

PRODUCT PROFILE



INSTANTANEOUS GAS WATER HEATERS

AUSTRALIA'S STANDBY POWER STRATEGY 2002 - 2012

AN INITIATIVE OF THE MINISTERIAL
COUNCIL ON ENERGY FORMING
PART OF THE NATIONAL
GREENHOUSE STRATEGY

The National Appliance and Equipment Energy Efficiency Committee seeks comment on this proposal from any interested person or organisation.

Please email comments to:

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Alternatively, hard copy comments can be mailed to:

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Comments received by 30 June 2004 will assist in determining the final form of the policy proposals taken to government regarding instantaneous gas water heaters.

An electronic version of this Standby Product Profile and other Profiles released for public discussion can be obtained from www.energyrating.gov.au under standby.

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PRODUCT DESCRIPTIONS

Gas water heaters have been available in Australia since reticulated gas was made available to the residential sector, well over 30 years ago. Traditionally, gas water heaters for residential use were storage systems (typically 90 to 150 litres) and used a pilot light to provide ignition for the gas burner. Instantaneous gas water heaters have also been available over the same period, but until the 1990's, these units mostly used a pilot light or manual ignition and had a small share of the market. More recently, a new generation of instantaneous gas water heaters has emerged onto the market. These tend to be high efficiency models with electronic ignition and often with electronic user-adjustable temperature controls.

This standby profile covers instantaneous gas water heaters for residential use that have a 240V mains powered connection and sets requirements for the electricity consumption of these units.

Instantaneous gas water heaters, also called continuous flow systems, differ from traditional gas and electric storage systems in that they do not store any hot water. They heat water as it is required by the user.

They essentially have a large capacity burner¹ and a heat exchanger to transfer heat from the gas combustion to the water that is passing through the water heater. The combustion products and waste energy not transferred to the hot water are exhausted through a flue. The heat exchanger is typically copper, but may also have parts made of aluminium or titanium.

The overall energy efficiency of instantaneous water heaters (per MJ of hot water delivered) tends to be high because there are no heat losses associated with the storage of hot water in a tank (the relative efficiency however depends on the amount of hot water delivered per day). However, there are other energy issues for instantaneous water heaters.

Each time an instantaneous water heater starts, it uses “startup energy” to heat the water heater components (eg heat exchanger) and water in the unit from ambient conditions (cold) up to a usable temperature. This may take several seconds and there is also some water wastage associated with each separate start. The energy efficiency benefits of instantaneous gas water heaters therefore depend to some degree on the frequency and duration of hot water drawoffs in the home. Instantaneous water heater capacity is rated on the basis of litres of hot water per minute (based on a standard temperature rise of 45K), typically in the range 10 to 32 litres/minute. Where there are multiple users drawing water at the same time, smaller instantaneous systems will not be able to provide the same energy service (in terms of volume of hot water and pressure) as a storage system, particularly when cold water temperatures are low.

Control types for hot water temperature range from simple mechanical controls (where water temperature delivered partly varies with cold water temperature and flow rate) through to sophisticated electronic controls which sense hot water outlet temperature and adjust the gas burner capacity to meet the target temperature, independent of the cold water temperature and flow rate² (the outlet temperature in these cases can be either a pre-set outlet temperature or a user selectable temperature via a control panel).

Some higher end instantaneous water heaters have fan-forced flues that generally offer greater output control, flexibility of operation and burner efficiency. Flue fans are mains powered and only operate during heating and usually for a period afterwards to cool the

heat exchanger and burner (typically 5 to 15 minutes). Flue types can be either conventional or balanced in various configurations.

As there is no storage of hot water, an instantaneous gas water heater requires a method of sensing when there is hot water flow (demand), so that the burner is ignited when water flow commences and stopped when water flow stops. This can be done using mechanical or electrical sensors.

Instantaneous water heaters also vary in the method of ignition of the gas. The technologies used include pilot lights, electronic ignition (usually mains powered, but some models use batteries for ignition only) and more recently a new technology which uses water flow through the heater to power an ignition circuit (e.g. Bosch HydroPower range). Energy used in pilot lights for instantaneous water heaters (which can be 5 MJ/day or more) serves no useful purpose, so there is an energy incentive to remove a pilot light where possible (this energy is included in the energy label value). However, mains powered ignition will have some energy associated with it. Electrical energy consumption is now included in the gas energy label's measurement of total annual energy consumption (introduced in AS4552 Amendment 2 in 2002).

Because an externally mounted instantaneous water heater is essentially at ambient temperature when not in use, frost protection can also be an issue. In cold areas subject to freezing, some instantaneous water heaters offer frost protection through the provision of a mains powered electric heater while some offer protection through the provision of a drain down valve which operates when the temperature in the water heater falls below a specified temperature (typically 4°C – similar to drain down valves used for solar water heater protection). In cold areas, mains powered frost protection energy consumption could be significant (frost protection heaters are typically 70W to 100W but their hours of operation will vary on the water heater position and weather). The frost protection function of gas water heaters are not considered as part of this standby profile.

The main aspect of concern in this product profile is electricity consumption of those models that are mains powered. Mains power may be used for sensing and control circuits, electronic ignition, flue fans during operation, and frost protection.

¹ Instantaneous water heaters typically have an energy input requirement of up to around 200 MJ/hour, compared to a typical storage gas water heater which has a rating of around 50 MJ/hour.

² Minimum flow rates for instantaneous gas water heaters typically vary from less than 2 litres per minute to more than 5 litres per minute to keep the unit operating.

CURRENT OWNERSHIP AND TRENDS

Nearly all Australian homes have some form of water heating. The penetration of gas water heaters has been increasing steadily since the earliest available data from the 1960's, when 20% of households had a gas water heater, to 2004, where about 37% of households Australia wide used a gas water heater.

The penetration of gas water heaters varies markedly by State. The share for gas water heaters by State to 2002 with projections to 2015 are shown in Figure 1.

Total water heater sales in Australia are now about 700,000 units a year, up from 600,000 in the mid 1990's. This is consistent with the increase in new houses (2% per annum) and an average replacement period of about 12 years.

Gas water heaters now make up about 50% of all water heater sales in Australia (BIS Shrapnel 2002) (about 350,000 units in 2003) and this share is expected to gradually increase as overall gas penetration increases. Nearly 60% of new homes install a gas water heater.

Data on the sales share of instantaneous gas water heaters is ambiguous, but historical data from BIS Shrapnel has allowed some initial estimates to be made of sales share over the past 10 years. Data for

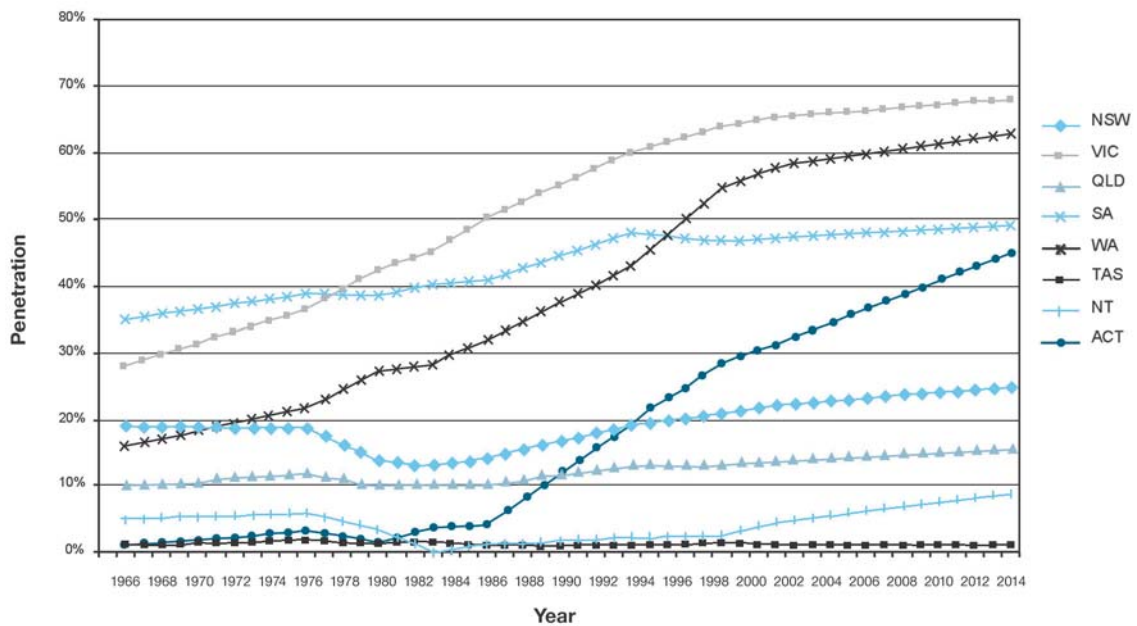
years from 1998 is more certain. These trends are illustrated in Figure 2.

Instantaneous gas water heaters have been available for many years in Australia. In fact ABS data from 1986 shows that instantaneous gas water heaters made up a total of 36% of all gas water heaters installed at that time (450,000 out of a total of 1.25 million units) (ABS 8212.0-1986). At that time, many of these were likely to be small capacity sink or bath heaters that used a pilot light or manual ignition.

Data from the Australian Bureau of Statistics reports that in 1999 around 30% of installed gas water heaters were the instantaneous type (ABS 2000).

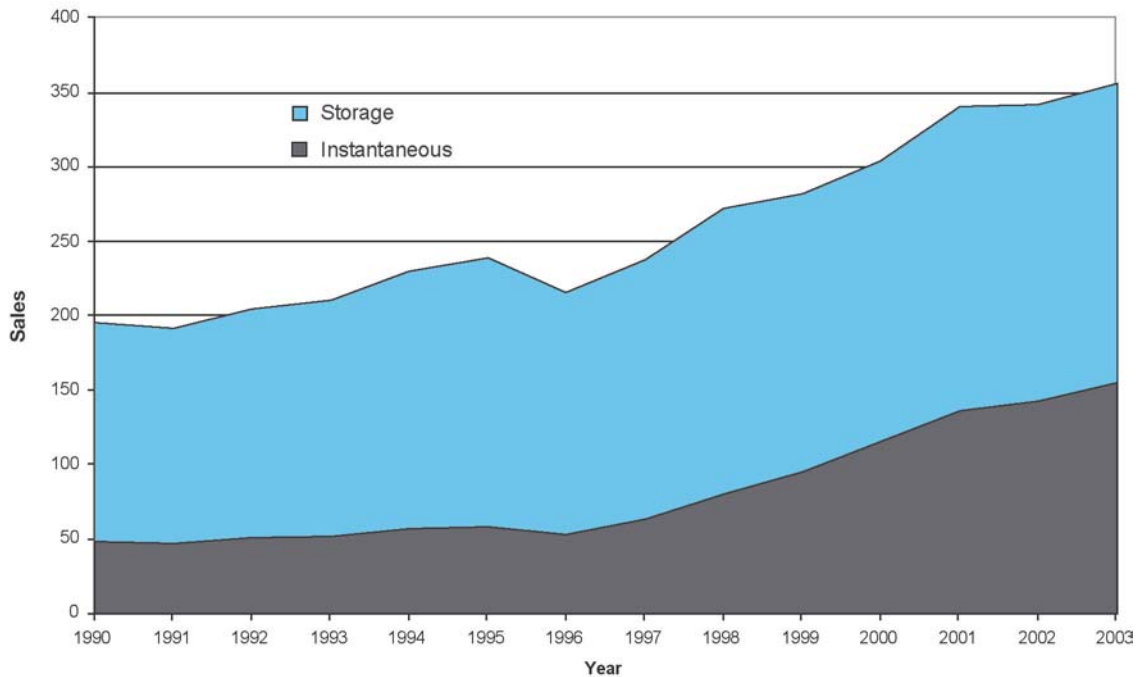
Mains powered models really only appeared in the early 1990's (although one model was available on a very limited basis as early as 1989). These types of units, which have superior temperature control and flexibility, now dominate the market and it is estimated that these types now constitute more than 80% of instantaneous gas water heater sales. Depending on trends, sales of mains powered gas instantaneous units could be approaching 200,000 units per year by 2010.

FIGURE 1: STATE SHARE OF GAS WATER HEATER PENETRATION



Source: EES estimates based on ABS4602.0-2002 and EES 1999.

FIGURE 2: SALES OF GAS WATER HEATER BY TYPE



Source: EES estimates, BIS Shrapnel 2002 and unpublished data tables (BIS Shrapnel 2003)

RELEVANT MODES FOR THE 'ONE WATT' POWER PLAN

Instantaneous gas water heaters that are mains powered have several modes:

- On mode – the water heater is producing hot water.
- Cool down mode – this occurs after on mode for a short period.
- Frost protection mode – this optional feature is only present in some units and only operates in very cold conditions.
- Passive standby mode – water heater is monitoring and waiting to activate other modes.

On mode is where the water heater is performing its primary function of producing hot water. Typically gas solenoids are operating, electronics are controlling operation of the water heater and burner and usually a flue fan is operating. The power consumed can be dependent on the water flow rate and temperature rise. The typical power consumption range in this mode is 40W to 120W.

Cool down mode (also called post purge) occurs after **on mode** and where the water heater flue fan continues to operate to cool the system down. Not all

models will have this mode. The period of operation of the fan can be controlled by a temperature sensor or a fixed timer. Typically, **cool down mode** would operate for 5 to 15 minutes after each on mode. Typical power consumption range in this mode is 10W to 40W.

Frost protection mode is only present in units with this feature. Most units will have a small resistive heater that activates when the temperature inside the water heater falls to below a preset temperature (typically 4°C). This system operates in order to prevent water freezing in the heat exchanger, which has a large surface area, meaning that any water inside the unit will be cooled quickly if the unit is mounted outdoors). Frost protection can also be provided by a drain down solenoid or temperature activated valve that operates at a certain temperature. Typical power consumption range in this mode is 50W to 120W for resistive heater types. Drain down types will have none or negligible power consumption. Note that this mode is highly dependent on climate and location of the water heater (e.g. indoors or outdoors) and may not ever activate in many cases.

Passive standby mode is the predominant mode for instantaneous gas water heaters in terms of hours

per year. In this mode, power is supplied to the water heater controller and the unit is monitoring for hot water flow. The unit will also be monitoring for frost protection (if present) and could also be supplying power for control panel LEDs and user control panels and/or displays (where provided).

Other modes: After power is reconnected a mains powered water heater will usually reboot the control system, but this mode generally only takes a few seconds and is not relevant to this study. Australian Standard AS4552 also identifies electric energy consumption associated with each start-up, but this is associated with **on mode** and will essentially be a similar power level to **on mode**.

The only mode of interest for the “One Watt” Power Plan is **passive standby mode**. Other modes are related to a specific energy service (delivery of hot water) or are not present in many water heaters (eg presence of frost protection mode is highly location and climate dependent).

KNOWN STANDBY DATA FOR NEW PRODUCTS

Although NAEEEC commissioned four store surveys of new electrical products during the period 2001 to 2003, no data was collected for instantaneous gas water heaters during these surveys (Energy Efficient Strategies and EnergyConsult 2003).

Gas water heaters are generally sold through specialist outlets, so special surveys would be required to cover these products in future years.

Presently there are about 20 electric mains powered instantaneous gas water heater models which have been approved by the Australian Gas Association (AGA 2003). These are set out in Table 1.

TABLE 1: MAINS POWERED INSTANTANEOUS GAS WATER HEATER MODELS - 2003

Brand	Model Range Name	Number of Models Approved
Aquamax	Continuum	2
Dux	Deliverance	2
Bosch	Highflow	3
Edwards	Comfort	2
Rheem	Integrity	3
Rinnai	Infinity	6+

Source: AGA 2003.

Paloma and Vulcan also have a range of instantaneous gas water heaters, but data on whether any of these are mains powered is not readily available.

Product details for instantaneous gas water heaters are available on the websites for each of the companies shown at the end of this profile. However, none of the product data or specifications on these web sites gives information on passive standby mode power consumption.

The majority of mains powered instantaneous gas water heaters appear to be imported from Japan. Bosch has a manufacturing and assembly facility in Melbourne but uses imported components.

Some of these companies have privately provided data on power consumption for passive standby mode. These values tend to range from 6W to 8W.

Data on brand share for instantaneous gas water heaters is available in BIS Shrapnel 2002. This data suggests that sales in 2002 were dominated by Rinnai (over 50% share, all being mains powered), with Bosch also having a significant market share at around one quarter, but these will include mains powered and other models. Other brands have only small market shares.

KNOWN STANDBY DATA FOR INSTALLED STOCK

Until late 2003, no systematic data collection had been undertaken regarding power consumption in passive standby mode for instantaneous gas water heaters in Australia, either in new units or units installed in households. In early 2004, measurements in passive standby mode were undertaken on nearly 40 mains powered instantaneous gas water heaters, mostly installed in Canberra. Some units in Sydney and Melbourne were also measured.

Some models from all major manufacturers were present in the field sample (except for Dux). However, the sample was dominated by Rinnai units, which is expected given their apparent dominance in the market share for mains powered models. The field data is presented in Figure 3. Where the year of purchase or installation was not known, the data is shown as year 1995.

Generally the values for Rinnai models were in the range 8W to 11W (average 9.9W), with no obvious trend over time for any of the brands. Other brand average values were Rheem (4.6W), Edwards (8.0W), Aquamax (11.4W) and Bosch (6.85W). The average of all models measured was 9.4W, but this value is of course dominated by the Rinnai values. Rinnai claim that some of their newer models have a standby of

around 6W, but no units with a passive standby mode this low were found in the field sample (the newest Rinnai models measured were manufactured 2002/06 and installed in 2003).

All mains powered instantaneous gas water heaters are left connected to power during normal use. Passive standby will therefore be the predominant mode in terms of hours per day.

There is little data available on the hours of operation of instantaneous gas water heaters. However, some engineering estimates of hours of use are possible from energy consumption data. Two possible extreme scenarios are shown below to illustrate the range of likely values for passive standby in terms of hours per day. The most important factors that determine passive standby time are energy delivered per day and the number of starts per day (and fan time associated with each start).

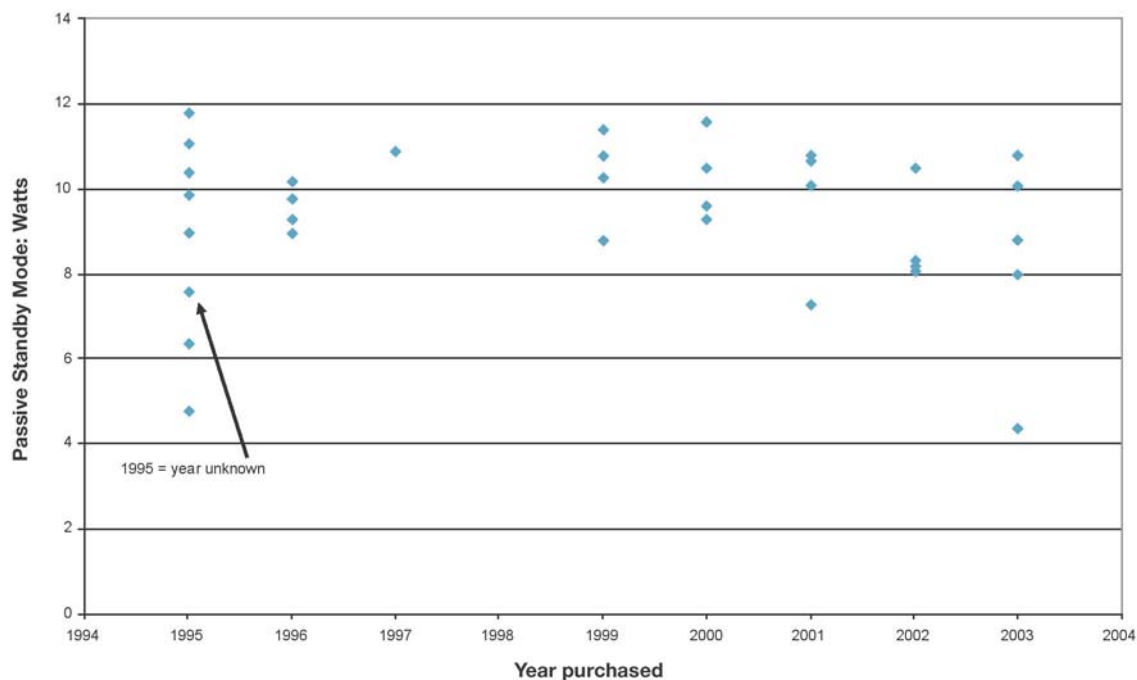
Passive standby time is expected to be in the range 18 hours to 23.5 hours per day. A typical time per day in passive standby mode is estimated to be 21 to 22 hours. Note that this figure is only of interest as it allows an estimate to be made of the magnitude of greenhouse emissions attributable to instantaneous gas water heater standby mode. A figure of 22 hours per day is assumed for greenhouse gas emission calculations (note that AS4552 assumes 23 hours per day).

TABLE 2: POSSIBLE PASSIVE STANDBY TIMES FOR GAS WATER HEATERS

Parameter	Low Standby Scenario	High Standby Scenario
Energy delivered (MJ/d)	15	50
Starts per day	6	20
Fan time (mins after stop)	5	15
Temperature rise (K)	45	30
Flow delivered (L/minute)	15	6
Delivered (litres/day)	80	398
On time (minutes/day)	5.3	66.4
Fan time (minutes/day)	30	300
Total time (minutes/day)	35.3	366.4
Standby (minutes/day)	1405	1074
Standby (hours/day)	23.4	17.9

Note: Startup times have been ignored.

FIGURE 3: FIELD MEASUREMENTS OF INSTANTANEOUS GAS WATER HEATERS - 2004



Note: Multiple units appear as a single point where data is common.

GREENHOUSE EMISSIONS

The greenhouse emissions reduction potential for the proposed standby target of 1W for passive standby mode by 2012 is in the order of 17 kt CO₂-e pa by 2010 and 37 kt CO₂-e pa by 2015, with continued savings growing well beyond 2020. The model weighted passive standby power consumption of all mains powered instantaneous water heaters sold in Australia in 2004 is estimated to be approximately 8W. This is expected to decline slightly irrespective of government actions.

To examine the potential for greenhouse savings, one scenario was modelled based on a standby power

target of 1W for passive standby mode applying to 90% of the market in 2012. Figure 4 shows the potential greenhouse emissions reduction. The projected share of instantaneous gas water heater sales is expected to rise gradually to about 50% of all gas water heater sales by 2010. Cumulative greenhouse savings to 2015 are estimated to be about 200 kt CO₂-e.

The projected total cumulative energy savings from instantaneous water heaters to 2015 based on the implementation of these targets in Australia is shown in Figure 5.

FIGURE 4: BAU VS. POLICY TARGET GREENHOUSE EMISSIONS FOR INSTANTANEOUS WATER HEATERS

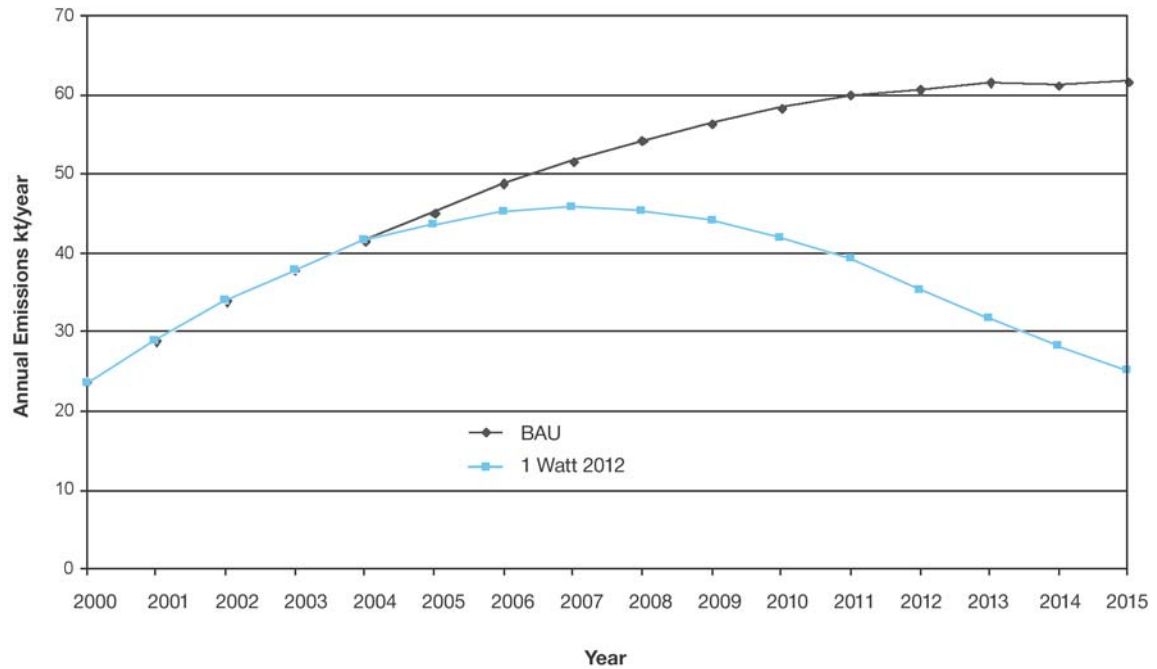
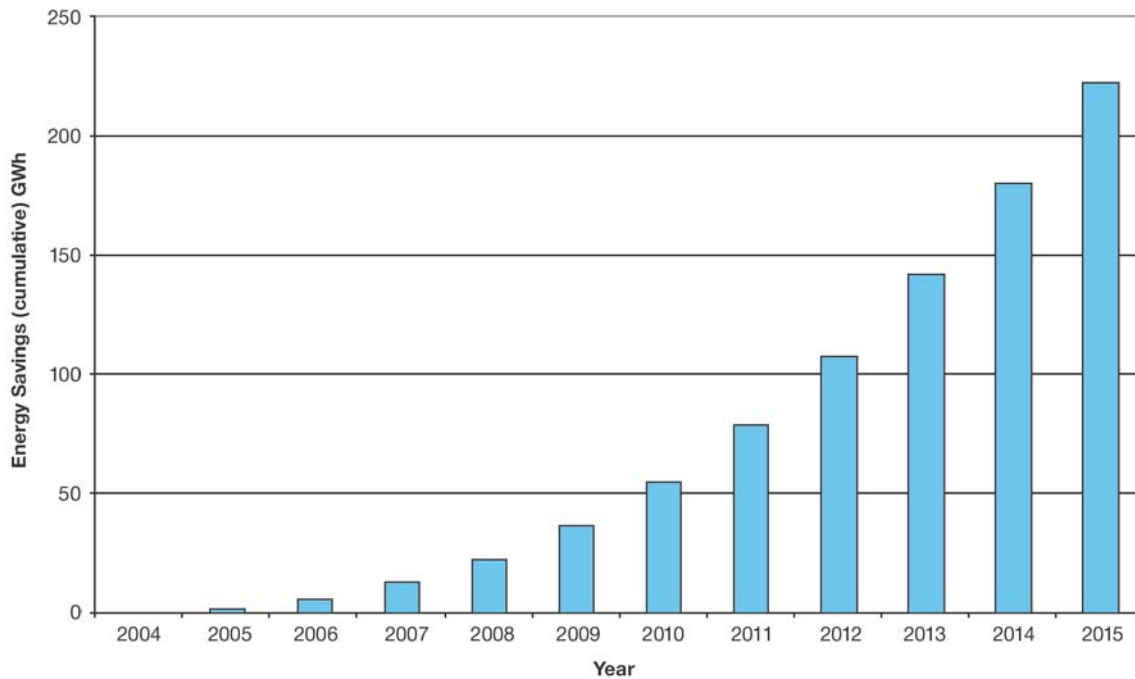


FIGURE 5: ENERGY SAVINGS FROM STANDBY TARGETS FOR INSTANTANEOUS GAS WATER HEATERS



CURRENT OVERSEAS POLICIES AND TRENDS

We are unaware of any specific policies that cover standby of electricity consumption for gas instantaneous water heaters. A number of countries regulate instantaneous gas water heaters for energy efficiency (eg USA) and Japan is introducing a “Top Runner” requirement for these units, but none of these requirements set limits for electricity consumption in passive standby mode.

This target applies to all mains powered instantaneous gas water heaters sold in Australia that year. NAEEEC proposes to monitor the sale of mains powered instantaneous gas water heaters in that year and to move toward regulation should that target not be met by a significant number of products.

GOVERNMENT TARGET

In accordance with the National Standby Strategy, NAEEEC intends to recommend to the Ministerial Council on Energy an ‘interim’ target. The purpose of which is to provide governments with confidence that Australian products will meet the ultimate target, of 1W in 2012. If the ‘interim’ target is not met in the specified year, government will commence dialogue with industry to explore other options, including the possibility of moving to Stage 2 mandatory measures.

2. NATIONAL STANDBY STRATEGY TARGET – 2012

Product	Passive Standby mode
Mains Powered Instantaneous Gas Water Heaters	1 Watt

1. INTERIM TARGET - 2007

Product	Passive Standby mode
Mains Powered Instantaneous Gas Water Heaters	3 Watts

The National Standby Strategy sets out the target of 1W, to be achieved by 2012. This is consistent with international activities, in particular, the IEA “One Watt Initiative”. This target should apply to all mains powered instantaneous gas water heaters.

The above requirements will be inserted into the relevant Australian Standard.

GOVERNMENT PROPOSALS TO ACHIEVE THIS TARGET

Government agencies intend to take the following actions to assist industry meet the standby targets for mains powered instantaneous gas water heaters:

Voluntary Tool Available	Use for this Product	Action / Rationale	Date
Government procurement list	✓	<ul style="list-style-type: none"> MCE will consider creating Government Policy of purchasing low standby mains powered instantaneous gas water heaters where available and fit for purpose. This policy will encourage manufacturers to supply government agencies with instantaneous gas water heaters that are energy efficient. 	2004
Industry Code of Conduct	✗	<ul style="list-style-type: none"> Not considered appropriate at this stage. 	NA
Australian Standard	✓	<ul style="list-style-type: none"> To communicate government expectations in the relevant Australian Standard, likely to be a part of AS/NZS 4552 or its successor. 	Initiate 2005
In-store surveys	✓	<ul style="list-style-type: none"> To collect data on passive standby for new mains powered instantaneous gas water heaters and to analyse trends. Surveys may include measurements of products provided by manufacturers or delivered through wholesalers and retailers. 	Ongoing
Publish statistics	✓	<ul style="list-style-type: none"> NAEEEC will highlight the range of performances of mains powered instantaneous gas water heaters in the marketplace through publishing data on a website or other means. 	Ongoing
Energy Rating label	✓	<ul style="list-style-type: none"> Electricity consumption of gas water heaters has already been incorporated into the Energy Rating label requirements for instantaneous gas water heaters (in a form that is equivalent to gas energy consumed) as part of AS4552 Amendment 2 published in 2002. Consideration may be given to showing passive standby power separately on the energy label or in published data (AGA listings or the gas efficiency website). NAEEEC will be working with the relevant Standards Committees on these issues. 	Ongoing

Government will announce whether this product should be targeted for Stage 2 intervention under the National Standby Power Strategy (involving possible regulatory intervention) or whether the abovementioned actions together with industry intervention have been successful in meeting the target at the NAEEEC Forum in the year:

2008

REFERENCES

- ABS 4602.0, *Environmental Issues: People's views and practices*. March 2002 (also 1999 and 1994 editions). See www.abs.gov.au
- ABS 8218.0 1986, *National Energy Survey: Household Appliances Facilities and Insulation, Australia, 1985/86*. Australian Bureau of Statistics 1987. See www.abs.gov.au
- ABS 2000, *Population Survey Monitor*, private cross tabulations of household data from 1997 to 1999, Australian Bureau of Statistics.
- AGA 2003, *Directory Of Certified Gas Appliances And Components*, Australian Gas Association, 31 July 2003 update. Available from www.gas.asn.au
- AS4552 – 2000, *Gas water heaters*, published by Standards Australia, includes amendment 1 (2001) and amendment 2 (2002). See www.standards.com.au
- BIS Shrapnel 2002, *The Household Appliances Market in Australia, 2002-2004 Vol 1(i): Whitegoods - Consumer Survey*.
- BIS Shrapnel 2003, unpublished tables of water heater sales and imports by type, personal communication.
- EES 1999, *Study of Greenhouse Gas Emissions from the Australian Residential Building Sector to 2010*, by Energy Efficient Strategies for the Australian Greenhouse Office.
- Energy Efficient Strategies and Energy Consult 2002, *Appliance Standby Energy Consumption: Store Report 2002*, report for the National Appliance and Equipment Energy Efficiency Committee, June 2002, Canberra. NAEDEC Report 2002/08. Available from www.energyrating.gov.au in the electronic library.
- Energy Efficient Strategies and Energy Consult 2003, *Appliance Standby Energy Consumption: Store Report 2003*, report for the National Appliance and Equipment Energy Efficiency Committee March 2003, Canberra. NAEDEC Report 2003/04. Available from www.energyrating.gov.au in the electronic library.
- Harrington & Kleverlaan 2001, *Quantification Of Residential Standby Power Consumption In Australia: Results Of Recent Survey Work*, report for the National Appliance and Equipment Energy Efficiency Committee prepared by Lloyd Harrington (EES) and Paula Kleverlaan (EnergyConsult), Canberra. Available from www.energyrating.gov.au in the electronic library.
- MCE 2002, *Australia's Standby Power Strategy 2002-2012 - "Money Isn't All Your Saving"*. Final report of long-term strategy to achieve Australia's One-Watt Goal 2002 to 2012, Ministerial Council on Energy. NAEDEC Report 2002/12. Available from www.energyrating.gov.au in the electronic library.

MANUFACTURER WEBSITES

- Aquamax – www.aquamax.com.au
- Bosch Australia – www.bosch.com.au
- Dux Hot Water – www.dux.com.au
- Edwards Hot Water – www.edwards.com.au
- Rheem Australia – www.rheem.com.au
- Rinnai – www.rinnai.com.au