Country:	Republic of Korea
Technology:	Air Conditioners
Sub Category:	Residential, Unitary (Packaged), Split and Multi-split

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:

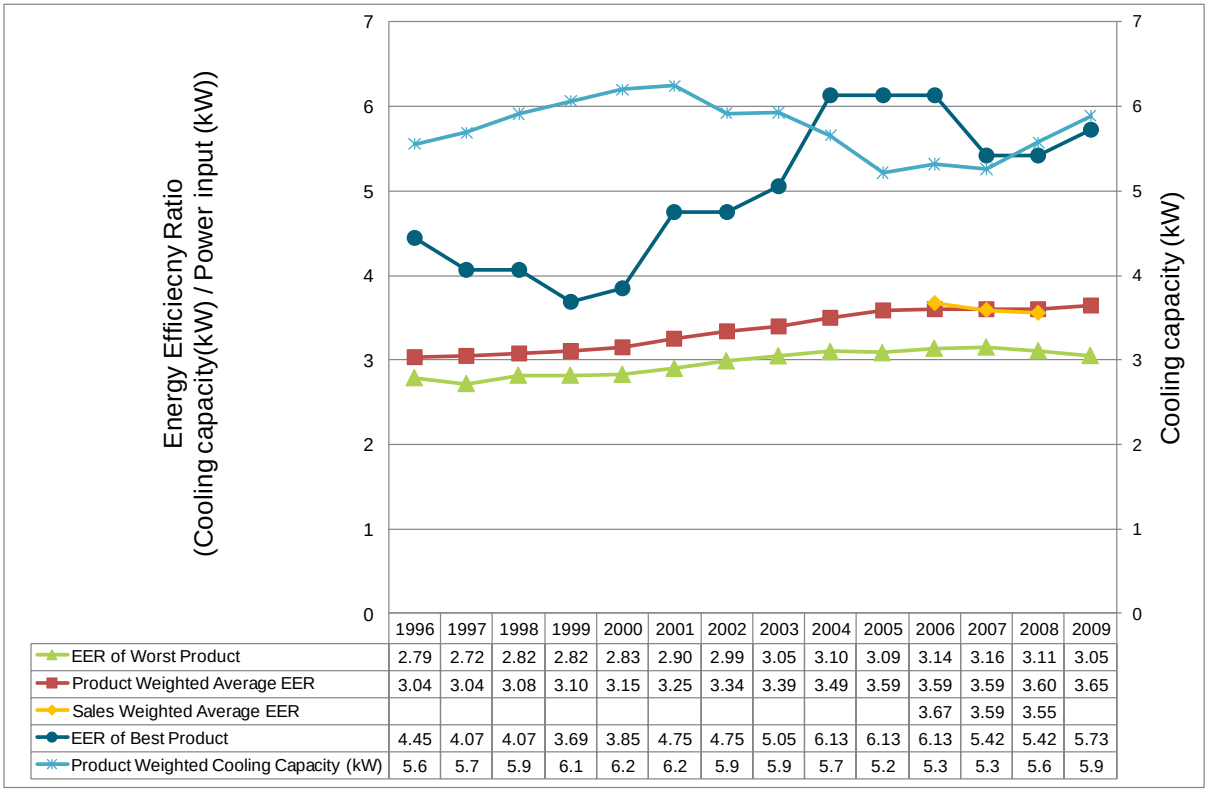
<table>
<tr><td>Definition & scope</td><td colspan="3">‘Air conditioners used in dwellings and designed to maintain the temperature of indoor air at a given temperature level for a given heat load to be extracted.’

Including only:
Products of up to 14 kW cooling capacity (indicative, to exclude products used only in commercial premises)
Electrically driven vapour compression (Absorption units excluded)
Cooling only units, and cooling function of reverse cycle units. (Data for heating cycle / heat pumps to be invited but not analysed).
Air cooled condensers, and water/condensate spray assisted (water cooled units excluded)
Only air to air units (water chillers excluded)</td></tr>
<tr><td>Type</td><td>Unitary
(‘packaged’, in single mounting, including double duct units)</td><td>Split units,
(single room unit and single condenser linked by pipe-work)</td><td>Multi-split
(two or more room units and single condenser linked by pipe-work)</td></tr>
<tr><td>Other variables invited (but not analysed)</td><td colspan="3">Mounting (Window / thru-wall; Other fixed mounting; Mobile)
Variable speed drive / multi-speed compressor (yes / no)
Refrigerant (designated according to ASHRAE refrigerant numbering system)
Standby consumption</td></tr>
</table>

Important note: Ducted air conditioners (central) are excluded from this analysis as they are not generally used outside of the USA and Canada.

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

Energy Efficiency Ratio of New Residential Air Conditioners - Republic of Korea

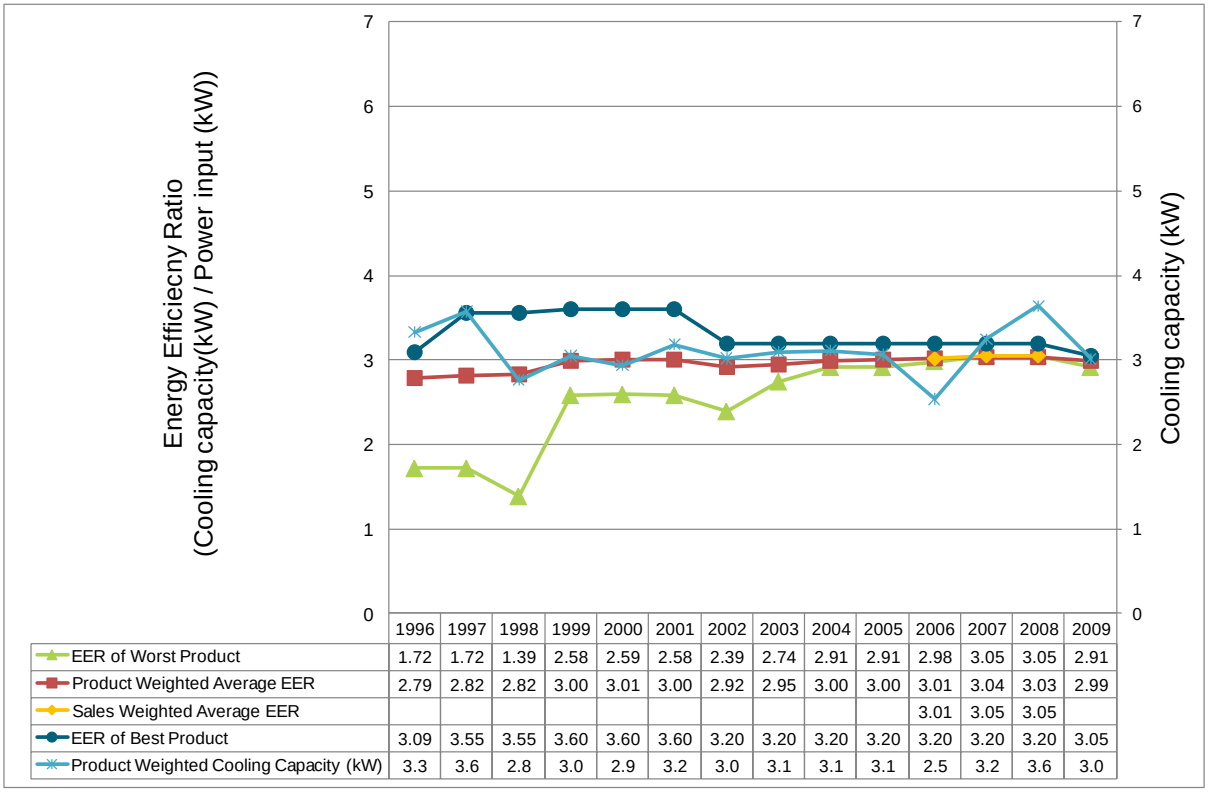


	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
EER of Worst Product	2.79	2.72	2.82	2.82	2.83	2.90	2.99	3.05	3.10	3.09	3.14	3.16	3.11	3.05
Product Weighted Average EER	3.04	3.04	3.08	3.10	3.15	3.25	3.34	3.39	3.49	3.59	3.59	3.59	3.60	3.65
Sales Weighted Average EER											3.67	3.59	3.55	
EER of Best Product	4.45	4.07	4.07	3.69	3.85	4.75	4.75	5.05	6.13	6.13	6.13	5.42	5.42	5.73
Product Weighted Cooling Capacity (kW)	5.6	5.7	5.9	6.1	6.2	6.2	5.9	5.9	5.7	5.2	5.3	5.3	5.6	5.9

Key notes on Graph (see notes section 1)

- This graph includes unitary (packaged), split and multi-split products under 14kW cooling capacity. The EER units are kW per kW.
- The dataset is considered representative of the whole market for split and packaged / unitary products as it is derived from a Government mandatory registration scheme. But the scheme excludes multi-split and all portable product types.
- The data source was the mandatory registration scheme database for February 2010 which includes products registered in earlier years. Products available in each year were assumed to be those registered in the given year, plus those registered in the previous year for 2008-9 and previous 2 years for years 1996-2007 (ie 2008 includes all products registered in 2008 and 2007 while 2007 includes 2007, 2006 and 2005). In addition, products that did not meet the MEPS prevalent at the year in question were deleted from the data set.
- The database was also populated with sales figures for 2006-8 which have been used to calculate sales weighted averages for those years. All products that had recorded sales in 2006, 2007 and 2008 are included in the product weighted average calculations for that year (not restricted to only one or two prior years as described above).
- In order to indicate a Worst performing product that reflects the broad market (as opposed to representing perhaps a single unusual or wrongly reported product), the 'EER of worst product' is in fact the EER of the product at the 'worst 5%' point of a ranked list in the dataset. The Best performing product is that with the highest EER.
- In 2009 unitary and split products were sold in the following proportions:
  Unitary (packaged): 1% Split: 99%

Energy Efficiency Ratio of New Unitary Air Conditioners Republic of Korea

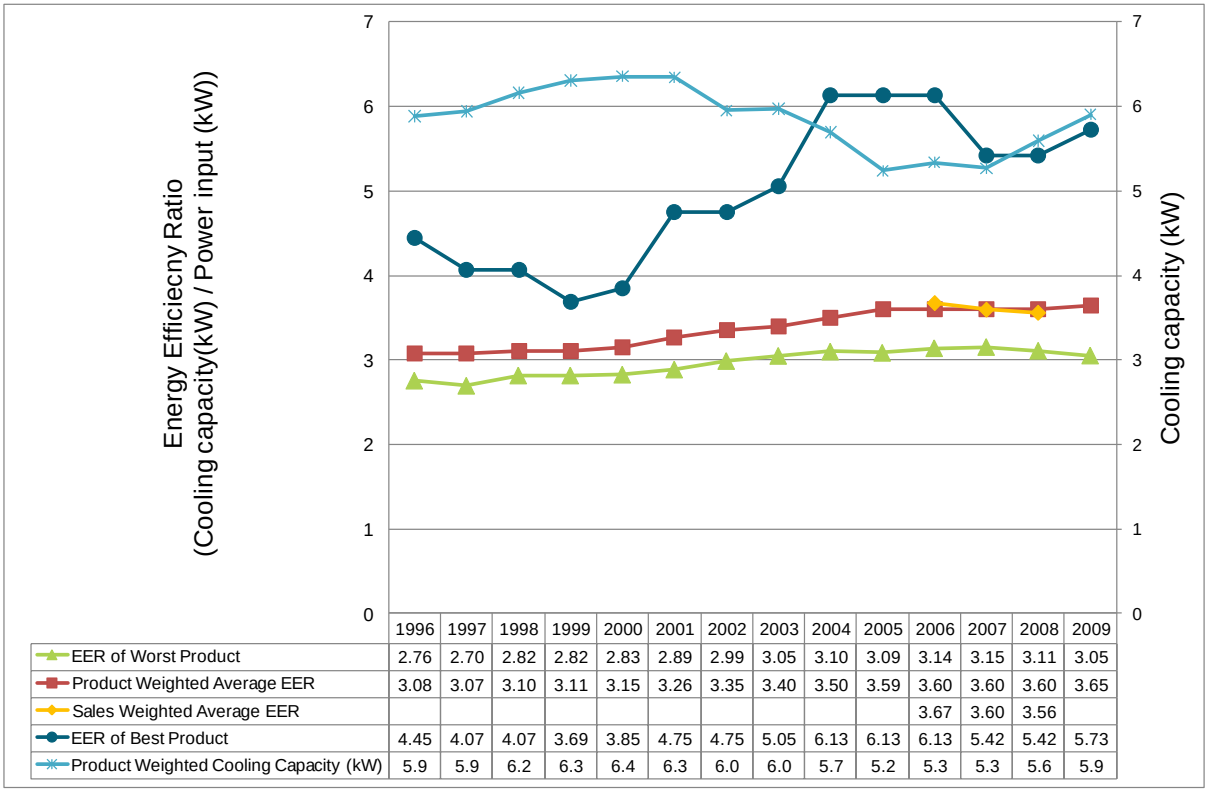


	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
EER of Worst Product	1.72	1.72	1.39	2.58	2.59	2.58	2.39	2.74	2.91	2.91	2.98	3.05	3.05	2.91
Product Weighted Average EER	2.79	2.82	2.82	3.00	3.01	3.00	2.92	2.95	3.00	3.00	3.01	3.04	3.03	2.99
Sales Weighted Average EER											3.01	3.05	3.05	
EER of Best Product	3.09	3.55	3.55	3.60	3.60	3.60	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.05
Product Weighted Cooling Capacity (kW)	3.3	3.6	2.8	3.0	2.9	3.2	3.0	3.1	3.1	3.1	2.5	3.2	3.6	3.0

Key notes on Graph (see notes section 1)

- This graph includes unitary (packaged) air conditioners with cooling capacity under 14kW. The EER units are kW per kW.
- The dataset is considered representative of the whole market for packaged / unitary products as it is derived from a Government mandatory registration scheme, but very few unitary products are registered in the Republic of Korea.
- The data source was the mandatory registration scheme database for February 2010 which includes products registered in earlier years. Products available in each year were assumed to be those registered in the given year, plus those registered in the previous year for 2008-9 and previous 2 years for years 1996-2007 (ie 2008 includes all products registered in 2008 and 2007 while 2007 includes 2007, 2006 and 2005). In addition, products that did not meet the MEPS prevalent at the year in question were deleted from the data set.
- The database was also populated with sales figures for 2006-8 which have been used to calculate sales weighted averages for those years. All products that had recorded sales in 2006, 2007 and 2008 are included in the product weighted average calculations for that year (not restricted to only one or two prior years as described above).
- In order to indicate a Worst performing product that reflects the broad market (as opposed to representing perhaps a single unusual or wrongly reported product), the 'EER of worst product' is in fact the EER of the product at the 'worst 5%' point of a ranked list in the dataset. The Best performing product is that with the highest EER.

Energy Efficiency Ratio of New Split Air Conditioners Republic of Korea



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
EER of Worst Product	2.76	2.70	2.82	2.82	2.83	2.89	2.99	3.05	3.10	3.09	3.14	3.15	3.11	3.05
Product Weighted Average EER	3.08	3.07	3.10	3.11	3.15	3.26	3.35	3.40	3.50	3.59	3.60	3.60	3.60	3.65
Sales Weighted Average EER											3.67	3.60	3.56	
EER of Best Product	4.45	4.07	4.07	3.69	3.85	4.75	4.75	5.05	6.13	6.13	6.13	5.42	5.42	5.73
Product Weighted Cooling Capacity (kW)	5.9	5.9	6.2	6.3	6.4	6.3	6.0	6.0	5.7	5.2	5.3	5.3	5.6	5.9

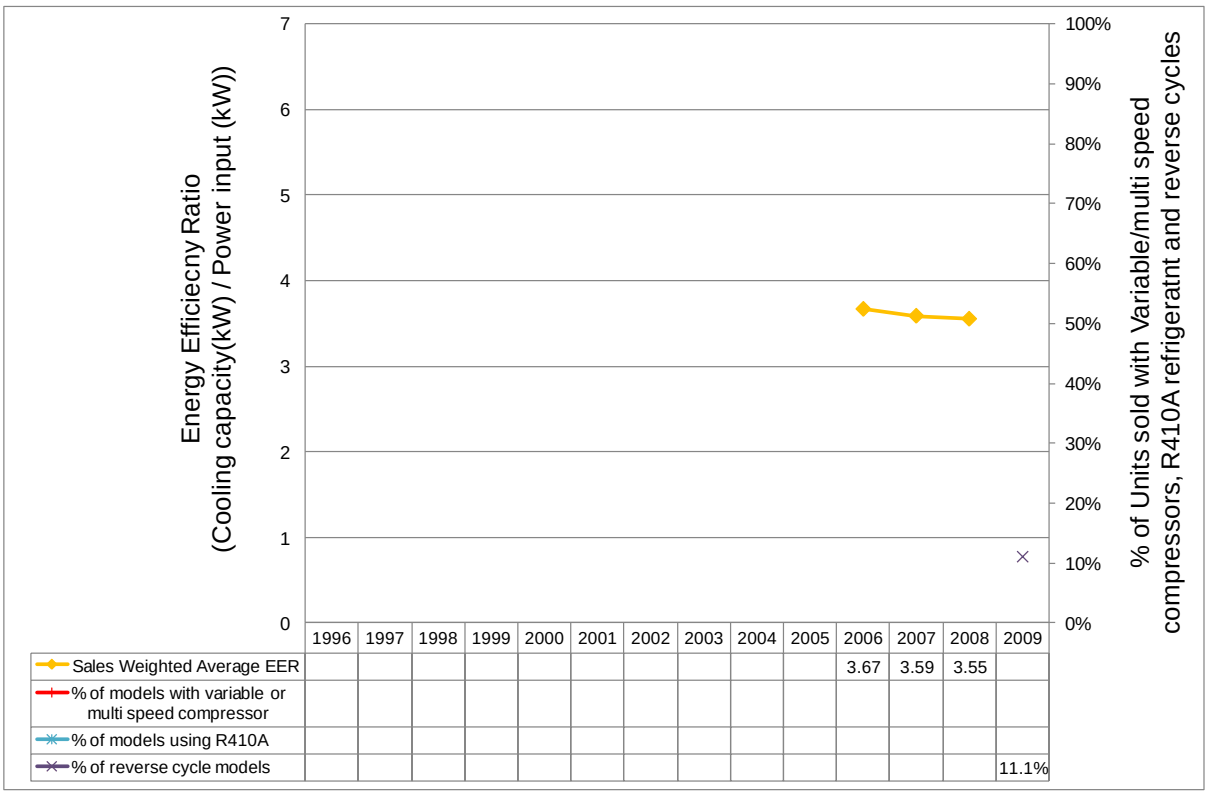
Key notes on Graph (see notes section 1)

- This graph includes unitary (packaged) air conditioners with cooling capacity under 14kW. The EER units are kW per kW.
- The dataset is considered representative of the whole market for packaged / unitary products as it is derived from a Government mandatory registration scheme, but very few unitary products are registered in the Republic of Korea.
- The data source was the mandatory registration scheme database for February 2010 which includes products registered in earlier years. Products available in each year were assumed to be those registered in the given year, plus those registered in the previous year for 2008-9 and previous 2 years for years 1996-2007 (ie 2008 includes all products registered in 2008 and 2007 while 2007 includes 2007, 2006 and 2005). In addition, products that did not meet the MEPS prevalent at the year in question were deleted from the data set.
- The database was also populated with sales figures for 2006-8 which have been used to calculate sales weighted averages for those years. All products that had recorded sales in 2006, 2007 and 2008 are included in the product weighted average calculations for that year (not restricted to only one or two prior years as described above).
- In order to indicate a Worst performing product that reflects the broad market (as opposed to representing perhaps a single unusual or wrongly reported product), the 'EER of worst product' is in fact the EER of the product at the 'worst 5%' point of a ranked list in the dataset. The Best performing product is that with the highest EER.

Energy Efficiency Ratio of New Multi-split Air Conditioners Republic of Korea

No data on multi-split products was available to the annex at the time of publication as they are excluded from the mandatory registration scheme in the Republic of Korea.

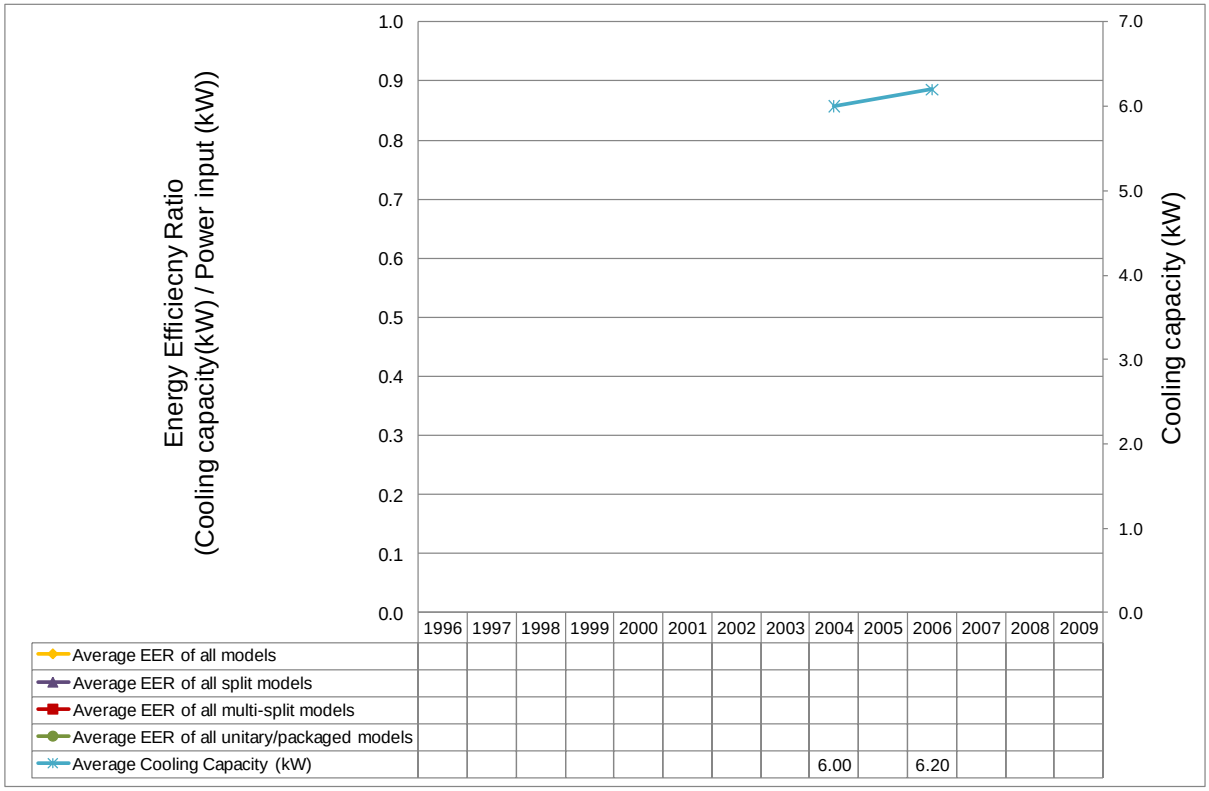
Other Characteristics of New Residential Air Conditioners Republic of Korea



Key notes on Graph (See notes section 2)

- The dataset is considered representative of the whole market for split and packaged / unitary products as it is derived from a Government mandatory registration scheme. But the scheme excludes multi-split and all portable product types.
- The data source was the mandatory registration scheme database for February 2010 which includes products registered in earlier years. Products available in each year were assumed to be those registered in the given year, plus those registered in the previous year for 2008-9 and previous 2 years for years 1996-2007 (ie 2008 includes all products registered in 2008 and 2007 while 2007 includes 2007, 2006 and 2005).
- The database was also populated with sales figures for 2006-8 which have been used to calculate sales weighted averages for those years. All products that had recorded sales in 2006, 2007 and 2008 are included in the product weighted average calculations for that year (not restricted to only one or two prior years as described above).
- Whilst no specific data is available on percentage of the market with inverter driven compressors, almost every product with a high EER is inverter driven on the Republic of Korea market, and their market share is increasing.

Energy Efficiency Ratios in the Installed Residential Air Conditioner Stock - Republic of Korea

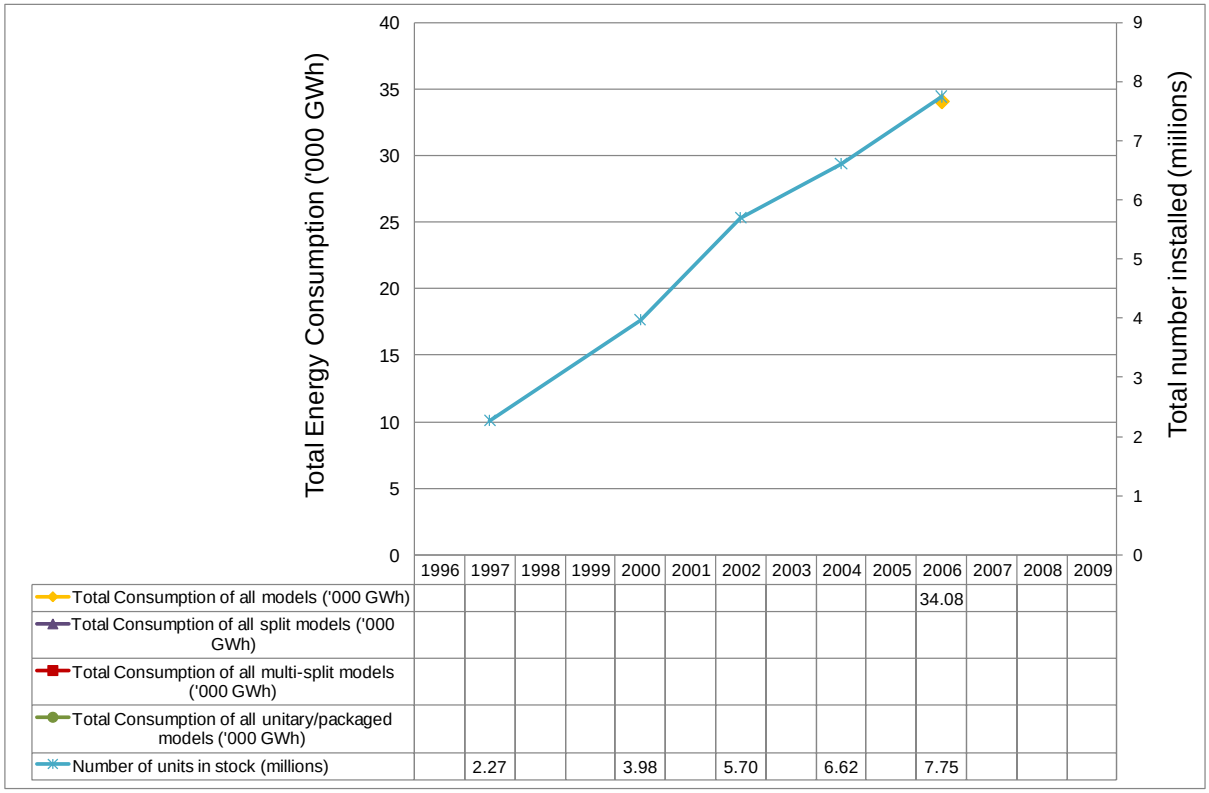


Key notes on Graph (See notes section 3)

- Data provided from 2006 survey results[1].

[1] Survey on Electricity Consumption Characters of Home Appliances (KPX(Korea Power Exchange), 2006.

Energy Consumption in the installed Residential Air Conditioner Stock - Republic of Korea



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total Consumption of all models ('000 GWh)											34.08			
Total Consumption of all split models ('000 GWh)														
Total Consumption of all multi-split models ('000 GWh)														
Total Consumption of all unitary/packaged models ('000 GWh)														
Number of units in stock (millions)		2.27			3.98		5.70		6.62		7.75			

Key notes on Graph (See notes section 4)

- Data provided from 2006 survey results[2].

[2] Survey on Electricity Consumption Characters of Home Appliances (KPX(Korea Power Exchange), 2006.

Major Policy Interventions (See notes Section 5)

An energy efficiency label was introduced for cooling only air conditioners in January 1994, and reverse cycle products were added to the scheme in January 2009. The energy label has five grades numbered 1 to 5 and the best products achieve grade 1. The policies exclude multi-split and portable products. Labels include requirements for standby consumption.

MEPS and energy label grade standards were introduced in 1994 and they were strengthened several times including an update in 2010. The MEPS level coincides with the lower limit of Grade 5 of the energy label. The energy label Grade thresholds are adjusted upwards whenever the MEPS are reviewed. A new set of standards came into force in January 2009 for reverse cycle products.

There is a mandatory product registration scheme for all unitary and split products, plus a voluntary registration scheme for multi-split products.

Additional policies include preferential procurement of high efficiency models (Energy Label grade 1) for Government purchases, public buildings and certain new apartment developments.

Cultural Issues (See Notes Section 6)

Average cooling capacity of the products in domestic market is increasing steadily because of consumers' preference for products with bigger capacity.

Market share of multi-split products linked by pipe-work or ducts is growing very fast because of their convenience and low electricity price in Korea. Air conditioning has become one of the main contributors to peak electricity load in summertime. However they are excluded in this data set because they are covered only by a voluntary High Efficiency Equipment Certification Program and there are as yet few certified models, accounting for a small proportion of the market.

Notes on data

Section 1: Notes on Product Energy Efficiency Ratio

1.1 Test methodologies, Performance Standards and Labelling Requirements

Cooling Energy Efficiency Ratio (CEER) shall be measured by the test method of KS C 9306, which is obtained from the cooling capacity divided by the cooling power consumption. (This test method is not available in English). The detailed test conditions are generally in line with ISO 5151 and ISO 13253 at Climate Class T1, except for a minor difference in that the indoor wet bulb temperature during test is 0.5°C higher than is used in other participating countries. One published report[3] provides analysis of what difference this makes to the reported EER figures, from which it is concluded that lowering the EER results by 1.2% (and capacity results by 1.6%) would render them comparable to ISO5151 Temperature class T1 results. Note that the test methodology is being amended and the conventional wet bulb temperature of ISO 5151will apply from January 2011.

The data in this report has not been adjusted as the existence of the anomaly only came to light after the analysis process, and the adjustment is small. The data for the Republic of Korea will be normalised for comparison in the benchmarking analysis.

1.2 Product Energy Efficiency Ratio Graphic

Source:

The data for this graphic is the Government mandatory registration scheme.

Key calculations undertaken:

No additional normalisations were required for the mapping analysis as the test conditions are very close to Climate Class T1. As noted above, a slight normalisation adjustment will be made for the mapping analysis.

Usage assumptions:

No usage assumptions required – consumption data provided from Government modelling.

Proportion of data set included:

The data source was the mandatory registration scheme database for February 2010 which includes products registered in earlier years. Products available in each year were assumed to be those registered in the given year, plus those registered in the previous year for 2008-9 and previous 2 years for years 1996-2007 (ie 2008 includes all products registered in 2008 and 2007 while 2007 includes 2007, 2006 and 2005). In addition, products that did not meet the MEPS prevalent at the year in question were deleted from the data set.

[3] APEC-ESIS report: *Benchmarking Of Air Conditioner Efficiency Levels In Five Asian Countries*, Prepared For The Australian Greenhouse Office, Danish Energy Management, June 2004, page 11.

Section 2: Notes on Other Energy Related Metrics

2.1 Test methodologies, Performance Standards and Labelling Requirements

No additional information relevant. Refer to section 1.2

2.2 Other Energy Related Metrics

The other metrics used to characterise the market are:

- The percentage of market that use variable speed drives or multi-speed compressors. These features improve efficiency in real use by more closely matching capacity to cooling demand, although efficiency under standard test conditions may not show savings.
- The percentage of market that use refrigerant R410A. This is a high pressure refrigerant fluid that has become commonly used throughout the world. It has been chosen for these graphs as indicative of the move to HFC refrigerants (away from CFCs / HCFCs).
- The percentage of the market that are reverse cycle products. These can be used for heating as well as cooling (often referred to as heat pumps, and in the Republic of Korea as 'EDH' – Electrically Driven Heat pumps).

Section 3: Notes on EER of Stock

None.

Section 4: Notes on Consumption of Stock

None.

Section 5: Notes on Policy Interventions

No further issues to add.

Section 6: Notes on Cultural Issues

None.