

Household refrigerators and freezers: Recommendations for policy design

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Summary

The efficiency development of cold appliances over the last 20 years is a success story. Nevertheless, there are still large improvement potentials and the current revision of the Energy Labelling and Ecodesign regulation can support developments towards refrigerators and freezers consuming even less energy.

Scope

- Wine coolers and minibars should remain in the scope of the domestic refrigeration regulations
- Furthermore, wine coolers and minibars with a transparent door should be covered by the domestic and not by the commercial refrigeration regulations
- Wine coolers, minibars and professional as well as commercial static air appliances should be explicitly mentioned in the scope of the regulation

Energy Labelling classes and Minimum Energy Performance Standards (MEPS)

- Topten accepts the proposed energy labelling classes and minimum efficiency requirements
- Topten data shows that the proposed classes are adequately ambitious, as best available technologies can reach the proposed new A class with 21% to 41% efficiency improvements, depending of the type of appliance
- Energy Labelling classes and minimum efficiency requirements should therefore not be relaxed and the timing for the introduction of the new regulations should be kept as tight as possible

EEL Formula and Compensation Factors

- Topten welcomes that the new EEL formula is not based on the volume of 10 different categories anymore
- Unfortunately, there are still many compensation factors that blur the real impact additional features have on the energy consumption of appliances. Topten generally opposes compensation factors, such as the proposed multi-door, the highly increased combi-factor and the discussed factor for glass doors

Resource Efficiency

- Topten welcomes the first steps made towards integrating resource efficiency requirements into the regulations
- However, more could have been done such as setting a minimum warranty duration of eight years, asking for an availability of spare parts for priority parts, ensuring standardised access to appliance repair and maintenance information etc.
- Due to the unknown risks and environmental disadvantages of halogenated hydrocarbons (HFOs), Topten calls for a ban of those substances as refrigerants and foam blowing agents in household refrigerators

1. Introduction

Refrigeration is responsible for 14% of residential electricity consumption (JRC, 2009). Household refrigerators were the first appliance to be labelled and regulated, and their efficiency has increased by around 60% since the 1990s. There is still a large saving potential – from a technical point of view, but also because of their large contribution to household energy consumption.

The legislation defining the Energy Label and the Ecodesign requirements for cold appliances (and other products) is currently being revised. Together with ECOS, Topten and other environmental organizations have written a position paper on current draft regulations. The following policy recommendations by Topten are based on this position paper showing how the future Energy Label and Ecodesign requirements can contribute to achieving a future stock of cold appliances that consumes considerably less energy.

2. Regulatory Context

Ecodesign and Energy Labelling regulations in force

Refrigerators have improved a lot in the 20 years since the first Energy Label was introduced in 1994: the least efficient refrigerators on today`s market are around 60% more efficient than the 1994 average. In 1996 first minimum energy efficiency requirements were announced and came into force in 1999 (EU Parliament and Council, 1996), banning the majority of classes D, E and F from the market. In 2004, 55% of the sold products were in class A (Figure 1), and the Label was amended, introducing the new A+ and A++ classes (EC, 2003). In 2009 more ambitious requirements were introduced (EC, 2009): Based on the Ecodesign regulation No 643/2009, products less efficient than class A were banned from the EU market in 2010. In 2011, the new Energy Label (No 1060/2010) including class A+++ was introduced (EC, 2010). In the period from 2012 to 2014, class A has been banned from the market in two steps (Energy Efficiency Index < 44 as of July 2012, EEI < 42 as of July 2014), considering the measurement tolerances that were tightened. Since July 2014, new models can only be in the classes A+, A++ and A+++.

Table 1 summarizes the EU policy measures for domestic refrigeration between 1995 and 2014. The last adjustments of the minimum energy efficiency requirements were made in 2012 (ban of class A) and the current best class (A+++) was already added in 2011. This timeline indicates the importance of the current revision of the Energy Label and Ecodesign regulation. Furthermore, since the new regulation will only enter into force in 2020, it is crucial to adopt the new regulations as soon as possible in order to avoid any delays.

Year of application	Measure
1995	Energy Label A-G
1999	Ban of classes D, E and F
2004	Label classes A+ and A++ added
2010	Ban of classes B and C
2011	Label class A+++ added
2012/2014	Ban of class A

Table 1: EU energy policies covering household refrigerators and freezers, source: Michel et. al (2016).

Now: Revisions

Since 2014 both Ecodesign and Labelling regulations are being revised. In 2015, a preparatory study was started by VHK and two stakeholder meetings were organised. The study was then published in 2016. In December 2017, a Consultation Forum meeting took place for a new Ecodesign and Energy Labelling regulation to be published in 2018.

Policies in other countries

Switzerland has banned A+ refrigerators and freezers since January 2013; hence only A++ and A+++ refrigerators are allowed on the Swiss market. For wine coolers Switzerland has also implemented stricter minimum efficiency requirements: since January 2013 only class A wine coolers are allowed on the market (Swiss Confederation, 2017). For professional wine coolers these requirements are implemented, too.

3. Market Developments

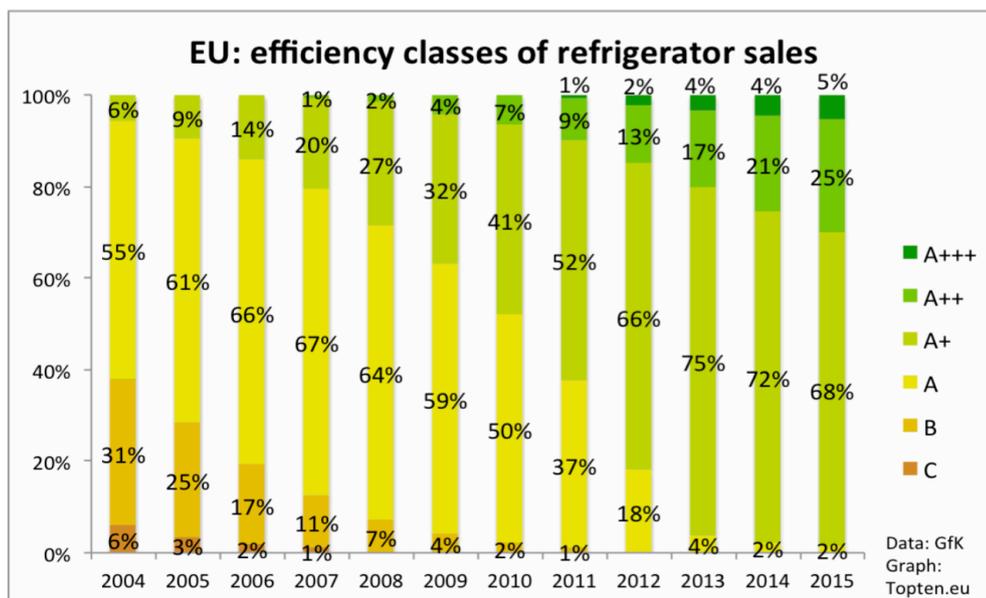


Figure 1: Efficiency classes of refrigerator sales in the EU, source: Michel et. al (2016).

The Topten market monitoring report (Michel et al., 2016) based on sales data has shown a constant efficiency improvement for refrigerators. Between 2004 and 2015, average refrigerator efficiency improved by 37% in this period. The report shows that at the same time, energy consumption has been reduced by 26% only. This deviation between efficiency gains and energy reduction must be due to oddities of the efficiency formula: this is rewarding features contributing to higher energy consumption (frost-free function, built-in, and tropic models, chill compartments, and a bias towards combi fridge-freezers) instead of making this transparent. Figure 1 and 2 illustrate the efficiency improvements and reductions in the average energy consumption of refrigerators between 2004 and 2005.

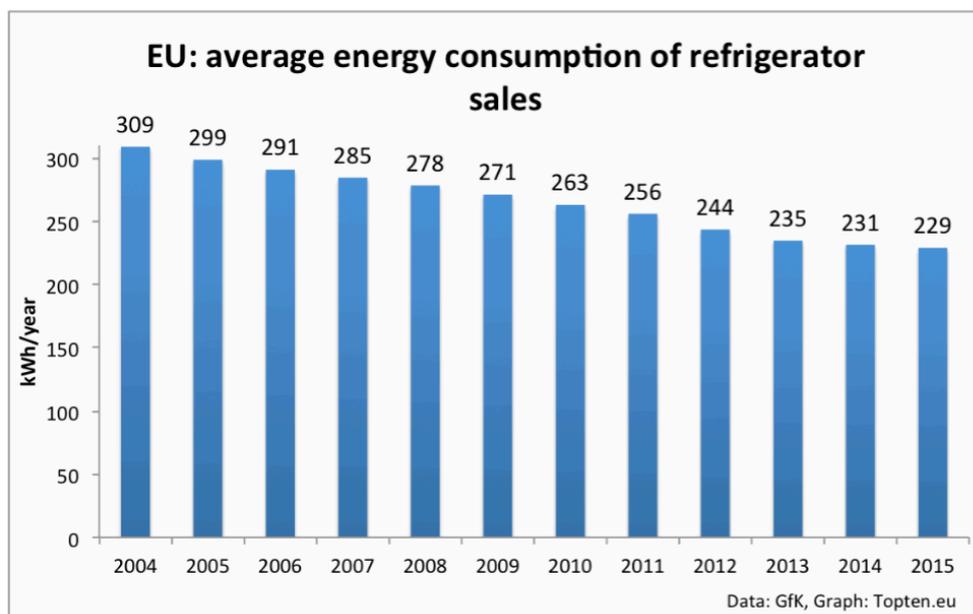


Figure 2: Average energy consumption of refrigerator sales in the EU between 2004 and 2015, source: Michel et. al (2016).

4. Best Available Technologies

Data from Topten shows that a large number of A+++ models is offered today: in January 2018, 151 refrigerator-freezers, 66 refrigerators and 70 freezers from 15 different brands were listed on Topten.eu – a total of 287 A+++ models (excluding models of similar construction).

Table 2 gives an example of best available technologies on topten.eu. Five refrigerator-freezers from different brands were chosen, all labelled with class A+++. The vast amount of A+++ models available on the market today, shows, that new incentives to produce even better technologies are necessary. Topten therefore welcomes the current revision of the Ecodesign and Energy Labelling regulation.

Brand	Liebherr	Liebherr	Siemens	Gorenje	Gorenje
Model	CP(ef)4315	CBPes 4358	KD33EAI40	RK LX/LW/LR/LCH/LC/LRD	6193 NRK 6193 TX
Total net volume (l)	335	321	293	322	302
Cooling compartment (l)	220	220	226	227	222
Freezing compartment (l)	115	101	67	95	80
Frost free	no	yes	no	no	yes
Energy class	A+++	A+++	A+++	A+++	A+++
EEI	17.7%	17.7%	21.4%	21.8%	21.8%
Energy (in kWh/year)	131	133	139	154	165

Table 2: Topten five best refrigerator-freezers (freestanding, 2-door, until 190 cm), source: Topten.eu.

2. Topten Policy Recommendations

Scope

The scopes of the regulations for domestic refrigeration, professional storage refrigeration (ENTR Lot 1) and commercial refrigeration (ENER Lot 12) should be carefully defined to avoid that important product categories are left out. While an Energy Labelling and Ecodesign regulation for professional storage refrigeration has been published in 2016, there exists still only a draft regulation for commercial refrigeration.

Definition 1., Article 2, in both, the proposed new Ecodesign and Energy Labelling draft regulations for household refrigerators, “includes equivalent refrigerating appliances used in non-household environments” as household refrigerating appliances. This implicitly includes wine coolers and minibars in the scope of the draft regulation. Topten welcomes the inclusion of wine coolers and minibars in this proposition. However, to avoid loopholes, Topten recommends to further explicitly mention wine coolers and minibars in the definition. Today, the formulation is not clear enough, and most wine coolers sold for non-domestic use (the vast majority) show no label.

Unfortunately, wine coolers and minibars with a display-function (transparent door) are not in the scope of the current draft regulation. Definition 6., Article 2 assigns them to the commercial refrigerating appliances, which are excluded from the regulation in Article 1, 2 (b). However, there is no reason to take out appliances with glass doors from the scope of the household regulation and cover them in a regulation for commercial products. Besides, consumers should be able to understand the impact of glass-door appliances/compartments on energy efficiency. Topten therefore also clearly opposes an introduction of a compensation factor, as discussed in the Explanatory Memorandum to the draft eco-design regulation. Instead of showing the consumer the real energy consumption of appliances with glass-doors, it would give an advantage to the more inefficient models.

Furthermore, technological solutions to increase the efficiency of transparent appliances/compartments already exist: Topten lists show that there is an A++ rated minibar with a glass door (IndelB/K40 Ecosmart G PV)¹ and A++ wine coolers with transparent door (Liebherr/Wkes 653)² available in Europe.

Next to wine coolers and minibars, Topten identifies professional and commercial static air appliances as a third product category for which an explicit inclusion is desirable. As static air appliances are excluded from the professional regulation and the commercial draft regulation, they should be explicitly mentioned in Definition 1, Article 2, as part of the household refrigerating appliances.

Topten therefore proposes the following Definition 1: “household refrigerating appliances” means a refrigerating appliance, integrating the condenser and cold generator in one package with a factory-sealed cooling circuit used in household environments. This also includes equivalent refrigerating appliances used in non-household environments such as professional horizontal and professional and commercial static refrigerating appliances, wine coolers and minibars.

¹ <http://www.topten.eu/english/professional-refrigerators/minibars.html>

² <http://www.topten.eu/english/professional-refrigerators/wine-coolers/one-temperature-zone.html>

Ecodesign requirements and Energy Labelling classes

In the proposed regulation Labelling classes are rescaled from A to G. An impact assessment by the European Commission shows, that at the time of introduction of the proposed regulation, classes A and B are left empty for household refrigerating appliances, allowing for future efficiency improvements.

Furthermore, eco-design requirements determine, that household refrigerating appliances except for wine storage appliances in class G are taken from the market with tier 1 in 2020. Tier 2 further bans class F appliances except for wine storage appliances in 2023.

In contrast to CECEDs arguments, Topten argues that the proposed efficiency requirements and new energy labelling classes are acceptable and that ambitions are not too high. The timing shall be kept as tight as possible, as there have been substantial delays with this product group and no serious regulatory tier since 2012. This represents years of lost savings, which need to be swiftly caught up. A+ models have been allowed on the market for more than a decade now, although they should have been phased out already, as they are now way above the least life-cycle cost point.

In addition, it is important to note that the least life-cycle cost (LLCC) calculations that are used to set the 2023 tier level are based on flat cost data from 2015 or before, not considering learning effects. Between now and 2023, there will be cost reductions on efficient technologies because of mass production and learning effects, as it has always been the case in the past. This means that the 'genuine' LLCC in 2023 will be below what is proposed here (about 8% below according to our estimation). This explains why the proposed tiers should not be considered as excessively ambitious.

Analysis of best available technology (BAT) refrigerator models on Topten.eu shows that the proposed new A class (EEI = 41) can be reached with 21% (refrigerators without freezer), 35% (refrigerators without freezer) or 41% (1-door fridge-freezers) efficiency improvement. Topten calculations show that the combination of the proposed 'correction factors' alone can allow models to reach up to 25% higher efficiency levels. BAT models are up to 59% more efficient than proposed tier 1 (2020), and up to 48% compared to tier 2 (2023). Therefore, if the Label is to trigger real efficiency improvements for many years, the classes must not be relaxed.

Figure 3 compares the current (blue lines) and proposed classes for fridge-freezer combinations with a 30% freezer volume. The triangles show that current best technologies will be in classes D and C with regard to the proposed regulation.

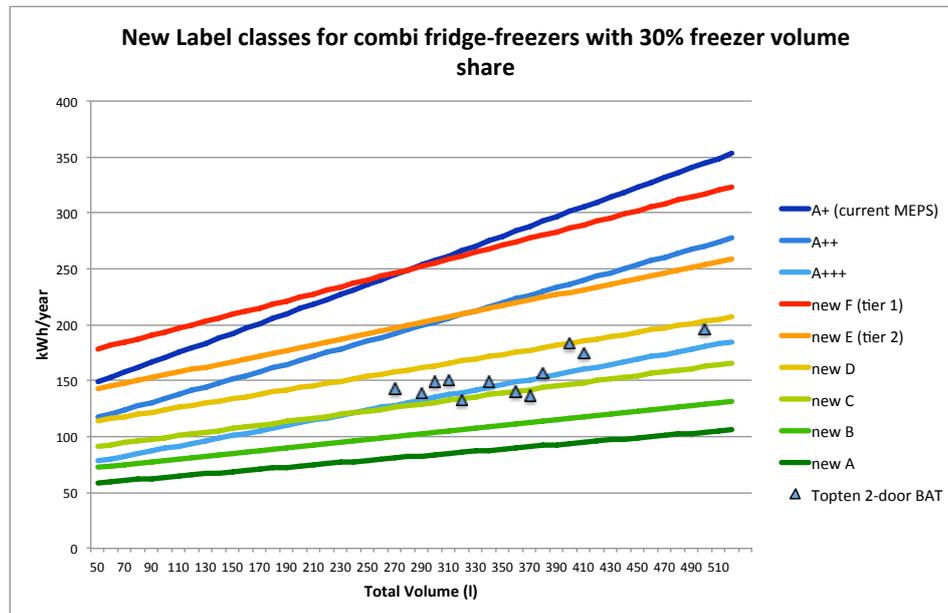


Figure 3: Current and new proposed classes with Ecodesign tiers. Neither compensation factors nor the possible effects of the new measurement standard have been considered in this chart. Source: Topten, own calculations, 2018.

To set incentives for technological improvements between tier 1 and 2, tightening of the eco-design requirements is essential. In the proposed regulation, the maximum EEIs are strengthened between tier 1 and 2 for household refrigerating appliances and low noise appliances. Unfortunately, the maximum EEI for wine storage appliances is not adjusted for tier 2 leaving it at a level of 155%. However, it can be expected that technological improvements will lead to higher energy efficiency levels also for wine storage appliances. To set the right incentives, it is therefore highly recommended to strengthen the tier 2 maximum EEI of wine storage appliances, too. In the long-run, the goal should even be to apply similar MEPS levels for wine coolers and other household refrigeration appliances.

It is absolutely key that all appliances even with glass-doors are covered by the regulation. Knowing that this market segment takes more time to become more efficient, Topten accepts to start with lower ambitions for these appliances.

EEI calculation and compensation factors

The EU Energy Labelling scale and the minimum efficiency requirements of the regulations are based on the Energy Efficiency Index (EEI). The current EEI is the annual energy consumption (AE) of a model relative to the consumption of a 'standard' model (SAE) of the same category and with the same volume and temperature.

In the draft regulation, the calculation of the EEI and the SAE is not based on the volume of 10 different categories (Refrigerator-freezer, Chest Freezer, refrigerator with a 1-star compartment etc.) any more, as it is the case in the current regulation. Instead, the new regulation refers to the different refrigerator types by setting different default parameters per compartment type, which are then included into the calculation of the standard annual energy consumption. Topten welcomes this new approach based on compartments instead of categories.

However, the EEI formula in the proposed regulation has not become simpler nor transparent as proposed by Topten for a long time. This is mainly due to the different compensation factors. In the EU there are bonuses granted for several functions ('compensation factors'), which are multiplied with the volume of the compartments or the model to receive the 'adjusted' volume, based on which the standard energy consumption is calculated. Topten argues, that the energy efficiency should be defined considering only a product's primary function instead of adding bonuses for additional functions that lead to higher energy consumptions.

Although, in the proposed regulation, the climate-class factor (a bonus for modes with oversized compressors that can keep a constant temperature even in tropical climate) has been removed and some other factors have been reduced (for built-in models and models with a frost-free function), extra features or functions still receive bonuses through compensation factors. The factors alone can still help a model jump one class up and look much more efficient, while consuming 25% more electricity.

The multi-door factor, which has been proposed for appliances with 3, 4 or more external doors should be removed. Topten is strictly opposed to introducing a new compensation factor for models with multiple doors. Additional doors can lead to increased leakage – nothing the Energy Label should promote. Instead, it should make lower efficiency transparent. Refrigerators with multiple doors may have advantages for consumers, but using the Energy Label as a marketing tool for these would be misleading.

Another discussed compensation factor, that Topten opposes, is the factor for glass doors. If an appliance is inefficient due to glass doors, this should be made transparent to consumers. The credibility of the label would be clearly undermined if bad models receive an advantage through the introduction of a compensation factor.

Furthermore, Topten opposes the increase in the value of the combi-factor. Why has it been increased by up to 60% for some products, compared to what was suggested in the preparatory study for this review? A 50% higher energy allowance for 'controlling the cooling of multiple compartment types' seems excessive and should therefore be adjusted for the new regulation.

Measurement standard

A new test standard has been published in 2015. This new standard IEC 62552:2015 achieves an international harmonisation across many regions and will be used in MEPS and Energy Labelling in Australia, Japan, China and soon also in North America. It aims at a measurement that resembles more real-life conditions through measurements at different ambient temperatures (16°C and 32°C), for example.

According to CECED, the new measurement standard will deliver higher energy consumption values for some models and should therefore be taken into account when setting the new Energy Labelling classes. However, Topten sees no need to adapt the Energy Label to the results according to the new standard. It can be expected, that new products will be optimised according to the new standard resulting in energy consumption levels similar to the ones before.

Verification tolerances are unchanged compared to the 2009 Regulations. The decision not to tighten them is based on a conclusion of the preparatory study suggesting that as a new measurement standard will be applied, laboratories and market surveillance authorities need to gain some experience first. This might be true in the first years, but it should not be

forever. The preparatory study also highlights that most of the changes in the new standard 'aim to increase or maintain the accuracy, reliability and reproducibility of the test results', hence suggesting that verification tolerances can be further reduced with the application of this new standard.

Topten therefore proposes to maintain the current tolerances for the first tier, but then reduce them when the second tier enters into force in 2023, from 10% to 7% for the declared energy consumption and freezing capacity. 5 years should be fully sufficient to gain experience with the standard.

Circumvention clause

Topten supports the introduction of an anti-circumvention clause in Annex II.3 of the Ecodesign proposal, since this has been explicitly mentioned in the 2017 Energy Labelling Regulation and is not present in the 2009 Ecodesign Directive.

Resource efficiency

In 2011, the European Commission set out a new "roadmap" to integrate resource efficiency as a measure towards a more sustainable future. In line with the roadmap further activities were planned through the launch of the Circular Economy Package in 2015, which also foresees the inclusion of material and resource efficiency aspects into the Ecodesign requirements.

The proposed Ecodesign Directive makes a first step towards a consideration of material efficiency aspects. The provision on the availability of spare door gaskets for example, is a new requirement much appreciated by Topten. However, more policy options could have been provided in the new proposal.

Therefore, Topten and other environmental organizations propose the following requirements to facilitate repair and recycling of domestic refrigeration:

- Specify that door gaskets should be replaceable without proprietary tool, in situ, without the need to change the doors and without having to interfere with any other part of the appliance, risking deteriorating them and the overall performance.
- Manufacturers to ensure unrestricted and standardised access to appliance repair and maintenance information to independent operators, free of charge or for a reasonable fee in order to not hinder small independent operators in their activity.
- Availability of spare parts for at least the priority parts for repair, i.e. thermistors, electronic processors, door seals and interior elements for a minimum of 15 years (at least beyond the baseline lifetime of the appliances).
- A minimum warranty duration of eight years. This will help prevent reverting product lifetimes, especially newer models with increasingly sophisticated and fragile electronic components. As suggested by RREUSE members, the following technical requirements could help extend the lifetime of products:
 - Putting valves on the cooling circuit to ease the recharge of the cooling fluid following a leak;
 - Minimum insulation and protection for the internal motor;
 - Protections for electronics from power surges;
 - Input and output tubes to/from the compressor do not trap oil and hinder it from returning to the engine.
- Requirements for the product design that support and simplify the work of recyclers, such as ensuring that parts that require selective removal treatment or that can be reused, can be individually dismantled/separated.

- Restrictions on the use of plastics/polymers that impede adequate recycling, such as non-compatible for recycling polymer blends, incompatible coatings, very dark plastics that have no recycling routes, etc.

Refrigerants

Due to their environmental impact, refrigerants and foam blowing agents used in different appliances such as household refrigerating appliances, have been under discussion for a long time. Different international and European regulations have concentrated on the phase-out of certain types of gases due to their ozone depleting (ODP) and global warming potential (GWP):

Chlorofluorocarbons (CFCs), which have been used as refrigerants and foam-blowing agents, have been replaced under the Montreal Protocol, due to their ozone depleting potential. Instead, Fluorinated hydrocarbons (HFCs) have been used as replacement refrigerants. These substances do not destroy the ozone layer, but still have a high Global Warming Potential. R 134a has been one of the most commonly used HFCs, which is now increasingly replaced by substances with no ODP and only low GWP. These substances are called halogen-free hydrocarbons such as isobutane and pentane.

Furthermore, new synthetic HFOs exist which are currently tested by manufacturers as foam blowing agents. These substances also have no ODP and a low GWP. However, according to the Öko-Institut (2017), these HFOs are potentially persistent and therefore problematic out of a number of reasons – one example is their long-term accumulation in specific environmental compartments (water, soil, air etc.). Next to their potential persistence, their impact on environment and health are unknown, risk of toxic substances in case of fire and challenges for recycling can furthermore occur.

Because of the unknown risks and known disadvantages of HFOs, the Öko-Institut (2017) asks for a strict regulation of HFOs and proposes a ban of these substances in household refrigerating appliances. In light of the existing, environmental friendly natural refrigerants and foam-blowing agents Topten supports these arguments and calls for banning HFOs in household refrigerators.

Display of label

The new Energy Labelling Regulation stipulates that on commercial and ad material, the energy class shall be shown together with ‘the range of the efficiency classes available on the label.’ The purpose of this provision is for consumers to better understand how the energy class displayed compares to the state of the market (and understand if this class currently corresponds to best or worst performers).



Figure 4: Display of energy class and range of efficiency classes in visual advertisements and in promotional material, EC draft regulation.

Topten believes this provision should be interpreted as showing the range of efficiency classes that are populated by products, and not just that are written on the label. This means the range should not always be A to G (which provides little added-value to the consumer) but the range of classes that are not greyed on the label. Therefore, the range displayed for standard refrigerating appliances should be:

- A to F at tier 1 (i.e. from 2020 to 2023)
- A to E at tier 2. (i.e. from 2023 onwards).

References

European Parliament and Council: DIRECTIVE 96/57/EC of the European Parliament and of the Council 3 September 1996 on energy efficiency requirements for household electric refrigerators, freezers, and combinations.

European Commission: COMMISSION DIRECTIVE 2003/66/EC of 3 July 2003 amending Directive 94/2/EC implementing Council Directive 92/75/EEC with regard to energy labelling of household electric refrigerators, freezers and their combinations.

European Commission: 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.

European Commission: Commission delegated regulation No 1060/2010 of 28 September 2010 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of household refrigerating appliances.

European Commission: DRAFT Commission regulation of XXX implementing Directive 1009/125/EC of the European Parliament and of the Council with regard to the eco-design requirements for household refrigerating appliances and low noise refrigerating appliances.

European Commission: DRAFT Commission delegated regulation of XXX supplementing Regulation (EU) 2017/1369 of the European Parliament and of the Council with regard to energy labelling of household refrigerating appliances and low noise refrigerating appliances.

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Van Holsteijn et Kemna B.V. (VHk) (2016). "[Preparatory/review study with regard to eco-design and energy labelling regulation for household refrigeration appliances](#)". European Union.

Topten Links:

- Best refrigerators and freezers of Europe: www.topten.eu > Household > Refrigerators / Freezers
- Best minibars of Europe: <http://www.topten.eu/english/professional-refrigerators/minibars.html>
- Best wine Coolers of Europe: <http://www.topten.eu/english/professional-refrigerators/wine-coolers/one-temperature-zone.html> and <http://www.topten.eu/english/professional-refrigerators/wine-coolers/multi-temperature-zones.html>
- Policy recommendations for commercial display cabinets:
<http://www.topten.eu/english/recommendations/commercial-display-cabinets.html#fromid>
- Policy recommendations for professional storage refrigerators:
<http://www.topten.eu/english/recommendations/professional-storage-refrigerators-2.html#fromid>

Annex

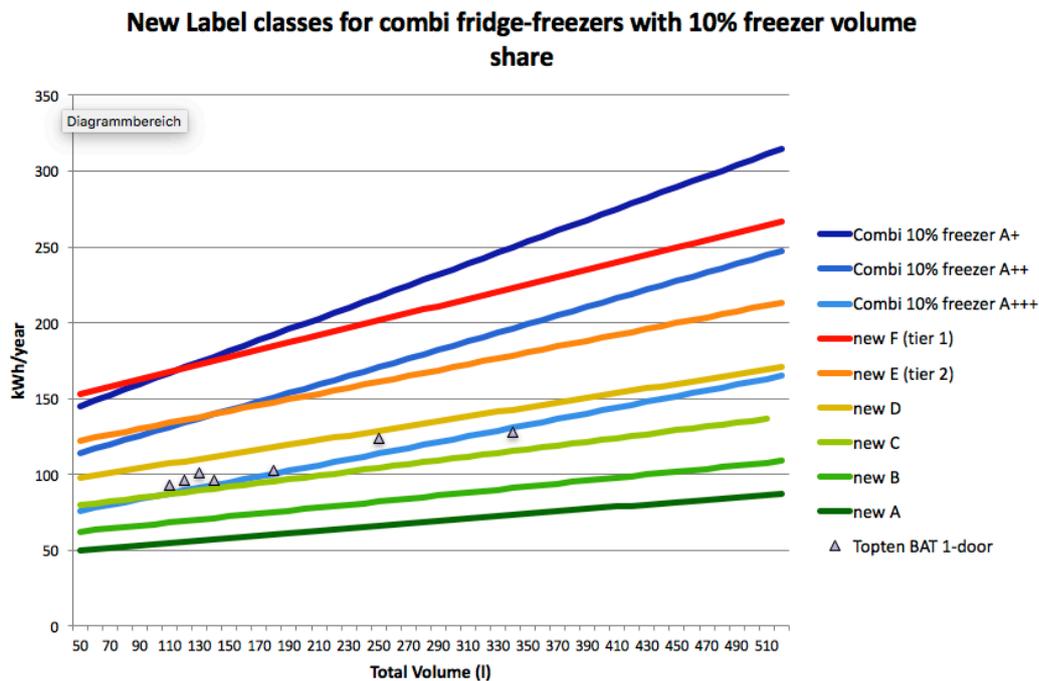


Figure 1: Current and new proposed classes for combi fridge-freezers with 10% freezer volume. With Ecodesign tiers and Topten Best Available Technologies (BAT). Source: Topten, own calculations, 2018.

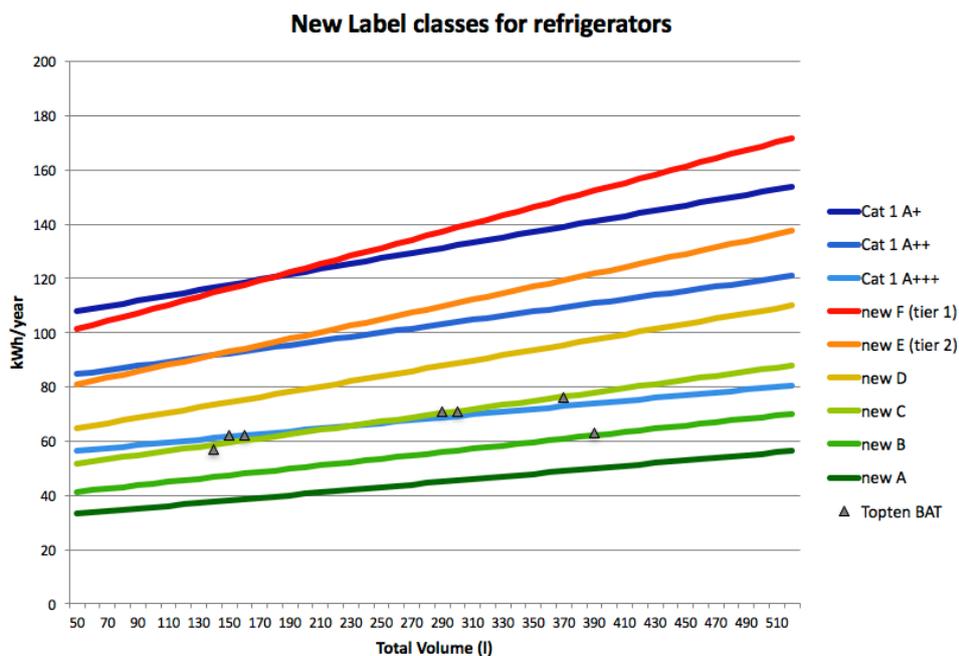


Figure 2: Current and new proposed classes for refrigerators. With Ecodesign tiers and Topten Best Available Technologies (BAT). Source: Topten, own calculations, 2018.

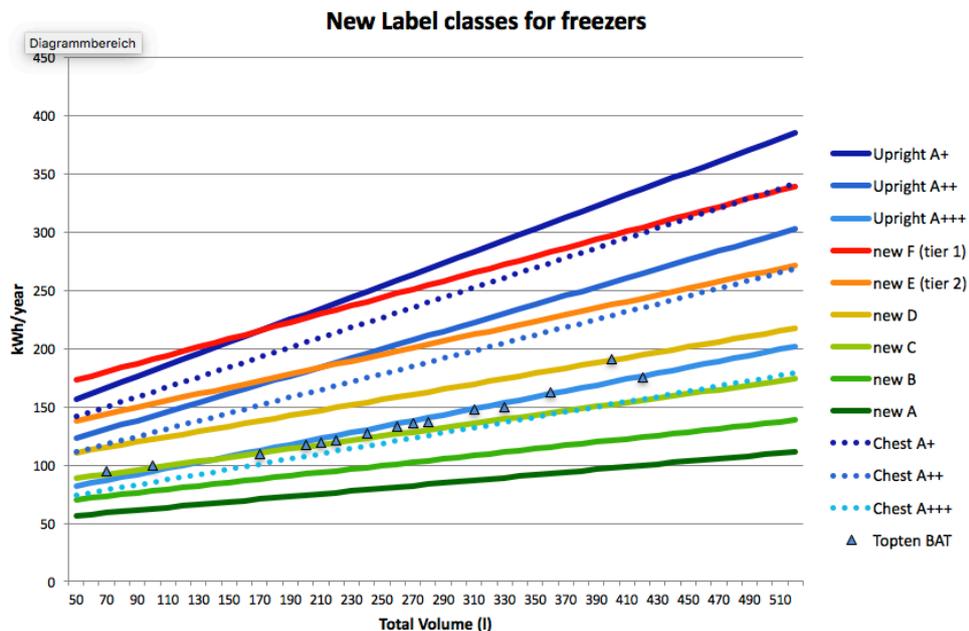


Figure 3: Current and new proposed classes for freezers. With Ecodesign tiers and Topten Best Available Technologies (BAT). Source: Topten, own calculations, 2018.