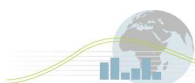# Mapping Document

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. Doing this ensures that comparison between the participating countries is done against a specific and consistent set of products.

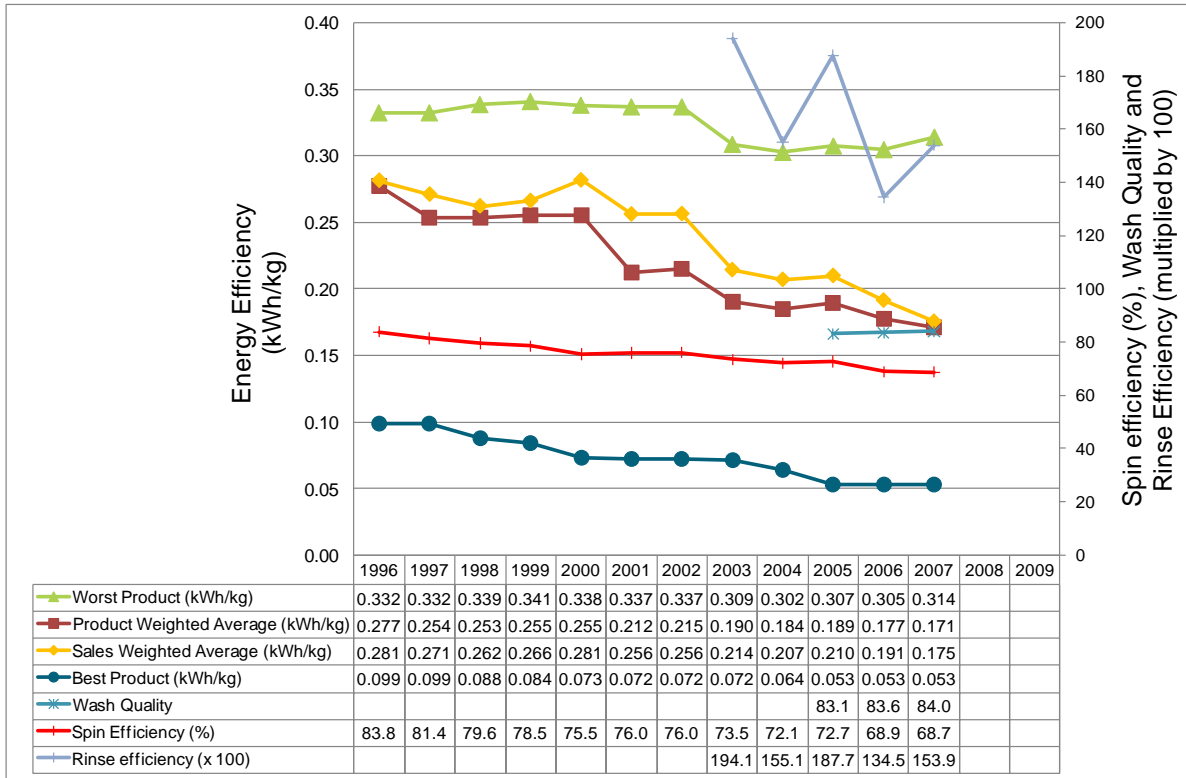The summary definition for this product is:

Washing machines, defined as:
'An appliance for cleaning and rinsing of textiles using water which is principally designed for use within a domestic environment. The appliance may draw water from a cold and/or hot water supply and may also have a means of extracting excess water from the textiles.'
Data will be analysed for the following types of washing machine :

Technology	User intervention	All Types - Automatic, semi-automatic and manual
	Orientation	All Types - Horizontal (front loaders) and Vertical Plane (top loader)
	Configuration	All Types - Drum, Impeller, Agitator, Nutators Exclude all types of Washer/Dryer
	Coin/Card Operation	All Types
	Water intake	All Types - Hot fill/cold fill
	Spin Speed	All Speeds
Other variables	Capacity	Consider only units between 1Kg - 13kg (Use kWh/Kg as metric)

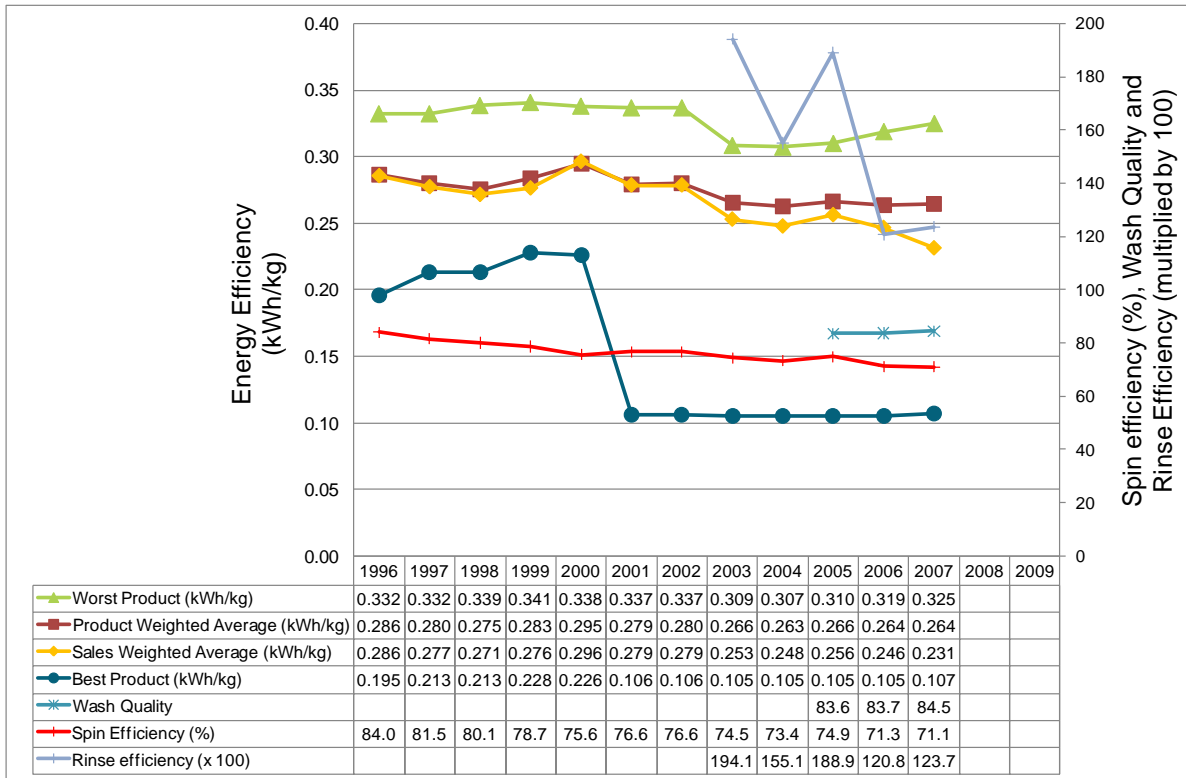The detailed product definitions can be found at the Annex website:
http://mappingandbenchmarking.iea-4e.org/matrix

Energy Efficiency of New Washing Machines Australia

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Worst Product (kWh/kg)	0.332	0.332	0.339	0.341	0.338	0.337	0.337	0.309	0.302	0.307	0.305	0.314		
Product Weighted Average (kWh/kg)	0.277	0.254	0.253	0.255	0.255	0.212	0.215	0.190	0.184	0.189	0.177	0.171		
Sales Weighted Average (kWh/kg)	0.281	0.271	0.262	0.266	0.281	0.256	0.256	0.214	0.207	0.210	0.191	0.175		
Best Product (kWh/kg)	0.099	0.099	0.088	0.084	0.073	0.072	0.072	0.072	0.064	0.053	0.053	0.053		
Wash Quality										83.1	83.6	84.0		
Spin Efficiency (%)	83.8	81.4	79.6	78.5	75.5	76.0	76.0	73.5	72.1	72.7	68.9	68.7		
Rinse efficiency (x 100)								194.1	155.1	187.7	134.5	153.9		

Key notes on Graph (see notes section 1)

- The data shown is based on the results from warm wash tests (Australia undertakes both a warm and cold wash test - the cold wash test data is not presented here).

- Data prior to 2001 records only approximately 70% of sales to market and a lower proportion of models available. Significantly higher coverage (95%) from 2001 onwards, accounting for some discontinuity in data from 2000 to 2001.

- In order to indicate a 'Worst' performing product that reflects the broad market (as opposed to representing perhaps a single unusual or wrongly reported product), the 'energy efficiency of worst product' is the energy efficiency of the product at the 'worst 5%' point of a ranked list of products (ie not sales weighted) in the dataset. The 'Best' performing product is a single product with the lowest energy efficiency.

- Wash quality data covers only 5% of the dataset in 2005 rising to over 57% in 2007.

- Rinse efficiency data covers only 4% of the models in the dataset in 2005 rising to over 52% in 2007.

- The proportion of front loader washing machines in the market increased from 44% in 2001 to 62% in 2007 (product weighted), although sales weighted values are lower than this.
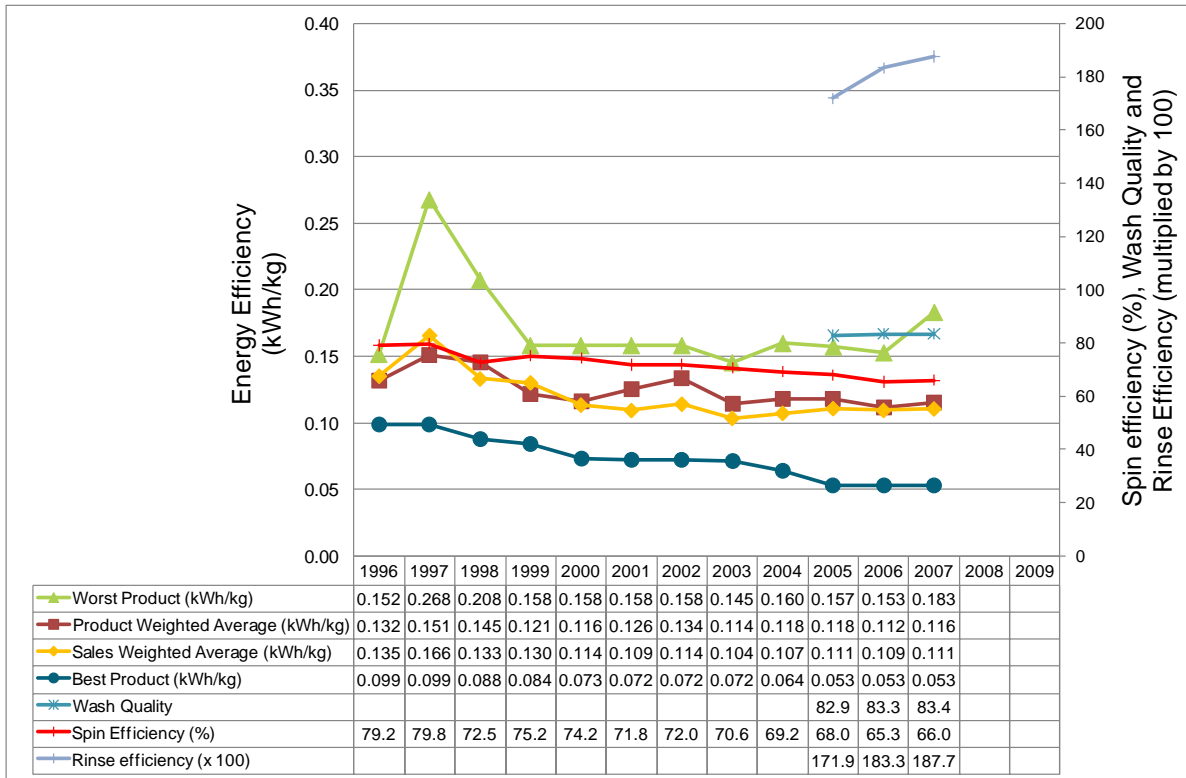
Energy Efficiency of New Top Loader Washing Machines Australia

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Worst Product (kWh/kg)	0.332	0.332	0.339	0.341	0.338	0.337	0.337	0.309	0.307	0.310	0.319	0.325		
Product Weighted Average (kWh/kg)	0.286	0.280	0.275	0.283	0.295	0.279	0.280	0.266	0.263	0.266	0.264	0.264		
Sales Weighted Average (kWh/kg)	0.286	0.277	0.271	0.276	0.296	0.279	0.279	0.253	0.248	0.256	0.246	0.231		
Best Product (kWh/kg)	0.195	0.213	0.213	0.228	0.226	0.106	0.106	0.105	0.105	0.105	0.105	0.107		
Wash Quality										83.6	83.7	84.5		
Spin Efficiency (%)	84.0	81.5	80.1	78.7	75.6	76.6	76.6	74.5	73.4	74.9	71.3	71.1		
Rinse efficiency (x 100)								194.1	155.1	188.9	120.8	123.7		

Key notes on Graph (see notes section 1)

- The data shown is based on the results from warm wash tests (Australia undertakes both a warm and cold wash test - the cold wash test data is not presented here).

- Data prior to 2000 records only approximately 70% of sales to market and a lower proportion of models available

- In order to indicate a 'Worst' performing product that reflects the broad market (as opposed to representing perhaps a single unusual or wrongly reported product), the 'energy efficiency of worst product' is the energy efficiency of the product at the 'worst 5%' point of a ranked list of products (ie not sales weighted) in the dataset. The 'Best' performing product is a single product with the lowest energy efficiency.

- Wash quality data covers only 3% of the products in 2005 rising to over 61% in 2007.

- Rinse efficiency data covers only 6% of the products in 2005 rising to over 59% in 2007.
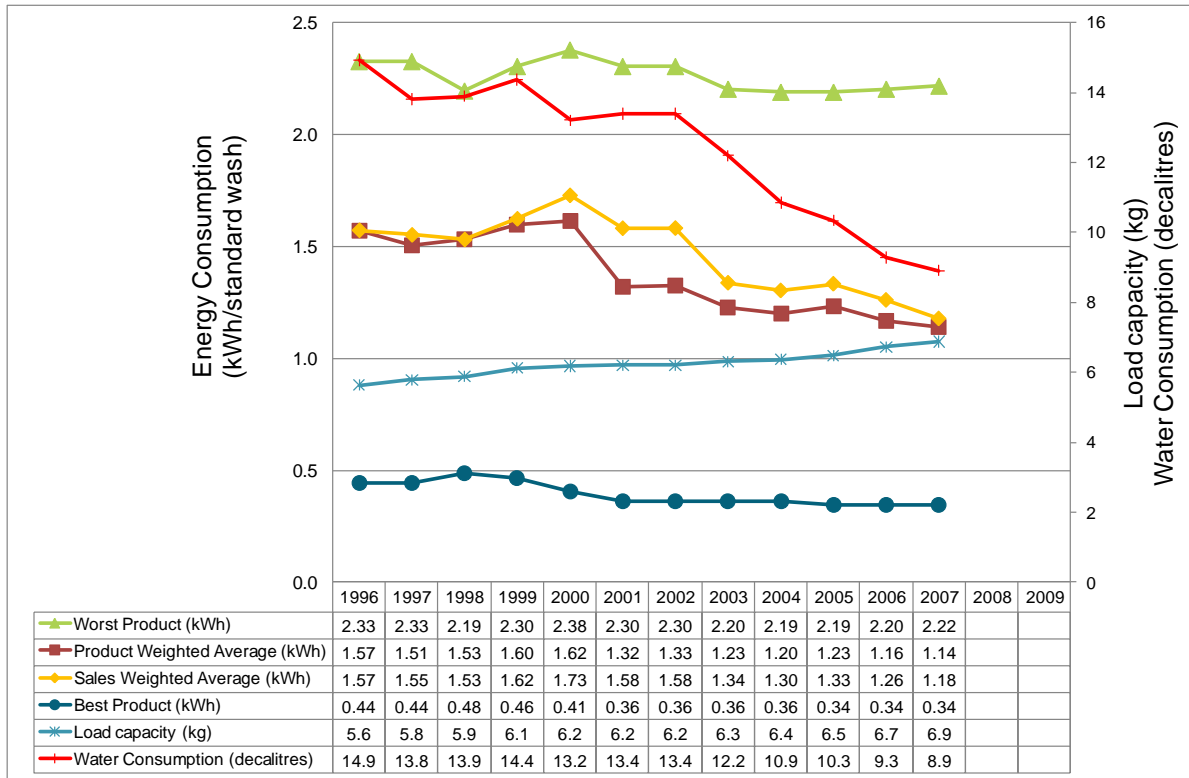
Energy Efficiency of New Front Loader Washing Machines Australia

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Worst Product (kWh/kg)	0.152	0.268	0.208	0.158	0.158	0.158	0.158	0.145	0.160	0.157	0.153	0.183		
Product Weighted Average (kWh/kg)	0.132	0.151	0.145	0.121	0.116	0.126	0.134	0.114	0.118	0.118	0.112	0.116		
Sales Weighted Average (kWh/kg)	0.135	0.166	0.133	0.130	0.114	0.109	0.114	0.104	0.107	0.111	0.109	0.111		
Best Product (kWh/kg)	0.099	0.099	0.088	0.084	0.073	0.072	0.072	0.072	0.064	0.053	0.053	0.053		
Wash Quality										82.9	83.3	83.4		
Spin Efficiency (%)	79.2	79.8	72.5	75.2	74.2	71.8	72.0	70.6	69.2	68.0	65.3	66.0		
Rinse efficiency (x 100)										171.9	183.3	187.7		

Key notes on Graph (see notes section 1)

- The data shown is based on the results from warm wash tests (Australia undertakes both a warm and cold wash test - the cold wash test data is not presented here).

- Data prior to 2000 records only approximately 70% of sales to market and a lower proportion of models available

- In order to indicate a 'Worst' performing product that reflects the broad market (as opposed to representing perhaps a single unusual or wrongly reported product), the 'energy efficiency of worst product' is the energy efficiency of the product at the 'worst 5%' point of a ranked list of products (ie not sales weighted) in the dataset. The 'Best' performing product is a single product with the lowest energy efficiency. Wash quality data covers only 6% of products in 2005 rising to over 56% in 2007.

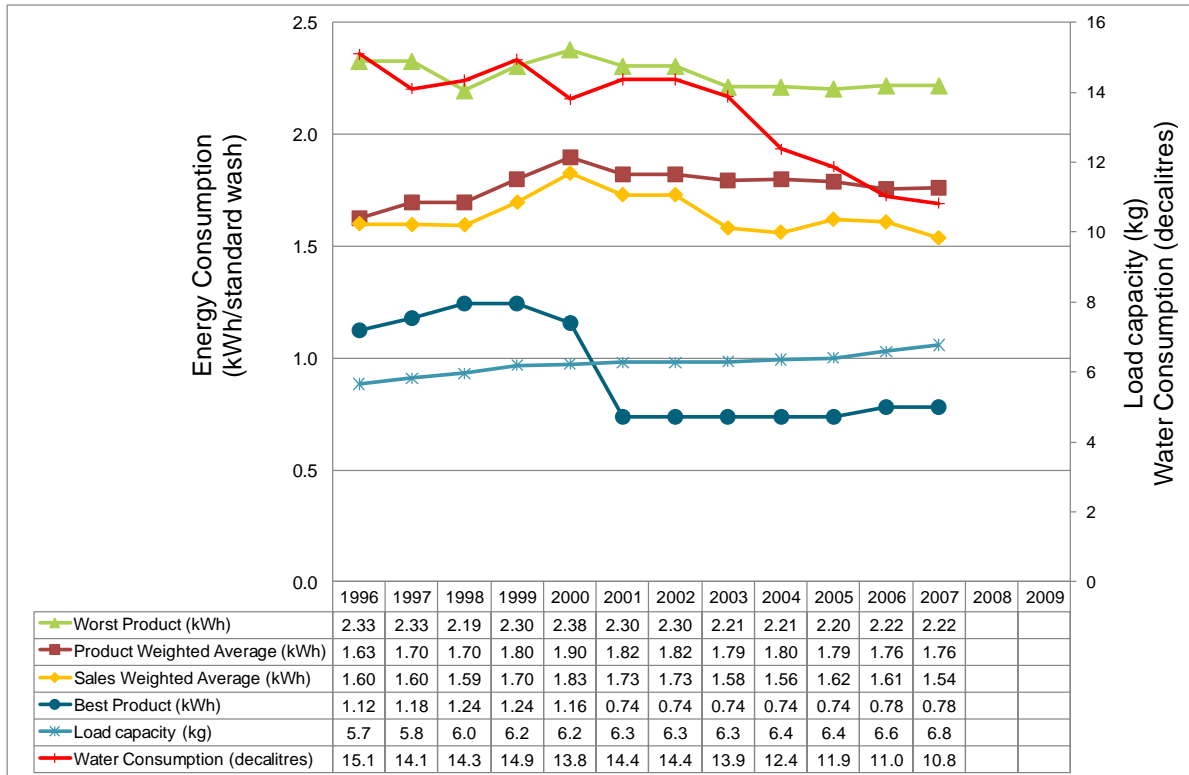- Rinse efficiency data covers only 3% of products in 2005 rising to over 51% in 2007.

Energy Consumption of New Washing Machines Australia

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Worst Product (kWh)	2.33	2.33	2.19	2.30	2.38	2.30	2.30	2.20	2.19	2.19	2.20	2.22		
Product Weighted Average (kWh)	1.57	1.51	1.53	1.60	1.62	1.32	1.33	1.23	1.20	1.23	1.16	1.14		
Sales Weighted Average (kWh)	1.57	1.55	1.53	1.62	1.73	1.58	1.58	1.34	1.30	1.33	1.26	1.18		
Best Product (kWh)	0.44	0.44	0.48	0.46	0.41	0.36	0.36	0.36	0.36	0.34	0.34	0.34		
Load capacity (kg)	5.6	5.8	5.9	6.1	6.2	6.2	6.2	6.3	6.4	6.5	6.7	6.9		
Water Consumption (decalitres)	14.9	13.8	13.9	14.4	13.2	13.4	13.4	12.2	10.9	10.3	9.3	8.9		

Key notes on Graph (See notes section 2)

- The data shown is based on the results from warm wash tests (Australia undertakes both a warm and cold wash test - the cold wash test data is not presented here).

- Data prior to 2000 records only approximately 70% of sales to market and a lower proportion of models available

- In order to indicate a 'Worst' performing product that reflects the broad market (as opposed to representing perhaps a single unusual or wrongly reported product), the 'energy efficiency of worst product' is the energy efficiency of the product at the 'worst 5%' point of a ranked list of products (ie not sales weighted) in the dataset. The 'Best' performing product is a single product with the lowest energy consumption. .

- The proportion of front loader washing machines in the market increased from 44% in 2001 to 62% in 2007 (product weighted).
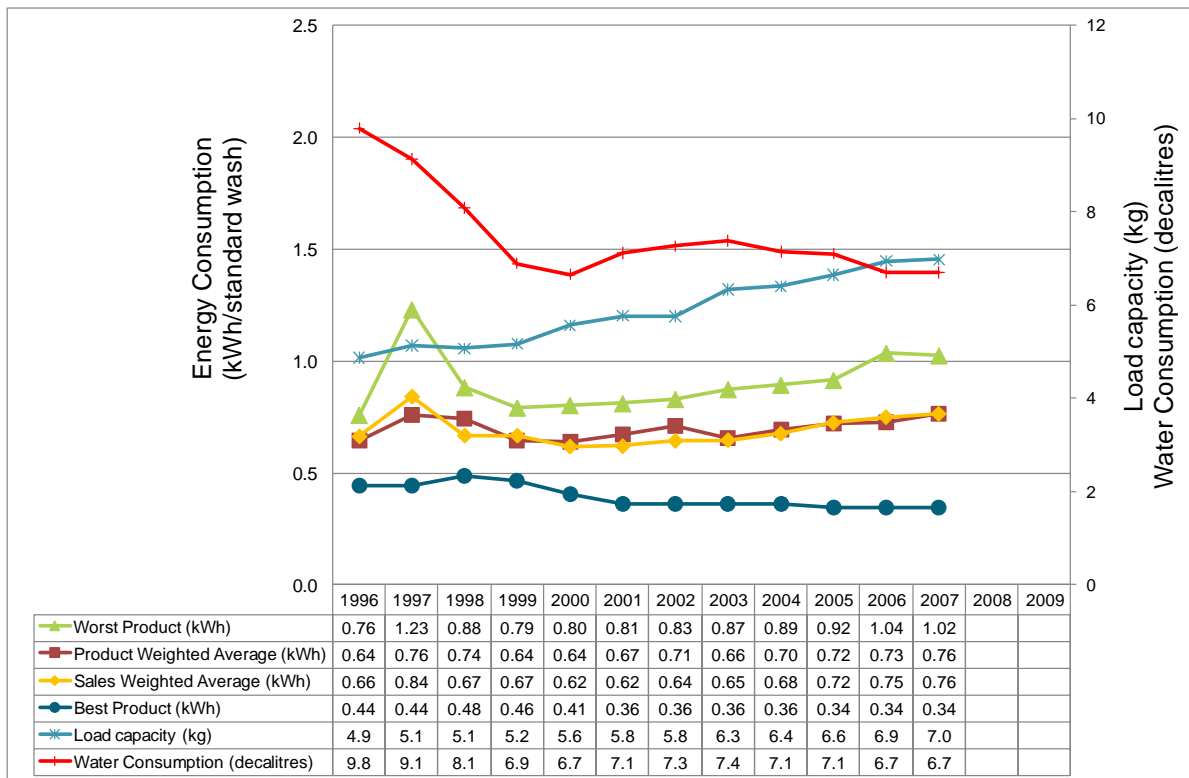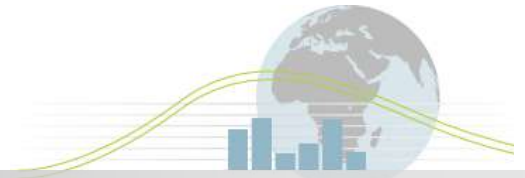
Energy Consumption of New Top Loader Washing Machines - Australia

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Worst Product (kWh)	2.33	2.33	2.19	2.30	2.38	2.30	2.30	2.21	2.21	2.20	2.22	2.22		
Product Weighted Average (kWh)	1.63	1.70	1.70	1.80	1.90	1.82	1.82	1.79	1.80	1.79	1.76	1.76		
Sales Weighted Average (kWh)	1.60	1.60	1.59	1.70	1.83	1.73	1.73	1.58	1.56	1.62	1.61	1.54		
Best Product (kWh)	1.12	1.18	1.24	1.24	1.16	0.74	0.74	0.74	0.74	0.74	0.78	0.78		
Load capacity (kg)	5.7	5.8	6.0	6.2	6.2	6.3	6.3	6.3	6.4	6.4	6.6	6.8		
Water Consumption (decalitres)	15.1	14.1	14.3	14.9	13.8	14.4	14.4	13.9	12.4	11.9	11.0	10.8		

Key notes on Graph (See notes section 2)

- The data shown is based on the results from warm wash tests (Australia undertakes both a warm and cold wash test - the cold wash test data is not presented here).

- Data prior to 2000 records only approximately 70% of sales to market and a lower proportion of models available

- In order to indicate a 'Worst' performing product that reflects the broad market (as opposed to representing perhaps a single unusual or wrongly reported product), the 'energy efficiency of worst product' is the energy efficiency of the product at the 'worst 5%' point of a ranked list of products (ie not sales weighted) in the dataset. The 'Best' performing product is a single product with the lowest energy consumption.

Energy Consumption of New Front Loader Washing Machines – Australia

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Worst Product (kWh)	0.76	1.23	0.88	0.79	0.80	0.81	0.83	0.87	0.89	0.92	1.04	1.02		
Product Weighted Average (kWh)	0.64	0.76	0.74	0.64	0.64	0.67	0.71	0.66	0.70	0.72	0.73	0.76		
Sales Weighted Average (kWh)	0.66	0.84	0.67	0.67	0.62	0.62	0.64	0.65	0.68	0.72	0.75	0.76		
Best Product (kWh)	0.44	0.44	0.48	0.46	0.41	0.36	0.36	0.36	0.36	0.34	0.34	0.34		
Load capacity (kg)	4.9	5.1	5.1	5.2	5.6	5.8	5.8	6.3	6.4	6.6	6.9	7.0		
Water Consumption (decalitres)	9.8	9.1	8.1	6.9	6.7	7.1	7.3	7.4	7.1	7.1	6.7	6.7		

Key notes on Graph (See notes section 2)

- The data shown is based on the results from warm wash tests (Australia undertakes both a warm and cold wash test - the cold wash test data is not presented here).

- Data prior to 2000 records only approximately 70% of sales to market and a lower proportion of models available

- In order to indicate a 'Worst' performing product that reflects the broad market (as opposed to representing perhaps a single unusual or wrongly reported product), the 'energy efficiency of worst product' is the energy efficiency of the product at the 'worst 5%' point of a ranked list of products (ie not sales weighted) in the dataset. The 'Best' performing product is a single product with the lowest energy consumption.

Energy Efficiency in the Installed Washing Machines Stock Australia

No data on the Unit Energy Efficiency of washing machines in the installed stock was available to the Mapping and Benchmarking Annex at the time of publication.

Energy Consumption in the installed Washing Machines Stock Australia

No data on the Unit Energy Consumption of washing machines in the installed stock was available to the Mapping and Benchmarking Annex at the time of publication.

Major Policy Interventions (See notes Section 5)

The primary policy Australian Policy related to washing machines is the mandatory requirement for energy and water labelling of products.

Suppliers are required to register their products prior to sale[1]. Under the standard AS/NZS2040, all products are required to meet minimum washing, spinning, gentleness of action and rinsing requirements as specified in AS/NZS2040.1. Suppliers are required to supply test reports confirming compliance with the standard when registering. Retailers are then required to display the energy and water consumption labels at point of sale. Both these labels follow the 6 star labelling used on many regulated products in Australia (more stars equate to more water efficient). All registered products are listed on the government website. A number of the performance requirements (including the energy labelling algorithm are defined *in "AS/NZS2040: Performance of household electrical appliances- Clothes washing machines Part 2: Energy labelling requirements"*[2]
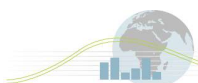
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[1] See http://www.waterrating.gov.au/manufacturers/index.html and
http://www.energyrating.gov.au/man1.html
[2] http://www.energyrating.gov.au/cw2a.html

Cultural Issues (See Notes Section 6)

More than 95% of households in Australia own a clothes washer. Clothes washers are used on average about 7 times per week, although this varies considerably by household[3].

The table below[4] is *sales weighted* and shows that purchases are gradually migrating from top loaders to front loaders with twin tubs exiting the market.

	1993	1994	1995	1996	1997	1998	1999	2000
Top Loading	88.4%	89.1%	88.0%	87.0%	84.2%	84.5%	85.2%	85.8%
Front Loading	7.5%	6.6%	7.7%	9.4%	12.6%	12.8%	12.4%	12.1%
Twin Tub	4.1%	4.4%	4.3%	3.6%	3.2%	2.7%	2.4%	2.1%

Whilst data on twin tub machines was removed from the dataset used in this analysis, the trend in products available on the market (ie product weighted) is clearly continuing to move towards front loading washing machines up to 2007 as shown in the table below:

	2001	2002	2003	2004	2005	2006	2007
% of front loader units in dataset	44%	45%	50%	54%	52%	57%	62%
% of top loader units in dataset	56%	55%	50%	46%	48%	43%	38%

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[3] http://www.energyrating.gov.au/cwl.html
[4] Supplied by the Australian Government from analysis of Gfk sales data

Notes on data

Section 1: Notes on Product Efficiency

1.1   Test methodologies and Performance Standards

1.1.1 Test Method, Performance and Labelling Requirements

"Clothes washers which are intended for household or similar use" are subject to mandatory registration prior to sale and mandatory labelling. The requirements are set out in:

- AS/NZS2040: Performance of household electrical appliances- Clothes washing machines Part 1: Energy Consumption and Performance[5] *(the test methodology was originally based on IEC60456 Edition 1 when it was first developed in 1990, but since that time significant differences have been introduced)*
- AS/NZS2040: Performance of household electrical appliances- Clothes washing machines Part 2: Energy labelling requirements[6]

Overview of AS/NZS2040[7]

Products are classified into either drum type (generally front loading) or non drum type (all other types eg top loaders with impellers or agitators, twin tub machines). A number of performance requirements must be met by clothes washers during a test for energy consumption. These include:

- Wash performance - soil removal from soiled swatches (swatch type AS9), which are attached to a clothes load of rated capacity, must exceed 80% (there are also limits on the variability of the wash).
- Spin performance - the water extraction index (defined as ratio of the remaining water in the load after the final spin to the bone dry mass) must not exceed 1.1.
- Rinse performance - a maximum concentration of 2.25 mg PBIS per kg of load. This is a new mandatory requirement from July 2006 - more details are on the rinse performance page.
- Severity of washing - the severity of washing index must not exceed 0.3 after a single run.
- Water consumption - the claimed water consumption cannot be less than the measured value, but the verification limit for check testing shall not exceed 110% of the value stated by the manufacturer.
- Water pressure - machine shall be capable of operating at the maximum and minimum water pressure stated by the manufacturer.
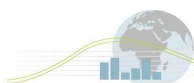
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[5] http://www.energyrating.gov.au/cw2.html
[6] http://www.energyrating.gov.au/cw2a.html
[7] http://www.energyrating.gov.au/cw2a.html

Summary Details of Testing Requirements

Standard Number (test)	AS/NZS2040.1
Standard Scope	
Voltage	230V 50Hz
Load Capacity of Model	Rated capacity in kg as declared by the manufacturer
Drum Capacity - if local measure of capacity	Parameter not defined in Australian Standard
Type of test (Hot/Cold/Both)	Warm wash 40°C. Standard technically requires >35°C. Cold wash temperature is nominal 20 °C. More accurately, this test should be defined as a cool wash as some use of warm water permitted. Test is optional with manufacturers supply data on approximately 50% of units
Energy consumption of model under test	Total energy consumption by unit completing a full cycle of programme declared by manufacturer as "warm wash" (including energy embodied in external hot water if not self heated) in kWh/load. Power consumed in off mode and end of cycle mode are also added to the annual energy consumption. The same requirement applies to the cold wash but the declared programme is the "cold wash".
Energy efficiency	Model energy consumption under test divided by the declared load capacity
Wash quality rating under test	This is the soil removal value calculated under the standard (as a %). 80 is the minimum permitted value. This uses the Kubelka-Munk equation $(KS_s - KS_w)/(KS_s - KS_u)$ where KS is ratio of coefficient of reflectance over the coefficient of light scattering and is given by $(1-R)2/2R$ where R is reflectance and value for subscripts are: s is soiled (unwashed), w is washed, u is unsoiled. Wash quality not measured in cold test

Total Water consumption under test	Water consumption in one complete cycle of warm wash (or cold wash as per test undertaken). Typically consumption of water under warm and cold wash is similar.
Spin efficiency under test	This value (called water extraction index) is defined as $(mw - mbd)/mbd$ where mbd is the bone dry mass as 0% moisture content.(Note that this is different to the IEC and European calculation of spin efficiency, which is based on normalised mass as 0%, which is about 7% moisture based on bone dry mass). Spin efficiency (water extraction index) is not measured in the cold test.
Rinse efficiency/quality	This is a local measure using a marker in the wash load PBIS. The maximum permitted value is 2.25 which are considered barely acceptable. Rinse efficiency not measured under cold test
Cold intake temperature wash	Defined in the standard as 20ºC (± 2K)
Hot water intake	Defined in the standard as 60ºC (± 2K)
Wash temp	Defined in the standard as nominally 40ºC although technical requirement is >35ºC
Wash cycle time	Program time in minutes (until user can access load) – note that cycle time is defined differently (until all activity ceases)

1.2 Product Efficiency Graphic

1.2.1 Sources:

- Sales data is derived from model sales purchased from GfK.

- Sales data is then linked to products on the Australian Government Registration Database (mandatory registration required for sale of washing machines)

1.2.2 Data Clarifications and limitations

Until 2000, sales data provided identified about 70% of models sold, although significantly lower proportion of models on the market.

From 2001, about 95% of models were identified. Occasionally models were not registered (often legitimately) and in this case information is not recorded (although this is thought to have a limited impact on the overall market representation).

Full details on the models included (product weighted) in the analysis are given in the table below:

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	
Number of front loader units in dataset	3	12	11	10	16	115	119	154	199	214	
Number of top loader units in dataset	48	47	54	47	56	145	147	155	169	198	
% of front loader units in dataset	6%	20%	17%	18%	22%	44%	45%	50%	54%	52%	
% of top loader units in dataset	94%	80%	83%	82%	78%	56%	55%	50%	46%	48%	

Additional Specific Data Cautions

1.2.3 Proportion of data set included

All twin tub washing machines were removed from the dataset. One additional unit had to be removed from years 1996, 1998, 2000 and 2001 as the model was not a registered product and had artificial data included.

1.2.4 Key calculations undertaken

Additional key parameters and calculations on data are as follows:

Declared Rated Capacity: Unit Rated capacity in kg is declared by manufacturers (Unit kg). The unit has to meet all performance requirements at the claimed rated capacity. Load composition is defined in the standard AS/NZS2040

(Note: This capacity is defined using the mixture of materials defined in the standard which is not necessarily in line with the mixture of material used elsewhere (for local load mix, refer to Section 1.1 on "Notes on Data")).

Model Energy Consumption: Model Energy Consumption is the energy consumed by the unit to complete one wash cycle as defined by local test conditions. Annual energy on the energy label assumes one load per day plus energy consumed in off mode and end of cycle mode over a whole year (Unit: kWh/wash).

Sales-Weighted Energy Consumption of New Models: For each year, value calculated by [Sum of (Model Energy Consumption multiplied by sales volume of Model in year) for all Models] divided by [Sum of (sales volume of all Models in year)]. Unit kWh/wash.

Model-Weighted Consumption of New Models: For each year, value calculated by [Sum of (Model Energy Consumption for all models sold in year)] divided by [Sum of (Number of Models sold in year)]. Unit kWh/wash.

Model Energy Efficiency: Unit value calculated by dividing Model Energy Consumption by Declared Unit Load Capacity (kWh/Kg/Wash).

Sales Weighted Energy Efficiency of New Models: For each year, value calculated by [Sum of (Derived Model Energy Efficiency multiplied by sales volume of Model in year) for all Models] divided by [Sum of sales volume of all Models in year]. Unit kWh/kg/Wash.

Model Weighted Energy Efficiency of New Models: For each year, value calculated by [Sum of Model Energy Efficiency for all models sold in year] divided by [Number of Models sold in year]. Unit kWh/Kg/Wash.

Spin Efficiency: The efficiency of removal of water from the test load as defined in local test conditions (refer to Section 1.1 on "Notes on Data").

Wash Quality: The efficiency of cleansing of test load as defined in local test conditions (refer to Section 1.1 on "Notes on Data").

Rinse Efficiency: The efficiency of removal of detergent, softener or other additive from the test load as defined in local test conditions (Unit: comparative percentage).

Section 2: Notes on Product Consumption
2.1 Test methodologies, Performance Standards and Labelling Requirements

Refer to section 1.1

2.2 Product Consumption Graphic

Refer to section 1.2

Section 3: Notes on Efficiency and Unit Energy Consumption of Stock
No additional notes


Section 4: Notes on Consumption of Stock
No additional notes

Section 5: Notes on Policy Interventions

Both energy and water consumption labelling is mandatory for washing machines in Australian. Both labels follow the 6 star labelling used on many regulated products in Australia (more stars more efficient performance). Below image below gives an example of the energy label.

(Refer also to Notes Section 1.1)
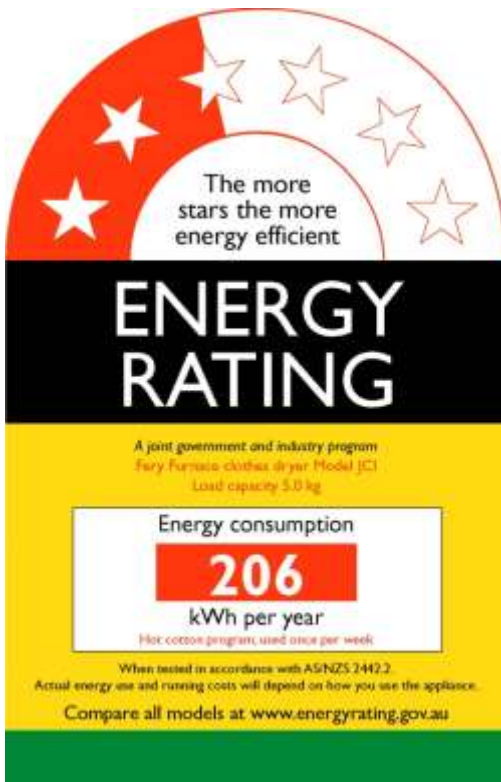
Section 6: Notes on Cultural Issues

No additional notes.