

Country: Australia

Technology: Dishwashers

Sub Category: with a capacity of between six and sixteen place settings

Introduction

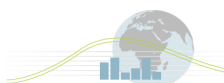
The first stage in the Mapping and Benchmarking process is the definition of the products, i.e. clearly setting the boundaries that define the products for use in data collection and analysis. This ensures that comparison between the participating countries is done against a specific and consistent set of products.

The summary definition for this product is:

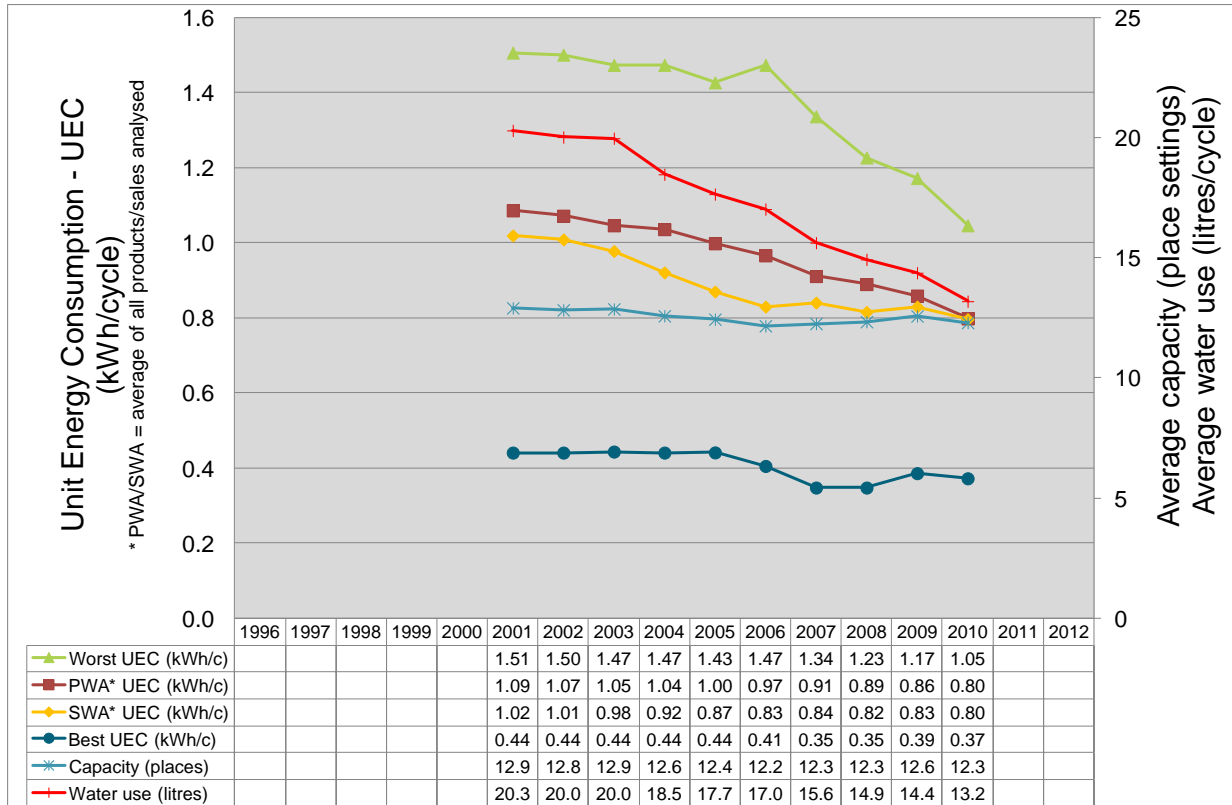
M&B Category	Description
Definition and Scope	<p><i>A machine which cleans, rinses, and dries dishware, glassware, cutlery, and, in some cases, cooking utensils by chemical, mechanical, thermal, and/or electric means, normally through the use of water and detergent. The machine may or may not have a specific drying operation at the end of the programme.</i></p> <p>The scope is to primarily include:</p> <ul style="list-style-type: none"> • Single door built-in (this includes freestanding units in European definitions), portable and drawer-type dishwashers; • Both non-soil-sensing and soil-sensing unit. <p>The scope will <i>exclude</i>:</p> <ul style="list-style-type: none"> • Table top dishwashers (with fewer than 6 place settings)
Rated Capacity	6-16 place settings
Other Characteristics to be Noted	<p>Wash Cycle Time</p> <p>Cleansing Performance</p> <p>Drying Performance</p> <p>Standby Functionality and Power Levels (Delayed Start, End of Cycle and Off)</p> <p>Load Type</p>

The detailed product definition can be found at the Annex website:

<http://mappingandbenchmarking.iea-4e.org/matrix?type=product&id=11>

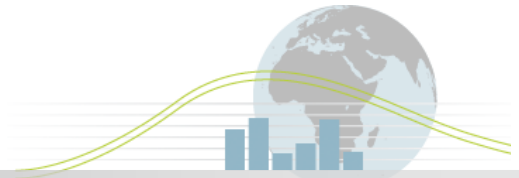


Unit Energy Consumption (UEC) of dishwashers in Australia

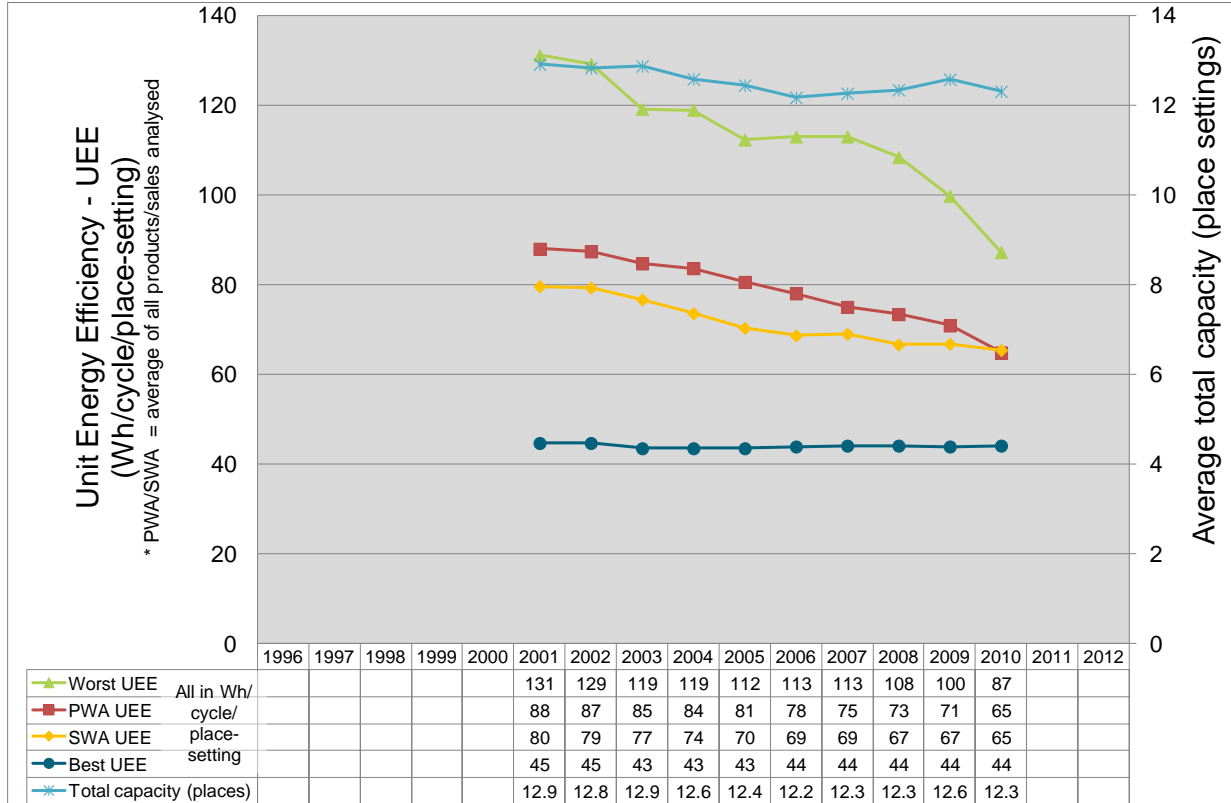


Key notes on Graph (see notes section 1)

- All data presented is based on locally measured values that have not been adjusted.
- All capacity and water consumption values listed are sales weighted averages.
- The 'Worst UEC' is the UEC of the product at the 'worst 5%' point of a ranked list of products in the dataset.

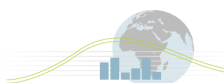


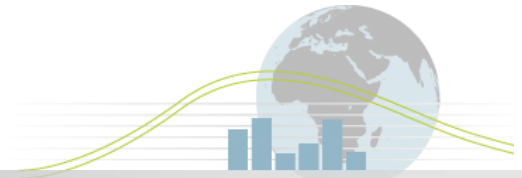
Unit Energy Efficiency (UEE) of dishwashers in Australia



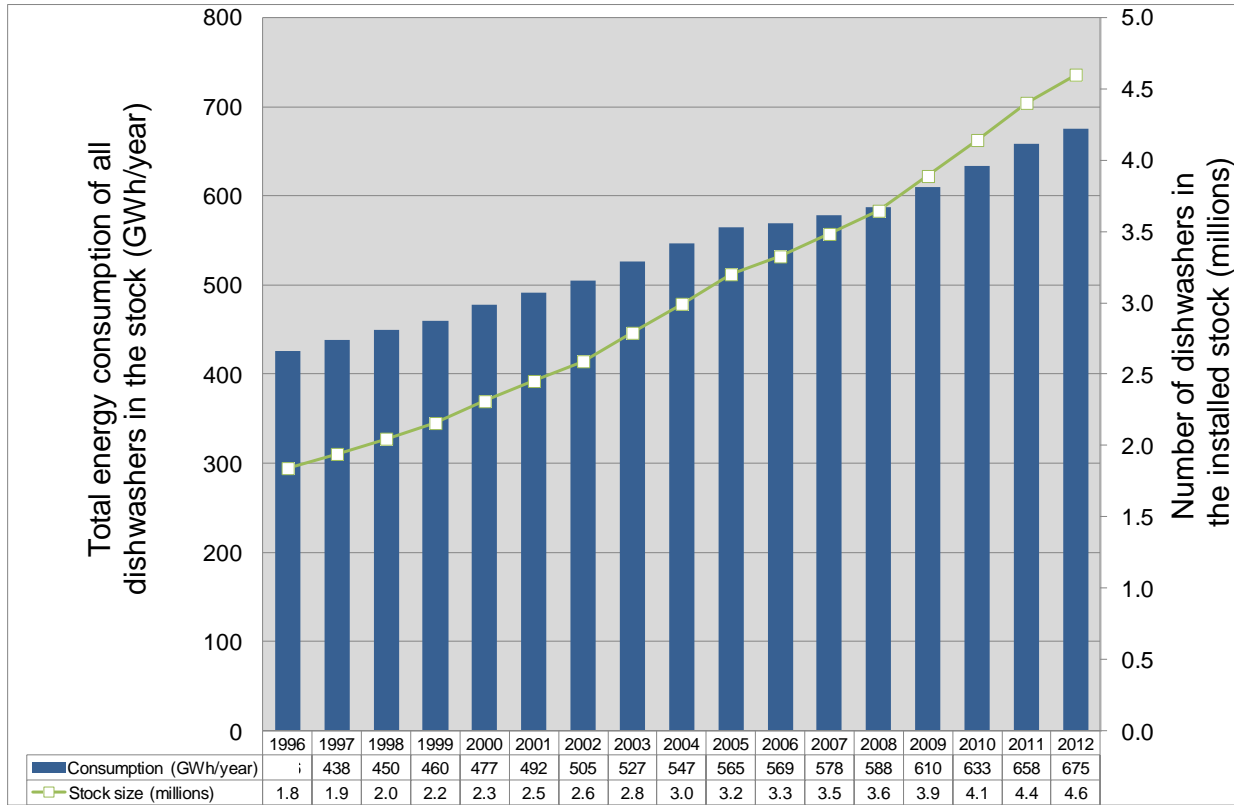
Key notes on Graph (see notes section 1)

- All data presented is based on locally measured values that have not been adjusted.
- All capacity values listed are sales weighted averages.
- The 'Worst UEE' is the UEE of the product at the 'worst 5%' point of a ranked list of products in the dataset.



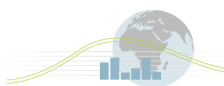


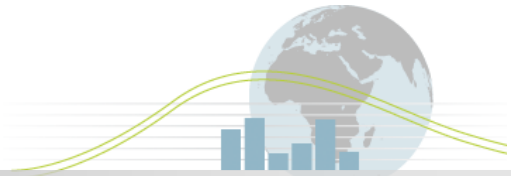
Energy Consumption of the installed stock of dishwashers in Australia



Key notes on Graph (see notes section 2)

- Data is taken from a report on energy use in the residential sector and is derived from an end-use or bottom-up stock model.

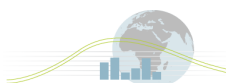


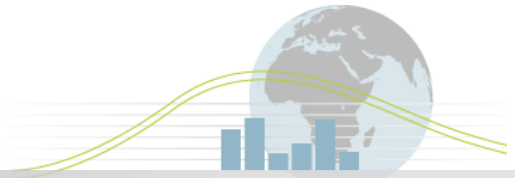


Major Policy Interventions (see notes section 3)

Minimum Performance Standards and Mandatory labelling are the primary policy interventions for improving the energy efficiency of domestic appliances in Australia. These are currently implemented as follows for dishwashers:

- **Minimum Efficiency Performance Standards (MEPS):** There are no MEPS in place for dishwashers in Australia. There are minimum mandatory performance standards in place for cleaning and drying performance.
- **Mandatory Labelling:** Energy labelling was introduced in 1988 with the label itself being updated in 2000. The current label includes the star rating (coloured stars), annual energy consumption (CEC), energy consumption per cycle, rated capacity (plus other information such as energy consumption if an auxiliary water heating supply is used – so called supplementary energy consumption). A separate declaration on the water consumption of the unit is also made but, although measured during the test in order to meet a minimum requirement, cleaning performance and drying performance are not included on any label.
- **Water Efficiency labelling:** Water efficiency labelling was introduced in 2006. This is a similar scheme to energy (star rating based on water efficiency) and it uses a common test, but the label is separate and is administered by a different department.



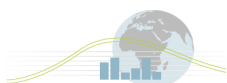


Cultural Issues (see notes section 4)

The Australian Bureau of Statistics (ABS4602) records data on the ownership of dishwashers at regularly intervals (nominally each 3 years). Ownership has been increasingly steadily for the past 30 years. Current national ownership in 2011 was 51.5% and this has been growing steadily at 1.5% per annum for the past 10 years. This survey also records some information about frequency of use, but this data is recorded in a way that is of low value. The ABS data and a range of other survey and end use metering campaigns suggest that average usage is around 200 to 250 cycles per year. This is significantly lower than the frequency assumed on the energy label (365 times per year). Consumers use a mix of programs (normal and economy type programs). No program wash temperature is specified for energy labelling and the programs selected by users are broadly reflective of the labelling programs.

For many years in Australia only single water connection dishwashers have been sold. Some of these can be connected to hot water, although this is not commonly done. Standard width 600mm units dominate the market, although a significant number of models are drawer configurations (1 or 2 drawers, these can operate independently).

Dishwashers in Australia are normally fitted with a standard 10 Amp plug, so the maximum power is limited to 2.3kW (nominal 230V supply).



Section 1. Unit Energy Consumption and Unit Energy Efficiency Graphics

1.1 Test methodologies

1.1.1 Regulations

The majority of the information in this section refers to:

AS/NZS 2007.1:2005
 AS/NZS 2007.2:2005
 (both published in 2005 and in force 31 March 2007)

However, the mapping and benchmarking process takes data from years preceding the introduction of this standard. In particular the following standards were in force prior to 2007:

AS/NZS 2007.1:2003
 (published in 2003 and in force from 1 April 2004)

AS/NZS 2007.2:2000

AS/NZS 2007.1:1998
 AS/NZS 2007.2:1998

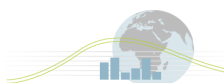
The **major** of relevant changes between the current standards and previous editions are:

- 1) Definitions more in line with IEC60436 Edition 3
- 2) Algorithm changed for energy label calculation in the 2000 edition and Standby included in annual consumption and energy label indicator in the 2005 edition (mandatory reporting in 2006)
- 3) Load harmonised with IEC from Dec 2007 (in practical terms), with both IEC and national loads allowable from 2003
- 4) AS/NZS and IEC evaluation scoring systems are now aligned.

Summary details of both the test methodology and the performance and labelling requirements are included below:

1.1.1.1 Test Conditions:

General approach: Part 1 of the Standard provides the test methodology to establish the energy consumption (including standby power consumption); the washing and drying performance, and the water consumption of the dishwasher (the washing and drying performance by comparison with a “reference” unit). Measurement of the energy consumption of the unit is done in parallel with some of these performance tests. The reference machine is as specified in IEC60436. Measurement of standby power is a separate test.



Part 1 of the standard also specifies minimum performance levels for washing (cleaning) and drying performance.

Part 2 of the Standard specifies the algorithms for defining energy performance for labelling and the associated labelling requirements.

Rated Capacity: The rated capacity of the dishwasher is defined as the whole number of place settings together with the serving pieces stated by the manufacturer, which can be cleaned and dried when loaded in accordance with the manufacturer's instructions.

A place setting (a set of crockery, glass and cutlery for use by one person) and the associated serving pieces are defined.

Test load: The test load consists of the whole number of complete place settings (excluding serving pieces) which together comprise the manufacturer's rated capacity.

The specific load prior to the 2003 was a Australia/New Zealand Specific load, and after 2007 the non-AHAM load described in IEC60436 (exclusive of serving pieces) became mandatory. In the interim years, either load (excluding serving pieces) was acceptable.

(NOTE The reference machine always uses a 12 piece IEC load irrespective of the load used on the test machine).

Soiling Agent: The make-up of the soiling agents includes the following:

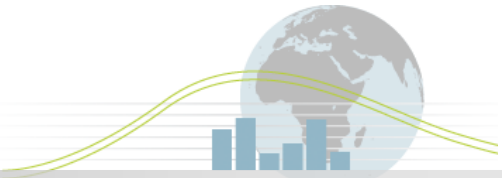
- Tomato juice
- Egg yolks
- Tea
- Reconstituted fortified skim milk
- Infant cereal
- Spinach Tinned (not frozen)
- Margarine

The food items used for soiling the load in this Standard are slightly different to IEC 60436, Edition 3. AS/NZS more closely resembles the soiling from IEC 60436:1981. Some soil items are slightly different (e.g. tinned spinach versus frozen spinach) and the preparation of some items and the allocation of soils to the load itself are also slightly different.

In addition, IEC allows for the use of either oven drying or air drying of the soiled load prior to washing, while AS/NZS only allow air drying.

Cycle, Programme and Time: The supplier shall nominate the program for energy efficiency labelling. This shall be the program recommended in the product literature i.e. operating manual or user instructions, to wash a normally soiled load at rated capacity.

Program time is measured from the initiation of the program (excluding any user programmed delay) until the end of program is indicated. If the end of program is not indicated, the program time is equal to the cycle time.



A cycle time is defined as the time measured from the initiation of the program (excluding any user programmed delay) until all activity ceases. Activity is considered to have ceased when the power consumption reverts to a steady state condition that persists indefinitely without user intervention. If there is no activity after the end of the program, the cycle time is equal to the program time.

Cleaning Performance: The standard (part 1) requires a minimum wash index. The index is a ratio of the performance of the dishwasher under test compared with the reference unit. The cleansing performance of the unit under test has to be at least 90% (defined as an index level of 0.9) that of the reference machine. The scoring method is identical to IEC.

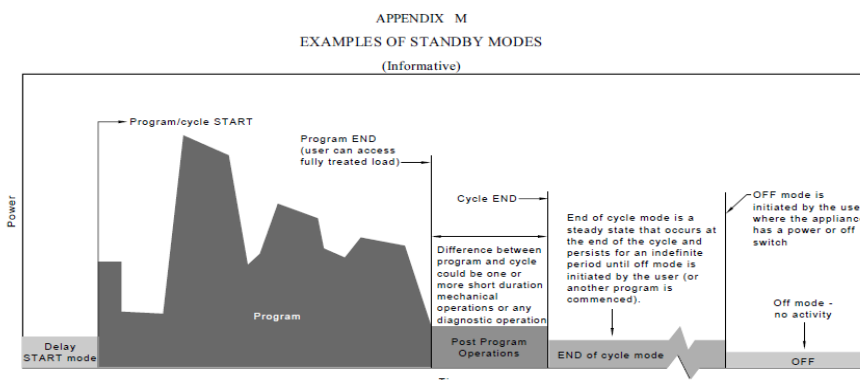
Within the standard it is noted that IEC 60436, Edition 3 uses the Universal 65°C as the reference program, but this is used to determine a relative performance index for declaration by the manufacturer (wash and dry performance is included on the EU energy label). The reference program in this Standard is Gentle 45°C which is used to set a pass/fail for wash performance, rather than a manufacturer declaration of wash performance as is the case in Europe.

Drying Performance: The method for measuring drying performance is based on a specification of number and size of droplets of water remaining after the test relative to the number of place settings (ie not a comparative test with the performance of the reference machine). An algorithm is used to determine absolute drying performance with a minimum performance of 0.5 set in part 1 of the standard. The scoring method is identical to IEC.

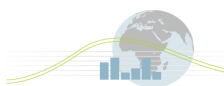
Stand-by: In regulations in force prior to 2007, there was no requirement to measure or declare standby power consumption. However, in the issue of *AS/NZS 2007.1:2005* a measurement methodology for standby power was included, and part 2 of the regulation required this stand-by power to be included in the overall annual consumption for the unit, and included in the calculations for declaration on the units energy label.

Measurement procedures are specified for “delayed start”, and “off” mode and the “end of cycle mode” (defined as the state the appliance enters at the end of the cycle). However, the post 2007 consumption declaration are based on a standby calculated as a simple average of off mode and end of cycle mode standby only.

The standard provides the following graphic to illustrate the various “stand-by power modes”.



Water consumption: Total water consumption is defined as the sum of hot and cold water consumption (as applicable) consumed during the cycle. Any water consumption that occurs



between the end of the program and the end of the cycle shall be included in this value. The measurements are taken during the energy consumption test.

Water consumption is required to be labelled on the machine using a separate label from that declaring energy consumption. (under separated regulations).

Embodied Water Energy/ Nominal Water Inlet Temperature: The nominal water supply temperature is 20°C. Adjustments for embodied energy in the water are made for supplies that vary from this temperature for operations where there is heating or where hot water is drawn into the machine (identical to IEC but the cold water temperature is different).

Water Hardness: Mains water shall be used and its total hardness (CaCO₃ equivalent) shall be adjusted (if necessary) to 45 ±5 ppm by mass, at a temperature of 20°C ±2 K (equivalent to IEC soft water).

Detergent/ Rinse Agent/Water Softener: The quantity and formula of the detergent, rinse aid and (if required) water softening salt is proscribed.

Noise: Noise is not measured.

Energy Consumption:

Energy consumption for a cycle (E_t) is the sum of electrical consumption for the full cycle, plus embodied water energy.

Energy consumption and declarations are then calculated as follows:

From 1998 to 1st October 2001 (note the regulations for declaration of “new” energy rating calculations came into effect on 1st October 2001, but for mapping and benchmarking purposes this is assumed to be 31st December 2001)

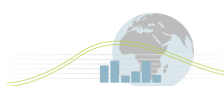
Projected Annual Energy Consumption (PAEC) of the unit is

$$PAEC = E_t \times 365 \text{ (kWh/year)}$$

The Comparative Energy Consumption (CEC) is the average value of PAEC over a number of machines used in the derivation of information for the registration/labelling process.

$$EER = 8 - \left[\frac{CEC}{10 \times RC} \right]$$

Where RC is the number of place settings. EER is then used to define the labelling star as per the table below.



**TABLE 2.3
DERIVATION OF STAR RATING**

Energy efficiency rating	Star rating
< 2.0	1
2.0 to 2.9	2
3.0 to 3.9	3
4.0 to 4.9	4
5.0 to 5.9	5
≥ 6.0	6

From the 1st Oct 2001 to 1st April 2007 (note the regulations for declaration of “new” energy rating calculations came into effect on 1st April 2007, but for mapping and benchmarking purposes this is assumed to be 1st January 2002 to 31st December 2006)

Projected Annual Energy Consumption (PAEC) of the unit is

$$PAEC = Et \times 365 \text{ (kWh/year)}$$

The Comparative Energy Consumption (CEC) is the average value of PAEC over a number of machines used in the derivation of information for the registration/labelling process.

The Base Energy Consumption (BEC) of the dishwasher is given by:

$$BEC = 48 \times \text{rated capacity}$$

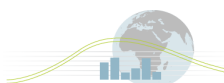
The star rating index (SRI) for use on the energy label is then calculated as follows (note this index only came into force in 2000):

$$SRI = 1 + \left[\frac{\log_e \left(\frac{CEC}{BEC} \right)}{\log_e (1 - 0.30)} \right]$$

The SRI index is then used to allocate the appropriate star rating based on the following table:

DERIVATION OF STAR RATING

Star rating index (SRI)	Star rating
SRI < 1.5	1.0
1.5 ≤ SRI < 2.0	1.5
2.0 ≤ SRI < 2.5	2.0
2.5 ≤ SRI < 3.0	2.5
3.0 ≤ SRI < 3.5	3.0
3.5 ≤ SRI < 4.0	3.5
4.0 ≤ SRI < 4.5	4.0
4.5 ≤ SRI < 5.0	4.5
5.0 ≤ SRI < 5.5	5.0
5.5 ≤ SRI < 6.0	5.5
6.0 ≤ SRI	6.0



Post 2007 (note the regulations for declaration of “new” energy rating calculations came into effect on 1 April 2007, but for mapping and benchmarking purposes this is assumed to be 1st January 2007)

Cycle energy consumption E_t is measured as previously.

Projected Annual Energy Consumption (PAEC) is then calculated as shown in the extract

The PAEC of a single dishwasher shall be given by the following equation:

$$PAEC = E_t \times 365 + [P_s \times (8.76 - T_c \times 0.365)] \quad (\text{kWh/year}) \quad \dots 2(1)$$

where

- E_t = tested energy consumption expressed in kilowatt-hours in accordance with AS/NZS 2007.1:2005 (includes post program operation up to the end of the cycle)
- P_s = the average measured standby power, in Watts which is the average of end of cycle mode and off mode, (where this mode is present) where these have been determined in accordance with AS/NZS 2007.1:2005
- T_c = the cycle time (hours)

from the standard below:

The 0.365 is the number of days (assumed to be 365 rather than accounting for leap years as elsewhere) divided by 1000 to convert to kWh as the standby value is measured in Watts. 8.76 is the same for total number of hours in a year divided by 1000.

The Comparative Energy Consumption (CEC) is the average value of PAEC over a number of machines used in the derivation of information for the registration/labelling process.

The Base Energy Consumption (BEC) of the dishwasher is given by:

$$BEC = 48 \times \text{rated capacity}$$

The star rating index (SRI) for use on the energy label is then calculated as previously as

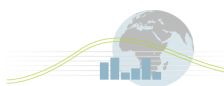
$$SRI = 1 + \left[\frac{\log_e \left(\frac{CEC}{BEC} \right)}{\log_e (1 - 0.30)} \right]$$

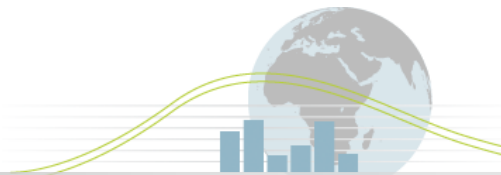
follows (note this index only came into force in 2000):

(The 0.3 represents a 30% improvement between individual star levels.)

1.2 Product Classifications

The Standard sets out the method of determining the performance characteristics of electric dishwashers intended for household and similar use.





Definition

Dishwasher Definition: A machine which cleans, rinses and dries dishware, glassware, cutlery, and, in some cases, cooking utensils by chemical, mechanical, thermal and/or electric means. A dishwasher may or may not have a specific drying operation at the end of the program.

1.3 Data sources

Australian data is sourced directly from the Department of Climate Change and Energy Efficiency. It is a mix of the Government's product registration database and GfK sales data and consequently is a very robust representation of the whole Australian market.

The number of models and sales analysed are presented in the tables below.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Products in dataset	292	326	417	482	512	559	598	569	585	341
Products analysed	268	323	388	479	506	530	597	556	569	341
% products included	92%	99%	93%	99%	99%	95%	100%	98%	97%	100%
Sales in dataset	167,763	175,536	197,852	202,432	288,656	303,823	297,141	325,476	355,936	331,049
Sales analysed	162,018	175,523	192,211	202,376	288,573	294,728	297,140	324,655	355,582	331,049
% Sales included	96.6%	100%	97%	100%	100%	97%	100%	100%	100%	100%

This data covers approximately 95% of the market See Greening Whitegoods for details¹.

1.4 Data manipulations and specific limitations

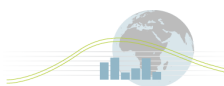
1.4.1 Overview of the mapping and benchmarking process

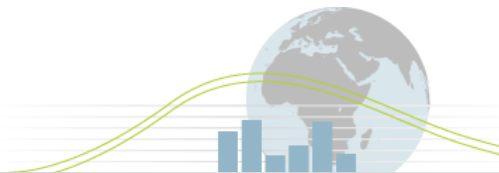
There are essentially 4 stages to the mapping and benchmarking process for dishwashers as detailed below:

Stage:	Description
1. Data Cleaning and Pre-processing	<ul style="list-style-type: none"> • Removal of duplicate entries • Pre-processing to align all terminology and reported test values to be consistent between countries • Assigning of local, mapping and benchmarking and EU categories • Etc
2. Production of mapping outputs	<ul style="list-style-type: none"> • Production of mapping outputs based on local test methodologies
3. Normalisation of test data	<ul style="list-style-type: none"> • Calculation of full cycle Unit Energy Consumptions • Normalisation for test temperature differentials
4. Production of Benchmarking outputs	<ul style="list-style-type: none"> • Post processing of benchmarking results • Production of benchmarking report

The details of this process are described in two supporting documents that accompany this mapping report:

¹ <http://www.energyrating.gov.au/resources/program-publications/?viewPublicationID=2149>





1. The **product definition** describes the exact characteristics of the product being analysed; the energy metrics that will be calculated; the technological, usage and other characteristics that will be considered; and any other policy or cultural information that will be collected
2. The **summary of approach** provides an overview of the mapping and benchmarking process for analyzing dishwashers for all countries and regions.

These documents can be found at the annex website:

<http://mappingandbenchmarking.iea-4e.org/matrix?type=product&id=11>

Aspects of the Australian analysis that are specific to the local dataset or regulations are described below.

1.4.2 Specific cautions for the Australian data

1.4.2.1 Data cleaning and processing specific to the Australian dataset

No data cleaning or processing specific to Australia was required.

1.4.2.2 Test methodology details used in the analysis

The specific aspects of the Australian test methodology that were used in the benchmarking analysis are listed below:

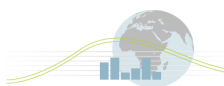
- Ambient temperature is 20°C ± 2 K. This is assumed to be the temperature of the load at the start of the cycle.
- Inlet water temperature is either 20°C ± 2 K.
- The weight of the load by component (crockery, cutlery, glassware) is based on two different load types; the AZ/NZ load and the IEC load. Both were in use between 2003-2007 and so the following assumptions are made:

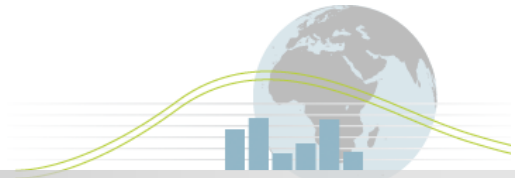
From 2005 the IEC test load was the predominant load used in tests and for the purpose of this analysis, is assumed to be used for all models. The weight of load is as follows:

Number of place settings	6	7	8	9	10	11	12	13	14	15	16
Mass of crockery in Australia load (kg)	9.6	11.2	12.8	14.4	16.0	17.6	19.2	20.8	22.4	24.0	25.6
Mass of cutlery in Australia load (kg)	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2

Prior to 2005, the AZ/NZ test load is assumed for all models. The weight of load is as follows:

Number of place settings	6	7	8	9	10	11	12	13	14	15	16
Mass of crockery in Australia load (kg)	10.5	12.3	14.0	15.8	17.5	19.3	21.0	22.8	24.5	26.3	28.0
Mass of cutlery in Australia load (kg)	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2
Mass of glass in Australia load (kg)	0.9	1.1	1.2	1.4	1.5	1.7	1.8	2.0	2.1	2.3	2.4





1.4.2.3 Australia specific normalisation steps

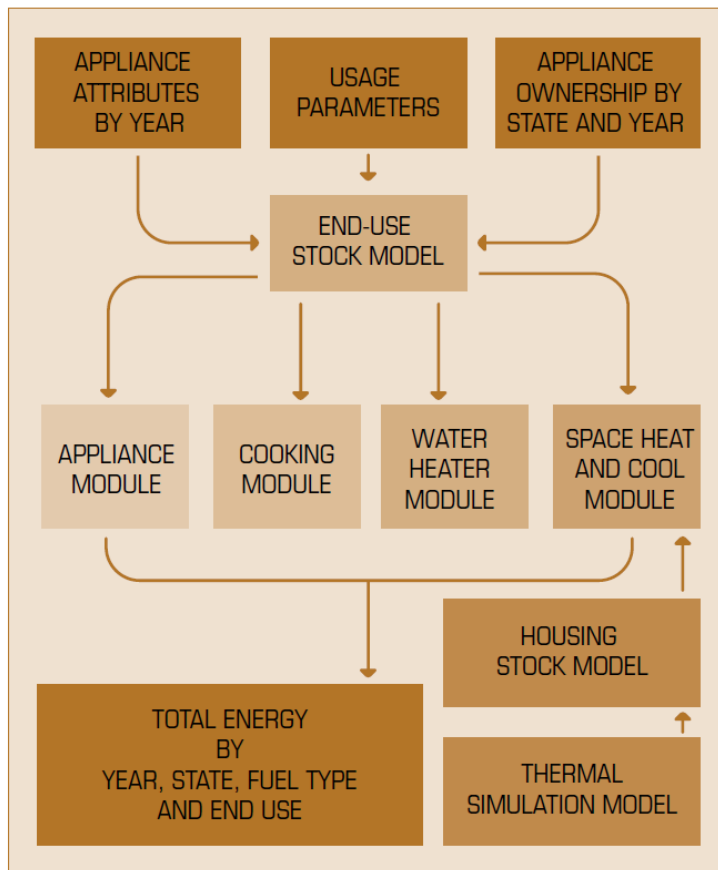
Prior to 2007, the Australian load included a glass component. In order to normalise for test load, the *Load Differential Energy Consumption (LDEC)* described in section 2.3.4.1 of the *Summary of the Approach to the Analysis* document included this glass component with an assumed specific heat capacity of 670 J/kg².

² <http://www.diracdelta.co.uk/science/source/s/p/specific%20heat%20capacity/source.html#UWaGmZOG1z8>

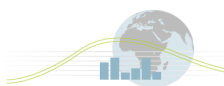
Section 2. Energy Consumption of the installed stock of dishwashers graphic

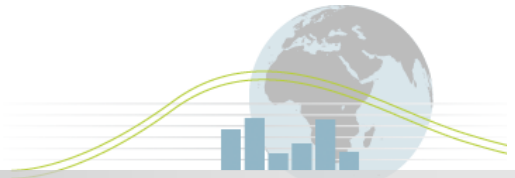
Source:

The stock data is taken from the Australian Government report: *Energy Use In The Australian Residential Sector 1986 – 2020*³. The data is derived using an end-use or bottom-up model which is based on a stock model of the type show in the figure below. This takes into account the average technical characteristics of both new appliances and buildings entering the stock and old ones leaving the stock to provide a stock-weighted average for each year during the modelling period. The model is described in detail in the report.



³ <http://www.energyrating.gov.au/resources/program-publications/?viewPublicationID=2141>





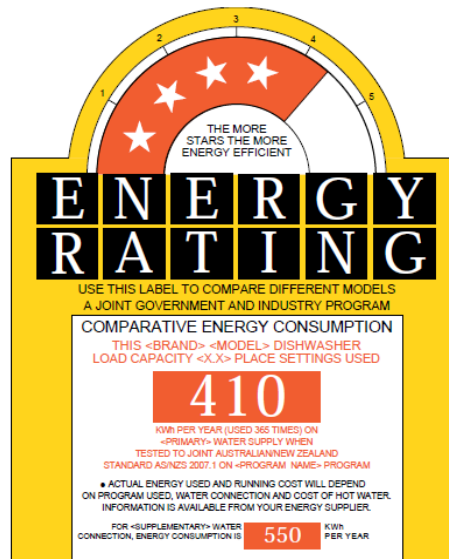
Section 3. Major Policy Interventions

3.1 Minimum Energy Performance Standards (MEPS)

There are no MEPS in place for dishwashers in Australia. There are minimum performance standards in place for cleaning and drying performance.

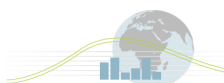
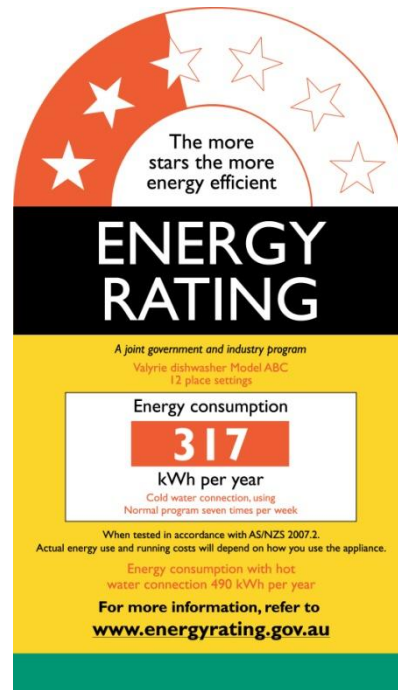
3.2 Mandatory Labelling

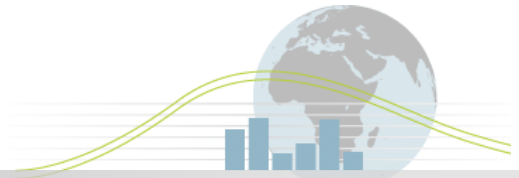
Energy labelling was introduced in 1988 with the label shown here:



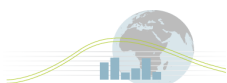
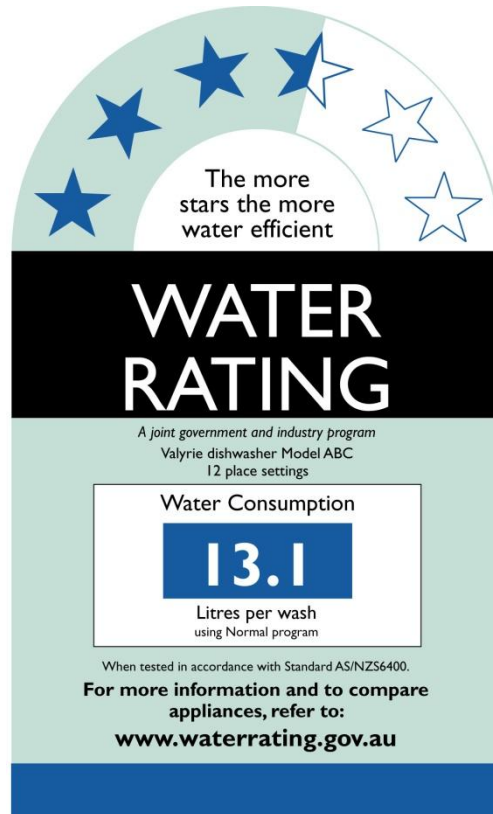
Current label

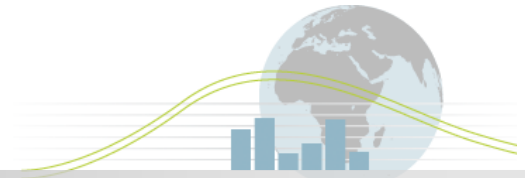
A new label came into use on 1st October 2000 (start of transition) that included the star rating (white stars reversed on a red band, unearned stars visible in outline), annual energy consumption (CEC), rated capacity (plus other information such as energy consumption if an auxiliary water heating supply is used, program tested). The label is shown here:





Note: Water consumption used to be shown on the energy label, but this was removed once mandatory water labelling was introduced in 2006. The water label has a similar star rating to the energy label and declares the water consumption in litres for a given was as shown here:





Section 4. Cultural Issues

No additional notes.

