Product Fact Sheet — Household Appliances: Refrigerators and Freezers

Table 1. Overview of Household Refrigerators and Freezers

Country	MEPS	High Label	S&L metric [1]	Test procedure	Reference test procedure & metric	Test Procedure (*) [2]	Energy Performance Metric (*) [3]	Notes
Russia	N/A	N/A	kWh/Adjusted volume	GOST	ISO15502 temperate	1.26	See note 3	Aligned with Europe
India	522 (B10 small) 628 (B11 med.)	214 (B10 small) 257 (B11 med.)	kWh/Adjusted volume	IS	AS/NZS	1.08	See note 3	Local metric
China	394 (B10 small) 575 (B11 med.)	225 (B10 small) 329 (B11 med.)	kWh/Adjusted volume	GB	ISO15502 temperate	1.26	See note 3	Local metric
EU	258 (B10 small) 370 (B11 med.)	135 (B10 small) 194 (B11 med.)	kWh/Adjusted volume	EN	ISO15502 temperate	1.26	See note 3	
Mexico	408 (B10 small) 499 (B11 med.)	N/A	kWh/Adjusted volume	MX NOM	IEC62552	1.17	See note 3	Aligned with US - older version
US	294 (B10 small) 360 (B11 med.)	N/A	kWh/Adjusted volume	10 CFR Part 430 Appendix A1 to Subpart B	IEC62552	1.00	See note 3	
Australia	448 (B10 small) 540 (B11 med.)	177 (B10 small) 251 (B11 med.)	kWh/Adjusted volume	AS/NZS	US AHAM HRF-1 [4]	1.08	See note 3	Local metric, labeling and MEPS different

(*) Conversion factors

Notes: IEC 62552-3-2014 is used as reference test procedure for this product type. It is not used directly for regulatory purposes in any economy yet.

1. While most countries use kWh per adjusted liter, there are a wide range of approaches in terms of defining lines or curves for the functional relationship between kWh and size or capacity. Adjusted volume has many technical limitations (e.g., it is calculated for a single ambient temperature) and it does not make sense to apply this to single compartment products. However, it is widely used but with large variations in application, so is less harmonized than would appear from the table. Some countries (including Australia for energy labeling) use a different approach that is a better indicator of efficiency (surface area estimate).

2. Test procedure adjustment factor depends on the product type and size. Example shown is for a mid-sized refrigerator-freezer. Australia and US have both old and new test procedures adjustments (old shown, new close to 1.0).

3. Most energy performance metrics are defined as a reference efficiency level (straight lines or curves, usually with a fixed offset) with efficiency thresholds then defined relative to the reference efficiency level. The reference efficiency levels and the way thresholds are defined are highly variable across countries, so a simple conversion is not possible. Analysis has provided an estimated energy for each threshold and MEPS level for 4 reference product types to assist with comparisons.

4. While AS/NZS test procedure was originally broadly based on the US approach in the 1980s, it has evolved significantly since that time.

Products

1. The types of products covered are household refrigerators, refrigerator-freezers and freezers. In most countries a significant proportion of these are used in offices and workplaces (for a similar purpose as in domestic use). Typical products range from storage capacities of 50 liters to 750 liters. Most countries set labeling thresholds and MEPS levels based on internal assessment of products and typical efficiencies found on their markets and in some cases, engineering analysis. There is some alignment in terms of program requirements between some regions, although there are often time lags and adjustments. Historically, Mexico has aligned with US and Australia has also adapted some MEPS levels from the US for these products (only). South Africa and Russia usually adopt EU requirements with some time lag. India, China and Indonesia develop their own labeling and MEPS thresholds, although there is probably some external influence.

Overview of international situation with regards to S&L for this product category

1. All of the test procedures covered measure the energy consumption of the product at a single elevated ambient temperature but without any user related loads or interaction. Each of the test procedures set different internal temperatures for energy measurements and reference test procedure ISO15502 also requires test packages to be included in the freezer during energy tests. While these test procedures do provide useful comparative data for products tested under that specific test procedure, it does not provide information at other operating conditions (or test procedures) or the energy consumption that is likely during normal use. So from this perspective, all of the existing test procedures have significant limitations in adequately and representatively testing products. The new IEC62552-3-2014 measures energy at two ambient temperatures (16°C and 32°C) as well as processing efficiency, so provides more information on likely field performance. Estimates of energy made for this report have used a wide range of performance data. So there is a good opportunity for all countries to align with IEC62552-3-2014 into the future. The reference test procedure selected is the new IEC62552-3-2014 at an ambient temperature of 32°C.

2. While most countries appear to use energy consumption per adjusted volume as the raw efficiency metric, there are in fact many variations on this approach and the general approach is, in

broad terms, poorly aligned. Firstly, adjusted volume is normally calculated at a single ambient temperature, so the volume calculation varies considerably by country for the same product. Secondly, most metrics use a fixed offset plus a variable energy per adjusted volume, although this is highly variable (offsets can range from zero to large). The concept of adjusted volume has many flaws and a better approach for a more consistent efficiency metric warrants investigation once more countries align with IEC62552-3-2014. Some countries use a curve based on a proxy for surface area (over volume), which may be a better reflection of the drivers of energy consumption. This is an area where future work could assist in regional alignment.

3. International comparisons are currently very difficult due to the historical poor alignment of test procedures. Also test procedures are generally not reflective of normal use, so there may be significant discontinuities and issues regarding comparisons and using this data to estimate real energy savings in the field. Once there is more widespread use of IEC62552-3-2014, international comparisons and in-use benchmarks will be much easier and will allow larger economies to set thresholds that can be more easily adopted in other regions.

General description of conversion for test procedures and metrics/ efficiency metrics and standards

1. As the test procedures and efficiency metrics for this product are so complex and there are so many product categories (as few as 3 per country but as many as 42 product categories in the US), the only feasible approach to compare metrics and test procedures is to estimate energy thresholds for sample products under each of the regimes examined. The energy thresholds under the local requirements can be calculated accurately; these can then be converted to a reference test procedure using the best data available on the impact of changes in ambient temperature and internal temperature conditions.

2. The reference test procedure selected was IEC62552-3-2014, which is likely to be used widely around the world by 2020. Many of the existing countries already test at an ambient of 32°C and this temperature is included in IEC62552-3-2014. Note that IEC62552-3-2014 also includes an ambient temperature of 16°C, but energy estimates under this lower ambient temperature have not been made as this is not used to any extent at this point in time. But this data will be critical in future when estimating savings in normal use.

3. Within household refrigeration there are almost an infinite number of product sizes and there are a large number of product types defined in local requirements. So any comparative study has to focus on comparison of representative sample products to get any meaningful results. A total of four products were selected – these were smaller products and are more reflective of those that may be used in developing countries, which is the focus of this study (100 liter all-refrigerator, 190 and 380 liter refrigerator-freezer and a 160 liter chest freezer).

4. Estimates of energy thresholds under different test procedures and local program requirements assume that widely observed characteristics obtained through analysis of extensive test data apply to individual products (such as energy impact of changes in internal and ambient temperature). In broad terms, these adjustments will be representative for comparison of product types. However, at an individual product level, some designs may react differently and some may not be designed to allow internal temperatures to be optimized under different test methods. So naturally data at a product level needs to be treated with caution.

5. The estimates of thresholds are considered to be quite reliable for those products where the native test procedure is at or close to an ambient of 32°C. The energy estimates for products originally tested under ISO15502 at an ambient of 25°C will be reasonable, but necessarily less reliable.

Notes and assumptions

Key assumptions are set out above.

List of sources

Local test procedures and efficiency requirements in each country, and IEC62552-1

Wide range of energy test data and performance data evaluated for different projects

Author estimates and calculations

AS/NZS 4474, Performance of Household Electrical Appliances – Refrigerators and Freezers (Parts 1 and 2)

Australian Government: Regulatory Discussion Document: Government agency proposed pathway to regulate refrigeration equipment sold to consumers in Australia and New Zealand from about April 2015, E3, August 2012 (Paper 5) http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Library/Refrigeration/Domestic_Refrigeration/refrigerator-regulatory-discussion-document.pdf

Calwell 2013, Are Test Procedures Passing the Test? Ensuring That Measured Results Are Representative of Energy Use in the Field, Chris Calwell, Ecvoa, paper presented to EEDAL 2013, Coimbra, Portugal.

COMMISSION REGULATION (EC) No 643/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for household refrigerating appliances

COMMISSION DELEGATED REGULATION (EU) No 1060/2010 of 28 September 2010 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labeling of household refrigerating appliances

EES 2011, Paper 1: Summary of New MEPS Levels for Refrigerator in the US, October 2011. : http://www.energyrating.gov.au/blog/resources/events-calendar/24102011

EES 2011, Paper 2: Road Map for MEPS3 in Australia and NZ – Issues for Stakeholders in the Alignment with US MEPS 2014, October 2011. : http://www.energyrating.gov.au/blog/resources/events-calendar/24102011

EES 2012, Paper 3: MEPS3 in Australia and NZ – Preliminary Impact Assessment of New MEPS Levels in 2015, May 2012 http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Library/Refrigeration/Domestic_Refrigeration/Paper3-meps-impact.pdf

EES 2012, Paper 4: Refrigerators and Freezers in Australia and NZ: Technical Support Document on MEPS and Labeling for 2015 for Energy-using Refrigeration Equipment, May 2012 http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Library/Refrigeration/Domestic_Refrigeration/Paper4-technical-support.pdf

EES 2013, Review of Energy Efficiency Thresholds for Household Refrigerators in Selected ASEAN Countries, report in preparation, 2013 (An analysis of MEPS and energy labeling thresholds in Malaysia, Singapore, Thailand, China, Vietnam and Australia), Prepared by Energy Efficient Strategies for the Australian Government

EES 2013, Test report data for a range of whitegoods, including performance and energy data, internal data.

Harrington 2012, Investigation into Ambient Temperature Correction Formula for Steady State Power Measurements – IEC 59M/35/CD Annex B, Prepared by Lloyd Harrington, EES for SC59M, July 2012.

IEA Implementing Agreement for a Co-operating Programme on Efficient Electrical End-Use Equipment (4E) – Mapping and Benchmarking Annex – comparative studies and analysis for whitegoods, http://mappingandbenchmarking.iea-4e.org/

IEC 62552-1: Household refrigerating appliances - Characteristics and test methods - Part 1: General requirements (CDV stage)

IEC 62552-2: Household refrigerating appliances - Characteristics and test methods - Part 2: Performance requirements (CDV stage)

IEC 62552-3: Household refrigerating appliances - Characteristics and test methods - Part 3: Energy consumption and volume (CDV stage)

ISO15502, Household refrigerating appliances — Characteristics and test methods, Edition 1, International Electrotechnical Commission, Geneva, www.iec.ch (identical to ISO15502)

ISO15502, Household refrigerating appliances — Characteristics and test methods, International Standards Organisation, Geneva, www.iso.org

Mexico Secretary of Energy, NOM-015-ENER-2002 on Energy Efficiency of Refrigerators & Freezers (Spanish), see http://www.sener.gob.mx/res/Acerca_de/015ener2002.pdf

US EPA, ENERGY STAR® Program Requirements , Residential Refrigerators and Freezers Specification Version 5.0, www.energystar.gov

US DOE Test Procedure for Residential Refrigerators and Freezers. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/43#testprocedures

US DOE regulation. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/43#standards

Product Fact Sheet — Household Appliances: Clothes Washers

Table 2. Overview of Clothes Washers

Country	MEPS	High Label	S&L metric [1]	Test procedure	Reference test procedure & metric	Test Procedure (*) [2]	Energy Performance Metric (*) [3]	Notes
Russia	N/A		kWh/kg	GOST	EN/IEC	0.55	See note 3	Old EU requirements
India	N/A	N/A	kWh/kg	IS		N/A	See note 3	Ignores external hot water energy
China	N/A	0.627	kWh/kg	GB	EN/IEC	0.55	See note 3	Ignores external hot water energy
EU	0.895 (mixed prog.)	0.698 (mixed prog.)	kWh/kg	EN	**IEC**	0.68	See note 3	Includes standby
Mexico	N/A	N/A	Energy factor	Mex NOM	US	1	See note 3	
South Africa	N/A	N/A	kWh/kg		EN/IEC	0.65	See note 3	Old EU requirements
US	0.934 (top) ; 0.661 (front)	N/A	Energy factor + spin efficiency factor	Code of Federal Regulations 10CFR430		1	See note 3	Single standard sized product, heavy emphasis on residual moisture, includes standby
Australia		0.277	kWh/kg + spin	AS/NZS		1	See note 3	Includes standby

(*) Conversion factors

Notes:

1. While the metrics are often expressed as kWh/kg, there are wide variations on the assumed usage per year and the type of metric function used (fixed plus variable energy per kg rated capacity). North America only defines two sizes of products (compact and standard) and uses drum volume to define loads (compared to rated capacity in all other regions). EU, US and Australia include standby power into annual energy (broad approach is similar). US and Australia include some element of spin performance (US directly include energy estimated for drying (spin performance) into washer energy (large factor), Australia includes a small element of spin performance into the star rating algorithm (but not the washer energy)).

2. The reference test procedure is assumed to be the energy required for a single warm wash at rated capacity under IEC60456. China is in the process of changing their test procedure. US has had several changes of test procedure. India and

China ignore the energy embodied in any imported hot water (this could represent more than 80% of the energy for hot connected machines).

3. Comparison of energy performance metrics are almost impossible for clothes washers as there are many parameters that cannot be controlled in any comparison. These include: The assumed number of uses (cycles or loads per year) varies by country. Some countries have performance requirements for washing (e.g. EU and Australia) while others do not measure or control performance (e.g., US). Several regions include standby (generally small). The US includes a significant element of energy into their energy value that is the implied energy used for drying (on the assumption that most users will use a dryer, so the residual moisture after spinning has a large effect). The program specifications for testing also vary a lot by country, so this also makes the resulting data difficult to compare (e.g. EU specify average of cotton 60°C full, cotton 60°C half and cotton 40°C half, US specify a mixture of all representative temperature settings, China is rated capacity cotton 60°C full and half, Australia is cotton 40°C full).

Products

1. Household washing machines are generally broken down into horizontal axis (drum) and vertical axis (agitator and impeller). Most products are in the range 3kg to 10kg capacity, but smaller and larger products do exist. Some test procedures approach these types in a uniform manner while some test them very differently. While a number of countries use IEC standards as the broad basis for a test procedure, many variables like load tested and program settings (wash temperature) are defined based on local habits and practices. IEC standards measure performance but do not set minimum performance requirements. Efficiency requirements and thresholds are almost always set on local conditions and the type of products available on local markets.

Overview of international situation with regards to S&L for this product category

1. Test procedures for washing machines define a load and place this into a machine. Beyond that, there are few similarities in test procedures or approaches. While most regions use rated capacity (manufacturer claim of capacity), many regional specifications now include part loads and a range of wash temperatures. Load compositions are different and sometimes other components (standby and implied tumble dryer energy) are also included. So in general terms, local energy values are completely incomparable across regions.

2. Test procedures are poorly aligned and efficiency metrics are highly variable. There is great variation on how performance parameters such as washing and spin performance (and other parameters) are taken into account (or not). Given that local user habits and practices are highly variable at a regional level, the prospects for any sort of alignment for washing machines would appear to be very poor.

3. Given the high level of variability in how performance is controlled, what energy is included, local specifications regarding loading and wash temperature and differences in test procedure, international comparisons are of low value and are almost impossible in any meaningful way.

General description of conversion for test procedures and metrics/ efficiency metrics and standards

1. Given the large variation in all parameters used to measure energy and define efficiency for this product, the only feasible approach was to define a standard horizontal and vertical axis machine and calculate each local energy metric and efficiency threshold requirements. These were then corrected for known issues regarding test procedure and wash temperature settings. In the case of the US, the implied drying energy was removed from the estimated energy in order to give

the comparative energy used for washing.

2. The reference test procedure is effectively a warm wash at rated capacity under IEC60456. The energy embodied in imported water and internally heated water were treated equally (as per the IEC standard).

3. Regional requirements set very different parameters for load size and wash temperature. As far as possible these were estimated for a warm wash condition at rated capacity for the representative products for comparison. It is not possible to control for washing performance, so this is a large unknown in this type of analysis and changes in performance may make comparative values quite inaccurate in some cases.

4. While washing machines themselves are relatively global in their designs, the regional approaches taken with respect to testing and efficiency metrics make comparison of regional energy data almost impossible.

5. Generally the estimates for regional energy for efficiency standards and efficiency thresholds have a low level of reliability due to the large number of confounding factors set out above.

Notes and assumptions

Key notes and assumptions are outlined above.

List of sources

Local test procedures and efficiency requirements in each country, IEC60456

Wide range of energy test data and performance data evaluated for different projects

Author estimates and calculations

AS/NZS 2040, Performance of Household Electrical Appliances – Clothes Washing Machines (Parts 1 and 2)

Bureau of Energy Efficiency, India, Schedule 12, Voluntary Energy Labeling Requirements for Washing Machines.

Calwell 2013, Are Test Procedures Passing the Test? Ensuring That Measured Results Are Representative of Energy Use in the Field, Chris Calwell, Ecvoa, paper presented to EEDAL 2013, Coimbra, Portugal.

COMMISSION REGULATION (EU) No 1015/2010 of 10 November 2010 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to Ecodesign requirements for household washing machines

COMMISSION DELEGATED REGULATION (EU) No 1061/2010 of 28 September 2010 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labeling of household washing machines

EES 2013, Test report data for a range of whitegoods, including performance and energy data, internal data.

IEA Implementing Agreement for a Co-operating Programme on Efficient Electrical End-Use Equipment (4E) – Mapping and Benchmarking Annex – comparative studies and analysis for whitegoods, http://mappingandbenchmarking.iea-4e.org/

IEC60456, Clothes washing machines for household use – Methods for measuring the performance, International Electrotechnical Commission, Geneva, www.iec.ch

Top Ten Washers for China, See http://www.top10.cn/news/135/58/.html

US Code of Federal Regulations: Part 430—Energy Conservation Program for Consumer Products

- Subpart A—General Provisions
- Subpart B—Test Procedures
- Subpart C—Energy and Water Conservation Standards
- Various editions from 1995 to 2013

US EPA, ENERGY STAR® Program Requirements, Clothes Washers Program Requirements Version 6.0, www.energystar.gov

US DOE Test Procedure and Regulations, Residential refrigerators and freezers
http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/39

Product Fact Sheet — Household Appliances: Clothes Dryers

Table 3. Overview of Household Clothes Dryers

Country	MEPS	High Label	S&L metric [1]	Test procedure	Reference test procedure & metric	Test Procedure (*) [2]	Energy Performance Metric(*) [3]	Notes
EU	3.49	0.99	kWh/kg	EN	**IEC**	1.3	See note 3	Includes standby
South Africa		N/A	kWh/kg		EN/IEC	N/A		Old EU requirements
US	3.05	2.94	Energy factor	Code of Federal Regulations 10CFR430		1.3		Includes standby
Australia		2.07	kWh/kg	AS/NZS	US	0.78		No standby

(*) Conversion factors

Notes:

1. While the metrics are often expressed as kWh/kg load dried, there are wide variations in the assumed usage per year and the type of metric function used (fixed plus variable energy per kg load dried). Effectively, the metric used (indirectly) is kWh of energy consumed per kg of moisture removed (this is generally a fairly stable number, but it is affected by moisture content). The EU and US include standby power into annual energy (broad approach is similar). North America only defines two sizes of products (compact and standard) (compared to rated capacity in all other regions).

2. Reference test procedure is assumed to be the energy required for a single load at rated capacity dried under IEC61121. There are substantial differences in the test procedure requirements (in particular, initial and final moisture content of the load and the load composition), which all impact on the measured energy consumption.

3. Comparison of energy performance metrics is somewhat complex for clothes dryers, mainly because test procedures vary by region (in particular initial and final moisture content and to some extent, load composition). The assumed number of uses (cycles or loads per year) varies considerably by country, which is based on local data. Some regional requirement include some part loads.

Products

1. A number of product types exist for electric clothes dryers. Firstly there are air-vented versus condensing dryers (little significance in performance for most products). There are differences in control (timer/manual versus automatic sensing to terminate the load when dry – a range of technologies are used for sensing). Finally the heat source for drying can be an electric resistance heater (most common historically and generally low capital cost) and more recently electric heat pumps (double the efficiency, high capital cost). Dryer usage varies a lot by region (e.g. Australia is very low, US is quite high with 90% of washer loads dried in a dryer). Standards development appears to take into account the type of products on the market and cultural factors in their local use. This product is predominantly used in developed countries.

Overview of international situation with regards to S&L for this product category

1. Test procedures for dryers are, in principle, quite similar in that a damp load is placed into the dryer and dried. However, there are significant differences in load (e.g. Australia uses a mixed "realistic" load at rated capacity, EU uses a simplified IEC cotton load with a mixture of rated and part loads, US uses polyester-cotton make-weights of low capacity) – these differences (especially US) have a significant impact on how easily the load is dried. The other major factor is that different regions specify different initial and final moisture contents. Initial moisture content should reflect the spin performance of local clothes washers, which can be expected to vary by region. In fact this parameter varies substantially between individual washers, so the use of a regional average value is a substantial over-simplification of what a user can expect (washer spin performance in a region will be a distribution). Final moisture content reflects what should be generally understood as "acceptably dry". The US and Australia (which was based on US requirements before an IEC standard existed) tend to be a somewhat drier specification for final moisture content than IEC/Europe. Note that small differences in final moisture content can have large impacts on measured energy (marginal energy to remove remaining moisture when the load is close to dry becomes very high).

2. Currently test procedures and metrics are not all that well aligned, mostly due to historical differences in test procedures and approaches that have persisted over time. However, IEC61121 Edition 4 does provide a good basis for international alignment of test procedures, if the IEC load and the final moisture content specification can be generally accepted. IEC61121 Edition 4 has an option to allow a load to be tested at a low and high initial moisture content – the energy response to changes in initial moisture content are quite linear across a wide range, so these two test points can be used to make a reasonable estimate of energy consumed for any initial moisture content within the range, providing a good option for a single set of global tests that can be applied to suit regional conditions (e.g., match spin performance of local washers). This can also be used to estimate the energy impact of partial loads (which are quite common for dryers).

3. International comparisons are useful and can certainly drive policy development for this product to some extent, but care is required to ensure that data is being compared on a fair and comparable basis (mainly related to load composition and initial and final moisture content, which can appear as large energy differences). Getting global agreement on what constitutes acceptable user performance expectations (what constitutes dry clothes) appears feasible and the flexibility in IEC61121 allows regional test data to be generated without the need to retest so can provide a sound basis for alignment.

General description of conversion for test procedures and metrics/ efficiency metrics and standards

1. To allow comparison across regions, given the different approaches to test procedures and efficiency metrics for this product, the only feasible approach was to define a standard product and calculate local energy and efficiency threshold requirements. These were then corrected for differences in test procedure (moisture content and load composition) and specified usage (generally part loads).

2. The reference test procedure is drying a load at rated capacity under IEC61121. Part load and variations in initial moisture content (wetness and load size) should form part of a reference test procedure and efficiency metric to allow test procedure alignment in parallel with development of locally relevant metrics, but have not been included in this analysis.

3. Regional requirements vary, but these are mostly for historical reasons rather than any

fundamental requirement. The use of representative products enabled energy values to be compared after correction for the main test procedure and local program requirements.

4. While there is some variation in the sophistication of product designs, the basic functionality of a clothes dryer is fairly uniform globally. The capabilities of products may vary by region as these are sometimes dictated by local requirements, but differences are generally minor (even though underlying technologies used to deliver the energy service can vary a lot). Regional energy values will be highly variable due to factors such as load type, load size, initial and final moisture content, part loads and assumed usage, so great care is required when comparing nominal energy thresholds under current conditions.

5. The level of reliability for energy estimates are considered moderate for clothes dryers, as reasonably large adjustments are required to correct for load, moisture and usage.

Notes and assumptions

Key notes and assumptions are outlined above.

List of sources

Local test procedures and efficiency requirements in each country, IEC62552-1

Local test procedures and efficiency requirements in each country, IEC61121

Wide range of energy test data and performance data evaluated for different projects

IEA 4E Mapping and Benchmarking Comparisons – clothes dryers

Author estimates and modeling

AS/NZS 2442, Performance of Household Electrical Appliances – Rotary Clothes Dryers (Parts 1 and 2)

COMMISSION DELEGATED REGULATION (EU) No 392/2012 of 1 March 2012 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labeling of household tumble driers

COMMISSION REGULATION (EU) No 932/2012 of 3 October 2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for household tumble driers

EES 2013, Test report data for a range of whitegoods, including performance and energy data, internal data.

IEA Implementing Agreement for a Co-operating Programme on Efficient Electrical End-Use Equipment (4E) – Mapping and Benchmarking Annex – comparative studies and analysis for whitegoods, http://mappingandbenchmarking.iea-4e.org/

IEC61121, Tumble dryers for household use – Methods for measuring the performance, International Electrotechnical Commission, Geneva, www.iec.ch

US EPA, ENERGY STAR® Program Requirements , Product Specification for Clothes Dryers, Eligibility Criteria, Draft 2 Version 1.0, www.energystar.gov

US DOE Test Procedures and Regulations, residential clothes dryers

http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/36

Product Fact Sheet — Household Appliances: Dishwashers

Table 4. Overview of Dishwashers

Country	MEPS	High Label	S&L metric [1]	Test procedure	Reference test procedure & metric	Test Procedure (*) [2]	Energy Performance Metric (*) [3]	Notes
Russia	N/A	N/A	Energy (kWh) per place setting	GOST	EN/IEC	1	See note 3	Old EU requirements
EU	1.04	0.83	Energy (kWh) per place setting	EN	**IEC**	1	See note 3	Includes standby
South Africa		N/A	Energy (kWh)per place setting		EN/IEC	1	See note 3	Old EU requirements
US	1.32	1.28	Energy factor	Code of Federal Regulations 10CFR430		0.93	See note 3	Includes standby
Australia		0.4	Energy (kWh) per place setting	AS/NZS	IEC	1.05	See note 3	Includes standby

(*) Conversion factors

Notes:

1. While the metrics are often expressed as kWh/place setting, there are wide variations in the assumed usage per year and the type of metric function used (fixed plus variable energy per place setting). North America only defines two sizes of products (compact and standard) (compared to rated capacity in all other regions). EU, US and Australia include standby power into annual energy (broad approach is similar).

2. The reference test procedure is assumed to be the energy required for a single wash at rated capacity under IEC60436. The US has had several changes of test procedure, mainly associated with standby.

3. Comparison of energy performance metrics are complex for dishwashers, mainly because performance requirements vary by region. The assumed number of uses varies by country. Some countries have performance requirements for washing and drying (e.g. EU and Australia) while others do not measure or control performance (e.g., US). Several regions include standby (generally small).

Products

1. The majority of dishwashers are a standard size (usually 600mm width) but smaller under-bench and bench-top models do exist. Some larger models also exist. Dishwashers in the US generally use more water and energy compared to dishwashers in other regions (which tend to be European style) even when corrected for load and measurement conditions (see IEA 4E Mapping and Benchmarking Comparison). Dishwashers are generally only regulated in developed countries and the global variation in product designs is limited (apart from North America/ rest of world differences). While a number of countries use IEC standards as the broad basis for a test procedure, performance requirements vary. IEC standards measure performance but do not set minimum performance requirements. Efficiency requirements and thresholds are almost always set according to local conditions. This product is predominantly used in developed countries.

Overview of international situation with regards to S&L for this product category

1. Test procedures for dishwashers define a load and place this into a machine. Most regions use rated capacity (manufacturer claim of capacity) as the basis for an efficiency metric. There are significant differences on how performance is controlled.

2. In general terms, most regions outside of North America are aligned or are close to being aligned for dishwashers in terms of test procedures. The US has used a different test load historically (although these differences could be almost eliminated in IEC60436 Edition 4, which is in preparation). So there is good potential for global alignment of test procedures for dishwashers in the near future. The US regulations do not take into account rated capacity and generally test with an unsoiled load, unless the machine has a sensing program, then they test with a very heavily soiled AHAM load. The US usually also normally specify a hot water connection, which is different to most regions. There are still widely varying approaches to dealing with performance (washing and drying), so this makes alignment of efficiency metrics more problematic than test procedures.

3. International comparisons are useful and can certainly drive policy development for this product to some extent. However, there is a strong link between energy, water and performance, so defining performance benchmarks at a regional level can lead to differences in the underlying energy thresholds. Getting global agreement on what constitutes acceptable user performance expectations is likely to be difficult.

General description of conversion for test procedures and metrics/ efficiency metrics and standards

1. To allow comparison across regions, given the different approaches to efficiency metrics for this product, the only feasible approach was to define a standard product and calculate local energy and efficiency threshold requirements. These were then corrected for known issues regarding test procedure (generally only water supply temperature).

2. The reference test procedure is a wash at rated capacity under IEC60436. The energy embodied in imported water and internally heated water were included (as per the IEC standard). At this stage, part load performance is not examined, but this could form part of a reference test procedure and metric, but have not been included in this analysis.

3. Regional requirements vary a little in terms of load and soiling (US in particular) and some test conditions. It is not possible to control for performance, so this is a significant unknown in this type of analysis: energy values can be compared with some certainty but the resulting performance may differ (and in fact may explain many of the threshold variations between regions).

4. Globally, dishwashers are basically of similar design (although US machines are slightly different due to historical reasons, in part driven by the local test procedure). Therefore, fair comparisons can be made to some extent (noting differences in performance by region).

5. The level of reliability for energy estimates are considered quite reasonable for dishwashers. However, performance benchmarks vary by region, so this will impact on the absolute energy thresholds in each region to some extent.

Notes and assumptions

Key notes and assumptions are outlined above.

List of sources

Local test procedures and efficiency requirements in each country, IEC60436

Wide range of energy test data and performance data evaluated for different projects

IEA 4E Mapping and Benchmarking Comparisons - dishwashers

Author estimates and calculations

AS/NZS 2007, Performance of Household Electrical Appliances – Dishwashers (Parts 1 and 2)

COMMISSION REGULATION (EU) No 1016/2010 of 10 November 2010 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for household dishwashers

COMMISSION DELEGATED REGULATION (EU) No 1059/2010 of 28 September 2010 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labeling of household dishwashers

EES 2013, Test report data for a range of whitegoods, including performance and energy data, internal data.

IEA Implementing Agreement for a Co-operating Programme on Efficient Electrical End-Use Equipment (4E) – Mapping and Benchmarking Annex – comparative studies and analysis for whitegoods, http://mappingandbenchmarking.iea-4e.org/

IEC60436, Electric dishwashers for household use – Methods for measuring the performance, International Electrotechnical Commission, Geneva, www.iec.ch

US Code of Federal Regulations: Part 430—Energy Conservation Program for Consumer Products

- Subpart A—General Provisions
- Subpart B—Test Procedures
- Subpart C—Energy and Water Conservation Standards
- Various editions from 1995 to 2013

US EPA, ENERGY STAR® Program Requirements for Residential Dishwashers, Version 5, www.energystar.gov

US DOE Test Procedures and Regulations, residential dishwashers

http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/67