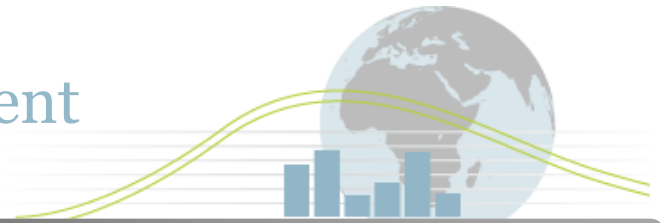


# 4E

## Mapping Document



Country:	Republic of Korea
Technology:	Domestic Cold Appliances
Sub Category:	Freezers and Refrigerator/ Freezers Combinations

### Introduction

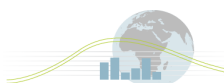
The first stage in the Mapping and Benchmarking process is the definition of the products, i.e. clearly setting the boundaries that define the products for use in data collection and analysis. Doing this ensures that comparison between the participating countries is done against a specific and consistent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

The summary definition for this product is:

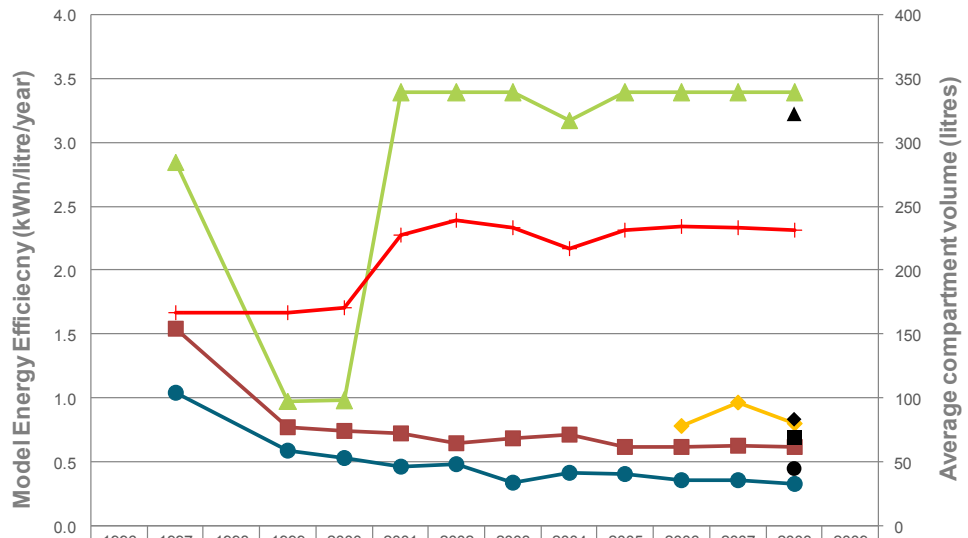
Under Counter/ upright Refrigerators  (Single Grouping – collect data only)	Refrigerator with freezer (ice) compartment  (Single grouping – collect data only)	Side-by-Side and Freezer top/ Refrigerator bottom and Refrigerator top/ Freezer bottom  (Collect data on proportion of each type of unit in the market)	Chest/Under Counter/Upright Freezer  (Collect data on proportion of each type of unit in the market)
Where units are:			
<ul style="list-style-type: none"> <li>From all climate classes (but collect data on specific climate class that may be useful for later analysis)</li> <li>Have freezer compartments with rated temperatures below -12 (all temperature ratings to refrigerator with freezer (ice) compartment)</li> <li>Differentiated (if possible) between units with peripheral water coolers and ice makers</li> </ul>			
Do not differentiate between			
<ul style="list-style-type: none"> <li>Defrost Cycles including Manual/Cyclical/Automatic (although collect data in case normalisation is required)</li> <li>Controls mechanisms including manual, automatic and cyclical</li> <li>Built in and stand-alone units (but where differentiated in market, collect data to enable normalisation)</li> <li>Volume (but collect data on gross volumes as base metric)</li> <li>Climate class (but collect data on climate class in case future analysis required, plus data on related local test conditions for climate classes)</li> </ul>			

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

<http://mappingandbenchmarking.iea-4e.org/>



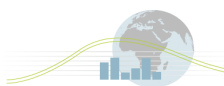
## Energy Efficiency of New Fridge Freezers Republic of Korea



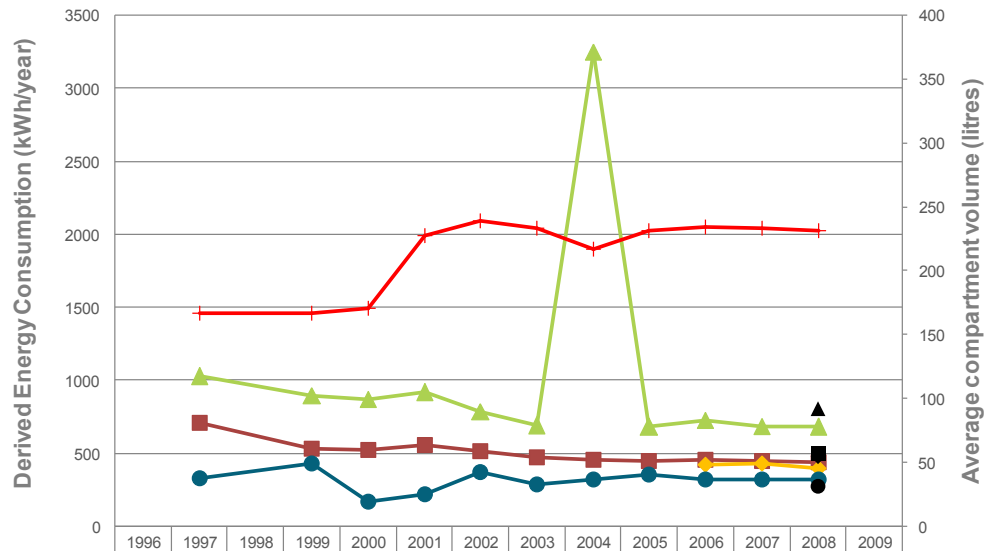
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
▲ Worst product		2.85		0.97	0.98	3.39	3.39	3.39	3.17	3.39	3.39	3.39	3.39	
■ Product Weighted Average		1.54		0.77	0.74	0.72	0.64	0.68	0.72	0.62	0.62	0.63	0.62	
◆ Sales Weighted Average											0.78	0.96	0.80	
● Best Product		1.04		0.59	0.53	0.47	0.48	0.34	0.41	0.40	0.36	0.36	0.33	
▲ Worst Product (15502)													3.23	
■ Product Weighted Average (15502)													0.69	
◆ Sales Weighted Average (15502)													0.83	
● Best Product (15502)													0.45	
— Ave Freezer Volume		167		167	171	228	239	233	217	232	234	233	231	

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

- Some data points are calculated using only a partial data set as some products have been excluded due to incomplete model data (e.g. volumes of compartments).
- Data for product efficiency in years 1997, 1999 and 2000 is based on data sets smaller than 100 and should therefore be treated with particular caution.
- Note that the energy efficiency dataset changes in 2008 with the introduction of a new test methodology.
- Sales data for the calculation of sales weighted averages is only available from 2006 onwards.
- Energy consumption and efficiency figures are based on performance under local test conditions.



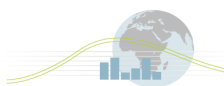
## Energy Consumption of New Fridge Freezers Republic of Korea



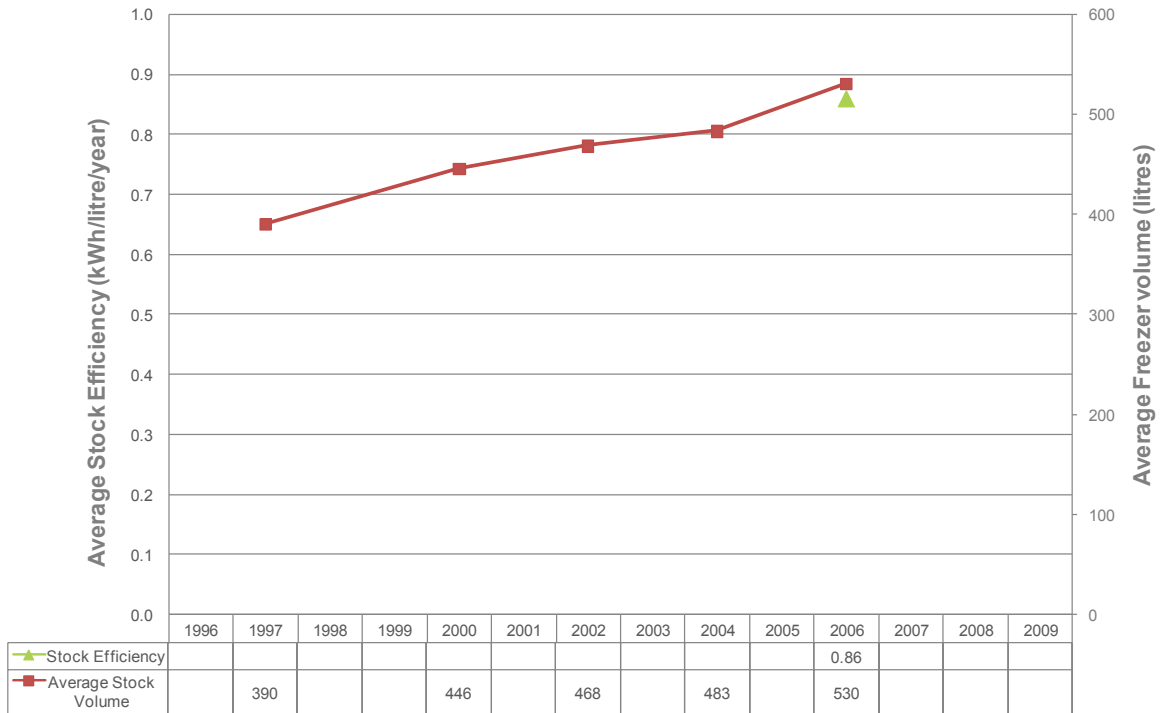
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
▲ Worst Product		1027		896	874	917	788	690	3251	682	726	684	682	
■ Product Weighted Average		711		535	520	562	513	472	456	450	453	447	439	
◆ Sales Weighted Average											421	434	397	
● Best Product		328		432	168	220	370	288	319	357	320	320	323	
▲ Worst Product (15502)													809.4	
■ Product Weighted Average (15502)													505.9	
◆ Sales Weighted Average (15502)													480.7	
● Best Product (15502)													273.6	
— Ave Freezer Volume		167		167	171	228	239	233	217	232	234	233	231	

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

- Some data points are calculated using only a partial data set as some products have been excluded due to incomplete model data (e.g. volumes of compartments).
- Data for product efficiency in years 1997, 1999 and 2000 is based on data sets smaller than 100 and should therefore be treated with particular caution.
- Note that the energy consumption data set changes in 2008 with the introduction of a new test methodology.
- Sales data for the calculation of sales weighted averages is only available from 2006 onwards.
- Energy consumption and efficiency figures are based on performance under local test conditions.

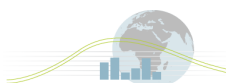


## Energy Efficiency in the Installed Fridge Freezer Stock Republic of Korea

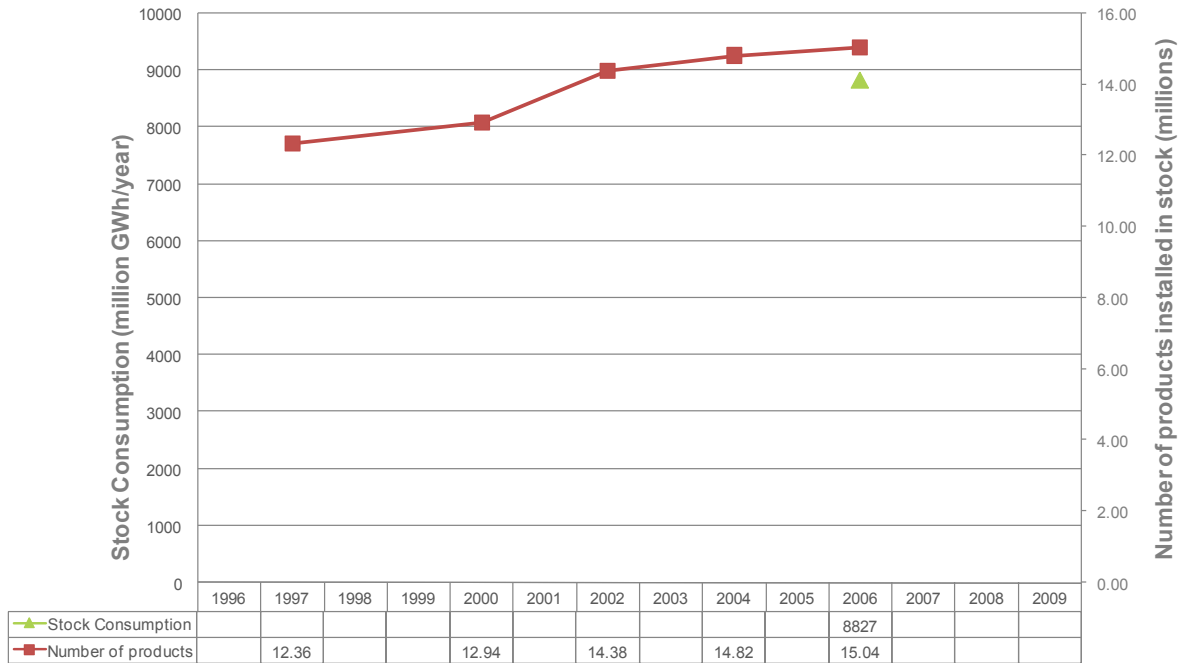


### Key notes on Graph (See Notes Section 3)

- Graph is based on a 2006 Survey on Electricity Consumption Characters of Home Appliances (KPX(Korea Power Exchange)).
- Stock consumption data only available in 2006.
- Average energy efficiency of stock derived from a combination of this survey and new sales data with assumptions and therefore should be interpreted with care.
- Average stock volumes are for both fridge and freezer compartments and (other than in 2006) are deduced with assumptions from the survey and therefore should be interpreted with care.

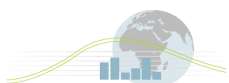


## Energy Consumption in the Installed Fridge Freezer Stock Republic of Korea

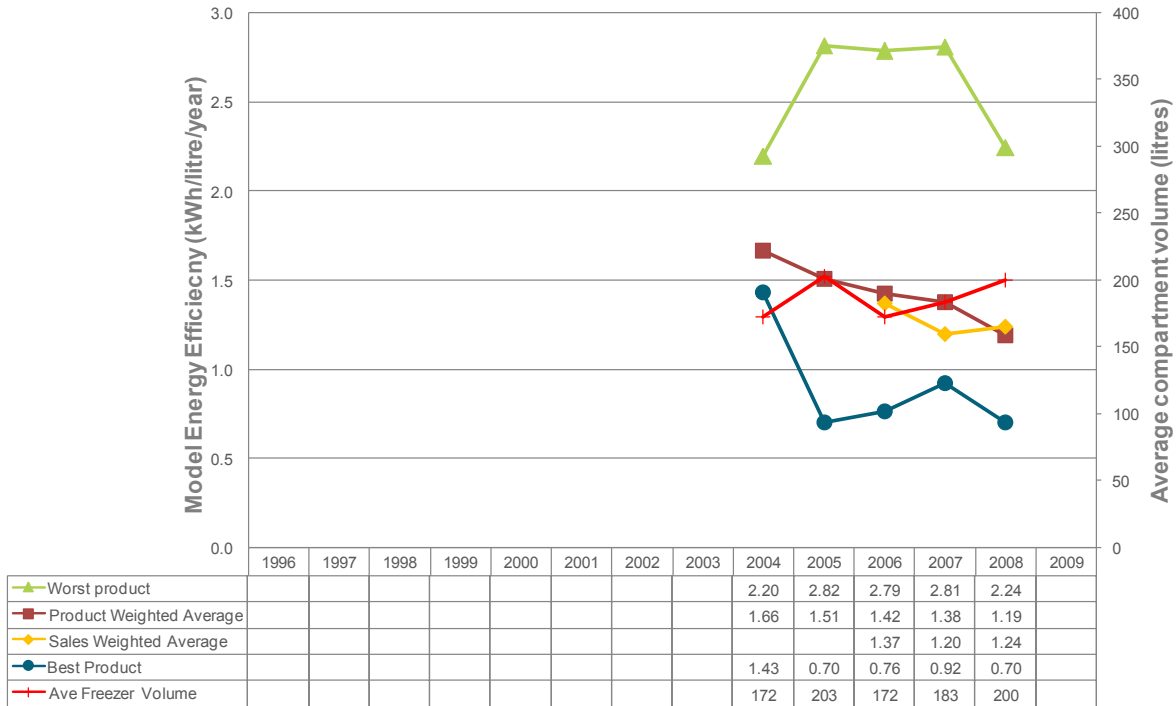


### Key notes on Graph (see Notes Section 4)

- Graph is based on A 2006 Survey on Electricity Consumption Characters of Home Appliances (KPX(Korea Power Exchange)).
- Stock consumption data only available in 2006.
- Number of products in stock is derived with assumptions from a combination of the survey and new sales data and therefore should be interpreted with care.

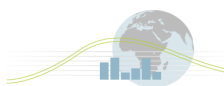


## Energy Efficiency of New Freezers Republic of Korea

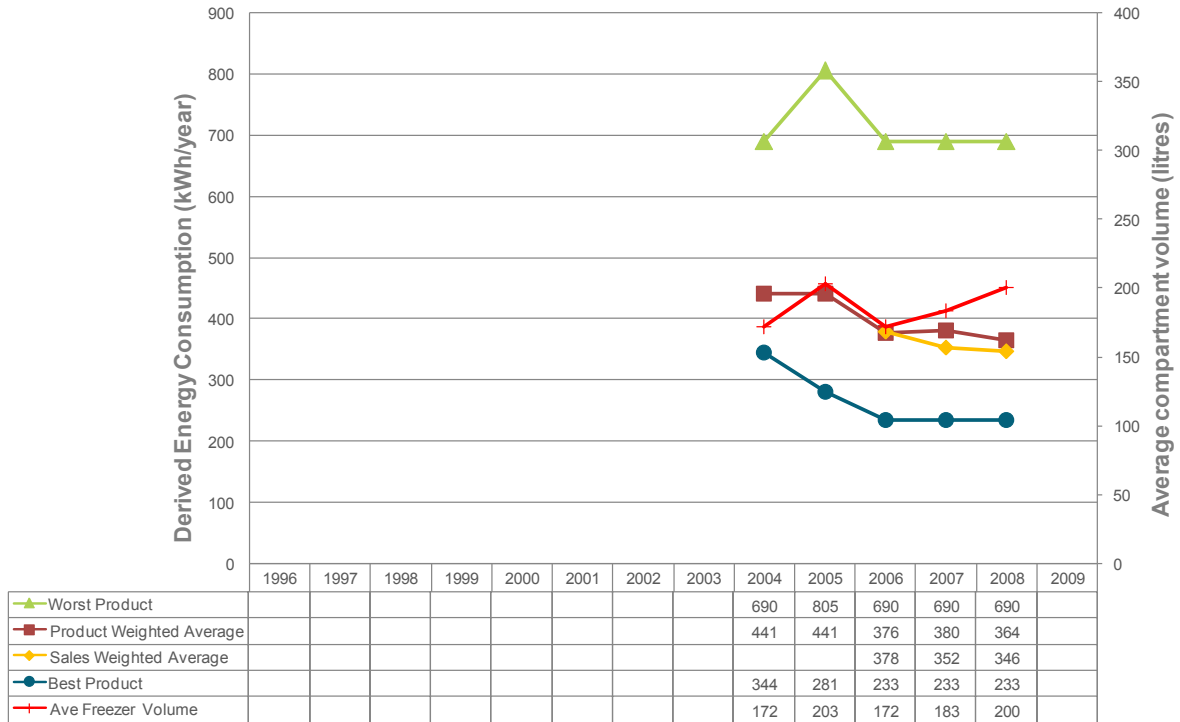


### Key notes on Graph (see notes section 1)

- Some data points are calculated using only a partial data set as some products have been excluded due to incomplete model data (e.g. volumes of compartments)
- Sales data for the calculation of sales weighted averages is only available from 2006 onwards.
- All data points are based on data sets smaller than 100 and should therefore be treated with caution.
- Energy consumption and efficiency figures are based on performance under local test conditions.

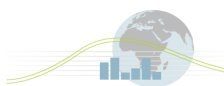


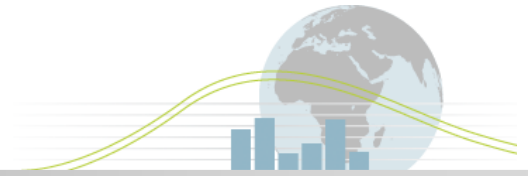
## Energy Consumption of New Freezers Republic of Korea



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

- Some data points are calculated using only a partial data set as some products have been excluded due to incomplete model data (e.g. volumes of compartments)
- Sales data for the calculation of sales weighted averages is only available from 2006 onwards.
- All data points are based on data sets smaller than 100 and should therefore be treated with caution.
- Energy consumption and efficiency figures are based on performance under local test conditions.



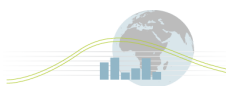


## Energy Efficiency in the Installed Freezer Stock Republic of Korea

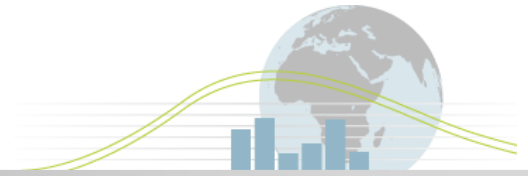
No data available.

### **Key notes on Graph (See Notes Section 3)**

- None.





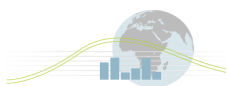


## Energy Consumption of the Installed Freezer Stock Republic of Korea

No data available.

### **Key notes on Graph (see Notes Section 4)**

- None



## Major Policy Interventions (See notes Section 5)

Korea has two primary policies targeting refrigerators and freezers:

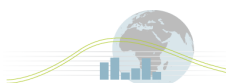
- **Mandatory Energy Labelling:** Required since 1992, the label requires an indication of efficiency on a 1-5 grade scale, where grade 1 is typically 30-40% more efficient than grade 5.

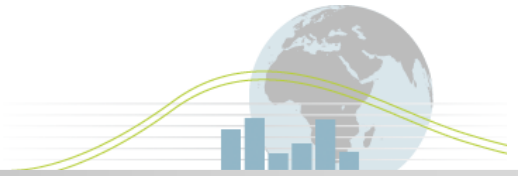
The labelling requirement was defined by a special standard "Regulation on Energy Efficiency Labeling and Standards" and applies to refrigerators, freezers and combination fridge/freezers only. This standard was strengthened several times and test method was revised for refrigerators in April 2008 and for freezers in January 2010.

- **Mandatory Energy Performance Standards (MEPS):** For refrigerators and combination fridge/freezers introduced in 1994 and for freezer introduced in 2004, and prohibits the sale of appliances below the 5th grade on the labelling scale.

Both these policies sit within an overall framework of energy efficiency policies that target over 23 products<sup>1</sup>. In this program, every manufacturers and importers of target product must report their products with test result, and they have to attach efficiency grade label on their products.

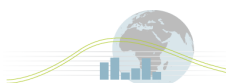
<sup>1</sup> See presentation "Korea's SL and Market Intervention (LeeKiHyun).ppt"





## Cultural Issues (See Notes Section 6)

- Average product lifetime is unusually short compared with many countries. Average refrigerator lifetime is 6.8 years. This results in the potential to increase the overall efficiency of the stock much more quickly than in countries where lifetime is considerably longer (typically twice this period).



## Notes on data

### Section 1: Notes on Product Efficiency

#### 1.1 Test methodologies, Performance Standards and Labelling Requirements

##### 1.1.1 Test Methodology<sup>23</sup>

Refrigerator (including combination refrigerator/freezers):

- Prior to 30th April 2008: National test methodology was KS C 9305 (Household electric refrigerators, refrigerator –freezers and freezers : IEC 60335-2-24:1999, MOD) and was implemented on Dec. 28th 1970
- Following 30th April 2008: National test methodology is KS C ISO 15502 (Household refrigerating appliances –Characteristics and test methods: ISO 15502:2005, MOD. The change in methodology was formally announced on 31 October 2007.

Freezers:

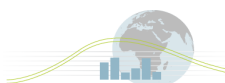
- Current: National test methodology was KS C 9305 (Household electric refrigerators, refrigerator –freezers and freezers : IEC 60335-2-24:1999, MOD) and was implemented on Dec. 28th 1970
- To be changed on 1 January 2010: National test methodology is KS C ISO 15502 (Household refrigerating appliances – Characteristics and test methods: ISO 15502:2005, MOD. The change in methodology was formally announced on 31 October 2007.

##### 1.1.2 Testing Method Temperatures<sup>12</sup>

- KS C 9305 (Refrigerator)  
Ambient external test temperature 30°C  
Internal Refrigerator Compartment: 3°C  
Internal Freezer Compartment: -18°C
- KS C 9305 (Freezer)  
Ambient external test temperature 30°C  
Internal Freezer Compartment: one-star -18°C
- KS C 15502 (Refrigerator)  
Ambient external test temperature 25°C (32°C for Tropical T Class)  
Internal Refrigerator Compartment: 5°C  
Internal Freezer Compartment: one-star -6°C, two-star -12°C, three-star -18°C
- KS C 15502 (Freezer)  
Ambient external test temperature 25°C (32°C for Tropical T Class)

<sup>2</sup> Notice 2009-158 (Refrigerator KS C ISO 15502), page 41 of Notice 2007-70 (Refrigerator KS C 9305)

<sup>3</sup> Notice 2007-70 (Freezer KS C 9305)



*Internal Freezer Compartment: one-star -18°C*

**1.1.3 Testing Method Volume Adjustments<sup>45</sup>**

*In all cases, AV means “Adjusted Volume”. Individual measured compartment volumes are **net storage volumes** that remains after deduction of the volume of components and spaces recognized as unusable for the storage of food (refer page 4 of ISO 15502).*

- *KS C 9305 (Refrigerator)*  
 $AV = (\text{volume of freezer compartment} \times 1.78) + \text{volume of fresh compartment}$
- *KS C 9305 (Freezer)*  
 $AV = (\text{volume of freezer compartment} \times 1.6) + \text{volume of fresh compartment}$
- *KS C 15502 (Refrigerator and Freezers)*  
 $AV = (\text{sum of refrigerator and freezer volumes}) \times K \times F$   
*(where, for a refrigerator only  $k=1$ , and for a refrigerator/freezer combination  $K$  depends on frozen compartment temperature/star rating;  $F=1.2$  for auto defrost and  $F=0$  otherwise)*

**1.1.4 Testing Method Power Consumption Calculations<sup>34</sup>**

(Measured) **Monthly Power Consumption** = Measured result according to test method and the unit is kWh/month. Values are simply multiplied by 12 to calculate annual figures.

**1.2 Product Efficiency Graphic**

Source: Korea Energy Management Corporation.

Note that On 30<sup>th</sup> April 2008, the National Test Methodology changed (from KS C 9305 to KS C 15502) and the absence of certain data from the 15502 data set makes it impossible to normalise between the two test methodologies. Datasets are therefore presented separately.

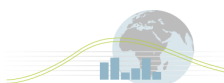
**Key calculations undertaken:**

**Derived Total Model Volume:** based on net volume (as defined in local regulations), multiply freezer by a local factor to get equivalent fridge volume. Add this volume to the net fridge volume to establish the net total volume normalised to refrigerator. This volume is the Derived Total Volume

**Derived Model Energy Consumption:** based on total annual energy consumption under test conditions. Reduce consumption by 5% if the unit has an ice maker. This energy consumption is the Derived Unit Energy Consumption

<sup>4</sup> Notice 2009-158 (Refrigerator KS C ISO 15502), page 41 of Notice 2007-70 (Refrigerator KS C 9305)

<sup>5</sup> Notice 2007-70 (Freezer KS C 9305)



**Derived Model Energy Efficiency:** Equals Derived Model Energy Consumption divided by Derived Total Model Volume

**Sales Weighted Energy Efficiency of New Models:** (Sum of (Derived Model Energy Efficiency multiplied by sales volume of Model in year) for all Models) divided by (Sum of sales volume of all Models in year)

**Model Weighted Energy Efficiency of New Models (used where no sales data is available):** (Sum of Derived Model Energy Efficiency for all models sold in year) divided by (Number of Models sold in year).

**Ave Product Volume:** is the product weighted average volume of products sold in each year.

## **Section 2: Notes on Product Consumption**

### *2.1 Test methodologies, Performance Standards and Labelling Requirements*

Refer to section 1.1

### *2.2 Product Consumption Graphic*

Refer to section 1.2

## **Section 3: Notes on Efficiency of Stock**

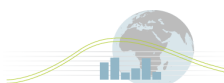
(Source: Survey on Electricity Consumption Characters of Home Appliances (KPX(Korea Power Exchange), 2006)

Survey provides data on all refrigerators for years 1993, 1995, 1997, 2000, 2002, 2004, 2006:

1. Number of products in stock
2. Proportion of volume in stock (%) by bands <199L, 200~299L, 300~399L, 400~499L, 500~599L, > 600L including actual average total volume for 2006
3. Power consumption of products in stock (W) by bands <199L, 200~299L, 300~399L, 400~499L, 500~599L, > 600L and overall average volume for 2006
4. Annual operation time (hour/year)
5. Annual power consumption (wh/year) for 2006

Calculations undertaken were:

- Average energy consumption of stock = (Average annual power consumption)/(Average adjusted total volume) where:
  - Average adjusted total volume = average fridge volume + (average freezer volume)\*(local adjustment factor)
  - Average freezer volume and fridge volume were calculated from the actual average total volume for 2006 by assuming the ratio of freezer volume to fridge volume for this average 2006 model was the same as the average ratio



of freezer volume to fridge volume for all refrigerator freezers in the sales database.

- Average volumes in each year were calculated from 2. assuming the average size of each band was in the middle of the range and upper and lower bands were 50L above/below the range limit respectively.

#### **Section 4: Notes on Consumption of Stock**

(Source: Survey on Electricity Consumption Characters of Home Appliances (KPX(Korea Power Exchange), 2006)

Survey provides data on all refrigerators for years 1993, 1995, 1997, 2000, 2002, 2004, 2006:

1. Number of products in stock
2. Proportion of volume in stock (%) by bands <199L, 200~299L, 300~399L, 400~499L, 500~599L, > 600L
3. Power consumption of products in stock (W) by bands <199L, 200~299L, 300~399L, 400~499L, 500~599L, > 600L and overall average volume for 2006
4. Annual operation time (hour/year)
5. Annual power consumption (wh/year) for 2006

Calculations undertaken were:

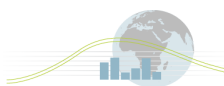
- Proportion of 1. above attributable to refrigerator freezers is estimated by applying the proportion of all refrigerator sales in all years of the Korean sales data that were refrigerator-freezers.
- Total consumption of stock for 2006 was calculated = estimated number of refrigerator freezers in stock \* actual average annual power consumption for 2006

#### **Section 5: Notes on Policy Interventions**

##### **5.1 Energy Efficiency Standards and Labelling Program**

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 enables 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, a fine up to 20 thousand dollars will be charged.

### 1.5 Mandatory Energy Efficiency Standards (MEPS)

The labelling and MEPS requirements specify the rated power consumption are below 500W and the available content capacities are below 1,000 litres (ie defining domestic units).

Minimum Energy Performance Standards calculated according to the following regulations:

- First introduced in 1994 to prohibit the sale of poor performing products. Requirements were revised in from 1 January 2004 (1 October 2004 for freezers) with details as follows<sup>6</sup>:

Items	MEPS
Refrigerator only	$P \leq 0.037AV + 16.75$
Refrigerator-freezer whose compensated cubic volume is less than 500 L	$P \leq 0.025AV + 29.45$
Refrigerator-freezer whose compensated cubic volume is no less than 500 L	$P \leq 0.043AV + 16.19$

Remark)

1.  $AV$  = compensated cubic volume = cubic volume of the freezing compartment  $\times K$  + cubic volume of the fresh compartment

- 1)  $K$  value in the refrigerator only is 0
- 2)  $K$  value in refrigerator-freezer is 1.78

$$K \text{ (compensation coefficient)} = \frac{T_1 - T_3}{T_1 - T_2}$$

Where

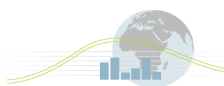
- $T_1$  = ambient temperature in testing (30 °C)
- $T_2$  = averaging indoor temperature of the fresh compartment (3 °C)
- $T_3$  = averaging indoor temperature of the freezer compartment (-18 °C)

2.  $P$  = Maximum power consumption (kWh/month)

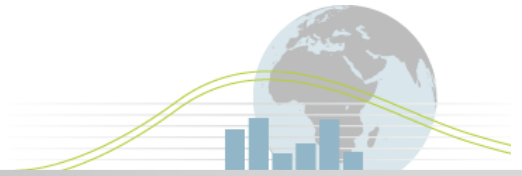
- Following 30th April 2008 (1 January 2010 onward for freezers) the requirements were raised to the following<sup>7</sup>:

<sup>6</sup> Page 41 of Notice 2007-70 (Refrigerator KS C 9305) (from 1 October 2004 onward only for freezers)

<sup>7</sup> Page 125 of Notice 2009-158 (Refrigerator KS C ISO 15502)







Items	MEPS From 30 April 2008
Refrigerator only	$P \leq 0.037AV + 16.75$
Refrigerator-freezer whose compensated cubic volume is less than 500 L	$P \leq 0.025AV + 29.45$
Refrigerator-freezer whose compensated cubic volume is no less than 500 L without ice-dispenser or homebar door	$P \leq 0.043AV + 16.19$
Refrigerator-freezer whose compensated cubic volume is no less than 500 L with ice-dispenser or homebar door	$P \leq 0.043AV + 16.19$ +4.4 (through-the-door ice dispenser) +0.044 (the length of the actual sealing perimeter of the homebar door of fresh compartment, cm) +0.073 (the length of the actual sealing perimeter of the homebar door of freezer compartment, cm)

Remark)

1.  $AV = \text{compensated cubic volume} = \sum \{ \{ \text{cubic volume of the each compartment} \} \times K \times F \}$

- 1) K value in the refrigerator only is 1
- 2) K value in refrigerator-freezer is

$$K \text{ (compensation coefficient)} = \frac{T_1 - T_c}{T_1 - T_2}$$

Where

$T_1$ =ambient temperature in testing(25 °C)

$T_2$ =averaging indoor temperature of the fresh compartment(5 °C)

3) F = 1.2 if it is auto defrost, otherwise F=1.0

2.  $P = \text{Maximum power consumption (kWh/month)}$

Item	MEPS
	From 1 <sup>st</sup> of January, 2010
Freezer	$P \leq 0.028AV + 32.40$

Remark)

1.  $AV = \text{compensated cubic volume} = \sum \{ \{ \text{cubic volume of the each compartment} \} \times K \times F \}$

$$K \text{ (compensation coefficient)} = \frac{T_1 - T_c}{T_1 - T_2}$$

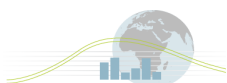
Where

$T_1$ =ambient temperature in testing(25 °C)

$T_2$ =averaging indoor temperature of the fresh compartment(5 °C)

F = 1.2 if it is auto defrost, otherwise F=1.0

2.  $P = \text{Maximum power consumption (kWh/month)}$



## 1.6 Mandatory Energy Labelling

The Energy Labelling of Refrigerators has been mandatory in Korea since 1992. Over time the label has evolved in appearance with the most recent including a CO<sub>2</sub> emissions value.



The values are defined on a 1-5 scale (1 being the best, 5 the worst). Values are calculated based on a ratio defined by the MEPS value and were revised in 2004. Values for 1 April 2008 (1 January 2010 for freezers) are<sup>8</sup>:

- Refrigerators:

### A. Energy Efficiency Level Index

$$R(\text{Energy Efficiency Level Index}) = \frac{\text{MEPS [kWh/month]}}{\text{Measured monthly power consumption [kWh/month]}}$$

### B. Energy Efficiency Level

R	Level
1.60 ≤ R	1
1.45 ≤ R < 1.60	2
1.30 ≤ R < 1.45	3
1.15 ≤ R < 1.30	4
1.00 ≤ R < 1.15	5

- Freezers (note for the period to January 2010, current freezer label efficiency levels are based on Target Energy Performance Standards (TEPS) rather than MEPS):

<sup>8</sup> Page 125 of Notice 2009-158 (Refrigerator KS C ISO 15502)

A. Energy Efficiency Level Index

$$R(\text{Energy Efficiency Level Index}) = \frac{\text{MEPS [kWh/month]}}{\text{Measured monthly power consumption [kWh/month]}}$$

B. Energy Efficiency Level

R	Level
$2.20 \leq R$	1
$1.90 \leq R < 2.20$	2
$1.60 \leq R < 1.90$	3
$1.30 \leq R < 1.60$	4
$1.00 \leq R < 1.30$	5

1st grade products save 30~40% more energy than 5th grade products.

1.7 *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 Korean Energy Management Company (KEMCO) and made publicly available on the internet (<http://www.kemco.or.kr>). The latest regulations also include a requirement to submit annual sales figures.

**Section 6: Notes on Cultural Issues**

No notes

