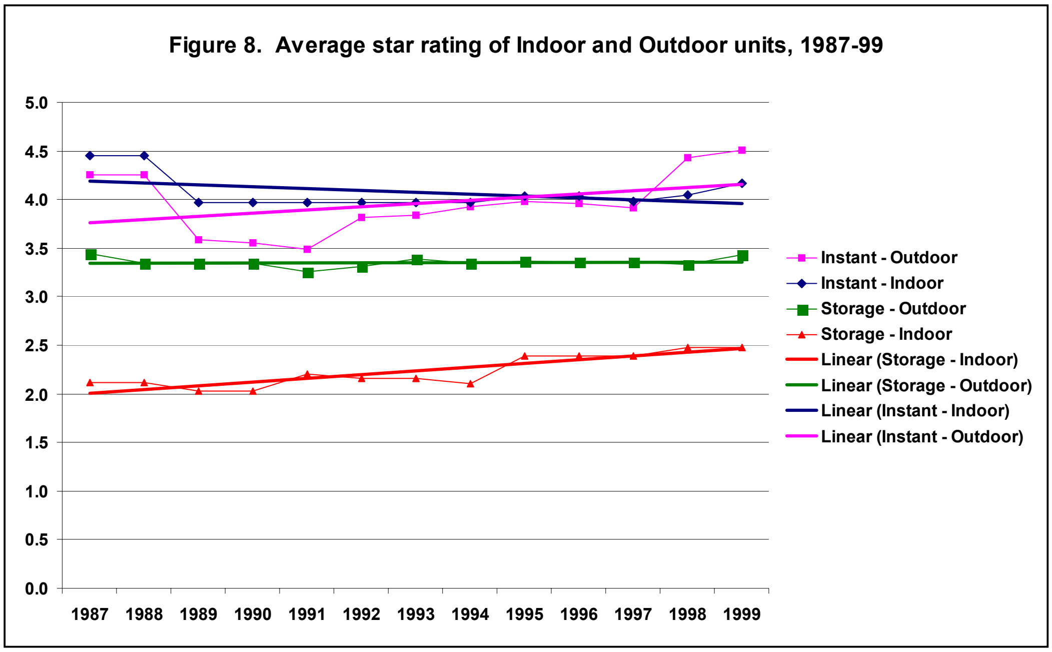


Figure 8 shows that models are grouped into three distinct efficiency categories: outdoor storage water heaters, indoor storage water heaters and instantaneous water heaters. Indoor storage types are the least efficient, but their average efficiency increased by about 0.5 stars between 1987 and 1999. The average efficiency of outdoor storage types, whose introduction in the mid 1980s prompted the original development of labelling, remained virtually unchanged.

Among instantaneous models the efficiency difference between indoor and outdoor models was less, but the average efficiency of outdoor models increased while that of indoor model declined.



2.4 Brands

There is considerable difference in the average efficiency of the models offered by different suppliers. Figure 8 indicates the model average star rating for the 9 brands of storage water heater that appeared on the register over the period (untested one-star models excluded). Braemar disappeared after 1990. Servgas and Edwards appeared in 1991 and Aquamax in 1993. Edwards and Aquamax had the highest model average ratings, while Servgas and Rheem had the lowest.[9] The average for all brands increased over the period with the exception of Dux, where there was a noticeable reduction in model average efficiency.

[9] The average for Edwards was dominated by default 1-star units until these were removed in 1990. Aquamax had only one model of 5.0 stars until it introduced, new, less efficient models in 1999. A new group of Rheem 5-star outdoor water heaters was introduced just after the period covered in this analysis.

For instantaneous water heaters (see Figure 10) the highest model average rating was for Rinnai, Cascade and Bosch/Harman (ie made by Harman in Japan but rebadged and distributed by Bosch in Australia). The brands with the lowest model average star rating were Vaillant , Everdure and Heatmaster/Leblanc.

Figure 9. Gas storage water heaters - average star ratings by brand (includes non-tested 1-star models)

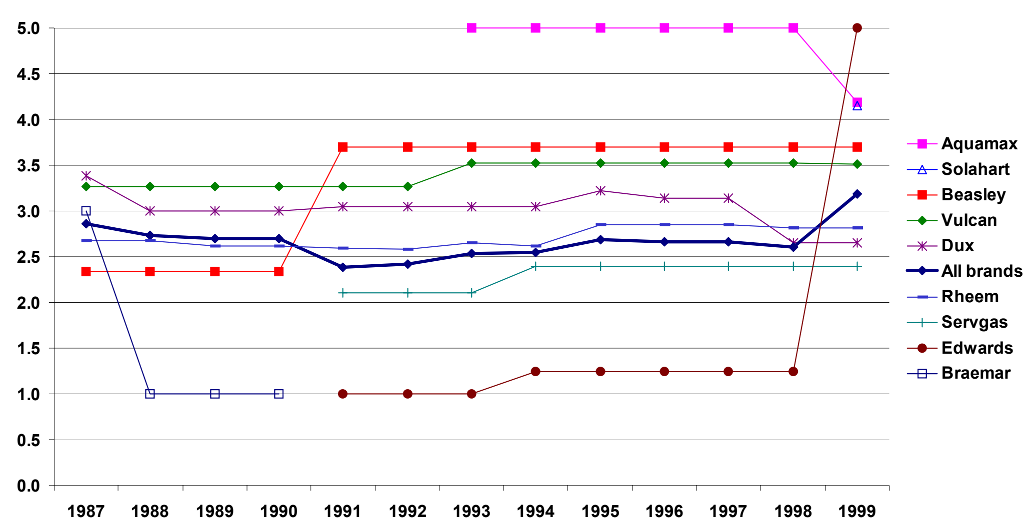
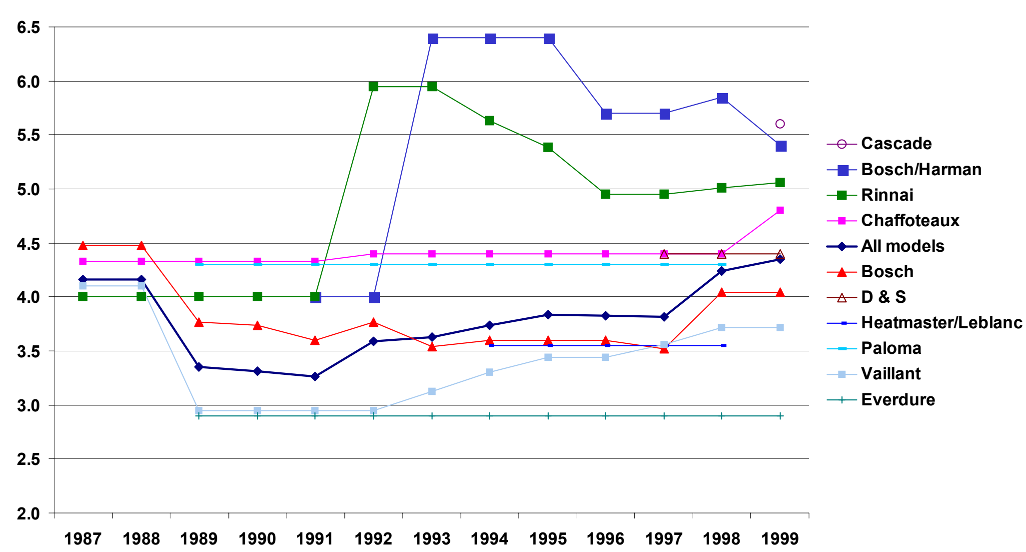


Figure 10. Gas instantaneous water heaters - average star ratings by brand



The values in Figures 9 and 10 may not be close to the true sale-weighted average for that brand, except in the few instances where the brand only had one model. For example, Aquamax had only one model, rated 5.0 stars, until it introduced new models rated between 3.3 and 4.0 in 1999. Its model-weighted average then declined to 4.2, with a range of 3.3 to 5.2. Rheem had the largest number of models, with an average star rating of 2.8 in 1999, and a range of 1.4 to 4.4.

2.5 Potential Influence on User Choice

Water heater purchasers who wish to reduce the gas consumption of their gas water heaters can do so by:

1. Selecting an instantaneous rather than a storage configuration (assuming there is flexibility to do so);
2. Selecting an outdoor rather than an indoor installation (assuming there is flexibility to do so); and
3. Selecting the most efficient within the category.

Because the categories have such distinct energy characteristics, the selection of instantaneous rather than storage, and of outdoor rather than indoor will generally lock in a lower lifetime gas consumption at the time of purchase. If purchasers were made aware of this, they could exercise their preference without referring to the energy rating, or indeed even if the labelling program did not exist.

However, the label does perform the following functions:

- In the absence of information on the energy implications of configuration and installation, the label can steer purchasers towards outdoor and/or instantaneous models, since those will have the higher star ratings; and
- It enables users to select the most energy-efficient within the category they have chosen, or the one to which they are restricted (ie in replacement situations, where it may be difficult or expensive to change from indoor to outdoor installation, but it is still be possible to select a more efficient indoor unit).

Figure 11 indicates the range of label star ratings on the gas water heater market in 1999. For indoor storage units the range was 1 to 3 stars, for outdoor storage units 1 to 5 stars, for indoor instantaneous units 2 to 5 star and for outdoor instantaneous 2 to 6 stars. Of course, this covers units of all capacities, so a buyer searching in a narrower range (eg 90 litre delivery or equivalent) may face a narrower range.

Even so, it shows that the range of ratings is wider than for electrical appliances. The clustering of models at the top of the star rating scale, which is a feature of the maturity and high market impact of the electrical appliance label, has not occurred.

Each star rating step represents about 2020 MJ of annual gas consumption, on the AGA standard water heating task. At 1c/MJ, a typical urban natural gas price, this would represent about $ 20/yr, or $200 over a 10-year service life. Therefore there should be both scope and monetary incentive to seek out more highly rated products.

For their part, suppliers of storage water heaters appear to have acknowledged that there is commercial value in a higher star rating. Figure 12 expands on Figure 11 to show the number of models at each *decimal* star rating rather than each *integer* star rating. There is distinct clustering at 2.0, 3.0 and 4.0, suggesting that where an additional star was in reach, suppliers took steps to achieve it.

Figure 11. Number of models at various Star Ratings, 1999

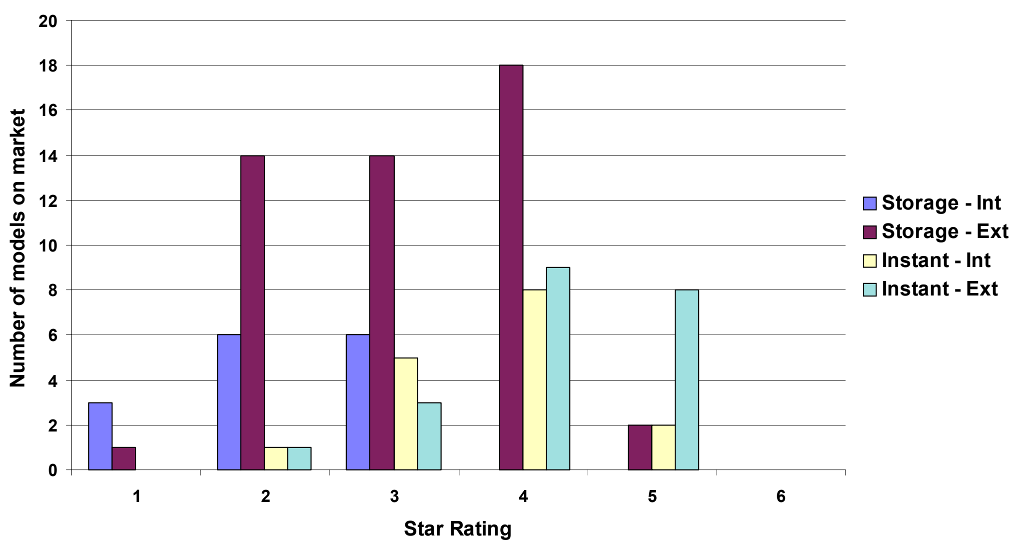
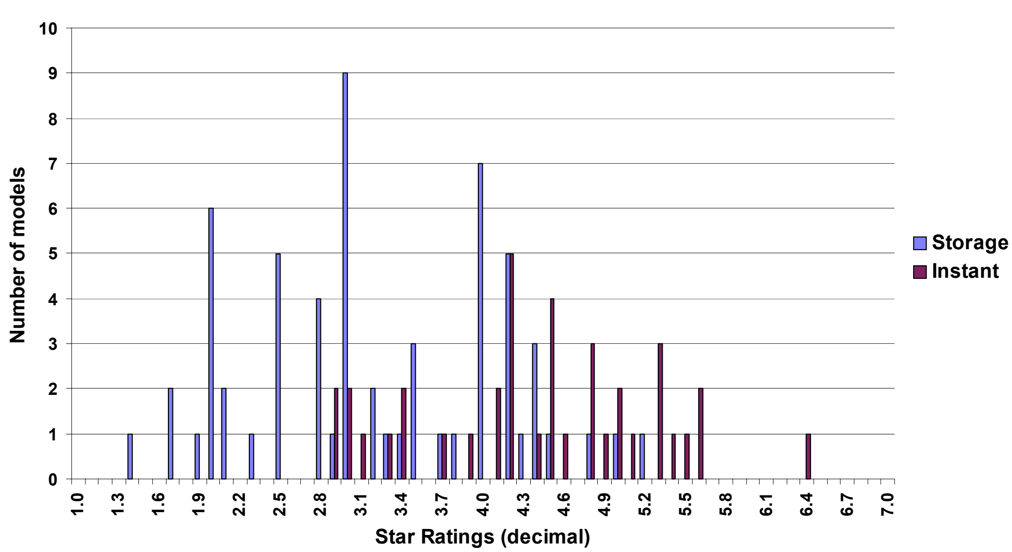


Figure 12. Number of models at decimal Star Ratings, 1999



2.6 Partial Sales-Weighted Efficiency

A "model average" star rating or energy consumption value would only match the actual average star rating or energy consumption of gas water heaters sold if all registered models were actually on sale and each model held an equal share of the gas water heater market. This is of course not the case – some models sell in far greater numbers than others. It would only be possible to calculate a full "sales-weighted" star rating or energy consumption for any given year if the market share of each of the models sold in that year were known.

"Partial sales-weighting" – when brand shares of the market are known, but not model shares – can provide an intermediate level of detail. This approach proved useful in helping to assess the impact of electrical appliance labelling between its introduction in 1986 and 1991, before the start of full market monitoring (GWA et al 1991). It gave results which (a) differed significantly from simple model-weighted analysis of the appliance register, and (b) were partially validated by later market monitoring. Therefore it is worth examining to see if this approach might be useful in the case of the gas water market, in the event that full sales-weighted data remains unavailable.

In this approach it is assumed that each model of a brand contributes equally to that brand's sales. (The approach could be refined if there were data on market shares by other parameters – eg by delivery volume – but such data has not been made available). In effect, the model data underlying Table 4 and Table 5 are combined with the market share by brand data in Table 7.

Table 8 summarises the brand share estimates of the gas storage water heater market in 1997/98 (data supplied by AGO).

Table 7 Estimated gas water heater market shares, 1997/98

	Share of gas storage	Share of Instantaneous	Share of total gas water heater market
Rheem	53%	NA	37%
Vulcan	22%	32%	25%
Dux	4%	NA	3%
Rinnai	NA	38%	11%
Bosch	NA	21%	6%
Other	21%	9%	17%
Brand share	100%	100%	100%
Type share[1]	33%	14%	47%

Source: Data supplied by AGO. 1. Balance of market is electric (47%) and solar (6%).

There were 67 storage models registered in that year, of which 16 were not tested and so rated 1 star by default. One of those models was Dux and 15 were Edwards (part of "other brands"). Their exclusion slightly raises the average star rating for Dux, and raises it markedly for "other brands" (see Table 8). On this analysis the partial sale-weighted star ratings of new gas storage water heaters sold in 1997/98 was either 2.76 or 3.16. These values were higher than the simple model averages (2.60 and 3.10 respectively).

Table 8 Partial sales-weighted analysis, gas storage water heaters sold 1997/98

Brand	Share of gas storage water heater market	Number of models on register	Weighted average star ratings	
			All registered models	Tested models only
Rheem	53%	28	2.8	2.8
Vulcan	22%	11	3.5	3.5
Dux	4%	6	2.7	3.0
Other brands	21%	22	1.9	3.7
Total	**100%**	**67**	**2.76**[a]	**3.16**[a]
Model average star rating			**2.60**	**3.10**
Annual MJ of partial weighted average star rating			25340	24520
Annual MJ of most efficient model on register			20303	20303
Potential MJ reduction from transferring purchase			5037	4217

a. Partial sales-weighted value: model average for brand scaled by brand market share

Table 9 shows the equivalent data for instantaneous water heaters. The partial sale-weighted star ratings of new gas instantaneous water heaters sold in 1997/98 was either 4.25 (or 4.33, with the small number of untested models excluded). These values were also higher than the simple model averages (4.00 and 4.20 respectively). The difference between partial-sales-weighted and model-weighted averages is higher for IWH than for SWH, suggesting that brands which offered models with a higher star rating had a higher market share in the IWH market than in the SWH market.

Table 9 Partial sales-weighted analysis, gas instantaneous water heaters sold 1997/98

Brand	Share of gas instantaneous water heater market	Number of models on register	Weighted average star ratings	
			All registered models	Tested models only
Rinnai	38%	13	5.0	5.0
Bosch	21%	18	3.9	4.3
Vaillant	32%	8	3.7	3.7
Other brands	9%	11	3.8	3.8
Total	**100%**	**50**	**4.25**[a]	**4.33**[a]
Model average star rating			**4.00**	**4.20**
Annual MJ of partial weighted average star rating			22330	22160
Annual MJ of most efficient model on register			17900	17900
Potential MJ reduction from transferring purchase			4430	4260

a. Partial sales-weighted value: model average for brand scaled by brand market share

These difference suggest that, with the data presently available, shifting from model-weighted to partial sales-weighted analysis may add a little to the understanding of the composition of the gas water heater market by star rating. However, trend movements could only be estimated using this technique if brand shares were tracked over a period, and at present only one data point is available.

Some suppliers have questioned the validity of this approach. In the absence of complete sales-weighted data, however, it may help improve the tracking of sales-weighted efficiency.

It should be noted that sales-weighted data could be compiled in a number of ways, some involving third party monitoring agencies (eg GfK or BIS-Shrapnel) and some involving manufacturers and importers only.

The simplest way would be for each supplier to provide annually (to the AGO or to some intermediary such as an accounting firm) a sales-weighted star rating value (to 1 decimal place) for its IWH sales and its SWH sales by brand. This would then be combined with brand share data compiled by a market monitoring agency, and two aggregated values would be published: one for all gas SWH and one for all gas IWH.

3. Potential energy and emissions savings

3.1 Preliminary Estimate of Potential

Table 8 and Table 9 indicate the annual gas consumption, at the AGA standard hot water delivery task, for models of average partial sales-weighted star rating and the model with the highest star rating on the market, for storage and instantaneous types respectively. This indicates the potential annual energy saving per unit from transferring a sale from the market average to the most efficient.

In each case, the potential saving (for tested models only) is of the order of about 4200 MJ per year. At 1c/MJ, a typical urban natural gas price, this would represent a saving of $ 42/yr, or $420 over a 10-year service life. This order of savings may well be considered worthwhile by customers using energy labels to assess alternative units. It is comparable to the annual savings available to consumers from using the refrigerator label to seek out the most efficient models in preference to those of average efficiency.

The typical greenhouse gas intensity of natural gas is about 68g/MJ (full fuel cycle). Therefore the potential greenhouse benefit is of the order of 290 kg/year, or 2.9 tonnes over a 10-year service life. This is comparable to the greenhouse savings available to consumers from using the electric appliance labels to seek out the most efficient models in preference to those of average efficiency.

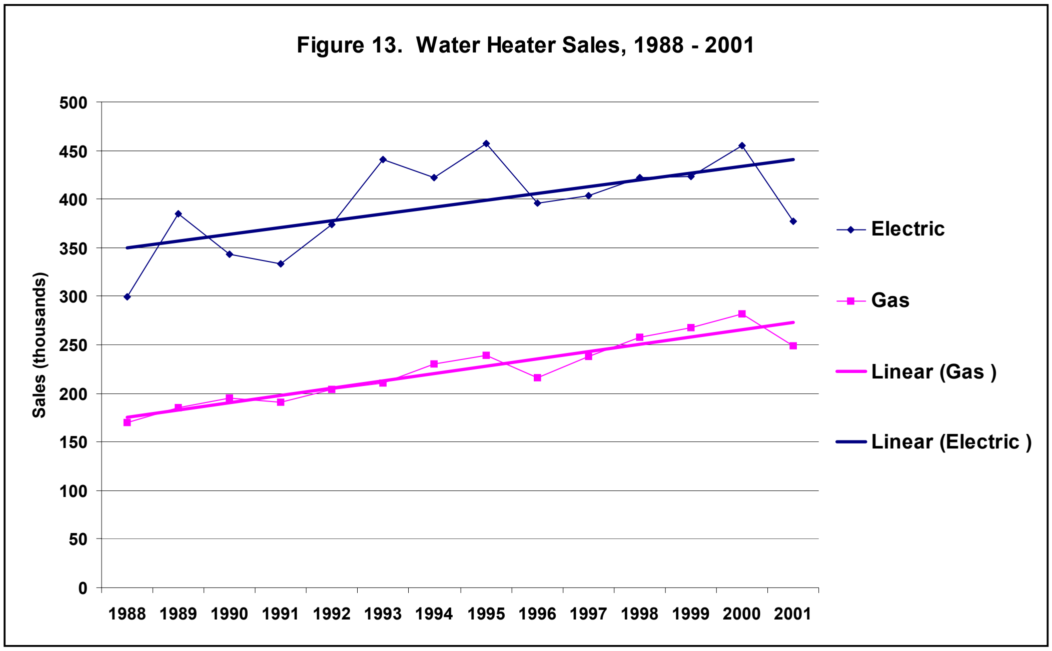
Of course, the real savings available from increasing the effectiveness of energy labelling will almost certainly differ from this indicative value, because:

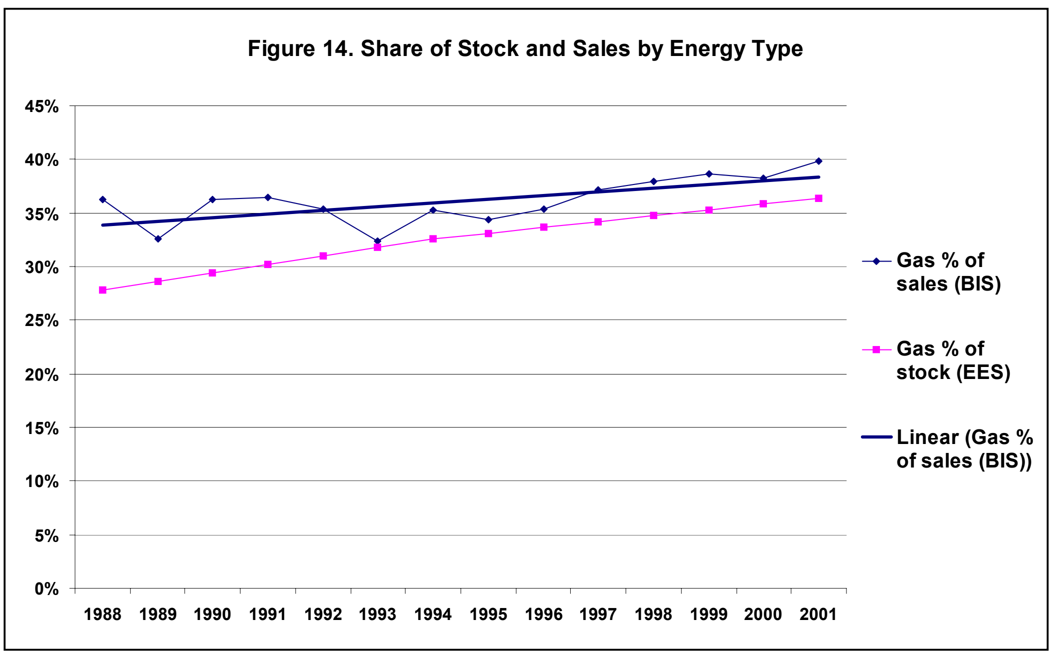
- The highest star rating model may only be available within a limited range of delivery capacities, and some customers will purchase outside that range. It would be necessary to know the sales-weighted average and the most efficient in each size range;
- Customers may well use less or more hot water than in the AGA standard task;
- The impact of labelling is gradual, not immediate – as more customers become label-aware, purchase preferences shift toward higher star rating models over time, not in one step;
- Label-aware buyers will purchase a model with a higher star rating than otherwise, but not necessarily the model with the highest star rating.

Therefore considerable computation is required to realistically simulate the impact of enhanced labelling effectiveness on the gas water heater market.

3.2 Market Size

Figure 13 illustrates historical trends in annual gas and electric water heater sales, derived from BIS Shrapnel data supplied by the AGO. Raw sales are currently about 275,000 gas units per year, but the number varies considerably, largely driven by the housing cycle, so linear trend lines have been superimposed for clarity. These show that the trend rate of increase in gas water heater sales is greater than for electric water heaters. This is confirmed by Figure 14, which shows the share of new water heater sales by energy type. Figure 14 also shows the gas share of the existing water heater stock, from EES et al (1999). The fact that the gas share of sales is higher than the gas share of the stock indicates that the market shift towards gas water heating is continuing, but the convergence of the two trend lines suggests that it is slowing.





It is estimated that over the projection period 2000 – 2015, the average annual increment in sales will be the same as the average of the past decade (ie 7,700 more sales in each successive year). However, this implies a declining *rate* of increase in sales: 2.4% per annum over the projection period, compared with 3.7% per annum over the period 1988 – 1999.

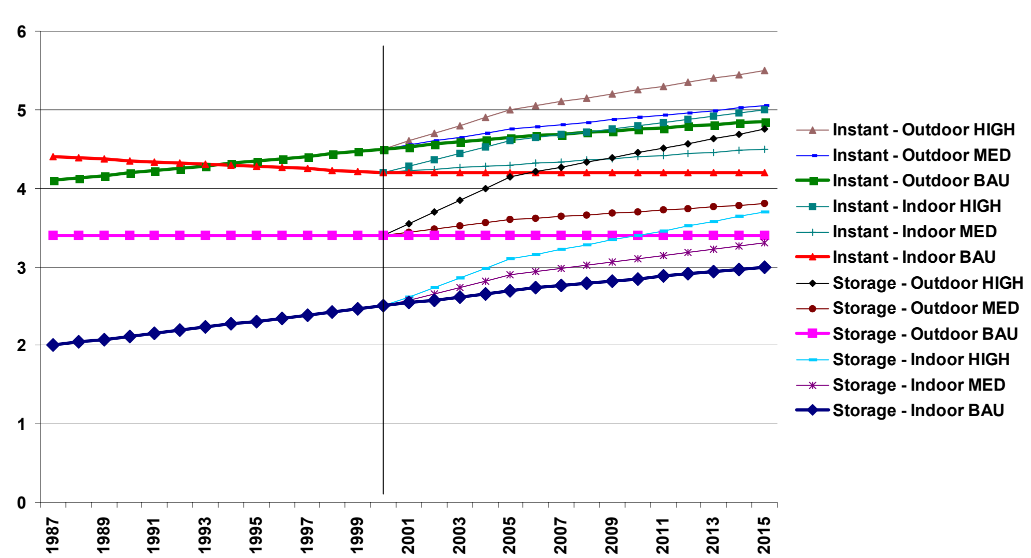
3.3 Efficiency Trends and Projections

The estimated historical and projected trends in the energy efficiency of gas water heater sales, as indicated by average star ratings, is illustrated in Figure 15. The historical trend estimates are averages for the models on the AGA register, since sales data are not available.

The average efficiency of outdoor instantaneous water heaters appears to have been increasing, and is projected to continue to increase at about the same rate under "business as usual" (BAU), which assumes that labelling continues at its current level of effectiveness. By contrast, the average efficiency of indoor instantaneous units appears to have declined slightly, but it is expected to remain constant under BAU.

For outdoor storage water heaters there appears to have been no change in average efficiency since the 1980s, and this is projected to continue. The average rating for indoor storage water heaters has been increasing, albeit from a low base, and is projected to keep increasing at about the same rate under BAU.

Figure 15. Historical and projected star rating trends



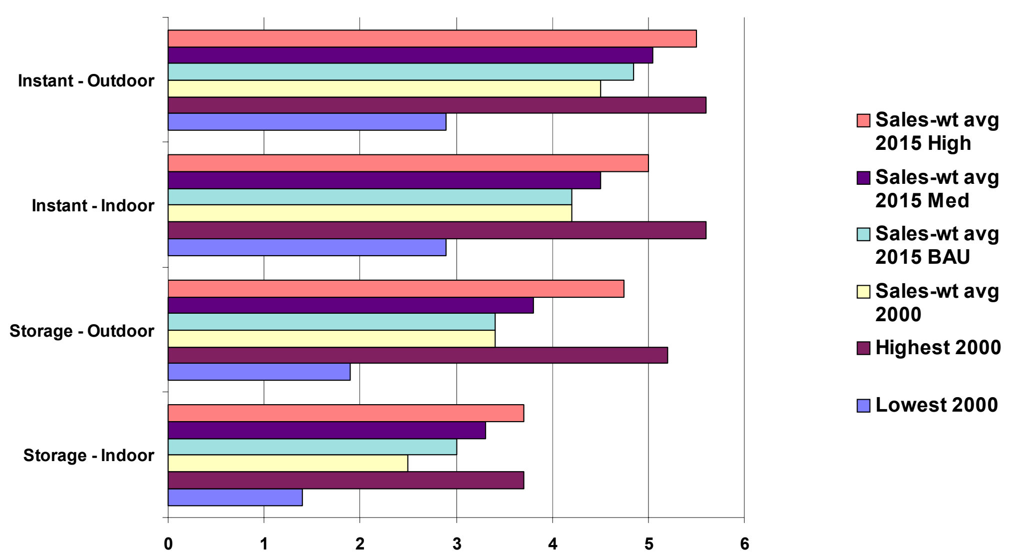
The energy savings from increasing the effectiveness of gas water heater labelling will depend largely on the rate of increase in sales-weighted star ratings above the BAU trend. Two scenarios have been devised – "MEDIUM" and "HIGH" impact.

The key efficiency assumptions under each are summarised in Table 10 and illustrated in Figures 15 and 16. The highest star rating on the register in 2000 has been set as a limit; ie there needs to be no technological improvement to reach the projected levels of sales-weighted efficiency, only a shift in preference towards the highest rated products. Indeed, even under the HIGH scenario the only category where the sales-weighted efficiency in 2015 reaches the level of the highest rating on the market in 2000 is indoor storage water heater types.

Table 10 Estimated current and projected star rating of gas water heaters by type

	Lowest 2000	Highest 2000	Sales-wt avg 2000	Sales-wt avg, 2015 BAU	Sales-wt avg, 2015 Med	Sales-wt avg, 2015 High
Storage - Indoor	1.4	3.7	2.5	3.0	3.3	3.7
Storage - Outdoor	1.9	5.2	3.4	3.4	3.8	4.8
Instant - Indoor	2.9	5.6	4.2	4.2	4.5	5.0
Instant - Outdoor	2.9	5.6	4.5	4.9	5.1	5.5

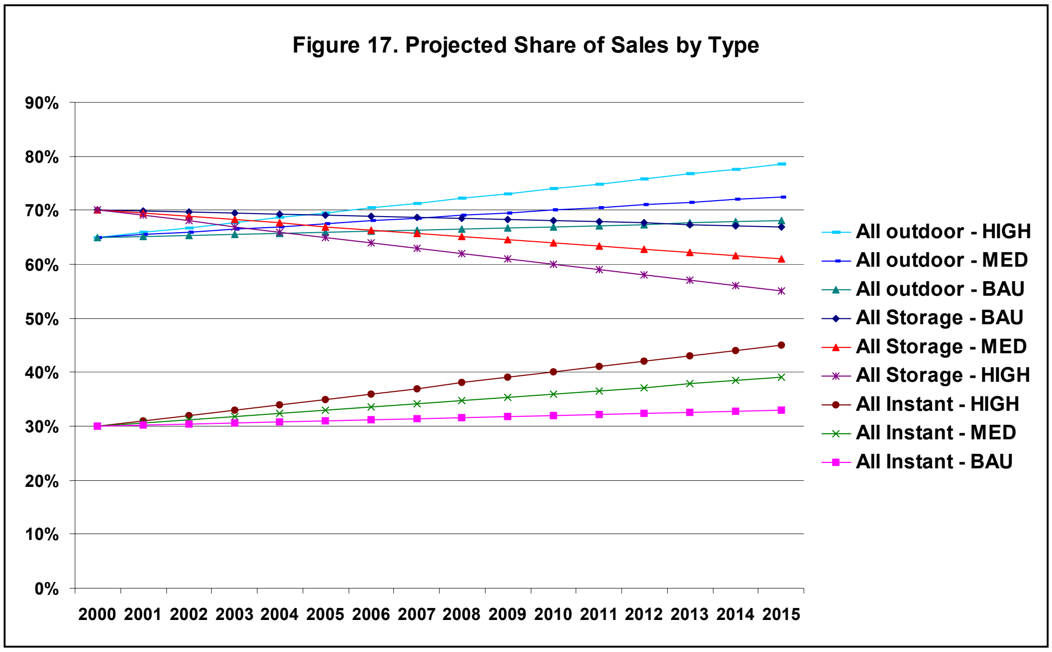
Figure 16. Estimated and projected star ratings



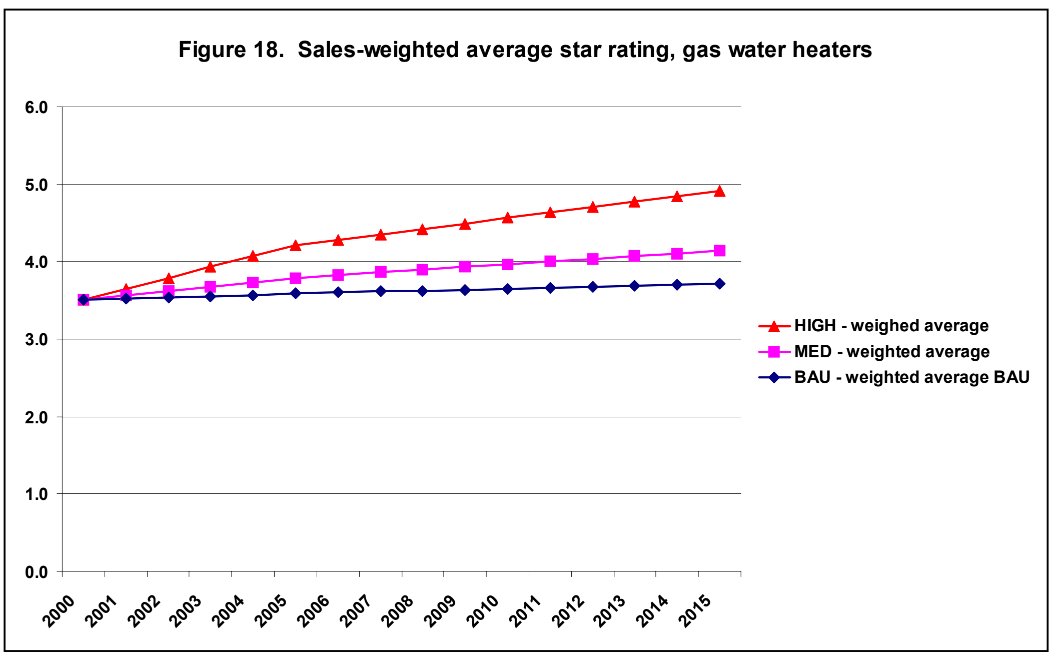
If buyers become more energy-aware and make greater use of label information in their purchase decisions, there are likely to be other shifts in the market as well:

- Greater preference for instantaneous types compared with storage types
- Greater preference for outdoor rather than indoor types (although in replacement situations this will be limited by the constraints of existing plumbing layouts);

Shifts in these directions are already under way, and are projected to continue in the BAU case, but they are expected to accelerate in the MEDIUM and HIGH cases (see Figure 17).



The Projected trends in weighted average star ratings for all gas water heaters sold under the three scenarios is illustrated in Figure 18. Under the MED scenario, the weighted average star rating in 2015 would be about 0.4 higher than under the BAU scenario, and under the HIGH scenario it would be about 1.1 higher.



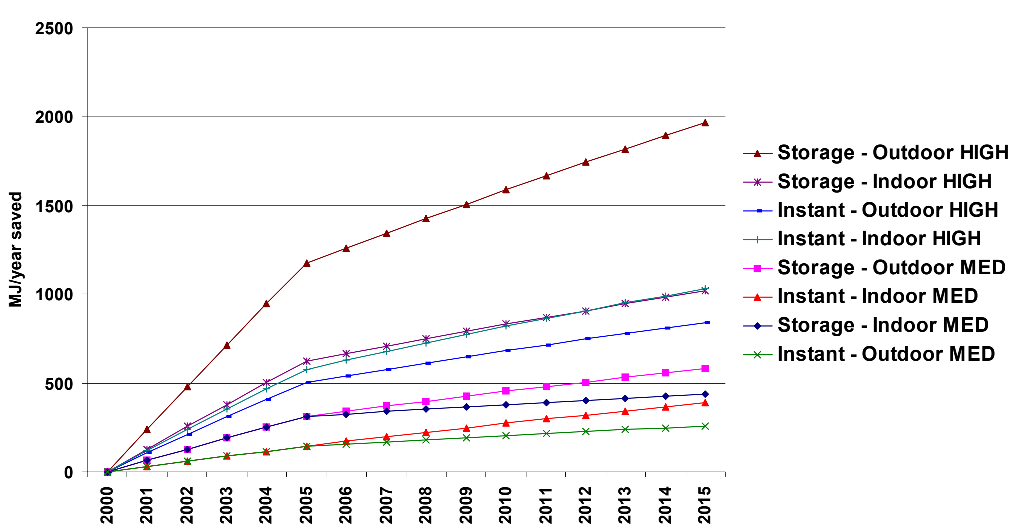
The average annual gas consumption for new gas water heaters added to the stock in each year is calculated from the number sold, the average star ratings and weighting factors that relate the theoretical consumption to actual consumption. EES et al (1999) estimate that gas consumption for water heating will be about 54.1 PJ in 2010. The mean service life assumed in the present study is 10 years for storage units and 12 for instantaneous, so by 2010 nearly all the gas water heaters in use will have been sold in 2000 or later. This means that the performance of remaining pre-2000 stock can be ignored for the purposes of estimating water heating gas consumption in 2010.

The AGA formula assumes a standard useful hot water delivery of 13,760 MJ/year (about 200 litres of hot water per day). Under this assumption, total gas consumption for water heating in 2010 would be nearly 72 PJ, or 32% higher than projected by EES at al. The projections have been aligned using the following assumptions:

- Actual in-use gas consumption is 75% of the AGA standard value for instantaneous water heaters and 80% of the AGA standard for storage water heaters, reflecting smaller family sizes, holiday absences etc;
- In addition, progressive increases in the efficiency of hot water use (and reduced demand, eg through increasing tendency for cold-water clothes washing) lead to a further 15% reduction in per-unit gas demand by 2015 for instantaneous units and 10% reduction for storage units (where reductions in gas use are not linearly proportional to reductions in water demand because of standing losses).

These assumptions will reduce the actual gas savings due to the increases in efficiency brought about by enhanced labelling. These gas savings are illustrated in Figure 18. In the HIGH scenario, the average gas consumption of an outdoor storage heater purchase in 2005 would be about 1200 MJ/yr less than in the BAU scenario, and in 2015 it will be about 2,000 lower. This is about half the theoretical potential of 4,200 MJ/yr for storage units estimated in Table 8.

Figure 19 Reductions in actual annual gas consumption due to efficiency improvements



Greater emphasis on gas water heater efficiency could also increase general awareness among all water heater buyers about the energy and greenhouse implications of water heater choice, and accelerate the shift towards gas. This has been modelled by assuming additional annual sales as indicated in Table 11. The additional sales are capped at a 2% increase over BAU gas water heater sales.

Table 11 Additional gas water heater sales from increased fuel substitution

	2000	2005	2010	2015
BAU sales ('000)	267.3	305.8	344.2	382.7
Extra sales under MED labelling scenario ('000)	0	1.5	3.4	3.8
Extra sales under HIGH labelling scenario ('000)	0	3.0	6.9	7.7

Figure 20 illustrates the annual emissions associated with delivering the specified amount of useful energy (projected to decline, as discussed earlier) by electric storage water heating and by gas water heaters of weighted average efficiency under BAU, MED and HIGH labelling effectiveness. It is clear that the emissions reduction available from substituting a gas for an electric water heater (about 1,800 kg CO_2-e/yr per water heater) is far greater than the emissions reduction available from increasing the efficiency of the gas water heater (about 130 kg CO_2-e/yr per water heater).

A large measure of substitution has already been assumed even under BAU, as evidenced by a shift in market share from electric to gas waters. EES et al (1999) has taken this into account in its overall projections of household fuel mix and greenhouse gas emissions. The point is that any *additional* substitution beyond this BAU trend that enhanced gas labelling could bring about would have significant greenhouse benefits.

Figure 20 Emissions to deliver same useful energy, gas and electric water heaters

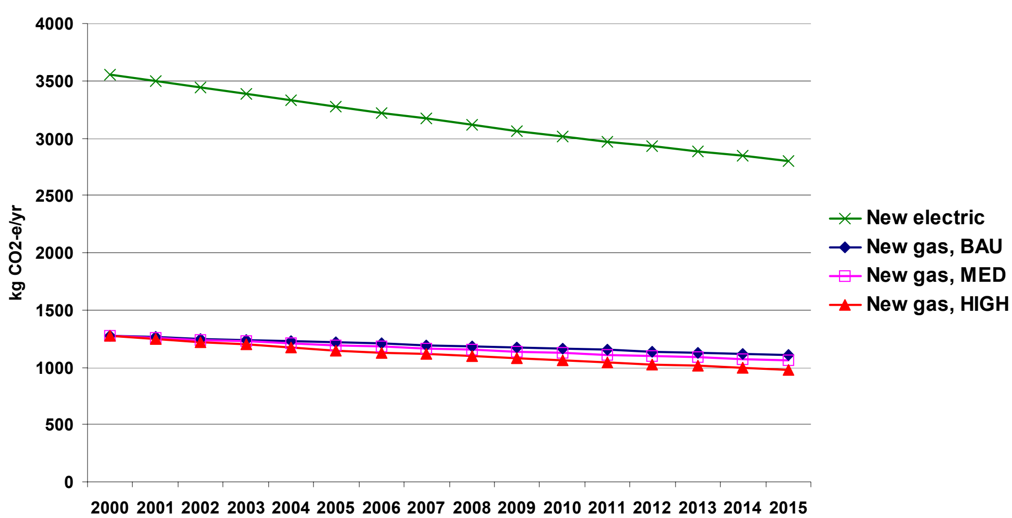
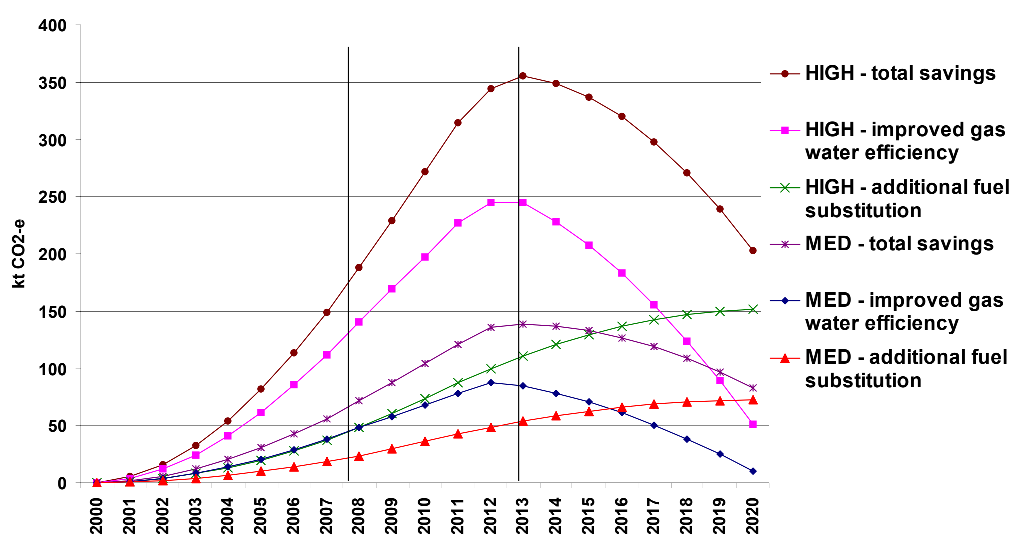


Figure 21 illustrates the projected reductions in greenhouse emissions below the BAU assumptions associated with enhanced gas water heater labelling. The calculation takes into account the estimated service life of new gas water heaters. It shows that:

- the greenhouse reductions peak in 2012 and decline thereafter – in effect, the enhancement of labelling brings forward efficiency increases that would take place later;
- in the MED scenario, greenhouse reductions from greater gas water heater efficiency would reach about 90 kt CO_2-e (0.09 Mt CO_2-e) by 2012, and average 70 kt/yr (0.07 Mt/yr) during the Kyoto commitment period;
- in the HIGH scenario, greenhouse reductions from greater gas water heater efficiency would reach about 250 kt CO_2-e (0.25 Mt CO_2-e) by 2012, and average 200 kt/yr (0.20 Mt/yr) during the Kyoto commitment period;
- additional substitution of gas for electric water heating could produce an extra 50 kt CO_2-e/yr savings by 2012 in the MED case and 110 kt CO_2-e in the HIGH case. These reductions would continue to increase, since the substitutions are not just brought forward but are additional to what would otherwise have occurred
- the projected impacts of the two effects combined average about 0.10 Mt CO_2-e/yr during the Kyoto commitment period in the MED case and 0.27 Mt CO_2-e/yr under the HIGH case.

Figure 21 Emissions saved for gas water heaters sold 2000 - 2015



3.4 Monetary Costs and Benefits

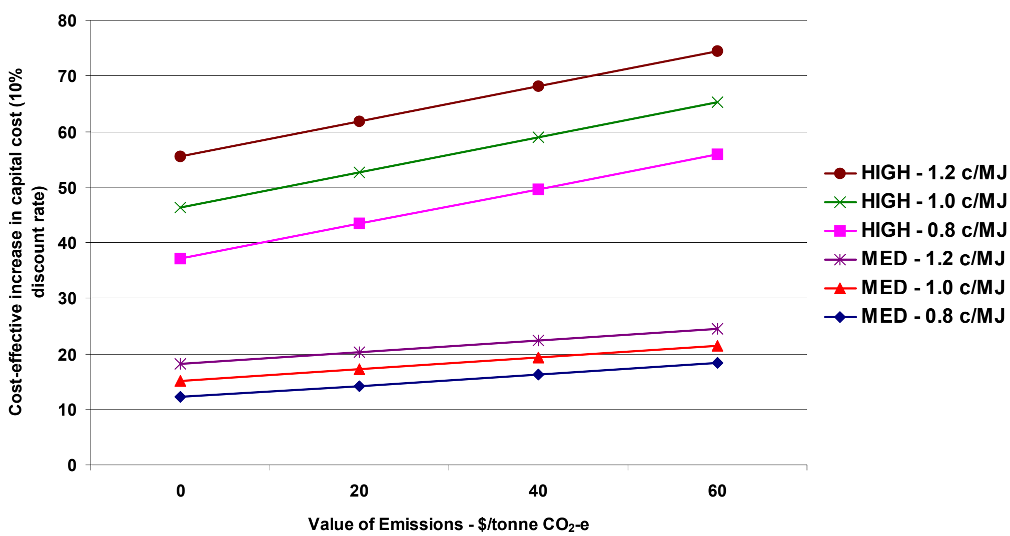
There is not enough information available on real average retail prices and installation costs to derive relationship between capital cost and energy efficiency. More efficient gas water heaters generally incorporate more sophisticated controls, higher quality burners and more insulation, so a higher purchase price would be expected. On the other hand, outdoor units require no fluing through the building shell, so a shift to outdoor installation in preference to indoor could reduce average installation costs.

One approach to assessing the cost-effectiveness of increases in gas water heater efficiency is to establish the increase in capital cost which the projected savings in operating costs would support. This has been done on the basis of net present values (NPV) in 2000, using a discount rate of 10% for future expenditure. The permissible cost-effective increases in average water heater capital costs have been calculated for:

- gas tariff levels of 0.8, 1.0 and 1.2 cents per MJ (covering the range of current capital city tariffs); and
- CO_2-e values of $0, $20, $40 and $60 per tonne, the indicative range used in recent analyses of electrical appliance programs (GWA 1999). Existing gas tariffs value emissions at zero, but non-zero emissions costs could eventually be included in shadow prices (for economic analyses) or in actual tariffs in the event that emissions permit trading is introduced.

Figure 22 indicates the maximum increase in capital cost for which the MED and HIGH case efficiency improvements would be cost-effective. At zero value for CO_2-e, the range is $12 to $56, and at $60/tonne CO_2-e, it is $19 to $75. The purchase price of gas water heaters (excluding installation) is in the range $ 800 – 1200, so these capital costs could represent anywhere from 1% to 10%.

Figure 22 Relationship between capital cost increase, tariff and CO_2 costs



4. Conclusions

4.1 Efficiency Trends

There is some evidence that the average efficiency of gas water heater models on the market has increased since the introduction of labelling:

- Minimum star ratings of registered models have increased (although this trend is complicated by the fact that in early years untested models were assigned one star, even though they may have had higher ratings);
- Maximum star ratings have increased;
- Model average star ratings have increased in two of the four product categories (internal SWH and external IWH) but have remained steady in two others (external SWH and internal IWH).
- Suppliers of SWHs, nearly all of which are locally made, seem to have perceived a commercial value in a higher star rating: where an additional star was in reach, suppliers took steps to achieve it.

However, there is no direct information on how the sales-weighted average star rating has changed. Partial sale-weighted analysis (ie using brand shares) could give yield somewhat more information than model-weighted analysis (ie using the AGA product directory alone), but only id reliable brand share data were available over a period. However, more complete sale-weighted sales-analysis appears necessary to allow robust conclusions to be drawn.

There is little information on how water heater buyers have responded to labelling. There is not enough information to assess whether customers have shown a shift in preference towards (or away from) the more efficient of the models on the market.

4.2 Form of Label

The form of the label itself and the star rating algorithms are less of an issue with gas appliances than with electrical appliances. Judging from consumer research on electrical appliance labels, Australian consumers are very familiar with the star rating scale and value it as a quick indication of relative energy efficiency (GWA 1999). The US label, the only other gas water heater label currently in common use, does not appear to have these advantages (see Appendix).[10]

For refrigerators, freezers, dishwashers and air conditioners, the increase in product energy efficiency since labelling was implemented is such that there was "bunching" near the top of the six-star scale as early as 1991 (GWA et al 1991). More efficient products that have come on the market since have not been able to derive sufficient

[10] It is understood that a draft EN (European Norms) method for labelling of gas water heaters has been issued (prEN13203). This would involve a dynamic draw-off test and the reporting of efficiency in the standard EC appliance label (ie grades A to G). However, the European Community (EC) does not appear to have plans for implementation at this stage.

commercial advantage from higher star ratings. This was the main reasons for the relaunch of the labels with new scaling algorithms, which is taking place in 2000 (GWA 1999).

The changes proposed for the electric appliance label are:

- *The form of the energy labels*: new labels are to be introduced, similar to the existing labels in order to build on the already high level of consumer recognition and acceptance, but with sufficient changes in shape and text to ensure that consumers do not confuse new labels with old ones. There will also be a transitional period during which the new label will carry a message to this effect.

- *The star rating algorithms*: the new label will retain a 6 star scale but with different rating algorithms, so that a product which currently rates, say, 5 stars will rate only around 3 stars on the new scale. During the transition period the new labels will also state what the rating would have been on the previous scale.

- *Other content of the energy labels*: some information will be removed, presented in a different way or added.

- *Clarification of presentation aspects*: the guidelines for presentation of partial stars on the present label are unclear, and some suppliers have printed labels in a way that arguably exaggerates the comparative star rating of the product. The description of the new label is much clearer, and so should reduce the prospect of consumers being confused or misled;

- *Changes in the energy consumption test*: the revision of the label gives the opportunity to revise minor aspects of the energy tests on which the label is based.

The proposed changes are being included in the Australian Standards which describe the energy testing and labelling requirements for each product type, and which are called up in State and Territory labelling regulations. The transition will be effected through the timing of the Australian Standard revisions, through managing the product registration process and though over-sticking "old" labels with "new" labels on product in showrooms to minimise the period of potential confusion. These measures will impose some additional costs on suppliers, which are expected to be passed on to appliance purchasers, as are the costs of the existing labelling program.

The conditions which necessitated the redesign of the electric appliance label do not yet apply to gas water heaters. There is a reasonable range of star ratings on the market, and bunching at the top of the scale is not yet a problem. For indoor SWHs the range is currently 1 to 3 stars, for outdoor SWHs 1 to 5 stars, for indoor IWHs 2 to 5 stars and for outdoor IWHs 2 to 5 stars (there have been 6 star units in the past). Of course, this covers units of all capacities, so a buyer searching in a narrower capacity range (eg 90 litre delivery or equivalent) may face a narrower star rating range.

It is likely that the main key to increasing sales-weighted energy efficiency is not the introduction of still more efficient products, but shifting consumer preference toward the more efficient of those already on the market. This could be accomplished by building a more effective communication strategy on the present label.

A potential area of improvement in the electrical label design which could be applied to the gas label is the standardisation on half-star steps. Integer steps are too coarse but giving star ratings to one decimal place, which are equivalent to nominal differences of only 200 MJ/yr and may be too fine, and confuse rather than clarify the real efficiency differences between models. If user awareness of the gas label is to be increased, either through direct promotion or via the impending relaunch of the electric label, it would be consistent to emphasise the same steps. This would require a minor change in the AGA labelling rules regarding in the presentation of the information on labels and in the *Directory*.

4.3 Use of Supplementary Communications

One area where gas labelling is much less developed than electric is in the use of supplementary communications media. The Internet now offers a flexible and low-cost opportunity to rectify this. The AGA directory has all the data necessary for a user-friendly, searchable site. There could be links to it from the AGO's energyrating.gov.au site and from gas utility sites.

In fact, the AGA should consider requiring that the energyrating address be printed on gas labels. It will be printed on all electric energy labels and over time may well become the first point of reference for all label- and energy-aware appliance buyers, irrespective of appliance or energy form.

The AGA should also consider guidelines for the use of star rating data in supplier brochures. A degree of standardisation would be introduced by showing all ratings to the complete half star (eg 5.5, 4.0).

4.4 Messages that Could be Emphasised

Category Preferences

Analysis of the model register suggests that products fall into four efficiency categories (although the second and third are similar in efficiency):

1. Outdoor instantaneous (the most energy-efficient category);
2. Indoor instantaneous;
3. Outdoor storage; and
4. Indoor storage.

The differences between outdoor and indoor models are greater for storage than for instantaneous, and some of the more efficient instantaneous models have indoor installations kits, whereas the more efficient storage units can only be installed outdoors.

Label-related communications (eg on the AGA website) should emphasise the following linked but separate messages:

1. that large efficiency gains can be made through category selection alone (ie by preferring instantaneous to storage, and outdoor to indoor installation);
2. the star rating should then be used to select the best of the category.

Value of Stars

Each star rating step represents about 2020 MJ of annual gas consumption, on the AGA standard water heating task. At 1c/MJ, a typical urban natural gas price, this would represent about $ 20/yr, or $200 over a 10-year service life. Therefore there is both scope and monetary incentive to seek out more highly rated products.

However, electric consumer research has indicated that buyers make more use of simple reminders of the relative "energy value" indicated by the star rating of products than they do of complex running cost or life-cycle cost messages. They are more likely to use the label information in their purchase if they have a sense of whether 3 stars is "good" or just "acceptable". These reference points have shifted since the launch of labelling. Whereas a 4 star refrigerator was originally "good" it is now just "acceptable" to label-aware buyers, who regard 5 and 6 as "good".

There is considerable scope for building in value references of this type into the communications supporting gas water heaters labelling - eg "less than 3 stars is poor, 3 and 4 is acceptable and 5 and 6 is good" should be part of the message.

Energy Form Preference

An important difference between gas and electric labelling is the potential for the gas labelling program to influence choice of energy form. This is likely to be an indirect rather than a direct effect, since labelling applies to gas water heaters but not electric ones. (The only area where some consumers may be tempted to use labels for cross-fuel comparisons at present are with gas space heaters vs the heating mode of reverse cycle air conditioners. Since air conditioners are almost always purchased primarily for cooling, however, the incidence of this is probably negligible).

Nevertheless the gas water heater labelling program has a real potential to influence fuel choice by positioning gas water heaters, as a group, as more "greenhouse-friendly" than electric water heaters - and indeed, equal to solar-electric water heaters in greenhouse terms in the mainland States.

The space constraints of the label make it difficult to include a greenhouse message that is both succinct and legally defensible. Even a simple statement such as "natural gas appliances produce less greenhouse gas emissions" would probably need to be so heavily qualified as to either lose meaning to take up too much space.

On the other hand it would be easy to include information in leaflets, or control the sequence of websites, to emphasise the greenhouse characteristics of alternative water heating fuel/technology combinations, before leading users to the gas rating material.

The retention of the present rating spread of water heaters, with several already at 5.5 stars and 6 stars a possibility, will create a visual difference between gas labels and the new electric labels, which will at first have very few appliances rated higher than 3.5 stars. This visual difference could be exploited as a rough “greenhouse marker”, even though there is no cross-fuel labelling of water heaters for the time being.

It is noted that the AGA water heater rating does not allow for comparison between the performance of gas-boosted solar models and conventional models. The January 2000 *Directory* gives star ratings for solar-gas models (3.4 and 4.4 respectively) but these seem to be related to performance on 100% boost, so give no indication of true performance of the solar section. The gas consumption of a solar-boosted product should be *less* than the standard hot water delivery, but the star ratings as currently presented imply that they use *more* gas (when performing as gas-boosted solar) than many other conventional gas water heaters. Tests published in Choice (December 1999) indicate that in Sydney the gas-booster model used some 9,200 MJ les than a “high-efficiency” storage gas water heater to deliver 200 litres/day, which is similar to the AGA standard delivery task.

Again, this is difficult to include on a label (unless the star rating scale is revised to accommodate solar water heaters, eg by rescaling so that only water heaters using *less* gas than the delivery task of 13,760 MJ can qualify for 6 stars). However, it would be easy to include information in leaflets, or control the sequence of websites, to cover the solar issues more fairly.

4.5 Recommendations

Maximising the effectiveness of gas water heater labelling could bring greenhouse benefits in two ways:

- Increasing the sales-weighted energy efficiency of new gas water heaters compared to what it would otherwise be; and

- Assisting gas to gain market share from more greenhouse-intensive forms of water heating (and possibly cooking and space heating as well, once gas-connection is established).

While there has been an increase in the average efficiency of gas water heater models offered to the market since the start of labelling, the extent to which this been a consequence of labelling is not known; nor is the effectiveness of labelling on influencing purchase behaviour.

It is recommended that:

1. A market monitoring system be established so that sales-weighted efficiency trends can be tracked in future, as for electric appliances;

2. Consumer tracking surveys be established to monitor awareness and comprehension by appliance purchasers of gas labels and related communications (these could be combined with tracking surveys for electric labels, which are expected to commence in advance of the relaunch of the electric label);

3. Supporting communications for gas water heater labelling (internet sites and perhaps leaflets) listing all products, not just the most efficient, should be established nationally;

4. The internet communications for gas water heaters (and perhaps other gas appliances, subject to review) should be integrated with those for electric appliances at the energyrating.gov.au site, by
   a. adding a searchable gas water heater listing to the energyrating site;
   b. linking to the site from the AGA and gas utility sites;
   c. requiring that the gas label state the site address (as the new electrical label does);

5. The supplementary communications for gas water heaters (eg the preliminaries to the listings on the energyrating website) should carry messages related to:
   a. greenhouse implications of choice of energy form (with solar/gas treated as a form distinct from gas);
   b. category choice (ie instantaneous vs storage, outdoor vs indoor);
   c. energy value (ie "less than 3 stars poor, 3 and 4 acceptable, 5 and 6 good").

The label itself does not appear to need major revision at this stage. Judging by consumer research on the electrical label, the star rating format has wide recognition and acceptance, and there appears no reason to consider the format of the other known gas water labels, that of the USA, or the proposed European label. As yet there is no bunching at the top of the star scale, as there was for electrical appliances. However, the following minor change should be considered (apart from the addition of an internet address):

6. The textual and graphical presentation of stars should be limited to half star steps (as in the new electrical labels) rather than decimal or angular increments.

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Appendix – US Gas Water Heater Label

The only other gas water heater energy labelling program of which we are aware is in the USA (both Canada and the USA have a minimum energy performance standard for gas water heaters). The current label is 190mm high by 135mm wide, and printed in black on yellow and white.

The National Energy Policy and Conservation Act of 1978 required the Federal Trade Commission (FTC) to mandate labels for a wide range of appliances, including gas, electric and oil-fired storage water heaters. The FTC issued guidelines for the labels in November 1979 and labelling commenced in mid-1980.

The label originally showed only the annual cost of operation with no direct indication of energy consumption. The label design was complicated by the need to accommodate a range of gas tariffs, with a table from which the users could read off annual running costs for that model. The label design was simplified in 1999 to show annual gas consumption (in therm units), a linear scale with the highest and lowest annual consumption of models of similar capacity (communicated to the supplier by the FTC) and an estimated annual running cost (based on a tariff of US$ 0.58 per therm). A copy of the label is attached.

In summary, the US appliance energy labelling program is the longest running US Federal energy efficiency program and one of the older energy labelling programs in the world. The labelling program is generally seen as having some impact and as being integral to the overall US effort of testing, labelling, and standards. To date, however, there has been no effort to quantify the energy impact of the EnergyGuide labelling program.