

D2.2 - Topten ACT Criteria Paper

Household refrigerators & freezers

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Topten ACT aims at transforming the European market of energy-using products towards higher energy efficiency.

Topten ACT identifies the top energy-efficient products in 16 European countries, and makes this information available to consumers and large buyers on tailored national websites. The most energy efficient models in different product categories (such as household appliances, lighting, office equipment, consumer electronics, cars) are presented with comprehensive product information based on official labels and standardized declarations. Topten works with manufacturers and thus increases both market offer and consumer demand of high energy efficiency products. Topten is strictly neutral and independent from manufacturers and retailers, its selection criteria are always published online.

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More information and access to all national websites on the European site: www.topten.eu

WP2 European Product Analysis , Task 2.1 Determining energy efficiency criteria, D 2.2 Periodic Criteria Papers (second set)

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1. Topten.eu, refrigerators & freezers: current selection criteria and products selected

Topten.eu selection criteria in August 2018:

Energy efficiency	Class A+++
Annual energy consumption	Max. 200 kWh/year

Declarations according to the Energy Label.

Number of refrigerators and freezers currently on Topten.eu (August 2018):

Refrigerators*		Built-in	Freestanding	Total
Without freezer		28	24	52
With freezer compartment	1-door	36	11	47
	2-door	24	55	79
Total		88	90	178

Freezers*	
Chest freezers	18
Upright freezers	53
Total	71

*Similar models have not been counted if from the same brand.

There are 178 refrigerator and 71 freezer models on the Topten.eu product lists, of 19 different brands: AEG, Bauknecht, BEKO, Blomberg, Bosch, Comfee, Electrolux, Haier, Gorenje, Küppersbusch, LG, Liebherr, Miele, Neff, Panasonic, Samsung, Sibir, Siemens and V-ZUG. There are almost as many freestanding as built-in refrigerator models, and the vast majority has a freezer compartment. There are thrice as many upright freezers on Topten than chest freezers.

Selection criteria should be defined cautiously, not only considering the energy efficiency, but also absolute energy consumption. The Label classes do not communicate that refrigerators without freezer compartment consume 50% less energy than combined refrigerator-freezers. Because the EEI formula is favouring them (see boxes below), there are many more A+++ combi models than simple refrigerators – despite the large energy consumption differences. Also the higher energy consumption of other factors is ‘hidden’ by the EEI formula instead of made transparent: frost-free function (which is actually a heater in the freezer), models fit for tropical climate (thanks to oversized compressors), built-in models (less insulation, less ventilated condenser), models with chill compartment (cold 0°C).

2. Expected selection criteria in 2019

At the moment it is difficult to define more ambitious criteria, since there are only models from the best efficiency class on Topten.eu already. The only possibility to tighten the criteria is with a lower annual energy consumption:

Topten.eu selection criteria expected for 2019:

Energy efficiency	Class A+++
Annual energy consumption	170 kWh/year?

3. Technical background

Refrigerators and freezers are basically an insulated box with a heat pump and a thermostat. The heat pump consists of a refrigerant fluid circulating in the system of evaporator, compressor, condenser and expansion valve and thus transporting heat from inside to the outside of the appliance. Whenever it switches on, the compressor drives the cycle with electrical energy. Household refrigerators and freezers use natural refrigerant R-600a (isobutane), with low global warming potential (GWP). Fridge-freezers can be operated with one or two compressors (but in any case two heat exchangers). Some efficient models use variable speed-compressors, but also single speed motors are used. The best insulation applied are vacuum insulation panels (VIP), with polyurethane as core material in most cases.

A different technology is used by absorber refrigerators. This technology is very inefficient, but silent (no compressor). Therefore it is common in minibars.

4. Policy measures, standards and labels

Apart from the mandatory EU Energy Label, there are no other Ecolabels for refrigerators and freezers (e.g. EU Ecolabel, Blue Angel).

The EU Energy Labelling and Ecodesign regulations cover household refrigerators and freezers, wine coolers and minibars. Both regulations are currently being revised, with the final vote supposed to take place by the end of 2018.

Expected savings from the revision are 9.6 TWh/yr in 2030 and GHG emission savings of 3.1 MtCO₂eq./a (according to the August 2018 draft of the new Labelling regulation).

Energy Label

The original Energy Label for refrigerators and freezers introduced in 1995; today's version is based on regulation No. 1060/2010. The Label shows the following quality aspects:

- energy efficiency class: the classification is based on the energy efficiency index (EEI)
- annual energy consumption (kWh/year)
- storage volume cooling / freezing in litres
- noise emissions (dB(A))



Wine coolers have a separate Label, which shows the number of standard bottles instead of storage volume.

Additionally, the Label Fiche must inform about the category of the model (there are ten categories, but only five are 'active': cat. 1: refrigerators without freezer compartment, cat. 2 wine coolers, cat. 7: refrigerator-freezers, cat. 8 upright freezers, cat. 9 chest freezers), if the freezer compartment has a frost-free function, is intended to be built-in, its climate class and some additional information.

The table below shows that currently only three classes remain on the market.

Energy efficiency	EEl	Comments
A+++	< 22	
A++	< 33	
A+	< 42	
A	< 55	These classes have been banned from the market stepwise. Class A is banned since July 2014.
B	< 75	
C	< 95	
D	< 110	
E	< 125	
F	< 150	
G	≥ 150	

The energy efficiency index (EEl) is calculated as follows:

$EEl = A_{Ec} / SAEc \times 100$, with

- A_{Ec} is the annual energy consumption of the model in kWh/year that has been calculated from the test result
- $SAEc$ is the standard annual energy consumption, to which the test result is compared to – the reference. See box below about its calculation.

The $SAEc$ is calculated based on the storage volume of the different compartments, taking into consideration their temperature. The volume of freezer compartments is multiplied with 2.15, to account for the lower compartment temperature. The incline of the $SAEc$ – the additional energy consumption ‘allowed’ per additional litre of adjusted volume – depends on the category (refrigerator with or without freezer compartment, chest freezer..). Additionally, the $SAEc$ formula contains ‘correction factors’ for specific features: for a frost-free function, built-in design, tropical and sub-tropical climate classes and a chill compartment (0°C).

The formula is not as easy as one would think it is for a chilled box. If you need to calculate the EEl, have a close look at pages 40-45 of the Labelling regulation, or ask Juraj, Andrea or Anette.

In August 2017, the new Energy Labelling framework Regulation (EU) 2017/1369 entered into force, repealing Directive 2010/30/EU11. Under the repealed Directive, energy labels were allowed to include A+ to A+++ classes to address the overpopulation of the top classes. Over time, due to technological development, also the A+ to A+++ class became overpopulated, thereby significantly reducing the effectiveness of the labels. To resolve this, the new framework regulation requires a rescaling of existing energy labels, back to the original A to G scale¹.

The complexity of EEl technical equations will not be changed in the revision. Correction factors remain almost unchanged.

Ecodesign requirements

The Ecodesign regulation for refrigerators and freezers No. 643/2009 applies since July 2010. On that date it banned class B from the market. Class A was banned in two steps (July 2012: $EEl < 44$, July 2014: $EEl < 42$). The reason is that, with the introduction of the Ecodesign regulation, the measurement tolerance for the declared energy consumption was

¹ Energy Label draft from August 2018, repealing Regulation (EU) No 1060/2010, Explanatory Memorandum Art.1

tightened to 10%. It seems that some models had troubles meeting compliance with this tightened tolerance, therefore more time was given to manufacturers to adapt. Wine coolers and absorption refrigerators (mostly minibars) are exempted from these requirements. Instead, absorbers must meet class D (EEI < 110) since 1st July 2015. For wine coolers there are no efficiency requirements to date.

In the current (August 2018) draft of the Ecodesign revision, minimum requirements cover refrigeration appliances, wine storage appliances and minibars (low noise refrigeration appliances) in two tiers: 1.04.2021 and 01.04.2024. Separate minimum requirements are set each for wine storage appliances with solid door, with transparent doors, minibars with solid door and with transparent doors.

Measurement standard

Household refrigerators & freezers are currently tested based on EN 62552:2015. This standard tests at 16°C and 32°C ambient temperature and includes door openings. Each region around the globe that wants to use this standard can define how it is weighting the results for the two ambient temperatures to reach a result relevant for the regional climate. For Europe, the two test conditions are weighted to either reach an ambient temperature of 24°C or, like for EN 62552:2013, 25°C. The fresh food storage temperature is set to 4°C, and additional compartments are by the standard (pantry – 17°C, wine – 12°C, chill 0°C). The globally harmonised standard allows comparing and using results across regions.

5. Market analysis

Market: 68% A+ in 2015

The Topten market monitoring report from March 2017 (published in ECEEE 2017 Summer study), based on sales data from GfK, has shown that the average efficiency index of refrigerators (including refrigerator-freezers, but not separate freezers) across the EU has improved by 37% from 2004 to 2015 (the average EU efficiency index in 2015 was 39 – in A+).

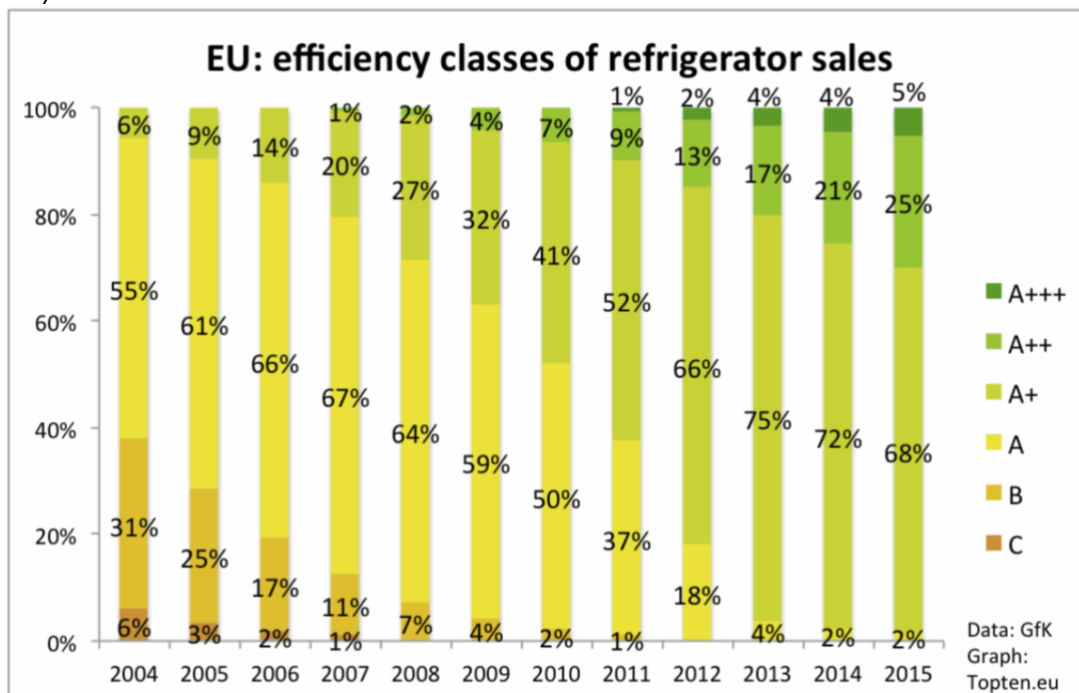


Figure 1 EU: efficiency classes of refrigerator sales

The average energy consumption in 2015 was 229 kWh/year. Average volume of refrigerators according to energy classes is shown in Figure 2.

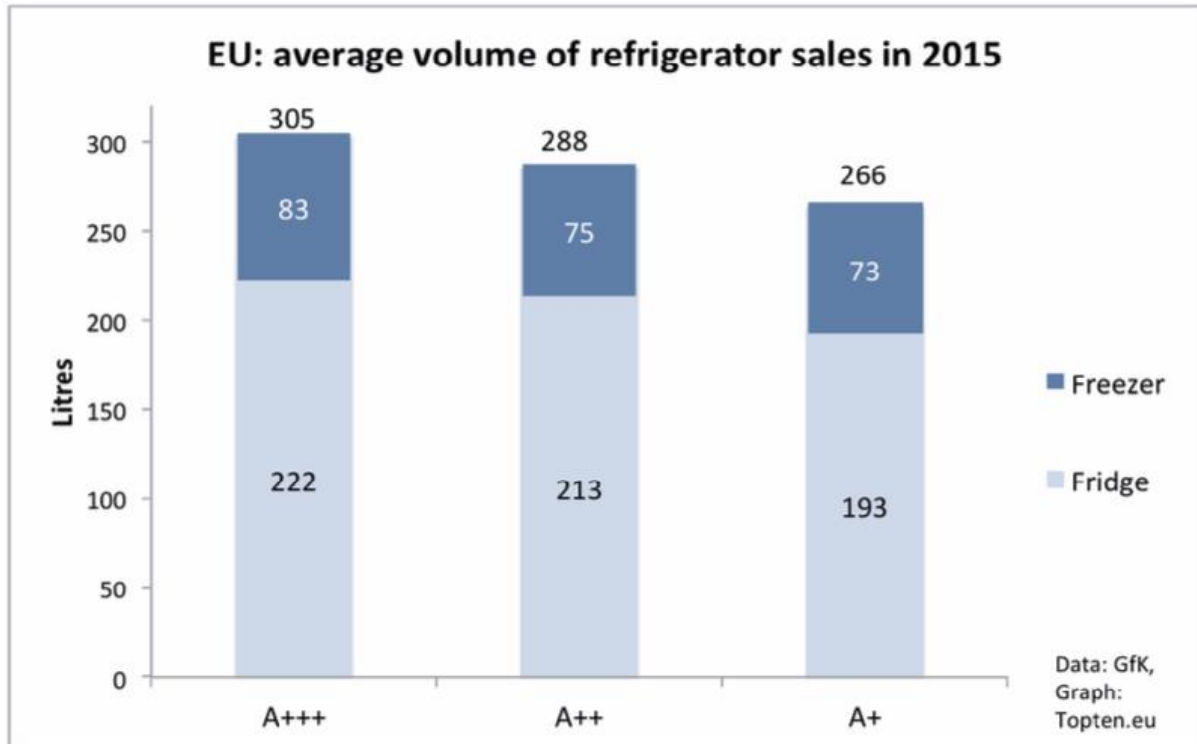


Figure 2 EU: average volume of refrigerator sales according to classes in 2015

The report showed that the reduction of the declared energy consumption (26%) was lower than the efficiency increase (37%) over the past 14 years. The volume has only increased by 3% (Michel, Attali, Bush, 2016), so the main reason for the difference are likely energy-consuming features that are not reflected in the energy classes (different reference lines for different refrigerator types, ?correction factors? For frost-free, inbuilt and tropic models and chill compartments) (Michel, Attali, Kreitz, Bush, 2017).

According to the interim preparatory study from VHK, the vast majority of all models are combined fridge-freezers (around 60%), and there is a trend to more built-in appliances (29% in 2014), tropical climate class (73%) and models with defrost function (40%) (these results are based on a model database from CECED).

These are all aspects leading to higher energy consumption, while the EEI formula does 'correct' for it and the Label class is not showing it.



6. FAQ

Refrigerator with or without freezer compartment?

In case you have a separate freezer or need none: from the energy point of view it is advisable to buy a refrigerator without freezer compartment. The Energy Label does not communicate these differences well, but a combi fridge-freezer consumes twice as much energy as a refrigerator without freezer compartment.

When comparing the energy consumption of A+++ refrigerator without freezer and chest freezer (75 kWh + 120 kWh = 195 kWh) and a rather large A+++ combi model (170 kWh), the latter is slightly favourable from an energy point of view (but includes only 90 instead of > 200 litres of freezer volume). So, it mainly depends on the freezer volume you need.

Chest or upright freezer?

Chest freezers offer a lot of storage room, are robust, usually cheaper than upright freezers and consume less energy. Upright freezers might be the more comfortable choice because they fit better into the kitchen and offer handy drawers.

7. References and links

Useful links

Topten.eu refrigerators and freezers selection criteria (and product lists):

www.topten.eu/english/criteria/freezers_ak.html&fromid=

References

Energy Labelling regulation No 1060/2010 for household refrigerating appliances:

www.topten.eu/uploads/File/Energy%20Label%20regulation%20cold%202010.pdf

Ecodesign regulation No. 643/2009 for household refrigerating appliances:

www.topten.eu/uploads/File/Household_refrigerator_regulation_090723.pdf

Topten policy recommendations, January 2018:

http://www.topten.eu/uploads/File/PolicyRecommendations_2018_JE.pdf

Monitoring the market based on sales data: Do 2015 white goods consume less energy than ten years ago? TIS, ECEEE Summer Study 2017.

https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2017/8-monitoring-and-evaluation-building-confidence-and-enhancing-practices/monitoring-the-market-based-on-sales-data-do-2015-white-goods-consume-less-energy-than-ten-years-ago/

Energy efficiency of white goods in Europe: monitoring the market with sales data. TIS, 3. June 2015. www.topten.eu/uploads/File/WhiteGoods_in_Europe_June15.pdf

Revision of the Labelling and Ecodesign regulations, preparatory study project website:

<http://www.ecodesign-fridges.eu/Pages/welcome.aspx>

VHK, Ecodesign and Labelling review, household refrigeration: preparatory / review study. Interim report, 1.6.2015.