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Accompanying document to the

PROPOSAL FOR A COMMISSION REGULATION
implementing Directive 2005/32/EC with regard to household refrigerating appliances

FULL IMPACT ASSESSMENT

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FULL IMPACT ASSESSMENT

Lead DG: TREN

Associated DG: ENTR

Other involved services: COMP, ECFIN, ENV, INFSO, LS, MARKT, RTD, SANCO, SG, TRADE

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EXECUTIVE SUMMARY

Household refrigerating appliances are covered by Directive 96/57/EC of the European Parliament and of the Council on energy efficiency requirements for household electric refrigerators, freezers and combinations thereof. These requirements, which became applicable in 1999 (three years after the entry into force of the Directive), have long been overtaken by recent innovations and can be considered obsolete.

Directive 2005/32/EC of the European Parliament and of the Council (the Ecodesign Framework Directive), adopted in the meantime, lays down a framework for the Commission, assisted by a Regulatory Committee, to set new ecodesign requirements for energy-using products. Refrigerating appliances were identified in the European Economic Recovery Plan, COM(2008) 800, as one of the priority product groups for which an update of the ecodesign requirements is needed.

The approach to developing the proposed ecodesign implementing measure for refrigerating appliances and conducting the impact assessment followed four steps:

Step 1: assessment against the criteria for an ecodesign implementing measure set out in Article 15(2) of the Ecodesign Framework Directive, taking into account the parameters listed in Annex I and the method for setting specific requirements laid down in Annex II of the Ecodesign Framework Directive;

Step 2: consideration of relevant Community initiatives, market forces and disparities in the environmental performance of equipment on the market with equivalent functionality, as laid down in Article 15(2) of the Ecodesign Framework Directive;

Step 3: setting policy objectives including the desirable level of ambition, the policy options for achieving the objectives, and the key components of the ecodesign implementing measure as required by Annex VII of the Ecodesign Framework Directive;

Step 4: impact assessment on environment, consumers and industry, with a view to the criteria on implementing measures set out in Article 15(5) of the Ecodesign Framework Directive.

Step 1: Legal base for an implementing measure: compliance with the Ecodesign Framework Directive, Article 15

In order to assess the criteria for ecodesign implementing measures as set out in Article 15(2) of the Ecodesign Framework Directive, the Commission carried out a technical, environmental and economic preparatory study on domestic refrigerating appliances[1] pursuant to Article 15(4)(a) and Annexes I and Annex II of the Ecodesign Framework Directive. The study has shown, as illustrated in Table 1, that (1) household refrigerating appliances are placed on the EU market in large quantities, (2) the environmental impact related to the life cycle electricity consumption of these products, despite significant energy improvements, remains significant, and (3) there is a wide disparity in the environmental impacts of appliances currently on the market, and technical, cost-effective solutions exist that could lead to significant improvements. The study demonstrated that the greatest environmental impact of household refrigerating appliances is energy consumption in use.

Table 1: Total household refrigerating appliances in EU-27 in 2005

Article 15(2)(a):	Annual sales volume in the Community	Compressor-type appliances: 20 million units Absorption-type appliances: 250 000-300 000 units Wine appliances: 300 000 units[2]
Article 15(2)(b):	Environmental impact: electricity consumption of appliances (BaU)	In 2005: 122 TWh[3] and 56 Mt CO_2 equivalent In 2020: 83 TWh and 38 Mt CO_2 equivalent
Article 15(2)(c):	Improvement potential of household refrigerating appliances (applying existing cost-effective technology)	Between 3 and 6 TWh depending on the sub-options in 2020 compared to the BaU scenario[4] (in 2025, the potential for energy savings increases up to 14 TWh compared to the BaU scenario)

1 '*Preparatory studies for ecodesign requirements — Lot 13 on domestic refrigerators and freezers*'. Available on: www.ecocold-domestic.org.

2 This is only an estimated figure since no precise data are available on the sales of wine appliances.

3 This represents 4.4% of the total EU electricity consumption of about 2760 TWh in 2005.

4 Compared to the 2005 level, i.e. including the savings achieved in the BaU scenario, the savings will amount to 39-46 TWh (depending on policy options).

Step 2: Existing initiatives and the capacity of market forces to address the issue

Further to Articles 15(2) and 15(4)(c) of the Ecodesign Framework Directive, relevant Community and national environmental legislation were considered. Related (voluntary) initiatives both at Community and Member State level were taken into account, and barriers preventing the market take-up of technologies with improved environmental performance (leading to market failures) were analysed.

Unlike other product groups considered under the Ecodesign Framework Directive, refrigerating appliances have long been addressed by legislative initiatives.

Regulated by energy labelling[5] and minimum efficiency requirements[6] since 1994 and 1996, domestic refrigerators and freezers are one of the success stories of Community energy efficiency policy. Over the last 12-13 years, an energy efficiency improvement of almost 30% has been achieved and the EU Energy Label has become one of the most important market drivers. Despite stock growth of 15% over the period, the absolute energy consumption of domestic 'cold appliances' is currently 15% lower than in 1990. In the same period, the industry has practically phased out CFCs and HCFCs and replaced them with hydrocarbons, thus diminishing the ozone depletion potential (ODP) and greenhouse gas (GHG) impact of the refrigerant and foaming agents.

In the meantime, however, the minimum energy efficiency requirements have long been surpassed and the industry (CECED) introduced a voluntary commitment banning the least efficient appliances from the market. However, partly as a consequence of enlargement but mainly because the market has become too scattered for proper and fair implementation, the industry has decided not to table a new voluntary agreement. In addition to minimum requirements, an energy labelling scheme was in force. The labelling for the energy efficiency classes, revised in 2003 by adding two classes A+ and A++, is proving to be no longer sufficient to drive innovation, so that stakeholders, including the industry and consumer organisations, are unanimously asking for a combined revision of both the Ecodesign and Labelling Directives on refrigerating appliances[7].

Therefore, given the lack of voluntary initiatives by the sector, this impact assessment pays particular attention to the rationale for developing tighter measures under the Ecodesign and the Labelling Framework Directives as a means to providing consumers with meaningful product information on energy efficiency and giving European manufacturers the long-term security they need to invest in innovative technology. The aim is to maintain the trend towards efficiency improvements and support the global competitiveness of the EU-27 industry.

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5 Commission Directive 2003/66/EC amending Commission Directive 94/2/EC implementing Directive 92/75/EEC with regard to energy labelling of household electric refrigerators, freezers and their combinations.

6 Directive 1996/57/EC of the European Parliament and of the Council on energy efficiency requirements for household electric refrigerators, freezers and combinations thereof.

7 Member States have, in the past, initiated fiscal incentives programmes to foster the market take-up of energy-efficient appliances but the uncertainty about the future of the energy efficiency classes prevents them from starting up new support programmes. Furthermore, the Ecodesign Framework Directive implies that legislative action on domestic appliances cannot be taken at Member State level.

From the first two steps, it was concluded that the criteria for ecodesign implementing measures as set out in Article 15(2) of the Ecodesign Framework Directive are met, and refrigerating appliances should be covered by a measure pursuant to Article 15(1) of the Ecodesign Framework Directive complemented by an upgraded energy labelling scheme.

Step 3: Policy objectives and levels of ambition

Annex II to the Ecodesign Framework Directive provides that the level of ambition for improving the environmental performance and electricity consumption be determined by an analysis of the least life cycle cost for the user of equipment. Furthermore, benchmarks for technologies yielding best performance, as developed in the preparatory study and the discussions with stakeholders during the meeting of the Ecodesign Consultation Forum[8] on 5 December 2008, are considered. The minutes of the meeting are attached in Annex 1. The results are reflected in the objectives that the proposed regulation aims to achieve.

The objective is to trigger a market shift that would enable the potential for improvement to be achieved. Several policy options were considered, including self-regulation, mandatory energy labelling and mandatory minimum energy performance requirements. Considering the strong interrelationship between the energy labelling scheme and the ecodesign requirements, and the demand from Member States, the industry, consumer organisations and environmental NGOs for a coordinated revision of the existing legislation, this impact assessment also considers, in sections 5 and 6, the combined impact of both measures.

Step 4: Environmental, economic and social impact assessment

An assessment of the proposed implementing measure is carried out. Considering that the most significant environmental impact of household refrigerating appliances is their energy consumption in use, sub-options for gradual ecodesign requirements together with revised energy efficiency classes were analysed in section 6. The sub-options considered for compressor-type appliances are as follows:

– **BAU:** Business-as-usual scenario, i.e. continuation of current Community policy measures (current labelling scheme only) and no further action at EU level;

– **Sub-option EE44-15:** EEI[9] < 55 in 2010, EEI < 44 in 2015;

– **Sub-option EE44-13:** EEI < 55 in 2010, EEI < 44 in 2013;

– **Sub-option EE42-15:** EEI < 55 in 2010, EEI < 42 in 2015;

– **Sub-option EE42-13:** EEI < 55 in 2010, EEI < 42 in 2013.

– **Sub-option EE44/42-12/14**: EEI < 55 in 2010, EEI < 44 in 2012 and EEI < 42 in 2014.

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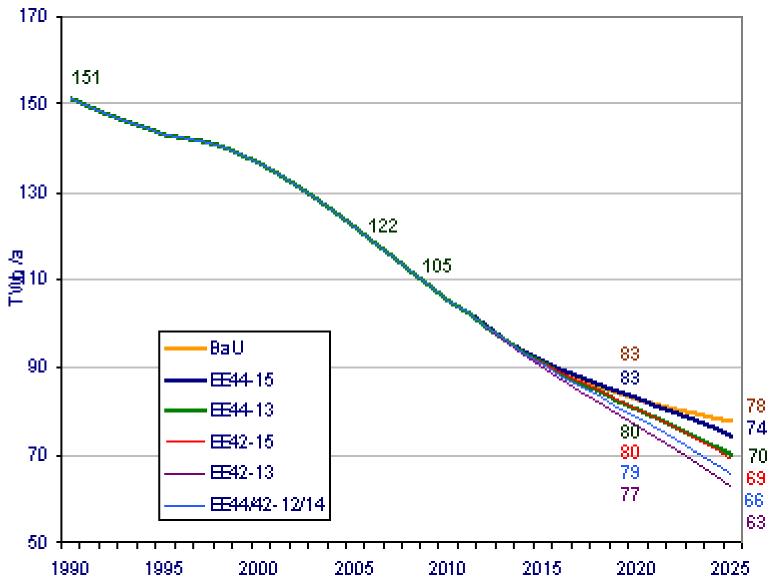
8 The Consultation Forum is composed of representatives of the Member States and of interested parties such as the industry, consumer and environmental NGOs called to express their views.

9 EEI refers to the energy efficiency index, an algorithm defined in the current Directives 96/57/EC and 94/2/EC, which takes into account the effects of the volume and other features of cold appliances in order to allow a fair comparison between products.

The following graph illustrates the savings achieved for each scenario.

Figure 1: EU-27 total electricity consumption of compressor-type refrigerating appliances according to sub-options 1 to 5 in TWh/year (electric) (EU-27 demand 2005: 3106 TWh, including energy sector)



Source: Input to this Impact Assessment by VHK

Compared with 1990 — the reference year for the climate change policy — the annual energy consumption and carbon emissions of household refrigerating appliances in 2020 will be 50-60% lower, saving around 75 TWh electricity and 25 Mt CO_2 equivalent per year (1990: 153 TWh; 2020: 77-83 TWh, depending on the scenario). In 2025, savings are projected to be around 90 TWh and 40 Mt CO_2 per year (compared to 1990).

The graph shows that substantial savings will be achieved in the business as usual scenario. This is due to the fact that this market is already characterised by strong market demand for energy-efficient products, which is the outcome of 15 years of effective energy labelling. However, to prevent the slow-down in energy savings which is expected to occur from 2015, and to ensure that the cost-effective level is reached, an upgrade of the existing legal framework appears necessary.

The biggest threat to further energy improvements identified by the industry itself is in fact failure to put into place the legislative framework to support the market dynamics. The fact that the energy efficiency classes in the current labelling scheme are outdated will have several negative impacts: consumers will no longer be able to differentiate between products on the basis of their energy efficiency (all models will be in the same labelling class), retailers will lose interest in displaying the energy label, the authorities will no longer be able to promote the most efficient models and the industry will not be motivated to invest in energy efficiency but might instead invest in other features (mostly more energy-consuming) in order to differentiate their products from those of their competitors.

Sub-option EE42-13 (EEI<55 in 2010 and EEI<42 in 2013) is shown to deliver the most important savings without negative impacts on other functions of the appliances. However, in order to reduce the risks of a negative impact on industrial competitiveness minimum energy efficiency requirements in three stages would be more appropriate. This would leave enough time to the industry to adapt to the reduction of tolerances for the measurement of energy consumption. In that scenario, it is suggested that the requirement is set at EEI<55 in 2010, EEI<44 in 2012 and EEI<42 in 2014 (sub-option 'EEI44/42-12/14').

The analysis demonstrates that the best policy option for achieving the environmental improvement potential of refrigerating appliances is a combined revision of the ecodesign requirements and the labelling scheme in two stages (one year and four years after entry into force). This approach ensures that:

– ongoing energy improvements are maintained and fostered by setting a transparent legislative framework that will provide the industry with the long-term security it needs to invest in innovative technology;

– fair competition and product differentiation continues to operate on energy improvements by providing consumers with an effective and reliable tool to compare the energy consumption of products, in a context of strong market demand for energy-efficient appliances;

– by 2020, absolute electricity savings of 30-35% can be achieved against the reference year 2005 (due to the market inertia (i.e. full replacement of old models by new types takes about 15 years), the effects of the new measures will be very limited up to 2020 compared with the baseline scenario, but by 2025 the energy consumption of all installed domestic refrigerators and freezers could be half of the energy consumption in 2005);

– the cost-effective level of energy consumption is reached, with a savings potential of 4 TWh in 2020 compared to the BaU scenario, increasing to 12 TWh in 2025 if sub-option EE44/42-12/14 is implemented;

– more energy-consuming products are quickly removed from the market, securing electricity and CO_2 savings in the Community, while reducing the life cycle costs of these devices for consumers. Calculated in net present value (euro 2005), consumer expenditure — i.e. the annual purchase and running costs of the EU-27 stock — will drop by around € 400 mln./a in 2025 compared to 2005;

– a level playing field for all manufacturers is guaranteed, ensuring fair competition and free movement of products;

– the burdens on manufacturers are not excessive, as the transition periods take redesign cycles into account.

In addition, the impact assessment has considered other issues to be addressed as part of the revision of the current Ecodesign and Labelling Directives, in particular extending their scope to include new types of appliances (e.g. absorption-type appliances and wine coolers), the addition of new generic requirements and the revision of the calculation methodology for the energy efficiency index.

Finally, SMEs are considered to represent 30% of manufacturers (mainly as OEMs, i.e. suppliers of components like thermostats, shelves, etc.) and 80% of retailers. The analysis shows that the policy options will have no negative impact on them. On the contrary, they would benefit from stronger demand for new technologies and higher turnover.

As set out in Section 7, the impacts of the legislation will be monitored mainly through market surveillance carried out by Member State authorities ensuring that its requirements are met, while the appropriateness of the scope, definitions and concepts in the legislation will be monitored through ongoing dialogue with stakeholders and Member States.

1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.2 Organisation and timing

Household refrigerating appliances have been subject to energy labelling and energy efficiency requirements for some time, under *Commission Directive 2003/66/EC amending Commission Directive 94/2/EC implementing Directive 92/75/EEC with regard to energy labelling of household electric refrigerators, freezers and their combinations*[10] and *Directive 1996/57/EC of the European Parliament and of the Council on energy efficiency requirements for household electric refrigerators, freezers and combinations thereof*[11].

Since the recent market shift towards more energy-efficient appliances calls for a revision of both the labelling scheme and the energy efficiency requirements, the *Action Plan for Energy Efficiency: Realising the Potential*[12] identified cold household appliances (i.e. household refrigerating appliances) as one of 14 priority product groups for which updated minimum energy performance standards and labelling should be adopted by 2008.

This report assesses the impact of revising the ecodesign requirements for household refrigerating appliances set in Directive 1996/57/EC, pursuant to Article 15(4) of Directive 2005/32/EC of the European Parliament and of the Council establishing a framework for the Commission to set ecodesign requirements for energy-using products ('the Ecodesign Framework Directive')[13].

Commercial refrigerating appliances are not considered in this impact assessment since they are covered by separate measures.

The impact assessment was launched in November 2008 supported by an interservice steering group comprising COMP, ECFIN, ENTR, ENV, INFSO, LS, MARKT, RTD, SANCO, SG, and TRADE.

1.2 Impact Assessment Board

This impact assessment was scrutinised by the Commission's Impact Assessment Board (IAB). In its opinion, the IAB concluded that the impact assessment contains an adequate and proportionate analysis. The analytical steps based on the requirements of the Ecodesign Directive 2005/32/EC have been respected.

This impact assessment integrates the additional recommendations for improvements advocated by the IAB.

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10 OJ L 45, 17.2.1994, p. 1.

11 OJ L 236, 18.9.1996, p. 36

12 COM(2006) 545.

13 Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of ecodesign requirements for energy-using products and amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC, OJ L 191, 22.7.2005, p. 29.

1.3 Transparency of the consultation process

A preparatory study was carried out in 2007-2008 to provide the European Commission with the technical/economic background information supporting the development of ecodesign requirements following the methodology defined in Annex I and II of the Ecodesign Framework Directive[14].

The opinions of stakeholders were consistently sought through bilateral meetings and the Consultation Forum, which was set up to comply with Article 18 of the Ecodesign Framework Directive (see minutes of the Consultation Forum in Annex I). The Commission's minimum standards on public consultation have thus been met.

- The preparatory study was run in close cooperation with manufacturers, in particular through their European Federation, CECED. They contributed to the life cycle analysis of cold appliances the base case appliances identified being representative of the EU market) and to the analysis of technological means and costs of implementing ecodesign improvements. CECED, in particular, provided the European Commission with its yearly database on EU production, which was extremely useful in drafting the policy options and calculating their economic impact. The preparatory study is publicly available on the ECOCOLD website: http://www.ecocold-domestic.org.

- An extensive consumer survey was run in 2007 in order to better understand and identify consumers' needs, expectation and daily use of cold appliances. The opinions of 2 497 European households (250 per country on average) were gathered with the help of an external market research institute, ODC Services. The results are available on the ECOCOLD website quoted above[15].

- An Ecodesign Consultation Forum held on 5 December 2008 attracted Member States, consumer organisations, environmental NGOs and the industry. Working documents presenting the policy options for new ecodesign requirements implementing Directive 2005/32/EC, together with a revised labelling scheme, were sent out a month before the meeting. All replies to the working documents are available on CIRCA, together with the minutes of the meeting (see also Annex I).

1.4 Outcome of the consultation process

All respondents throughout the consultation process generally supported the revision of the ecodesign requirements. The following issues were raised and have been taken into account in this impact assessment:

- Some stakeholders wanted the EU to set more stringent requirements on energy efficiency and bring forward the implementation date proposed in the working document submitted to the Consultation Forum (see Annex 1). This impact assessment therefore incorporates this request in the analysis of the sub-options.

- Inconsistencies between the current Ecodesign and Labelling Directives were highlighted. Slight differences in the categories of cold appliances used for the calculation of the energy efficiency index (EEI), and a mismatch between the current ecodesign thresholds and the

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14 ISIS/ENEA, preparatory study for Lot 13, Domestic Refrigerators & Freezers.

15 See Preparatory study, results of Task 3.

energy efficiency classes, for example, made some stakeholders doubtful about the implementation of the two Directives. An effort was therefore made to review and align the methods for calculating the EEI and the definitions and categories of appliances. This harmonisation was proposed to, and fully supported by, the Consultation Forum.

- Some stakeholders asked for the measurement accuracy to be tightened. The impact assessment considers the reduction of tolerances for the measurement of energy consumption from 15% to 10%. Further reductions are not assessed on the grounds that any further reduction should be based on sound knowledge of the differences in measurement accuracy between EU laboratories and the cost of raising the standard of testing. The Round Robin Test to be run soon by CENELEC for the design of a new testing standard should provide the European Commission and Member States with solid data. This may prompt further decisions at a later stage.

- The Consultation Forum highlighted the need to further assess the generic requirements proposed for wine-storing appliances and the impact of bringing other wine appliances within the scope of the specific requirements (setting minimum energy efficiency requirements). Even though wine appliances still represent a niche market (they are not covered by the current legislation), it was agreed to consider them more extensively within this impact assessment.

- Some of the correction factors for the formulae used for calculating the energy efficiency index were contested: green NGOs expressed concern over the increase in the specific volume of the products and proposed that the energy-efficiency calculation methodology be adapted to penalise bigger appliances. Section 5.5 of this impact assessment addresses the issue. However, it became clear that there is a lack of the reliable data needed for an in-depth investigation.

2. PROBLEM DEFINITION

2.1 Market failure

Along with increasing market demand for energy-efficient products, improvements in the energy consumption of household refrigerating appliances — defined as <u>compressor-type</u> mains-operated appliances[16] — have been driven mainly by three initiatives: (1) the Ecodesign Directive 1996/57/EC, (2) the Labelling Directive 1994/2/EC, and (3) the industry voluntary agreement.

The impacts of the Waste Electrical and Electronic Equipment Directive 2002/96/EC (the WEEE Directive) and of Directive 2002/95/EC on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (the RoHS Directive) are discussed in section 2.2.2.

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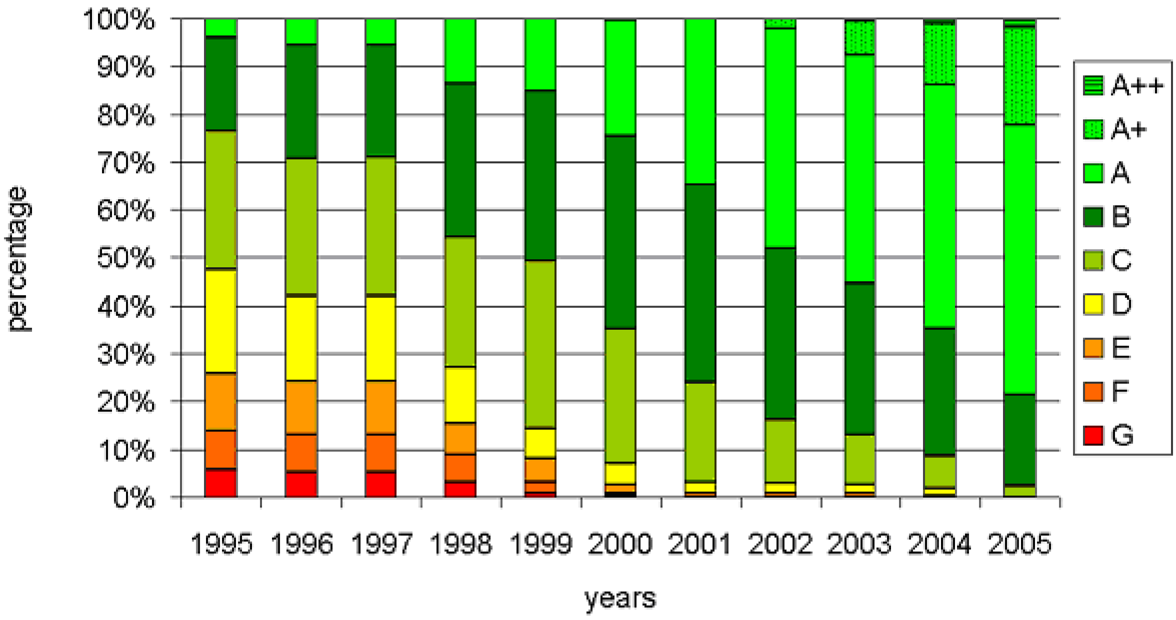
16 Compressor-type appliances, with sales of 20 million units a year, represent the vast majority of refrigerating appliances. Other types of appliances such as absorption-type or wine appliances (accounting for approximately 2.5% of market share) are not covered by the current legislative initiatives or the voluntary agreement. This impact assessment discusses the option of expanding the ecodesign implementing measure to include these types of appliances (see section 5.3).

2.1.1 *Existing ecodesign requirements*

Household refrigerating appliances are addressed in Directive 1996/57/EC *of the European Parliament and of the Council on energy efficiency requirements for household electric refrigerators, freezers and combinations thereof*. The Directive sets minimum energy efficiency requirements based on the energy efficiency index, an algorithm which takes into account the effect of the volume and other characteristics of cold appliances to produce a fair comparison between products. These standards, applied since 1999 (three years after the entry into force of the Directive), have long been surpassed by recent technology, as illustrated below, and can be considered obsolete.

Figure 2: EU-27 market distribution of cold appliances by energy efficiency class



Source: Preparatory study

The energy efficiency requirements, mandatory since 1999, were equivalent to removing appliances in energy efficiency classes D to G (depending on the category of appliance). The graph above clearly shows that these classes not only disappeared from the market but have long been replaced by significantly more energy-efficient products.

In addition, new types of appliances which were not included in the scope of the Directive have since come onto the market or are increasingly gaining market share (e.g. wine coolers).

2.1.2 *The existing Labelling Directive*

In addition to the minimum efficiency requirements, which eliminated the most energy-consuming appliances, the Labelling Directive has had and still has a major role in pulling the market towards more energy-efficient products.

The current Directive 94/2/EC, revised in 2003 to add two new energy efficiency classes (A+ and A++), does provide consumers with the means to identify the most energy-efficient appliances, i.e. a ranking on a scale of A to G (now A++ to G). The table below shows the market distribution of cold appliances by energy efficiency class[17].

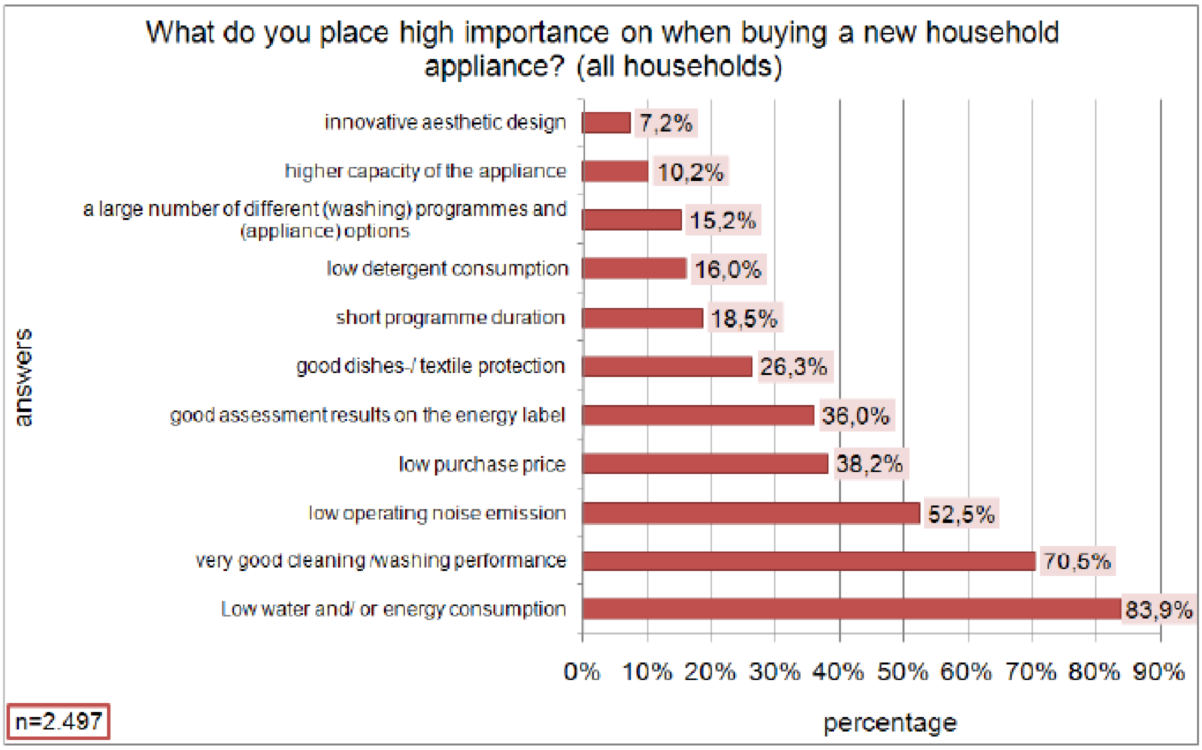
Table 2: market distribution of cold appliances by energy efficiency classes in 2005

Energy efficiency class		A++	A+	A	B	C	D	E	F	G
EEI		<30	<42	<55	<75	<90	<100	<110	<125	>125
Market share in 2005 (%)	Refrigerators	1	18	61	19	1	0	0	0	0
	Freezers	5	25	33	25	12	0	0	0	0

Source: Preparatory study, task 7

For freezers, there is still sufficient differentiation between products offered to consumers, with five classes populated, from C to A++. For refrigerators (including refrigerator-freezers) by contrast, there appears to be a more limited choice of products available to consumers, with the bulk of the market represented in class A. This is certainly a sub-optimal situation since consumer surveys reveal that energy consumption is one of the main criteria in consumers' purchasing decisions, as shown in the graph below.

Figure 3: Purchasing criteria of consumers for all household appliances



Source: Preparatory study, task 3, p.25

[17] NB: Only compressor-type appliances are represented in the table since absorption-type appliances are not covered by the current labelling directive.

Although the survey covered all household appliances, it seems clear from the results that energy consumption is a major criterion when consumers buy a new household refrigerating appliance (84% of the consumers interviewed identified energy consumption as a very important criterion). There should therefore be strong incentives for manufacturers to place more energy-efficient products on the market so as to gain market share.

In addition, the denominations A+ and A++, adopted when urgent revision of the labelling scheme was needed, are not fully supported by either manufacturers or consumers, as they are placed at the same level as the 'A' arrow. There is strong demand from stakeholders for an upgrade of the energy efficiency classes. The uncertainty as to the future of the current energy efficiency classes also explains why manufacturers fail to invest to move into class A++.

This brief analysis demonstrates that, while the labelling scheme still provides incentives for further energy efficiency improvements, it could be more effective.

2.1.3 Voluntary agreement

The cold appliance industry, under the auspices of CECED, the European Committee of Domestic Equipment Manufacturers, signed a Voluntary Commitment in 2002 which proved to be very successful in driving energy efficiency for cold appliances[18]. It set:

- *a hard target*, which committed participants to stopping production for and imports into the Community market (under their own brands or private labels) of electric compressor-based household refrigerating appliances with an EEI of 75 by 31 December 2004; likewise, for chest freezers, CECED set an EEI limit of 90 with the same deadline;

- *a 'fleet' target,* which committed each participant to reducing its own production-weighted average energy efficiency index to a value of 55 for production and imports into the EU market by 2006;

- *a soft target,* which committed participants to strengthening their overall efforts to achieve further energy savings and to educating consumers on ways to save energy.

This Voluntary Commitment was successfully met, but the industry did not renew it. Although EU producers account for a large market share, rising imports from Asian countries (China, India and South Korea) in the last five years have made voluntary agreements more difficult to put into practice: the industry association fears that it may not be able to bring important market players into a voluntary agreement and thus prevent free riders. The industry therefore sought legally binding energy efficiency requirements instead. In addition, consumers and environmental organisations are sceptical about the value of such voluntary agreements and favour a harmonised ecodesign and labelling scheme[19].

Taking into account on one hand the strong market demand for better appliances and on the other hand the rejection of a new Voluntary Commitment as an alternative for tackling the environmental impact of domestic cold appliances, Member States, the industry and consumer organisations asked for a revision of both the Ecodesign Directive and the Labelling

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[18] CECED Voluntary Commitment on Reducing Energy Consumption of Household Refrigerators, Freezers and their Combinations (2002-2010), 31 October 2002, downloadable from www.ceced.org.

[19] See for example ANEC/BEUC's contribution to the revision of the Energy-using Products Directive (2005/32/EC), *Consumer interests in Eco-design (of energy-using products),* Sylvia Maurer, 2008.

Directive. The Ecodesign Framework Directive, adopted in July 2005, laid down the criteria for adopting a new ecodesign measures.

2.2 Grounds for an implementing measure: compliance with Article 15 of the Ecodesign Framework Directive

Article 15(1) and (2) of the Ecodesign Framework Directive sets clear criteria for assessing whether to adopt or revise (as in this case) ecodesign requirements for a specific energy-using product (EuP):

(1) the energy-using product must 'represent a significant volume of sales and trade, indicatively more than 200 000 units a year';

(2) it must 'have a significant environmental impact within the Community';

(3) it must 'present significant potential for improvement in terms of its environmental impact without entailing excessive costs, taking into account in particular:

- the absence of other relevant Community legislation or failure of market forces to address the issue properly;
- a wide disparity in the environmental performance of EuPs available on the market with equivalent functionality.'

2.2.1 Sales volume of household refrigerating appliances

Total sales of compressor-type household refrigerating appliances in the EU-27 were around 20 million units in 2005, well above the indicative threshold of 200 000 set by the Ecodesign Framework Directive for deciding whether the sales volume is significant. Even wine coolers, considered to be a niche market, account for more than 200 000 units per year.

Almost 16 million refrigerators were sold in 2005, of which 14 million went to primary households and 2 million to non-domestic applications and secondary dwellings. Fridge-freezers accounted for around 84% of the refrigerator categories[20]. Around 4.1 million freezers were sold, 3.6 million of them to primary households. The freezer market is divided evenly between upright freezers and chest freezers.

Note that the cold appliance market is marked by a high level of saturation, with practically all 197 million households in the EU-27 owning at least one refrigerator (mostly refrigerator-freezers) and some 34% owning a freezer. The potential for energy improvement will therefore mainly be achieved through stock renewal (replacement by individual households of old appliances). which accounted for around 90% of all sales in the EU-15 in 2005 [21].

Most importantly, other types of appliances which are not covered either by the current Directive (96/57/EC) or by the Labelling Directive on refrigerating appliances are coming

[20] Fridge-freezers are in categories 7 and 10 of Commission Directive 2003/66/EC. Other refrigerators (with or without internal freezer compartments) are in categories 1 to 6 and have a market share of 16%. Freezers are in categories 8 (upright) and 9 (chest freezers).

[21] In the newest Member States of Central Europe, including Romania and Bulgaria, the percentage of the sales representing stock renewal is lower (around 60%), but still significantly higher than the purchase of new appliances. See preparatory study, Task 2, p. 48.

onto the market or rapidly gaining market share. They include absorption-type refrigerators, wine-storage appliances and wine coolers, mini-refrigerators/chillers and mini drinks chillers (Peltier effect type). These types of appliances still represent a niche market, but their constant growth in market share may require the adoption of specific measures.

Absorption types account for sales of 250 000–300 000 units annually[22]. European data on wine storage appliances are not available, but the UK Market Transformation Programme (MTP) reported sales of 30 000 units in 2007 (up from 15 000 units in 2006, i.e. sales doubled in one year), accounting for 2.5% of total refrigerator unit sales. For mini-refrigerators/chillers and drinks chillers (Peltier type), no comprehensive EU market data are available.

2.2.2 Environmental impact

A life cycle analysis (LCA) was run as part of the preparatory study to identify the environmental impact of household refrigerating appliances, following the methodology laid down in Annex I, Part I, of the Ecodesign Framework Directive:

- definition of four base cases representative of the average appliance for refrigerators (COLD1), refrigerator-freezers (COLD7), upright freezers (COLD8) and chest freezers (COLD9):

- sending of inventory tables to manufacturers, including data on raw materials, manufacturing, transport, distribution, use and end-of-life arrangements for the base case appliances.

- aggregation of the results using the EuP EcoReport and SimaPro software.

The analysis shows that the use phase is responsible for about 72% of the environmental impact of household refrigerating appliances (according to SimaPro outputs[23]).

Despite the energy efficiency improvements made so far, electricity consumption remains the factor with the greatest environmental impact, with 90% of it occurring in the use phase.

- the use of hazardous substances during the production phase is dealt with by Directive 2002/95/EC on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (the RoHs Directive);

- hydro chlorofluorocarbon (HCFC) and hydro fluorocarbon (HFC) used as refrigerating and foaming agents have in practice been totally replaced by hydrocarbons (HC). In fact, almost all models in the 2005 database use hydrocarbons as a foaming agent and only a residual ~5-8% of models are still using HFC as a refrigerant. These remain because of current safety standards (HC is inflammable) which do not allow the use of HC above a load in the circuit of 150gr. HFC therefore continues to be used in a small share of the market for large horizontal freezers and side–by-side refrigerators which have a load of up to 150/200[24];

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22 Preparatory study, Task 7.

23 See preparatory study, Task 5, p. 45-62.

24 In addition, a small share of the production of side-by-side products is exported from the EU to countries where the use of HC is restricted. A ban on HCF in the circuits would indirectly mean asking manufacturers to move that production outside the EU.

- end-of-life phase is addressed in the Waste Electrical and Electronic Equipment Directive 2002/96/EC (the WEEE Directive). Refrigerating fluids with a global warming potential (GWP) of more than 15, such as HFC, have to be extracted from the appliance at the end of its life without leakage into the environment. A refrigerator collection, recycling and residual waste disposal scheme has been in place for over a decade. The preparatory study reports materials recycling percentages between 89 and 92%, depending on the type of appliance;

- the environmental costs of the transport of refrigerating appliances cannot be addressed by the legislator in a free-market.

Considering therefore the total scope of product policies already in place, covering many aspects of lifecycle emissions (RoHS and WEEE), it appears appropriate to focus ecodesign requirements on energy consumption in the use-phase. All in all, installed household refrigerating appliances are indeed responsible for around 4,4 % of EU final end-use electricity demand[25].

Taking the total 2005 stock of household refrigerating appliances (232 million installed refrigerators and 75 million freezers in the EU-27), refrigerators and refrigerator-freezers are responsible for 92 TWh of electricity consumption and 42 Mt CO_2 equivalent, while freezers account for 30 TWh of electricity consumption and 14 Mt CO_2 equivalent[26]. The electricity consumption of the stock of household refrigerating appliances is also indirectly responsible for a significant fraction of acidifying emissions at 329 kt SO_2 equivalent[27] and the consumption of 0.85 million m^3 of process water[28].

2.2.3 *Potential for improvement*

The combined effect of the labelling scheme and the minimum energy efficiency requirements introduced respectively in 1995 (a year after the entry into force of Directive 94/2/EC) and 1999 (three years after the entry into force of Directive 96/57/EC) have already led to significant energy savings. In 1995, refrigerators consumed on average 425 kWh/year; in 2005, they consumed approximately 290 kWh/year, which represents a 30% reduction[29].

Despite these drastic improvements and the fact that the majority of household refrigerating appliances today are in energy efficiency class A, the range of performance between appliances placed on the market indicates that further improvements are still achievable (see Table 3).

Table 3: Energy consumption of cold appliances by category in 2005

Category as defined in	Net volume (litre)	Energy consumption (kWh/year)	**EEI**

[25] EU-27 electricity final demand without the energy sector was 2755 TWh in 2005. With distribution losses, final demand was 3106 TWh in the same year.

[26] At 0.458 kg CO_2 eq/kWh electricity (source: VHK, MEEUP Report, Nov. 2005).

[27] Acidifying agents at 0.0027 kg SO_2-equivalent/kWh electricity (source: VHK, MEEUP Report, Nov. 2005). Compared with the EU-15 total in 2005: 10,945 kt SO_2 equivalent (source: European Environmental Agency, EEA, Copenhagen, 2007), of which cold appliances then constitute 2.6%.

[28] At 0.7 litre/kWh electricity (source: VHK, MEEUP Report, Nov. 2005).

[29] Preparatory study, Task 2, p. 44. The same is valid for freezers, with a 34% reduction from 426 kWh/year to 279 kWh/year.

Directive 96/57/EC									
	min	max	average	min	max	average	**min**	**max**	average
1	88	403	231	83.0	241.0	159.7	**29.6**	**78.3**	52.9
2	150	390	314	131.0	226.0	164.2	**40.4**	**72.4**	53.0
3	67	155	123	102.0	211.0	182.1	**38.9**	**74.9**	66.3
4	45	155	91	120.0	208.0	177.4	**53.3**	**79.2**	69.6
5	106	290	145	165.0	277.0	217.6	**53.2**	**75.0**	68.8
6	118	202	150	207.0	285.0	249.9	**54.7**	**74.9**	72.2
7	98	627	277	124.1	786.0	324.1	**28.0**	**89.8**	54.4
8	45	335	177	135.0	540.2	274.5	**29.1**	**105.1**	56.3
9	57	572	254	134.0	595.0	300.1	**27.4**	**108.2**	64.4
10.7	160	501	289	190.0	657.0	336.1	**27.3**	**77.7**	50.6

Source: Preparatory study, Task 5, p.11

The energy consumption of refrigerators in absolute terms is of course heavily dependent on their volume and characteristics (whether or not they have additional features: climate class, built-in appliances, no-frost function, etc.). The energy efficiency index, which is calculated on equivalent volume and correction factors applied to the different characteristics, allows the performance of refrigerators to be compared irrespective of their size or characteristics. The wide variation of the EEI illustrated in the table above shows that there is a wide disparity in the performance of cold appliances with equivalent functions on the market. Moreover, top models like the 2004 winner of the Energy Plus award show that an EEI of 19 is feasible[30].

In addition, the life cycle costs of household refrigerating appliances are more than double their purchase price, which reflects the importance of annual operating costs, in particular electricity, in the total cost of the appliance. This indicates the potential for cost-effectively reducing the energy consumption of cold appliances: increased production costs (hence increased purchase price) due to improvements in energy consumption will be compensated by the savings achieved in the use phase.

30 Appliance Magazine, Blomberg Honored with Energy+ Award, Feb. 27, 2004 (model Blomber CT 1300A, 2 door fridge-freezer). Unfortunately that model disappeared from the market very few months after the award. The reason is not clear (too low price for an acceptable manufacturer profit, energy performance decaying rapidly after few months from manufacturing, expected lifetime too short due for example to short life of vacuum panels if used, etc…).

2.2.4 *Failure of market forces to address the issue properly — baseline scenario*

As highlighted in the first section on market failure, improvements in energy efficiency have been and are still mostly driven by market demand which was made possible by the current labelling scheme (enabling consumers to differentiate products on the basis of their energy consumption). Former ecodesign requirements and the industry voluntary agreement have also significantly speeded up energy efficiency improvements in the past, but have come to an end. Since the current design of the energy label deters producers from placing of class A++ products on the market compared to class A+ (see section 2.1.2), the Baseline Scenario anticipates a slow increase in products in class A++ under the following assumptions:

for refrigerators:

- efficiency classes A, A+ and A++ will represent the totality of the market in 2009; this year, class A will account for 70% of the market, class A+ 26% and class A++ the residual 4%;
- the market share of higher efficiency classes will gradually improve until 2030 when class A+ appliances will dominate the market with 75% of the share, followed by class A++ ones with 25%;

for freezers:

- in 2005 there was still a significant presence of class B and C models (together representing more than 50% of the market) and a notable penetration of class A+ units (25%);
- in this situation, a gradual phase out of class B is expected by 2020, matched by significant and steady penetration of class A+ (70% in 2030) and A++ (30% in 2030) appliances.

The tables below illustrate these assumptions for compression-type appliances currently covered by the current labelling scheme:

Table 4. Energy efficiency class trend in the baseline scenario for compression-type refrigerators

Year	A++	A+	A	B	C	Tot.	**sales unitary energy**
	(%)	(%)	(%)	(%)	(%)	%	**kWh/yr**
2005	1	18	61	19	1	100	302
2009	4	26	70	0	0	100	271
2014	12	43	45	0	0	100	251
2019	16	64	20	0	0	100	234
2025	20	80	0	0	0	100	219
2030	25	75	0	0	0	100	216
EEI	30	42	55	75	90	--	
Energy consumption (kWh/y)	166	232.4	291.6	397.7	477.2	--	

Source: ISIS/ENEA 2008

Table 5: Energy efficiency class trend in the baseline scenario for compression-type freezers

Year	A++	A+	A	B	C	Tot.	**sales unitary energy**
	(%)	(%)	(%)	(%)	(%)	%	**kWh/yr**
2005	5	25	33	25	12	100	285
2009	10	35	40	15	0	100	250
2014	15	52	28	5	0	100	233
2019	20	63	17	0	0	100	222
2025	25	75	0	0	0	100	216
2030	30	70	0	0	0	100	213
EEI	30	42	55	75	90	--	
Energy consumption (kWh/y)	166.1	232.5	251.5	342.9	411.5	--	

Source: ISIS/ENEA 2008

In addition, since manufacturers will not benefit from placing products on the market with an energy consumption better than the current level of class A++ (because they have no way, in the absence of higher classes than the A++ of the current labelling scheme, to show this to consumers), it is assumed in the baseline scenario that no new technologies will penetrate the market without new distinctions being introduced on the label.

The conjunction of these factors, added to the expected increase in the stock (presented in Table 4), leads to the following baseline scenario for compression-type refrigerating appliances (a more detailed explanation of the data on which this scenario is based is given in Annex 3):

Table 6. BaseCase 2005 and BaU scenario

		1990	1995	2000	2005	2010	2015	2020	2025
Primary dwellings/ households	**mln.**	**176**	**186**	**194**	**197**	**201**	**205**	**209**	**213**
sales primary dwellings	**mln.**	**16,0**	**16,5**	**17,0**	**17,5**	**18,0**	**18,5**	**19,1**	**19,4**
of which refrigerators		12,4	12,9	13,4	13,9	14,4	14,9	15,5	15,7
of which freezers		3,6	3,6	3,6	3,6	3,6	3,6	3,6	3,7
stock primary dwellings	**mln.**	**217**	**239**	**256**	**268**	**276**	**284**	**293**	**300**
of which refrigerators %	%	98%	101%	102%	102%	102%	103%	103%	103%
of which freezers %	%	26%	27%	31%	34%	36%	38%	38%	38%
of which refrigerators units	'000	171	188	196	202	204	207	213	219
of which freezers units	'000	45	51	60	66	72	77	79	81
Total, including secondary dwellings & non-domestic									
sales total	**mln.**	**18,4**	**19,0**	**19,5**	**20,1**	**20,7**	**21,3**	**21,9**	**22,3**
stock total	**mln.**	**249**	**275**	**295**	**308**	**317**	**327**	**336**	**345**
Energy consumption (historical data and projections prep. study)									
sales energy BAU	kWh/a	496	426	360	289	250	234	218	202
Total stock electricity consumption (result stock model+15%)									
Per unit									
stock avg. unit electr. BAU	kWh/a	608	520	464	396	332	277	246	225
Total stock									
stock total electricity BAU	TWh/a	**151**	**143**	**137**	**122**	**105**	**91**	**83**	**78**

Source: input to this impact assessment by VHK

In the table above, the energy consumption of new sales in kWh per unit per year is still declining, but at a slower pace than in the past. In the period 1990-2005, unit electricity consumption improved from 496 to 289 kWh/a (a fall of 40%). In 2005-2020, only a 20% improvement is forecast, i.e. from 289 to 218 kWh/a. Because it takes 15 years to replace the installed stock this slow-down in the improvement rate will only be visible in the long run. In fact, the stock unitary electricity consumption in the table still shows a considerable improvement based on past improvements, hiding the underlying long-term trend. In other words, if it takes 15 years to replace the installed stock, it also takes 15 years to realize the full effect in terms of energy saving from the moment of implementing a measure. This is true for new measures that are introduced in 2013 and will have their full effect in 2028. It is also true for measures from the past, like minimum standards (implemented 1999) and energy labelling (1996 and revised 2003). Therefore, for the coming 10-15 years the energy use of the stock will still benefit from measures taken in the past. Only from 2015-2020 it will become evident if no or insufficient measures are taken today (2009) to be implemented in 2013.

* * *

Examination of all the criteria enshrined in Article 15(2) of the Ecodesign Framework Directive shows that household refrigerating appliances qualify for the adoption of an implementing measure setting new ecodesign requirements. In contrast to that for other product groups, the baseline projection to 2020 shows significant energy savings which are the outcome of existing legislative initiatives and market demand, but there is an increasing discrepancy between the improvements achieved and the energy efficiency classes and minimum requirements, which is slowing down the improvement rate and will have a long-term negative impact on the total energy consumption of domestic refrigerating appliances. Section 5.1 discusses in detail the existing cost-effective potential for reducing electricity consumption beyond the BaU scenario.

2.3 Impact on stakeholders

Consumers: Surveys show that reducing energy consumption is one of consumers' main concerns in relation to white goods. Setting of higher ecodesign requirements would meet consumers' expectations and provide everyone, and in particular low-budget households, with more cost-effective appliances. In addition, consumers may feel increasingly frustrated by the lack of differentiation in the energy consumption of products offered to them, considering that this is one of their main purchasing criteria.

Industry: The industry is primarily affected by the labelling scheme's failure to function optimally, which reduces the incentives for manufacturers to place better-performing products on the market. The lack of long-term perspectives as to the future of the energy efficiency classes and the setting of new energy efficiency requirements is keeping the industry from investing heavily in energy improvements, even though there would be a market for more energy-efficient products.

Society: Society is directly affected by the indirect emissions of greenhouse gases due to wasted energy consumption by cold appliances.

2.4 Legal basis for EU action

Article 16 of the Ecodesign Framework Directive provides the legal basis for the Commission to adopt an implementing measure on this product category.

3. OBJECTIVES

3.1 General, specific and operational objectives

The above problem definition and its drivers lead us to set the following objectives.

- **General policy objectives**

  – Reduce energy consumption and related CO_2 and pollutant emissions from domestic refrigerators and freezers following Community environmental priorities such as those set out in Decision 1600/2002/EC and in the Commission's European Climate Change Programme (ECCP)

  – Promote energy efficiency, hence contribute to security of supply in the framework of the Community objective of saving 20% of the EU's energy consumption by 2020

- **Specific objectives**

  – Promote market take-up of energy-efficient refrigerators and freezers for domestic use

  – Maintain and support the current market trend towards more energy-efficient refrigerators and freezers

  – Drive investments in R&D towards environment-friendly refrigerators and freezers

  – Make sustainable refrigerators and freezers more affordable through mass production

- **Operational objectives**

  – Comply with the requirements laid down in Article 15(5).

Article 15(5) of the Ecodesign Framework Directive requires that ecodesign implementing measures meet the following criteria:

"(a) there shall be no significant negative impacts on the functionality of the product, from the perspective of the user;

(b) health, safety and the environment shall not be adversely affected;

(c) there shall be no significant negative impact on consumers in particular as regards affordability and life cycle cost of the product;

(d) there shall be no significant negative impacts on industry's competitiveness;

(e) in principle, the setting of an ecodesign requirement shall not have the consequence of imposing proprietary technology on manufacturers;

(f) no excessive administrative burden shall be imposed on manufacturers."

3.2 Consistency with other EU policies

Increased market take-up of energy-efficient domestic refrigerators and freezers, through the introduction of new energy efficiency requirements and possibly a revised energy labelling scheme, will contribute to reaching the 20% energy savings potential by 2020 identified in the Energy Efficiency Action Plan (COM(2006) 545).

Promoting market take-up of efficient domestic refrigerators and freezers is in line with the Lisbon and renewed Sustainable Development strategies[31] as it will encourage investment in R&D and provide for a level playing field for all.

It is among the key objectives defined in the Community Lisbon Programme for 2008-2010 (COM(2007) 804), i.e. the promotion of an 'industrial policy geared towards more sustainable consumption and production', as further developed in the Action Plan on Sustainable Consumption and Production and Sustainable Industrial Policy (COM(2008) 397)[32].

Lastly, the European Economic Recovery Plan (COM(2008) 800)[33] lists energy efficiency as one of its key priorities, in particular the promotion of the rapid take-up of 'green products' including refrigerators and freezers.

4. POLICY OPTIONS

4.1 Policy options discarded

- No EU action — baseline scenario

This option would have the following implications.

– The market failure would persist, although the labelling scheme could to some extent still drive further energy efficiency improvements in the short term. The impact of this option is described in more detail in Section 2.

– It is to be expected that Member States would want to take individual, non-harmonised action on cold appliances. This would hamper the functioning of the internal market and lead to high administrative burdens and costs for manufacturers, contrary to the goals of the Ecodesign Framework Directive.

– There is a risk of competitive disadvantage, in particular for very price sensitive products, for those manufacturers designing their products to high standards compared with competitors who are not using technology that reduces energy consumption, as explained further below.

– It goes against the specific mandate given by the Council and Parliament.

Therefore this option is not examined further.

[31] OJ L 242, 10.9.2002, and Council document 10917/06, 26.6.2006.
[32] Adopted by the Commission on 16 July 2008.
[33] Adopted by the Commission on 26 November 2008.

- **Support a new Voluntary Commitment**

This option is discarded for the following reasons.

– The sector publicly stated that the industry would not commit to a new initiative on self-regulation.

– Relevant voluntary initiatives were terminated in 2006 by the industry (see section 2.1.3), which has called for a clear legal framework ensuring fair competition (a 'level playing field'), since voluntary agreements could lead to competitive advantages for free riders and/or non-participants in the voluntary commitment.

– It goes against the specific mandate given by the Council and Parliament.

- **Adopt new ecodesign requirements only (without revising the labelling scheme)**

This option is discarded for the following reasons:

– The adoption of new ecodesign requirements will ban the most energy-consuming appliances from the market but will not provide a dynamic framework for further investment in energy improvements, although there is proven strong demand from consumers for energy-efficient products. The absence of market differentiation would concentrate competition mainly on price, reducing the margin available for innovation and development of more efficient and environmentally friendly products.

– The industry, consumer organisations and Member States consulted on the impact assessment and in the consultation forum have repeatedly asked for a combined revision of both measures (labelling and ecodesign).

- **Revise the labelling scheme only (without adopting new ecodesign requirements)**

In general two main objectives of labelling schemes are to increase the market penetration of, in this case, energy efficient products by providing incentives for innovation and technology development, and to help consumers to make cost effective purchasing decision by addressing running costs. Energy labelling pursuant to the Energy labelling Directive creates market transparency, fosters awareness of consumers and creates incentives for manufacturers for innovation.

This option is however discarded for the following reasons:

– A labelling scheme alone does not ensure that cost effective improvement potentials are realised for all products on the market, implying that the full energy and cost savings potential is not captured.

– The speed of the market transformation is entirely determined by the voluntary take-up of labelled products. The market transformation due to the implementation of the labelling scheme will not be driven forward by the 'pushing' effect from ecodesign requirements setting minimum energy efficiency thresholds.

– The industry, consumer organisation and Member States, within the impact assessment and the consultation forum have repeatedly asked for a combined revision of both measures (labelling and ecodesign).

– Member States could set minimum requirements individually, and the administrative burdens for manufacturers would be higher when compared with the burdens associated to ecodesign requirements.

– The specific mandate of the Legislator (Article 15.1) would not be respected: all of the criteria listed in Article 15(2) giving grounds for an implementing measure are met.

The policy option which appears to be most recommended and which is advocated by all stakeholders is the following:

- **Revise the labelling scheme and the ecodesign requirements simultaneously in a coordinated approach**

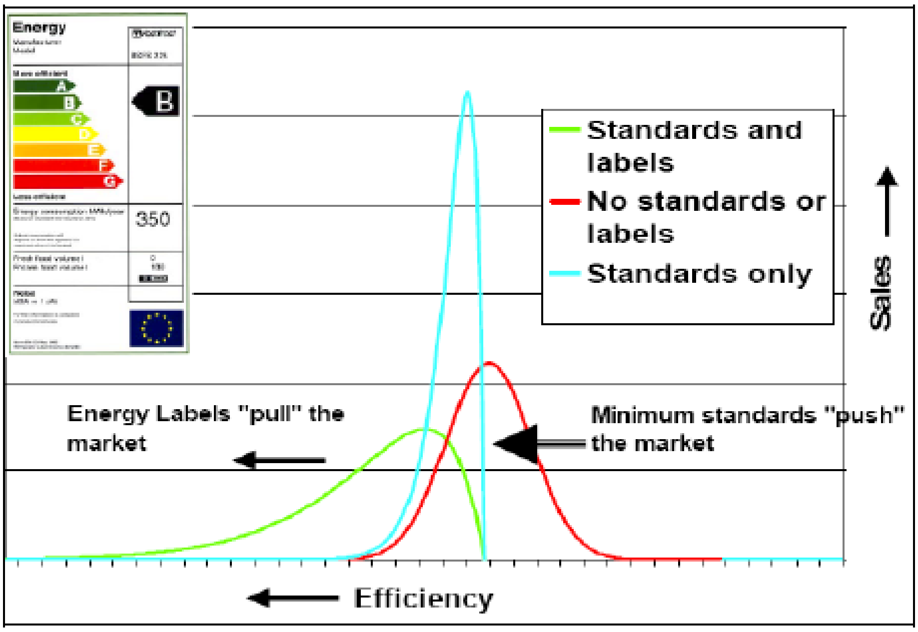
The simultaneous revision of both measures (ecodesign and labelling) would ensure:

– optimum coordination of the application dates for the two measures;

– synergy between the pushing effect of the specific ecodesign requirements and the pulling effect of the new labelling energy efficiency scale, according to the qualitative but well-known relation illustrated in Figure 4; this includes new differentiation allowing incentives at Member State level to support the best-performing appliances;

– harmonisation/rationalisation of the two measures, minimising the burden on industry and market surveillance authorities by applying a single measurement.

Figure 4: Cumulative impact of ecodesign and labelling



Source: IEA, P. Waide, International use of policy instruments: country comparisons, Copenhagen, 5 April 2006.

4.2 Combined revision of the ecodesign and labelling schemes

This option would include the following measures derived from the drivers of the market failure pointed out in section 2:

Measure 1: Adopt new energy efficiency requirements

Measure 2: Revise the labelling scheme accordingly

Measure 3: Extend the scope of the Ecodesign Directive to include new types of appliances, namely absorption-type appliances, wine appliances and mini-refrigerator/chillers

Measure 4: Adopt new ecodesign requirements to tackle functions fitted on refrigerators which are not taken into account in the calculation of the energy efficiency index but still have an impact on energy consumption

Measure 5: Revise the calculation methodology for the energy efficiency index.

5. ANALYSIS OF IMPACTS

This section describes the possible content of combined revision of the ecodesign and labelling schemes and its impacts.

5.1 Measure 1: Adoption of new energy efficiency requirements (for compressor-type refrigerating appliances)

This section addresses only compressor-type appliances which currently fall within the scope of the Labelling and Ecodesign Directives and represent 95% of the market. The remaining 5% of the market, mainly absorption-type appliances, is considered in Measure 3 on the extension of the scope of the two Directives.

The life cycle analysis referred to in section 2.2.2 identified energy consumption as the only environmental parameter which needs to be addressed by specific requirements (waste and refrigerants being already addressed by the WEEE and the RoHS Directives). According to the methodology laid down in the Ecodesign Framework Directive, Annex II, the minimum energy efficiency requirements should be set close to the level which entails the least life cycle cost (LLCC) to end-users[34] provided there are no significant negative impacts on the parameters listed in Article 15(5).

5.1.1 Least life cycle cost analysis

As part of the preparatory study, a list of possible technological innovations (already applicable and/or forecast to be available in the future) likely to improve the energy consumption of cold appliances was identified in close cooperation with manufacturers, together with the price increase and environmental impact of each of the identified options[35]. Applied to the four standard base cases, it is possible to identify the level with the LLCC, at which ecodesign requirements should be set[36]. The following graphs illustrate the results of the analysis. The first point on the left of the curves represents the base case; the lowest point

[34] 'Concerning energy consumption in use, the level of energy efficiency or consumption will be set aiming at the life-cycle cost minimum to end-users for representative EuP models, taking into account the consequences on other environmental aspects'.

[35] See results in the preparatory study, Task 6, p.52-59.

[36] Key economic assumptions: product life: 15 years; discount rate: 5%/year; electricity price: €0.17 /kWh; maintenance and repairs: €5.5/year; disposal and recycling: €61/life (at end of life); refrigerator price (category one): €485, upright and chest freezers price: €328.

on the curves represents the LLCC, i.e. the point at which energy efficiency requirements are cost-effective. The best available technology (BAT) is the last point on the right of each curve.

Legend: Category 1 to 6 on the graph refer to the standard base case COLD1 which represents the average appliance for refrigerators, category 7&10 refers to COLD7 (refrigerator-freezer), category 8 refers to COLD8 (upright freezer) and category 9 refers to COLD9 (chest freezer). The energy consumption scale decreases from left to right.

Figure 5: Life cycle cost (lifetime=15 years) as a function of the energy consumption for each of the cold appliance standard base cases. The average standard base case is the first point on each curve.

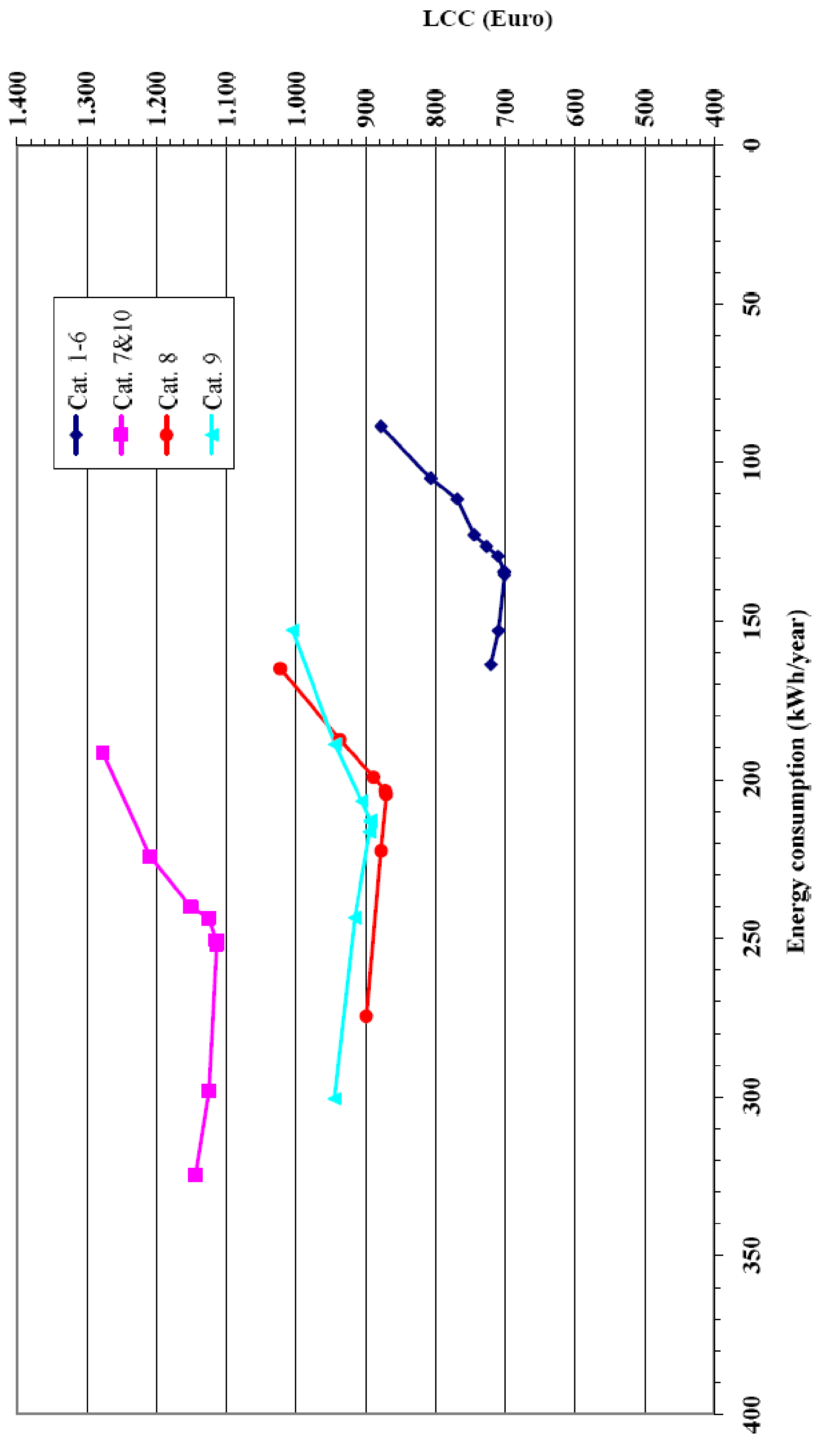


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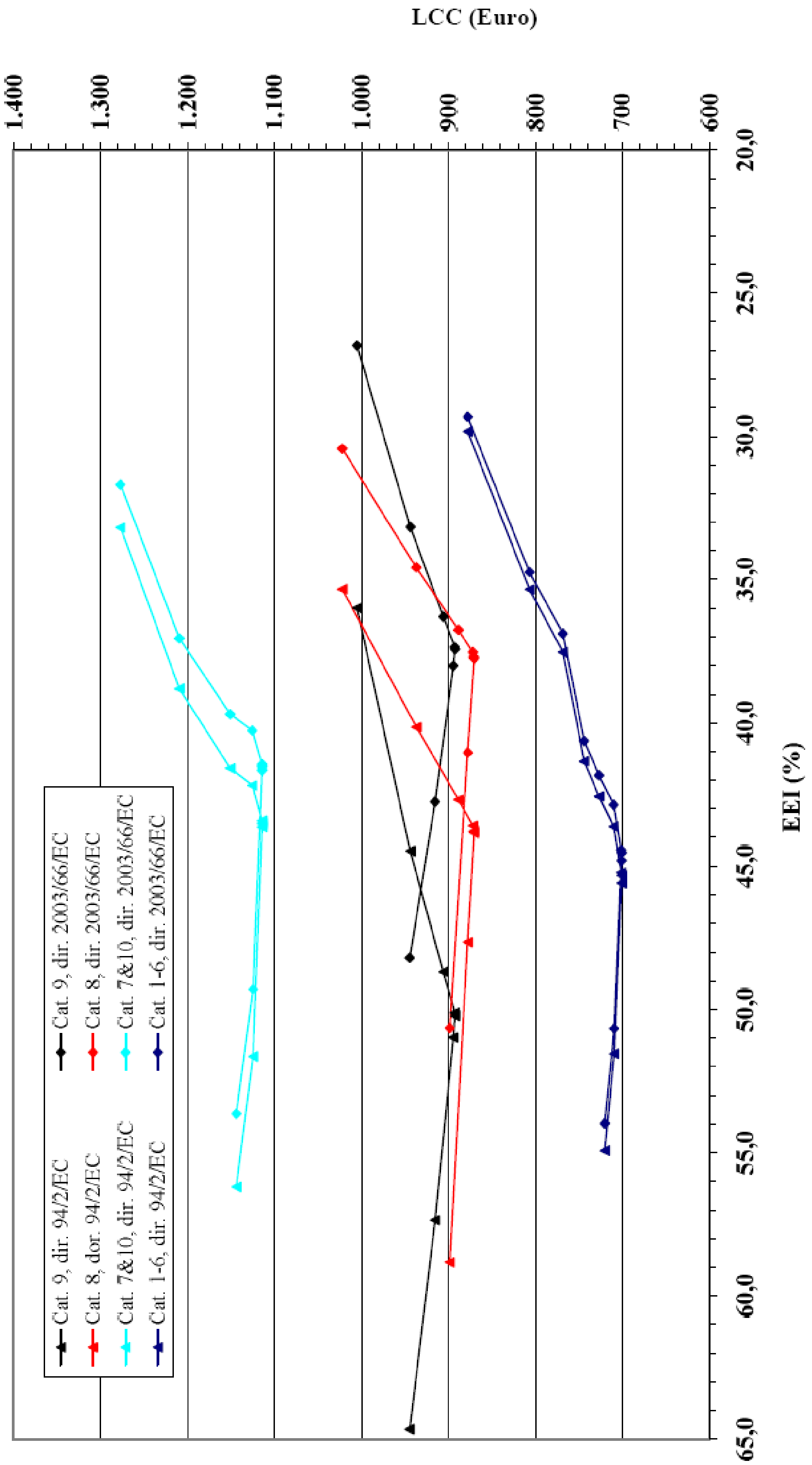
Figure 6: Life Cycle Cost (lifetime=15 years) as a function of the energy efficiency index in Directives 94/2/EC and 2003/66/EC for each of the cold appliance standard base cases. The average standard base case is the first point on each curve.



Source: Preparatory study, Task 6, p. 69-70

Table 7 gives a clearer overview of the levels achieved at LLCC.

Table 7: Energy consumption and EEI for cold appliance base cases and $LLCC_{av}$

	Energy consumption		EEI(%)			
Standard base case	Base case (kWh/year)	$LLCC_{av}$ (kWh/year)	Base case (94/2/EC)	$LLCC_{av}$ (94/2/EC)	Difference	**$LLCC_{av}$ (2003/66/EC)**
Refrigerator (COLD1)	163.7	134.8	54.4	45.4	9.0	**44.6**
Refrigerator-freezer (COLD7)	324.4	250.6	54.3	43.4	10.9	**41.4**
Upright freezer (COLD8)	274.5	203.4	56.3	43.6	12.7	**37.5**
Chest freezer (COLD9)	300.6	212.8	70.8	50.1	29.2	**37.4**

Source: Preparatory study, Task 6, p.67

As illustrated in Table 7, the specific ecodesign requirements for energy consumption should be set **between 37 and 44** on the energy efficiency index, which is equivalent to the current class A+ (taking the newest formula of Directive 2003/66/EC which would be applied in a new ecodesign implementing measure). The estimated sales-weighted average EEI for cold appliances at the point of LLCC in 2005 (measured according to the algorithms and reference lines of Directive 2003/66/EC) is 41 for the average standard base case[37].

The sensitivity analysis performed as part of the preparatory study, with different assumptions for the electricity price at €0.10/kWh and €0.25/kWh (compared to €0.17/kWh in the scenario presented above) and for the life duration of the appliance at 10, 12 and 17 years (compared to 15 years assumed in the scenario presented above), demonstrates that even in the worst scenario (electricity price at €0.10/kWh and 10-year life duration), the EEI level achieved by implementing the identified list of technological options remains close to the LLCC average: in the worst case, consumers would lose €11 over the lifetime of the product (see summary tables in Annex 2).

5.1.2 Impact on consumers

The purchase price increase is estimated in the table below based on the estimated costs of implementing new technologies. In reality, the purchase price of the $LLCC_{av}$ should decrease over time once the new technologies become mass production.

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37 This level is confirmed by the LCC analysis run on real standard base cases, i.e. on real appliances close to the average base cases, which shows that the EEI at LLCC level is just below 40%. Preparatory study, Task 6, p.71-76.

Table 8: Marginal payback time and incremental purchase price for cold appliance base cases and $LLCC_{av}$

	Purchase price			MPB[38] (years)	LCC (over 15 years)	
Standard base case	Base case (€)	**$LLCC_{av}$ (€)**	Increase (%)		Base case (€)	$LLCC_{av}$ (€)
Refrigerator (COLD1)	345.1	**378.2**	9.6	6.7	720	702
Refrigerator-freezer (COLD7)	485.0	**585.5**	20.7	8.0	1144	1114
Upright freezer (COLD8)	328.0	**426.8**	30.1	8.2	899	872
Chest freezer (COLD9)	328.0	**431.0**	31.4	6.9	945	893

Source: Preparatory study, Task 6, p.67

The life cycle costs, which include the purchase price together with the operating costs of the appliance (assuming a 15-year product life), confirm that the $LLCC_{av}$ level is cost-effective: consumers will not lose money but the marginal payback time is rather long, between 7 and 8 years. It is assumed that the combined effect of the labelling scheme, by driving innovation forward, will progressively reduce the cost of technological improvements, hence the purchase price and the marginal payback time for consumers. Section 6.3 discusses the aggregate impact on consumers.

5.1.3 Possible new energy efficiency requirements

The table below gives the distribution of cold appliances on the market in 2005 and 2009.

38 Marginal payback time.

Table 9: Evolution of the distribution of appliances by energy efficiency class in the baseline scenario

Energy efficiency class		A++	A+	A	B	C	D	E	F	G
EEI		<30	<42	<55	<75	<90	<100	<110	<125	>125
Market share in 2005 (%)	Refrigerators	1	18	61	19	1	0	0	0	0
	Freezers	5	25	33	25	12	0	0	0	0
in 2009 (%) (baseline scenario)	Refrigerators	4	26	70	0	0	0	0	0	0
	Freezers	10	35	40	15	0	0	0	0	0
In 2014 (%) (baseline scenario)	Refrigerators	12	43	45	0	0	0	0	0	0
	Freezers	15	52	28	5	0	0	0	0	0

Source: ISIS/ENEA 2008

In 2005, 80% of refrigerators and 63% of freezers were class A or above, while the baseline scenario based on the current speed of market transformation, suggests that 100% of refrigerators and 85% of freezers will be in class A or above in 2009. It seems, therefore, feasible to secure ongoing market distribution by setting the first stage for setting minimum energy efficiency requirements at the current class A (EEI<55) one year after the entry into force of the implementing measure. Since the latter is expected in 2009, this impact assessment considers 2010 as the implementation date of this first stage. This first stage would be mainly intended at facilitating the implementation of the labelling scheme, in the sense that it will harmonise the documentation ('technical fiche') to be provided by manufacturers for market surveillance purposes. The same calculation method will be used at the same time for both legislative initiatives (labelling and ecodesign).

The second stage of EEI should be set close to the point of LLCC in compliance with Annex II of the Ecodesign Framework Directive. This level was identified as between **37 and 44** in the previous section, with a weighted average of 41. Taking into account that the proposed reduction in measurement uncertainty from 15% to 10%[39] will have the effect of increasing the real level of EEI by 1- 2% (see box 1), this weighted average increases to 42-43.

[39] This received the full support of stakeholders in the Consultation Forum with some Member States asking to even reduce further the tolerance until to 3-4%.

Box 1: Impact of the reduction in measurement uncertainty on the level of EEI For example, from the ecodesign preparatory study, the base case refrigerator-freezer (the biggest-selling appliance category in Europe) has the following characteristics: energy consumption, 324.4 kWh/year; volume of the refrigerator compartment, 209 litres; volume of the freezer compartment, 67 litres; climatic class, ST; equivalent volume, 358 litres (according to the formula used in the proposed Regulation); and a corresponding EEI of 53.7. The effect of reducing measurement uncertainty from 15% to 10% can be analysed by increasing the declared energy consumption by maximum 2.5 % (to 332.5 kWh/year), which result in a new EEI of 55.0. The difference between the two EEI values is 1.3 percentage points (the EEI is expressed as a percentage). The same calculation applied to other types of appliance results in a decrease of the EEI of between 1.2 and 1.4 percentage points. Therefore it is appropriate to consider that reducing measurement uncertainty from 15% to 10% results in an increase of about 1-2 percentage points in the EEI.

Consequently, two ecodesign requirements may be considered at the second stage: 42 (which would be in reality below the weighted EEI_{LLCC} average estimated at 41, i.e. 43 taking into account the 1-2% increase of the EEI due to the reduced measurement uncertainty) or 44 which would be slightly above the EEI_{LLCC} weighted average.

Sub-option EE44-15: EEI<55 in 2010, EEI<44 in 2015

Sub-option EE42-15: EEI<55 in 2010, EEI<42 in 2015

These two sub-options would take the current class A out of the market. Given the usual rate of market transformation expected by 2015, the removal of class A by that date would ban between 33% and 45% of appliances (Table 9). Section 5.1.4 below discusses the possibility of setting separate thresholds for each category of appliance.

The timing for the second stage — in accordance with the preparatory study — is set at 6 years after entry into force of the measure in order to take into account the design cycle and production platform change of the industry (between 4 and 5 years). Since some Member States and environmental NGOs favoured setting the second stage earlier, section 6 of this impact assessment also considers, in the sensitivity analysis, the possibility of setting the second stage in 2013; i.e. fours years after the entry into force of the implementing measures, which would still be close to the design cycle and production platform change of the industry.

Finally, a sub-option EEI44/42-12/14 is considered that would give the industry more time to adapt to the reduction of tolerances. After the first stage in 2010 there is an intermediate step in 2012 at EEI44-level. The third step sets the EEI42 as a minimum in 2014.

5.1.4 Alternative proposal: adoption of specific thresholds by category of appliance?

Table 7 on energy consumption of household refrigerating appliances at the point of LLCC shows that there is a significant discrepancy between the categories of appliances. The EEI of upright and chest freezers, for instance, is close to 37.5 (more than 200 kWh/year), while the EEI of refrigerators is 44.6 (135 kWh/year), seven percentage points more. Consequently, different energy thresholds could be considered for each category of appliance. This would ensure than an even burden is laid on each category of appliance.

This approach was, however, rejected by stakeholders during the preparatory study and later confirmed in the consultation forum for the reasons below.

- Manufacturers: the use of classes in labelling means that when the thresholds between the classes are set, products are designed to comply with one of these thresholds (i.e. the minimum efficiency level for a model to be labelled as being in a certain class). There is very little or no scope for manufacturing a model with an energy efficiency better than just the minimum needed to reach the target class, because this extra energy efficiency improvement is 'invisible' to the consumers and will therefore not be rewarded in the price of the model. This universal phenomenon is known as 'sitting on the threshold'. For manufacturers there is no incentive to improve a model unless it moves up one class.

- Consumers: when Directive 96/57/EC came into force in September 1999, consumers were told that all models below 'class D' would be phased out, but this was not quite true because the labelling classes and minimum requirements were not perfectly matched). Soon consumer organisations started to notice and complain that 'class D' models were still on the market, although this was perfectly legal.

- National authorities: verification and market surveillance is easier when the phase-out of models corresponds to the phase-out of a labelling class. Also, awareness campaigns and information dissemination are easier to prepare and manage.

As a consequence, there was a consensus among stakeholders that the thresholds for the labelling classes and of the minimum requirements should be the same.

The following analysis for freezers illustrates the potential impact of setting similar thresholds for all categories of appliance.

The EEI_{LLCC} of freezers is around 37, which means 39 to 40 taking into account the reduction in measurement uncertainty from 15% to 10% (see box 1). The labelling scheme proposed, for example in the first sub-option **EE44-15,** is:

EEI <15
15 ≤ EEI <18
18 ≤ EEI < 22
22 ≤ EEI < 28
28 ≤ EEI < 35
35 ≤ EEI < 44
44 ≤ EEI < 55
55 ≤ EEI < 75
75 ≤ EEI < 100
EEI ≥ 100

So setting a minimum requirement threshold at EEI = 39-40 for freezers would mean it fell between two labelling classes, going back to the situation stakeholders wanted to avoid. One could argue that a threshold of EEI = 35 for freezers could be set, but this would be higher than the EEI_{LLCC} by about 4-5 percentage points.

In addition, the proposed threshold (in this example 44) is close to the EEI_{LLCC} of refrigerator-freezers which represent 60% of the market, but is more demanding for refrigerators and less demanding for freezers thus the effects offset each other: the EEI_{LLCC} for refrigerators is 44.6 (see the following table) which considering the reduction in the measurement uncertainty represents 46.6-47.6. This means that a minimum requirement threshold of 44 is higher than the LLCC for refrigerators by about 2-4 percentage points.

Category of appliance	EEI_{LLCC}
Refrigerators	44.6
Refrigerator-freezers	41.4
Upright freezers	37.5
Chest freezers	37.4

Since the market share for refrigerators (2005) is 17% and that of upright and chest freezers is 13.5+8.5=22%, an overall threshold for all refrigerating appliances at EEI < 44 is contemporarily less demanding for some appliances (freezers) and more demanding for about the number of other appliances (refrigerators), and perfectly in line for refrigerator-freezers.

Finally, setting of threshold of 39-40 for freezers would leave very little room for product differentiation beyond this, which might have a negative impact on the industry.

Aligning the thresholds, appliance categories and formula will therefore allow the phases and revision time horizon of the two policy measures to be coordinated optimally and will ensure synergy between the pushing effect of the specific ecodesign requirements and the pulling effect of the new energy labelling scheme.

5.2 Measure 2: Revision of the labelling scheme

5.2.1 Short- to medium-term achievable energy efficiency improvements – BAT analysis

As illustrated in Figures 5 and 6 in the preceding section, additional energy savings may be achieved by applying further technologies beyond the point of LLCC. The last points on the curves indicate where the market may be reasonably be driven in the short to medium term taking into account consumer demand for energy savings. The design of the energy efficiency classes of the labelling scheme should reflect these levels so as to provide incentives for further innovation.

Table 10 indicates the level of EEI achievable by applying the best available technologies (BAT) on the market (i.e. technologies already fully commercialised).

Table 10: Energy consumption and EEI for cold appliance base cases and BAT_{av}

	Energy consumption		EEI(%)			
Standard base case	Base case (kWh/year)	BAT_{av} (kWh/year)	Base case (94/2/EC)	BAT_{av} (94/2/EC)	Difference	**BAT_{av} (2003/66/EC)**
Refrigerator (COLD1)	163.7	89.1	54.4	30.0	24.4	**29.5**
Refrigerator-freezer (COLD7)	324.4	191.6	54.3	33.2	21.1	**31.7**
Upright freezer (COLD8)	274.5	164.9	56.3	35.3	21.0	**30.4**
Chest freezer (COLD9)	300.6	152.8	70.8	36.0	49.2	**26.8**

Source: preparatory study, task 6, p.67

The last column of the table gives a realistic idea of what the short- to mid-term level of the best energy efficiency classes (**27<EEI<32**) should be.

The purchase price increase for consumers is estimated in Table 11 based on the assumed cost of implementing the best available technologies.

Table 11: Marginal payback time and incremental purchase price for cold appliance base cases and BAT_{av}

	Purchase price			MPB[40] (years)	LCC (over 15 years)	
Standard base case	Base case (€)	**BAT_{av} (€)**	Increase (%)		Base case (€)	BAT_{av} (€)
Refrigerator (COLD1)	345.1	**635.2**	84.6	22.8	720	878
Refrigerator-freezer (COLD7)	485.0	**852.4**	75.7	16.3	1 144	1 277
Upright freezer (COLD8)	328.0	**644.8**	96.6	17.0	899	1 022
Chest freezer (COLD9)	328.0	**649.1**	97.9	12.8	945	1 005

Source: Preparatory study, Task 6, p.67

40 Marginal payback time.

The price increases for each category of products appear too high for the time being to expect a quick take-up of these products on the market. The EEI level defined with BAT, however, sets the level towards which the market might be progressively driven if a revised labelling scheme were introduced. The purchase price of the BAT_{av} should decrease over time once the new technologies become mass production.

Past experience does indeed show that the increase in the purchase price has always been greatly overestimated in preparatory studies for legislation. SAVE studies on minimum standards and labels in the 1990s[41] predicted similar price increases to those in Table 9. In reality, without a change in the impact on profitability, the industry has managed to maintain the same average prices over the last 15 years. This implies that, through rationalisation, the costs decreased at the level of inflation (2-3% per year). Only in the first two years, when not all manufacturers were capable of producing the highest energy label levels (class 'A' at the time), was there a slight price premium, which subsequently disappeared.

Therefore, the next 11 years (2009-2020) are likely to see cost reductions of at least 25% compared to the estimates presented in Table 9 above, especially for BAT products that are currently not mass produced. For instance, for refrigerator-freezers (COLD7) this would mean a BAT purchase price of €639 instead of €852. BAT life cycle costs would be €1 064 and the payback period would be considerably lower than the product life.

5.2.2 Long-term potential energy efficiency improvements – BNAT analysis

To evaluate the long-term energy efficiency level possibly achievable, the same calculation is performed applying the 'best not-yet available technologies' (BNAT), i.e. technologies which have been identified by the industry as potentially available in the coming years but not yet cost-effective to implement in the short run.

The only results available are from the COLD-II study performed in 1998. They give a good indication, however, of the next energy efficiency levels achievable. The explanatory study identified other BNAT but could not evaluate their potential long-term effect on energy efficiency and costs for lack of data. They concluded, on the basis of further interviews with the industry, that the outcome of the COLD II study remains the best proxy of the long-term energy efficiency levels achievable[42].

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41 SAVE study, COLD I, 1993. SAVE study, COLD II, 1998-2000.

42 See Preparatory study, Task 6, p. 115-117.

Table 12: Energy consumption and EEI for cold appliance base cases and $BNAT_{av}$

	Energy consumption (C)		EEI(%)	
Base case appliance	Base case (kWh/year)	BAT_{av} (kWh/year)	Base case (94/2/EC)	**$BNAT_{av}$ (94/2/EC)**
Refrigerator	252.7	59.4<C<64.1	90.2	**16.6<EEI<18.1**
Refrigerator-freezer (bottom-mounted)	603.41	125<C<142	89.3	**20.2<EEI<22.8**
Refrigerator-freezer (top-mounted)	643.0	125<C<135.5	89.5	**18.8<EEI<20.5**
Upright freezer	371.6	95.7<C<97.9	95.2	**25.2<EEI<25.8**
Chest freezer	271.4	76.5<C<22.2	76.6	**21.6<EEI<22.2**

Source: Preparatory study, task 6, p.114

The EEI are only given using the algorithm in Directive 94/2/EC. The new algorithm in Directive 2003/66/EC has the impact of reducing the EEI level of upright and chest freezers, but the EEI levels of the other categories of appliances remain stable. We can therefore assume with reasonable certainty that **18<EEI<23** is a long-term target which may be achievable using the BNAT.

5.2.3 Possible new energy efficiency classes

This section considers only the thresholds of the energy efficiency classes, it is not in the scope of this impact assessment to discuss their name nor the layout of the label in general.

Table 13 shows the current thresholds for the energy efficiency classes laid down in Directive 94/2/EC as amended by Directive 2003/66/EC (introduction of new classes A+ and A++ together with a new formula for the EEI).

Table 13: Current energy efficiency classes

Class		A++	A+	A	B	C	D	E	F	G
EEI		<30	<42	<55	<75	<90	<100	<110	<125	>125
Relative improvement (%)		29	24	27	17	10	9	12	-	-
Market share in 2005 (%)	Refrigerators	1	18	61	19	1	0	0	0	0
	Freezers	5	25	33	25	12	0	0	0	0

Class A++, at EEI<30, is set at the level achievable in the short to medium term using the BAT ($27<EEI_{BAT}<32$).

For the purpose of this impact assessment, the following scenarios for the energy efficiency classes are discussed. Other thresholds may be considered depending on the outcome of the comitology procedure provided that they are in line with the potential for long-term improvements identified above and with the proposed levels of minimum energy efficiency requirements (at 44 in the EE44-15 scenario and 42 in the EE42-15 scenario).

Sub-option EE44-15

Energy efficiency class	Current EEI thresholds	Proposed new EEI thresholds	Relative improvement (unit)	Relative improvement (%)	Stage 1	Stage 2
10		EEI<15	-	-		
9	EEI<30	15 ≤ EEI<18	3	17%		
8	30 ≤ EEI < 42	18 ≤ EEI < 22	4	18%		A
7	42 ≤ EEI < 55	22 ≤ EEI < 28	6	21%	A	B
6	55 ≤ EEI < 75	28 ≤ EEI < 35	7	20%	B	C
5	75 ≤ EEI < 90	35 ≤ EEI < **44**	9	20%	C	D
4	90 ≤ EEI < 100	44 ≤ EEI < **55**	11	20%	D	E
3	100 ≤ EEI < 110	55 ≤ EEI < 75	20	27%	E	F
2	110 ≤ EEI < 125	75 ≤ EEI < 100	25	25%	F	G
1	EEI≥125	EEI ≥ 100	-	-	G	-

Comments: Class A, below 28, should be populated by the date of entry into force (first stage in 2010) since the BAT level is **27<EEI_{BAT}<32**, while class A, below 22, should be populated by 2015 (second stage). It corresponds to the BNAT level, **18<EEI_{BNAT}<23**. The minimum requirement is set at 55 for the first stage in this scenario, which means that the production of refrigerating appliances with an EEI above 55 should cease in 2010, but remaining appliances in stock (only freezers according to the baseline scenario) will continue to be sold on the market. In the end, consumers will have a choice, for compressor-type appliances, between 4 classes in the first stage (A to D) and 5 classes in the second stage (A to E). Classes F and G provide for absorption-type appliances covered by Measure 3.

Sub-option EE42-15

Energy efficiency class	EEI thresholds	Relative improvement (unit)	Relative improvement (%)	Stage 1	Stage 2
10	EEI<13	-	-		
9	13 ≤ EEI<16	3	19%		
8	16 ≤ EEI < 20		20%		A
7	20 ≤ EEI < 25	5	20%	A	B
6	25 ≤ EEI < 30	5	17%	B	C
5	30 ≤ EEI < **42**	12	29%	C	D
4	42 ≤ EEI < **55**	14	24%	D	E
3	55 ≤ EEI < 75	20	27%	E	F
2	75 ≤ EEI < 100	25	25%	F	G
1	EEI ≥ 100		-	G	-

Comments: Class A, below 25, appears very ambitious but may still be populated by the date of entry into force (first stage) since the EEI with BAT identified in 2005 was **27<EEI<32.** By the date of entry into force of the labelling scheme (expected in 2010), new technologies which were not taken into account in the preparatory study are likely to enter the market. Class A below 20 at the second stage also appears ambitious but still corresponds to the identified EEI level **(18<EEI<25)** using the BNAT identified in 1998.

5.3 Measure 3: Enlarge the current scope of the Ecodesign Framework Directive to include new types of refrigerating appliances

5.3.1 Absorption-type appliances:

Absorption-type appliances use a technology which consumes much more energy than compressor-type appliances but has the advantage of emitting no noise or vibration and which can also be run using multiple energy sources. This zero-noise added value of absorption and thermoelectric (Peltier) refrigerators allows their use in rooms and spaces where absence of noise is of primary importance (e.g. hospitals and hotels). At present there are no noiseless alternatives to absorption/thermoelectric products in applications where noise is perceived by the user to be a major issue (compressor refrigerators can achieve a relatively low noise emission, but still do not match absorption/thermoelectric technology). It is therefore important to maintain this niche market.

- **Market share and aggregated energy consumption**

The absorption-type appliances to be covered by an ecodesign implementing measure account for 1.5% of the domestic cold appliance market with 250 000 to 300 000 units sold in 2005[43]. This is the sales volume to hotels (250 000) and households (10-20 000), which represents a third of total absorption-type refrigerator sales (700 000-800 000). The remaining two thirds of sales go to recreational and other non-electric uses which are (and will remain) excluded from the scope of the ecodesign implementing measure.

In the majority of applications — namely in hotel rooms — they are small-volume (<80L) refrigerators usually without a freezer compartment. The total electricity consumption of the stock is estimated at around 1,5 TWh per year (1,2% of total domestic cold appliance electricity consumption)[44].

- **Potential for improvement**

A survey conducted for the preparatory study identified the following distribution by energy efficiency.

Table 14: Distribution of absorption-type appliances by energy efficiency class in 2007

EEI	EEI<90	90<EEI<100	100<EEI<110	110<EEI<125	125<EEI<150	EEI>150
Current class	C	D	E	F	G	-
Market share (%)	0	3	17	30	27	23

Source: Preparatory study, Task 7, p.113

Table 14 suggests that a 20% efficiency improvement (from an average EEI of 125 to an EEI of 100) is technically feasible.

- **Possible energy efficiency requirements**

Taking into account the current distribution of absorption-type appliances and the fact that the scope for technological innovation (in terms of the energy efficiency improvement) for this type of appliances is smaller, the energy efficiency requirements could be set at 150 in the first stage (which should ban approximately 25% of the market), 125 in the second stage and 110 in the third stage. Three stages are proposed as a gradual approach to a market which has never been covered by the legislation before. Interviews with the industry and discussions with stakeholders at the consultation forum suggest the following time line:

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43 Interviews with the industry confirm that the confidence level of these data on sales of absorption-type appliances is good.

44 Common volumes for hotel and household refrigerators are 30, 40, 60 and 80 litres, with energy consumption in the range 0.6-1.2 kWh/24h (or 219-438 kWh/year). The energy estimate is based on energy use of 1 kWh/yr (365 kWh/yr) and product life of 15 years. The electricity consumption of the installed stock is thus 270 000 annual unit sales * 15 years * 365 kWh = 1 478 250 000 kWh = 1.5 TWh.

– EEI<150 in 2010 (one year after entry into force)

– EEI<125 in 2012 (three years after entry into force)

– EEI<110 in 2015 (six years after entry into force)

These limits suggest a possible saving of 12% (from EEI 150 to EEI 110) from setting minimum efficiency requirements without taking into account the effect of labelling. As for compressor-type appliances, the inclusion of this type of appliance in the labelling scheme was requested by the industry in order to obtain a return on investment in energy improvements. A labelling scheme providing information to consumers on energy efficiency by means of a ranking would indeed enable the industry to differentiate their products from those of their competitors on a parameter which is proving significant in consumer purchasing decisions (see Figure 3, consumer survey). The inclusion of absorption-type appliances in the labelling scheme will enable industry to compete on energy consumption.

- **Economic impact**

In view of the above, the minimum efficiency standards for absorption refrigerators are likely to save around 12% at total stock replacement. Against the baseline this is an annual saving of 0,19 TWh in 2020 compared to the energy consumption expected in the 'business as usual' scenario. Taking into account 8-10% growth in the stock by 2020, absolute electricity consumption in 2020 will be around the same as in 2005 (1.5 TWh) which means that growth in the total energy consumption of this sector will have been avoided.

If the labelling scheme succeeds in pulling the market towards the current 'D' efficiency class (EEI<100) then savings could reach 20% (0.3 TWh lower than the baseline). In absolute terms, after complete stock renewal (2030) electricity consumption would be around 1.35-1.4 TWh.

Since 90% of absorption-type appliances are used in hotel rooms, the question of affordability is not relevant.

5.3.2 Wine appliances

Wine appliances present specific characteristics for the storage and ageing of wine including:

- the capability of maintaining continuously a nominal temperature in the range from +9 °C to +15 °C, by cooling as well as by heating;
- the capability of maintaining the storage temperature constant over time to within 0.5 K
- the capability to actively or passively maintain humidity in the range 50-80%
- a construction to reduce the transmission of vibration to the compartment, whether from the refrigerator compressor or from external sources.

20% of the appliances on the market are also equipped with multi-temperature devices, allowing the cooling or storage of wine at a wider range of temperatures, usually between 0 and 20°C.

- **Market share and aggregated energy consumption**

There is no solid data available on the sales of wine appliances. According to the estimates provided for the UK government's Market Transformation Programme, they account for 1.5-2% of market share (300 000 units per year). In situ measurements show energy consumption of around 1.3 kWh/24h (474 kWh/year). This is a relatively new type of product, with a current stock of around 1.5 to 2 million units, but it is assumed that by 2020 the market will be saturated at a level of 1.5% of stock (4 million installed units). The baseline 2005 is thus estimated at up to 0.95 TWh/year. In baseline 2020, the stock electricity consumption is estimated at 2 TWh/year.

- **Potential for improvement**

If they are included in the ecodesign and labelling initiatives on refrigerating appliances, efficiency improvements of up to 50% on new sales are deemed possible from 2015. It will take full stock replacement to realise this potential (between 2025 and 2030), but given that it is a product with a substantial share of new sales, half of the savings could be realised by 2020. This implies a 2020 scenario with the adoption of labelling and ecodesign measures at a stock electricity consumption of 1.5 TWh/year. This is a 0.5 TWh saving (-25%) with respect to the baseline 2020.

- **Possible energy efficiency requirements and labelling scheme**

Energy efficiency requirements could be set at the same level as for regular refrigerators, as typically these appliances can also be used at regular refrigerator temperatures (5°C) and use the same technology. However, these appliances have never been addressed before by such legislation, with the result that no particular investment in energy consumption has been made in the past. Current appliances therefore consume significantly more than the usual compressor-type appliances even though their technology is very similar. A longer timeline for compliance could be devised to leave this market segment with enough time to catch up. Another alternative could be to include wine appliances in the labelling scheme and adopt minimum requirements at a later stage, once detailed information has been collected on the distribution of the appliances according to their energy consumption. One could also consider the need to compensate, via a correction factor, for the increased heat loss through a glass door or set less stringent energy efficiency requirements to avoid banning them completely from the market.

- **Economic impact**

Wine storage appliances are a premium product and directed at a very small and fairly high-income part of the population. Issues of 'affordability' and Least Life Cycle Costs under Article 15 of the Ecodesign Framework Directive are therefore deemed irrelevant to this impact analysis.

5.4 Measure 4: Adopt new generic requirements

The following generic requirements may be considered to address new market trends:

- **WINTER SWITCH**: for refrigerator-freezers with one compressor and one thermostat, mandatory **automatic control** according to the ambient temperature variation of the heating function (the so-called 'winter setting switch', or a similar device or function).

For some of the refrigerator-freezers with one compressor and one thermostat to be used in cool ambient temperature below 16°C (according to the manufacturers instructions) the so-called winter switch setting (which activates a heating device or function) has to be switched-on to allow correct operation of the freezer compartment at this low ambient temperature. The associated additional energy consumption can be only estimated at present, and depends on how often and for how long the temperature of the room, where the refrigerator-freezer is installed, remains below 16°C. A generic requirement for an automatic control of the heating device/function depending on the ambient temperature would keep this extra energy at the real minimum.

The application of this requirement for all type of refrigerator-freezers would imply phasing out the thermo-mechanical thermostats used in refrigerator-freezers in favour of electronic controls, which would allow automatic activation/deactivation of the heating function. Installing an electronic control, however, entails a small increase in annual energy consumption. A simulation was run to evaluate the conditions under which this increase is offset by the reduction in energy losses from consumers forgetting to switch off the winter setting when the ambient temperature rises above 16°C.

According to CECED[45], the extra electricity consumption due to the electronic board would be 15.9 GWh for all refrigerators sold in one year, i.e. 0.24 TWh/year for a stock consisting of 15 year of sales.

The electricity saved for 50% of consumers forgetting to manually switch off the winter switch is put at 6.4 GWh over annual sales, i.e. 0,1 TWh/year for a stock of 15 years of sales (full stock replacement).

Overall, the extra energy consumption of the electronic board / winter switch is 9.5 GWh/year (sales) and 0.14 TWh/year at full stock replacement[46]. Therefore, mandatory automatic control of the winter switch seems inappropriate for those refrigerator-freezers equipped with electromechanical controls because it will result in an overall increase in energy consumption[47]. It is therefore advisable to require that the winter setting switch be operated automatically according to the ambient temperature only for refrigerator-freezers with one thermostat and one compressor which are already equipped with an electronic board, which represent 80% of the market. This requirement would require a change in the software of the electronic board installed on refrigerator-freezers with only minor costs to manufacturers, and would therefore remain proportionate to the savings potential.

- **FAST FREEZING FACILITY**: automatic reversion of the fast freezing facility/function after 72 hours in freezers and freezer compartments to avoid over-consumption when users forget to switch it off.

For freezers and freezer compartments with a fast-freeze capability there is a need to switch off this feature automatically once the fresh food put in the cabinet/compartment has been correctly frozen. This will prevent wasted energy due to suboptimal use by consumers, who may forget for some time to switch off the feature manually. The proposed maximum period of 72 hours is considered to allow complete food freezing even if the consumer has carelessly

45 Excel annex to CECED reply to the consultation forum held on 5 December 2008 (see CIRCA website).

46 This is excluding the use of the heating element itself.

47 However, as discussed in relation to mini-chillers, below, if the electronic control is used to control both the winter switch and the fast freezing facility the outcome of the impact analysis is more positive.

overloaded the cabinet or compartment, while still limiting the extra energy consumed when the fast-freeze is left on.

Some stakeholders asked to reduce the 72 hours to 48hours, but this was not considered appropriate for two reasons: there is a danger, if too much food is put in, that 48 hours might not be sufficient to freeze all of it, and the energy saved by the change from 72 hours to 48 hours (i.e. from 3 days to 2 days) would result in 1 or 2 kWh per year, which is marginal compared to the energy potentially wasted by discarding food affected by suboptimal freezing.

For freezers, there is a reversible thermo-mechanical thermostat on the market, but for freezer compartments in refrigerator-freezers complying with this requirement will mean installing an electronic control. This measure is briefly evaluated above for the winter switch.

According to CECED[48], the extra electricity saving from the fast-freeze reset after 72 hours is 4.66 GWh/year on new sales and thus 0.07 TWh/year at full stock replacement (after 15 years).

Taking into account the advantages of in enabling the winter switch reset, the total net extra electricity consumption of the electronic board is 0.24 – 0.1 – 0.07 = 0.07 TWh/year at full stock replacement. This result is very sensitive to the number of customers 'forgetting' to use the manual switch, as underlined previously. For the same reason as for the winter switch, it is therefore advisable to require that the fast-freeze facility be operated automatically according to the ambient temperature only for refrigerator-freezers with one thermostat and one compressor already equipped with an electronic board, which represent 80% of the market. This requirement would require a change in the software of the electronic board installed on refrigerator-freezers, with only minor costs to manufacturers, and would therefore remain proportionate.

- **MINI-CHILLER:** automatic switching to zero power consumption for refrigerating appliances with a volume below 10 litres, when left empty for more than 1 hour.

According to the UK Market Transformation Programme, mini-chillers are widely available in high street stores such as supermarkets, multiple retailers, DIY stores and catalogue stores, often sold as gadgets or toys; such mini-refrigerators can cool from one to several cans or bottles and their usage pattern is not well known: some are claimed to be used only as and when the cooling is needed, but there is the possibility that they are left running but empty.

The energy consumption of such appliances was tested in 2005 under the UK Market Transformation Programme. The results show that these types of appliances consume an incredibly high level of energy. For instance, a mini-drinks-chiller with a storage volume below 3 litres (typically for 6 to 8 cans), consumes 1.13 kWh/day, which would add up to 406 kWh/year if it were switched on for the entire year[49]. By comparison, an average refrigerator-freezer (current class A) with a volume of about 294 litres (the standard base case for refrigerator-freezers in the ecodesign preparatory study (Task 5) consumes 324 kWh/year, with some refrigerator-freezers around 125 kWh/year (current class A++).

48 Excel annex to CECED reply to the consultation forum held on 5 December 2008 (see CIRCA website).

49 The tests were conducted at 230V in a controlled environment at ambient conditions of 25°C and 65% relative humidity. Although the EN standard requires 220V, these tests were considered close enough to standard conditions to give an indication of where the results would be on the energy label scale. See Preparatory study, Task 7, p. 94-95.

For refrigerating appliances with a volume of less than 10 litres it is impractical to evaluate energy consumption because of their very small volume, although it is not explicitly excluded in the current EN 153 standard. To avoid energy waste when they are running without a load, one could require that, if they can be connected to the mains, they automatically revert to a condition with a power consumption of 0.00 Watts after 1 hour when left empty.

The problem with estimating the real energy consumption of these mini-chillers and drink dispensers is determining their time of actual use. Typically, they are 'hyped' products, bought as a gift, perhaps used intensely by the receiver in the first few months of ownership and on occasion in the year after and in their second year they are completely forgotten. Their manufacturers, with OEMs (Original Equipment Manufacturers) often outside the EU, are not traditional refrigerator manufacturers, but at best small appliance manufacturers that keep the product in their catalogue for a few years, often with the assistance of a beverage manufacturer.

The savings heavily depend on the actual use of the appliance. Assuming a stock of 10 million of these products (5% of EU-27 households) and a time of use of 5% on average (18 days, 400 h/year) and an electricity consumption of 600 kWh/year (e.g. beer dispenser) then the total electricity consumption would be no more than 0.3 TWh/year, and probably far less. If the time of use is 10% (800 h/year of 36 days) the saving is 0.6 TWh. Considering that the use of these appliances may be limited only to the hottest summer days, and that in the summer period June-August the mini-refrigerator is used only 60 days (excluding one month's holiday out of the three months) then the expected savings are about 1 TWh/year. If the ownership level is higher than the estimated 5% or if the use is longer, then the expected savings may be significantly higher.

The cost-benefit assessment of the proposed requirement (to install an automatic cut-out for mini-drink-chillers when empty) heavily depends on the actual use of the appliance by consumers. One has also to take into account the proportionality of requiring the mandatory fitting of a sensor-based system to identify when the appliance is empty, which would be quite costly for an otherwise low-cost product in addition to the difficulty of market surveillance for any type of measure applicable to these gadget-like products.

5.5 Measure 5: Revision of the energy efficiency calculation methodology for the short to long run

Several concerns were raised by stakeholders during the impact assessment concerning the current formula used for the calculation of the energy efficiency index on which both the energy efficiency classes and minimum energy efficiency requirements are based.

First, the current market trend shows a slight increase in the volume of refrigerating appliances, which automatically increases the total energy consumption of the appliances. Some stakeholders, including environmental NGOs, proposed to adapt the energy efficiency calculation methodology to penalise bigger appliances in order to discourage consumers from buying larger refrigerating appliances (see box 2). Second, the correction factors were criticised on the grounds that they do not convey transparent information to consumers (a refrigerator for instance with the no-frost function will consume more than one without but may still have the same energy class).

Box 2: *Impact of size of the appliances on EEI-rating:*

-the IEE index is based on volume in a linear equation;
-the energy consumption of a refrigerator depends on the (insulated) outer surface of the volume;
-the correlation between the volume and the outer surface is not linear, i.e. a larger volume does not result in an equally larger outer surface;
-hence, the bigger the volume of the appliance(from the reference), the bigger the advantage of this non-linearity in the EEI.
Example: assume an appliance with an inner volume of 4.4 x 4.4 x 12 dm= 232 litres, with 12 dm (1.2 m) being the height of the appliance. The outer surface of the six sides of this volume is 2x0.44x0.44 + 4x0.44x1,2 = 0.3872 + 2.112= 2.499 m2.
With a new height of 13 dm (1.5m) the volume becomes 4.4x4.4x15= 252 litres. This is a 9% increase. The outer surface of the six sides of this volume is 2x0.44x0.44 + 4x0.44x1.3 = 0.3872 + 2.228= 2.675m2. This is only a 7% increase. In other words, there may be an advantage of 1.8 EEI-point (109/107) if you increase, starting from the IEE-reference, the volume by 9-10% at the same insulation-thickness. This average 10% is what is reported in the preparatory study.

As regards the influence of the increase in size and correction factors, the preparatory study showed indeed that there was a 10% volume increase for refrigerator-freezers over the past 10 years; probably due to the relatively new segment of US-style side-by-side appliances in Europe. Also the appliances in climate classes "ST" (sub-tropical) and "T" (tropical), which benefit from a correction factor, have a higher market share than seems appropriate for the actual climate in the EU Member States where they are sold.

Nevertheless, the projections of the preparatory study of the unitary energy consumption in kWh/a (Table 6, row "sales energy BaU") show the overall influence to be limited (box 2). Possible remedies are:

– a regular update of the EEI reference values (last 2003 on the basis of data probably 2-3 years old) and/or

– using a non-linear equation (curve) for EEI reflecting the effect above.

Both remedies create a discontinuity in the rating of the appliances and therefore confusion. The question is if/when it is proportionate to take such measures given the extent of the error.

A detailed study is necessary to assess, for the short run, the necessity and impact of correction factors, including possible new correction factors to introduce more stringent energy efficiency demands on appliances as their volume increases. For the long run, a more holistic approach and evaluation method could be devised, looking at refrigerating appliances as more than just a cold storage space. The popularity of separate, energy-guzzling drink-chiller solutions such as beer dispensers and wine storage appliances — that could easily be built into the conventional refrigerator — shows, for example, that there is consumer demand that could be met more energy-efficiently. But the fact that, implicitly, the current calculation method penalises through-the-door dispensers could well stand in the way of innovation[50].

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[50] Through-the-door-dispensers are a thermal bridge to the outside and difficult to insulate. Consequently, they have a negative impact on energy consumption in tests. But if the test method took into consideration that they might help avoid the purchase and operation of separate drinks- and mini-

Most beverages do not need to be stored cold, they just need to be served chilled. Storage at room temperature in appropriate, largely oxygen-free, containers plus a long chilling pipe just before the dispenser would satisfy consumer needs while consuming less energy[51]. In addition, it could be beneficial for the environment to have a larger storage volume, enabling the purchase of large volume foodstuffs and beverages, requiring less packaging and less shopping trips or home deliveries from an internet shop. A more detailed examination of these issues can be found in the MEEUP Product Cases Report[52].

6. COMPARING THE OPTIONS

The option of revising the labelling scheme without setting ecodesign requirements, and vice-versa, was discarded at an early stage of the analysis. This section therefore looks into the cumulative impacts of the different options for combined revision of the ecodesign and labelling scheme.

The options were assessed against the criteria set out in Article 15(5) of the Ecodesign Framework Directive, and the impacts on manufacturers, including SMEs. The aim is to find a balance between quickly achieving appropriate targets, with associated benefits for the environment and the user (due to reduced life cycle costs), on the one hand, and potential burdens related e.g. to the unplanned redesign of equipment to comply with ecodesign requirements, on the other hand, while avoiding disadvantages for the user, in particular with regard to affordability and functionality.

To assess the impact of the policy measures and the relevant sub-options, the following factors were taken into account:

Economic impacts

Savings:
– annual electricity cost savings in 2020
– cumulative electricity cost savings
– competitiveness benefits

Costs:
– possible additional costs related to the improved technology, e.g. for additional and/or more expensive components (independent of sub-option)
– re-design of products currently not compliant with the proposed requirements (depending on sub-options)
– assessment of conformity with ecodesign requirements and re-assessment of conformity with further requirements (safety, etc.; depending on sub-options)
– possible reorganisation of the supply chain (depending on sub-options)

Social impacts
– jobs related to the production of affected equipment (depending on sub-options)
– affordability of equipment (independent of sub-options, see below)

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coolers, it might be a significant bonus — for the environment, for consumer comfort and for the manufacturer's competitiveness in offering innovative solutions.

51 E.g. a beer-barrel in a bar is kept at room temperature and chilled through a spiral tube just before serving. At home, keeping the oxygen (air) from the container would improve longevity.

52 Kemna, R. et al., Methodology Study Eco-design of Energy-using Products (MEEUP), VHK for the European Commission, Final Report, 28.11.2005. Section; Refrigerators & Freezers, Chapter 4 (Technical Analysis).

Environmental impacts

– annual electricity savings and reduction of CO_2 emissions in 2020
– cumulative electricity savings and reductions of CO_2 emissions
– reduction of acidifying emissions.

6.1 Economic impact in terms of energy savings

6.1.1 Combined impacts of Measures 1 and 2

Sections 5.1 and 5.2 identified the EE44-15 and the EE42-15 sub-options for setting new energy efficiency requirements and the redesign of the energy efficiency classes.

Energy efficiency class	New EEI thresholds **Sub-option EE44-15**	New EEI thresholds **Sub-option EE42-15**	Stage 1	Stage 2
10	EEI<15	EEI<13		
9	15<EEI<18	13<EEI<16		
8	18 < EEI < 22	16< EEI < 20		A
7	22 < EEI < 28	20 < EEI < 25	A	B
6	28 < EEI < 35	25 < EEI < 30	B	C
5	35 < EEI < **44****	30< EEI < **42****	C	D
4	44 < EEI < **55***	42< EEI < **55***	D	E
3	55 < EEI < 75	55< EEI < 75	E	F
2	75 < EEI < 100	75< EEI < 100	F	G
1	EEI > 100	EEI > 100	G	-

Energy efficiency requirements	**Sub-option EE44-15**	**Sub-option EE42-15**
*Stage 1 in 2010	EEI<55	EEI<55
**Stage 2 in 2015	EEI<44	EEI<42

- **Sensitivity analysis**

During the consultation forum some stakeholders asked for the second stage (proposed in 2015) to be set earlier. Taking into account the design and production platform change cycles for the industry (between 4 and 5 years), it seems possible to set the second stage at 4 years after the adoption of the Regulations. Two sub-scenarios are therefore considered for bringing the second stage forward **from 2015 to 2013** (assuming the proposal is adopted in 2009). Another alternative is the setting of the second step of minimum energy efficiency requirements in three steps in order to leave enough time to the industry to adapt to the reduction of tolerances for the measurement of energy consumption. In that scenario, a second step could be set at 44 in 2012 and a third step at 42 in 2014.

Energy efficiency requirements	**Sub-option EE44-13**	**Sub-option EE42-13**	**Sub-option EE44/42-12/14**
*Step 1	in 2010: EEI<55	in 2010: EEI<55	in 2010: EEI<55
**Step 2	in 2013: EEI<44	in 2013: EEI<42	in 2012: EEI<44
***Step 3	/	/	in 2014: EEI<42

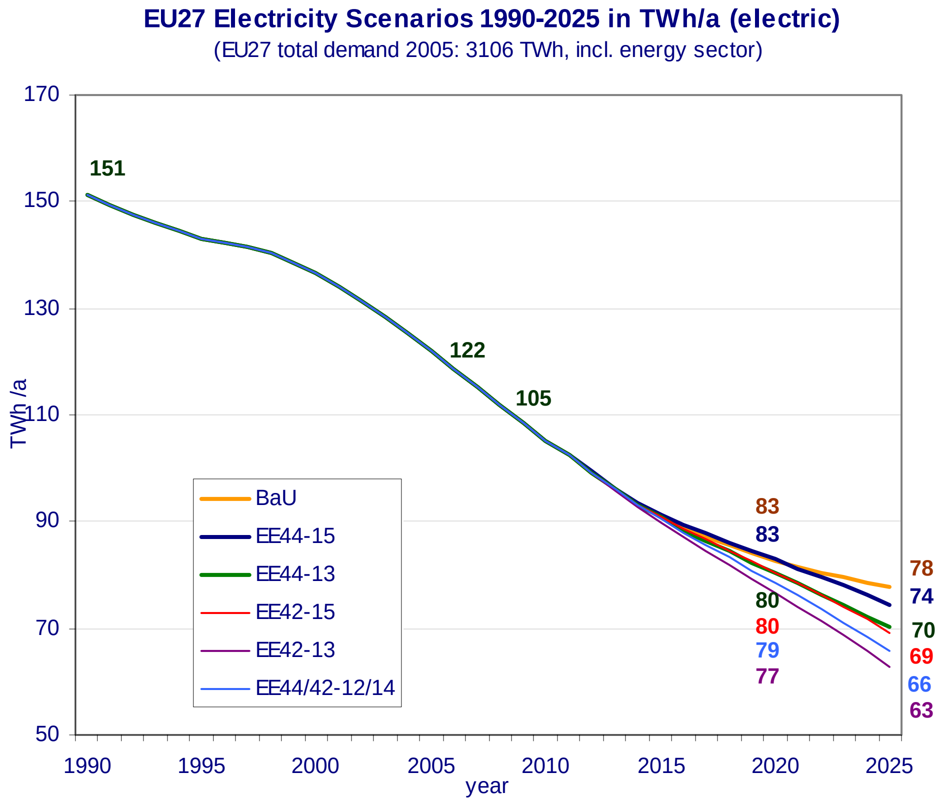
- **Results**

The table and graphs below show electricity consumption for the four sub-options compared with the baseline scenario.

Table 15: Stock model electricity consumption and savings vs BaU

Sub-options	Total electricity consumption						Savings 2020 vs BaU		Savings 2025 vs BaU	
	Unit	2005	2010	2015	2020	2025	TWh	%	TWh	%
BaU	TWh/y	122	105	91	83	78	0	ref	0	ref
EE44-15	TWh/y	122	105	91	83	74	0	0%	3	4%
EE44-13	TWh/y	122	105	91	80	70	3	3%	8	10%
EE42-15	TWh/y	122	105	91	80	69	3	3%	9	11%
EE42-13	TWh/y	122	105	90	77	64	6	7%	14	18%
EE44/42-12/14	TWh/yr	122	105	90	79	66	4	5%	12	15%

Source: Input to this impact assessment by VHK



The most important conclusions are that:

- the greatest energy savings occur in the BaU scenario, going from electricity consumption of 122 TWh in 2005 to 83 TWh in 2020 (-33%). This decreasing trend is due to current market demand and the labelling scheme which give some incentives[53] to manufacturers to place energy-efficient products on the market (see detailed analysis in section 2.2.4);

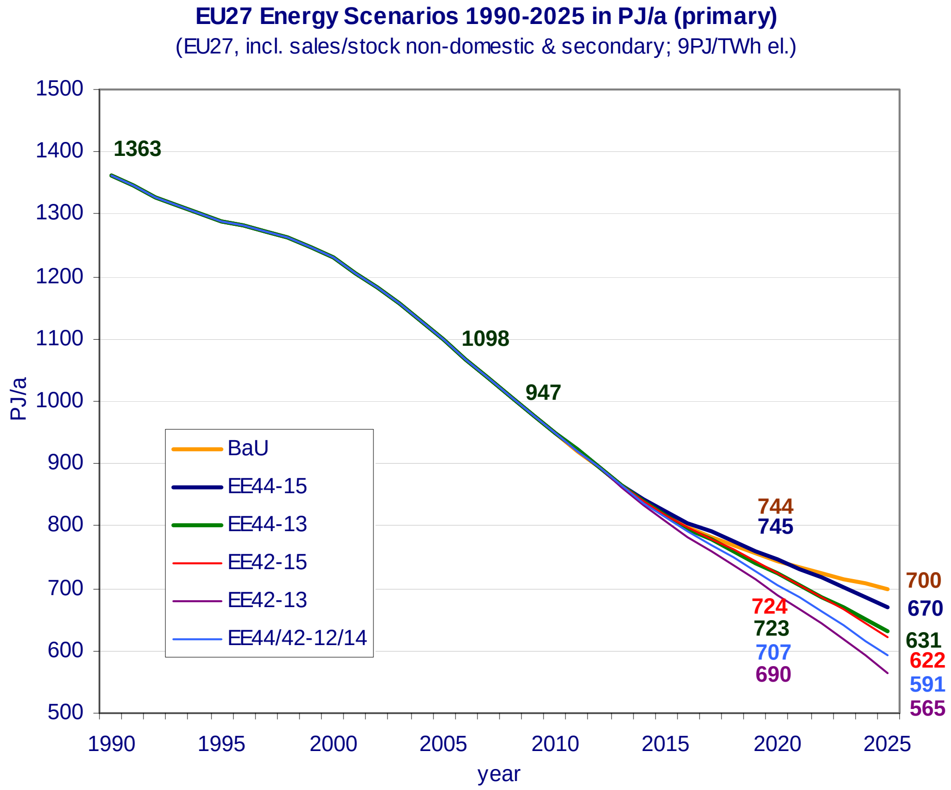
- the policy scenarios are fairly close to each other and offer an extra improvement of up to 7% in 2020 and 18% in 2025. From the graph it is shown that <u>their main merit appears to be keeping the current momentum in efficiency improvement</u>;

- the sub-option EE42-13 is the scenario which would bring the highest savings followed immediately by the EE44/42-12/14 scenario.

- Annual electricity cost savings in 2020 and the cumulative savings over the 2010-2020 and 2010-2025 periods are given in Summary Tables 18 to 21 at the end of this chapter.

The graph below translates the electricity savings into primary energy equivalent at a rate of 9 PJ per TWh of electricity. This is a more common unit for Security of Energy Supply considerations and enables direct comparison with the impacts of non-electric appliances (e.g. fossil fuel fired boilers, water heaters, etc.).

53 NB: The baseline scenario does not assume a revision of the labelling scheme – see section 2.2.4.



6.1.2 Impact of Measures 3 and 4

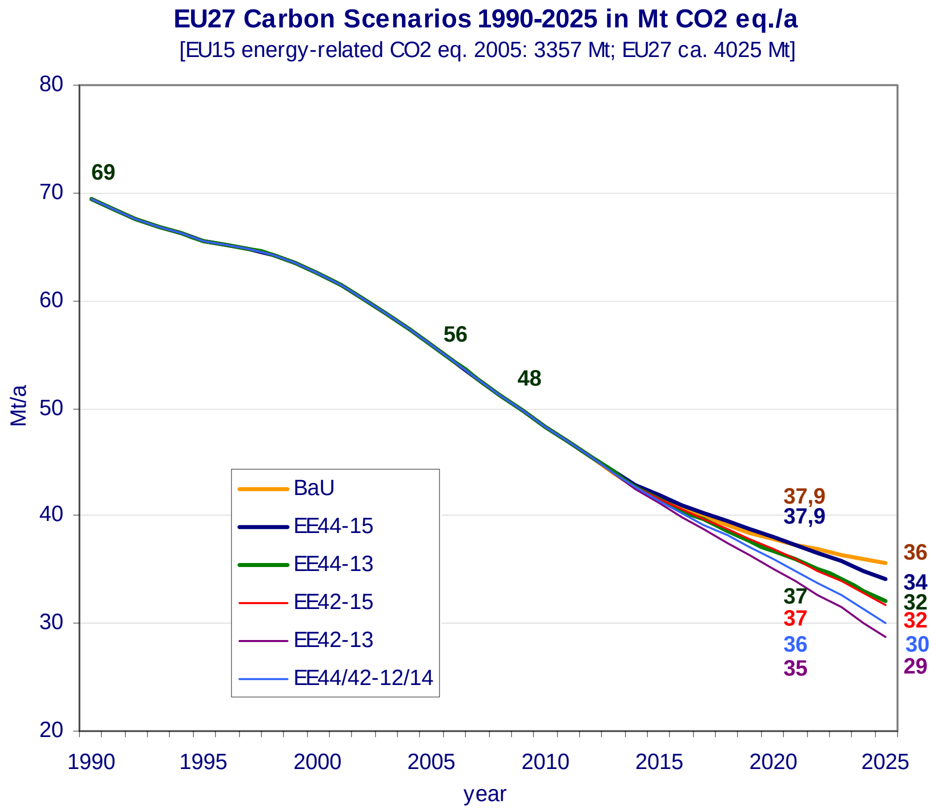
Including Measure 3 — widening coverage to absorption-type refrigerators and wine storage appliances — would add a saving of up to 0.8 TWh/year in 2020, equivalent to an annual electricity cost saving of €150 million in 2020. The cumulative savings over the period 2010-2020 would be around 6-8 TWh (see section 5.3).

Adding the generic requirements (Measure 4, section 5.4) requires the appliance to have an electronic control board instead of the conventional thermostat; the impact of this on energy savings depends on the actual use of the appliance. If the ambient temperature is above 16 ºC and the fast-freeze switch is set back after 72 hours, the additional energy consumed by the extra electronics just about offsets the energy benefit from automatic reset of the winter switch, so there is no extra electricity saving. If a high percentage of consumers forget to switch off the winter switch and fast freeze, there are energy savings.

6.2 Environmental impact

The main environmental impacts investigated in terms of greenhouse gas reduction are illustrated in the graph below for measures 1 and 2.

Other environmental impacts in terms of greenhouse gases, notably impacts related to leakage of refrigerants and or foam blowing agents with high GWP and/or ODP, have not been assessed in detail. It is assumed, however, that the preferred energy efficiency scenarios will not prevent the current market drive towards low GWP refrigerants and/or foam-blowing agents.



The reduction in carbon emissions reflects reduced electricity consumption, as the latter determines over 98% of carbon emissions.

The most effective scenario (EE44-13 with the second stage in 2013) achieves a saving of around 3 Mt CO_2 equivalent compared with the 'business as usual' scenario in 2020 (7-8% saving). In 2025 the difference is more significant, with a saving of 7 Mt CO_2 equivalent (close to 20% saving).

Annual carbon emission savings in 2020 and the cumulative savings over both the 2010-2020 and 2010-2025 periods are given in Summary Tables 18 to 21 at the end of this chapter.

The refrigerator designs necessary to comply with the proposed energy efficiency requirements must not have a negative impact on health, safety or the environment.

Concerning the use of hydro chlorofluorocarbon (HCFC) and hydro fluorocarbon (HFC) as refrigerating and foaming agents, only 5 to 8% of refrigerating appliances are still equipped with HFC instead of hydrocarbon (HC)[54]. Possible measures to reduce this share may be considered under Regulation No 842/2006 on certain fluorinated gases when it comes up for review in 2011.

54 As a reminder, HFCs have a significant negative impact, with a global warming potential (GWP) of 1300 compared to HC with a GWP below 10.

6.3 Impact on consumers

Table 16 shows for measures 1 and 2 total annual EU-27 expenditure on domestic cold appliances, i.e. purchase cost and discounted running costs (more than 95% of which are electricity costs and the rest repairs and maintenance).

For purchase price and maintenance costs, the data from the preparatory study are used as starting values for the BaU scenario (baseline year 2005). The average weighted purchase price (incl. VAT) is €462/unit for refrigerators and €328/unit for freezers. For average cold appliances this amounts to a sales-weighted figure of €421/unit. Refrigerator unit prices, corrected for inflation, remained stable between 1996 and 2004, while the price of freezers fell in real terms by 1.9% annually over the same period. For the average annual price decrease a figure of 1% was applied.

On average, the cost of saving 1 kWh/yr translates to an average consumer purchase cost increase of €1.32 between the BaseCase and the LLCC point and €4.33/kWh for improvements between LLCC point and BAT.

Table 16: Energy and price characteristics of refrigerating appliances

	Energy Consumption (kWh/year)			**Consumer Price (€)**			**Manufacturers' Price (€)**			share	
Product	**Base**	**LLCC**	**BAT**	**Base**	**LLCC**	**BAT**	**Base**	**LLCC**	**BAT**	cat	tot
Refrigerators	164	135	89	345	378	635	138	151	254	16%	
Fridge-freezers	324	251	186	485	586	852	194	234	341	84%	
Avg. 'Refrigerators'	**298**	**232**	**170**	**462**	**552**	**817**	**185**	**220**	**327**		69%
Upright Freezers	275	203	165	328	427	645	131	171	258	50%	
Chest Freezers	301	213	153	328	431	649	131	172	260	50%	
Average Freezers	**288**	**208**	**159**	**328**	**429**	**647**	**131**	**172**	**259**		31%
Average Cold	**295**	**224**	**167**	**421**	**514**	**765**	**168**	**205**	**306**		100%

Price increase per kWh saved (analysis VHK)

PriceInc 1	**1,32** € per kWh saved, from BaseCase to LCC
PriceInc 2	**4,33** € per kWh saved, from LCC to BAT

Source: Preparatory study

The market share in the above table is based on the Preparatory Study split shown in Table 17.

Table 17: Categories and market share

Cat. Nr	Description	Sales	Totals
1	simple refrigerator	14.10%	
2	refrigerator chiller	0.62%	
3	0-star refrigerator	0.68%	
4	1-star refrigerator	0.29%	
5	2-star refrigerator	0.50%	
6	3-star refrigerator	0.15%	
	refrigerators		**16.34%**
7	1-door 4-star fridge-freezer	62.46%	
10	2-door Side-by-Side fridge-freezer		
7	2-door BM fridge-freezer	15.60%	
7	2-door TM (NF) fridge-freezer		
7	2-door TM (manual defrost) fridge-freezer	5.62%	
	fridge-freezers		**83.68%**
Total			
8	upright freezers	50%	
9	chest freezers	50%	
Total			

BM=Bottom Mounted Freezer
TM=Top Mounted Freezer
NF=No Frost

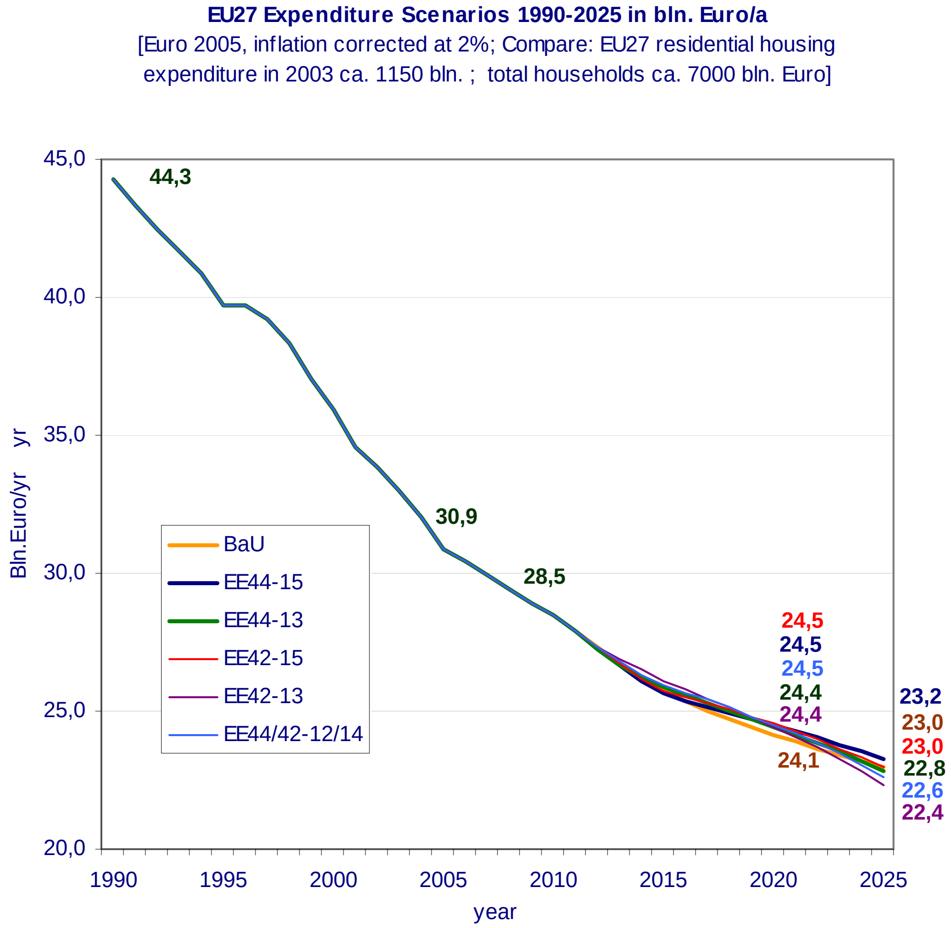
Source: Preparatory study

The average product life of cold appliances is 15 years (14 years for refrigerators, 17 years for freezers). The electricity rate is €0.17/kWh (household tariff, including taxes) with an annual increase of 4% over the scenario period.

The discount rate was set at 4%[55].

Annual maintenance and repair costs were set at €5.5/unit, equivalent to one or two repairs over the lifetime of the product.

55 Please note that the preparatory study uses the US methodology based on the E-GRIM model with a discount rate of 5%, which might result in a small discrepancy in outcome with the underlying report.



The most significant trend in consumer expenditure occurs in the 'business as usual' scenario, since manufacturers are already placing less energy-consuming appliances on the market; the expected cost saving between 2010 and 2015 is €4.4 billion (-15%).

On the short run, i.e. in 2020, when only part of the stock has been replaced and consumers are paying up-front for the higher purchase price, the policy scenarios do less well. For instance, the projected average purchase price in the EE42-13 scenario is estimated to be 14% higher than in the business as usual scenario (€508 vs €443)[56]; for this money the consumer should get an appliance that uses 27% less energy (160 as against 218 kWh/year) in 2020.

Only in 2025 do the policy scenarios start to catch up on the baseline and will EU households as a whole feel that the extra energy saving is also paying off economically. This effect will even be stronger in 2030. The average cold appliance purchase price difference between the BaU scenario and the EE42-13 scenario in 2025 will be around 20% (€541 vs €439), but for this money the consumer will have an appliance that consumes almost half the electricity (107 versus 202 kWh/year). At a 2025 electricity rate of over € 0.20/kWh, for example the annual saving would be around €20 and the payback period is in the order of six years. This also applies also for the EEI44/42-12/14 scenario.

[56] Calculated in 2005 euros, corrected for inflation, interest, and production cost reduction through rationalisation. Prices are consumer prices including VAT.

6.4 Impact on manufacturers

6.4.1. Impact on turnover

The impact of BaU and measures 1 and 2 on stakeholders' turnover has been calculated from the (increase in) product prices and broken down as follows:

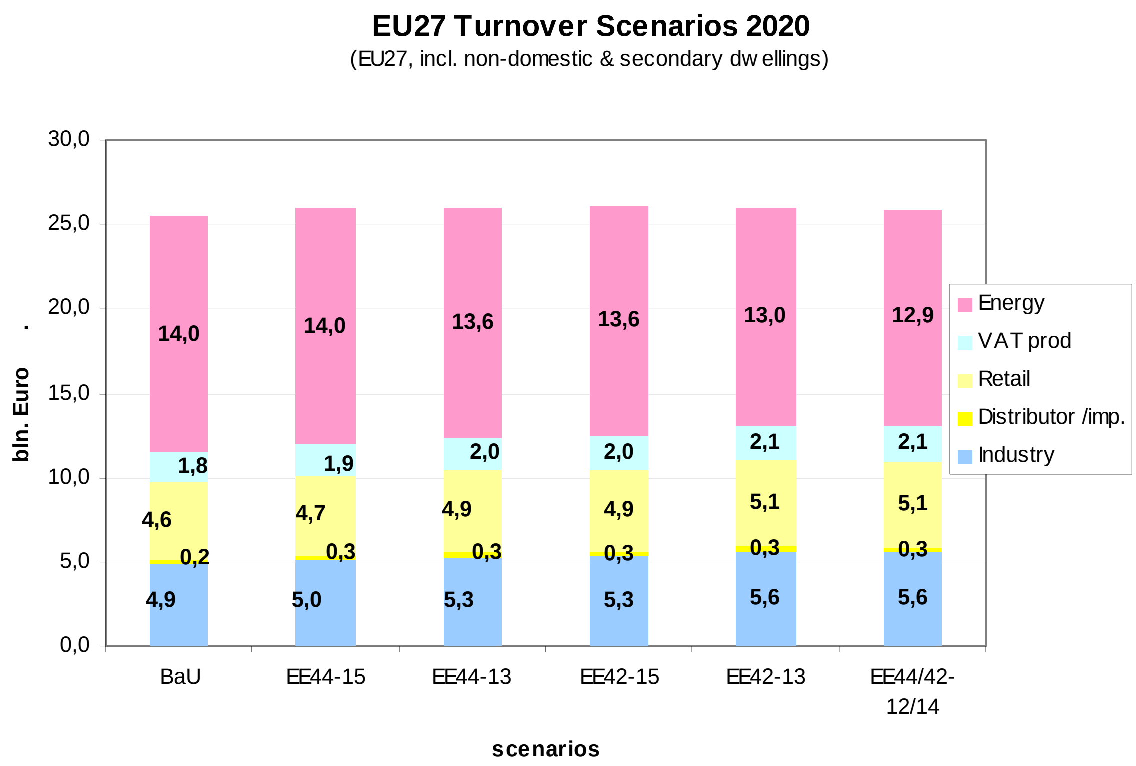
– The manufacturing selling price (MSP) is estimated to be 50% of the consumer price.

– Wholesalers' increased costs are estimated to be low because this market is very restricted. On average, their costs give a mark-up of 5% due to franchising organisations and other centrally shared services.

– The retail margin is estimated at 60%.

– VAT (Value Added Tax) is estimated at 19%.

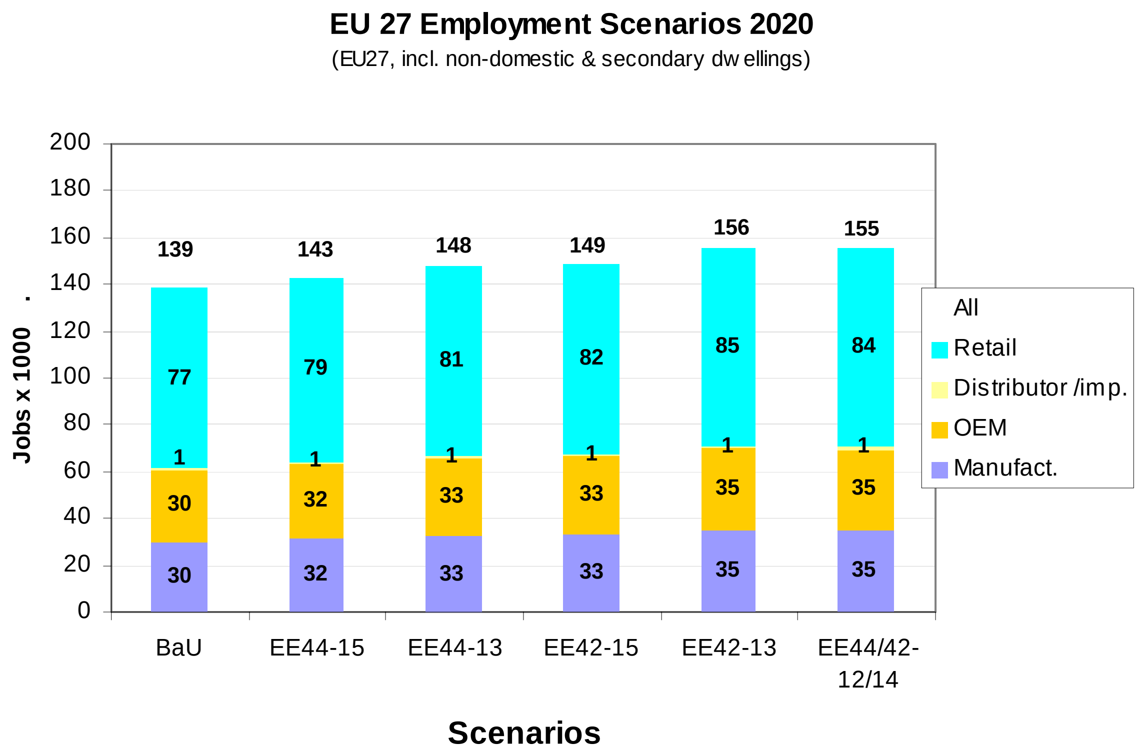
This is a quick estimate but currently the best available and – for BaU — has been checked against other sources (see Annexes). Local levies and recycling contributions were not taken into account for lack of specific data. Energy costs were estimated on the basis of an electricity rate of €0.17/kWh and the calculated energy consumption.



6.4.2. Costs of testing

Energy efficiency will be tested according to EN 153, based on current practice of a system of self-declaration in combination with spot checks by the authorities. Since refrigerating appliances already have to be tested under the labelling scheme, no extra costs are expected, apart from the tests needed for the new types of appliances which may be covered by the revised implementing measures, namely absorption-type and wine appliances.

6.5 Social impact

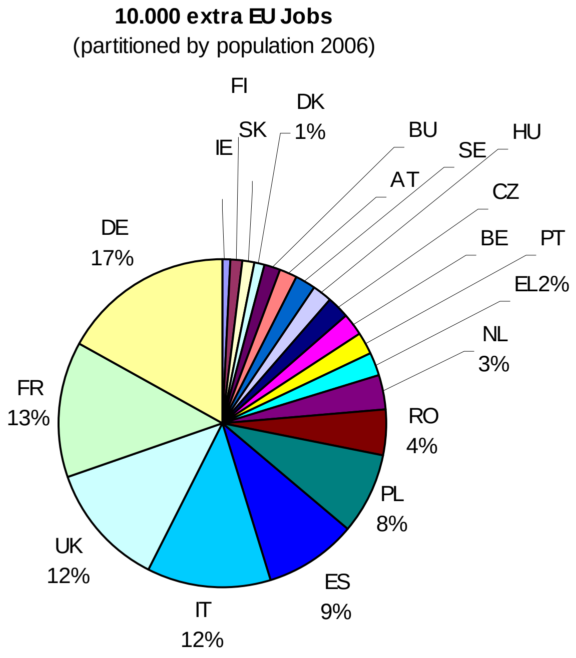


Employment impacts of measures 1 and 2 were calculated on the basis of the average turnover per employee in the sector and the order of magnitude of the outcomes was checked against annual reports from individual companies (see Annexes). The applicable rate for industry is €160 000/employee in manufacturing and an OEM share (Original Equipment Manufacturer, i.e. the suppliers of compressors, foam, etc) that is equal to manufacturing. In the wholesale sector, a rate of €260 000,-/employee was applied and for white goods retailers €60 000 per employee was taken as the basis. The number of jobs created then follows from the expected product price increase due to the policy measures.

Overall, the graph shows — especially taking into account the usual margin of uncertainty (say approx. 10%) — that the possible effect on employment with all scenarios is small.

The BaU scenario itself keeps employment at its current level, i.e. in line with population growth but with strict pressure on prices. In this scenario, the 2020 cold appliance industry would employ around 60 000 people (30 000 in manufacturing + 30 000 OEM) and the retail sector would employ around 77 000 people.

The policy scenarios all give an employment increase of around 10%, creating between 4 000 and 16 000 new jobs more than the BaU scenario. Considering that half of the OEM-jobs and 20% of manufacturing jobs would be outside the EU-27, EU employment would be at most around 5 000 to 10 000 jobs. The graph below shows job distribution broken down by population. In reality, although we have no exact data to make a quantitative estimate, Eastern European Member States — with their relatively higher retail and production plant density — would profit rather more from any job creation for this product group.



6.6 Impact on trade

The requirements proposed are based on a technical, environmental and economic analysis, which was carried out in preparation of the draft regulation in full transparency with participation of stakeholders from around the world (reports available on http://www.ecocold-domestic.org/). In addition, the most important EU-manufacturers are global players so that their consultation has ensured that EU ambition is in line with global developments. Before the proposed Regulation on ecodesign is adopted by the Commission a notification under WTO-TBT will be also issued.

Competitive disadvantages for EU manufacturers exporting refrigerating appliances to third countries are not expected (on the contrary, leadership in efficient appliances would be reinforced). The revised labelling Directive, which is proposed for adoption simultaneously to the ecodesign requirements, will improve the competitiveness of the industry by giving value to more energy efficient appliances on the market: it will enable the industry to get better return on their investments on energy efficiency. In addition, the dates set for the implementation of mandatory requirements take into account the design cycle of the appliances and transition period are set to leave manufacturers enough time to adapt their production to the requirements.

The requirements of the regulation apply to all equipment independent from the origin of the equipment, thus ensuring that a level-playing field is achieved. Considering the rather high cost of transporting voluminous appliances like refrigerating appliances, EU27-based manufacturers provide around 75% of EU sales and most producers from 3rd countries exporting to the EU are situated close to the EU borders, in particular in Turkey or non-EU Eastern Europe. Other extra-EU importers also include Korea and China who are confronted with mandatory minimum energy requirements for refrigerators and freezers also in their home-countries so that the proposed Ecodesign requirements do not seem overly ambitious with respect to those requirements.

The comparison of the different efficiency requirements for cold appliances around the world with those applied in the EU could not be performed because of the disparities of the standards used to measure the energy consumption and the other parameters. The analysis run within the preparatory study showed never the less that cold appliances policy measures are in force in most industrialised economies and industrialising economies worldwide[57].

6.7 Administrative burden

The form of the proposed ecodesign legislation is a Regulation, which is directly applicable in all Member States. This ensures no costs for national and Community administrations in transposing the implementing legislation into national legislation and ensures timely and harmonised entry into force in the internal market.

Pending the adoption of the proposed recast of the 1992/75/EEC Directive, the revision of the labelling scheme has to take the form of a Directive.

In terms of conformity assessment, there are no extra costs with respect of the current situation, where these issues are already mandatory.

Extending the scope of the implementing measures to include new types of appliances such as wine coolers and absorption-type appliances would entail additional market surveillance costs, which should be proportional to the unit sales, i.e. 3 to 4% (as a reminder, the total sales of compressor-type appliances currently covered by the Ecodesign Directive amounted to 20 million units in 2005, while the absorption type amounted only to 250 000-300 000 units).

The generic requirements for the temperature-controlled winter switch and the reset of the fast-freeze function can be tested in a normal room (with no specific air-conditioning) and do not require special tools, apart from a small cooler to trigger the winter-switch sensor into winter condition and an extra thermometer/sensor to see whether the freezer has de-activated fast-freeze after 72 hours. The labour costs for the test laboratory should not be more than 1 hour at an integrated rate of e.g. €150-200/hour. Compared to total current testing costs of around €2000-3000/product this is about a 5-10% increase for the relevant appliances. Assuming, generously, that the relevant appliances account for 20% of unit sales, the generic requirements will increase total surveillance costs by another 2% maximum.

All in all, the two new features above will increase the authorities' surveillance costs by around 5% to 6%. It is not possible to evaluate precisely how much this will cost in absolute terms (euro), because it is not known how many spot checks on refrigerators and freezers the various Member States carry out[58].

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57 See for example summary table of policy measures worldwide in the preparatory study, task 7, Table 7.1, p. 4.

58 There are no official data available but it is expected that there are no more than 150-200 spot checks a year for the whole EU-27, i.e. roughly the same as the number of tests of refrigerating appliances by consumer associations. If this is true, then this is a total cost of less than EUR 0.5 million a year for this product group. So 5-6% is EUR 25 000-30 000 per year extra costs in total.

6.8 Conclusion: comparison matrix

The matrices below give an overview of impacts versus objectives and boundary conditions. The first two matrices show the annual impacts of the BaU scenario and the four sub-options for 2020 and 2025 (measures 1 and 2). The last two matrices show the cumulative impacts and savings of the BaU scenario and the four sub-options for the periods 2010-2020 and 2010-2025 respectively.

Table 18. Main annual impacts by 2020

			Scenario's 2020					
			1	2	3	4	5	6
IMPACTS (as Art. 15, sub. 4.e. of 2005/32/EC)			**BAU**	**EE44-15**	**EE44-13**	**EE42-15**	**EE42-13**	**EE44/42-12/14**
ENVIRONMENT								
	ELECTRICITY	TWh/a	**83**	**83**	**80**	**80**	**77**	**79**
	ENERGY	PJ/a	**744**	**745**	**723**	**724**	**690**	**707**
	GHG	Mt CO2 eq./a	**38**	**38**	**37**	**37**	**35**	**36**
	environmental	kt Sox eq./a						
CONSUMER								
EU totals	expenditure	€ bln./a***	**24,1**	**24,5**	**24,4**	**24,5**	**24,4**	**24,5**
	purchase costs	€ bln./a	8,3	8,7	9,0	9,1	9,6	9,4
	running costs	€ bln./a	15,8	15,8	15,4	15,4	14,8	15,1
per product	product price	€	443	461	480	484	511	499
	install cost	€	0	0	0	0	0	0
	energy costs	€ /a	37	34	31	31	27	28
	payback(SPP)	years	reference	**6,7**	**6,7**	**6,7**	**6,7**	**6,7**
BUSINESS								
EU turnover	manuf	€ bln./a	**4,9**	**5,0**	**5,3**	**5,3**	**5,6**	**5,5**
	whole-sale	€ bln./a	**0,2**	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**
	retail	€ bln./a	**4,6**	**4,7**	**4,9**	**4,9**	**5,1**	**5,0**
EMPLOYMENT								
employ-ment (jobs)	industry EU (incl OEM)	'000	46	47	49	50	53	51
	industry non-EU	'000	15	16	16	17	18	17
	whole-sale	'000	1	1	1	1	1	1
	retail	'000	77	79	81	82	85	83
	TOTAL	'000	**139**	**143**	**148**	**149**	**156**	**153**
	of which EU	'000	123	127	132	132	138	136
	EXTRA EU jobs	'000	reference	**4**	**8**	**9**	**15**	**12**
	of which SME**		reference	3	5	6	10	8

***=all money amounts in Euro 2005 (inflation corrected)

BOUNDARY CONDITIONS ("should be no negative impacts")

	Scenario's 2020/ 2025					
	1	2	3	4	5	6
IMPACTS "No negative impacts" following Art. 15, sub 5 of 2005/32/EC	**BAU**	**EE44-15**	**EE44-13**	**EE42-15**	**EE42-13**	**EE44/42-12/14**
functionality of product	+	+	+	+	+	+
health, safety and environment	+	+	+	+	+	+
affordability and life cycle costs	+	+	+	+	+	+
industry competitiveness	+	+	+	+	+/0	+
no proprietary technology	+	+	+	+	+	+
no excessive administrative burden	+	++	+	+	+	+

Table 19: Main annual impacts by 2025

			Scenario's 2025					
			1	**2**	**3**	**4**	**5**	**6**
IMPACTS (as Art. 15, sub. 4.e. of 2005/32/EC)			**BAU**	**EE44-15**	**EE44-13**	**EE42-15**	**EE42-13**	**EE42/44-12/14**
ENVIRONMENT								
	ELECTRICITY	TWh/a	**78**	**74**	**70**	**69**	**63**	**66**
	ENERGY	PJ/a	**700**	**670**	**631**	**622**	**565**	**591**
	GHG	Mt CO2 eq./a	**36**	**34**	**32**	**32**	**29**	**30**
	environmental	kt Sox eq./a						
CONSUMER								
EU totals	expenditure	€ bln./a***	**23,0**	**23,2**	**22,8**	**23,0**	**22,4**	**22,6**
	purchase costs	€ bln./a	8,0	8,8	9,1	9,4	9,9	9,7
	running costs	€ bln./a	15,0	14,4	13,7	13,5	12,5	13,0
per product	product price	€	439	484	503	518	544	532
	install cost	€	0	0	0	0	0	0
	energy costs	€ /a	34	27	24	22	18	19
	payback(SPP)	years	reference	**6,4**	**6,4**	**6,4**	**6,4**	**6,4**
BUSINESS								
EU turnover	manuf	€ bln./a	**4,9**	**5,4**	**5,6**	**5,8**	**6,1**	**5,9**
	whole-sale	€ bln./a	**0,2**	**0,3**	**0,3**	**0,3**	**0,3**	**0,3**
	retail	€ bln./a	**4,7**	**5,0**	**5,1**	**5,2**	**5,4**	**5,3**
EMPLOYMENT								
employ-ment (jobs)	industry EU (incl OEM)	'000	46	51	52	54	57	56
	industry non-EU	'000	15	17	17	18	19	19
	whole-sale	'000	1	1	1	1	1	1
	retail	'000	78	83	85	87	90	89
	TOTAL	'000	**140**	**152**	**156**	**160**	**167**	**164**
	of which EU	'000	125	135	139	142	148	146
	EXTRA EU jobs	'000	reference	**10**	**14**	**18**	**24**	**21**
	of which SME**		reference	7	9	12	15	14

***=all money amounts in Euro 2005 (inflation corrected)

Table 20: Cumulative main impacts 2010-2020

Totals			Scenario's 2020					
			1	**2**	**3**	**4**	**5**	**6**
IMPACTS (as Art. 15, sub. 4.e. of 2005/32/EC)			**BAU**	**EE44-15**	**EE44-13**	**EE42-15**	**EE42-13**	**EE44/42-12/14**
ENVIRONMENT								
	ELECTRICITY	TWh/a	**1014**	**1019**	**1009**	**1010**	**995**	**1002**
	GHG	Mt CO2 eq./a	**465**	**467**	**462**	**462**	**455**	**459**
	Acidification	kt Sox eq./a						
CONSUMER								
EU totals	expenditure	€ bln./a***	**286,1**	**286,6**	**287,5**	**287,5**	**288,8**	**288,2**
	purchase costs	€ bln./a	94,6	94,3	96,9	96,8	100,7	98,8
	running costs	€ bln./a	191,5	192,3	190,6	190,6	188,1	189,5
	of which electricity	€ bln./a	171,8	172,6	170,9	171,0	168,4	169,8
BUSINESS								
EU turnover	manuf	€ bln./a	**52,3**	**52,2**	**53,7**	**53,6**	**55,8**	**54,7**
	whole-sale	€ bln./a	**2,6**	**2,6**	**2,7**	**2,7**	**2,8**	**2,7**
	retail	€ bln./a	**49,6**	**49,5**	**50,4**	**50,4**	**51,8**	**51,1**

Savings vs. Baseline			Scenario's 2020					
			1	**2**	**3**	**4**	**5**	**6**
IMPACTS (as Art. 15, sub. 4.e. of 2005/32/EC)			**BAU**	**EE44-15**	**EE44-13**	**EE42-15**	**EE42-13**	**EE44/42-12/14**
ENVIRONMENT								
	ELECTRICITY	TWh/a	**ref**	**-5**	**5**	**5**	**20**	**12**
	GHG	Mt CO2 eq./a	**ref**	**-2**	**2**	**2**	**9**	**5**
	Acidification	kt Sox eq./a	**ref**	**0**				
CONSUMER								
EU savings	expenditure	€ bln./a***	**ref**	**-1**	**-1**	**-1**	**-3**	**-2**
	purchase costs	€ bln./a	**ref**	**0**	**-2**	**-2**	**-6**	**-4**
	running costs	€ bln./a	**ref**	**-1**	**1**	**1**	**3**	**2**
	of which electricity	€ bln./a	**ref**	**-1**	**1**	**1**	**3**	**2**
BUSINESS								
Extra turnover	manuf	€ bln./a	**ref**	**0**	**1**	**1**	**3**	**2**
	whole-sale	€ bln./a	**ref**	**0**	**0**	**0**	**0**	**0**
	retail	€ bln./a	**ref**	**0**	**1**	**1**	**2**	**2**

***=all money amounts in Euro 2005 (inflation corrected). Note that although individual consumers are saving money (see tables 18 and 19) the accumulative effect on the EU27 as a whole shows only at full stock exchange (2028-2030).

Table 21: Cumulative main impacts 2010-2025

Totals			Scenario's 2025					
			1	**2**	**3**	**4**	**5**	**6**
IMPACTS (as Art. 15, sub. 4.e. of 2005/32/EC)			**BAU**	**EE44-15**	**EE44-13**	**EE42-15**	**EE42-13**	**EE42/44-12/14**
ENVIRONMENT								
	ELECTRICITY	TWh/a	**1412**	**1409**	**1381**	**1379**	**1337**	**1358**
	GHG	Mt CO2 eq./a	**647**	**645**	**632**	**631**	**612**	**622**
	Acidification	kt Sox eq./a						
CONSUMER								
EU totals	expenditure	€ bln./a***	**403,2**	**405,5**	**405,1**	**405,6**	**404,9**	**405,4**
	purchase costs	€ bln./a	135,2	138,1	142,5	143,3	149,6	146,7
	running costs	€ bln./a	268,0	267,4	262,6	262,3	255,3	258,7
	of which electricity	€ bln./a	239,0	238,3	233,6	233,3	226,3	229,7
BUSINESS								
EU turnover	manuf	€ bln./a	**76,7**	**78,5**	**81,0**	**81,5**	**85,2**	**83,5**
	whole-sale	€ bln./a	**3,8**	**3,9**	**4,1**	**4,1**	**4,3**	**4,2**
	retail	€ bln./a	**72,8**	**74,0**	**75,6**	**75,9**	**78,2**	**77,1**

Savings vs. Baseline			Scenario's 2025					
			1	**2**	**3**	**4**	**5**	**6**
IMPACTS (as Art. 15, sub. 4.e. of 2005/32/EC)			**BAU**	**EE44-15**	**EE44-13**	**EE42-15**	**EE42-13**	**EE42/44-12/14**
ENVIRONMENT								
	ELECTRICITY	TWh/a	**ref**	**4**	**32**	**34**	**75**	**55**
	GHG	Mt CO2 eq./a	**ref**	**2**	**15**	**15**	**34**	**25**
	Acidification	kt Sox eq./a	**ref**	**0**				
CONSUMER								
EU savings	expenditure	€ bln./a***	**ref**	**-2**	**-2**	**-2**	**-2**	**-2**
	purchase costs	€ bln./a	**ref**	**-3**	**-7**	**-8**	**-14**	**-11**
	running costs	€ bln./a	**ref**	**1**	**5**	**6**	**13**	**9**
	of which electricity	€ bln./a	**ref**	**1**	**5**	**6**	**13**	**9**
BUSINESS								
Extra turnover	manuf	€ bln./a	**ref**	**2**	**4**	**5**	**8**	**7**
	whole-sale	€ bln./a	**ref**	**0**	**0**	**0**	**0**	**0**
	retail	€ bln./a	**ref**	**1**	**3**	**3**	**5**	**4**

***=all money amounts in Euro 2005 (inflation corrected). Note that, although individual consumers are saving money (see tables 18 and 19) the accumulative effect on the EU27 as a whole show only at full stock exchange (2028-2030).

The analysis demonstrates that the following measures would bring the most significant benefits and meet all conditions in Art. 15 of the Ecodesign Framework Directive:

Recommended measures	**Benefits in terms of energy savings**
Setting new energy efficiency requirements for compressor-type appliances (sub-option EE44/42-12/14) and updating the labelling scheme with more stringent energy efficiency classes	4 TWh in 2020 compared to BaU, increasing to 12 TWh in 2025
Widening the scope of the ecodesign implementing measure to include absorption-type appliances	0.19 TWh in 2020 compared to BaU
Including wine appliances in the labelling scheme, leaving open the question of the feasibility of adopting energy efficiency requirements for wine appliances taking into account the lack of reliable data on this niche market	0.5 TWh in 2020 compared to BaU

The impact assessment on possible new generic requirements (i.e. automatic control according to ambient temperature of the winter switch feature, automatic switch-off of the fast-freeze facility and automatic switch-off of mini-chillers when they are empty) in section 5.4 demonstrated that they would bring marginal energy savings. The results are, however, heavily dependent on the number of customers neglecting to use the manual switch or to switch off the mini-chiller. The adoption of these generic requirements in an ecodesign implementing measure is therefore questionable but may still be considered.

Household refrigerators and freezers, placed on the EU market, have been regulated for the last 12 to 13 years, leading to an energy efficiency improvement of almost 30%. Despite population growth of 15% over the period, the absolute energy consumption of domestic 'cold appliances' is now 15% lower than in 1990. In the same period the industry has practically phased out CFCs and HCFCs and replaced them mainly with hydrocarbons (and to a minor extent with HFCs), thus diminishing the ozone depletion potential and greenhouse gas impact of the refrigerant and foaming agents for new equipment[59].

The purpose of the new measures under the Ecodesign Directive is to keep this momentum going by providing an up-to-date legal framework that will continue to provide consumers with meaningful product information on energy efficiency and environmental impacts and that will give European manufacturers the long-term security they need to invest in innovative technology.

59 Note that a significant amount of old equipment containing CFCs and HCFC is still circulating, hence forming part of a significant 'bank' of ozone depleting substances and greenhouse gases that will have to be disposed of in an environmentally sound manner. The total worldwide ODS/GHG bank in 2002 is estimated at approx. 3 million tonnes ozone depleting potential or 2 billion tonnes of CO_2-eq. See also COM (2008) 585 final.

If successful, the measures will ensure that in the longer term, we can expect the same kind of efficiency and environmental improvements, keeping up the global competitiveness of the EU-27 industry. The implementing measures proposed ensure a 30-35% absolute electricity saving in 2020 against the baseline year 2005. Due to market inertia, i.e. the 15 years it takes for old models to be fully replaced by new types, the effects of the new measures up to 2020 will be very limited with respect to the already ambitious baseline scenario. But by 2025 the energy consumption of all installed domestic refrigerators and freezers could be half of that consumed in 2005.

Compared with 1990 — the reference year for climate policy — the annual energy consumption and carbon emissions of this product group in 2020 will be 50-60% lower, saving around 75 TWh electricity and 25 Mt CO_2 equivalent per year (1990: 153 TWh; 2020: 74-83 TWh depending on the scenario). In 2025, savings are projected to be around 90 TWh and 40 Mt CO_2 per year (compared to 1990)[60].

Calculated in net present value (euro 2005), consumer expenditure — i.e. the annual purchase and running costs of the EU-27 population — will drop from around €30 billion today to €24 billion in 2020 and approximately €23 billion in 2025.

The biggest threat to success is that the legislators do not recognise and revise the ecodesign requirements and labelling scheme according to market dynamics (regulatory failure). This could lead to consumers no longer being able to differentiate models on energy efficiency because they would all be in the same labelling class, retailers not seeing the point of showing off the energy label, authorities not being able to promote the most efficient models and the industry no longer being motivated to invest in more efficient appliances.

7. MONITORING AND EVALUATION

The main monitoring tool will be the tests carried out to verify correct rating and labelling. Monitoring of the impacts should be done by market surveillance carried out by Member State authorities ensuring that the rating on the label is truthful. The main indicator of progress on market take-up of more efficient refrigerators and freezers will be the effective market shift towards the upper labelling band.

The appropriateness of the scope, definitions, and concept of the implementing measure and any trade-offs, will be monitored by means of the ongoing dialogue with stakeholders and Member States. The main issues for a revision of the proposed labelling scheme are:

– improved test standards (mandate CEN/ CENELEC) and measurement accuracy;

– need to revise the labelling classification scheme in line with technological improvements;

– implementation of more demanding minimum requirements;

– extension to include new types of refrigerating appliances (e.g. mini-chillers).

[60] This assumes that equipment will be disposed of in an environmentally sound manner, i.e. without emitting refrigerants or foam-blowing agents at the end-of-life stage.

Revision and adaptation to technical progress (e.g. availability of suitable measurement or testing standards, upgrading of classes following market developments, etc.) could be implemented through comitology.

Taking into account the time necessary to collect, analyse and supplement the data and experience of the labelling scheme and assess technological progress, a review of the main elements of the framework could be presented five years after the entry into force of a labelling scheme.

ANNEX 1: MINUTES OF THE CONSULTATION FORUM 05.12.2008

DRAFT MINUTES of the

Consultation Forum on two implementing measures with regard to Ecodesign and Labelling for refrigerating appliances - 04/12/2008

Centre Albert Borschette (CCAB), Brussels

Participants: see Annex A

The Chairman opened the meeting by recalling the aim of the proposed two implementing measures for refrigerating appliances (RF) which is to improve their energy efficiency, hence contribute to the 20% energy efficiency target set for 2020. The *working document on a possible Commission Regulation implementing Directive 2005/32/EC with regard to household refrigerating appliances* (Annex 2) proposes to set new minimum requirements phasing out the less efficient models from the market, while the proposed *working document on a possible Commission Directive implementing Directive 1992/75/EC with regard to household refrigerating appliances* (Annex 3) foresees the revision of the labelling scheme in order to drive the market towards more energy efficient models.

The Chairman highlighted that the two working documents tabled for discussion were presented in the format of a draft legislative proposal so as to give a clear view of those provisions meant to be included respectively in the Eco-design or in the Labelling measure. Although the EU labelling scheme does not fall under the competence of the Ecodesign Consultation Forum, it was considered appropriate to present both draft measures to MS representatives and other stakeholders to show the synergy between those provisions meant to be included respectively in the Eco-design or in the Labelling measures.

The layout of the label was not addressed during the meeting, since it is the object of a specific discussion and decision within the EELEP in its Labelling formation.

In general, there was a consensus among stakeholders that the combined approach between the ecodesign requirements and the labelling scheme, setting common definitions, measurement standards and algorithm for the calculation of the Energy Efficiency Index, is a very positive approach which not only will simplify and facilitate the implementation of both measures but will also result in a more effective framework towards the energy efficiency improvement of the covered products.

The debate was mainly concentrated on three issues: the level of ambition of the ecodesign specific and generic requirements, the revision of the labelling energy efficiency classes and the inclusion of wine cooler appliances into the scope of both implementing measures.

Specific ecodesign requirements

The working document considers the following minimum energy efficiency requirements (hereafter also referred to as thresholds):

(1) First stage, one year after entry into force of the implementing measure: EEI<55 for compression-type appliances, EE1<150 for absorption-type appliances

(2) Second stage, three years after entry into force of the implementing measure: EEI<125 for absorption-type appliances

(3) Third stage, six years after entry into force of the implementing measure: EEI<44 for compression-type appliances, EE1<110 for absorption-type appliances

TREN introduced the discussion by underlying that according to the preparatory study based on the appliance market in 2005, the impact of these specific requirements will be to remove at the first step 46% of the model, and at the third step, 80% of the models.

The majority of stakeholders confirmed that the first stage was a good step in the sense that it will secure the removing of all products below current class A. The second step for compressor–type could however be advanced from six years after entry into force of the implementing measure to 3 or 4 years (UK, DK, DE, environmental NGOs). This would be also in line with the recommended timing of the preparatory study. According to the NL, a front-runner approach should be followed for the setting of the specific ecodesign requirements: the most efficient appliances on the market today shall set the minimum energy efficiency thresholds in 6 years time. This level could be set at EEI<30 or less for compressor type refrigerating appliances.

CECED confirmed that they advocated in their preceding position papers an earlier timing for the setting of minimum energy efficiency requirements but only at the condition that the labelling scheme is revised with energy efficiency classes being open-ended and providing room for getting return on investments.

Concerning the energy efficiency requirements proposed for absorption-type appliances, CECED underlined that the first step will remove 75% of the appliances of today's market while the second step would require energy improvement of 40% which represents 100% of the total energy improvement possible today applying the best available technologies. There is a need therefore to review the specific requirements for this type of appliance.

The chairman recalled that the Ecodesign Framework Directive 2005/32/EC sets criteria upon which specific ecodesign requirements should be set. Minimum energy efficiency requirements should be aiming at the point of least life cycle costs for the end user and assess the impact of the timing for the implementation of the requirements according to the criteria listed in Article 15(5) (e.g. no negative impact on the functionality of the product, on health, safety and the environment, no negative impact on consumers, on industry's competitiveness etc.).

Generic requirements

Life-duration of refrigerating appliances: ANEC/BEUC stressed that it would be important to work on the possibility to repair RF for example by setting mandatory requirements on the availability of spare parts in order to extend their life duration. No-one could however confirm the existence of problems on this matter. TREN answered that the practical enforcement of such generic requirement would be very difficult, if not impossible, therefore putting a burden on compliant manufacturers and be ineffective on 'free-riders'.

Automatic switch-off of the fast freezing facility: On the question whether the proposed generic requirement to automatically switch-off the fast-freezing facility after 72 hours could be reduced to 48h, TREN replied that this was not advisable for two reasons: there is a danger in the case of over-load of the freezer that 48 hours might not be sufficient to freeze all foodstuff loaded by consumers, and the energy saved from moving from 72 hours to 48 hours (i.e. from 3 days to 2 days) would result in 1 or 2 kWh per year, which is marginal compared to the energy potentially lost with discarded food due to its lower quality resulting from a suboptimal freezing.

Winter setting switch: For appliances which can be used with an ambient temperature below 16°C, the working documents foresee the mandatory fitting of automatic control of the heating function according to the ambient temperature for refrigerator-freezer with one compressor and one thermostat having also the fast-freezing facility. TREN confirmed that electromechanical refrigerator-freezers with one compressor and one thermostat but with no fast freezing capacity were not concerned by this requirement. The reason is that it would cost more energy to install electronic control on this type of appliances than the energy saved from switching off the winter switch facility when it is not needed. CECED expressed doubts about the cost-effectiveness of this measure, since its assumed benefits are directly dependant of consumer behaviours (i.e. the extent where consumers would have forgotten to switch off manually both the winter-switch and the fast freezing button in the absence of an automatic operation of the winter setting/fast freezing facility).

Automatic switch off of RF<10 litres when they are empty: CECED highlighted that this measure may have a negative health impact (growth of mould in the absence of ventilation) if consumers forget to leave open the door of such appliances. TREN replied that since these very small appliances are essentially used for cooling cans and bottles, the possible mould growth will have only a very marginal impact on consumers, if any.

Labelling scheme

Formula of the energy efficiency index: ECOS in the name of environmental NGOs[61] expressed concern over the increase in net volume of refrigerating appliances and proposed to adapt the energy efficiency calculation methodology to penalise bigger appliances. TREN replied that in the preparatory study the technical database of the last 10 years were analysed; the results of this analysis, presented during the meeting, demonstrated that for two out of the four major refrigerating appliance categories (refrigerators, refrigerator-freezers, upright and chest freezers) the net volume is either stable (in refrigerator-freezers) or decreasing (chest freezers), while for refrigerators and chest freezers it increased of 25 litres. So all in all the concern over the volume increase is not technically justified. The perception of a larger volume increase is very likely due to the fact that larger appliances (i.e. American style side-by-side models) are more frequently displayed in the shops due to their higher prices (and therefore higher margin for the retailers).

The UK, NL and DK, supported by ECOS and ANEC/BEUC, also called for a review of the correction factors, especially the climate class factors, on the ground that they do not convey transparent information to consumers (a refrigerator for instance with the no-frost function will consume more than one without but may still have the same energy class). TREN replied that some of the factors are technically justified in order to make the comparison of the different appliance configurations and compartment composition possible without the creation of an excessive number of Categories. In other major worldwide markets, namely USA and Australia, there are, for instance, a lower number of correction factors but a higher number of categories. Nevertheless the number and value of the proposed factors could be assessed.

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[61] Including INFORSE (International Network for Sustainable Energy), EEB (European Environmental Bureau), CAN (Climate Action Network Europe), Greenpeace European Unit, WWF-Europe.

Inclusion of the absorption-type appliances into the energy efficiency classes: ECOS contested the inclusion of absorption-type refrigerator in the A-G energy efficiency scale: the large difference in energy consumption between absorption type and compressor type refrigerating appliances leads to a scale where there is not enough space left for differentiation between compressor-type RF. This would leave de facto consumers with a choice between only two classes while absorption-type RFs mainly concern the tertiary sector. ECOS therefore asked for the design of two different labelling schemes for each type of appliance. ANEC/BEUC and CECED on the other side supported the inclusion of absorption-type in a unique energy efficiency scale on the ground that there is a danger to pave the way for unfair competition between both products. In a situation where more and more households have open kitchen, consumers may be more interested in buying low noise RF. There is a need therefore to clearly indicate to consumers that low-noise appliances, i.e. absorption-type RF, are much more energy consuming than compressor-type RF.

3 months transitory period

The working document foresees a three months transitory period where the circulation of models with the old label will be allowed for 3 months after the end of its validity at the same time as the introduction of the new label. CECED and BE underlined that the current formulation of this provision needs clarification, especially concerning the reference to the 'free circulation of labels'. TREN replied that an improved and clearer formulation of the provision will be drafted.

Wine appliances

For wine storage appliances the working documents propose to set a generic requirement on the provision of information to consumers in booklets of instructions saying that '*this appliance is intended to be used exclusively for the long term storage and the aging of wine'*. (There is no need to warn consumers on the models displayed in shops as it is obvious by construction that wine coolers are not to be confused with standard RFs.)

Wine storage appliance shall be understood as refrigerating appliance having only one or more wine storage compartment with:

- the capability of maintaining continuously a nominal temperature in the range from +9 °C to +15 °C with cooling as well as heating;
- the capability of maintaining the storage temperature within a variation over time of less than 0,5 K
- the capability to actively or passively control of the compartment humidity in the range 50-80%
- a construction to reduce the transmission of vibration to the compartment, whether from the refrigerator compressor or from external source.

Other wine appliances with a wider temperature range (from 5 to 20°C), usually used for the cooling of wine, should respect the proposed level of energy efficiency requirements. This poses a major challenge for wine appliances with transparent doors which will hardly be able to comply with the new energy efficiency requirements. This may de facto lead to banning all wine appliances with glass doors out of the market (AT).

A question was raised by Malta as to the proportionality of including wine storage appliance inside the scope of the two implementing measures on RF for only one general information requirement taking into account that their inclusion will require as a consequence to have all models EC marked.

On the grounds raised above, CECED requested, instead of exempting wine storage appliances from the scope of the energy efficiency requirements and the labelling scheme, to draft ecodesign measures specifically devoted to all wine appliances and to include them in the current labelling scheme with no specific treatment. The current proposal would have the impact to distort significantly the market. According to CECED data, out of the 250 000 units sold between September 2007 and August 2008, 20% of the appliances were multi-temperature devices and 80% single temperature devices (between 2 and 20°C). The likely outcome of the proposal presented in the working document will be the phasing out of the multi-temperature devices so as to benefit from the exemption from the energy efficiency requirements given to wine storage appliances. The question is therefore the following: do we want to allow the further commercialisation of wine coolers on the market or do we want to remove them at the benefit of appliance with a single temperature device between 9 and 15°C?

In addition, the exclusion of wine storage appliances from the scope of the specific ecodesign requirements will require a measurement standard to certify that the appliance is indeed a wine storage appliance but no such standard is yet available.

Scope

UK also stressed that there is a need to avoid that the exemption provided for refrigerating appliances in which the removal of refrigerated items is automatically transmitted through a network connection to an accounting system, also includes domestic refrigerating appliances with electronic networking. TREN replied that this is not the intention. Only refrigerating appliances acting as ‘vending machines’ will be exempted from these implementing measures because they are designed and intended for commercial use.

Verification procedure

The working document proposes to reduce the measurement uncertainty from 15% to 10% on the ground that production variability should be left to the responsibility of producers. Several stakeholders (UK, SE, NL, ANEC/BEUC) believe that it could be possible to reduce further the measurement uncertainty from 10% to 3 or 4% which is the current level of accuracy of e.g. UK accredited laboratories. TREN highlighted however that the measurement accuracy will be further defined on the basis of a round robin test within the mandate delivered to ESOs by the European Commission for the preparation of the EN harmonised standard. After the vote on the measures within the EELEP this mandate will be prepared and discussed with MS before the transmission to ESOs.

The UK asked to enshrine in the implementing measure the possibility for Member States to apply a narrower measurement uncertainty if their laboratories make it possible. AT underlined however that the more accurate the testing methods, the more costly the verification procedure for Member States, with a possible contra-productive effect that in the end, less products will be tested due to costs constrains. Romania also underlined that 50 to 60% of the Member States currently have no laboratories to test the products. This problem and costs of testing need to be addressed.

Finally, CECED mentioned their project to test products' compliance with the labelling scheme and assess the variability of testing laboratories within the last Call of Intelligent Energy Europe Programme. If the project was selected for founding, it could give hard results about the level of accuracy achievable. According to CECED, there is a need to improve the quality of a great number of testing laboratories in order to ensure an effective verification procedure by Member States based on reliable test results.

Annex A: List of participants

Member States or company/organisation's name
Norway
Austria
Belgium
Bulgaria
Czech Republic
Denmark
Estonia
France
Germany
Hungary
Ireland
Italy
Latvia
Lithuania
Luxemburg
Malta
Netherlands
Portugal
Romania
Slovakia
Spain
Sweden
United Kingdom
ANEC/BEUC
CECED
CENELEC
ECOS
EEB
Grayling Global

ANNEX 2: SENSITIVITY ANALYSIS

Comparison of the Life Cycle Costs for cold appliances at different lifetimes and electricity prices – Source: Preparatory study, Task 6, p. 108

Electricity price (€/kWh)	Average standard Base Case (description)	Consumer price (€)	Energy consumption (kWh/year)	Annual energy costs (€/year)	LCC at 10 years (€)	LCC at 12 years (€)	LCC at 15 years (€)	LCC at 17 years (€)
Average standard base case								
0,17	Refrigerators	345	163,7	27,83	640	674	720	747
0,17	Refrigerator-freezers	485	324,4	55,15	991	1.057	1.144	1.195
0,17	Upright freezers	328	274,5	46,67	768	824	899	943
0,17	Chest freezers	328	300,6	51,10	803	864	945	993
$LLCC_{av}$								
0,17	Refrigerators	377,9	134,8	22,92	635	664	702	725
0,17	Refrigerator-freezers	585,5	250,6	42,60	994	1.045	1.114	1.154
0,17	Upright freezers	426,8	203,4	34,58	774	816	872	905
0,17	Chest freezers	431,0	212,8	36,18	790	834	893	927
BAT_{av}								
0,17	Refrigerators	634,6	89,1	15,15	831	852	878	894
0,17	Refrigerator-freezers	852,4	191,6	32,57	1.184	1.224	1.277	1.308
0,17	Upright freezers	644,8	164,9	28,03	941	976	1022	1049
0,17	Chest freezers	649,1	152,8	25,98	930	962	1005	1031
Average standard base case								
0,10	Refrigerators	345	163,7	16,37	551	573	601	618
0,10	Refrigerator-freezers	485	324,4	32,44	815	855	908	939
0,10	Upright freezers	328	274,5	27,45	620	654	699	726
0,10	Chest freezers	328	300,6	30,06	640	677	726	756
$LLCC_{av}$								
0,10	Refrigerators	377,9	134,8	13,48	562	580	604	618
0,10	Refrigerator-freezers	585,5	250,6	25,06	859	890	932	957
0,10	Upright freezers	426,8	203,4	20,34	664	690	724	745
0,10	Chest freezers	431,0	212,8	21,28	675	702	738	760
BAT_{av}								
0,10	Refrigerators	634,6	89,1	8,91	783	796	814	824
0,10	Refrigerator-freezers	852,4	191,6	19,16	1.080	1.105	1.138	1.157
0,10	Upright freezers	644,8	164,9	16,49	852	874	902	919
0,10	Chest freezers	649,1	152,8	15,28	847	867	894	910

Electricity price (€/kWh)	Average standard Base Case (description)	Consumer price (€)	Energy consumption (kWh/year)	Annual energy costs (€/year)	LCC at 10 years (€)	LCC at 12 years (€)	LCC at 15 years (€)	LCC at 17 years (€)
Average standard base case								
0,25	Refrigerators	345	163,7	40,93	741	791	856	895
0,25	Refrigerator-freezers	485	324,4	81,10	1.191	1.287	1.413	1.488
0,25	Upright freezers	328	274,5	68,63	938	1.019	1.127	1.190
0,25	Chest freezers	328	300,6	75,15	988	1.077	1.194	1.264
$LLCC_{av}$								
0,25	Refrigerators	377,9	134,8	33,70	718	759	814	846
0,25	Refrigerator-freezers	585,5	250,6	62,65	1.149	1.223	1.322	1.380
0,25	Upright freezers	426,8	203,4	50,85	899	960	1.041	1.089
0,25	Chest freezers	431,0	212,8	53,20	922	985	1.070	1.119
BAT_{av}								
0,25	Refrigerators	634,6	89,1	22,28	887	915	952	974
0,25	Refrigerator-freezers	852,4	191,6	47,90	1.302	1.360	1.436	1.481
0,25	Upright freezers	644,8	164,9	41,23	1.043	1.093	1.159	1.198
0,25	Chest freezers	649,1	152,8	15,28	1.024	1.070	1.132	1.168

ANNEX 3: SCENARIO CALCULATION METHODOLOGY AND KEY INPUTS

This Annex reports on the methodology of the scenario calculation methodology and key inputs in as far as they have not already been mentioned in the main report.

The **calculation method** for the scenario analysis is a so-called **Stock Model,** which means that it is derived from cumulative annual sales and waste figures for water heaters over the period 1990-2020 (with a start-up period 1960-1990).

The stock-model sets the pace for the scenarios. The direction is determined by trends in terms of increase/decrease in:

– number of households,

– comfort (consumer behaviour, e.g. longer showering),

– ownership (number of water heaters per households) and

– energy efficiency.

The first three are a given and derived from statistics and trends as described in the preparatory study. The main variable in the various scenarios is energy and its derived parameters.

There is a significant **margin of uncertainty** in the sales and stock data, mainly caused by the fact that there are several datasets that would lead to different stock totals and the fact that a significant part of sales ends up not only in primary dwellings/ households, but also in non-domestic applications (hotels, bars, restaurants, medicine storage, etc.) and in secondary dwellings (second homes, holiday homes, etc.).

The first data set contains the measured retail sales data accumulated over product life (14 years for refrigerators, 17 years for freezers). For the retail sales, the preparatory study uses the input of GfK as a source, which is probably the most reliable source available.

The second data set is the ownership rate, which is measured in many Member States (especially in the EU-15) and—multiplied by the number of households—gives a number of cold appliances in stock. In each Member States these figures are deemed as a highly reliable source for policy making.

Finally, there is the industry, which reports its sales (and production data). Reliability may be more limited than with the previous sources, but especially when the data are accompanied by notary supervision they may also be deemed reliable. The production figures plus extra EU exports minus extra EU imports should yield the ‘apparent consumption’, which—apart from stock effects—should not be far off from EU sales. Apart from the sometimes limited reliability of production data, this approach also suffers from the incomplete and unreliable PRODCOM data in this sector.

In principle all three data sets should be consistent, i.e. lead to the same sales and stock total. However, as highlighted above, domestic cold appliances are sold also in non-domestic applications and in secondary dwellings. Both are not captured in the calculated stock data from the ownership rate. Furthermore, they are only partially captured in the GfK data, as a part of the non-domestic sales will not follow the traditional retail route and for secondary homes there is the problem of an unknown share of second hand market.

The preparatory study has tried to force-fit the GfK data with the stock model data, which gives an order of magnitude of energy use and savings. In the underlying study a dual approach was followed, i.e.:

- Calculate the EU-25 stock model[62] for primary dwellings/ households with known penetration rates and estimated sales figures very close to GfK data.

- Apply a multiplier of 3% -coherent with relative electricity consumption data of the latest two Member States versus EU25[63]- to arrive at the figures for EU-27.

- Apply a second multiplier, estimated at 15% (see Annex II), for sales to secondary dwellings and non-domestic applications to arrive at total sales.

As they are both relevant for policy makers, the impact of cold appliances is presented separately for the EU-27 primary dwellings and the EU-27 total including the secondary dwellings and non-domestic applications.

Another uncertainty is in the specific ('unitary') energy consumption, where the real-life energy consumption may not be equal to the energy consumption according to the test standard EN 153. This phenomenon is explained in the following annex. Unfortunately, there is no more robust alternative and therefore the underlying study will use the EN 153 data.

BaU Scenario and Base Case 2005

The EU-27 BaseCase represents the average product sold in the reference year 2005. This paragraph summarises the main findings of the background preparatory study.

The 2005 refrigerator unit sales amount to almost 14 million refrigerator units/a, split 16/84 between refrigerators (Cat. 1-6) and fridge-freezers (Cat 7&10). In 2005 around 3.6 million freezers/a were sold to primary dwellings, split evenly between upright freezers (Cat. 8) and chest freezers (Cat. 9). These are appliances sold to households/ primary dwellings[64]. Including sales for secondary dwellings and non-domestic applications the 2005 refrigerator sales are estimated at close to 16 million units and the freezer sales to around 4.1 million. In total this amounts to 20.1 million cold appliances sold, as is shown in the table below.

[62] The reparatory study uses EU-25 data.

[63] Source: Eurelectric 2008 (production data 2005/2006 for EU-25 and EU-27).

[64] excluding e.g. mini drinks chillers (Peltier effect type), non-compressor mini refrigerators (absorption type), mini-refrigerator/chillers (sometimes with ice compartment), wine cellars.

Table 22. BaseCase 2005 and BaU scenario

		1990	1995	2000	2005	2010	2015	2020	2025
Primary dwellings/ households	**mln.**	**176**	**186**	**194**	**197**	**201**	**205**	**209**	**213**
sales primary dwellings	**mln.**	**16,0**	**16,5**	**17,0**	**17,5**	**18,0**	**18,5**	**19,1**	**19,4**
of which refrigerators		12,4	12,9	13,4	13,9	14,4	14,9	15,5	15,7
of which freezers		3,6	3,6	3,6	3,6	3,6	3,6	3,6	3,7
stock primary dwellings	**mln.**	**217**	**239**	**256**	**268**	**276**	**284**	**293**	**300**
of which refrigerators %	%	98%	101%	102%	102%	102%	103%	103%	103%
of which freezers %	%	26%	27%	31%	34%	36%	38%	38%	38%
of which refrigerators units	'000	171	188	196	202	204	207	213	219
of which freezers units	'000	45	51	60	66	72	77	79	81
Total, including secondary dwellings & non-domestic									
sales total	**mln.**	**18,4**	**19,0**	**19,5**	**20,1**	**20,7**	**21,3**	**21,9**	**22,3**
stock total	**mln.**	**249**	**275**	**295**	**308**	**317**	**327**	**336**	**345**
Energy consumption (historical data and projections prep. study)									
sales energy BAU	kWh/a	496	426	360	289	250	234	218	202
Total stock electricity consumption (result stock model+15%)									
Per unit									
stock avg. unit electr. BAU	kWh/a	608	520	464	396	332	277	246	225
Total stock									
stock total electricity BAU	TWh/a	**151**	**143**	**137**	**122**	**105**	**91**	**83**	**78**

Of these 2005 sales, over 2 million refrigerators and 0.3 million freezers can be attributed to the EU10 (PL, CZ, HU, SK, SI, MT, CY, EE, LV, LT). Data for the latest EU-members (RO, BG) are not available but are expected to follow the same pattern as is shown in the tables below. Please note that penetration of freezers is low.

Table 23: Refrigerators EU 10: sales, stock and energy data 1995, 2000, 2005

	sales	owner-ship rate	stock	stock energy	stock unitary energy	sales unitary energy
	000 units/yr	%	000 units	GWh/a	kWh/a	kWh/year
1995	869	93.00%	25 111	13 804	550	425
2000	1 712	95.00%	26 763	12 832	479	363
2005	1 833	97.00%	28 220	11 580	410	292

Table 24: Freezers EU 10: sales, stock and energy data 1995, 2000, 2005

	sales	owner-ship rate	stock	stock energy	stock unitary energy	sales unitary energy
	000 units/yr	%	000 units	GWh/a	kWh/a	kWh/year
1995	190	7.80%	2 123	1 297	611	427
2000	216	9.60%	2 697	1 369	508	351
2005	230	10.10%	3 198	1 332	417	279

Most cold appliances are of the compressor-type but also there are some 250-300 000 thermo-electric absorption refrigerators, usually sold to the tertiary sector (hotels), because they are quiet. And some are sold in the leisure sector (e.g. holiday homes), because many can run also on other energy sources than electricity (gas, oil).

The average 2005 capacity (gross volume) of the refrigerators was around 275 litres, with 294 litres for the fridge-freezer and 230 litres for the refrigerators. On average this is 10% more than a decade ago (1995: 235 litres vs 2005: 275 litres) The fridge freezer has an average volume of 277, split between a four-star 67-litre freezer compartment and a 209-litre fresh food compartment. With the freezers there is a considerable difference between the upright (202 litres) and chest freezer (260 litres), resulting in an average of 230 litres/unit.

The average 2005 energy consumption of the fridge freezer is 324 kWh/yr (EEI 54.4; energy class A), whereas the refrigerator uses 167 kWh/yr (EEI 54.3; energy class also A). On average a value of 292 kWh/yr is calculated.

The energy consumption of the BaseCase upright freezer is 274 kWh/yr (EEI 56.3; energy class A/B), with the BaseCase chest freezer using 301 kWh/yr (EEI 64.4; energy class B). Statistically the 2005 average is 308 kWh/yr.

The picture below gives a split up of refrigerator and freezer sales by Energy Labelling Class, based on the GfK data, CECED technical database and the Notary report accompanying the CECED unilateral (voluntary) agreement. These data were used to calculate the sales unitary energy shown in the previous EU-27 energy data.

Table 25: Energy efficiency class trend in the BaU Scenario for refrigerators (percentage of models in each class are shown). Source: ISIS/ENEA 2008

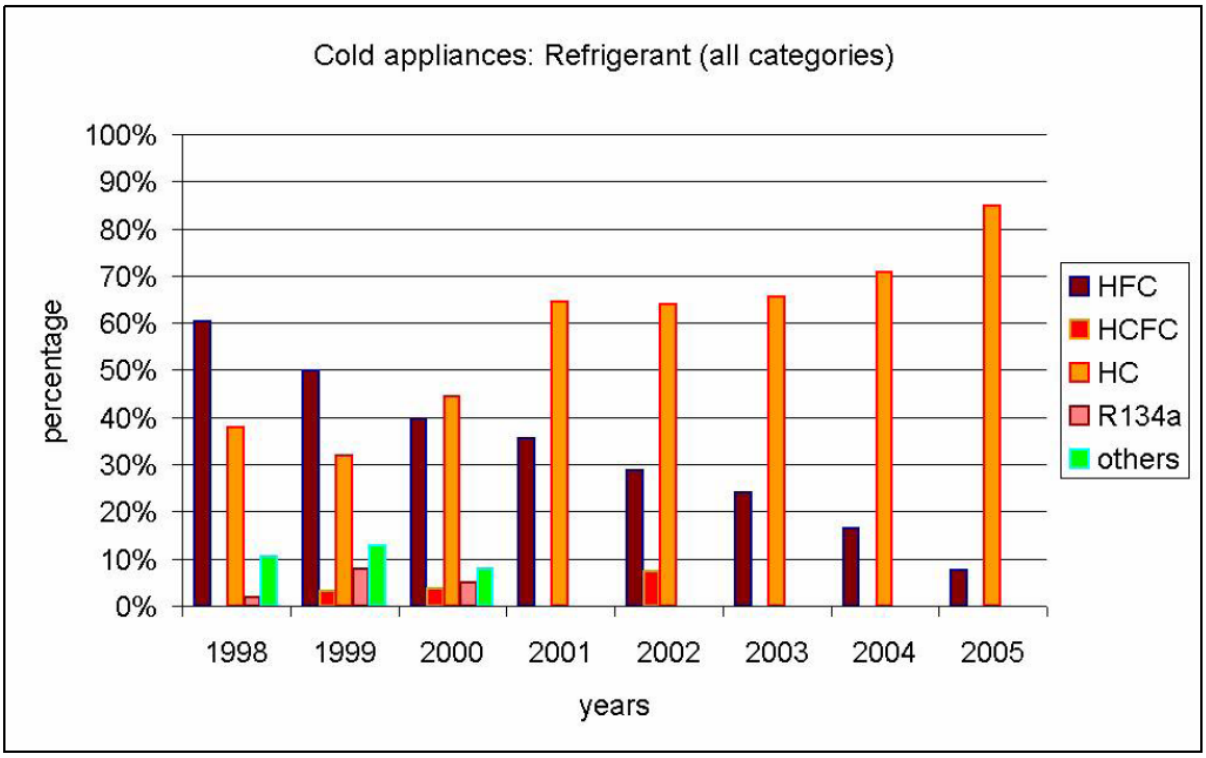
Year	A++ (%)	A+ (%)	A (%)	B (%)	C (%)	Tot. %	**sales unitary energy kWh/yr**
2005	1	18	61	19	1	100	302
2009	4	26	70	0	0	100	271
2014	12	43	45	0	0	100	251
2019	16	64	20	0	0	100	234
2025	20	80	0	0	0	100	219
2030	25	75	0	0	0	100	216
EEI	30	42	55	75	90	--	
Energy consumption (kWh/y)	166	232.4	291.6	397.7	477.2	--	

Table 26: Energy efficiency class trend in the BaU Scenario for freezers (percentage of models in each class are shown). Source: ISIS/ENEA 2008

Year	A++ (%)	A+ (%)	A (%)	B (%)	C (%)	Tot. %	**sales unitary energy kWh/yr**
2005	5	25	33	25	12	100	285
2009	10	35	40	15	0	100	250
2014	15	52	28	5	0	100	233
2019	20	63	17	0	0	100	222
2025	25	75	0	0	0	100	216
2030	30	70	0	0	0	100	213
EEI	30	42	55	75	90	--	
Energy consumption (kWh/y)	166.1	232.5	251.5	342.9	411.5	--	

The above data are based on a Life Cycle Analysis for the four BaseCase types, which all show similar eco-profiles, according to the EuP-Ecoreport[65]. The background preparatory study has also made a comparison between results from the EuP-Ecoreport and the EcoIndicator95 method in SimaPro v. 7.1 in accordance with IS 14040. Results were found to be fully in line for energy, greenhouse gases, acidification and ozone depletion. They are not in line for emissions of PAHs (polycyclic aromatic hydrocarbons) from waste incineration, a subject where sources are scarce and tend to differ in conversion factor[66]. For all other environmental impacts the results from the two tools were partially in line[67].

A special environmental concern has traditionally been the use of the refrigerant, where in the past there has been a significant contribution to Ozone Depletion and Climate Change (CO_2 emissions) from HFCs and HCFCs . Here the industry has made significant progress with the largest part of the compressors now working on hydrocarbons (HC), which is assumed to be applied in all four BaseCase products. See picture below.



The noise level for the BaseCase is 38 dBA for the refrigerator (Cat. 1-6), 40 dBA for the refrigerator freezer (Cat. 7-10) and upright freezer (Cat. 8) and 42 dBA for the chest freezer (Cat. 9).

65 Kemna, R. et al., MEEUP Methodology Report, Van Holsteijn en Kemna for European Commission, Delft, 28.11.2005.

66 EuP-EcoReport uses conversion factors from the limits value for Benzo(a)pyrene in EC Air Quality directive 2004/107/EC to recalculate to Nickel (Ni) equivalent in the same Directive. EcoIndicator95 typically uses scientific data sources that might have a different (and evolving) opinion on the carcinogenous effects of the substance. EcoReport rated the emissions from waste incineration >factor 10 higher than the comparable EcoIndicator95. Furthermore, a difference was found in Energy at End-of-Life, where the adapted EcoIndicator 95 also rated the recycling credit significantly higher than the EuP-EcoReport results, but still very small compared to the energy in the Use Phase.

67 Defined as <factor 10 difference (i.e. within the same decimal).

BAU scenario: Trends 1990-2020

Using BaseCase 2005 as an anchor point, the projections 2005-2020 are based on trends in Population increase 2005-2020: 8%.

Market penetration 2020: increase up to 104% (from 102%) for refrigerators, up to 38% for freezers (from 26%, with freezer penetration increase mainly due to EC-12).

Behavioural factors, i.e. the increase in product volume leading to an increase of 10% in volume (no linear relationship with energy, so less than 10% increase in energy).

The data 1990-2005 are based on the market analysis and projections to 2020 are based on the ISIS/ENEA projections for BaU as shown in the previous subsection (see Table 6)[68].

At present, without any new policy measure, no further penetration of new technologies is expected in the BaU scenario. Indeed, due to the market transformation induced by the EU energy labelling scheme, consumers will continue to purchase class A appliances as average models on the market, and class A+ models as more efficient units, especially in Member States where economic incentives for efficiency have been put in place. Since manufacturers will very likely not decrease the price difference between class A++ and class A+ appliances, A++ models will still remain almost as a niche product for some time in the future. This leads to the following scenario assumptions:

<u>for refrigerators:</u>

– efficiency classes A, A+ and A++ will represent the totality of the market in 2009; in that year, class A will account for 70% of the market, class A+ 26% and class A++ the residual 4%;

– the market share of higher efficiency classes will gradually improve until 2030 when class A+ appliances will dominate the market with 75% of the share, followed by class A++ appliances with 25%;

<u>for freezers:</u>

– in 2005 there was still a significant presence of class B and C models (together representing more than 50% of the market) and a notable penetration of class A+ units (25%);

– in this situation, a gradual phase-out of class B is expected until 2020, and a parallel significant and steady penetration of classes A+ (70% in 2030) and A++ (30% in 2030).

Taking the values of the BaseCase 2005 as an anchor point and the above trends, the time-series as already shown in the tables are found.

Sub-options: General considerations

As mentioned, only various ambition levels for scenarios that use both minimum standards and energy labelling are considered. It is assumed that Member States will at the very least

[68] ISIS/ENEA, Preparatory study, Task 2 report, 2007.

continue their efforts in promoting the best appliances though information and financial incentives.

Sub-option EE44-15

Assumed market distribution by labelling class in this scenario is given below

Table 27: Energy efficiency class trend in the EE44-15 Scenario for refrigerators (percentage of models in each class are shown). Source: ISIS/ENEA 2008

New labelling classes	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**Tot.**	**sales**
Year	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	**kWh/yr**
2005	0	0	0	0	1	18	61	19	1	100	304
2009	0	0	0	0	5	40	55	0	0	100	267
2014	0	0	0	0	24	75	0	0	0	100	229
2019	0	1	5	14	80	0	0	0	0	100	184
2025	1	4	10	20	65	0	0	0	0	100	174
2030	4	6	20	30	40	0	0	0	0	100	158
EEI	<15	<18	<22	<28	<35	<44	<55	<75	<90	--	
Energy (kWh/y)	83	99.6	121.8	155	193.7	243.5	291.6	397.7	477.2	--	

Table 28: Energy efficiency class trend in the EE44-15 Scenario for freezers (percentage of models in each class are shown). Source: ISIS/ENEA 2008

New labelling classes	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**Tot.**	**sales**
Year	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	**kWh/yr**
2005	0	0	0	0	5	25	33	25	12	100	289
2009	0	0	0	0	25	50	25	0	0	100	233
2014	0	0	0	1	52	47	0	0	0	100	217
2019	0	0	5	15	80	0	0	0	0	100	184
2025	1	4	10	20	65	0	0	0	0	100	174
2030	5	10	20	25	40	0	0	0	0	100	155
EEI	<15	<18	<22	<28	<35	<44	<55	<75	<90	--	
Energy (kWh/y)	83	99.6	121.8	155	193.7	243.6	251.5	342.9	411.5	--	

Sub-option EE42-15

Assumed market distribution by labelling class in this scenario is given below

Table 29: Energy efficiency class trend in the EE44-15 Scenario for refrigerators (percentage of models in each class are shown). Source: ISIS/ENEA 2008

New labelling classes	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**Tot.**	**sales unitary energy**	**EU25 stock energy**
Year	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	**kWh/yr**	**GWh/yr**
2005	0	0	0	0	1	18	61	19	1	100	302	71 082
2009	0	0	0	0	5	40	55	0	0	100	262	65 609
2014	0	0	0	1	24	75	0	0	0	100	216	59 188
2019	0	1	5	14	80	0	0	0	0	100	159	52 592
2025	1	0.04	10	20	65	0	0	0	0	100	147	43 715
2030	4	6	20	30	40	0	0	0	0	100	137	36 401
EEI	<13	<16	<20	<25	<30	<42	<55	<75	<90	--		
Energy (kWh/y)	55.3	83	110.7	138.4	166	232.4	291.6	397.7	477.2	--		

Table 30: Energy efficiency class trend in the EE42-15 Scenario for freezers (percentage of models in each class are shown). Source: ISIS/ENEA 2008

New labelling classes	9	8	7	6	5	4	3	2	1	Tot.	sales unitary energy	EU25 stock energy
Year	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	**kWh/yr**	**GWh/yr**
2005	0	0	0	0	5	25	33	25	12	100	285	34 986
2009	0	0	0	0	25	50	25	0	0	100	221	30 901
2014	0	0	0	1	52	47	0	0	0	100	197	25 609
2019	0	0	5	15	80	0	0	0	0	100	159	21 892
2025	1	4	10	20	65	0	0	0	0	100	151	18 790
2030	5	10	20	25	40	0	0	0	0	100	134	16 456
EEI	<13	<16	<20	<25	<30	<42	<55	<75	<90	--		
Energy(kWh/y)	55.4	83	110.7	138.4	166.1	232.5	251.5	342.9	411.5	--		

The table below gives the economic variables that are used as inputs in the Stock Model.

ECONOMICS		
Baseprice	421	Consumer product price incl. VAT in year 2005 [€]
PriceInc Eur	1.32	Price increase per kWh/yr saving [€/ kWh]
Rel	0.17	Electricity rate 2007 [€/ kWh electric]
Rgas	0.047	Gas rate 2005 [€/ kWh primary GCV]
Roil	0.061	Oil rate 2005 [€/ kWh primary GCV]
Rmaint	5.5	Annual maintenance costs [€/ a]
Relinc	2%	Annual price increase electricity [%/ a]
Rgasinc	5.60%	Annual price increase gas [%/ a]
Roilinc	8.20%	Annual price increase oil [%/ a]
Rmaintinc	2%	Annual cost increase maintenance [%/ a]
PriceDec	1.00%	Annual product price decrease [%/ a]
InstallDec	2.00%	Annual installation cost decrease [%/ a]
ManuFrac	50.0%	Manufacturer Selling Price as fraction of Product Price [%]
WholeMargin	5%	Margin Wholesaler [% on msp]
RetailMargin	60%	Margin Retailer on product [% on wholesale price]
VAT	19%	Value Added Tax [in % on retail price]
ManuWages	0.16	Manufacturer turnover per employee [€m/a]
OEMfactor	1	OEM personnel as fraction of WH manufacturer personnel [-]
WholeWages	0.25	Manufacturer turnover per employee [€m/a]
RetailWages	0.06	Manufacturer turnover per employee [€m/a]
ExtraEUfrac	0.5	Fraction of OEM personnel outside EU [% of OEM jobs]
Inflation	2%	Inflation rate [%/ a]
ProductLife	16	Product Life [years]

ANNEX 4: RESULTS FOR THE DIFFERENT SUB-OPTIONS

Table B1. WH STOCK Environmental

	1990	1995	2000	2005	2010	2013	2015	2020	2025
net load (kWh/a)	**496**	**438**	**360**	**295**	**249**	233	**223**	**212**	**201**
sales (000)	**18360**	**18952**	**19544**	**20137**	**20729**	21084	**21321**	**21913**	**22269**
park (000)	**248982**	**275011**	**294674**	**307970**	**317446**	323132	**326922**	**336398**	**345163**
Efficiency									
BaU	**100%**	**100%**	**100%**	**100%**	**100%**	100%	**100%**	**100%**	**100%**
EE44-15	**100%**	**100%**	**100%**	**100%**	**100%**	100%	**100%**	**100%**	**100%**
EE44-13	**100%**	**100%**	**100%**	**100%**	**100%**	100%	**100%**	**100%**	**100%**
EE42-15	**100%**	**100%**	**100%**	**100%**	**100%**	100%	**100%**	**100%**	**100%**
EE42-13	**100%**	**100%**	**100%**	**100%**	**100%**	100%	**100%**	**100%**	**100%**
EE44/42-12/14	**100%**	**100%**	**100%**	**100%**	**100%**	100%	**100%**	**100%**	**100%**
kWh/a.unit									
BaU	**496**	**426**	**360**	**289**	**250**	240	**234**	**218**	**202**
EE44-15	**496**	**426**	**360**	**289**	**250**	247	**245**	**202**	**159**
EE44-13	**496**	**426**	**360**	**289**	**250**	245	**228**	**185**	**142**
EE42-15	**496**	**426**	**360**	**289**	**250**	241	**235**	**182**	**128**
EE42-13	**496**	**426**	**360**	**289**	**250**	232	**211**	**157**	**104**
EE44/42-12/14	**496**	**426**	**360**	**289**	**250**	239	**221**	**168**	**115**
TWh /a new sales (without corr.)									
BaU	**9**	**8**	**7**	**6**	**5**	5	**5**	**5**	**4**
EE44-15	**9**	**8**	**7**	**6**	**5**	5	**5**	**4**	**4**
EE44-13	**9**	**8**	**7**	**6**	**5**	5	**5**	**4**	**3**
EE42-15	**9**	**8**	**7**	**6**	**5**	5	**5**	**4**	**3**
EE42-13	**9**	**8**	**7**	**6**	**5**	5	**4**	**3**	**2**
EE44/42-12/14	**9**	**8**	**7**	**6**	**5**	5	**5**	**4**	**3**
Stock electricity in TWh/a									
BaU	**151**	**143**	**137**	**122**	**105**	96	**91**	**83**	**78**
EE44-15	**151**	**143**	**137**	**122**	**105**	96	**91**	**83**	**74**
EE44-13	**151**	**143**	**137**	**122**	**105**	96	**91**	**80**	**70**
EE42-15	**151**	**143**	**137**	**122**	**105**	96	**91**	**80**	**69**
EE42-13	**151**	**143**	**137**	**122**	**105**	96	**90**	**77**	**63**
EE44/42-12/14	**151**	**143**	**137**	**122**	**105**	96	**90**	**79**	**66**
Stock energy in PJ/a									
BaU	**1363**	**1288**	**1229**	**1098**	**947**	864	**816**	**744**	**700**
EE44-15	**1363**	**1288**	**1229**	**1098**	**947**	867	**823**	**745**	**670**
EE44-13	**1363**	**1288**	**1229**	**1098**	**947**	866	**817**	**723**	**631**
EE42-15	**1363**	**1288**	**1229**	**1098**	**947**	864	**817**	**724**	**622**
EE42-13	**1363**	**1288**	**1229**	**1098**	**947**	863	**807**	**690**	**565**
EE44/42-12/14	**1363**	**1288**	**1229**	**1098**	**947**	864	**813**	**707**	**591**
CO2 in Mt (1 PJ= 0,0577 Mt)									
BaU	**69**	**66**	**63**	**56**	**48**	44	**42**	**38**	**36**
EE44-15	**69**	**66**	**63**	**56**	**48**	44	**42**	**38**	**34**
EE44-13	**69**	**66**	**63**	**56**	**48**	44	**42**	**37**	**32**
EE42-15	**69**	**66**	**63**	**56**	**48**	44	**42**	**37**	**32**
EE42-13	**69**	**66**	**63**	**56**	**48**	44	**41**	**35**	**29**
EE44/42-12/14	**69**	**66**	**63**	**56**	**48**	44	**41**	**36**	**30**

Table B2. WH STOCK Consumer Economics (not corrected for inflation unless indicated otherwise)

	1990	1995	2000	2005	2010	2013	2015	2020	2025
El price	**0,126**	**0,139**	**0,154**	**0,170**	**0,188**	0,199	**0,207**	**0,229**	**0,253**
Maintenance	**4**	**4**	**5**	**6**	**6**	6	**7**	**7**	**8**
Share electricity									
BaU	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	100,0%	**100,0%**	**100,0%**	**100,0%**
EE44-15	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	100,0%	**100,0%**	**100,0%**	**100,0%**
EE44-13	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	100,0%	**100,0%**	**100,0%**	**100,0%**
EE42-15	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	100,0%	**100,0%**	**100,0%**	**100,0%**
EE42-13	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	100,0%	**100,0%**	**100,0%**	**100,0%**
EE44/42-12/14	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	100,0%	**100,0%**	**100,0%**	**100,0%**
Avg. Fuel price									
BaU	**0,13**	**0,14**	**0,15**	**0,17**	**0,19**	0,20	**0,21**	**0,23**	**0,25**
EE44-15	**0,13**	**0,14**	**0,15**	**0,17**	**0,19**	0,20	**0,21**	**0,23**	**0,25**
EE44-13	**0,13**	**0,14**	**0,15**	**0,17**	**0,19**	0,20	**0,21**	**0,23**	**0,25**
EE42-15	**0,13**	**0,14**	**0,15**	**0,17**	**0,19**	0,20	**0,21**	**0,23**	**0,25**
EE42-13	**0,13**	**0,14**	**0,15**	**0,17**	**0,19**	0,20	**0,21**	**0,23**	**0,25**
EE44/42-12/14	**0,13**	**0,14**	**0,15**	**0,170**	**0,19**	0,20	**0,21**	**0,23**	**0,25**
Avg. Purchase Product									
BaU	**694**	**601**	**515**	**421**	**472**	485	**494**	**515**	**536**
EE44-15	**694**	**601**	**515**	**421**	**472**	476	**479**	**536**	**592**
EE44-13	**694**	**601**	**515**	**421**	**472**	479	**502**	**558**	**615**
EE42-15	**694**	**601**	**515**	**421**	**472**	484	**492**	**563**	**633**
EE42-13	**694**	**601**	**515**	**421**	**472**	496	**524**	**595**	**665**
EE44/42-12/14	**694**	**601**	**515**	**421**	**472**	488	**510**	**581**	**651**
Avg. Energy costs Eur/a.unit									
BaU	**63**	**59**	**55**	**49**	**47**	48	**48**	**50**	**51**
EE44-15	**63**	**59**	**55**	**49**	**47**	49	**51**	**46**	**40**
EE44-13	**63**	**59**	**55**	**49**	**47**	49	**47**	**42**	**36**
EE42-15	**63**	**59**	**55**	**49**	**47**	48	**49**	**42**	**32**
EE42-13	**63**	**59**	**55**	**49**	**47**	46	**44**	**36**	**26**
EE44/42-12/14	**63**	**59**	**55**	**49**	**47**	48	**46**	**38**	**29**
Total purchase costs EU per annum (inflation corrected, in Euro 2005)									
BaU	**17,1**	**13,9**	**11,1**	**8,5**	**8,9**	8,7	**8,6**	**8,3**	**8,0**
EE44-15	**17,1**	**13,9**	**11,1**	**8,5**	**8,9**	8,5	**8,3**	**8,7**	**8,8**
EE44-13	**17,1**	**13,9**	**11,1**	**8,5**	**8,9**	8,6	**8,7**	**9,0**	**9,1**
EE42-15	**17,1**	**13,9**	**11,1**	**8,5**	**8,9**	8,7	**8,6**	**9,1**	**9,4**
EE42-13	**17,1**	**13,9**	**11,1**	**8,5**	**8,9**	8,9	**9,1**	**9,6**	**9,9**
EE44/42-12/14	**17,1**	**13,9**	**11,1**	**8,5**	**8,9**	8,7	**8,9**	**9,4**	**9,7**
Total running costs (energy+maint) (inflation corrected, in Euro 2005)									
BaU	**27,1**	**25,8**	**24,8**	**22,4**	**19,6**	18,0	**17,2**	**15,8**	**15,0**
EE44-15	**27,1**	**25,8**	**24,8**	**22,4**	**19,6**	18,1	**17,3**	**15,8**	**14,4**
EE44-13	**27,1**	**25,8**	**24,8**	**22,4**	**19,6**	18,1	**17,2**	**15,4**	**13,7**
EE42-15	**27,1**	**25,8**	**24,8**	**22,4**	**19,6**	18,0	**17,2**	**15,4**	**13,5**
EE42-13	**27,1**	**25,8**	**24,8**	**22,4**	**19,6**	18,0	**17,0**	**14,8**	**12,5**
EE44/42-12/14	**27,1**	**25,8**	**24,8**	**22,4**	**19,6**	18,0	**17,1**	**15,1**	**13,0**
Of which total electricity costs (inflation corrected, in Euro 2005)									
BaU	**25,7**	**24,3**	**23,2**	**20,7**	**17,9**	16,3	**15,4**	**14,0**	**13,1**
EE44-15	**25,7**	**24,3**	**23,2**	**20,7**	**17,9**	16,3	**15,5**	**14,0**	**12,6**
EE44-13	**25,7**	**24,3**	**23,2**	**20,7**	**17,9**	16,3	**15,4**	**13,6**	**11,8**
EE42-15	**25,7**	**24,3**	**23,2**	**20,7**	**17,9**	16,3	**15,4**	**13,6**	**11,7**
EE42-13	**25,7**	**24,3**	**23,2**	**20,7**	**17,9**	16,2	**15,2**	**13,0**	**10,6**
EE44/42-12/14	**25,7**	**24,3**	**23,2**	**20,7**	**17,9**	16,3	**15,3**	**13,3**	**11,1**
Consumer expenditure (inflation corrected, in Euro 2005)									
BaU	**44,3**	**39,7**	**35,9**	**30,9**	**28,5**	26,7	**25,8**	**24,1**	**23,0**
EE44-15	**44,3**	**39,7**	**35,9**	**30,9**	**28,5**	26,6	**25,6**	**24,5**	**23,2**
EE44-13	**44,3**	**39,7**	**35,9**	**30,9**	**28,5**	26,7	**25,9**	**24,4**	**22,8**
EE42-15	**44,3**	**39,7**	**35,9**	**30,9**	**28,5**	26,7	**25,7**	**24,5**	**23,0**
EE42-13	**44,3**	**39,7**	**35,9**	**30,9**	**28,5**	26,9	**26,1**	**24,4**	**22,4**
EE44/42-12/14	**44,3**	**39,7**	**35,9**	**30,9**	**28,5**	26,8	**26,0**	**24,5**	**22,6**

Table B3. WH STOCK Business Economics (inflation corrected, in Euro 2005)

	1990	1995	2000	2005	2010	2013	2015	2020	2025
Avg. Product Price [Euro 2005]									
BaU	172	266	344	421	449	448	447	443	439
EE44-15	172	266	344	421	449	440	433	461	484
EE44-13	172	266	344	421	449	442	454	480	503
EE42-15	172	266	344	421	449	447	445	484	518
EE42-13	172	266	344	421	449	458	474	511	544
EE44/42-12/14	172	266	344	421	449	450	462	499	532
Avg. Energy/unit new sales [Euro 2005]									
BaU	84	72	61	49	42	41	40	37	34
EE44-15	84	72	61	49	42	42	41	34	27
EE44-13	84	72	61	49	42	42	39	31	24
EE42-15	84	72	61	49	42	41	40	31	22
EE42-13	84	72	61	49	42	39	36	27	18
EE44/42-12/14	84	72	61	49	42	40	37	28	19
INDUSTRY Turnover [€ bln 2005]									
BaU				4,2	4,7	4,7	4,8	4,9	4,9
EE44-15				4,2	4,7	4,6	4,6	5,0	5,4
EE44-13				4,2	4,7	4,7	4,8	5,3	5,6
EE42-15				4,2	4,7	4,7	4,7	5,3	5,8
EE42-13				4,2	4,7	4,8	5,1	5,6	6,1
EE44/42-12/14				4,2	4,7	4,7	4,9	5,5	5,9
WHOLESALER Turnover [€ bln 2005]									
BaU				0,2	0,2	0,2	0,2	0,2	0,2
EE44-15				0,2	0,2	0,2	0,2	0,3	0,3
EE44-13				0,2	0,2	0,2	0,2	0,3	0,3
EE42-15				0,2	0,2	0,2	0,2	0,3	0,3
EE42-13				0,2	0,2	0,2	0,3	0,3	0,3
EE44/42-12/14				0,2	0,2	0,2	0,2	0,3	0,3
INSTALLER Turnover [€ bln 2005]									
BaU				4,1	4,4	4,5	4,5	4,6	4,7
EE44-15				4,1	4,4	4,4	4,4	4,7	5,0
EE44-13				4,1	4,4	4,4	4,6	4,9	5,1
EE42-15				4,1	4,4	4,5	4,5	4,9	5,2
EE42-13				4,1	4,4	4,5	4,7	5,1	5,4
EE44/42-12/14				4,1	4,4	4,5	4,6	5,0	5,3
VAT on product (excl. Energy) Turnover [€ bln 2005]									
BaU				1,6	1,8	1,8	1,8	1,8	1,9
EE44-15				1,6	1,8	1,8	1,8	1,9	2,0
EE44-13				1,6	1,8	1,8	1,8	2,0	2,1
EE42-15				1,6	1,8	1,8	1,8	2,0	2,1
EE42-13				1,6	1,8	1,8	1,9	2,1	2,2
EE44/42-12/14				1,6	1,8	1,8	1,9	2,0	2,2
ENERGY SECTOR Turnover [€ bln 2005], incl. VAT and other taxes									
BaU				20,7	17,9	16,3	15,4	14,0	13,1
EE44-15				20,7	17,9	16,3	15,5	14,0	12,6
EE44-13				20,7	17,9	16,3	15,4	13,6	11,8
EE42-15				20,7	17,9	16,3	15,4	13,6	11,7
EE42-13				20,7	17,9	16,2	15,2	13,0	10,6
EE44/42-12/14				20,7	17,9	16,3	15,3	13,3	11,1
ALL SECTORS Turnover [€ bln 2005] (=consumer expenditure inflation corrected)									
BaU				30,9	28,9	27,5	26,7	25,5	24,8
EE44-15				30,9	28,9	27,4	26,5	25,9	25,2
EE44-13				30,9	28,9	27,4	26,8	25,9	24,9
EE42-15				30,9	28,9	27,5	26,7	26,0	25,1
EE42-13				30,9	28,9	27,7	27,1	26,0	24,6
EE44/42-12/14				30,9	28,9	27,5	26,9	26,1	24,8

Table B4. WH STOCK Social-Economics

	1990	1995	2000	2005	2010	2013	2015	2020	2025
INDUSTRY									
MANUFACTURER Personel [000]									
BaU				**26**	**29**	30	**30**	**30**	**31**
EE44-15				**26**	**29**	29	**29**	**32**	**34**
EE44-13				**26**	**29**	29	**30**	**33**	**35**
EE42-15				**26**	**29**	29	**30**	**33**	**36**
EE42-13				**26**	**29**	30	**32**	**35**	**38**
EE44/42-12/14				**26**	**29**	30	**31**	**34**	**37**
OEM Total Personell [000]									
BaU				**26**	**29**	30	**30**	**30**	**31**
EE44-15				**26**	**29**	29	**29**	**32**	**34**
EE44-13				**26**	**29**	29	**30**	**33**	**35**
EE42-15				**26**	**29**	29	**30**	**33**	**36**
EE42-13				**26**	**29**	30	**32**	**35**	**38**
EE44/42-12/14				**26**	**29**	30	**31**	**34**	**37**
of which OEM Personell in EU [000]									
BaU				**13**	**15**	15	**15**	**15**	**15**
EE44-15				**13**	**15**	14	**14**	**16**	**17**
EE44-13				**13**	**15**	15	**15**	**16**	**17**
EE42-15				**13**	**15**	15	**15**	**17**	**18**
EE42-13				**13**	**15**	15	**16**	**18**	**19**
EE44/42-12/14				**13**	**15**	15	**15**	**17**	**19**
WHOLESALER									
Personell Wholesaler [000]									
BaU				**1**	**1**	1	**1**	**1**	**1**
EE44-15				**1**	**1**	1	**1**	**1**	**1**
EE44-13				**1**	**1**	1	**1**	**1**	**1**
EE42-15				**1**	**1**	1	**1**	**1**	**1**
EE42-13				**1**	**1**	1	**1**	**1**	**1**
EE44/42-12/14				**1**	**1**	1	**1**	**1**	**1**
INSTALLER									
Personell [000]									
BaU				**68**	**73**	74	**75**	**77**	**78**
EE44-15				**68**	**73**	74	**74**	**79**	**83**
EE44-13				**68**	**73**	74	**76**	**81**	**85**
EE42-15				**68**	**73**	74	**75**	**82**	**87**
EE42-13				**68**	**73**	76	**78**	**85**	**90**
EE44/42-12/14				**68**	**73**	75	**77**	**83**	**89**
ALL SECTORS									
Personell x 1000									
BaU				**122**	**132**	134	**136**	**139**	**140**
EE44-15				**122**	**132**	132	**132**	**143**	**152**
EE44-13				**122**	**132**	133	**137**	**148**	**156**
EE42-15				**122**	**132**	134	**135**	**149**	**160**
EE42-13				**122**	**132**	137	**142**	**156**	**167**
EE44/42-12/14				**122**	**132**	135	**139**	**153**	**164**

ANNEX 5: SALES AND STOCK DATA: MARGIN OF UNCERTAINTY

The **margin of uncertainty** in the sales and stock data is significant, not so much because of the uncertainty of the specific ('unitary') energy consumption, but because of the uncertainty in sales and stock data. A number of considerations play a role:

- Sales data are commercially sensitive and usually confidential. Unless they are retrieved anonymously and checked by an independent source (notary report, e.g. CECED data or data from some national trade organisations) their reliability is limited and—if anything—sales and production figures tend to be too high. This would for instance typically be the case with EU refrigerator production (18 million units a year). Nonetheless, for production data it is often the only source available and therefore the figures are given 'as they are' in order to give at least a maximum boundary. Sales data are more reliable (see fig. below).

- Trade figures from Eurostat (PRODCOM system), which in turn rely on data provided by national statistics offices, very often—as is the case with cold appliances—lack accuracy mostly due to unclear definition of the product categories. In the case of domestic refrigerators and freezers there are a considerable (unknown) number of 'fun', mobile, house-bar, wine storage etc. devices possibly contaminating the trade volume. On the other hand, there is a whole category of two-door refrigerators where all data is lacking. Still, the PRODCOM data are 'official figures' and it is important for policy makers to know what the basis was for more aggregated policies. Production figures from Eurostat for these products with only a few manufacturers are, where available, wholly unreliable because of their confidential character and not included here.

- Sales figures retrieved from specialist marketing organisations such as GfK are deemed the most reliable source as they are based on shop-floor measurements throughout most EU Member States. Their EU-25 sales data cover 99% of the total, leaving out only the smaller new Member States (CY, MT, EE, LT, LV). However, not every domestic refrigerator or freezer is sold through the retail chain and most certainly not all applications of the products are 'domestic'. For instance, domestic-type refrigerators can be found in hotels, bars, restaurants, canteens, and holiday facilities; homes for the elderly, children, and the disabled; schools, hospitals, pharmacies, doctors', dentists' and veterinarians' surgeries (medicine storage), and even most offices without a canteen have a household fridge somewhere to store the coffee milk and the occasional snack. As mentioned, many of these will be sold through the normal white-goods retail chain, but some will also be sold through specialist suppliers for the service sector. The exact number is difficult to estimate, especially as product life in those non-domestic sectors may be much shorter than average, but as a ballpark figure it may amount to 5-10% of sales. In other words, the 2004 GfK unit sales in the EU-25 amount to 14.2 million units, but—including the missing countries and some sales not through retail—may be rounded up to around 14.5 million refrigerators a year. But the actual EU-25 sales to households, i.e. contributing to energy consumption in the residential sector, may not be more than 13.5 million refrigerators a year.

- In 2001, in an attempt to firm up the consumption of domestic refrigerators and freezers CECED employed a stock model bringing into balance the penetration rates (refrigerators/household) (which are usually well known from panel-research in the largest Member States), the number of households from official sources (e.g. Eurostat), product life and unit sales. Especially in saturated, uneventful markets such as that for large domestic appliances, this should create a consistent and reliable picture. Hence, CECED

2001 projects sales of 11.63 million refrigerators in the EU-15 for 2005. Adding around 2 million units for the EU-10, this would put sales at around 13,5 million refrigerators a year for the EU-25 and a stock of around 190 million refrigerators installed. However, it should be noted that the figures cover ‘only’ sales to domestic households, i.e. the installed stock, in their permanent habitat. It does not include non-domestic applications (see above) and it also does not include refrigerators and freezers in non-permanent houses, secondary homes, etc. Hence, in 2005 for example, the EU-25 had around 185 million households, but VHK estimates that there are over 220 million dwellings (apartments and houses). And the latter, especially in the EU-15, also use refrigerators (incl. fridge-freezers) and would raise the installed stock by some 20%. Given the limited usage and the high share of second hand sales, the net effect on the stock model may amount to 5-10%.

- Furthermore, the penetration rates and product life estimates in the stock models can only be as good as their original sources. In that sense, households tend to forget the old beer-fridge in the garage, thus underestimating both penetration rate and average product life.

- Freezer sales data pose a special challenge. For decades (since 1990) freezer sales have remained more or less constant in absolute numbers. This means, i.e. taking into account population increase, that in fact the penetration rate of separate freezers is probably decreasing in favour of the sales of fridge-freezers. Commercially, this is not a welcome message for some of the stakeholders and data sources in this respect tend to be fuzzy at least, but usually over-optimistic. As this decreasing penetration rate is actually not based on ‘hard data’ it is rather difficult to bring that message from simple stock model calculations. As a consequence the stock data for freezers tend to be muddy and—overall—too high. This is true for most commercial sources, but also the CECED stock model tends to overestimate the freezer sales. In that sense, the preparatory study by ISIS/ENEA—which in general follows CECED line but with corrections from the latest GfK data—has corrected these data downward.

Figure 7: EU-25 refrigerator unit sales 2005 by source and sector[69]

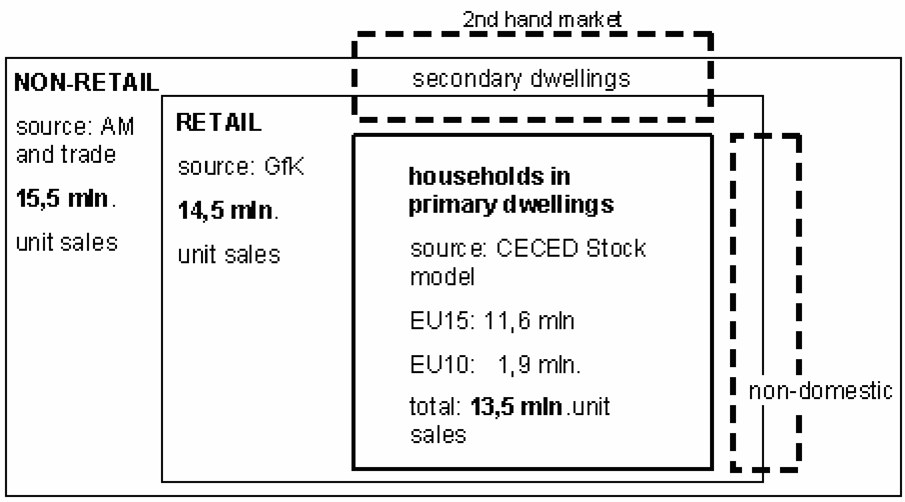
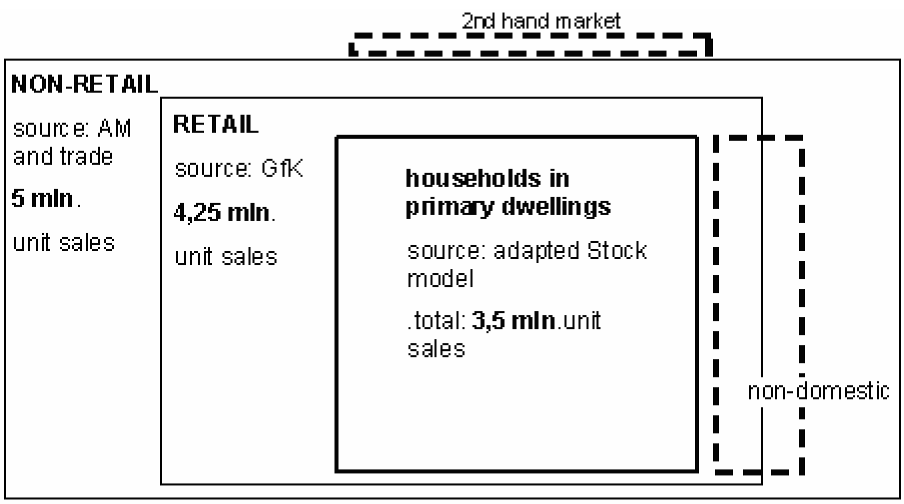


Figure 8: EU-25 freezer unit sales 2005 by source and sector[70]



Finally it should be stated that although—as mentioned—the specific energy data are more reliable, there may be some deviations between what is known as the real-life energy consumption and the Standard (EN 153) test data employed throughout this report (and most background reports).

- The EN 153 standard is different from real-life in that the appliance is tested at 25°C ambient, whereas in practice the ambient temperature can be as low as 10°C in a garage in winter, 16-18°C in a utility room or 20°C in a kitchen. The occasional 30°C in a southern-European kitchen in summer is an exception. Given that, as a rule of thumb, one degree

69 Note that original GfK 2004 data (14.2 mln. units/a) was updated to include MT, CY, EE, LT, LV. CECED stock data was updated from 2001 to 2005 and from EU-15 to EU-25 (see also MEEUP Product Cases report, VHK 2005).

70 Note that original GfK 2004 data (14.2 mln. units/a) was updated to include MT, CY, EE, LT, LV. CECED stock data was updated from 2001 to 2005 and from EU15 to EU25 (see also MEEUP Product Cases report, VHK 2005). Note that freezer penetration rates from CECED stock model were brought in line with GfK data.

Celsius difference in ambient temperature can cause up to 4% difference in the energy consumption of a cold appliance, this is a very significant parameter. If we assume a real-life ambient temperature of 20°C, the EN 153 test standard would indicate an energy consumption that is 15 to 20% too high (c.p.).

- The higher EN 153 ambient temperature is intended to compensate for door opening and the insertion of warm (20°C) loads. Various consumer surveys have shown that the influence of door opening is marginal, due to the low heat capacity of the air. At 20 times per day (approx. the EU average) for a 200-litre fridge, over 300 days, door opening accounts for 1200 m3 of air/year that has to be cooled from 20 to 5°C. At around 1 kJ/K/m3 this is no more than 18 MJ (18 000 kJ) or—even with a low-efficiency compressor—a few kWh of electricity consumption per year. This results in an influence on the total electricity consumption of 1-2%. The higher percentage would apply to typically more humid and warmer (indoor) climates.

- The periodic insertion of a 'warm' load is a more important influence. At e.g. 1 000 kg load per year (approx. 20 kg/week) and a heat capacity of 4.2 kJ/K/kg (=heat capacity of water), the influence is around 4 to 5 times higher, so around 4-10%.

- Linked to door opening and the insertion of food is the icing-up of the evaporator. Although more and more cold appliances are equipped with automatic de-icing control, 'manual' de-icing—especially with older (leaking) cabinets—may be necessary to stay close to the EN 153 energy consumption. Completely iced-up evaporators may reduce efficiency by as much as 10-20%. No data on actual ice coverage could be found.

- The fourth parameter in the direct interaction of the consumer with the refrigerator is the thermostat setting. There have been some consumer surveys on this matter, some indicating an average temperature of 4°C and others an average of 7°C (compare EN 153 design temperature 5°C). Overall, the outcomes are not conclusive or can be deemed representative for the EU-25. Also no data could be found on the actual use of the 'eco' temperature switch for freezers in practice. However, given that 1°C difference in temperature causes a 4% difference in energy consumption, this could be important but is outside the scope of the underlying study.

- The above are not the only consumer parameters that are of influence. Maintenance and local infrastructure, e.g. position in the kitchen, can also severely worsen energy performance. But on the whole, a preliminary conclusion is that the EN 153 energy use, with its exaggerated ambient temperature, is not a bad representation of real-life use.

Despite of the above, there are not enough conclusive and robust data on real-life conditions that would warrant creating a Real-Life BaseCase that is different from the Standard BaseCase and therefore throughout this report we have no choice but to use the EN 153 data.