# Annex 2: Product Fact Sheets

This Annex contains fact sheets on each of the product types covered in this report:

Household appliances

- Refrigerators and freezers
- Clothes washers
- Clothes dryers
- Dishwashers

Lighting products

- Compact fluorescent lamps (CFLs)
- Lamp / Filament directional lamps
- Lamp / Filament non-directional lamps
- Ballast/ HID
- Lamp / HID
- Ballast / Linear fluorescent
- Lamp / Linear fluorescent

Consumer electronics (CE) & Information and Communications Technology (ICT) equipment

- CE: Televisions
- CE: Displays
- CE: Digital television decoders (Set top boxes)
- CE: Audio
- ICT: Computers, games consoles and servers
- ICT: Imaging equipment
- ICT: Power supplies

Air conditioning

- Central (ducted) air conditioning
- Room air conditioners
- Chillers

Space and water heating

- Central heating boiler
- Central heating furnaces
- Other space heaters
- Industrial boilers
- Water heaters and storage tanks

Commercial refrigeration equipment

- Reach-in coolers
- Refrigerated vending machines
- Walk-in cold rooms

Cooking products

- Residential cooking appliances
- Commercial cooking appliances
- Coffee makers

Motors, pumps and fans

- Motors
- Pumps
- Fans

Transformers

- Distribution transformers

Miscellaneous products

- Commercial laundry appliances
- Medical imaging equipment

## Contents of the product fact sheets

The product fact sheets in this annex differ in length and level of detail given the diversity of the products, the MEPS, labels and test procedures supporting them and the information available for each product area. They each, however, include the following sections:

- An overview table by country including MEPS, high label, S&L metric, test procedure, reference procedure and metric, test procedure conversion factors, energy performance metric conversion factors and notes;
- A description of the products covered;
- An overview of the global situation with regards to S&L for the product category;
- A general description of conversion for test procedures and metrics/ efficiency metrics and standards;
- Notes and assumptions; and
- A list of sources.

## Conversion factors and reliability

Two types of conversion factors are listed in the tables in each Product Fact Sheet: test procedure conversion factors and energy performance metric conversion factors. The former (test procedures conversion factors) are the numbers by which the result from the test procedure (the regional test

procedure) should be multiplied in order to convert it to the reference test procedure (which is often an international standard but not always). The latter (energy performance metric conversion factors) is often the same as the former (test procedure conversion factors). It is the number by which the result from the national energy performance metric should be multiplied in order to convert it to the reference test procedure. The test procedures that the conversion factors refer to are identified in bold in the tables.

As mentioned in the report, these conversion factors are not intended to be used for conversions on an individual product (model by model) basis but rather for representative conversions between product types at a national level. Some product types have significantly different requirements for sub-types, in which conversions need to be derived for representative sub-types. Although this approach is a fair approximation of an average conversion for the product type overall, as intended with this study, it does not necessarily mean that this also provides an accurate conversion for individual models or all sub-types of products.

Given the possibility of widely diverging levels of reliability for conversion factors, the expert team evaluated the reliability of the conversion factors developed. As well as documenting potential issues with conversion factors, a traffic light system was used to clearly indicate how reliable the factors were for high-level comparisons of high volumes of products (not for individual products). Conversion factors were coded as follows:

- Green indicates a high level of confidence in the conversion factor. Converted results would be in the right ballpark, with expert assumption that results are within 10% of the indicated value.
- Amber indicates a medium level of confidence in the conversion factor. Converted results would broadly be in the right ballpark, with the potential for substantial outliers and the margin of error is larger. Expert assumption is that results are within 25% of the indicated value.
- Red indicates unreliable conversion factors. Converted results would be better than nothing, but may be substantially off. Expert assumption that results could be more than 25% from the indicated value.
- In several cases, conversion factors are listed as not applicable (N/A), indicating there is insufficient information even for unreliable conversion factors.

# 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

# Product Fact Sheet — Lighting products: Compact Fluorescent Lamps (CFLs)

## Table 5. Overview of CFLs

| Country | MEPS | High label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **Australia** | 56 | | Efficacy = luminous flux / lamp power | AS/NZS 4847.1 | **IEC 60969** | 1 | 1 | |
| **China** | 56 | Efficacy requirement varies based on lamp power and color temp | Efficacy = luminous flux / lamp power | GB 19044-2013 | IEC 60969 | 1 | 1 | |
| **EU** | 56 | Efficacy requirement varies based on lamp flux | Efficacy = luminous flux / lamp power | EN 60969 | IEC 60969 | 1 | 1 | |
| **US** | 60 | Efficacy >=55 lm/W (lamps <15W), >=65 (lamps >=15W). | Efficacy = luminous flux / lamp power | 10 CFR Part 430.23(y) | IEC 60969 | 1 | 1 | |
| **Mexico** | 60.5 | Efficacy requirement varies based on lamp power | Efficacy = luminous flux / lamp power | NOM-017-ENER/SCFI-2008 | IEC 60969 | 1 | 1 | |
| **Indonesia** | | Efficacy requirement varies based on lamp power | Efficacy = luminous flux / lamp power | IEC 60969 | IEC 60969 | 1 | 1 | |

**(*) Conversion factors**

## Product

1. Compact fluorescent lamps (CFLs) or bulbs are the often curly, screw-in versions of the long tube fluorescent lights consisting of fluorescent lamp tubes. Ballasts are integrated into the lamp, not sold as a separate item as for large tubes. This makes CFLs a standalone retrofit solution to replace incandescent lamps. CFLs are available in a range of light colors, including incandescent-like "warm" tones. Some CFLs are encased in a bulb-shaped cover to further diffuse the light. These can be used with clamp-on lampshades. CFLs can provide the same lighting as traditional

incandescent bulbs for reading and room lighting.

2. CFLs are fluorescent lamps that include all the components necessary for starting and stable operation of the lamp.

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

1. All but one of the countries in the table above set mandatory MEPS for CFLs, and many countries have had MEPS for some time. These are typically set by national Governments, or the European Commission in the case of the EU. These MEPS all cover efficacy, and in most cases many other performance parameters are also subject to MEPS, such as lifetime, start time, color rendering index, etc.

2. All these countries base their CFL test procedure on IEC 60969.

3. The test procedures, at least for efficacy, are well harmonized between the IEC and North American standards bodies.

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

1. No conversion necessary for CFL test procedures (efficacy) or metrics (efficacy).

2. The referenced test procedure is IEC 60969 which references globally-accepted CIE photometry methods.

3. Representative products (e.g., 1000lm CFL, 6500K color temperature) were used in order to compare MEPS limits, as the MEPS limit varies depending on product parameters such as lamp power and in some cases lamp color temperature.

4. This product type is very comparable, noting the above point.

5. The only materially specific issue relates to the EU MEPS limit, as described above.

## Notes and assumptions

None other than those mentioned above.

## List of sources

Regulations and standards from each country, as listed in CLASP's Global S&L Database http://www.clasponline.org/en/Tools/Tools/SL_Search.aspx

# Product Fact Sheet — Lighting products: Lamp / Filament Directional Lamps

## Table 6. Overview of Lamp / Filament Directional Lamps

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **Australia** | >= (2.8 ln (flux) - 4.0). And MR16 lamp power capped at 37W | | Efficacy = luminous flux / lamp power | AS/NZS 4934.1 | **CIE 84** | 1 | 1 | |
| **EU** | Minimum efficacy as a function of flux (complex table of formulae) | Minimum efficacy as a function of flux (complex table of formulae) | Efficacy = luminous flux / lamp power | EN 50285 | CIE 84 | 1 | N/A | |
| **US** | Minimum efficacy as a function of lamp power and lamp diameter | Minimum efficacy as a function of lamp power and lamp diameter | Efficacy = luminous flux / lamp power | 10 CFR Part 430 Appendix R to Subpart B | CIE 84 | 1 | 1 | |

**(*) Conversion factors**

## Product

1. Filament lamps are lamps in which light is produced by means of a threadlike conductor which is heated to incandescence by the passage of an electric current. The lamp may or may not contain gases influencing the process of incandescence. Incandescent filament lamps produce radiant power as a result of electric current passing through a tungsten filament, which is surrounded by an inert atmosphere or vacuum within a glass or quartz envelope. Some lamps contain halogens that are employed to maintain a clean bulb wall. Such lamps may also employ bulb coatings that redirect infrared energy back to the filament for improved efficacy or to filter radiation for color control.

2. The directional element refers to a lamp having at least 80% light output within a solid angle corresponding to a cone with angle of 120).

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

1. Australia, the EU and the US have MEPS for these lamps. These are typically set by national governments, or the European Commission in the case of the EU. MEPS typically cover efficacy, and in some cases other performance parameters are also subject to MEPS, such as lifetime, lumen maintenance.

2. All testing is based on CIE 84.

3. The test procedures, at least for efficacy, are well harmonized.

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

1. No conversion necessary for test procedures (efficacy) or metrics (efficacy).

2. For the EU (MEPS) it is not possible to convert the MEPS metric because EU MEPS (directional lamps) only considers light in a 90 or 120 degree cone (depending on lamp type) whereas most other economies (e.g. US, Australia) consider the light in 180 degree hemisphere. Converting between "cone" approach and the "hemisphere" approach is difficult because there is not likely to be a linear relationship between these (i.e. the relationship is likely to vary for various lamp types). Developing a relationship would require in-depth examination of "light distribution" data from many lamps. Note that the test method is the same (measure the light output) but the EU MEPS only considers a certain amount of light that you measured - the light within the "cone"

3. Note also that lower US mains voltage means filament lamps can be more efficient (hotter filament).

4. The referenced test procedure is CIE 84 which is the globally-accepted CIE photometry method.

5. This product type is quite comparable, noting the points above point.

6. The only material specific issues relate to EU MEPS and the US mains voltage, as described above.

## Notes and assumptions

None other than those mentioned above.

## List of sources

None other than those mentioned above.

# Product Fact Sheet — Lighting products: Lamp / Filament Non-Directional Lamps

## Table 7. Overview of Lamp / Filament Non-Directional Lamps

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **Australia** | 14.6 lm/W | | Efficacy = luminous flux / lamp power | AS/NZS 4934.1 | **CIE 84** | 1 | 1 | |
| **China** | | | N/A - eliminates incandescent lamps by technology definition, rather than MEPS | | | | | |
| **EU** | 16.3 lm/W | 22 lm/W** | Efficacy = luminous flux / lamp power | EN 50285 | **CIE 84** | 1 | 1 | |
| **US** | 23 lm/W | | | 10 CFR Part 430 Appendix R to Subpart B | **CIE 84** | 1 | 1 | |

**(*) Conversion factors**

** Represents the "B" label class. The EU uses one label for all non-directional lamps, which has a highest class limit of 118 lm/W (for a 1000 lm lamp). The highest class practically achievable with a filament lamp, however, is the "B" class which runs from 22 to 54 lm/W.

## Product

1. Filament lamps are lamps in which light is produced by means of a threadlike conductor which is heated to incandescence by the passage of an electric current. The lamp may or may not contain gases influencing the process of incandescence. Incandescent filament lamps produce radiant power as a result of electric current passing through a tungsten filament, which is surrounded by an inert atmosphere or vacuum within a glass or quartz envelope. Some lamps contain halogens that are employed to maintain a clean bulb wall. Such lamps may also employ bulb coatings that redirect infrared energy back to the filament for improved efficacy or to filter radiation for color control.

2. The non-directional element differentiates these lamps from their directional counterparts. Non-directional lamps distribute their light more or les evenly in all directions, whereas directional ones have at least 80% of their light output in one direction, a cone with angle of 120 degrees.

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

1. Australia, the EU and the US have MEPS for these lamps. China and Russia are eliminating

incandescent lamps using a technology definition, rather than a performance specification. These are typically set by national Governments, or the European Commission in the case of the EU. MEPS typically cover efficacy, and in some cases other performance parameters are also subject to MEPS, such as lifetime, lumen maintenance.

2. All testing is based on CIE 84.

3. The test procedures, at least for efficacy, are well harmonized.

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

1. No conversion necessary for test procedures (efficacy) or metrics (efficacy).

2. Note also that lower US mains voltage means filament lamps can be more efficient (hotter filament).

3. The referenced test procedure is CIE 84 which is the globally-accepted CIE photometry method.

4. Representative products were used in order to compare MEPS limits, as the MEPS limit varies depending on product parameters such as lamp power and in some cases lamp color temperature.

5. This product type is very comparable, noting the above point.

6. The only material specific issues relates to the EU MEPS limit and US mains voltage, as described above.

7. Results are intended to be used for high-level comparisons of high volumes of products – not individual products.

### Notes and assumptions

None other than those mentioned above.

### List of sources

Regulations and standards from each country, as listed in CLASP's Global S&L Database
http://www.clasponline.org/en/Tools/Tools/SL_Search.aspx

# Product Fact Sheet — Lighting products: Ballast / HID

## Table 8. Overview of Ballast / HID

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **China** | Ballast efficiency of 85% | N/A | Ballast Efficiency = corrected lamp power / total circuit power | | **IEC 60923** | 1 | 1 | |
| **EU** | Ballast efficiency of 85% | | Ballast Efficiency = corrected lamp power / total circuit power | EN 50294 | IEC 60923 | 1 | 1 | |
| **Mexico** | | N/A | Ballast Efficiency = corrected lamp power / total circuit power | NMX-J-503-ANCE<br><br>NMX-J-230-ANCE | IEC 60923 | 1 | 1 | |

**(*) Conversion factors**

### Product

1. High intensity discharge lamps are lamps in which the light is produced, directly or indirectly, by an electric discharge through a gas, a metal vapor or a mixture of several gases and vapors; and in which the light producing arc is stabilized by wall temperature and the arc has a bulb wall loading in excess of 3 watts per square centimeter.

2. Ballasts are lamp control gear which serves to limit the current of lamps to the required value in case it is connected between the supply and one or more discharge lamps. It may also include means for transforming the supply voltage, dimming the lamp, correcting the power factor and, either alone or in combination with a starting device, providing the necessary conditions for starting the lamps.

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

1. Three of the economies in the table above have S&L programs for HID ballasts. These are typically set by national Governments, or the European Commission in the case of the EU. These MEPS all cover ballast efficiency.

2. With the exception of Mexico, these countries base their test procedure on IEC 60923.

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

1. There is no conversion necessary for test procedures and metrics.

2. The referenced test procedure is IEC 60923.

3. Representative products were used in order to compare MEPS limits, as the MEPS limit varies depending on product parameters such as lamp power.

4. This product type is relatively comparable.

5. Results are intended to be used for high-level comparisons of high volumes of products – not individual products.

### Notes and assumptions

None other than those mentioned above.

### List of sources

Regulations and standards from each country.

# Product Fact Sheet — Lighting products: Lamp / HID

## Table 9. Overview of Lamp / HID

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **China** | 75 (high pressure sodium)<br>72 (metal halide) | Efficacy requirement based on lamp power | Efficacy = luminous flux / lamp power | GB/T 13434<br>GB/T 13259<br>GB 20054<br>GB 18661<br>QB/T 2515 | **IEC 61167**<br>**IEC 60662**<br>**IEC 60188** | 1 | 1 | |
| **EU** | 100 (high pressure sodium)<br>85 (metal halide) | | Efficacy = luminous flux / lamp power | EN 61167<br>EN 60662<br>EN 60188 | IEC 61167<br>IEC 60662<br>IEC 60188 | 1 | 1 | |
| **Mexico** | 75 (high pressure sodium)<br>65 (metal halide) | | Efficacy = luminous flux / lamp power | NMX-J-530-ANCE | IEC 61167<br>IEC 60662<br>IEC 60188 | 1 | 1 | |

**(*) Conversion factors**

### Product

1. High intensity discharge lamps are lamps in which the light is produced, directly or indirectly, by an electric discharge through a gas, a metal vapor or a mixture of several gases and vapors; and in which the light producing arc is stabilized by wall temperature and the arc has a bulb wall loading in excess of 3 watts per square centimeter.

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

1. Only three of the countries in the table above have S&L programs for HID lamps (metal halide, sodium and mercury vapor lamps). These are typically set by national Governments, or the European Commission in the case of the EU. These MEPS all cover efficacy, and in some cases other performance parameters are also subject to MEPS, such as lumen maintenance.

2. The test procedures are globally consistent and rely on CIE photometry methods.

3. The test procedures, at least for efficacy, are also well harmonized between the IEC and North American standards bodies.

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

1. No conversion necessary for test procedures (efficacy) or metrics (efficacy).

2. The reference test procedures are held in IEC standards which rely on globally-accepted CIE photometry methods.

3. Representative products were used in order to compare MEPS limits, as the MEPS limit varies depending on product parameters such as lamp power and in some cases lamp color temperature.

4. This product type is very comparable, noting the above point.

5. The only material specific issue relates to the EU MEPS limit, as described above.

6. Results are intended to be used for high-level comparisons of high volumes of products – not individual products.

## Notes and assumptions

None other than those mentioned above.

## List of sources

Regulations and standards from each country.

US DOE Test Procedures and Regulations, high-intensity discharge lamps.
http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/60

# Product Fact Sheet — Lighting products: Ballast / Linear Fluorescent

*Note: A CLASP benchmarking study focusing on linear fluorescent lighting is forthcoming in late 2014. It will provide a more detailed description of the comparability of linear fluorescent ballasts.*

### Table 10. Overview of Ballast / Linear Fluorescent

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **Australia** | Minimum energy efficiency index (EEI) of B2 | Energy efficiency index (EEI) of A2 | Energy Efficiency Index (EEI) = a discrete value (looked up from a table) based on ballast efficiency | AS/NZS 4783.1 | **EN 50294** | 1 | 1 | Australian, EU and Chinese metrics are quite comparable, as EEI and Ballast Efficiency Factor are related (lookup table). |
| **China** | Minimum energy efficiency index (EEI) of B2 | Energy efficiency index (EEI) of A2-BAT | Ballast Efficiency Factor = corrected lamp power / total circuit power | EN 50294 (Chinese equivalent of) | EN 50294 | 1 | 1 | Australian, EU and Chinese metrics are quite comparable, as EEI and Ballast Efficiency Factor are related (lookup table). |
| **EU** | Minimum energy efficiency index (EEI) of B2 | Energy efficiency index (EEI) of A2-BAT | Energy Efficiency Index (EEI) = a discrete value (looked up from a table) based on ballast efficiency | EN 50294 | EN 50294 | 1 | 1 | Australian, EU and Chinese metrics are quite comparable, as EEI and Ballast Efficiency Factor are related (lookup table). |
| **US** | Require-ment for "ballast luminous efficiency (BLE)" is a complex function | | Ballast luminous efficiency (BLE) = lamp power / total circuit power | ANSI C82.2 | EN 50294 | 1 | 1 | US "ballast luminous efficiency" is difficult to compare with test methods and parameters used in most other |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | of ballast para-meters. | | | | | | | countries. |

**(*) Conversion factors**

## Product

1. Fluorescent lamps are discharge lamps of the low pressure mercury type in which most of the light is emitted by one or several layers of phosphors excited by the ultraviolet radiation from the discharge. Fluorescent lamps are supplied either with or without integrated ballasts. The linear aspect refers to the shape of the bulbs which are straight.

2. Ballasts are lamp control gear which serves to limit the current of lamps to the required value in case it is connected between the supply and one or more discharge lamps. It may also include means for transforming the supply voltage, dimming the lamp, correcting the power factor and, either alone or in combination with a starting device, providing the necessary conditions for starting the lamps.

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

1. Four of the economies in the table above set mandatory MEPS for Linear fluorescent ballasts, and many countries have had MEPS for some time. These are typically set by national Governments, or the European Commission in the case of the EU. These MEPS all cover ballast efficiency (in one way or another).

2. With the exception of the US, these countries base their test procedure on EN 50294.

3. The US is moving to a simplified test procedure, which does not involve photometric testing. It is possible that other jurisdictions may follow this example.

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

1. The only conversion necessary for test procedures and metrics is for the US.

2. The referenced test procedure is EN 50294.

3. Representative products were used in order to compare MEPS limits, as the MEPS limit varies depending on product parameters such as lamp power.

4. This product type is relatively comparable, noting the above point.

5. The only material specific issue relates to the difference in US/EN test procedures limit, as described above.

6. Results are intended to be used for high-level comparisons of high volumes of products – not individual products.

## Notes and assumptions

None other than those mentioned above.

## List of sources

Regulations and standards from each country.

US DOE Test Procedures and Regulations, fluorescent lamp ballasts.
http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/62

# Product Fact Sheet — Lighting products: Lamp / Linear Fluorescent

*Note: A CLASP benchmarking study focusing on linear fluorescent lighting is forthcoming in late 2014. It will provide a more detailed description of the comparability of linear fluorescent lamps.*

## Table 11. Overview of Lamp / Linear Fluorescent

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **Australia** | e.g. 80 | | Efficacy = luminous flux / lamp power | AS/NZS 4782.1 | **IEC 60081** | 1 | 1 | |
| **China** | e.g. 62 | Minimum initial efficacy 75-88 lm/W depending on lamp power and color temperature | Efficacy = luminous flux / lamp power | GB 10682 | IEC 60081 | 1 | 1 | |
| **EU** | e.g. 92 | Initial efficacy requirement based on lamp power | Efficacy = luminous flux / lamp power | EN 60081 | IEC 60081 | 1 | 1 | |
| **US** | 88 | | Efficacy = luminous flux / lamp power | IESNA LM-9 | IEC 60081 | 1 | 1 | |
| **Mexico** | | Minimum initial efficacy 46-90 lm/W depending on lamp power and color temperature | Efficacy = luminous flux / lamp power | NMX-J-295-ANCE | IEC 60081 | 1 | 1 | |
| **India** | | >=92 lm/W | Efficacy = luminous flux / lamp power | IS 2418 | IEC 60081 | 1 | 1 | |

**(*) Conversion factors**

## Product

1. Fluorescent lamps are discharge lamps of the low pressure mercury type in which most of the light is emitted by one or several layers of phosphors excited by the ultraviolet radiation from the discharge. Fluorescent lamps are supplied either with or without integrated ballasts. The linear aspect refers to the shape of the bulbs which are straight.

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

1. All but two of the countries in the table above set mandatory MEPS for Linear fluorescent

lamps, and many countries have had MEPS for some time. These are typically set by national Governments, or the European Commission in the case of the EU. These MEPS all cover efficacy, and in many cases other performance parameters are also subject to MEPS, such as lumen maintenance and color rendering index.

2. With the exception of the US and Mexico, these countries base their linear fluorescent test procedure on IEC 60969.

3. The test procedures, at least for efficacy, are well harmonized between the IEC and North American standards bodies.

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

1. No conversion necessary for test procedures (efficacy) or metrics (efficacy).

2. The referenced test procedure is IEC 60081 which references globally-accepted CIE photometry methods.

3. Representative products were used in order to compare MEPS limits, as the MEPS limit varies depending on product parameters such as lamp power and in some cases lamp color temperature.

4. This product type is very comparable, noting the above point.

5. The only material specific issue relates to the EU MEPS limit, as described above.

6. Results are intended to be used for high-level comparisons of high volumes of products — not individual products.

### Notes and assumptions

None other than those mentioned above.

### List of sources

Regulations and standards from each country.

US DOE Test Procedures and Regulations, general service fluorescent lamps.
http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/70

# Product Fact Sheet — Consumer Electronics: Televisions

## Table 12. Overview of Televisions

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **China** | LCD-0.6 PDP-0.6 | 1.2 | (luminance * Screen Area)/(P broadcast - (6,10 or 17 depending on Input Signal Port)) | GB 24850-2013 | N/A | N/A | N/A | Luminance efficiency metric cannot be analytically converted into a Watts or Watts/Area Metric |
| **Europe** | 16 W + A · 3.4579 W/dm$^2$ | N/A | Watts/dm$^2$ | EN 50301 and Commission delegated regulation (EU) No 1062/2010 of 28 September 2010 supplementing Directive 2010/30/EU | **IEC 62087 Ed3** | 1 | 1 | Using Watts/Area as the reference as in EU, US and India |
| **US** | | N/A | 100*TANH(0.00085*(A-140)+0.052)+14.1W, with correction for ABC | ENERGY STAR Televisions V6 | IEC 62087 Ed3 | 1 | 1 | |
| **US California** | P ≤ 0.12 x A + 25 | | No ABC or ABC Disabled: Po_Broadcast as per IEC 62087 Ed3. With ABC enabled by default: (0.55 * Po_Broadcast) + (0.45 * Pabc_Broadcast) | ENERGY STAR Televisions V6 | IEC 62087 Ed3 | 1 | 6.45 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **India** | | P = (0.964 x A) + 4.38 | Po_Broadcast | IEC 62087 Ed 3 | IEC 62087 Ed 3 | 1 | 1 | |
| **Australia** | ≤ base load + 0.1825 x screen area | N/A | .365 x [(computer monitor Po_Broadcast* 10) + (14 hour standby active)] kWh/yr | AS/NZS 62087 2009 | IEC 62087 Ed 3 | 1 | 0.274 | Converts kWh per year and Area to Watts |

**(*) Conversion factors**

## Products

1. Televisions are commercially-available products with a display screen and associated electronics, often encased in a single housing and that, as their primary function, display visual information from wired or wireless sources, including:
   - broadcast and similar services for terrestrial, cable, satellite and/or broadband transmission of analog and/or digital signals; and/or
   - display-specific data connections, such as VGA, DVI, HDMI, [such as those from a computer or workstation which is not mechanically attached to the display]; and/or
   - storage devices such as a USB flash drive or a memory card; and/or
   - network connections, usually using Internet Protocol, typically carried over Ethernet or WiFi.

2. Common television display technologies include liquid crystal display (LCD), light emitting diode (LED), cathode-ray tube (CRT), and plasma display panel (PDP).

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

1. The televisions covered are mains powered. Battery powered TVs are not covered. CRT, Plasma, LCD and OLED TV are covered.

2. Standards are set by local standards development organizations or the IEC standard is adopted without change.

3. All known test procedures use the IEC 62086 Ed 3 Section 11 method for TV power measurement. All countries except China use a Watts/area metric although Australia converts this to an annual Total Energy Consumption (TEC) metric. China uses a luminance efficiency metric.

4. In terms of power measurement all economies are aligned using the IEC 62087 Ed 3 Broadcast loop. China is alone in using a luminance efficiency approach and not adopting an "Out of Box" condition for measurement. This makes comparisons between China and all other counties currently impossible.

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

1. The conversion factors are based on the standards from each country or where directly referenced IEC 62086 Ed3. All countries use the IEC Broadcast loop to determine power consumption and apply this to a Watts/Area Metric. Australia converts this to a kWh/annum TEC, using an assumed on period of 10 hours per day for TV use and 14 hours standby mode. The conversion factor comparing Australia to the US, EU, and India compensates for this.

2. The conversion factor comparing the EU, US, India and Australia are very reliable. No conversion factor can be generated for China, as discussed above.

### Notes and assumptions

There are no assumptions made for televisions, apart from a standby power consumption assumption for Australia.

### List of sources

IEC 62087 Ed3

AS/NZS 62087 2009

ENERGY STAR V6

GB 24850 2013

Regulations and standards from each country, can be found in CLASP's Global S&L Database http://www.clasponline.org/en/Tools/Tools/SL_Search.aspx

# Product Fact Sheet — Consumer Electronics: Displays

## Table 13. Overview of Displays

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **China** | CRT-0.14<br><br>LCD-0.55 | CRT: 0.18<br><br>LCD: 1.05 | (luminance * Screen Area)/Power | GB 21520 -2008 | None | N/A | N/A | The Chinese test procedure is fundamentally different from IEC ones, therefore, a comparison is not possible |
| **Europe** | 12W + A* 3.4579 W/dm$^2$ | 0,1* (15W + A 4,3224 W/dm$^2$) | Po_broadcast: | EN 50301 and EC 642/2009 | **IEC 62087 Ed 3** | 1 | 1 | |
| **Us** | PO(MEPS) = ([6 for ≤1.1 Mp or 9 for > 1.1 Mp)´ Screen resolution in MP) + (0.007 75 ´ Screen area in cm$^2$) + 3 | N/A | Po_broadcast: where possible. Pon with VESA static patterns where it is not[1] | ENERGY STAR V6 | IEC 62087 Ed 3 | 1 | 1 | |
| **Australia** | PO(MEPS) = ([6 for ≤1.1 Mp or 9 for > 1.1 Mp)´ Screen resolution in MP) + (0.007 75 ´ Screen area in cm$^2$) + 3 | N/A | 0.365 x [(computer monitor Po_Broadcast × 10) + (14 hour x standby active)] kWh/yr | AS/NZS 5815.1 2012 | ENERGY STAR Displays V5.1 | 1 | 0.274 | |

**(*) Conversion factors**

[1] The ENERGY STAR requirements are extremely complicated and there are several equations relating pixel density and the operation of ABC to the calculated power depending on the displays pixel density and whether ABC is enabled by default. There are also different calculations for displays with special features. ENERGY STAR displays V6 should be used to determine exact requirements.

## Product

1. This category includes products with a display and associated electronics of which the primary function is to display visual information and that is connected to the mains power source for its intended continuous use, either directly or via an external power supply. The displays covered are mains powered. Battery powered displays are not covered. CRT, Plasma, LCD and OLED TV are covered. Many displays are excluded for technology reasons particularly in ENERGY STAR specifications. The exclusions are quite complicated and the ENERGY STAR specification should be used to determine the exclusions. This is also true for Australia because their standard is also based on ENERGY STAR.

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

1. Standards are set by local standards development organizations and it is these standards that have been used as references.

2. All test procedures use a Watt/Area metric except China which uses a luminance efficiency metric. This makes comparisons between China and all other counties impossible.

3. The conversion factors are based on the standards from each country. All countries use a Watts/Area Metric. Australia converts this to a kWh/a TEC. Australia uses an on period of 10 hour per day for display use. The conversion factor compared to the US and EU is based on this.

4. The conversion factors comparing the EU, US and Australia are very reliable.

## Notes and assumptions

Display specifications are very complicated and have both elaborate methods for determining factors for pixel density as well as allowances for automatic brightness control. ENERGY STAR in particular is complicated and also has special equations for advanced technology. The individual standards should be consulted to determine exact requirements.

## List of sources

IEC 62087 Ed3
AS/NZS 5815.1 2012 and AS/NZS 5815.2 2013
ENERGY STAR Displays V6
GB 21520 2008

# Product Fact Sheet — Consumer Electronics: Digital television decoders (Set top boxes)

## Table 14. Overview of Set top boxes

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **China** | N/A | N/A | Pon and Psp | GB 25957 - 2010 | N/A | N/A | N/A | Cannot convert because too dependent on standby power |
| **EU** | Simple STB: Standby 1W+adders Active 5W+adders | | TEC = 0.365(5*Po+19 *Pstandby) | European Voluntary Agreement | **IEC 62087 Ed3** | 1 | 1 | Compared to US and Australia |
| **US** | N/A | N/A | $AEC = 0.365 \sum^{n} Pi * Ni$ | ENERGY STAR Set-top box Specification Version 4.1 | IEC 62087 Ed3 | 1 | 1 | Compared to EU and Australia |
| **Australia** | SD STBS (On Mode 7W Passive 2W) or (On Mode 8W Passive 1W) - HD (On mode 11W Passive 2W or (On mode 12W Passive 1W) | | Pon | AS/NZS 62087.1 | N/A | N/A | N/A | |
| **Australia** | Satellite and Cable base allowance 60 kWh/annum | | TEC = 0.365(Pon*5+P standby*19) | Australian CSTB Voluntary Code | IEC 62087 Ed3 | 1 | 1 | Compared to EU and US ENERGY STAR |

**(*) Conversion factors**

## Product

1. Set top boxes (STBs) vary greatly across regions and platforms. A set top box is a device combining hardware components with software programming designed for the primary purpose of receiving television and related services from terrestrial, cable, satellite, broadband, or local networks, providing video output using at least one direct video connection. There are two broad types of STB categorized for simplicity on the European market: 'Simple set top box' (SSTB) and 'Complex set top box'.

2. SSTBs are stand-alone devices which, irrespectively of the interfaces used,
   - have the primary function of converting standard-definition (SD) or high-definition (HD), free-to-air digital broadcast signals to analogue broadcast signals suitable for analogue television or radio;
   - have no 'conditional access' (CA) function;
   - offer no recording function based on removable media in a standard library format.

A SSTB can be equipped with the following additional functions and/or components which do not constitute a minimum specification of an SSTB:
- time-shift and recording functions using an integrated hard disk;
- conversion of HD broadcast signal reception to HD or SD video output;
- second tuner.

3. Complex set top boxes cover digital convertors for TVs, including additional features such as pay TV and network connectivity.

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

1. STBs vary greatly between regions and across platforms. There are two approaches of energy performance requirements in use. The first is a power on-mode requirement with a standby requirement. The second is a Total Energy Consumption approach, which is based on measuring energy consumption across a duty cycle. The TEC approach is useful because it includes the energy use of a STB in standby mode in the calculation. Standby is the main contributor to energy consumption in many regions and in particular for subscription TV platforms. The test methods and metrics for each approach are comparable within the approach but not between approaches.

2. The TEC approach is probably the best for inter region and platform comparisons.

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

1. The references used for the assessment of conversion factors are the regional standards used and ENERGY STAR where it is referred to directly; the reference test procedure is IEC 62087 Ed3.

2. Because standby power varies so greatly across regions and platforms for STBs no assumption can be made that allows for a conversion factor between the on power approach and the TEC approach.

3. The conversion factors specified are correct as a comparison between TEC programs or on-mode power programs but no conversion factor can be developed to compare on power with the TEC approach.

## Notes and assumptions

No assumptions have been made to provide conversion factors. It should be noted that most programs have complicated “functional adders” and the actual standards should be consulted for the detail of these in each region.

## List of sources

GB 25957 - 2010
European Voluntary Agreement
ENERGY STAR Set top Box Specification Version 4.1
AS/NZS 62087.1
AS/NZS62087.2.1
Australian CSTB Voluntary Code

# Product Fact Sheet — Consumer Electronics: Audio

## Table 15. Overview of Audio

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **US** | N/A | N/A | Pout/(Pin-Pdisk) | ENERGY STAR Audio/Video Specification Version 3.0 | **ENERGY STAR Audio/Video Specification Version 3.0** | N/A | N/A | Only one program |

**(*) Conversion factors**

## Product

1. Audio equipment can be found on a wide range of consumer electronics such as:

- Home-Theater-in-a-Box Systems
- Sound bars
- MP3 speaker docks
- Audio amplifiers
- AV receivers
- Shelf systems
- Blu-ray Disc players
- DVD players

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

1. There is only the US ENERGY STAR program in place for audio and it covers mains-connected products that offer Audio Amplification and/or Optical Disc Player functions.

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

1. As there is only one program there is no conversion factor. The metric is an efficiency metric.

## Notes and assumptions

No notes or assumptions needed to be made for this comparison.

## List of sources

ENERGY STAR Audio/Video Specification Version 3.0

# Product Fact Sheet — ICT: Computers, Games Consoles and Servers

## Table 16. Overview of Computers, Games Consoles and Servers

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **Computers and Small Scale Servers** | | | | | | | | |
| **US** | | TEC values depending on type of computer | TEC (kWh/a) | ENERGY STAR® Program Requirements for Computers | **ENERGY STAR® Program Requirements for Computers** | 1 | 1 | |
| **Australia** | | TEC values depending on type of computer | TEC (kWh/a) | AS/NZS 5813.1 | ENERGY STAR® Program Requirements for Computers | 1 | 1 | |
| **EU** | TEC values, depending on type of computer | TEC values depending on type of computer | TEC (kWh/a) | ENERGY STAR® Program Requirements for Computers, with modifications | ENERGY STAR® Program Requirements for Computers | 1 | 1 | Weightings between modes differ from to ENERGY STAR v6 |
| **EU** | Power supply efficiency requirements (similar to ENERGY STAR v6) | TEC values depending on type of computer | TEC (kWh/a) | ENERGY STAR® Program Requirements for Computers | ENERGY STAR® Program Requirements for Computers | 1 | 1 | |
| **Games Consoles** | | | | | | | | |
| **US** | | N/A | Power measured in Standby, Active Navigation and Active Streaming Modes. Determined by measurement | ENERGY STAR Program for Game Consoles: Performance Requirements Version 1.0 | None | N/A | N/A | No other program |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | method and has no Formula | | | | | |

**(*) Conversion factors**

## Product

1. For all the programs stated a computer is defined as:
*"A device which performs logical operations and processes data. Computers are composed of, at a minimum: (1) a central processing unit (CPU) to perform operations; (2) user input devices such as a keyboard, mouse, digitizer or game controller; and (3) a computer display screen to output information. For the purposes of this specification, computers include both stationary and portable units, including desktop computers, gaming consoles, integrated desktop computers, notebook computers, small-scale servers, thin clients, and workstations. Although computers must be capable of using input devices and computer displays, as noted in numbers 2 and 3 above, computer systems do not need to include these devices on shipment to meet this definition."*

2. In addition Games Consoles are defined as:
*"A standalone computer-like device whose primary use is to play video games"*

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

1. The requirements for these products are very complicated and for specific requirements for a product the specified reference should be used. All label programs are ENERGY STAR programs; therefore no comparison between requirements is needed. The EU has also introduced Ecodesign requirements for computers. For desktops and laptops, these use the ENERGY STAR approach, however, with different weightings between the energy demand per power modes. An accurate comparison between resulting energy consumption calculations cannot be made. For servers, the EU requires the provision of information about power demand in various modes as well as power supply efficiency requirements in line with ENERGY STAR.

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

1. The program requirements were determined from the actual program standards.

2. As ENERGY STAR is effectively the only program for computers, the only conversion factors that can be determined are between ENERGY STAR 5.1 and Australia. Since Australia uses a complete adoption of ENERGY STAR 5.1 the conversion factor must be 1.

## Notes and assumptions

No notes or assumptions needed to be made for this comparison.

## List of sources

ENERGY STAR® Program Requirements for Computers Version 5.1.

ENERGY STAR® Program for Game Consoles: Performance Requirements Version 1.0

AS/NZS 5813.1

AS/NZS 5813.2

# Product Fact Sheet — ICT: Imaging Equipment

## Table 17. Overview of Imaging Equipment

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **EU** | | N/A | kWh/a [1] | ENERGY STAR V1 | **ENERGY STAR V1** | 1 | 1 | Conversion factor for programs based on ENERGY STAR |
| **China** | N/A | N/A | kWh/a[1] | GB 21521-2008<br>GB 25956-2010 | ENERGY STAR V1 | 1 | N/A | English Translation not available so it is unclear as to the calculation of TEC |
| **US** | | N/A | kWh/a[1 2] | ENERGY STAR V1 | ENERGY STAR V1 | 1 | 1 | Conversion factor for programs based on ENERGY STAR |
| **Australia** | | N/A | kWh/a[1 2] | ENERGY STAR V1 | ENERGY STAR V1 | 1 | 1 | Conversion factor for programs based on ENERGY STAR |

**(*) Conversion factors**

Notes:

1. Actual metrics are complicated and the referenced document should be consulted for precise requirements for each product type.

2. ENERGY STAR V2 for Imaging Equipment comes into effect in January 2014 but the same comment applies as footnote 1.

### Product

1. Products covered in these programs are printers, copiers, facsimile (fax) machines, multifunction devices (MFDs), mailing machines.

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

1. The requirements are very complicated, making it impossible within the context of this study to provide a summary of the metrics. The referenced standards should be used to provide the specific requirement for each product type.

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

1. ENERGY STAR is essentially the only set of requirements in place and therefore the conversion factor for most programs is 1. Information about the test procedure and metrics for the Chinese program could not be retrieved in an accessible format; therefore, no conversion factor

could be determined for the Chinese requirements.

## Notes and assumptions

No notes or assumptions needed to be made for this comparison.

## List of sources

ENERGY STAR V1 for Imaging Equipment
GB 21521 - 2008 Imaging Equipment
GB 25956-2010 Printers
ENERGY STAR V2 for Imaging Equipment

# Product Fact Sheet — ICT: Power Supplies

## Table 18. Overview of Power Supplies

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **Power Supplies** | | | | | | | | |
| **China** | < 1W:0.49*Po<br>1W to 49W: 0.09 *Ln Po + 0.49<br>> 50W:<po<=250 0.84 | | Efficiency = Pout/Pin | GB 20943 - 2007 | **ENERGY STAR V2** | 1 | 1 | |
| **EU** | < 1W:0.49*Po<br>1W to 49W:0.09 *Ln Po + 0.49<br>> 50W:<po<=250 0.845 | | Pout/Pin | None | **ENERGY STAR V2** | 1 | 1 | |
| **US** | < 1W:0.5*Po +0.16;<br>1W to 49W:0.071 Ln Po - 0.0014 Po + 0.67;<br>> 50W:<po<=250 0.88; 250 <Po 0.875 | < 1W: 0.48*Po +0.140<br>1W to 49W:0.0626 *Ln Po + 0.622;<br>> 50W: <Po 0.87 | Pout/Pin | Test Method for Calculating the Energy Efficiency of Single-Voltage<br>External Ac-Dc and Ac-Ac Power Supplies (August 11, 2004 | ENERGY STAR V2 | 1 | 1 | |
| **Australia** | < 1W: 0.49*Po<br>1W to 49W:0.09 *Ln Po + 0.49<br>> 50W:<po<=250 0.84 | | Pout/Pin | AS/NZS 4665.1<br>AS/NZS 4665.2 | ENERGY STAR V2 | 1 | 1 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Battery Chargers** | | | | | | | | |
| **US** | N/A | N/A | ER=(Em+Es)/Eb | ENERGY STAR Battery Charging Systems Specification Version 1.1 | ENERGY STAR Battery Charging Systems Specifi-cation Version 1.1 | 1 | 1 | This is the only program |
| **Uninterruptable Power Supplies** | | | | | | | | |
| **US** | | N/A | Eff_avg=t25*EFF25%+t50%*EFF50%+t75%EFF75%+t100%*EFF100% | ENERGY STAR Uninterrupt-ible Power Supplies Program Requirements Version 1.0 | ENERGY STAR Uninterrupt-ible Power Supplies Program Requirements Version 1.0 | 1 | 1 | This is the only program |

**(*) Conversion factors**

## Product

1. This category covers external power supplies AC and DC, battery chargers and uninterruptible power supplies.

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

1. All programs, except the EU one, are based on ENERGY STAR.

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

1. As all programs are based on ENERGY STAR they are all harmonized. As there is only one set of requirements the conversion factors are all 1.

## Notes and assumptions

Some of the requirements are complicated and the ENERGY STAR or other relevant standard should be consulted for specific details.

## List of sources

ENERGY STAR® Program Requirements for Single Voltage External Ac-Dc and Ac-Ac Power Supplies: Eligibility Criteria (Version 2.0)

Test Method for Calculating the Energy Efficiency of Single-Voltage

External AC-DC and AC-AC Power Supplies (August 11, 2004)

AS/NZS 4665.1 and AS/NZS 4665.2

GB 20943 – 2007

# Product Fact Sheet — Air Conditioning: Central (ducted) air conditioning

## Table 19. Overview of Central (ducted) air conditioning

| Country | MEPS | High Label | S&L metric [1] | Test procedure | Reference test procedure & metric | Test Procedure (*) [2] | Energy Performance Metric (*) [3] | Notes |
|---|---|---|---|---|---|---|---|---|
| **China** | 2.9 - 3.2 | 3.3 - 3.6 / (5.2) | SEER | GB/T 18836; | ISO13253:1995 | N/A | N/A | Ducted, unitary type |
| **China** | 2.7 - 2.8 | 3.5-3.6 | IPLV[1] | GB/T 18837 | ISO 13253 (T1) | N/A | N/A | Multi-connected type |
| **EU** | 2.16 - 3.6 | ≥4.1 - ≥ 8.5 | SEER[2] | Based on EN 14 511:2004; EN12309-2:2000 | Eurovent (EN14511-1 (2011)) | N/A | N/A | ISO 5151 2010 closely aligned to EN 14511 |
| **Mexico** | | N/A | SEER | NOM-011-ENER-2006 | ASHRAE-37:2005 | N/A | N/A | Central, packaged or split |
| **US** | 3.1 - 3.8 | ≥14.5 (≥ 12); [4.2/(3.5)] ≥14 (≥ 11); [4.1 / (3.2)] | SEER | ISO 5151 T1 for water-cooled; Splits, AHRI 210/240-2006 | AHRI 210/240 (2008), ASHRAE-37:2005 | N/A | N/A | Central air conditioners (includes split units) |
| **Australia** | 3.2 - 3.5 | 5.25 | SEER, IPLV | AS/NZS 4776.1.1 and AS/NZS 4776.1.2 | AHRI 550/590, ASHRAE 90.1 and Eurovent (EN14511-1 (2011)) | N/A | N/A | Liquid chilling packages |

**Notes:**
1. Integrated part load value
2. This refers to ENTR Lot 6 air conditioners >12kW.

**(*) Conversion factors**

## Product

1. An air conditioner is an appliance designed to maintain the temperature of indoor air at a given temperature level for a given heat load to be extracted. There are different types of residential air conditioners. Central air conditioners are generally heat pumps or cooling units installed as part of a building's central heating and cooling system. They use ducts to distribute cooled or dehumidified air to more than one room.

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

1. There are some similarities in the test procedures in China, the US, EU and Australia, however significant differences exist, and have not been quantified.

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

1. There is very limited information available to develop conversion factors for central air conditioning units. No conversion factors between economies could be determined.

## Notes and assumptions

**EU:** in the EC's Working Document on air heating products, cooling products and high temperature process chillers, EN 14825:2012 is provisionally used as a basis for core test point measurements for comfort chillers, air conditioners and heat pumps, however the efficiency metric is developed further by the regulation itself, to consider e.g. conversion to primary energy; ISO WG3 is developing a new standard for air conditioners/heat pumps with part loads, which may reference EN 14825 and ISO 16358 (see SEAD reference, EU in sources below); EN14511:2007 used in regulation (EU) No 626/2011 on (ducted) room air conditioners, can be found in the Room Air Conditioners fact sheet.

**Mexico:** Mexico's mandate for Energy Efficiency Standards comes from a generic law, the 'Ley Federal sobre Metrología y Normalización' (Federal Metric and Standardization Law) of July 16, 1992, which defines the Normas Oficiales Mexicanas – NOM (Official Mexican Standards). In general, Mexico adopted energy standards in 1995 and has since established standards for eighteen products. Many of their standards are modeled on those of the US, but have been adapted to local situations and experience from their own program (see APERC source, below). The Mexican standard makes reference to ANSI / ASHRAE 37 Methods of testing for rating unitary air conditioning and heat pump equipment, - also used in US - however the exact relationship has not been assessed.

ANSI / ASHRAE 37: permits the indoor enthalpy test method only – unlike ISO 5151, which also describes the calorimeter room method.

**China:** GB/T 18836 is for Ducted air-conditioning (heat pump) units, references standard ISO 13253; GB/T 18837 is for multi-connected air-conditioner unit. Direct references to ISO 13253 or ISO 5151 have not been found, although the testing document (see sources below) does refer to the climate type of T1, which may be that of either ISO standard. This standard has been revised by: ISO 13253:2011

**Australia:** for liquid chilling packages, Australia does appear to accept products tested in accordance with AHRI 550/590, ASHRAE 90.1 and Eurovent (which in turn refers to definitions in EN14511-1 (2011), using ESEER, European Seasonal Energy Efficiency Ratio). Fact sheet: http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Fact_Sheets/Cooling/Chillers/factsheet-chiller-standards-regs.pdf

## List of sources

**Australia:** Eurovent: http://www.eurovent-certification.com/en/Certification_Programmes/Programme_Descriptions.php?lg=en&rub=03&srub=01&select_prog=LCP-HP**Mexico:** test method: http://translate.google.co.nz/translate?hl=en&sl=es&u=http://www.conae.gob.mx/work/sites/CONAE/resources/LocalContent/6933/11/NOM011ENER2006.pdf&prev=/search%3Fq%3DNOM-011-ENER-2006%26rlz%3D1C1AVNC_enNZ558NZ558%26espv%3D210%26es_sm%3D122APEC (http://aperc.ieej.or.jp/file/2012/12/28/Mexico_2011.pdf)

**EU:** EC Working Document (Central AC): '20130717_Lot21_ED'; SEAD document Air conditioner webinar (26 Nov, 2013), slide 30

**Other:** CLASP (2011-2012), Cooling Benchmarking Study

CLASP (2013) Air conditioning Mapping Report: An overview of the Russian market

**China:** China Energy labeling website (http://www.energylabel.gov.cn/en/EnergyEfficiencyStandards); GB/T 18837 http://www.energylabel.gov.cn/en/images/upFile/634643386875076250.pdf; GB/T 18837 and GB/T 18836: http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Library/Cooling/Air_Conditioners/2004ac-internat-yuezhan.pdf http://www.energylabel.gov.cn/en/EnergyEfficiencyStandards/FormulationandRevisionofStandards/detail/721.html

**EU:** Ecodesign Working Document '20130717_Lot21_TransMethod' p5 on central air conditioning equipment; Working Document on MEPS: '20130717_Lot21_ED'

**EU:** Regulation (EU) No 626/2011 of 4 May 2011 on room air conditioners (included ducted AC)

**US:** Central AC: CLASP RAC benchmarking_3 - Testing component 2012

# Product Fact Sheet — Air Conditioning: Room air conditioners

## Table 20. Overview of Room air conditioners

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **India** | 2.7 | 3.3-3.5 | EER | IS 1391-1:2005 Part 1 Unitary air conditioners; IS 1391-2:2004 Split air conditioners | Both parts are partially based on ISO 5151 | 1 | N/A | It is not clear from info available how the two standards differ |
| **China** | | N/A | EER | GB/T 7725-2004; GB 12021.3-2010 | ISO 5151: 1994 T1 test condition | 1 | 1.01 | Directly comparable with the EU, US, and Japanese steady state requirement. |
| **EU** | 3.24-3.6 | ≥ 8.5 | SEER | EN 14825 | ISO 5151 | 1 | 1.13 | Differences unknown |
| **South Africa** | | N/A | N/A | N/A | N/A | N/A | N/A | See notes below |
| **Indonesia** | | ≥12.83 (inverter)<br>≥10.41 (no inverter) | EER | SNI 04 - 6958-2003 | ISO 5151: 2010 | 1 | N/A | |
| **US** | 2.34 - 2.87 | 2.8 / (9.4); [2.8 / (9.4)] - 3.2 / (10.8); [2.8 / (9.4)] | EER | ASHRAE-37-1988 or ISO 5151 | **ISO 5151 T1 class** | 1.0096(**) | 1 | Water cooled unit test differs from ISO |
| **Australia** | N/A | N/A | EER/AEER | AS/NZS 3823.1.1-1.4 | ISO 5151 (non-ducted) ISO 13253 (ducted) | 1 | N/A | Non-ducted wet bulb conditions differ to ISO 5151 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Mexico** | N/A | N/A | EER | NOM-023-ENER-2010 | ISO 5151 | 1.0096** | 1 | Likely aligned with the US |

**(*) Conversion factors**

**(**)** $EER_{NAFTA} = EER_{T1} * 1.0096$

## Product

1. An air conditioner is an appliance designed to maintain the temperature of indoor air at a given temperature level for a given heat load to be extracted. There are different types of residential air conditioners. Residential room air conditioners are mounted in windows or through walls and deliver conditioned air to enclosed spaces. Room air conditioners typically extract heat from the room and vent it outdoors. These products are offered in a broad range of sizes and configurations. They are used in homes, apartments, and commercial settings.

2. Room air conditioners include the following: Split-packaged units (also called mini-split or duct free split on the US market); Multi Split packaged units; Single packaged units (typically window air conditioners in Europe, but also packaged terminal air conditioners on the US market); Single duct units; Double duct units; Residential chillers.

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

Relative to other product areas, coverage of S&L policies for room AC is expansive: all economies in this study except Russia have introduced requirements for room air conditioners.

1. The great majority of economies reviewed use ISO 5151 at least as the dominant procedure underlining their test procedures.

2. Testing procedures have been converging towards the EER testing procedure from ISO5151, however the annual/seasonal SEERs are beginning to be adopted, and are the focus of future development. This may actually increase differences between requirements, as different economies so far tend to adopt different SEER efficiency metrics. The key areas where potential differences may remain between standards relate to fair reflection of climatic conditions between economies, although these can be standardized/accommodated in a harmonized standard (via a climate zone approach). However the other key issue is the choice of method used within the standards – including ISO 5151 and EN14511, where often either the calorimeter room method or the indoor air enthalpy method may be used: the former is considered more reliable.

3. **Australia:** The Equipment Energy Efficiency (E3) Program is a joint initiative of the Australian, Commonwealth, State and Territory governments and the New Zealand Government. Australian legal instruments fall under the Australian Greenhouse and Energy Minimum Standards (GEMS) Legislation.

4. **China:** Article 14 of the e 1997 National Energy Conservation Law of China (revised 2008) provides the regulatory basis for mandatory energy efficiency standards for energy-consuming products and equipment. China National Institute of Standardization (CNIS) has been revising single-period mandatory energy efficiency standards and developing new standards to follow international best practice while the China Standards Certification Center has launched a new voluntary energy efficiency endorsement labeling program targeting the top 25% most efficient products. The mandatory categorical energy information label known as the China Energy Label was established in 2005. The MEPS program aims to remove the 20% least-efficient products from the markets

targeted. The SEAD Room Air Conditioners report provides further detail.

5. **India:** India has a national standard body, BIS, responsible for formulating and implementing national standards, and production, quality and EMS certification. The Bureau of Energy Efficiency is responsible (under the Energy Conservation Act, 2001) for the Standards and Labeling Program. Laboratories are accredited by the National Accreditation Board.

6. **Mexico:** Mexico's mandate for Energy Efficiency Standards comes from a generic law, the Ley Federal sobre Metrología y Normalización (Federal Metric and Standardization Law) of July 16, 1992, which defines the Normas Oficiales Mexicanas – NOM (Official Mexican Standards). In general, Mexico adopted energy standards in 1995 and has since established standards for eighteen products. Many of their standards are modeled on those of the US, but have been adapted to local situations and experience from their own program (see APERC source, below).

7. **Russia:** GOSTANDART regulations, (prefixed with GOST), contain product energy performance requirements and describe the product's energy test procedure. Mandatory MEPS introduced in the 1980's were converted to voluntary requirements in 2002, but were not effectively implemented. New energy-performance labeling requirements were introduced in 2011 (see CLASP source, below).

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

1. ISO 5151 is the procedure common to all local test procedures reviewed, at least in part and is therefore the logical reference. A robust analysis of these standards was carried out by CLASP in its 2012 Benchmarking Study of Room Air Conditioners. Where differences do exist, they are noted in the table above. The specific impact of these differences has not been established, except in the US's case.

### Notes and assumptions

**India:** According to the CLASP 2011 RAC Benchmarking study, the India standards are 'partially based on ISO 5151'. The key apparent difference is that in the India standard, outdoor air humidity is higher (wet bulb). Refrigerant piping is also shorter. It is assumed in the conversion factor that the impacts are small, but significant.

**China:** Uses the ISO 5151 test standard – no conversion needed

**EU:** Used ISO 5151 in previous requirements, however, new requirements use an ESEER where each test point is tested using the same method but often different test conditions to ISO5151 and then aggregated differently. New requirements also include standby energy demand.

Single and double-ducted RAC uses the EER metric based on prEN14825:2010 and possibly EN14511:2007, likely to be directly comparable with the ISO 5151 steady state climate class T1 procedure.

**Indonesia:** Uses the ISO 5151 test standard – no conversion needed

**Mexico:** NOM-023-ENER-2010 (split type air conditioners) cites ISO 5151 as one of its core references (see sources section below), however the precise relationship between the two test procedures has not been assessed.

**South Africa:** MEPS are in place in South Africa, however the test used in not known

**US:** test conditions are very similar ISO 5151 except for a variation in the indoor wet bulb temperature. A test procedure conversion factor, reported in the 2012 CLASP Study is assumed: $EER_{NAFTA} = EER_{T1} * 1.0096$

**Australia:** ISO 5151 is used for non-ducted units, while ISO 13253 is used for ducted units.

## List of sources

General: CLASP (2011), Cooling Benchmarking Study; http://www.clasponline.org/en/Resources/Resources/PublicationLibrary/2012/Cooling-Benchmarking-Study.aspx

Cooling the planet, Opportunities for Deployment of Super Efficient Air Conditioners, SEAD/LBNL, April 2013, http://www.superefficient.org/Activities/Technical%20Analysis/SEAD%20Room%20Air%20Conditioners%20Report.aspx

Australia: http://www.energyrating.gov.au/regulations/product-standards/overview/asnzs3823/

China: China Energy labeling website (http://www.energylabel.gov.cn/en/EnergyEfficiencyStandards; Institutional background: http://eneken.ieej.or.jp/data/3694.pdf

Mexico: http://aperc.ieej.or.jp/file/2012/12/28/Mexico_2011.pdf; reference to ISO 5151: http://dof.gob.mx/nota_detalle.php?codigo=5171765&fecha=20/12/2010

Russia: CLASP (2013) Air conditioning Mapping Report: An overview of the Russian market

# Product Fact Sheet — Air Conditioning: Chillers

## Table 21. Overview of Chillers

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **India** | 2.9/3.16 - 6.3/6.61 | | COP | ASHRAE 90.1-2004 | ASHRAE 90.1-2004 | N/A | N/A | Procedure may have been updated to a localized variant |
| **China** | 2.4 - 4.2 | 3.2 - 6.1 | COP | GB 19577-2004; | GB/T 18430.1 GB/T 18430.2 GB 18070 | N/A | N/A | Vapor-compression air and water chillers |
| **EU** | N/A draft | | Seasonal energy performance ratio | EC Working Document '20130717_Lot21_ED' | EN 14825:2012 | N/A | N/A | High temperature chiller (process chilling) |
| **EU** | N/A draft | | SEPR | Annex III, EC Working Doc "CF Ecodesign Lot1isc (Jun2013)" | unknown | N/A | N/A | Low, medium temperature chiller (process chilling) |
| **Australia** | 2.7 (5.0) / 3.7 (5.5) - 2.7 (6.0) / 4.1 (6.5) | | COP | AS/NZS 4776 | Possibly AHRI 550/590 | N/A | N/A | Chiller |

**(*) Conversion factors**

### Product

1. Chillers produce water that is used by building space cooling equipment and many industrial processes.

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

1. Standards and/or labels are in place in India, China and Australia. MEPS are in draft form in the EU. The US has ASHRAE 90.1, which is a non-binding industry standard for the efficient design of buildings and building systems.

2. There appears to be some confluence in standards towards seasonal performance metrics. However; there are no available sources describing a comparison of these test procedures and a newly developed comparison would require an in-depth assessment of test protocols and results which is beyond the scope of this study.

### Notes and assumptions

**EU:** the 'high temperature chiller' is divided into 2 groups: 1) chillers used for space cooling: includes air-to-water chillers (electric driven motor), water/brine-to-water chillers (electric driven motor), and air-to-water chillers (electric or fuel driven motor), all up to 2 MW cooling capacity. The efficiencies of these products are determined by a seasonal metric related to space cooling loads. For comfort cooling (and not process) chillers, MEPS are determined in part by the GWP of the refrigerant used; 2) high temperature process chiller (electric driven motor) – are intended for industrial process cooling. EN 14825:2012 is cited as a transitional method and is not available. It is applicable in all cases, with the exception of liquid or gaseous fuel sorption heat pumps, where EN 12309 is applicable. The energy efficiency metrics in the EC Working Document build upon these test methods; however the exact relationship is unclear.

Given the concurrent development/review of the EU's SEER - EN 14825:2012 and ISO 5151, and that the steady state conditions of related EERs are the same, it is likely that these two standards also share much in common. However a new EU standard is being developed, and the SEER MEPS calculation in the EU draft regulation includes additional factors relating to temperature control, ground water pump electricity consumption (where applied) and; it is expressed in primary energy terms.

**India:** Appears to have developed its own standards, due for release in March 2013 – evidence of which has not been found – but it is likely to have been based on the ASHRAE standard.

**Australia:** According to AHRI/Eurovent: "The rating and testing standards of the Air-Conditioning, Heating and Refrigeration Institute of the US (AHRI) and the European Committee of Air Handling and Refrigeration Equipment Manufacturers (Eurovent) were used as a basis for the Australian/New Zealand Standards".

**China:** GB/T 18430.1 (commercial/industrial packaged chiller/heat pump applications), GB/T 18430.2 (household equivalent), and GB/T 18430.1 GB/T 18430.2 for positive displacement & centrifugal water-chilling packages/heat pumps refer to GB 19577-2004 (coefficient of performance test) to demonstrate compliance with the Water Chillers Energy Efficiency Label (not freely available). These standards appear to be based on ASHRAE 30-1995 (see sources below).

### List of sources

**EU:** EC working documents '20130717_Lot21_TransMethod' (test methods); '20130717_Lot21_ED' (Ecodesign and test methods)

**India:**
http://www.rehva.eu/fileadmin/events/eventspdf/REHVA_Seminar_Brussels__18.10.2012/Indian_building_energy_efficiency_and_HVAC_policies_and_standards___codes_system.pdf

**Australia:** http://www.energyrating.gov.au/products-themes/cooling/chillers/meps/

**EU:** EC Ecodesign Working Document '20130717_Lot21_ED'

**China:** GB 19577-2004 (coefficient of performance) referred to in

http://www.energylabel.gov.cn/en/images/upFile/634643387755076250.pdf;

MEPS and label thresholds:
http://www.energylabel.gov.cn/en/EnergyEfficiencyStandards/FormulationandRevisionofStandards/detail/734.html;

Reference to ASHRAE:
http://www.clasponline.org/en/Resources/Resources/StandardsLabelingResourceLibrary/2011/~/media/Files/SLDocuments/2011-03_HarmonizationStudy/HarmonizationStudy-Part2/CLASP_HarmonizationStudyP2_AppendixA.pdf

# Product Fact Sheet — Space and water heating: Central heating boiler

## Table 22. Overview of Central heating boiler

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **China** | 84% | 92%-96% | Heat efficiency | GB 20665-2006; GB 6932; GB/T 13611 CJ/T 228 | unknown | N/A | N/A | Gas boilers (incl. combi boilers) |
| **EU** | 75% | ηs ≥ 150 | Seasonal efficiency (%) | As per Ecodesign regulation (see sources below) | FprEN 15502 is set to replace EN 297, EN 483, EN 677, EN 656, EN 13868, EN 15420 | N/A | N/A | Gaseous fuel boilers (incl. combi boilers) |
| **EU** | 42% (open) - 72% (closed | EEI ≥ 104 | Seasonal efficiency (%) | As per Ecodesign regulation (see sources below) | Modifies EN 15034:2008 (condensing boilers) and EN 304:1992; A1:1998; A2:2003 (atomizing boilers)[1] | N/A | N/A | Oil/liquid fuel boilers (incl. combi boilers) |
| **EU** | 100%-115% (low temp) | ηs ≥ 175 | Seasonal efficiency (%) | As per Ecodesign regulation (see sources below) | Modifies FprEN 14825: October 2011 | N/A | N/A | Electric heat pumps |
| **EU** | 86% | ηs ≥ 175 | Seasonal efficiency (%) | As per Ecodesign regulation (see sources below) | prEN 50465: 2010 Draft ed; | N/A | N/A | Cogeneration boilers |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **US** | 78%-84% | 85% | | 10 CFR 430.23(g), 10 CFR 430.23(o), and 10 CFR Part 430 Appendix G to Subpart B | | N/A | N/A | |

**(*) Conversion factors**

Notes:

1. For boilers with forced draught burner similar sections apply in EN 303-1, EN 303-2 and EN 303-4. For atmospheric, not fan-assisted burners EN 1:1998 applies. Ref: http://www.eceee.org/ecodesign/products/boilers/testing_calculation_6April2011 ; p2

## Products

1. Central heating boilers fall within the broader category of space heating. In this context, space heaters are devices which provide heat (in the case of boilers) to a water-based central heating system in order to reach and maintain at a desired level the indoor temperature of an enclosed space such as a building, a dwelling or a room. They are equipped with one or more heat generators. Boilers are space heaters which generate heat using the combustion of fossil fuels and/or biomass fuels, and/or using the Joule effect in electric resistance heating elements. Boilers heat water, providing either hot water or steam for heating. Steam is distributed via pipes to steam radiators, and hot water can either be distributed via baseboard radiators, radiant floor systems, or can heat air via a coil. Central heating boilers include boiler combination heaters which are boiler space heater also designed to provide hot drinking or sanitary water at given temperature levels, quantities and flow rates during given intervals, and are connected to an external supply of drinking or sanitary water.

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

1. Due to total energy use and scope for efficiency gains in these products, boiler standards and labels are relatively numerous, internationally. However, standards are in a state of flux, and are not easily comparable. There is a general shift away from steady state to seasonal efficiency metrics, as a result of which standards are gradually being changed.

2. The standard in India appears to be based on steady-state operation whereas the EU and the US use seasonal efficiency metrics, although they differ. China's standard is not available. Test standards for boilers in other economies have not been identified.

3. China: Article 14 of the e 1997 National Energy Conservation Law of China (revised 2008) provides the regulatory basis for mandatory energy efficiency standards for energy-consuming products and equipment. China National Institute of Standardization (CNIS) has been revising single-period mandatory energy efficiency standards and developing new standards to follow international best practice while the China Standards Certification Center has launched a new voluntary energy efficiency endorsement labeling program targeting the top 25% most efficient products. The mandatory categorical energy information label known as the China Energy Label was established in 2005. The MEPS program aims to remove the 20% least-efficient products from the markets targeted.

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

1. EU: The EU central heating boiler MEPS and labeling regulations use test standards and procedures which enable fair comparisons between the reported seasonal efficiencies of conventional and combination[2] gaseous and liquid fuel boilers, electric resistance boilers, low and (separately) high temperature electric heat pumps (air and water source), and cogeneration (or micro/mini CHP) – for products with rated (maximum) heat output not exceeding 400kW[3]. Efficiencies are based on two test points (full and 30% load), determined according to established test procedures, and manipulated to consider further variables such as type/level of control, auxiliary power consumption, and potential solar energy input, and then reported in primary energy terms.

2. US: Elements of the US boilers testing procedures were unavailable[4] for this analysis, however the calculation method includes fuel and power consumption during standby and active modes (including that related to electrical auxiliaries such as fans/blowers and/or pumps). ANSI/ASHRAE Standard 103-1993 is used to measure active mode efficiency. This document has been updated by ANSI/ASHRAE Standard 103-2007; IEC 62301 relates to the measurement of standby power.

## Notes and assumptions

No new assumptions. Test procedures differ so substantially that no meaningful assumptions regarding the comparability of these could be made within the scope of this study. Significantly more research would be needed to understand test procedure differences and whether conversion factors could be developed.

## List of sources

**EU:** Boilers Ecodesign regulation: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:239:0136:0161:EN:PDF;

Working Document, testing and calculations - boilers: http://www.eceee.org/ecodesign/products/boilers/testing_calculation_6April2011

**India:** standard: http://www.beeindia.in/energy_managers_auditors/documents/guide_books/2Ch2.pdf

**US:** Regulation http://www.law.cornell.edu/cfr/text/10/430/subpart-B/appendix-N

**China:** Testing procedures - introduction: http://www.energylabel.gov.cn/en/images/upFile/634707765374757285.pdf;

MEPS/labeling: http://www.energylabel.gov.cn/en/EnergyEfficiencyStandards/FormulationandRevisionofStandards/detail/731.html

[2] Or 'combi' boiler – which, in addition to providing space heating, has instantaneous domestic hot water functionality
[3] Labeling requirements are for products with rated output ≤70kW only
[4] I.e. those related to ANSI/ASHRAE Standard 103-1993 and IEC 62301

# Product Fact Sheet — Space and water heating: Central heating furnaces

## Table 23. Overview of Central heating furnaces

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **US** | 80% | 95% (90%) | Annual Fuel Utilization Efficiency | 10 CFR Part 430 Appendix N to Subpart B | ANSI/ASHRAE Standard 103-1993; IEC 62301 | N/A | N/A | Residential gas furnace |
| **US** | 80% gas ; 81% oil | | Thermal efficiency (full load) | 10 CFR 431.77 | ANSI Z21.47-2006 and ANSI Z21.10.3-2011 | N/A | N/A | Commercial gas and oil furnace |
| **EU** | 72% | | Seasonal space heating efficiency | EC Working Document5 | prEn1020:2007, EN1319:2009 EN 1196:2011, EN621:2009 EN 778:2009 | N/A | N/A | Liquid or gaseous fuel residential furnace |
| **Australia** | 70% | | Thermal efficiency | AS4556 | N/A | N/A | N/A | Indirect gas-fired ducted air heater |

**(*) Conversion factors**

### Product

1. Central heating furnaces fall within the broader category of space heating. In this context, space heaters are devices which provide heat to reach and maintain at a desired level the indoor temperature of an enclosed space such as a building, a dwelling or a room. Residential furnaces include gas, electric, and oil-fired furnaces. Furnaces heat air and distribute the heated air through the house using ducts.

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

1. Minimum energy performance standards are in place in the US and under development in the EU. No standards were found in other economies. The EU and the US both use seasonal efficiency metrics, albeit different ones.

[5] European Commission Working document on possible requirements for air heating products, cooling products and high temperature process chillers

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

1. Test procedures for these products are complex and could not be assessed in detail within the scope of this study. There are no available sources describing a comparison of these test procedures and a newly developed comparison would require an in-depth assessment of test protocols and results which is beyond the scope of this study.

## Notes and assumptions

**EU:** test standards relate to draft Ecodesign requirements/MEPS, but are not available.

**US:** residential furnaces: elements of the US furnaces testing procedures are not publicly available, however the calculation method includes fuel and power consumption during standby and active modes (including that related to electrical auxiliaries such as and fans/blowers and/or pumps).

ANSI/ASHRAE Standard 103-1993 is used to measure active mode efficiency. This document has been updated by ANSI/ASHRAE Standard 103-2007 – neither are available; IEC 62301 relates to the measurement of standby power and is not available.

**US:** commercial furnaces: 10 CFR 431.77 is based on ANSI Z21.47-2006 and ANSI Z21.10.3-2011 which are not available.

**Australia:** AS 4556-2011 is not freely available, however AS 4556-2000 is available: see sources below.

## List of sources

**EU:**
http://www.eceee.org/ecodesign/products/Lot21_Central_Heating_Products/resolveuid/de7c01a9779244bb81b82a3ddd68a9be

**US:** http://www.energystar.gov/index.cfm?c=furnaces.pr_crit_furnaces ;
http://www.law.cornell.edu/cfr/text/10/part-430/subpart-B/appendix-N

US DOE test procedures and regulations, Residential Furnaces.
http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/72

US DOE test procedures and regulations, Commercial Furnaces.
http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/71

**Australia:** http://www.paltech.com.au/standards/AS4556-2000.pdf

# Product Fact Sheet — Space and water heating: Other space heaters

## Table 24. Overview of Other space heaters

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **EU** | 38% to 79% dep. On types | | Seasonal efficiency | Annex III 'EU134_EN_1_1 Lot 20 Ecodesign WTO (Jul2013)' | Useful efficiency: for all other open/closed fronted appliances and cookers: EN 16510-1:2013 §7.3, A.6.2 for pellet fired appliances: EN 14785:2006 §6.4.2 , A.4.7 & A.4.8 for slow heat release appliances: EN 15250:2007-06 §6.3, A.4.6 & A.5 & A.6.2.2 | N/A | 1 | Solid fuel local space heater |
| **EU** | 42% (open fronted); 72% (closed fronted) | | Seasonal efficiency | Annex III 'EU134_EN_1_1 Lot 20 Ecodesign WTO (Jul2013)' | useful efficiency - prEN 613:2000 §7.11.2 EN 1266:2002 §6.12 & §7.12 | N/A | 1 | Gaseous or liquid fuel local space heater |
| **EU** | 36%-38.5% | | Seasonal efficiency | Annex III 'EU134_EN_1_1 Lot 20 Ecodesign WTO (Jul2013)' | IEC/EN 60335 | N/A | 1 | Electric local space heater |
| **EU** | 80%-88% | | Seasonal efficiency | Annex III 'EU134_EN_1_1 Lot 20 Ecodesign WTO (Jul2013)' | Luminous: EN 419-1; EN 419-1: Tube: EN 416-1; EN 416-2; EN 777 | N/A | 1 | Commercial local space heater (luminous or tube) |
| **US** | N/A | | Annual Fuel Utilization Efficiency | 10 CFR Part 431 | unknown | N/A | N/A | Unit heater |

**(*) Conversion factors**

## Product

1. Space heaters are devices which provide heat to reach and maintain at a desired level the indoor temperature of an enclosed space such as a building, a dwelling or a room. The products falling under “Other Space Heaters” include space heaters not covered under Central Heating Boilers and Central Heating Furnaces, as described above.

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

1. Currently, there are few standards and labels present in this product category, and few existing test standards. Notwithstanding possible regional variations in product design, this may render potential for future harmonization of test standards high, as in general these heating products make strong candidates for future minimum standards and labels.

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

1. Conversions of test procedures are not possible because test procedures are sometimes unknown, largely not aligned with international procedures and there is no comparative information available on which to base a comparison. Conversions for efficiency metrics are indicated for various products all within the EU, which uses different test procedures but ranks heating products with the same functionality on the same efficiency scale.

## Notes and assumptions

**EU:** Local space heaters (LSHs) are due to be covered by a single Ecodesign (MEPS) and a single labeling regulation which enables fair comparison between the efficiencies of the following products: open and (separately) closed-fronted LSH using solid (fossil or biomass) fuels; solid fuel cookers; open and (separately) closed fronted LSH using gaseous or liquid fuels; electric fixed, electric portable and electric storage LSHs (all ≤50kW) and; (for Ecodesign/MEPS only) commercial luminous and commercial tube LSHs (≤120kW). The labeling regulation excludes commercial LSHs. Efficiencies are based on established test procedures, and then manipulated to consider further variables such as type/level of control, auxiliary power consumption, and then reported in primary energy terms. The test standards mentioned above refer to useful efficiency tests only; tests related to power consumption, pilot flame energy consumption, etc., can be found in the 'transitional methods' WD listed in the sources section of this document (below).

## List of sources

**EU:** Local space heaters Ecodesign Working Document (January 2014): http://www.eceee.org/ecodesign/products/Lot_20_local__room_heating__products/ED_LocalSpaceHeatersFIN.pdf;

Labeling Working Document: http://ec.europa.eu/enterprise/tbt/tbt_repository/EU135_EN_1_1.pdf;

Transitional methods (test standards): http://www.eceee.org/ecodesign/products/Lot_20_local__room_heating__products/Transitional_method_local_space_heaters_postISC.pdf

**US:** http://www.law.cornell.edu/cfr/text/10/part-431/subpart-N

US DOE test procedures and regulations, residential direct heating equipment. http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/68

# Product Fact Sheet — Space and water heating: Industrial boilers

## Table 25. Overview of Industrial boilers

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **India** | | N/A | unknown | IS: 13979 (packaged boilers), possibly IS 8753 (steam boilers/ generators) | BS 845 : 1972; BS 2885 : 1974; ANSI PTC 4.1 | N/A | N/A | Industrial steam boiler |

**(*) Conversion factors**

## Products

1. Industrial boilers are used to generate steam and hot water for use in industrial processes.

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

1. Minimum energy performance standards have been considered in Australia; however, they were not adopted. India has adopted some standards for industrial boilers; however, it is unclear what exactly is regulated. The actual requirements for India are unavailable.

2. **Australia:** MEPS have been considered for industrial boilers in a recent (2010) government study. In this study, test standards AS 2593: 2004 and AS 1228-2006 were considered as candidate standards, although at that time neither contain energy performance requirements nor test methods. See sources section below.

3. **India:** has in place the Indian Boiler Regulations of industrial boilers; however it is not clear whether these regulate for minimum energy performance standards *per se*.

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

1. Only India has implemented standards for industrial boilers. These standards seem to include various aspects of product performance, possibly including energy performance.

## Notes and assumptions

No new assumptions. Given that there are standards only in India, a more detailed assessment of test procedures would not provide new information about comparability.

**India:** Indian standards IS: 13979 and IS 8753.1977 are publically available but have not been assessed (see sources, below) and international standards cited are not accessible: BS 845: 1972 is replaced by: BS 845-2:1987, BS 845-1987; BS EN 12952 1974 is replaced by: BS EN 12952-15:2003. Aspects of (or ASME) PTC 4.1 are available on line, but have not been assessed.

## List of sources

**Australia:** http://www.energyrating.gov.au/wp-content/uploads/2011/02/201009-indust-equip1.pdf ; p46 & 47

**India:** https://law.resource.org/pub/in/bis/S08/is.13979.1994.pdf - contains full test standard.

Also see http://www.beeindia.in/energy_managers_auditors/documents/guide_books/2Ch2.pdf - contains calculations; http://dipp.nic.in/boiler_rules_updated/contentsregulation.htm ; IS: 13979: https://law.resource.org/pub/in/bis/S08/is.13979.1994.pdf ; IS 8753.1977: https://law.resource.org/pub/in/bis/S08/is.8753.1977.pdf

# Product Fact Sheet — Space and water heating: Water heaters and storage tanks

## Table 26. Overview of Water heaters and storage tanks

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **India** | | N/A | unknown | unknown | IS 2082:1993 | N/A | N/A | Storage |
| **China** | 3.7 | | COP calculated, no draw-off | GB/T23137-2008; GB/T 21362-2008 | unknown | N/A | N/A | Heat pump water heater |
| **China** | N/A | N/A | unknown | CQC 2210-2009 | unknown | N/A | N/A | Storage |
| **China** | ≤1 (@≥50%) | ≤ 0.6 | Standing loss | GB/T 20289-2006 GB 21519-2008 | IEC 60335-2-21: 1997 | N/A | N/A | Electric storage water heaters |
| **China** | 84% | 86% | unknown | GB 6932 GB/T 13611 CJ/T 228 | unknown | N/A | N/A | Gas instant. |
| **China** | N/A | N/A | unknown | GB 26969-2011, GB/T 12915-1991 | unknown | N/A | N/A | Solar |
| **EU** | 30% (27%) | ηwh ≥ 163 | Efficiency (%) | Regulation (EU) No 814/2013 | EN 60379: 2004 | N/A | 1 | Instantan-eous or storage (multi-fuel incl. elec) : standards and labeling |
| **EU** | 23% (20%) | ηwh ≥ 62 | Efficiency (%) | Regulation (EU) No 814/2013 | EN 12897: 2006; EN 60379: 2004; EN 15332:2 | N/A | 1 | Storage tank: standards and labeling |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 007 | | | |
| **EU** | 30% (27%) | ηwh ≥ 163 | Efficiency (%) | Regulation (EU) No 814/2013 | EN 16147 | N/A | 1 | Heat pump WH: standards and labeling |
| **Mexico** | 84% (instant. Elec.) | | Thermal efficiency | NOM-003-ENER-2011 | ANSI-Z21.10.1 /2009; ANSI-Z21.10.3 /2004 | N/A | N/A | Residential & commercial instant., quick recovery, and storage water heater |
| **US** | Gas: For products with a Rated Storage Volume (Vs) of less than 2 gallons: EF = 0.62–(0.0019 × Vs).<br>Electric: For products with a Rated Storage Volume (Vs) of less than 2 gallons: EF = 0.93–(0.00132 × Vs). | | Energy Factor | 10 CFR Part 431.106 | ANSI Z21.47-2006, UL 727-2006 | N/A | N/A | Residential gas, electric instantaneous |
| **US** | Gas: For tanks with a Rated Storage Volume (Vs) of at least 20 and below 100 gallons: EF = 0.67–(0.0019 × Vs).<br>Oil: For tanks with a Rated Storage Volume at or below 50 gallons: EF = 0.59–(0.0019 × Vs)<br>Electric: For tanks with a Rated Storage Volume (Vs) of at least 20 and below 120 gallons: EF = 0.97–(0.00132 × Vs). | | Energy Factor | 10 CFR 430.23; 10 CFR Part 430 Appendix E to Subpart B | ASHRAE Standard 41.1-86 1986, ASTM-D-2156-80 1980 | N/A | N/A | Residential gas, oil, electric storage |
| **US** | Gas: EF = 0.82–(0.0019 × Rated Storage Volume in gallons) Elec: EF = 0.93–(0.00132 × Rated Storage | | Energy Factor | 10 CFR Part 430 Appendix E to Subpart B | unknown | N/A | N/A | Commercial gas, oil, electric instant. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Volume in gallons) | | | | | | | |
| **US** | Gas: For tanks with a Rated Storage Volume at or below 55 gallons: EF = 0.675−(0.0015 × Rated Storage Volume in gallons). For tanks with a Rated Storage Volume above 55 gallons: EF = 0.8012−(0.00078 × Rated Storage Volume in gallons). Elecl: For tanks with a Rated Storage Volume at or below 55 gallons: EF = 0.960−(0.0003 × Rated Storage Volume in gallons).For tanks with a Rated Storage Volume above 55 gallons: EF = 2.057−(0.00113 × Rated Storage Volume in gallons). | | Energy Factor | 10 CFR Part 431.106 | ANSI Z21.47-2006, UL 727-2006 | N/A | N/A | Commercial gas, oil, electric storage |
| **Australia** | N/A | | Efficiency (%) | AS 4552:2005 | unknown | N/A | N/A | Residential gas instantaneous |
| **Australia** | Max heat loss per day (kWh): 98% | | Standing loss; kWh/day | AS/NZS 4692.1 and .2 :2005, AS 1056.1-1991/Amdt 5-2005 | unknown | N/A | N/A | Residential unvented storage |
| **Australia** | N/A | | Efficiency (%) | AS1056.1 | unknown | N/A | N/A | Residential vented storage |
| **Australia** | N/A | | Efficiency (%) | AS1361 | unknown | N/A | N/A | Residential storage - 'heat exchange' type |
| **Australia** | N/A | | Seasonal | AS/NZS | unknown | N/A | N/A | Residential |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Performance<br>modelled (but not<br>reported as SCOP), no draw-off | 4234 | | | | heat pump water heater |

**(*) Conversion factors**

## Products

1. Water heaters are products that utilize oil, gas, or electricity to heat potable water for use upon demand for activities such as washing dishes or clothes, or bathing. Water heaters include storage type units that store heated water in an insulated tank and instantaneous type units that heat water on demand.

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

1. Despite the popularity of water heating standards and labels, few commonalities appear to exist as regards to their testing of efficiency. The possible exception relates to standing loses in storage water heaters/storage tanks. While the exact measurement methods for these standards have not been accessed, it is likely that they are broadly comparable. Other test methods are likely to vary widely; due to variations in draw-off regimes each economy tests its heaters to – which have a significant impact on performance.

2. **EU:** The EU standards-setting approach is broadly laid out in European Council (EC) Resolution of May 1985, which sets out the responsibilities between the EC legislator and the European standards bodies (CENELEC, CEN, ETSI), in a legal framework, allowing for the free movement of goods. The EC Directive (in this case, the Ecodesign of energy using products Directive 2009/125/EC, and Energy labeling Directive 2010/30/EU) define the essential requirements, while the European standards bodies draw up corresponding technical specifications which meet these essential requirements: thus compliance with the standards confers conformity with these requirements. Such specifications are referred to as 'harmonized standards'. A European standards adopted by CEN, CENELEC or ETSI implies an obligation to implement these standards nationally, and withdraw any conflicting standard (see sources section, below).

3. **Russia:** according to the Energy Charter Secretariat (2009; see sources below), Russia introduced a framework for energy efficiencies labeling in 1999 – standards have existed for a range of appliances for some time prior. However MEPS and labels have not been well implemented, if at all, are voluntary or lack a proper mandate, and are thought to have little impact: "GOST 51380 introduced the general requirements and the methods for the verification of energy efficiency indicators for energy consuming products listed in GOST 51388 – a manufacturer declaration, certification testing procedure and statistical data analysis."

4. **India:** India has identified water heaters as a priority for standards and labeling, however development has been stalled due to the absence of local testing facilities capable of testing to ISO standards (see sources below; India). India has a national standard body, BIS, responsible for formulating and implementing national standards, and production, quality and EMS certification.

The Bureau of Energy Efficiency is responsible (under the Energy Conservation Act, 2001) for the Standards and Labeling Program. Laboratories are accredited by the National Accreditation Board. Water Heaters ('Storage water geysers') fall under the current S&L Program. Solar water heaters are being considered for energy ('Star') labeling (See sources section, below)

5. **China:** Article 14 of the 1997 National Energy Conservation Law of China (revised 2008) provides the regulatory basis of mandatory energy efficiency standards for energy-consuming products and equipment. China National Institute of Standardization (CNIS) has been revising single-period mandatory energy efficiency standards and developing new standards to follow international best practice while the China Standards Certification Center has launched a new voluntary energy efficiency endorsement labeling program targeting the top 25% most efficient products. The mandatory categorical energy information label known as the China Energy Label was established in 2005. The MEPS program aims to remove the 20% least-efficient products from the markets targeted. See sources (esp. the LBL document) for further detail.

6. **Mexico:** NOM-003-ENER-2011relates to hot water storage, quick recovery, and instantaneous water heaters of either residential or commercial sizes. Test methods include multiple draw offs, and are publically available (see sources, below). Referenced standards include ANSI-Z21.10.1/2009, "Waters Heaters Gas. Volume I, Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less ", and ANSI-Z21.10.3/2004, "Waters Heaters Gas; Volume III; Circulating tank, instantaneous and large automatic Storage Water Heaters ".

7. **Storage tanks and storage water heaters:** according to Otago University (New Zealand, 2011) maximum standing loss limits (kWh/day) apply in the US, Canada, Australia, New Zealand and the EU – all of which are broadly comparable. However, test procedures used by each country have not been accessed and test procedure differences are known to significantly influence reported standing losses. Note however that China's standards are related to IEC 60335-2-21: 1997, which also measures standing losses of storage tanks or storage water heaters. India also has minimum standing loss requirements for water heaters, details of which are unknown.

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

1. **Heat Pump Water Heaters:** There is insufficient information to attempt developing conversion factors between standards. Key considerations include: whether and if so in what way draw-off/usage patterns are included in the test; heat-up period; consideration of standby operation; maximum single draw off (at given temperature); ambient temperatures & humidity for tests; evaporator defrost cycle; how controls and booster electric resistance heaters are treated (for more detail see SEAD report referenced below).

SEAD and CLASP recently published a study into the potential for harmonization of international test standards for heat pump water heaters. This report describes test procedure differences in more detail and discussed the potential for harmonization of test procedures. The report describes some limited comparative testing which finds that different products give extremely different result when tested with different test procedures, confirming that it is currently impossible to derive conversion factors for heat pump water heater test procedures.

## Notes and assumptions

**China:** for electric storage water heaters, reference standard IEC 60335-2-21: 1997 – which refers to standing losses and is not publicly available. China's standards are not available (in English, at least). GB/T 21362–2008 (heat pump water heaters) defines a 'Commercial & Industrial' HPWH as one with 'nominal heating capacity of 3000W and above', however residential applications may

have capacities well above 3kW. China's test standard (as with Korea's) requires no draw off test.

**Australia/New Zealand:** heat pump water heaters: AS/NZS 4234 and AS/NZS 5125 enable physical testing to determine key performance characteristics of a unit from which computer modeling is possible for a wide range of usage patterns and operating conditions. The modeled results are then used to determine efficiency/compliance with MEPS energy rating and to check whether it meets MEPS. MEPS and labeling standards are under development.

**EU:** all dedicated domestic water heaters (with a rated heat output ≤ 400 kW, including those integrated in packages of water heater and solar device), whether powered by oil, gas, electric resistance or electric heat pumps, are subject to the same MEPS and labeling requirements (and are therefore suitable for residential or commercial application). These requirements are broken down into sizes determined by a product's ability to meet various minimum usage patterns/load profiles. The test procedures allow efficiency credits for 'smart control' which enables the heater to adapt to/predict future usage when in normal use. The EU Ecodesign and labeling regulations distinguish between water heaters and storage tanks – both of which are within scope. The former (which are directly heated) are subject to operating efficiency requirements, while the latter are subject to standing loss requirements only. There are separate, but directly comparable MEPS and labeling requirements for the water heating function of combination (or 'combi') boilers.

**US:** Heat pump WH: the US (and Canadian) test method includes a single draw-off (repeated 6 times), for use in a mandatory EnergyGuide label, and for the voluntary Energy Star label (from 2015). See sources below - Heat pump water heaters. General: US test procedures are publicly available, but have not been compared with others, which are either unavailable or (e.g. EU) partially available.

**Russia:** Both minimum standards and labels exist for electric water heaters, and a label only for gas water heaters.

## List of sources

**Russia:** Energy Charter Secretariat: Policies that work; introducing energy efficiency standards and labels for appliances and equipment; p25: http://www.encharter.org/fileadmin/user_upload/document/EE_Standards_and_Labels_2009_ENG.pdf

**India:** http://www.un.org/esa/sustdev/publications/energy_casestudies/section3.pdf; p36; Institutional background: http://eneken.ieej.or.jp/data/3694.pdf

**China:** http://www.energylabel.gov.cn/en/EnergyEfficiencyStandards/FormulationandRevisionofStandards/detail/735.htm; LBL: http://china.lbl.gov/sites/all/files/china_sl_info.pdf

**India:** http://www.beeindia.in/energy_managers_auditors/documents/guide_books/2Ch2.pdf

**Mexico:** http://www.dof.gob.mx/nota_detalle.php?codigo=5203930&fecha=09/08/2011

**Australia:** http://www.energyrating.gov.au/products-themes/

**EU:** Standards setting: http://ec.europa.eu/comm/enterprise/newapproach/standardization/harmstds/index_en.html; http://www.cenorm.be/cenorm/index.htm

Water heaters regulation (MEPS):
http://www.eceee.org/ecodesign/products/water_heaters/Water_heaters_Ecodesign_Reg_814_2013.pdf; esp. annex III;

Water heaters labeling regulation:
http://www.eceee.org/ecodesign/products/water_heaters/06_Energy%20Labelling%20Water%20Heater-C%202013%20818.pdf

**US: test procedures:**
US DOE test procedures and regulations for residential water heaters.
http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/27

US DOE test procedures and regulations for commercial water heating equipment.
http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/51

**Storage tanks:** http://www.otago.ac.nz/csafe/research/otago055640.pdf

**Heat pump water heaters:** SEAD (June 2013) Heat Pump Water Heater Standards Interim Report - Final

# Product Fact Sheet – Commercial Refrigeration: Reach in coolers

*Note: The "CLASP Commercial refrigeration equipment: mapping and benchmarking" study was published after research for this report was completed. It provides a more detailed description of the comparability of reach in coolers and vending machines.*

### Table 27. Overview of Reach in coolers

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **China** | | N/A | un-known | GB/T 8059.1-1995 GB 12021.2-2008 GB 19606-2004 | unknown | N/A | N/A | Multi sector refrigerator |
| **China** | N/A | | un-known | GB 26920.1-2011 | unknown | N/A | N/A | Remote refrigerated display cabinet |
| **China** | N/A | | un-known | GB/T 21001 | ISO 23953 | 1 | N/A | Integral refrigerated display cabinet |
| **EU** | <125 | | EEI | based on ISO 23953, set out in 'CF Ecodesign Lot1isc (Jun2013)' p18 | based on ISO 23953 | 1 | N/A | Professional storage cabinet |
| **EU** | information requirements only | | EEI | set out in 'CF Ecodesign Lot1isc (Jun2013)' p18 | NF AC D40-003 | N/A | N/A | Blast cabinet |
| **EU** | N/A | | un-known | EN ISO 23953 | **ISO 23953** | 1 | N/A | Retail display cabinet |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Mexico** | vertical cooler: C = 0,2463 * ( V ) - 0,4537; horizontal cooler: C = 4,5922 * ( V ) - 1,0162; vertical freezer: C = 0,0725 * ( V ) - 0,1136; horizontal freezer: C = 0,0353 * (V) - 0,2142; bagged ice: C = 0,2245 * ( V ) - 0,5674 | | un-known | NOM-022-ENER/SCFI-2008 | Unknown | N/A | N/A | Commercial freezer |
| **Mexico** | C = 0,1555 * ( V ) - 0,2915 | | un-known | NOM-022-ENER/SCFI-2008 | Unknown | N/A | N/A | Refriger-ated cabinet |
| **US** | N/A | Refrigerator-freezers and refrigerators other than all refrigerators with manual defrost: 7.19 * AV + 202.5 | kWh/ 100 lbs. ice | 10 CFR Part 431.134; (ANSI)/(ASHRAE) Standard 29-2009, | ASHRAE 72: 2005 | N/A | N/A | Commercial freezer |
| **US** | (kWh/d, Volume) Refrigerator, solid door/s: 0.10V + 2.04; Refrigerator, transparent door/s: 0.12V + 3.34; Freezer, solid door/s: 0.40V + 1.38; Freezer, transparent door/s: 0.75V + 4.10; Fridge/freezer, solid doors: gtr of 0.27AV - 0.71 or 0.70 | | | 10 CFR Part 431.64; AHRI Standard 1200 (I-P)-2010 (post-January 1, 2016) and ARI Standard 1200-2006 (pre-January 1, 2016) | ASHRAE 72: 2005 | N/A | N/A | Refriger-ated cabinet |
| **India** | N/A | N/A | un-known | unknown | unknown | N/A | N/A | Refrigerator - multi-sector |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Indonesia** | N/A | | un-known | unknown | unknown | N/A | N/A | Refriger-ated display cabinets |
| **Australia** | Remote and self-contained must be purchased | | un-known | AS 1731.1-13:2003 | ISO 23953 | 1 | N/A | Refriger-ated display cabinets |

**(*) Conversion factors**

## Products

1. The 'Reach-in coolers' category covers a very wide range of commercial cooling products, which can vary according to ambient, storage and processing (e.g. blast cooling, pass through) conditions, use (retail or catering), enclosure shape and volume, and refrigeration system (e.g. integral or remote condenser).

2. Reach in coolers are used all over the world and range from large freezers which line supermarket aisles to the smaller fridges used for drinks etc. in smaller stores. They are non-household cabinets whose primary function is to store foodstuffs in one or more compartments or recesses accessible by reaching (but not stepping) into the cabinet, which is cooled at between -18 and +5oC, using any energy using refrigeration system.

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

1. For Reach-in coolers:
   - Over 10 separate standards are identified for retail display cases/cabinets (RDC) and commercial/professional service cases/cabinets/refrigerators/freezers (CSC) coolers, however most of the market within the scope of this study is covered by ASHRAE 72 or ISO 23953
   - AHRI standards are performance-rating standards that refer to ASHRAE 72 for the test method. These include AHRI 1200 and AHRI 1320
   - ISO 23953:2005 replaces EN441:1995 and key test methods remain the same
   - The ASHRAE standard 72:2005 combines both previous version ASHRAE 117 (open type) and ASHRAE 72 (closed) together eliminating the need for two individual standards
   - Energy Star and the California Energy Commission (CEC) refer to ASHRAE 72

2. Potential Issues for Reach-in Coolers:

The impact of key differences between ASHRAE 72 and ISO 23953 is difficult to quantify, when comparing efficiencies derived from each. A study to evaluate results with changes in key requirements would be beneficial in understanding the relative impact. This could be done first with the same sample tested utilizing each of the two key standards. Additional testing to evaluate the impact of specific criteria would also be needed. This could be accomplished with back-to-back tests while changing each of the key criteria individually. Changes equal to the maximum deviation (between the test procedures) would allow each specification to be evaluated independent of the others. Key specifications may include:

- Air velocity, direction and speed
- Ambient temperature
- Internal temperature
- Door opening frequency, duration, angle
- Loading material, number of measurement sensors, and load levels

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

1. The test procedures most suitable for comparison are ASHRAE 72 and ISO 23953 (replacing EN441). Most test parameters in these procedures are dealt with differently, which makes a conversion between the two test procedures complicated and impossible to do without further research, beyond the scope of this project.

2. The "CLASP Commercial refrigeration equipment: mapping and benchmarking" study was published after research for this report was completed. It provides conversion factors for some, but not all, types of reach in coolers discussed in this study.

## Notes and assumptions

**China:** Refrigerated display cabinets: RDCs with remote condensing units are tested according to GB 26920.1-2011 – where no association with the ISO standard is noted: however the test standard GB/T 21001.2—2007 for other RDCs is associated with ISO 23953 (the exact relationship is unclear due to language differences) – we assume therefore that this correlation relates to integral ('plug in'/self contained) RDCs only. GB/T 21001 also draws upon other standards for RDCs, including Australia's AS1731.14 and the US' ARI Standard 1200 (see sources section).

**EU:** Retail display cabinets: this regulation is in draft form, and it remains unclear how the efficiencies of these products will be calculated.

**US:** refrigerated freezers and cabinets: reference standard ARI Standard 1200– 2006 is available but has not been assessed.

**Indonesia**: the table entry is from the CLASP database. Indonesia has a MEPS and labeling product which covers 9 products (as at 2011), none of which cover commercial refrigeration. Standards are set by the National Standardization Agency and are based on Indonesia National standards (SNI): All of the 9 products currently regulated use SNI methods based on either EIC or ISO standards – indicating a strong preference for harmonized standards.

**South Africa:** SANS 60335-2-89(2003): part 2-89: stipulates particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or compressor, however the details are unknown: It is likely that this standard is a replication of IEC/EN 60335. Both standards appear to relate to safety requirements only.

## List of sources

**General:** CLASP; (2012) Scoping Study for Commercial Refrigeration Equipment Mapping and Benchmarking

CLASP (2014) CLASP Commercial refrigeration equipment: mapping and benchmarking
http://www.clasponline.org/en/Resources/Resources/PublicationLibrary/2013/SEAD-Analyzes-Potentials-for-HPWH-International-Test-Standard-Alignment.aspx

**China:** Refrigerated display cabinets: http://219.238.178.49/FileServer/Attach/L03729.doc; relationship between GB/T 21001, ISO 23953 Australia's AS1731.14 and the US' ARI Standard 1200: http://www.puntofocal.gov.ar/notific_otros_miembros/chn793s1_t.pdf

**EU:** professional storage cabinets, blast cabinets: European Commission Working Document "'CF Ecodesign Lot1isc (Jun2013)"

**EU:** retail display cabinet: http://www.eceee.org/ecodesign/products/commercial_refrigerators_freezers/DraftWD_V1_CF23April2010 for sale (2012 edition)

**Mexico:** refrigerated cabinets: 'SEAD (2013) Evaluation of Commercial Refrigeration Test Methods_Final Report' p20

**US:** refrigerated freezer, cabinet: 10 CFR Part 431.64 and 10 CFR Part 431.134 respectively

**Australia:** refrigerated display cabinets: 'SEAD (2013) Evaluation of Commercial Refrigeration Test Methods_Final Report' p18

**Indonesia:** GEF report: http://www.thegef.org/gef/sites/thegef.org/files/documents/document/11-19-2012%20Council%20document.pdf ;

Agency, products covered: http://eneken.ieej.or.jp/data/4064.pdf ; p36

**South Africa**: http://www.gov.za/documents/download.php?f=64861 ; p5

# Product Fact Sheet — Commercial Refrigeration: Refrigerated vending machines

*Note: The "CLASP Commercial refrigeration equipment: mapping and benchmarking" study was published after research for this report was completed. It provides a more detailed description of the comparability of reach in coolers and vending machines.*

### Table 28. Overview of Refrigerated vending machines

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **EU** | N/A | | Unknown/ under developme nt | EVA: Test Protocol for the Measurement of Energy Consumption in Vending & Dispensing Machines, Version 3.0 | unknown | N/A | N/A | Vending Machine - voluntary labeling |
| **Australia** | N/A | | kWh/ 300 cans/ day | AS/NZS 4864.1 | **ASHRAE 32.1 (2004)** | 1 | | |
| **US** | Type A: 0.055 × V + 2.56<br>Type B: 0.073 × V + 3.16 | 0.45 [8.66 + (0.009 x C)] | kWh/ 300 cans/ day | 10 CFR Part 431 Subpart Q, 10 CFR Part 431.294; | ASHRAE 32.1 (2004) | 1 | | |

**(*) Conversion factors**

## Products

1. Refrigerated vending machines are commercial refrigerated cabinets designed to accept consumer payments or tokens to dispense chilled or frozen products without on-site labor intervention. Vending machines are most often plug-in appliances. There are three main types: can, drum and spiral. The prevalence and functionality of these types varies by economy

2. Refrigerated beverage vending machines (regulated in the US), for example, dispense cooled bottles or cans of beverages, and some of these machines also dispense other merchandise. Refrigerated beverage vending machines are installed inside or outside of commercial, residential, and public establishments, such as gas stations, hotels and motels, apartments or dormitories, and government buildings.

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

1. MEPS and mandatory labeling is currently under consideration in the EU (the EVA offers a

voluntary label), while in the US and Australia, the voluntary ENERGY STAR label is available. The US has MEPS in place, and Australia (in conjunction with New Zealand) is considering MEPS. In addition to the economies above, standards and/or labels are present in Japan and Canada.

2. A detailed comparison of test procedures is made in the SEAD (2013) report on test methods for commercial refrigeration products (see sources section, below).

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

1. Australia: The ASHRAE 32.1 test standard and AS/NZ 4864.1:2008 require a different test temperature and humidity depending on whether the product is intended for indoor or outdoor use.

2. US and Australia: The metric kWh/ 300 cans/ day applies to drink machines only. The energy efficiency of snack/drink machines may be either in kWh/l of refrigerated volume per day, or in kWh/300 snack items per day, depending upon which capacity metric is available.

3. EU: harmonized test methods for proposed Ecodesign/MEPS have yet to be finalized. It is likely that they will be based on the test method developed/used by the European Vending Machine Association (EVA EMP 3.0A & 3.0B)

4. The "CLASP Commercial refrigeration equipment: mapping and benchmarking" study was published after research for this report was completed. It confirms that conversion factors for vending machines cannot be established with currently available information.

### Notes and assumptions

The 2013 SEAD comparison of vending machine test procedures does not produce conversion factors. It concludes "There are small differences in the test procedure and duration; however these are unlikely to have a significant impact on the comparability of results". Differences include variations in the 'standard package' used for tests, indoor vs. outdoor ambient conditions, type and position of internal/storage temperature measurement. However the IEA's 4E vending machine mapping document (see source below) reports EVA- tested consumption data normalized to the ASHRAE 32.1 standard. This was achieved by assuming a 3% increase (or reduction) in energy consumption for every 1oC increase (or reduction) in the difference between the storage and ambient temperatures at which the product is tested.

### List of sources

**Detailed comparison:** SEAD (August, 2013); Technical evaluation of national and regional test methods for commercial refrigeration products; final report: http://www.superefficient.org/~/media/Files/SL%20Project%20Reports/SEAD%20Evaluation%20of%20Commercial%20Refrigeration%20Test%20Methods_Final%20Report.xls ;

CLASP (2014) CLASP Commercial refrigeration equipment: mapping and benchmarking http://www.clasponline.org/en/Resources/Resources/PublicationLibrary/2013/SEAD-Analyzes-Potentials-for-HPWH-International-Test-Standard-Alignment.aspx

**IEA (2012):** 4E vending machine mapping reports (separately: Australia; EU, US): http://mappingandbenchmarking.iea-4e.org/matrix

**Australia:** IEA 4E Vending – Australia; CLASP (Klinckenberg, Puddle) (2012); Scoping Study for Commercial Refrigeration Equipment Mapping and Benchmarking

**US:** Market and technology assessment: https://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/bvm_final_fr_tsd_chapter_3.pdf ‘ CLASP (Klinckenberg, Puddle) (2012); Scoping Study for Commercial Refrigeration Equipment Mapping and Benchmarking

# Product Fact Sheet — Commercial Refrigeration: Walk-in cold rooms

## Table 29. Overview of Walk-in cold rooms

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **EU** | 0.35 medium temp ; 0.2 low temp | | U value / ψ value / x value | References of ETAG016 and EN14509 (to be translated into EN standard); | none | N/A | N/A | Walk in cold room |
| **US** | Too detailed | | U value, door closers/similar; motors/fans; anti-sweat control; lighting | ANSI/AHRI Standard 1250P (I-P) (2009) | ASTM C1363-05; NFRC-100 - 2010; DIN EN 13165:2009; DIN EN 13164:2009 | N/A | N/A | Walk in cooler |
| **Australia** | 0.22 [4.5] / 1.67 [6.0] | | U value/R value; motors/fans; anti-sweat control; lighting; seals & air tightness; defrost control; compressor efficiency | unknown | unknown | N/A | N/A | Walk in cold room |

**(*) Conversion factors**

### Products

1. Walk-in cold rooms temporarily store refrigerated or frozen food or other perishable goods and are used primarily in the food service and food sales industry. They are commercial enclosed storage spaces that can be walked into, and generally do not include products designed and marketed exclusively for medical, scientific, or research purposes.

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

1. The US is the only economy with MEPS in place: EU requirements are under development and Australia and New Zealand (jointly) have initial proposals. There are significant challenges associated with applying MEPS and/or labeling to these ‘products’. They vary greatly in size, level of customization and on-site assembly, and operating conditions (ambient and cooling temperatures, humidity, frequency of use). Efficiency gains cannot easily be captured in a single metric, and so tend to be dealt with elementally: levels of insulation, thermal bridging and air tightness; lighting and control; refrigeration plant (which comes in various configurations) — all of which render comparison and harmonization of test standards more challenging.

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

1. **EU:** Maximum heat transmission values for products sold as pre-assembled insulated envelopes or as prefabricated kits are likely to be determined by ETAG021 Guideline for European technical approval of cold storage premises kits, to be translated into an EN standard. Current standards being considered: EN ISO 10211 and prEN ISO 14683 are at this stage considered appropriate standards for thermal bridge (ψ and x values) measurement. U values for customized walk-in cold rooms are likely to be determined by ETAG016 and EN14509 (updated and translated into suitable harmonized standards for the purpose of the Ecodesign regulation). EN 13829 and EN ISO 12569 are considered candidate procedures for testing air permeability (see ETAG 021 document, listed in sources section below).

2. **U values:** EU and US U-value test methods have not been accessed, but it is likely that these values are broadly comparable.

## Notes and assumptions

**EU:** Proposals exclude consideration of the cooling plant - central refrigeration equipment (e.g. compressor racks) or mono-block units. The EC is considering separate Ecodesign/MEPS proposals for remote condensing units[6], which may be used in conjunction with walk in cold rooms.

**Australia:** There is a proposal from the Equipment Energy Efficiency Committee (E3) of the Australian and New Zealand Ministerial Council on Energy to regulate elemental parts of WIC systems

## List of sources

**EU:** EC Working Document: 'Part 3 - WICR official Dec 2011'; http://www.eceee.org/ecodesign/products/cold_appliances/resolveuid/f637ba6a01d377d7c3588899da91759c TAG 021 document; http://www.ue.itb.pl/files/ue/ETAG021_1.pdf (esp. p33); CLASP; (October, 2012) Scoping Study for Commercial Refrigeration Equipment Mapping and Benchmarking Project

**US:** http://www.law.cornell.edu/cfr/text/10/431.64 refers to the ARI standard; http://www.gpo.gov/fdsys/pkg/PLAW-110publ140/pdf/PLAW-110publ140.pdf

**Australia:** '200912b-in-from-the-cold-technical-vol2 WICRs…' p23

[6] Defined as "a piece of refrigeration equipment including at least one compressor and one condenser placed on the EU market as a package and intended to provide cooling to at least one refrigeration appliance or system"; ref: (includes draft MEPS) http://www.taitconsulting.co.uk/Ecodesign_Consultation_files/Adhoc%20Questionnaire_Condensing%20units_intro_2012-04-04.pdf

# Product Fact Sheet — Cooking products: Residential cooking appliances

## Table 30. Overview of Residential cooking appliances

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **Australia** | N/A | | unknown | AS 4551 (AG 101) | unknown | N/A | N/A | Cooktops and Ranges/ Ovens |
| **China** | N/A | N/A | unknown | GB 4706.29-2008 GB 4706.22-2008 GB 21456-2008 | unknown | N/A | N/A | Cooktop/Hob |
| **China** | 82%/5W | 90%/2W | Heat Efficiency Value (%)/standby power (W) | GB 21456-2008 | unknown | N/A | N/A | Induction cooker |
| **China** | N/A | | unknown | GB 4706.22<br>GB24849-2010 | IEC60705 ("the old one") | N/A | N/A | Microwave oven |
| **Russia** | N/A | | kWh | GOST 14919-83E (general); GOST 28398-89 (performance) | IEC 60350-71 | N/A | N/A | Electric cooking plates, electric ovens |
| **Russia** | N/A | | unknown | GOST R 51388-99 | IEC 60705 | N/A | N/A | Microwave oven |
| **Russia** | N/A | | Efficiency index (%) | GOST R 50696-2006 | EN 30-2-1:1998 | N/A | N/A | Gas burners: EN 30-2-1:1998 (is now 2003) |
| **US** | 1 W - 2.2. W | | Watts | 10 CFR 430.23(i) | Linkages to IEC 705, IEC 60705 ; IEC 62301 Edition 2.0 | N/A | N/A | Microwave oven |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 2011-01 (standby power) | | | |
| **US** | | ≥50%/ <9000 btu/h<br>≥50%/ <12000 btu/h<br>≥80%/ <1000W<br>≥80%/ <1100W | Heavy load cooking energy efficiency (%)/Idle energy rate (Btu/hr - gas, W - elec) | ASTM Standard F1361-99 | unknown | N/A | N/A | Fryer |
| **EU** | <120 | | EEI & m3/h | 2013.06.04 Ecodesign Regulation | unknown | N/A | N/A | Residential range hood |
| **EU** | N/A | | unknown | unknown | Possibly EN 60705/ IEC 60705 | Un-known - assumed close to 1 | N/A | Residential microwave ovens |
| **EU** | 0.716 kWh/ cycle; 313.5 | | unknown | 2013.06.04 Ecodesign Regulation | unknown | N/A | N/A | Residential cooktop/hob |
| **EU** | <146 | | kWh/y | 2013.06.04 Ecodesign Regulation; EN 50304:2009 | IEC 60350:1999 (MOD) + A1:2005 (MOD) + A2:2008 (MOD) | N/A | N/A | Residential oven |

**(*) Conversion factors**

## Product

1. Residential cooking appliances cook or heat food by means of gas, electricity, or microwave energy. These products are used primarily in homes and apartments. They include kitchen ranges and ovens (including conventional ranges, conventional cooking tops, conventional ovens, microwave ovens, and microwave/conventional ranges) and rice cookers, among others.

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

1. Standards are in place in Australia, Brazil, China, the EU, Mexico, the US and Russia – although those in Russia may not be well enforced. The EU is currently developing standards for microwave ovens. In general, where reference standards are referred to, the underlying test

methods have not been available and therefore conversion is not possible.

## Notes and assumptions

1. **EU:** the cooktop/hob and oven requirements are found in a single regulation - (EU) No 66/2014

2. **Microwave ovens:** whilst the exact relationships between the test standards used in US, EU, Brazil and Russia have yet to be determined, it is clear that all have, or will have at least some similarities with the IEC 60705, and therefore with each other - providing scope for comparison. However; most national test standards - and IEC 60705 - are not freely available.

3. **Rice Cookers:** a 2011, GEF-funded working group found significant differences between the rice cooker test procedures of Hong Kong, South Korea, Thailand and Japan (the study evidently excluded Indonesia): see List of Sources below.

4. **China:** cook top/hob: GB 4706.29-1992 appears to relate to safety standards only (http://www.cn-standard.net/qtweb/debzfy/debzdetail/C4E/657DD68D.shtml)

5. **China:** general: no linkages have been found between national standards (the details of which are unavailable) and international standards.

6. **Mexico:** tortilla making machine: Mexico's national standard NOM-019-ENER is the only known standard for this product (the details of which have not been analyzed).

7. **Russia:** Russia has in place minimum energy performance standards for household electric cooking ranges, cooking plates and cooking ovens, via regulation GOST 14919-83E, last amended in March, 1999. Standards for electric cooking ranges, hobs, ovens and grills are based on the international test standard IEC 60350-71, which is not freely available and has not been analyzed. A mandatory comparative label is effective, for kitchen stoves/ranges – the details of which are unknown.

8. **Russia:** Microwave ovens may subject to a mandatory, comparative (A-G) labeling regulation GOST R 51388-99, last known to be in draft form, referencing international test standard IEC 60705 , which is not freely available and has not been analyzed.

9. **Russia:** Gas Burners are subject to minimum energy performance standards via regulation GOST R 50696-2006, based on the test standard EN 30-2-1:1998 (subsequently updated to 2003).

10. **US:** microwave ovens: includes the measurement of standby mode and off mode energy use. The Department of Energy is responsible for assessing and determining appropriate cooking appliance test standards; standards are under development.

11. **EU:** Ecodesign and labeling regulations are under development for microwave ovens, domestic ovens, hobs and range hoods. Microwave ovens. It s is likely that related test procedures will at least reference EN/IEC 60705 . Domestic ovens (including when incorporated in cookers), domestic hobs and domestic electric range hoods, also when used for non-domestic purposes: Ecodesign requirements were adopted in July, 2013 and labeling requirements were adopted in October 2013. Test standards are determined via European Commission-appointed Working Groups, typically comprising experts representing industry and Member States. Further information on Ecodesign test standards is available in published Working Documents (see references section, below).

## List of sources

**Rice cookers:**
https://www.google.co.nz/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&ved=0CCoQFjAA&url=http%3A%2F%2Fwww.stc-group.org%2Fen%2Fserviceshow.aspx%3Fpcl1_id%3D57%26pcl2_id%3D5%26p_id%3D180&ei=HyvnUpa7JcubiQeY4ICADg&usg=AFQjCNESpPoAWMwuxFq-Wu9pNVJe4afx0Q&sig2=KCK6-MjJaBN427q96AYYbw ; p16, 107

**China:** cooktop/hob:
http://www.clasponline.org/en/Tools/Tools/SL_Search/SL_SearchResults/SL%20Detail%20Page?m=30694ea3-8431-4a0c-b4d0-052dc823d77c.

**China:** Induction cooker:
http://www.energylabel.gov.cn/en/EnergyEfficiencyStandards/FormulationandRevisionofStandards/detail/724.html

**China:** microwave oven:
http://www.energylabel.gov.cn/en/LabelNews/LabelRelatedActivities/detail/743.html

**EU:**(EU) No 66/2014 Ecodesign requirements for domestic ovens, hobs and range hoods :
http://www.eup-network.de/fileadmin/user_upload/2013.06.04_Ecodesign_Regulation.pdf

**EU:** http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2014:029:0033:0047:EN:PDF

**Russia:** electric cooking plates, electric ovens.
http://www.personal.ceu.hu/students/03/Alexandra_Novikova/Standards/MEPS/Ranges_electric/GOST_14919_83.html

**Russia:** gas burners:
http://www.personal.ceu.hu/students/03/Alexandra_Novikova/Standards/MEPS/Gas_cookers/GOST_50696_2006.html

**Russia:** microwave ovens:

http://www.personal.ceu.hu/students/03/Alexandra_Novikova/Standards/Labeling/Microwave/microwave_ovens_mandatory_labeling.html

**US:** microwave ovens: http://www.regulations.gov/#!documentDetail;D=EERE-2011-BT-STD-0048-0027

Other: http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/57

# Product Fact Sheet — Cooking products: Commercial cooking appliances

## Table 31. Overview of Commercial cooking appliances

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **EU** | N/A | | EEI | See Working Document (sources section, below) | unknown | N/A | N/A | Commercial electric oven |
| **EU** | N/A | | EEI | | unknown | N/A | N/A | Commercial gas oven |
| **EU** | N/A | | EEI | | unknown | N/A | N/A | Commercial electric & gas hobs |
| **US** | | ≥70%/1.0kW<br>≥70%/1.6kW<br>≥44%/13000 btu/h | Cooking energy efficiency(%)/Idle energy rate (kW) | ASTM F1496 | unknown | N/A | N/A | Commercial convection oven |
| **US** | | 50%/400W<br>50%/530W<br>50%/670W<br>50%/800W | Cooking energy efficiency (%)/Idle rate (W) | ASTM Standard F1484-99 | unknown | N/A | N/A | Commercial electric steam cooker |
| **US** | | 38%/6250<br>38%/8350<br>38%/10400<br>38%/12500 | Cooking energy efficiency (%)/Idle rate (Btu/h) | ASTM Standard F1484-99 | unknown | N/A | N/A | Gas steam cooker |
| **US** | | ≥70%<br>< 33 watts/$m^2$ (355 watts/$ft^2$)<br>≥38% | Normalized Idle Energy Rate Btu/h per $m^2$ (Btu/h per $ft^2$) | ASTM F1275; ASTM F1605 | ASTM F1275; ASTM F1605 | N/A | N/A | Griddle |

**(*) Conversion factors**

## Product

1. Commercial cooking appliances include kitchen ranges and ovens (including conventional ranges, conventional cooking tops, conventional ovens, microwave ovens, and microwave/conventional ranges). Cooking products cook or heat food by means of gas, electricity, or microwave energy. These products are used primarily in commercial settings.

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

1. Cooking products is an emerging area for standards and labeling globally, thus there is little evidence of harmonized test procedures for these products. The US is the only economy where commercial cooking equipment MEPS are currently in place. EU MEPS are in draft form.

2. **US:** no relationship has been found between US standards and standards potentially used in other economies.

3. **EU:** Ecodesign and labeling requirements apply to domestic ovens (including when incorporated in cookers), domestic hobs and domestic electric range hoods, also when used for non-domestic (commercial) purposes: These Ecodesign requirements were adopted in July, 2013 and labeling requirements were adopted in October 2013.

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

Conversions have not been attempted due to a lack of information.

## Notes and assumptions

No new assumptions. Test procedures differ so substantially that no meaningful assumptions regarding the comparability of these could be made.

**EU:** The table above provides standards for dedicated commercial cooking equipment, and for so-called residential equipment, that may nonetheless be applied commercially. The former are in draft form, while the latter have been implemented. The EU uses test standards for safety and for measuring the performance of commercial gas stoves (EN 203-2-1:2005) and domestic gas stoves (EN 30-2-1: 1998/A2: 2005).

## List of sources

**US**: microwave ovens: http://www.law.cornell.edu/cfr/text/21/1030.10; ASTM standards are not freely available

**EU**: Commission Working Document on possible Ecodesign Requirements for domestic and commercial ovens, hobs, grills and domestic range hoods: https://www.energimyndigheten.se/Global/F%C3%B6retag/Ekodesign/Produktgrupper/ugnar/WD%20Kitchen%20appliances%20Ecodesign%20Regulation%20for%20CF%20final%20(2).pdf;

Gas stoves (p26): http://china.lbl.gov/sites/all/files/pc_gas_stove_0.pdf (p26)

# Product Fact Sheet — Cooking products: Coffee makers

## Table 32. Overview of Coffee makers

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **EU** | Standby: 1 Watt | | Watts — standby | EN 50564:2011; | **IEC 62301: 2011 (modified)** | N/A | N/A | Domestic (non-tertiary_ coffee machines - MEPS |
| **Australia** | Standby:1-2.5 Watts | | Watts — standby | unknown | unknown | N/A | N/A | |

**(*) Conversion factors**

## Product

1. There are several types of coffee maker: the most common products are filter coffee machines and espresso machines. Besides the principle of operation, these products are differentiated mainly by their constituent materials. The filter coffee machines usually have a glass bowl, while the espresso machines contains a larger amount of ferrous materials. Both types of products generally contain an electrical system for heating water, a pump, a housing (typically including the water tank) and a percolation system.

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

1. Minimum efficiency standards of coffee machines are in place in the EU and are being formally considered in Australia. Labeling is being formally considered in the US.

2. EU: non-tertiary coffee machines are regulated via a standby power minimum energy performance measure

3. US: ENERGY STAR has produced a scoping study considering labeling of US coffee machines (see reference section below).

4. Australia: a scoping paper considering MEPS has been published by the Australian Greenhouse Office.

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

1. **US:** ENERGY STAR: the scoping study referenced below identifies several test procedures used internationally, including IEC 62301 Household Electrical Appliances — Measurement of Standby Power — standard is not freely available.

2. **EU:** Ecodesign proposal relates to standby energy consumption only. Based on the abstract describing EN 50564:2011, it appears that the underlying standard is IEC 62301: 2011 (modified), however the exact conversion remains unclear – both standards are not freely available.

3. **Australia:** the Australian Greenhouse Office has produced (2004) proposals for the standby energy consumption of espresso coffee machines.

## Notes and assumptions

**EU:** other known (but unavailable) test standards include:
EN 60661:2001 (pr=13638) – Methods for measuring the performance of electric household coffee makers;
EN 60661:2001/A1:2003 (pr=14420) - Methods for measuring the performance of electric household coffee makers; and
EN 60661:2001/A2:2005 (pr=16388) - Methods for measuring the performance of electric household coffee makers (see source below).

## List of sources

**US:** ENERGY STAR:
http://www.energystar.gov/ia/products/downloads/ENERGY_STAR_Scoping_Report_Coffee_Makers.pdf?ccc3-34cd ; p5

**EU:** Test method: http://www.eup-network.de/fileadmin/user_upload/Standby_measuring_method.pdf ;

Regulation: http://www.eceee.org/ecodesign/products/Lot25_non_tertiary_coffee_machines ;

Description of EN 50564:
http://www.cenelec.eu/dyn/www/f?p=104:110:5627405059370752::::FSP_LANG_ID,FSP_PROJECT:25,22637 ;

EN 60661:
http://www.cenelec.eu/dyn/www/f?p=104:22:2540179775577250::::FSP_ORG_ID,FSP_LANG_ID:114,25#2

**Australia:** http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Product_Profiles/Other/Coffee_Machines/sb200408-espresso.pdf

# Product Fact Sheet — Motors, pumps and fans: Motors

## Table 33. Overview of Motors

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **China** | IE2 (Grade 3) | IE4 | Efficiency (%) | GB/T series | **IEC60034-2-1** | 1 | 1 | |
| **Europe** | IE2 0.75 - 375kW | | Efficiency (%) | | IEC60034-2-1 | 1 | 1 | |
| **Mexico** | IE3 | IE4 | Efficiency (%) | NOM 014/16 | IEC60034-2-1 | 1 | 1 | |
| **US** | 1 - 200hp NEMA Premium Efficiency (Equivalent to IE3) & 201 - 500hp IE2 | | Efficiency (%) | IEEE Std112 | IEC60034-2-1 | 1 | 1 | |
| **India** | IE3 | IE4 | Efficiency (%) | | IEC60034-2-1 | 1 | 1 | |
| **Australia** | N/A | IE4 | Efficiency (%) | AS/NZS 1359.5 | IEC60034-2-1 | 1 | 1 | |

**(*) Conversion factors**

### Product

1. Electric motors convert electrical energy to rotating mechanical energy. When operating, the electrical energy is transferred as useful mechanical energy to some driven device such as a fan, pump, blower, compressor, or conveyor.

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

1. In summary, all motor test methods give results that for the purposes of this exercise (which is intended to be used at a macro-level and not for individual conversion) are very similar indeed and any differences can be neglected. The same is not necessarily the case on an individual motor basis.

2. There have been great efforts by the IEC to harmonize global motor test methods, culminating in the 2007 revision of the key standard IEC 60034-2-1. This was long overdue, as different global regions have, in the past, used significantly different test methods, not allowing comparison between motors tested to different standards. The US and Canada have always used the direct torque output;input method, Europe and many other IEC Countries have used the Summation of losses method. Japan used another method that gave yet different results, but no longer do so. This led to the IEC60034-2-1 2007 standard, which actually presents and in some cases updates a total of 10 methods that are in use. However, only 3 of these are used for regulatory work, one of which (summation of losses with assigned losses) is now effectively obsolete. Others are either of academic interest, or are too expensive for regular use (the calorimetric method). Critically it pronounces the uncertainty associated with each method (low to high), and states which is the preferred method for different motors. For the induction motors that are of most concern to

regulators, there are two methods, according to size. The current situation is that North America is still not ready to align with the IEC preferred methods, instead using the direct torque method for some sizes. The method for achieving this as stated in IEC60034 is very similar to that used in US IEEE112B, with just a minor correlation factor difference (ref Electrical Energy Efficiency, 2012, Sumper and Baggini).

3. The practical implications of this are that a manufacturer can use whatever method they like, but the regulator will specify what they will assess the motor by, and so it makes sense for the manufacturer to follow this specification. Meanwhile, Australia (alone) has MEPS listed for both standards.

4. The focus of efforts is on the induction motor, where the summation of losses method is preferred for all 3-phase motors above 1kW, and which use the bulk of energy

5. This is reflected in the fact that to date it is only these motors that have applicable MEPS. But smaller motors, such as used in appliances, will rarely be this type, and so should be tested by the output:input method for two reasons: This method is accurate in small sizes, and the alternative summation of loss method will anyway not work with anything other than three phase induction motors. This means that while the summation of losses method is more accurate in larger sizes, the output:input method will always be needed, and so cannot be abolished in pursuit of harmonization.

6. This essential co-existence is making it easier for the output:input method to still be used in size regions where is not the preferred method. From the User's perspective it does not matter in that either method will give a low uncertainty, but for the manufacturer it means testing to both standards, and each Regulator has to nominate the test method to be used. Efforts to gain a single global approach are ongoing in medium to large induction motors, but for other motors it is still early days and so no consensus has yet emerged.

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

1. As mentioned above, in summary, all motor test methods give results that for the purposes of this exercise are very similar indeed, and for most purposes any differences are not significant. All regulations are based solely on the full load performance.

2. For induction motors, the IEC 60034-2-1:2007 Summation of Losses Method is used in most countries, and is becoming increasingly popular. The other method used almost exclusively in the US is standard 10CFR part 431, which gives very similar results.

3. For new types of motor (non-induction motors) these methods can not be used, and so output:input methods are used instead. Again, IEC 60034-2-1:2007 is the most popular standard, with the output:input method being specified. Similarly the US uses a different standard IEEE112B:C Method A, which gives very similar results to the IEC standard.

4. Note that it is not mathematically possible to convert the efficiency measured with one method to give its equivalent value measured with a different method. Though the results obtained will be very similar.

5. Looking ahead, it is expected that part load efficiency of motors will also be recorded, and might possibly be used for regulatory purposes. In addition, methods for assessing the losses of motors under variable speed drive control are being developed, and so should also be considered as a possible future information requirement.

6. There are two labeling schemes in existence, with the IE scheme created by IEC, and the other scheme a US only NEMA scheme. These are now harmonized to have the same levels of efficiency.

| IEC Designation | Similar to NEMA class |
|---|---|
| **IE1** | Standard efficient |
| **IE2** | Energy efficient |
| **IE3** | Premium |
| **IE4** | Above premium |

## Notes and assumptions

None other than as described above.

## List of sources

Relevant IEC standards http://www.motorsystems.org/iec-standards

Review of test methods and MEPS:
http://www.eemods2013.org/paper/Oct30/Session%208.c/Papers/045_Angers_finalpaper_EEMODS13.pdf

http://www.motorsummit.ch/data/files/MS_2012/presentation/ms12_yuejin_update.pdf

IEA Motor Policy publication:
http://www.motorsystems.org/files/otherfiles/0000/0101/iea_falkner_holt_2011.pdf

# Product Fact Sheet — Motors, pumps and fans: Pumps

## Table 34. Overview of Pumps

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **Pumps** | | | | | | | | |
| **China** | N/A | N/A | GB 19762-2007 GB/T 3216 GB/T 5657 GB/T 7021 GB/T 13006 | ISO9906 | **ISO9906** | 1 | 1 | China and Europe metrics based on similar principles but the conversion varies with type and size of pump |
| **Europe** | MEI = 0.1 | | EUP Directive (MEI) | ISO9906 | ISO9906 | 1 | 1 | |
| **US** | N/A | | | ANSI 14.6-2011 | ISO9906 | 1 | 1 | |
| **Pump + Motor combinations** | | | | | | | | |
| **Mexico** | N/A | N/A | NOM-00X-ENER | ISO9906 | **ISO9906** | 1 | 1 | |
| **India** | | N/A | IS 11346:2004 | ISO9906 | ISO9906 | 1 | 1 | |
| **US** | | | ANSI 14.6-2011 | ISO9906 | ISO9906 | 1 | 1 | |
| **Circulators** | | | | | | | | |
| **Europe** | 0.27 | | EUP Directive | ISO9906 | **ISO9906** | 1 | 1 | |

**(*) Conversion factors**

## Product

1. Pumps are used in agriculture, oil and gas production, water and wastewater, manufacturing, mining, and commercial building systems. The primary functional parameters of pumps are: rated flow, head, and fluid properties.

2. Pumps contain motors. The boundaries of a system can be defined depending on how the pump and motor are manufactured. Where the motor can be removed and tested separately, the pump and motor are considered separate products. Where they cannot be easily separated they can be considered as an integral product.

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

1. Pumps are all tested to ISO9906, and only the Best Efficiency Point performance is included. The derivation of target efficiencies for a particular head:flow duty is complicated, but the different methods give similar values.

2. Where pumps are tested with their driving motor, then the target efficiency values will be shaped by the combination of pump efficiency and motor efficiency, both of which vary with size but in different ways. The results of pumps tested with and without their motors cannot be compared.

3. The central heating Circulator is used mainly in Western Europe, and uses an Extended Product Approach based on the Blue Angel time flow distribution. The regulation includes the complete pump+motor+control. There are currently no other test standards for these products.

4. The EU or China methods alone are probably the most appropriate for pump alone efficiencies.

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

1. The under-lying test methods for the hydraulic (wet end) are effectively identical. ISO9906 is used widely, with the exception of US that uses ANSI/HI 14.6 – 2011. This is functionally equivalent, and was just published due to delays in the ISO standard being published. ISO9906 is the method for measuring the pump efficiency only. Please note that ISO9906 was revised in 2012, not all regulations may have caught up with this yet.

2. There are several metrics that can be, and are, used with pumps:

- Pump (hydraulics only). This method is used by EU and China, and allows for more accurate setting of MEPS values, as it can separate the motor MEPS and pump MEPS. This is important because the same kW rating of pump will have different MEPS rating according to the duty (head and flow). Note that the same pump will have a different MEPS value according to the speed, as specific speed considerations will mean that it is inherently better at some speeds than others. Even taking this into account, the China standard GB 19762-2007 gives MEPS efficiency levels typically >5% higher efficiency than for the EU MEPS for the same pump. This also means that pump-set (motor + pump) efficiency values do not have to be altered should the motor efficiency regulations change. There are different ways of defining metrics, and so they will not be compatible, although in theory they could possibly be converted by an expert.
- The counter-argument is that most pumps are sold to the end user with a motor, and so it makes sense to reflect this in the information given. However, this then shifts responsibility for compliance to the systems integrator, who may not have the will or knowledge to apply any regulations properly.
- The most advanced methodology is based on what Europump call the "Extended Product Approach", and this considers the performance of the pump + motor + controls over a representative load profile. This hinges on being able to define an agreed standardized load profile that is typical of real life operation, but this has already been achieved by the European Circulator regulations. It is not possible to simply add the load profile factor to the motor+pump performance, as this neglects any controller losses and critically the performance at part load. Europump is currently working on a methodology (SAM = Semi Analytical Method) that will allow the prediction of part load performance, but this is still under development.

3. All countries appear to use ISO9906 for testing of the pump efficiency. However, there are various "acceptance grades" (tolerances) specified in here, and it is for the local regulator to specify which shall be applied.

4. The current situation is therefore that these metrics do not allow for simple conversion between them, but can be "unpicked" by anybody with an in depth knowledge.

5. US (DOE) and Europe have diverging approaches on the Extended Product Approach, but it would seem sensible to let both methods develop in order to identify which is best.

6. There is a clear opportunity to unify EU and Australian swimming pool pump standards.

### Notes and assumptions

None other than as described above.

### List of sources

Test procedures from each country, as listed in CLASP's Global S&L Database
http://www.clasponline.org/en/Tools/Tools/SL_Search.aspx
EUP LOT11 Preparatory study on Pumps

# Product Fact Sheet — Motors, pumps and fans: Fans

## Table 35. Overview of Fans

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **Ceiling Fans** | | | | | | | | |
| **China** | N/A | N/A | | CGC6101 | **IEC 60879-1986 Ed.2** | 1 | 1 | |
| **US** | N/A | N/A | | 10CFR Part 430 | IEC 60879-1986 Ed.2 | 1 | N/A | MEPS uses an ENERGY STAR method. |
| **India** | | N/A | | IS374 | IEC 60879-1986 Ed.2 | 1 | 1 | |
| **Portable Fans** | | | | | | | | |
| **Indonesia** | N/A | N/A | | SNI 04-6292.80-203 | | N/A | N/A | Insufficient data |
| **China** | | N/A | | Insufficient data | Insufficient data - probably ISO5801 | N/A | N/A | Insufficient data |
| **Industrial Blower** | | | | | | | | |
| **China** | N/A | N/A | | GBT 19761-2009 series | **ISO5801** | 1 | N/A | |
| **US** | N/A | | | | ISO5801 | 1 | N/A | |
| **EU** | | | ISO12759 | 327/2011 | ISO5801 | 1 | N/A | |
| **Fume Hood/Cooktop** | | | | | | | | |
| **China** | | N/A | | CQC 6101-2009 GB 4706.28 | **IEC 60665: 1980** | N/A | N/A | |
| **EU** | | | | | IEC 60665: 1980 | 1 | 1 | |
| **US** | N/A | | | | ISO5801? | N/A | N/A | |
| **Furnace/duct Fan** | | | | | | | | |
| **US** | N/A | | | | **ISO5801** | 1 | 1 | |

**(*) Conversion factors**

## Products

1. Fans have rotating blades that create a current of air for cooling or ventilation. This product group includes ceiling fans, portable fans, industrial blowers, fume hoods, cooktop/ cookers and furnace/duct fans.

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

1. For commercial fans, ISO5801 is the universally accepted global test standard, and ISO12759 has been developed to give the technical basis for efficiency metrics of a MEPS scheme.

2. No country regulates the fan (blades and hub) alone, with the reasoning being that fans invariably come attached to a motor.

3. It would be possible, but there are some practical points behind that need to be taken account of:
   - The introduction of highly integrated brushless DC fans that are non separable means that for this important group it would be practically impossible to regulate the fan without the motor.
   - For axial direct drive fans the fan itself cools the motor, reducing its losses, an effect which is currently only practical to measure with the motor and fan tested as an assembly.

4. Instead regulations are based on the whole assembly. This reflects the packaged product as bought "off the shelf". (The exception may be China for larger fans)

5. The EU approach is interesting in that it also gives an energy efficiency "multiplier" value to ascribe benefit to the use of variable speed control. The methodologies for defining the “Fan Efficiency Grades” are now included within ISO12759, and includes tables of efficiency grades for the combined assembly of motor + fan + controls.

6. This is though simplistic in that it does not consider actual part load performance in the way that the Extended Product Approach (EPA) does. It is therefore suggested that any new regulations should first look to the EPA, which is still under development. The US is most advanced in this regard.

7. For small fans, including ceiling, cooker hood and small domestic bathroom/kitchen extract fans, there is considerable diversity on the metrics to be used. This means that in practice, close inspection of the different standards will be needed in order to select the one most appropriate for a particular technology / usage pattern.

8. For ceiling fans the approach is to measure the energy consumption at rated flow only. But in addition the standby consumption may be taken account of (US and China) or there may be separate requirements for the speed regulator (India).

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

Fans can only be compared with others in the same category. For each category, the underpinning measurement standard references an agreed international standard. However, there will be some differences which mean that a precise comparison is not possible. Therefore a medium reliability is appropriate for most comparisons.

## Notes and assumptions

None other than as described above.

## List of sources

Test procedures from each country, as listed in CLASP's Global S&L Database
http://www.clasponline.org/en/Tools/Tools/SL_Search.aspx

Potential Global Benefits of Improved Ceiling Fan Energy Efficiency. Nakul Sathaye, Amol Phadke**, Nihar Shah, Virginie Letschert & Mia Forbes-Pirie, LBNL, Oct 2012

EUP LOT11 Fans Preparatory Study, European Commission.

US Ceiling Fans:
http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/25

US Commercial and Industrial Fans and Blowers:
http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/65

# Product Fact Sheet — Transformers: Distribution transformers

## Table 36. Overview of Distribution transformers

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **Australia and NZ** | Power efficiency at 50% load, based on power input and 50Hz. Varies with transformer type (oil-immersed or dry), single or three phase, and rating. | Power efficiency at 50% load, based on power input and 50Hz. Varies with transformer type (oil-immersed or dry), single or three phase, and rating. | | AS2374.1 .2-2003 | **IEC 60076-1 Ed 2.1** | 1.1 | 1 | |
| **EU** | N/A | | | IEC 60076-1 Ed 2.1 | IEC 60076-1 Ed 2.1 | 1.1 | 1 | |
| **Mexico** | N/A | N/A | | NMX-J-169-ANCE | IEC 60076-1 Ed 2.1 | 1 | 1 | |
| **US** | Power efficiency at 35% name-plate rated load for LV dry-type transformers<br>Power efficiency at 50% name-plate rated load for MV dry-type and liquid immersed transformer<br>For all types, MEP level varies with single or three phase and by rating. | EPA suspended the ENERGY STAR spec. in 2007 due to MEPS reaching that level | | Appendix A to Subpart K of Part 431 | IEC 60076 | 1 | N/A | |
| **China** | N/A | N/A | | GB 1094.1-1996 and GB 6450 | IEC 60076 | 1.1 | N/A | |
| **India** | | A star rating is given according to a maximum measured total losses (i.e. | | IS 2026 (part II), IS 2026 (part III), | IEC 60076-1 Ed 2.1 | 1.1 | N/A | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | combined iron and copper losses) at 50% and at 100% load | | IS 1180 (part I), IS 2026 (part I), IS 2500 (part I). | | | | |

**(*) Conversion factors**

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

1. While the efficiencies of transmission and distribution transformers are the highest of any energy using product, their constant use and place in the electrical supply of all appliances means that even small increases in efficiency are worthwhile. All countries surveyed use the same IEC60076 standard as the basis of the standard.

2. The energy performance metrics used in different countries are very similar, but subtle differences mean that there is still the need for harmonization. For example the load point at which efficiency is measured (100%, 50%, 40% or a combination), and the normalized operating temperature used in tests. Achievable efficiency levels are also impacted by factors such as the frequency of operation, where 60Hz has c.10% higher losses compared to 50Hz transformers.

3. Short circuit current requirements, which are defined by network requirements, will also impact transformer design.

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

1. In summary, efficiency levels can be considered broadly comparable. Adding 10% to the allowable losses of a 60Hz transformer gives an acceptable technical equivalent to the same 50Hz transformer, allowing comparison of both 50 and 60Hz transformers.

2. However, further work still needs to be done to harmonize the test load points, although to a first approximation this is not a large impact. Similarly, careful checks also need to be made on the normalized operating temperature, as this will have a modest impact.

## Notes and assumptions

None other than as described above.

## List of sources

Test procedures, regulations and standards from each country, as listed in CLASP's Global S&L Database http://www.clasponline.org/en/Tools/Tools/SL_Search.aspx

Electrical Energy Efficiency – Technologies and Applications. Sumper and Baggini, Wiley, 2012.

EUP Preparatory study on Power Transformers

# Product Fact Sheet — Miscellaneous: Commercial laundry appliances

## Table 37. Overview of Commercial laundry appliances

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **EU** | N/A | | EEITW | WD2_Lot24_Prof_Wet_Draft_Measure_v1.0. Annex III | unknown | N/A | N/A | Tunnel washer |
| **EU** | N/A | | EEIWE | | unknown | N/A | N/A | Washer-extractor |
| **EU** | | | EEI WCWW | | unknown | N/A | N/A | Textile dryer |
| **EU** | N/A | | unknown | | unknown | N/A | N/A | Washer-dryer |
| **India** | | 0.076 | unknown | IS 14155 | **IEC 60456** | 1 | N/A | Washing machines |
| **Russia** | | N/A | unknown | GOST 51380 (general requirements) | IEC 60456 | 1 | N/A | Washing machines |
| **US** | N/A | N/A | | 10 CFR 431.154 | unknown | N/A | N/A | Commercial clothes washers |

**(*) Conversion factors**

### Products

1. Commercial laundry products include washers (known as washing machines or clothes washers) and dryers and combinations of the two. Commercial clothes washers are used in commercial settings, multi-family housing, or laundromats. There are two main types of commercial clothes washers: front-loading and top-loading. These are generally horizontal axis (drum) and vertical axis (agitator and impeller) respectively.

2. A number of product types exist for 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 resistance (most common historically and generally low capital cost) and more recently heat pumps (double the efficiency, high capital cost).

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

1. Standards for commercial laundry appliances appear to lag behind developments in the residential sector, where regulations are more numerous. Method in India and Russia at least refer to IEC 60456, and it is likely that developments in the EU will consider this standard also (noting that its original purpose was for household washing machines — see sources.

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

Methodologies related to the standards cited are not available.

## Notes and assumptions

**EU:** regarding test standards, discussions are currently ongoing at the EU level within the CENELEC Technical Committee TC 59X (clothes washers, dryers and dishwashers). Several standards are available for household clothes washers, dryers and dishwashers, but none are identified for commercial variants. TC 59X is considering EN/ IEC 60456

**India:** clothes washers (multi-sector): the connection between IS 14155 and IEC 60456 has not been established, other that the latter has been described as equivalent to the former. (See reference below.)

**Russia:** The Energy Charter Secretariat has noted that test results for washing machines using EN 60456 were 'comparable' to those using Russian standards (see sources, below). However it is not clear whether those tested were residential or commercial types. Further, GOST 51380 specifies general requirements only; those relating specifically to commercial washing machines are unidentified.

**US:** test procedures are the same as those for US residential clothes washers, in appendix J1 to subpart B of part 431of 10 CFR 431.154. See the fact sheet on domestic washing machines for details.

## List of sources

**EU:** EC preparatory study – task 8 report: http://www.eup-network.de/fileadmin/user_upload/Produktgruppen/Lots/Working_Documents/Lot24_Dish_T8_ENER_clean.pdf;

For (residential) tumble dryers (also) sold for non-household use, see: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:278:0001:0010:EN:PDF;

EN 60456: https://shop.austrian-standards.at/Preview.action;jsessionid=C94DF2A28B0A01BA5CA0985ABBCFA49B?preview=&dokkey=366452&selectedLocale=en

**US:** regulation and test procedure: http://www.gpo.gov/fdsys/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-sec431-154.pdf

Also see: http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/46

**India:** clothes washers: https://archive.org/details/gov.in.is.14155.1994

**Russia:**
http://www.encharter.org/fileadmin/user_upload/document/EE_Standards_and_Labels_2009_ENG.pdf; p34

# Product Fact Sheet — Miscellaneous: Medical imaging equipment

## Table 38. Overview of Medical imaging equipment

| Country | MEPS | High Label | S&L metric | Test procedure | Reference test procedure & metric | Test Procedure (*) | Energy Performance Metric (*) | Notes |
|---|---|---|---|---|---|---|---|---|
| **EU** | N/A | | unknown | unknown | **ISO WD 13579-1** | N/A | N/A | Computer tomography, Ultrasound, X-ray, Magnetic resonance imaging (MRI), Nuclear medicine |

**(*) Conversion factors**

## Product

1. This group of products focuses on medical imaging equipment for human applications, including the following:

- Computer Tomography (CT),
- Ultrasound,
- X-Ray,
- Magnetic Resonance Imaging (MRI),
- Nuclear Medicine.

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

1. The EU is in the early stages of regulation (or more likely in this case, voluntary agreement) development: based on the literature available (see sources below), test standards have yet to be developed.

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

Test procedures are not yet available.

## Notes and assumptions

None

## List of sources

**EU:** Draft voluntary agreement (2013): http://www.eup-network.de/fileadmin/user_upload/draft_self_regulation_June_2011_Version_2.pdf

European Commission report (2013): http://www.eup-network.de/fileadmin/user_upload/COM_report_CSTB_Nov_2012.pdf