

Country: Republic of Korea

Technology: Dishwashers

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

## Introduction

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

The summary definition for this product is:

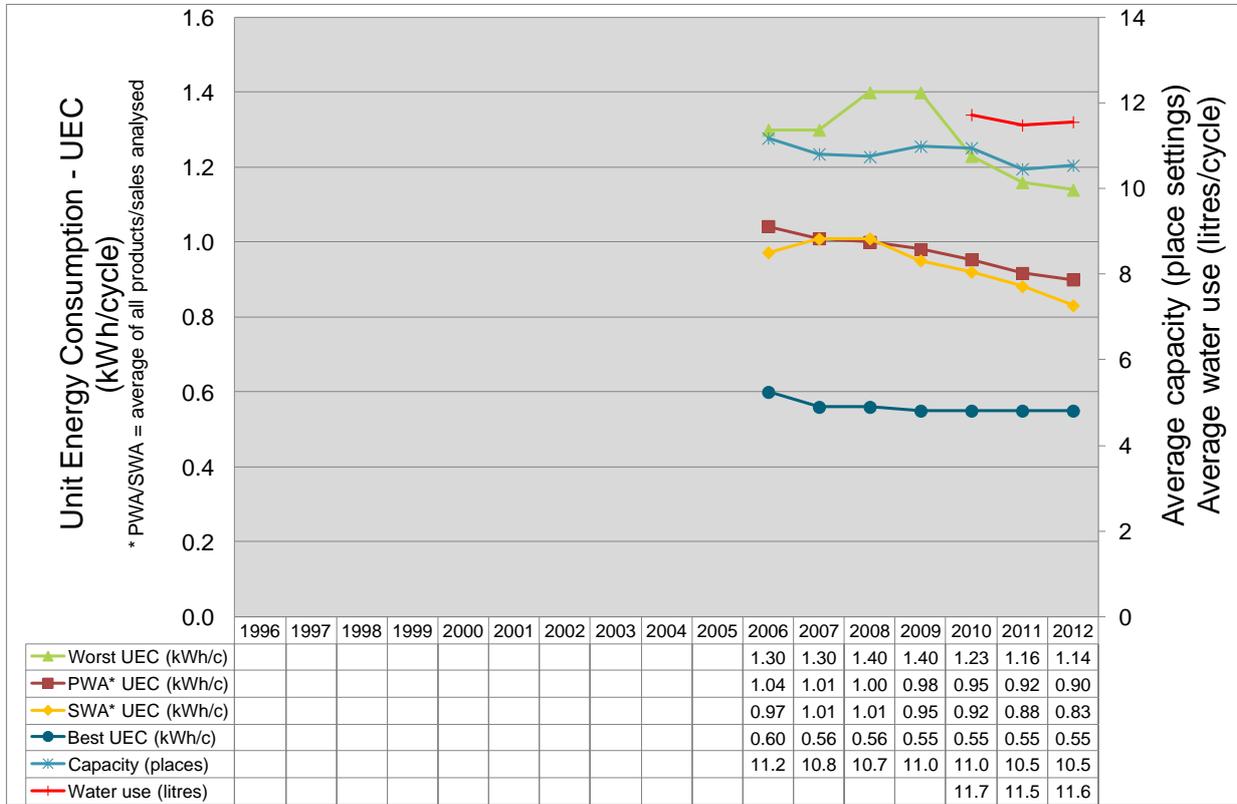
M&B Category	Description
<b>Definition and Scope</b>	<p><i>A machine which cleans, rinses, and dries dishware, glassware, cutlery, and, in some cases, cooking utensils by chemical, mechanical, thermal, and/or electric means, normally through the use of water and detergent. The machine may or may not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

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

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



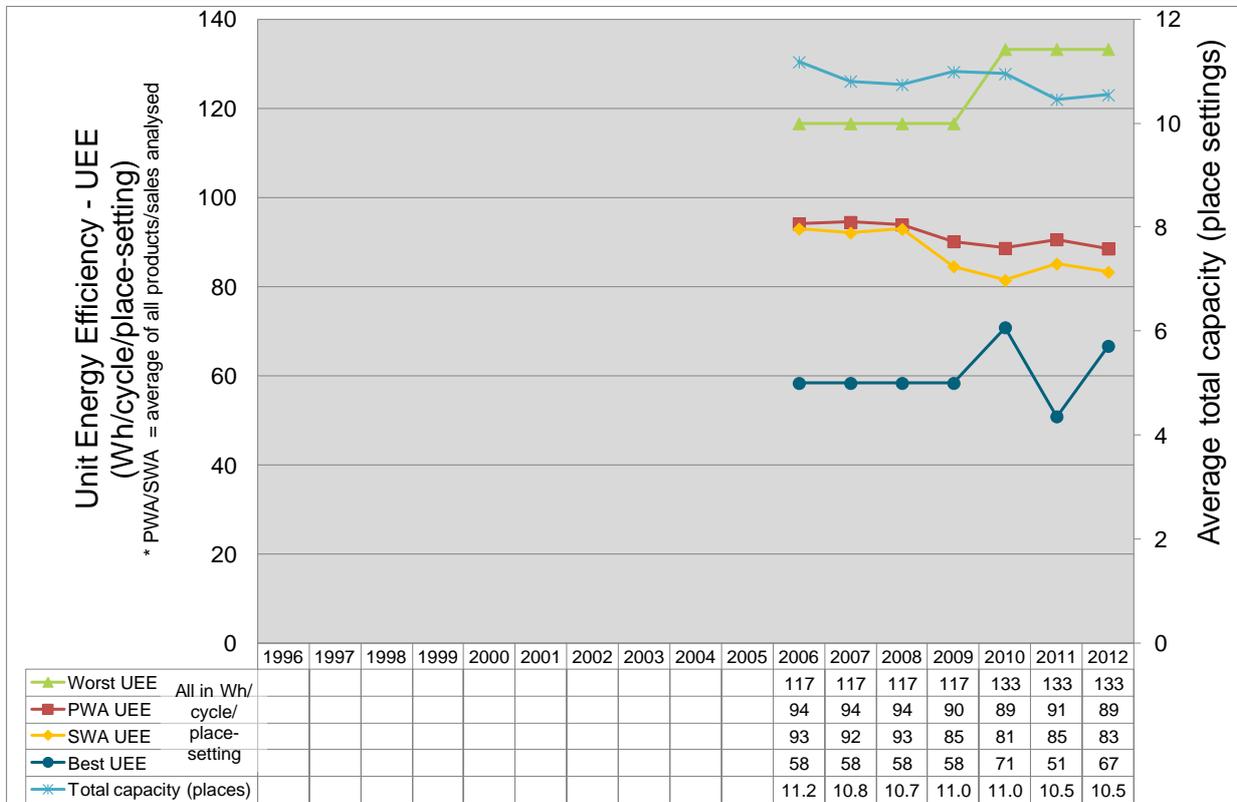
## Unit Energy Consumption (UEC) of dishwashers in the Republic of Korea



### Key notes on Graph (see notes section 1)

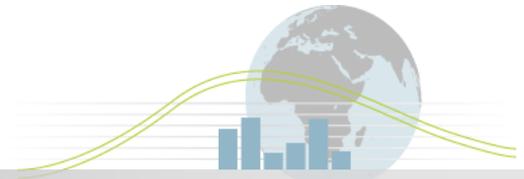
- All data is taken from the Republic of Korea's mandatory registration scheme database.
- All capacity and water consumption values listed are sales weighted averages.
- The 'Worst UEC' is the UEC of the product at the 'worst 5%' point of a ranked list of products in the dataset.

## Unit Energy Efficiency (UEE) of dishwashers in the Republic of Korea

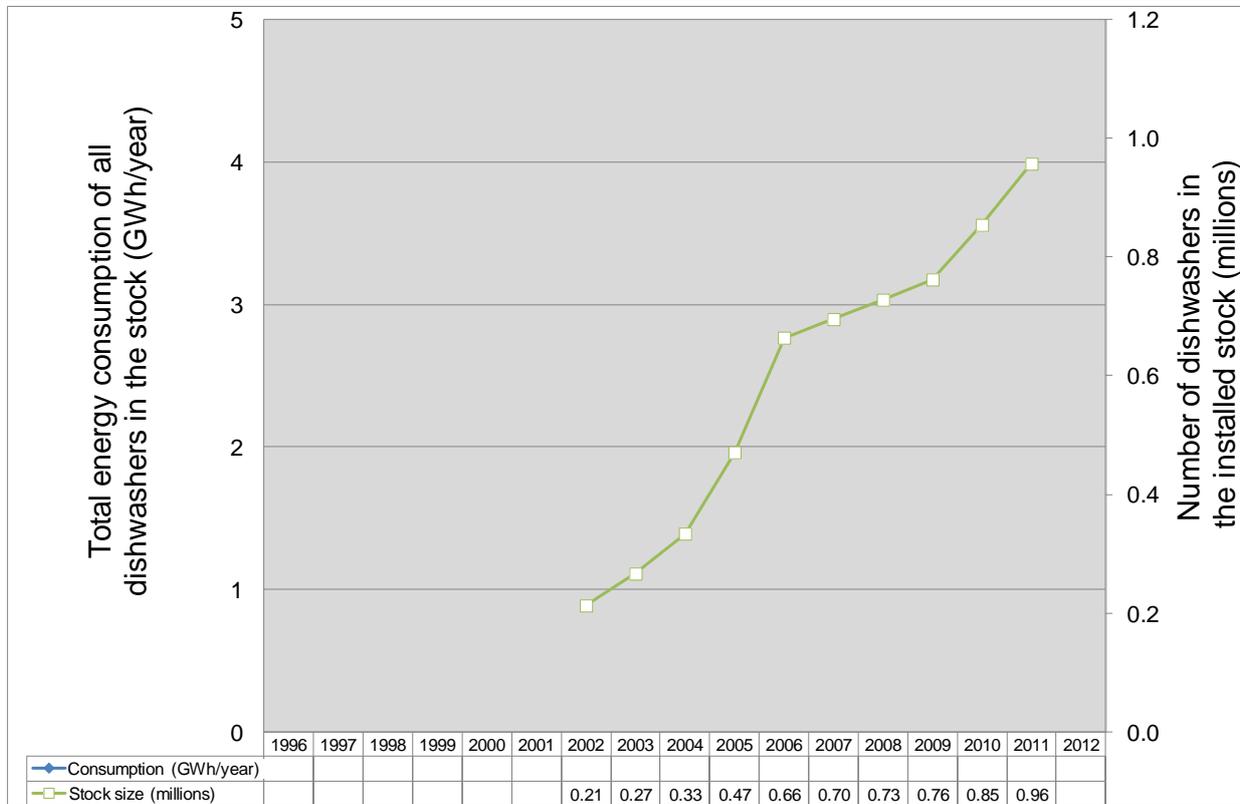


### Key notes on Graph (see notes section 1)

- All data is taken from the Republic of Korea's mandatory registration scheme database.
- All capacity values listed are sales weighted averages.
- The 'Worst UEC' is the UEC of the product at the 'worst 5%' point of a ranked list of products in the dataset.



## Energy Consumption of the installed stock of dishwashers in the Republic of Korea



### Key notes on Graph (see notes section 2)

- Total number of dishwashers in the stock is based on a simple cumulative sales calculation using sales data from the national database. This is believed to be a reasonable proxy for the number of dishwashers installed in the stock in the Republic of Korea.



## Major Policy Interventions (see notes section 3)

Korea has two primary policies targeting dishwashers:

- **Mandatory Energy Labelling:** Introduced in 1992, the Korean energy label requires an indication of efficiency on a 1-5 grade scale. The dishwashers label was introduced in 2002 and shows an energy efficiency index which is derived from both energy and water use with grade 1 being the best energy efficiency (with an index > 70 for full size models) and 5 being the least efficient (with an index ≤ 30 for full size models).

The labelling requirement was defined by a special standard "Regulation on Energy Efficiency Labelling and Standards"<sup>1</sup> which applies to many domestic appliances. This standard has been updated and strengthened many times since 1993 (see the standard for full details).

- **Mandatory Energy Performance Standards (MEPS) since 2002:** Production and sales of products that fall below the 5th energy label grade is prohibited thereby setting the MEPS. For dishwashers, the MEPS are currently set at:
  - Rated capacity ≤ 6: MEPS = 5.00
  - Rated capacity > 6: MEPS = 10.00

Both these policies sit within an overall framework of the Korean Energy Efficiency Program that targeted over 30 products in 2011, and 35 products in 2012<sup>2</sup>. In this program, every manufacturer and importer of target product must report their products with test results, and they have to attach efficiency grade label on their products.

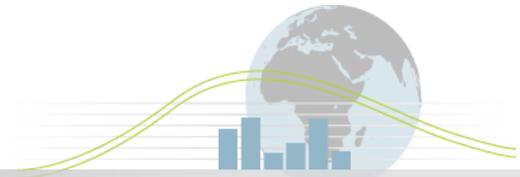
In addition, Korea has a range of policies that affect the energy consumption of appliances either directly or indirectly. In particular:

- Korea has standards for energy frontier. Energy frontier is designed to highlight products that achieve energy consumption/efficiency levels that are 30-50% better than the current 1\* grade thresholds.
- Korea has introduced a carbon pricing and annual energy cost information program since 2009 (requiring display of this information on many products).

<sup>1</sup> [http://www.kemco.or.kr/nd\\_file/kemco\\_eng/MKE\\_Notice\\_2010-124.pdf](http://www.kemco.or.kr/nd_file/kemco_eng/MKE_Notice_2010-124.pdf)

<sup>2</sup> See presentation "Korea's SL and Market Intervention (LeeKiHyun).ppt"





## Cultural Issues (see notes section 4)

The use of dishwashers in houses is not common in the Republic of Korea - it is estimated that only 5.5% of houses use dishwashers. This is at least partly because the Korean dishes are usually quite deep and deep dishes are not well suited to dishwasher layouts.



## Section 1. Unit Energy Consumption and Unit Energy Efficiency Graphics

### 1.1 Test methodologies

#### 1.1.1 Regulations

All current regulations are based on:

Ministry of Knowledge Economy, Korean Energy Management Corporation: Notification 2010-124: Regulation on Energy Efficiency Labeling and Standards, issued 16 June 2010.

This update was based on initial regulations Enacted by MORE 1992-71, 17 Aug. 1992 and subsequently revised as follows:

- Amended by MOCIE 1993-25, 1 Jun. 1993
- Amended by MOCIE 1993-130, 7 Jan. 1993
- Amended by MOTI 1995-125, 29 Dec. 1995
- Amended by MOTI 1996-393, 18 Nov. 1996
- Amended by MOCIE 1999-24, 8 Mar. 1999
- Amended by MOCIE 2000-101, 23 Sep. 2000
- Amended by MOCIE 2002-20, 16 Feb. 2002
- Amended by MOCIE 2003-40, 14 May 2003
- Amended by MOCIE 2003-88, 30 Dec. 2003
- Amended by MOCIE 2004-37, 30 Mar. 2004
- Amended by MOCIE 2005-50, 6 May 2005
- Amended by MOCIE 2006-26, 13 Mar. 2006
- Amended by MOCIE 2007-70, 25 May 2007
- Amended by MOCIE 2007-149, 26 Dec. 2007
- Amended by MKE 2008-99, 31 July 2008
- Amended by MKE 2009-26, 10 Feb 2009
- Amended by MKE 2009-158, 30 July 2009
- Amended by MKE 2009-304, 11 Dec 2009
- Amended by MKE 2009-317, 28 Dec 2009
- Amended by MKE 2010-124, 16 June 2010
- Amended by MKE 2012-227, 05 Oct 2010

*Note :*

*MORE : Ministry of Resource and energy*

*MOTI : Ministry of Trade and Industry*

*MOCIE : Ministry of commerce, industry and energy*

Initial effective enforcement date for dishwashers 1<sup>st</sup> July 2002



This Standard applies to electric dishwashers for household use that are supplied with hot and/or cold water.

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

**1.1.1.1 Test Conditions:**

**General approach:** The Standard provides the test methodology to establish the energy consumption (including standby power consumption); the washing and drying performance; and the water consumption of the dishwasher. Measurement of the energy consumption of the unit is done in parallel with some of these performance tests. Measurement of standby power is a separate test.

The specification requires at least 2 cycles to be performed on each of two machines.

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

**Test load:** The test load is similar to that defined by IEC 60436:2004 with a number of local modifications. Specifically that standard states:

One place setting shall consist of the pieces shown [Table 3]. The shapes and the sizes of the rice bowl and the soup bowl should be prepared based on [Table 2 convex shape], [Table 3 square shape] in KS L 9202. The others are based on IEC 60436 [Table 3]. The standard tableware should be evenness on the surface and white china. Spoons, chopsticks, and teaspoons should be stainless according to [Table 3].

Loads are based on rated capacity but move in two setting increments, eg units with ratings of 10 and 11 place settings have the same load.

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

**Soiling Agent:** The following soiling agents are required:

- Rice
- Egg yolk
- Margarine
- Kimchi
- Milk
- Coffee

The standard prescribes the specific preparation of these material, and method of application and drying.



**Cycle, Programme and Time:** A cycle is defined as “The sequence of event occurring in the dishwasher during the washing, rinsing and drying process (Where the latter is included). The test shall be with the standard mode (Auto or default setting mode for shipping), if there is no standard mode, it shall be operated with a similar mode. A complete cycle does not include a preserving mode after drying mode”.

Cycle time is the time to complete a full cycle and is expressed in minutes and seconds.

**Cleansing Performance:** The cleansing performance tests seeks to evaluate washing performance for the soiled tableware, and is tested twice with two samples per a model.

The test method for cleansing performance of the dishwasher under test is based on a comparison of the performance of the unit under test with the performance of the reference unit, and is conducted in conjunction with the energy performance test. Algorithms are provided to allow the calculation of an index of between 1% and 100% for the measurement of wash performance.

**The minimum performance requirement is 80%.**

**Drying Performance:** The drying performance test is conducted either in parallel with, or separately from, the wash performance/energy test/water consumption test. In either case the same cycle and load is used.

The drying performance is calculated (as an index) based on the number and size of droplets of water remaining after the test relative to the reference machine. An algorithm is then used to determine drying index between 1-100 to be declared.

**The minimum performance requirement is 50%.**

**Stand-by:** Defined as “Power consumption by machinery and tools, when connected to the external power supply, while not performing their primary functions or while awaiting instructions to provide full services.”

[Note, this has been defined as “off mode” standby for use in the mapping and benchmarking analysis]

The requirement to test for Standby Power came into force on 1 January 2008 with a requirement that maximum power consumption in off mode is equal to or less than 1W. This applies to the 1st efficiency grade only i.e. not the 2nd-5th.

From April 2013, maximum power consumption in off mode is equal to or less than 0.5W. Again this applies to the 1st efficiency grade only.

**Water consumption:** The measurement of total water consumption is taken during the energy consumption test. Total consumption is based on litres per cycle.

Monthly water consumption is calculated as follows:

$$PMWC = \frac{Q_c \times 365}{12} \quad (\ell/\text{month})$$

Where:

PMWC : Monthly water consumption ( $\ell/\text{month}$ ), one decimal place

Qc : Total water consumption ( $\ell$ ), one decimal place

12 : month/year

**Embodied Water Energy/ Nominal Water Inlet Temperature:** The water inlet temperature is  $15 \pm 2$  °C. Adjustments for embodied energy in the water are made for supplies that vary from this temperature..

**Water Hardness:** Water of 1.5 mmol/ $\ell$  (Ca+Mg) shall be used.

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

**Noise:** The maximum allowable noise is 60dB.

**Ambient Temperature:** The ambient temperature and the relative humidity required during the tests shall be reported in the test report.

– Ambient temperature of the room: ( $20 \pm 2$ ) °C

– Relative humidity: ( $65 \pm 5$ ) % RH

**Order of Tests:** The methodology specifies:

- 1 Step : The dishwasher shall be operated at least for two complete cycles using a clean dish load and without detergent and rinse agent. There shall be no interrupt cycle during running.
- 2 Step : Conduct 6.3 washing performance test and 6.4 energy consumption test.
- 3 Step : Conduct 6.5 drying performance test
- 4 Step : Conduct Standby power test

**Energy Consumption:**

Total Cycle Energy Consumption  $E_t$  is measured electrical consumption corrected for embodied (cold and hot) water energy.

Monthly power consumption is calculated as follows:

$$PMEC = \frac{E_t \times 365}{12} \quad (\text{kWh/month})$$

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Where:

PMEC : Monthly power consumption (kWh/month), one decimal place

Et : Total power consumption (kWh), two decimal place

12 : month/year



**Energy Efficiency Index Declaration:**

1) Electrical energy efficiency ratio

$$EER_e = (Rated\ Capacity \times 10) / PMEC$$

2) Water energy efficiency ratio

$$EER_w = (Rated\ Capacity \times 10) / PMWC$$

3) Total Energy Efficiency ratio

$$EER_t = EER_e \times EER_w$$

**Recorded Information**

The following data shall be recorded after test.

- a) Program at test
- b) Test condition : Power source, condition of laboratory, water supply, rated washing capacity
- c) Detergent and rinse agent
- d) Measured power consumption, correction factor of cold water, correction factor of hot water (applicable if using hot water), total power consumption
- e) Water consumption
- f) Number of tableware
- g) Washing performance index
- h) Drying performance index
- i) Length of cycle (wash and dry)

**1.2 Product Classifications**

**Definition**

A machine which washes rinses, and dries (when drying process is include) dishware, glassware, cutlery and, in some cases, cooking utensils by chemical, mechanical and/or electrical means with the rated capacity 20 person or less.

**1.3 Data sources**

Sources: Korea Energy Management Corporation.

The data provided is drawn directly from the National Registrations System managed by the Korea Energy Management Corporation (all products are required to be registered prior to sale).

	2006	2007	2008	2009	2010	2011
Products in dataset	83	116	118	97	86	78
Products analysed	83	116	118	97	86	78
% products included	100%	100%	100%	100%	100%	100%
Sales in dataset	126,599	197,321	232,735	191,682	151,936	103,942
Sales analysed	126,599	197,321	232,735	191,682	151,936	103,942
% Sales included	100%	100%	100%	100%	100%	100%



## 1.4 Data manipulations and specific limitations

### 1.4.1 Overview of the mapping and benchmarking process

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

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

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

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

These documents can be found at the annex website:

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

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

### 1.4.2 Specific cautions for the Republic of Korea data

#### 1.4.2.1 Data cleaning and processing specific to the Republic of Korea dataset

- a. No specific data cleaning actions were necessary.



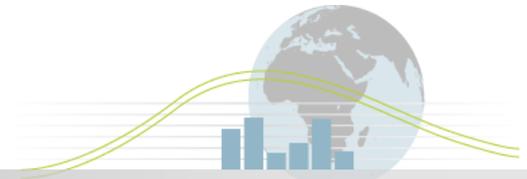
**1.4.2.2 Test methodology details used in the analysis**

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

- Ambient temperature is 20.0 °C. This is assumed to be the temperature of the load at the start of the cycle.
- Inlet water temperature is either 15°C or the energy consumption results is adjudged to a value equivalent to that if the inlet water temperature had been set at 10°C.
- The weight of the load by type is as follows:

Number of place settings	less than 4	6	8	10	12	14	16	18	20
Mass of crockery in Republic of Korea (kg)	6.356	9.624	12.892	15.980	19.248	22.516	25.604	28.872	32.140
Mass of cutlery Republic of Korea (kg)	0.318	0.477	0.636	0.795	0.954	1.113	1.272	1.431	1.590





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

The number of the installed stock regarding to dishwashers is referenced from Korea Power Exchange's Electric Home-appliances' Supply Status in 2011.



## Section 3. Major Policy Interventions

### 3.1 Energy Efficiency Standards and Labels Programme

Under the program, manufacturers (and importers) are mandated to produce and sell energy efficiency products. This program is Korea's core energy efficiency management scheme. The Energy Efficiency Label and Standard Program enable consumers to identify high efficiency energy efficiency products easily by:

- Mandatory indication of energy efficiency grade from 1st to 5th grade: According to the energy efficiency and consumption of the product, the product is required to indicate an energy efficiency grade from 1st to 5th grade
- Mandatory reporting: Mandatory reporting of energy efficiency grade by manufacturers (and importers)
- Applying minimum energy performance standard (MEPS): Production and sales of products that fall below the 5th grade is prohibited

In case of violation MEPS, a fine up to 20 thousand dollars will be charged. In case of violation of other regulations, a fine or penalty of up to 5 thousand dollars will be charged.

### 3.2 Minimum Energy Performance Standards (MEPS)

Minimum Standards were defined using an energy efficiency index as follows in 2002:

Type	MEPS	Target R
Rated Capacity =<6	8.0	16.0
Rated Capacity > 6	10.0	20.0

The MEPS were changed in 2010 as follows:

Type	MEPS
	From 1 <sup>st</sup> of January, 2010
Rated Capacity ≤ 6	5.00
Rated Capacity > 6	10.00

Where the energy efficiency index is defined as:

$$R(\text{Energy Efficiency Level Index}) = \frac{\text{Electric Energy Efficiency Ratio}(EER_e) \times \text{Water Energy Efficiency Ratio}(EER_w)}{1}$$

Where:

1) Electrical energy efficiency ratio

$$EER_e = (\text{Rated Capacity} \times 10) / PMEC$$

2) Water energy efficiency ratio

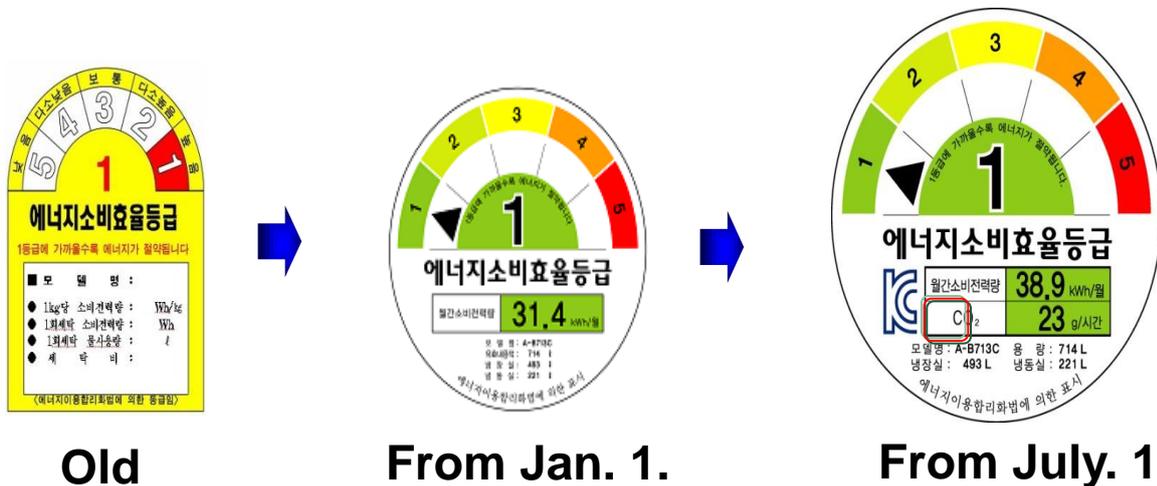
$$EER_w = (\text{Rated Capacity} \times 10) / PMWC$$





### 3.3 Mandatory Labelling

The Energy Labelling of dishwasher has been mandatory in Korea since 2002. Over time the label has evolved in appearance with the most recent including a CO<sub>2</sub> emissions value.



#### 3.3.1 World's first CO<sub>2</sub> energy label for electronic products

Starting from July 1st 2009, all new models of electricity using products including refrigerators, air conditioners, washing machines, lighting equipment, and 3 phase induction motors must display energy efficiency grades (1st ~ 5th) and CO<sub>2</sub> emissions. From the 1st January 2010 dishwashers also had to display CO<sub>2</sub> emissions. This is a measure to establish a sustainable production and consumption culture (so-called "Green Growth"). The extent of this policy has expanded to electronic goods and Korea became the first country to implement CO<sub>2</sub> energy label for electronic products. Over 160 million appliances and equipment subject to efficiency management (24 products) will be annually disseminated into the market with carbon dioxide emissions information.



Starting from July 1st 2010, it is mandatory to display the annual energy cost of household appliances (dishwasher, refrigerator, air conditioner etc.) on the energy label to induce



consumers' voluntary selection of energy saving products through the sharing of energy cost information.

### 3.3.2 Displaying annual energy cost information

The current Energy Efficiency Grade Label's core indicator is energy efficiency and this could misguide consumers' selection of small sized appliance with less energy consumptions. The motivation for displaying energy cost information in Energy Efficiency Grade Label is to provide more information to consumers so that products with less energy consumptions can be promoted.

Annual energy cost information is based on energy consumptions in absolute scale so that it hopes to complement the energy efficiency grade indicators. The energy cost information sends a clear message to the consumers that products with less energy consumption are also economical where such information is not conveyed in the energy efficiency indicators.



• Products with indication of CO<sub>2</sub> emissions and energy cost

Type	Target products	Date
Displaying CO <sub>2</sub> emissions (24 products)	Automobiles	From 1 August 2008
	Refrigerators, kimchi refrigerators, washing machines, drum washing machines, dish dryers, vacuum cleaners, electric fans, air cleaners, incandescent lamps, compact fluorescent lamps	From 1 July 2009
	Electric freezers, electric cooling equipments, dish washers, electric hot and cold water dispensers, electric rice cookers, fluorescent lamps, 3 phase electric motors, industrial refrigerators	From 1 January 2010
	Electric fan heaters, electric stoves	From 1 December 2011
	VRF multi-split heat pumps	From 1 April 2012
	TVs, dehumidifiers	From 1 July 2012
Displaying energy cost (19 products)	Refrigerators, electric freezers, kimchi refrigerators, electric cooling equipments, washing machines, drum washing machines, dish washers, dish dryers, electric rice cookers, vacuum cleaners, electric fans, air cleaners, industrial refrigerators	From 1 July 2010
	Electric fan heaters, electric stoves	From 1 December 2011
	Electric hot and cold water dispensers, 3 phase induction motors	From 1 January 2012
	TVs, dehumidifiers	From 1 July 2012

### 3.3.2.1 Label banding

- Dishwashers with a rated capacity of  $\leq 6$  without network function :

R	Standby power (Off mode power consumption)	Level
$50.00 < R$	$\leq 1.0 \text{ W}$	1
$50.00 < R$	N/A	2
$35.00 < R \leq 50.00$	N/A	3
$20.00 < R \leq 35.00$	N/A	4
$5.00 < R \leq 20.00$	N/A	5

- Dishwashers with a rated capacity of  $\leq 6$  with network function :

R	Standby power	Level
$50.00 < R$	$\leq 1.0 \text{ W (off mode)}$ $\leq 3.0 \text{ W (active standby mode)}$	1
$50.00 < R$	N/A	2
$35.00 < R \leq 50.00$	N/A	3
$20.00 < R \leq 35.00$	N/A	4
$5.00 < R \leq 20.00$	N/A	5



- Dishwashers with a rated capacity of > 6 without network function :

R	Standby power (Off mode power consumption)	Level
70.00 < R	≤ 1.0 W	1
70.00 < R	N/A	2
50.00 < R ≤ 70.00	N/A	3
30.00 < R ≤ 50.00	N/A	4
10.00 < R ≤ 30.00	N/A	5

- Dishwashers with a rated capacity of > 6 with network function :

R	Standby power	Level
70.00 < R	≤ 1.0 W(off mode) ≤ 3.0 W(active standby mode)	1
70.00 < R	N/A	2
50.00 < R ≤ 70.00	N/A	3
30.00 < R ≤ 50.00	N/A	4
10.00 < R ≤ 30.00	N/A	5

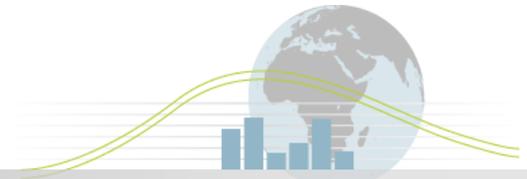
Where:

- Products with network function are defined as those which enable the exchange of data with and external network by wire or wireless.
- Off mode is the power state when the product is switched off or auto off.
- Active standby mode is when an appliances is switched to off/standby and is not performing its primary functions while still connected to a power supply but can be activated by a remote control or other internal signals.

### 3.3.1 Reporting Procedure of Energy Efficiency Labelling:

Energy efficiency labelling tests are conducted on request at designated national testing institutes (or self certified testing institutes) to determining the energy efficiency grades of products (imported goods included). Manufacturers or importers receive the test performance report from the designated testing institutes. The reports are sent to Korea Energy Management Corporation (KEMCO) and made publicly available on the internet (<http://www.kemco.or.kr>). Reporting of sales figures for the preceding 12 months is required in January of the following year.





## Section 4. Cultural Issues

No additional notes.

