Brussels, XXX
[…](2017) XXX draft

Explanatory Memorandum to

COMMISSION REGULATION (EU) No …/..

of XXX

implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for household refrigerating appliances and low noise refrigerating appliances

repealing
Regulation (EC) No 643/2009 with regard to ecodesign requirements for household refrigerating appliances

EXPLANATORY MEMORANDUM

1. CONTEXT OF THE PROPOSAL

Grounds for and objectives of the proposal

The Ecodesign Directive 2009/125/EC[1] establishes a framework for setting ecodesign requirements for energy-related products at EU level. It is a key instrument of EU policy for improving the energy efficiency and other aspects regarding the environmental performance of the products placed on the internal market. Article 16 of the Ecodesign Directive lists products which were initially identified by the Council and the European Parliament as priorities for the Commission for implementation, including consumer electronics, office equipment and domestic appliances. The reduced energy consumption household refrigerating appliances addresses therefore groups of priority products.

The ecodesign measures applicable to household refrigerating appliances are:

- Commission Regulation (EC) No 643/20092 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;
- as amended by Commission Regulation (EU) 2016/22823 of 30 November 2016 with regard to the use of tolerances in verification procedure.

The revision of Ecodesign measure for household refrigerating appliances in light of technological progress is required by Article 7 of Commission Regulation (EC) No. 643/2009. In particular, this review had to assess verification tolerances and the possibilities for removing or reducing the values of the correction factors.

In the Commission's Ecodesign Working Plan 2016-2019 [4] the revision of the implementing act for household refrigerating appliances is mentioned as one of the priority subjects.

Moreover, there are new policies that force the revision to look beyond the strict scope mentioned in the review articles of the existing implementing and delegated acts for household refrigerating appliances: A renewed effort in carbon emission abatement through the Paris climate agreement[5], the Commission's Circular Economy[6], the Better Regulation policy aiming at more efficient and effective legislation[7] [8], the need to address possible circumvention of testing standards, etc.[9]

General context

In 2014, the Commission conducted an 'Omnibus' review[10] of several product groups that indicated that there is still a large untapped saving potential for household refrigerating

[1] OJ L 285 of 31.10.2009, p 10-35
[2] OJ L 191 of 23.07.2009, p 53-68
[3] OJ L 346, 20.12.2016, p. 51–110
[4] COM(2016) 773 final, Brussels, November 2016.
[5] http://ec.europa.eu/clima/policies/international/negotiations/future/index_en.htm
[6] Closing the loop - An EU action plan for the Circular Economy". COM(2015) 614 final, Brussels, 2.12.2015
[7] https://ec.europa.eu/info/law/law-making-process/overview-law-making-process/evaluating-and-improving-existing-laws/reducing-burdens-and-simplifying-law/refit-platform_en
[8] http://ec.europa.eu/smart-regulation/better_regulation/key_docs_en.htm#_br
[9] http://www.europarl.europa.eu/committees/en/emis/home.html
[10] 'Omnibus' Review Study on Cold Appliances, Washing Machines, Dishwashers, Washer-Driers, Lighting, Set-top Boxes and Pumps, consortium of VHK, VITO, Viegand Maagøe, Wuppertal Institut für Klima, Umwelt, Energie for the European Commission, DG ENER-C3, Brussels/Delft, April 2014.

appliances making the regulations eligible for a revision. This was confirmed by the review study, concluded in March 2016. [11]

A full impact assessment, including possible alternative scenarios that might come up at the Consultation Forum, will be performed at a later stage. For the moment, the proposal is in line with the preliminary scenario analysis in the review study showing the following savings in 2030, in addition to the savings that can be expected under a Business-as-Usual (BAU) scenario. Savings LLCC 2030 vs. BAU 2030:

- 10 TWh/a electricity
- 3.2 Mt CO2 eq. /a in greenhouse gas emissions
- 1-1.2 billion Euro net consumer expenditure/a

The total absolute savings over the period 2015 until 2030, with the implementation of the new measures, amount to 38 TWh electricity per year and 18 Mt CO2 eq. GHG per year.

The figure below revisits the projections in the preparatory study using the latest industry data and projections as outlined in Figure 2 and Table 1.

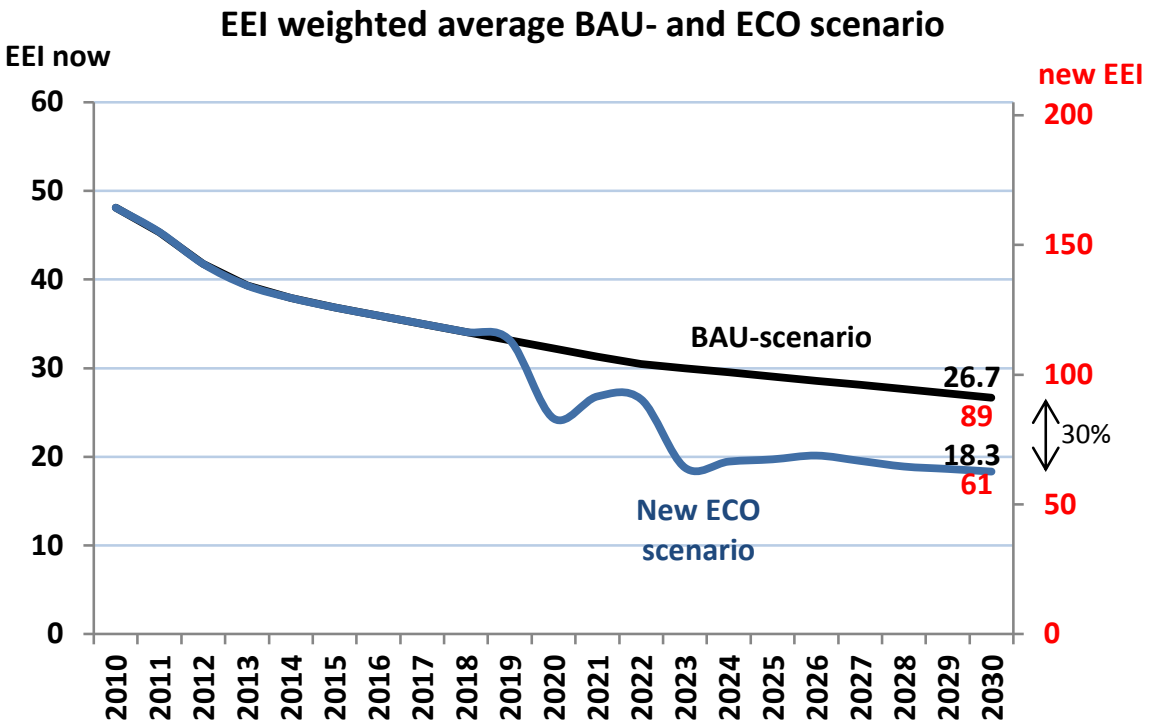
COMMISSION REGULATION (EU) No …/..

implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for household refrigerating appliances and low noise refrigerating appliances

repealing
Regulation (EC) No 643/2009 with regard to ecodesign requirements for household refrigerating appliances

Projections of savings following projections in Table 1.

[11] VHK and Armines, Preparatory Review Study Household Refrigeration Appliances, for the European Commission, Brussels/Delft, 4 March 2016.



Note that the slight bump in the 2021-2022 is a result of following the calculation model to the letter. In reality a smoother transition is expected.

At technical level, there is the introduction of a new global IEC test standard for refrigerators

At technical level, there is the introduction of a new global IEC test standard for refrigerators and freezers that can make a significant contribution in achieving many of the above-mentioned policy objectives[12]. It is faster, more effective and more efficient for both industry and market surveillances authorities, but it does require a new set-up of Ecodesign and Energy Labelling regulations as well as the harmonised standards behind them.

The metrics used in the existing Ecodesign and Energy Labelling regulations for household refrigerating appliances were developed 25 years ago. Since then there has been considerable technological progress, which is no longer reflected in today's metrics for efficiency levels that are >60% lower than 25 years ago. Furthermore, the appliance-based approach is complex in the legislation and unnecessarily rigid.

Regulation (EU) No 643/2009 includes correction factors for climate-class (1.1 for sub-tropical ST and 1.2 for tropical T), no frost (1.2), built-in appliances (1.2) and the bonus for the chill compartment (50 kWh at EEI=100). Some of these factors are used as (legal) loopholes and are obscuring the real electricity consumption and efficiency for the end-consumer.

Preliminary findings show that there are considerable benefits in proposing a revision of the current regulation, both in terms of optimising regulatory aspects as in realising additional energy-, CO_2 emission- and monetary savings. As such, a revised regulation would be more effective by supporting global test standards, addressing the outdated metrics and updating the correction factors. The proposed review would also improve the efficiency of the legislation:

[12] IEC 62552:2015, Household refrigeration appliances – Characteristics and test methods, Parts 1, 2 and 3.

verifiable exemptions and allowances are needed, and clear and more ambitious efficiency targets are possible.

2. CONSULTATION OF INTERESTED PARTIES AND IMPACT ASSESSMENT

Consultation of interested parties

The review process started in 2013 with the Omnibus review study covering multiple product groups amongst which were household refrigerating appliances. The Omnibus review involved bilateral stakeholder consultation and was published in April 2014, i.e. one month before it was discussed in a subsequent Consultation Forum (CF). At the CF it was decided to go ahead with a preparatory review study for the product group. This preparatory study took place from January 2015 until March 2016 (publication date). Stakeholders were informed and consulted through a project website www.ecodesign-fridges.eu, currently still on-line, bilateral meetings and expert interviews as well as two stakeholder meetings at the Commission's premises with over 40-50 participants each. The process was then interrupted for over a year due to uncertainties regarding the new Energy Labelling Regulation and the proposed working plan. During that time the complementary research on the role of household refrigeration, published in March 2017, was performed. In the late spring of 2017 bilateral consultations with experts from industry, NGOs and Member States resumed, involving amongst others input to early drafts of the proposal.

The draft WD and Explanatory Memorandum will be sent out to stakeholder one month before the upcoming Consultation Forum of 6 December.

Impact Assessment

An impact assessment is being prepared to support the preparation of this initiative and to inform the Commission's decision.

The following figure and table shows an initial estimation of the impact of the proposed regulation on household refrigerating appliances, excluding wine storage appliances. It is based on the number of models that are available with a certain EEI and is not coupled to sales data.

The number of models (in %) in a certain energy efficiency class over the period 2010-2030 are shown in Table 1. The figures from 2010 until 2016 are based on actual data and figures from 2017 until 2030 are based on projections.

Table 1

Energy label class distribution and EEI of household refrigerating appliances EU 2010-2030

			% of models									
	Year		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	EEI	class										
EEI according to 643/2009 & 1060/2010	EEI≤22	A+++	0.0%	0.9%	3.1%	6.4%	8.6%	9.9%	13.2%	16.5%	19.8%	23.1%
	22 ≤EEI<33	A++	9.9%	15.1%	26.3%	33.3%	41.3%	45.2%	47.0%	48.8%	50.6%	52.4%
	44≤EEI<55	A+	50.0%	56.3%	60.1%	58.0%	48.3%	44.9%	39.8%	34.7%	29.6%	24.5%
	55≤EEI<75	A	36.2%	26.9%	9.6%	1.6%	1.0%					
	EEI≥75	<A	3.9%	0.8%	0.9%	0.7%	0.8%					
EEI according to this proposal	EEI≤41	A										
	41<EEI≤51	B										
	51<EEI≤64	C							0.4%	0.5%	0.6%	0.7%
	61<EEI≤80	D							12.8%	16.0%	19.2%	22.4%
	80<EEI≤100	E							5.3%	5.5%	5.7%	10.0%
	100<EEI≤125	F							42.0%	44.0%	45.0%	42.0%
	EEI>130	G							40.0%	35.0%	30.0%	25.0%

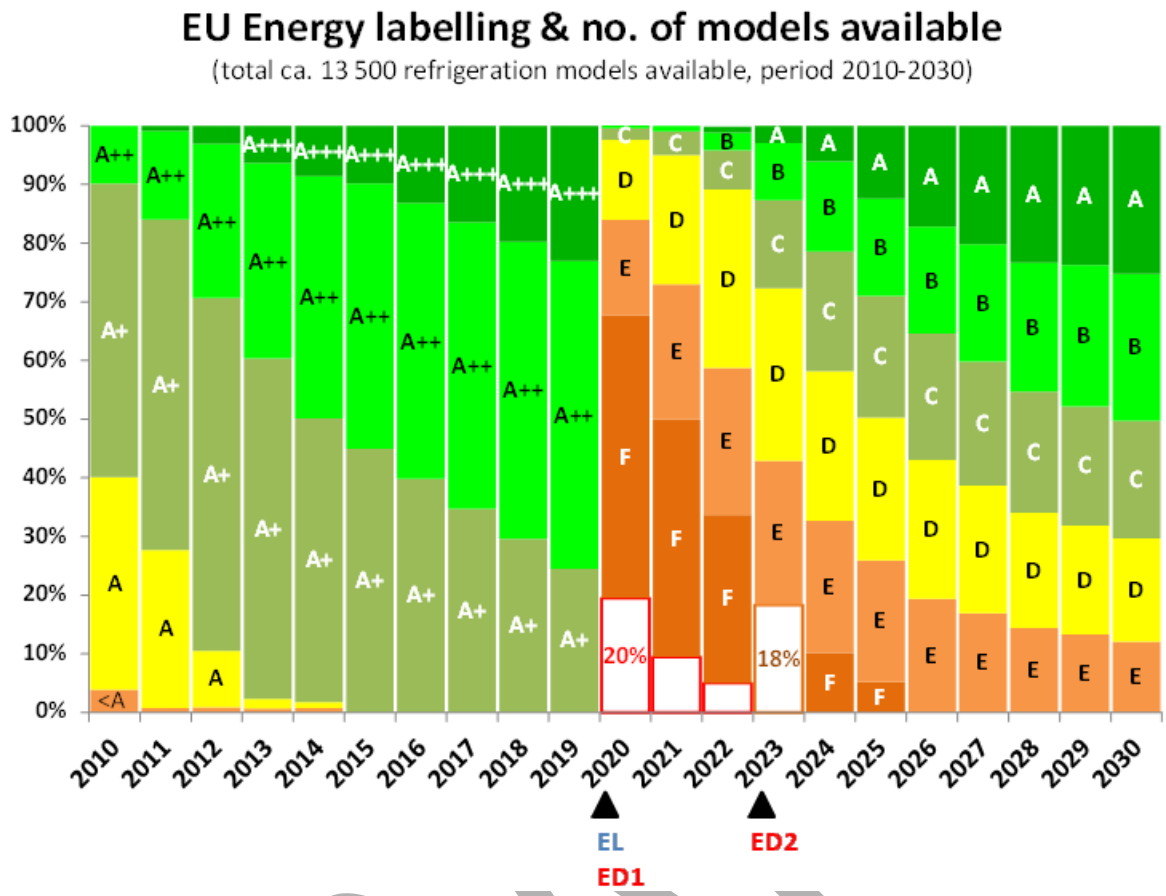
	Average EEI according to 643/2009 & 1060/2010		**48.1**	**45.3**	**41.8**	**39.3**	**37.9**	**36.9**	**35.9**	**35.0**	**34.1**	**33.2**
	Average EEI according to this proposal								117	116	113	110
			% of models									
	EEI	class	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
EEI according to 643/2009 & 1060/2010	EEI<22	**A+++**											
	22 ≤EEI<33	**A++**											
	44≤EEI<55	**A+**											
	55≤EEI<75	**A**											
	EEI≥75	**<A**											
EEI according to this regulation	EEI≤41	**A**			1.0%	2.0%	6.1%	12.4%	17.2%	20.2%	23.4%	23.8%	25.3%
	41<EEI≤51	**B**	0.4%	1.0%	3.0%	9.7%	15.3%	16.6%	18.3%	20.0%	22.0%	24.0%	25.0%
	51<EEI≤64	**C**	2.0%	4.0%	6.8%	15.0%	20.4%	20.7%	21.5%	21.2%	20.6%	20.4%	20.1%
	61<EEI≤80	**D**	23.0%	27.0%	30.4%	32.0%	25.5%	24.4%	23.7%	21.7%	19.6%	18.6%	17.6%
	80<EEI≤100	**E**	15.0%	18.0%	25.0%	23.0%	22.4%	20.7%	19.4%	16.9%	14.4%	13.2%	12.1%
	100<EEI≤125	**F**	40.0%	40.4%	28.7%	18.3%	10.2%	5.2%					
	EEI>130	**G**	19.5%	10.0%	5.0%								
	Average EEI according to 643/2009 & 1060/2010		*24.4*	*26.8*	*26.5*	*18.8*	*19.5*	*19.7*	*20.1*	*19.5*	*18.9*	*18.6*	*18.3*
	Average EEI according to this proposal		81	89	88	63	65	66	67	65	63	62	61

Following to this Table, a maximum EEI of 125 in 2020, would ban 20% of the models from the market in 2020; a maximum EEI of 100 in 2023, would ban 18% of the models from the market in 2023.

This is represented graphically in Figure 2.

Figure 2

Energy label class distribution of standard household refrigerating appliance models



3. LEGAL ELEMENTS OF THE PROPOSAL

Summary of the proposed action

1. Definition of the scope and updated definitions

The scope of the measures is standard electric (230V) household refrigerating appliances with a volume up to 1500 l, placed in the homes of EU citizens and based on compressor technology.

The current review tries to find solutions for the following ambiguities in the scope:

– whether refrigerating appliances intended for non-household use that are equivalent to refrigerating appliances intended for household use are in the scope of the Regulation or not. This leads to the potential placing on the market of inefficient products by allowing them to be indicated as intended for use in a non-household environment and thus escaping the minimum efficiency requirements;

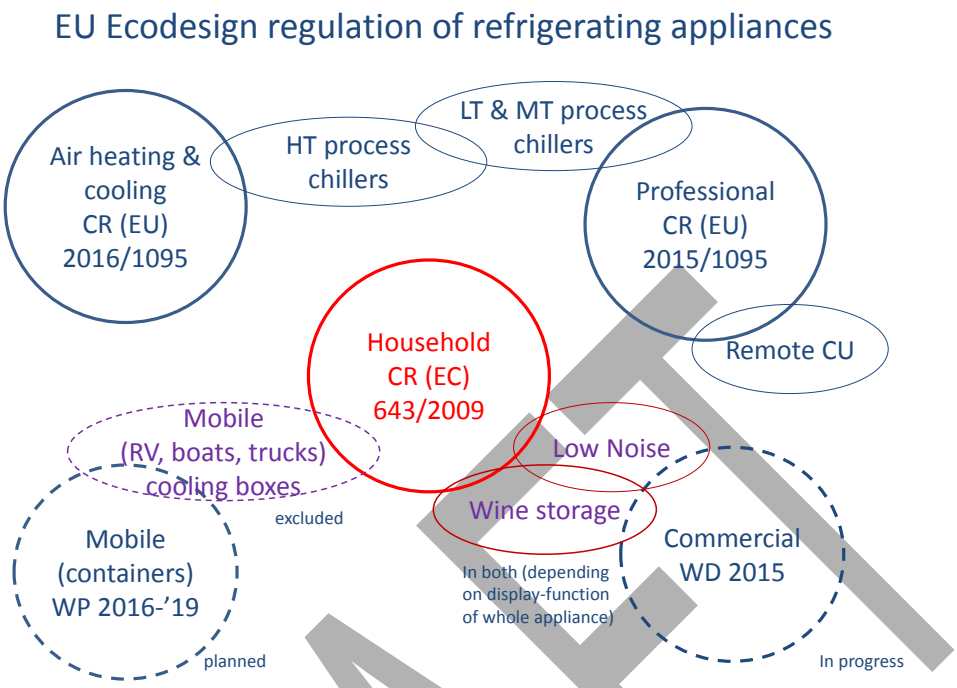
– whether refrigerating appliances using technologies other than those making use of a compressor, (such as absorption, thermo-electric and possibly future innovations like magnetic cooling or thermo-acoustics) and as a result have lower energy performances, but which have unique functional characteristics in terms of e.g. low noise or mobility. Current requirements could ban some of these products with unique functionalities from the European market.

– possible overlap with related existing or planned Ecodesign regulations that were not considered when Regulation (EC) 643/2009 was adopted.

An overview of existing and planned Ecodesign refrigerating regulations is given in the figure below.

Figure 3

Existing and planned EU Ecodesign regulation of refrigerating appliances.



Legend: CR=Commission Regulation, HT=High Temperature (+7°C), MT=Medium Temperature (-10°C), LT=Low Temperature (-35°C), CU=Condensing Units, WP=Ecodesign Working Plan, WD=Working Document presented to the Consultation Forum in 2015.

The review proposal tries to limit these ambiguities as much as possible, defining first the large functional and technology-neutral categories and expanding on what is in the scope and what is not.

In the scope are refrigerating appliances intended for household use and refrigerating appliances equivalent to those intended for household use, used in non-household environments; and low noise refrigerating appliances that have added functionality and thus different Ecodesign limits.

The low-noise appliances, currently using absorption and thermo-electric ('Peltier') technology, include most mini-bars in hotel (bed)rooms. They are defined as refrigerating appliances up to a volume of 60 litres and a noise level of no more than 20 dB(A). The performance will be that of a single cellar (+12°C) or pantry (+17°C) compartment.

Distinguishing features of products in the scope include mass-produced, thermally insulated cabinets with a fully integrated and factory-sealed cooling circuit, including one or more cold generators. In other words, custom-made cabinets or cabinets with remote condensing unit or cooled by remote process chillers are excluded.

Out of the scope are commercial refrigerating, professional refrigerating and mobile refrigerating appliances.

Commercial refrigerating appliances, for which a draft Working Document was presented to the Consultation Forum, are characterised by refrigerated display of products for sale ('merchandise'). The display function means transparent doors or open access for one or more sides of the appliance. For instance, wine storage appliances or hotel mini-bars with a display functionality can thus rightfully claim to be 'commercial' and thus out of the scope of the 'household' requirements. This avoids loopholes, e.g. where wine storage appliances with a

glass door in restaurants show large similarities with vertical display cabinets in the retail sector. It keeps the display functionality in the market place where it really matters, i.e. in the commercial sector.

Regulation (EU) 2015/1095 on professional refrigerating appliances, defines 'professional' as a rest group (non-household and non-commercial).

'Mobile' appliances are designed for use in means of transport (cars, mobile homes, boats, etc.), where there may be no access to the main electric grid and thus have to use battery-power of the transport vehicle (12 V) or a gas/kerosene tank. They are more resistant to mechanical vibration and shocks as well as operation in a tilted position.

2. Measurements and calculations

The metrics of the Ecodesign and Energy Labelling regulations for household refrigerating appliances is in need for a number of compelling reasons regarding globalisation, technological progress and transparency.

Globalisation

Over the last years experts the global refrigeration industry have been working to create a global standard for household refrigerating appliances. This global standard, IEC 62552:2015, was published in 2015 and will be used in MEPS (Minimum Energy efficiency Performance Standards, like the minimum efficiency requirements in Ecodesign) and Energy Labelling in Australia, Japan, China and –in due time—also North America. It aims not only to be globally applicable, using local variables but always in a globally harmonised context, but also to improve the efficiency (faster, lower costs), accuracy (more sophisticated defrost testing) and reliability (fighting loopholes, precise indications of relevant testing) of refrigerating appliance testing. Using this standard, adapted to the EU situation, in Ecodesign and Energy Labelling is thus crucial for global competitiveness but also for better market surveillance and lowering the administrative burden for industry. Most of the definitions in the proposed regulation stem from this new global standard. As regards quantitative test- and calculation methods the annotated version gives the details. Most important changes are:

– Energy testing at two ambient temperature conditions, 16 and 32 degrees, taking the average (24 °C) as a reference. This gives a better impression of real-life performance instead of design-optimisation for the current single ambient temperature testing at 25 °C. The new 24 °C reference was found to be yield results closest to the current practice.

– Fresh food compartment temperature is now +4 °C, instead of +5 °C, because it is better for food preservation. This leads to an increase in energy consumption for fresh food compartments (+11.9%).

– Freezer temperature (-18°C for 3- and 4 star) is established by measuring the air temperature, i.e. longer measured inside test-packages. This is faster, but will lead to a decrease (-6%) in energy consumption for these compartments due to the temperature difference inside and outside the packages. For an upright freezer the increase will be -1.8% with auto-defrost and -4.7% without auto-defrost. For a chest freezer the decrease will be -6%.

– Combining the above two points for a typical refrigerator-freezer the increase in energy consumption will 12.7% for a single thermostat design ('Type I') and 3.6% with auto-defrost or 1.6% without auto-defrost for a combi with two thermostats ('Type II').

– The standard sets target temperature for testing chill compartments is no longer 0 °C but at 2 °C. Note that, because the N and M factors are more favourable for chill than for fresh food compartments, this opens the possibility of loopholes and thus in the regulation and/or harmonised standard the chill compartment will have to comply with very strict performance requirements.

– Testing is no longer based on fixed 24 hour period (or more), but testing continues until well-defined steady state conditions are achieved.

– The energy consumption for defrosting (including recovery to set temperature) is measured separately, and will be added ex-post to steady state energy consumption as appropriate. It is no longer integrated in the 24 h test, thus also allowing more accurate monitoring. Testing now accommodates several types of defrosting control mechanisms.

– Test institutes involved in compliance testing are explicitly obliged to investigate anomalies that might be caused by attempts to circumvention and report circumvention to the market surveillance authorities. This stipulation is important in the light of the fact that, following widespread privatisation of test institutes in the EU over the last decades, almost all test institutes also work for the industry.

Technological progress

The metrics in the current (and preceding) regulations for Ecodesign and Energy Labelling of household refrigerating appliances were developed 25 years ago, using parameters (the N, M and correction factors) that were derived from an analysis of the trends in a commercial database from the early 1990s. Since then there has been considerable technological progress, which is not (no longer) reflected in today's metrics for efficiency levels that are >60% lower than 25 years ago. For instance, the reference line for refrigerators is almost flat, whereas –at the same index—the requirements for fridge/freezer combis are more lenient than for freezers. Furthermore, the appliance-based approach is complex in the legislation and unnecessarily rigid. In order to correct for these issues a more balanced and more flexible metric is proposed, mainly based on physics rather than only commercial trends. The proposed approach is primarily compartment-based, allowing maximum freedom of design. The 10 different appliance categories have been eliminated; what remains of the current appliance categorisation is a variable 'combi-factor' at a default value of 1.15 if more than one compartment type is used and a variable value between 1.3 and 1.56 for fridge freezers.

Transparency

For many years, NGOs and Member States have asked for the elimination or at least drastic reduction of the correction factors for climate-class (1.1 for sub-tropical ST and 1.2 for tropical T), no frost (1.2), built-in appliances (1.2) and the bonus for the chill compartment (50 kWh at EEI=100). Some of these factors are used as (legal) loopholes, e.g. leading to Sweden reportedly having more 'tropical' refrigerators than countries like Spain, and are anyway clouding the real electricity consumption and efficiency for the end-consumer. In this proposal the climate-class factor has been completely eliminated and the other correction-factors have been more than halved: 1.1 for no-frost, 1.1 (freezer) or 1.04 (fresh food) for built-in. The compensation for chill factors, which for the most common compartment sizes is anyway much lower than today, has been incorporated in the N and M factors.

Having said that, a new correction factor of 0.9 (negative impact) has been introduced for freezers to take more into account the effect of introducing and freezing the warm load in real-life. For refrigerators and combis this effect, and the effect of door-openings, this is implicitly compensated by testing at a 24 °C ambient temperature, instead of at the real-life

temperature of 20 °C. Also freezers are tested at 24 °C ambient temperature, but according to a recent study by Stiftung Warentest, at the currently high efficiency levels of the freezers this is no longer enough to compensate for the real impact. This will especially be the case for freezers used in professional environments (also in the scope of this regulation) and households in rural areas.

Furthermore, a small multi-door correction has been introduced for appliances with 3, 4 or more external doors with correction factors 1.02, 1.035, 1.05 respectively. Multi-door appliances have inherently more heat losses, in the door gasket area, than single or double door appliances of the same size. As a result the energy efficiency rating for the Energy Label is lower and there is no incentive for industry to go down that route. Currently, only about 15% of models offer the possibility to store food (also) at a different temperature than 4 °C. And of these 15% which offer a combi with also a chill compartment (0 °C) probably most are actually sub-compartments that share the external door with the fresh food compartment. Although in a controlled test environment such sub-compartments may pass the performance test, in real life such a chill sub-compartment solution is complex in terms of avoiding heat exchange with the fresh food compartment and in terms of accurate temperature control. This is also true for cellar compartments (8-14 °C, reference 12 °C), which are hardly used in the current market. Chill and cellar compartments represent important storage conditions for much perishable foodstuff, leading to an extension of shelf-life with a factor 2 or 3 with respect to storage at fresh-food conditions (see Circular Economy paragraph hereafter). Furthermore, the higher-than-fresh-food temperature of a cellar compartment offers additional saving options by not only displacing part of the fresh food compartment volume but also through possible use for cold air recovery from e.g. defrosting.

The most controversial correction factor in the proposal is the one for glass doors in wine storage compartments. Wine storage compartments with closed insulated doors can be handled just as normal refrigerators, but a glass door means a significant increase in energy consumption. For Energy Labelling, where wine storage compartments are already in the scope, this poses no problems: The appliance would simply be in the lowest class ('G'). But now the review clause requires that wine storage compartments are also included in Ecodesign measures. And in any overall Ecodesign limit that makes sense for all other appliances, the wine storage compartments/-appliances would be banned from the market. In the current proposal, glass door refrigerating appliances are out of the scope, they will be taken up in the Ecodesign measure for commercial refrigerating cabinets which is intended to be published at the same time. There was a proposal for a value of 1.2 for the wine storage glass door correction factor. But industry thinks it is too little and green NGOs think there should be no glass door correction factor at all. Member States and consumer associations have so far not expressed themselves clearly on the issue and thus the Consultation Forum will be crucial in determining the way forward.

Conversion

It is impossible to make a simple calculation to convert the current metrics to the newly proposed metrics. But, as a significant part of the previous analysis --e.g. on the LLCC and others-- starts from the current Energy Efficiency Index (EEI) it is important for policy makers to get an understanding of the implications in terms of the newly proposed EEI.

For that purpose a stochastic conversion was made on the basis of the models in the most recent (2016) CECED database. The table below shows how the rounded current EEI values (first column) in that database translate into the average, minimum, maximum and standard deviation values according to the new index. This is done for the three main categories in the

data-base: refrigerators (Cat. 1), refrigerator-freezer combis (Cat. 7) and the upright freezers (Cat. 8).

Table 1. Conversion from current to newly proposed EEI

(source: analysis based on 2016 CECED database)

Category-->		*1. Fridge*				*7. Combi*				*8. Upright freezer*				*Model count* (total 12493)		
EEI now		Avg	*Min*	*Max*	*Stdev*	Avg	*Min*	*Max*	*Stdev*	Avg	Min	Max	Stdev	1	7	8
42	*A+*	**140**	*130*	*150*	*1.8%*	**143**	*123*	*177*	*7.2%*	**130**	92	147	7.5%	642	3243	589
41		**141**	*133*	*143*		**135**	*133*	*159*		**117**	100	125		20	116	10
40		**132**	*132*	*132*		**134**	*120*	*143*		**123**	111	123		2	144	1
39		*128*				**129**	*117*	*144*		*119*				0	52	0
38		*125*				**130**	*119*	*133*		**116**	82	107		0	51	2
37		*121*				**134**	*131*	*138*		*113*				0	38	0
36		*117*				**129**	*128*	*130*		*111*				0	16	0
35		*113*				**120**	*111*	*128*		*109*				0	34	0
34		**110**	*110*	*110*		**120**	*120*	*120*		*108*				1	14	0
33	*A++*	**109**	*105*	*115*	*1.6%*	**113**	*89*	*139*	*7.0%*	**107**	75	118	7.0%	848	4564	311
32		**108**	*106*	*109*		**113**	*95*	*138*		**100**	86	105		9	58	6
31		*104*				**111**	*92*	*114*		**82**	74	82		0	17	1
30		*100*				**95**	*92*	*113*		*98*				0	35	0
29		**95**	*95*	*95*		**107**	*107*	*107*		*94*				1	1	0
28		*92*				*104*				*91*				0	0	0
27		*89*				*100*				*88*				0	0	0
26		*85*				*96*				*84*				0	0	0
25		*81*				*92*				*81*				0	0	0
24		*79*				*88*				*79*				0	0	0
23		*75*				**76**	*74*	*76*		*77*				0	5	0
22	*A+++*	**72**	*72*	*77*	*1.5%*	**74**	*65*	*92*	*7.8%*	**73**	56	78	5.9%	106	1454	54
21		*69*				**71**	*69*	*75*		**66**				0	18	0
20		*65*				**65**	*61*	*71*		**58**	52	58		0	8	1
19		*61*				**64**	*60*	*68*		*54*				0	2	0
18		**57**	*57*	*57*		**56**	*55*	*58*		*51*				1	18	0
17		*54*				*52*				*48*				0	0	0
weighted average														***total***		
New EEI		**119**	*113*	*126*	*1.6%*	**118**	*98*	*144*	*7.2%*	**107**	84.3	133	7.3%	1630	9888	975
EEI now (2016)		**35.9**				**34.5**				**37.8**						

Average values in small italic font are interpolations estimated from available values.

3. Ecodesign requirements

Ambition level

The basis for the ambition level of Ecodesign measures is the Least Life Cycle Cost (LLCC) for the consumer, under the boundary conditions in Art. 15 of the Ecodesign Framework Directive regarding the avoidance of a significant negative impact on functionality,

affordability, industry competitiveness, environmental impact. For the limits on Energy Label classes, rescaled to 'A-G', the new Energy Labelling Regulation gives indications on the top-classes being empty at introduction (*A&B* or just *A* depending on whether rapid development is expected), a review when top-classes are suspected to be populated with more than 50% (A&B) or 30% (just A) which should probably in the order of at least 6 years and the most 10 years, etc..

The LLCC is indicated in Task 6 of the preparatory review study, performed by Armines, and was commented by the industry association CECED. For refrigerators Armines found the LLCC at an EEI of 26 (SN-product), resulting in an energy saving of 34% with respect of the average product (EEI 36) and a price increase of 19% (from €495 to €589) with Life Cycle Costs (LCC) over a 16 year lifetime of €847 (down from €884) and a simple payback period (SPB) of 11.5 years. CECED is slightly less optimistic about certain options and finds a LLCC-point at 30, an energy saving of 25%, LCC of ~€835 and simple payback within 5 years. In general, CECED remarks that payback period is quite high.

For the COLD2 category, which includes mainly wine storage appliances, the LLCC found by both sources is at an EEI in the range of 40-47. Industry mentions an energy saving of 36% with respect of the average (EEI 56) and an LCC decrease from €1890 to €1825. The payback period is reportedly around 3 years.

For the largest category, the refrigerator-freezer combi (category 7), Armines calculates an LLCC at EEI=28 (SN product, 24 across climate classes), saving 34% in energy at the expense of a 17% average price increase for the consumer. The LCC drop from €1403 to €1206 and the simple payback period is thus ~5 years. CECED arrives at an EEI=30 for the LLCC, saving 32% at LCC of €1250 and a payback period of 2 years.

For the upright freezer (category 8), also approximately applicable to the chest freezers (category 9), the preparatory study and industry indicate the LLCC at level of EEI of 27-29, saving 30% in energy and €120 in LCC. Simple payback would be within two years.

From the viewpoint of affordability, the simple payback period of 11.5 years for the EEI-limit proposed by Armines for refrigerators is a bit harsh. As regards the functionality of the refrigerators, i.e. the capability for optimal food storage, no significant overall negative impact is expect but here the metrics for chill, cellar and wine storage compartments will be more critical (see Circular Economy).

For the Energy Label class-limits the Best Available Technology (BAT) is important for the lower class-limit of the B-class, which is assumed to remain empty at least at the time of this proposal (2016). Undoubtedly, before April 2020 there will be new B-class appliances entering the market, but at least it will ensure –as far as possible-- that there will be no A-class models in the market at the introduction of the label in the marketplace.

For refrigerators (currently Cat. 1) and combis (Cat. 7) the best available models are at an EEI of 17.5. For the freezers (Cat. 8 & 9) the BAT is slightly higher at an EEI of 20. At the lower end, taking into account that label classes should in the last stage preferably coincide with the final Ecodesign limit, the EEI of around 30 (current index) could be a suitable candidate for the class limit between classes E and F.

For information, the current EEI of 30 corresponds to an EEI of 100% in the new metrics. A current EEI of 17 corresponds to an EEI in the range of 48-54% according to Table 1.

Resource efficiency

The preparatory study investigated the possibilities for material resources reduction through the 5 R's (Reduce/Re-use/Recycle/Recover/Remove) and life-time extension. Furthermore it

looked at the Global Warming Potential (GWP) of refrigerants and foaming agents. As regards the latter, 99% of all models now use low-GWP substances, typically isobutane as refrigerant and cyclopentane as foaming agent.

Life-time extension, including from re-use, is currently –given the expected saving potential—not useful as it would stagnate the entry of new, more efficient models on the market. Currently the lifetime of household refrigerating appliances is 16 years, i.e. 12-13 years for first use (in the kitchen) followed by 3-4 years for secondary use (second-hand sales in the EU, transfer to the garage, student homes of the children, etc.). The secondary use in garage, utility room and garden shed to cool the odd bottle of beer is actively dissuaded by environmental agencies. Replacement of the refrigerating appliances is also only a result of technical failure. A 2015 German study showed that 43% (refrigerators and combis) to 52% (freezers) being replaced are in perfect working order, but were replaced for a 'better appliance'.[13] There are some anecdotal reports that the average lifetime would be decreasing and furthermore it is imperative that the energy efficiency of the refrigerator remains throughout its life time. For that reason a new general measure is proposed to ensure that replacement door-gaskets will be available until 10 years after production-stop of a model.

Recycling of refrigerators is regulated through the WEEE. Due to the large fraction of polyurethane foam (the insulation foam with the best thermal characteristics), which is practically unrecyclable, the WEEE-quota are tough on these appliances and there is a real danger that in the future manufacturers will be forced to increase the overall weight of the appliances by adding recyclable material fractions to meet these criteria.

However, despite the limited useful options for Ecodesign contributing to material resources involved in the production and end-of-life of the appliance itself, the most important contribution to reducing material resources comes from its primary function: The preservation of perishable foodstuffs. A complementary study in the context of Ecodesign and refrigeration[14], concluded that the material resources deployed and waste in the food chain are a manifold of those used in energy-related products. Roughly two-thirds of this food passes the household refrigerating appliances and 11% of food is thrown away, mainly because it is (believed to be) perished.

The study also concluded that the storage conditions offered by today's household refrigerating appliances are sub-optimal. The fresh food compartment temperature (4 °C) is right for (most) dairy products, but the shelf-life of meat and fish as well as leafy vegetables could be doubled or tripled by storage in the chill compartment (-1 to +2 °C). At the same time, many fruits and vegetables would be much better off in a cellar compartment.

For those reasons, the new regulation proposes to set more favourable N and M factors for chill compartments and introduced the multi-door correction factors discussed earlier.

Ecodesign requirements

Apart from the non-energy measures discussed in the previous paragraphs, the most important measures will concern energy-efficiency measures under Ecodesign ('market-push') and Energy Labelling ('market pull').

<u>Ecodesign</u>

[13] Prakash, S. et al., Einfluss der Nützungsdauer von Produkten auf ihre Umweltwirkung…, Öko-Institut with Bonn University for the UmweltBundesAmt (UBA), 2015.

[14] VHK in coll. with Oakdene Hollins, Complementary research: Optimal food storage conditions in refrigeration appliances, fort he European Commission, February 2017.

The implementation of Stage 1 of the Ecodesign measure is foreseen for April 2020. As this is an ambitious legislation, the final and second stage is then foreseen three years later, i.e. in April 2023.

At this final stage the LLCC applies. As mentioned in the paragraph on the ambition level, the LLCC occurs at an EEI of 100% (EEI 30 in the current index). When applied to the 2016 CECED database and assuming that, helped by the market pull effect of the energy label, the phased-out models will 'return' as the average of the current compliant model, the average energy consumption of the models on offer will drop by 30% for combis, 22% for refrigerators, 37% for upright freezers and 21% for chest freezers. Overall the energy consumption reduction will be approximately 30%.

It also implies that 82% of combis, 91% of refrigerators, 87% of upright freezers and 68% of chest freezers that were available in 2016 will be phased out in 2022, i.e. in less than 5 years.

For stage 1 a limit at EEI=125% is proposed, i.e. the energy label class limit between 'F' and 'G' proposed hereafter . Following the same assumption as above, the average energy consumption of the models on offer will drop by 12% for combis, 8% for refrigerators, 18% for upright freezers and 7% for chest freezers. Overall the average energy consumption reduction will be approximately 12%. It also means a phase out by April 2020 of 41% of combis, 38% of refrigerators, 45% of upright freezers and 14% of chest freezers available in 2016.

For household wine storage appliances a limit of EEI=155% (comparable to current index EEI 46-47) applies in stage 1 and 2. For household low noise appliances, limits at EEI=300% in stage 1 (comparable to current index EEI 90) and EEI=250% (comparable to current index EEI 75) in stage 2 applies.