Revision European Eco-label
criteria for refrigerators

Draft Final Report
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III. Draft Criteria for 1999 Refrigerator Eco-label
Chapter 1

Introduction

1.1. Objective
Revision and update of the European Eco-label criteria for refrigerators (Commission Decision 96/703/EC 1.)

1.2. Activities
The following list follows the format as specified in the Technical Annex for the Revision of EU Eco-label assignment. Activity numbers correspond with activity numbers used in the financial paragraph of this proposal.

a. Updating and extending market and life cycle information where appropriate.
   Means: Desk research, expert interviews

b. Developing a finalised criteria proposal, covering the relevant environmental aspects related to the product group, that, having taken into consideration the view of the Competent Bodies and interest groups, can be presented to the Eco-label Regulatory Committee. Specific attention shall be given to noise emissions and Design for Environment.
   Means:
   b.1. Drawing up a draft proposal, in consultation (phone, mail, individual meetings) with representatives of interest groups, Competent Bodies or the Consultation Forum, based on updated information as retrieved under points a. and c..
   b.2. Setting up an Ad Hoc Working Group with abovementioned parties
   b.3. Organising two meetings with the Ad Hoc Working Group, last meeting in Brussels.
   b.4. Drawing up the final proposal.

c. Preparing a list of relevant test methods for verification of the different criteria;
   Means: Desk research, expert interviews with standardisation bodies and representatives of technical committees.

d. Justifying the proposed criteria (including the chosen hurdle levels) giving the necessary argumentation and background data.
   Means: Writing a technical report, incorporating the results from abovementioned activities a. to c.

e. Preparing a user manual for applicants and Competent Bodies
   Means: Writing the user manual, to be added to the report from d. as a technical annex.

f. Establishing a specific work programme and corresponding time-table.
   Means: For procedural and planning purposes at least 2 meetings with DG XI are planned. Work-programme and corresponding time-table will be established immediately after the assignment.

Relevant EU policies (e.g. the Energy Label scheme) and work done on other related product groups shall be taken into account. Specifically, Van Holsteijn en Kemna is taking part in the SAVE II Cold Appliances study group which is preparing the new classification scheme for the Cold Appliances EU Energy Label. Work of this group has started recently and will be concluded May 2000. In this context, Van Holsteijn en Kemna is in contact with the Cold Appliances Working Group of the European


Article 3 (“The product group definition and the specific ecological criteria for the product group shall be valid for a period of three years from the date on which this Decision takes effect.”) implies that the present criteria are valid until 26.11.1999.
manufacturer’s association CECED and various consumer associations. (see also paragraph ‘Planning’).

1.3. Results

1. Draft report and presentation material (Powerpoint) for the first AHWG meeting

2. Final report, containing

- proposal for criteria following the 96/703/EC format
- justification of criteria and background information
- Annex I, listing relevant test procedures
- Annex II, user manual for applicants and Competent Bodies
- Annex III, methodology employed by Van Holsteijn en Kemna in the underlying work, sources of information used, summary of AHWG meeting minutes, involvement of interest groups, etc..

The final report, in the English language, shall be issued to EC DG XI in print (5 copies) and electronically (MS Office Word, Office’97).

1.4. Planning and coordination with parallel activities

The revision of eco-label criteria takes place mostly in parallel to the work of a Cold Appliances study group financed by the EU SAVE II program (EC DG XVII), which is revising the classification scheme and boundaries of the EU Energy Label for Cold Appliances for the period after the year 2000. The final report of this technical group, with experts from energy agencies (Ademe, Novem, ENEA), research institutes (Ecole des Mines, PWC, TNO, Van Holsteijn en Kemna) and industry (CECED), is expected approximately in May 2000. Consensus will be reached a few months beforehand, i.e. at the end of the 1st quarter of 2000. After the publication of the technical study group report a political discussion will take place. The present estimate is, that a revised energy label scheme will not be in place before 2002.

As energy consumption is one of the most important subjects in the eco-label revision, and as the EU Energy Label classes will most likely be used as a yardstick, this poses a planning problem.

The final report of the eco-label revision is due in September 1999, in order for the new eco-label criteria to be in place 26.11.1999. The numbers refer to the ones used in the paragraph ‘Activities’.
1.5. Interim Report

This draft final report is the result of the work of Van Holsteijn en Kemna and inputs provided by the AHWG (Ad Hoc Working Group) and CB (Competent Bodies) meetings, updating information relevant to the Ecolabel scheme. The various chapters look at changes over the 1996-1999 in the market, technology, energy efficiency, environmental aspects, life cycle costs, EU policy and various ecolabel criteria in existence in Europe at present. Data in these chapters was gathered through desk research and expert interviews with representatives of research institutes and industry.

On the basis of this information, the last chapter elaborates a proposal for revised Ecolabel criteria, to be discussed at the first AHWG meeting. Appendix III contains the draft proposal as it was prepared for the consultation forum.

The draft final report was preceded by an Interim report in May and a previous draft final report in June to be discussed in AHWG and CB-meetings.
Chapter 2

Market Update

2.1 Figures
The tables and graphs below show the general figures for production, consumption and market saturation of refrigerators and freezers in Western Europe, both in 1994 (basis for present Ecolabel) and 1997 (latest available year for analysis). Also, for refrigerators and freezers market shares of manufacturers are given for 1994 and 1997.
Later, in chapter 4, an overview will be provided of market figures by EU energy class.

2.1.1. Production
Figure 1 shows that the production of Northern Europe has fallen over the last two years, in favor of the production in Southern Europe and the UK. Consequently, as is shown in figures 2 and 3, manufacturers in Italy and Turkey have increased their market share in Europe.

<table>
<thead>
<tr>
<th>Country</th>
<th>Production mln. Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
<td>7,15</td>
</tr>
<tr>
<td>Germany</td>
<td>4,2</td>
</tr>
<tr>
<td>UK</td>
<td>1,75</td>
</tr>
<tr>
<td>Spain</td>
<td>1,21</td>
</tr>
<tr>
<td>Turkey</td>
<td>1,26</td>
</tr>
<tr>
<td>France</td>
<td>0,58</td>
</tr>
<tr>
<td>Denmark</td>
<td>0,58</td>
</tr>
<tr>
<td>Austria</td>
<td>0,47</td>
</tr>
<tr>
<td>Total</td>
<td>17,2</td>
</tr>
</tbody>
</table>


Fig. 1. Production Refrigerators and freezers Western Europe, by country of origin.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Market share in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrolux</td>
<td>24 21,4</td>
</tr>
<tr>
<td>Bosch-Siemens</td>
<td>11,8 13,2</td>
</tr>
<tr>
<td>Whirlpool</td>
<td>15,7 12,4</td>
</tr>
<tr>
<td>Merloni</td>
<td>7,7 7,4</td>
</tr>
<tr>
<td>Arcelik</td>
<td>n.a. 6,5</td>
</tr>
<tr>
<td>Groupe Brandt</td>
<td>7,5 5,8</td>
</tr>
<tr>
<td>Liebherr</td>
<td>7 4,8</td>
</tr>
<tr>
<td>Candy</td>
<td>1,8 4,5</td>
</tr>
<tr>
<td>GDA</td>
<td>3,3 3,3</td>
</tr>
<tr>
<td>Ardo Merloni</td>
<td>2,1 2,5</td>
</tr>
<tr>
<td>Others</td>
<td>19,1 18,2</td>
</tr>
<tr>
<td>Total</td>
<td>100 100</td>
</tr>
</tbody>
</table>


Fig. 2. Refrigerator Sales Western Europe, by manufacturer
### Manufacturer Market Share in %

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>1995</th>
<th>1997</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrolux</td>
<td>17.1</td>
<td>17</td>
</tr>
<tr>
<td>Bosch-Siemens</td>
<td>12.6</td>
<td>12</td>
</tr>
<tr>
<td>Liebherr</td>
<td>16.6</td>
<td>12</td>
</tr>
<tr>
<td>Whirlpool</td>
<td>9.1</td>
<td>10.7</td>
</tr>
<tr>
<td>Ardo Merloni</td>
<td>8.4</td>
<td>8.2</td>
</tr>
<tr>
<td>Groupe Brandt</td>
<td>6.1</td>
<td>5.5</td>
</tr>
<tr>
<td>IAR</td>
<td>4.2</td>
<td>4</td>
</tr>
<tr>
<td>Gram</td>
<td>3.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Merloni</td>
<td>n.a.</td>
<td>3.5</td>
</tr>
<tr>
<td>Candy</td>
<td>4.4</td>
<td>3</td>
</tr>
<tr>
<td>Others(e.g. Vestfrost)</td>
<td>24</td>
<td>20.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**Source:** Appliance, 1996, 1998

**Fig. 3. Freezer Sales Western Europe, by manufacturer**

#### 2.1.2 Consumption and saturation

The table from Appliance magazine below indicates that over the 1994-1997 period refrigerator sales have slightly risen, mainly due to a huge jump in Turkish and UK sales and despite a heavy fall in German sales. Without Turkey and Slovenia, the EU refrigerator sales have remained constant. Another source, working mainly with GfK data for 1994-1996, confirms the drastic fall in German sales, but not the suggested drastic increase in British sales. Overall, it is suggested that EU market volume has decreased by 4% over the 1994-1996 period, with EU sales totaling 16.3 million refrigerators and freezers in 1996 (17 million in 1995).

<table>
<thead>
<tr>
<th>Country</th>
<th>Fridge Consumption 1997</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1994</td>
</tr>
<tr>
<td>AU</td>
<td>271</td>
</tr>
<tr>
<td>F</td>
<td>2100</td>
</tr>
<tr>
<td>D</td>
<td>3725</td>
</tr>
<tr>
<td>I</td>
<td>1600</td>
</tr>
<tr>
<td>NL</td>
<td>577</td>
</tr>
<tr>
<td>E</td>
<td>1197</td>
</tr>
<tr>
<td>S</td>
<td>289</td>
</tr>
<tr>
<td>UK</td>
<td>1635</td>
</tr>
<tr>
<td>Turkey</td>
<td>788</td>
</tr>
<tr>
<td>Slovenia</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>12182</td>
</tr>
</tbody>
</table>

**Source:** Appliance, 1995, 1998

**Fig. 4. Refrigerator consumption by country**

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### Country Freezer Consumption 1997

<table>
<thead>
<tr>
<th>Country</th>
<th>Freezer Consumption (1000 units) 1997</th>
</tr>
</thead>
<tbody>
<tr>
<td>AU</td>
<td>129</td>
</tr>
<tr>
<td>F</td>
<td>780</td>
</tr>
<tr>
<td>D</td>
<td>1215</td>
</tr>
<tr>
<td>I</td>
<td>440</td>
</tr>
<tr>
<td>NL</td>
<td>189</td>
</tr>
<tr>
<td>E</td>
<td>225</td>
</tr>
<tr>
<td>S</td>
<td>146</td>
</tr>
<tr>
<td>UK</td>
<td>585</td>
</tr>
<tr>
<td>Turkey</td>
<td>18</td>
</tr>
<tr>
<td>Slovenia</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3727</strong></td>
</tr>
</tbody>
</table>

*Source: Appliance 1995, 1998*

**Fig. 5.** Freezer consumption by country 1994 and 1997

<table>
<thead>
<tr>
<th>Country</th>
<th>Freezer Saturation in % 1997</th>
</tr>
</thead>
<tbody>
<tr>
<td>AU</td>
<td>69</td>
</tr>
<tr>
<td>F</td>
<td>50</td>
</tr>
<tr>
<td>D</td>
<td>64</td>
</tr>
<tr>
<td>I</td>
<td>33</td>
</tr>
<tr>
<td>NL</td>
<td>47</td>
</tr>
<tr>
<td>E</td>
<td>18</td>
</tr>
<tr>
<td>S</td>
<td>68</td>
</tr>
<tr>
<td>CH</td>
<td>77</td>
</tr>
<tr>
<td>UK</td>
<td>39</td>
</tr>
<tr>
<td><strong>EU avg.</strong></td>
<td><strong>52</strong></td>
</tr>
</tbody>
</table>

*Source: Appliance 1995, 1998*

**Fig. 6.** Freezer saturation by country 1994 and 1997

The fig. 6 shows that market saturation of the freezer in the EU is slowly increasing.

Subdivided by EU energy label category, PW consulting reports that category 1 (larder refrigerators) lost 0.9% of the total cold appliance market from 1994 to 1996, Category 6 (refrigerators with a 3-star frozen food compartment) lost 1.4% of the total market and Category 7 (refrigerator-freezers) which gained 2.7% of the total market over the same period. The fact that refrigerator-freezers gained ground at the expense of 3-star refrigerators and larder refrigerators would ordinarily lead to an increase in sales-weighted average cold appliance energy consumption.

The same source reports that the market share of private labels (retailer “brands”) in Europe is a little over 16% and falling with respect to branded labels. Private labels are very important in Germany and the UK.

No frost appliances are a small but growing (13.5 % per year) market in Europe, accounting for 4.9% of total EU sales (750.000 units) in 1996. Great Britain accounts for the largest proportion of no frost...
sales with 32.2% of the entire EU no frost market equivalent to 10.1% of all British cold appliance sales in 1996. By contrast no frost appliances had negligible market shares in many other countries such as Sweden and Portugal.

A market split up by climate class shows that the temperate N class had the greatest market share with 54.6% of all EU cold appliance sales with known climate class, the sub-temperate SN class had a market share of 39.7%, sub-tropical ST class appliances had 18.1% and tropical class models had 3.5%.

2.2 Structure

2.2.1 Industry
Relative market shares of the various producers are given in the previous paragraph.

![EU Manufacturers of refrigerators](image)

Fig. 7. EU Manufacturers of refrigerators

2.2.2 OEM’s
Largest manufacturers of hermetic compressors are Electrolux, Embraco (to a large part owned by Whirlpool), Danfoss and Copeland. Although refrigerator-manufacturers will have a preference for their own brand of compressors, in practice different brands of compressors are used in the product line of each manufacturer.

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3 All cold appliances sold on the European market have to satisfy temperature performance tests that determine their suitability for use in different climatic ranges. Under the system defined by the European test standard, EN153, cold appliances are ranked as suitable for operation in sub-temperate ‘SN’, temperate ‘N’, sub-tropical ‘ST’ and tropical ‘T’ climates. In theory the same cold appliance can be rated as suitable for use in all four climate classes provided it can maintain the required internal temperatures under the full range of external ambient temperatures implied by each condition and many cold appliances do carry multiple climate class ratings. The market share of products by climate class is especially relevant given that the minimum energy performance standards Directive (96/57/EC of 18.9.96) specifies weaker energy performance requirements for ST and T class appliances compared to SN and N class appliances.
<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Brands (Country)</th>
<th>Annual production</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrolux</td>
<td>ZEM(I), VOE(A), Zel(China)</td>
<td>21 million</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Americold (US), UH(E), Kelvinator (US)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Embraco</td>
<td>Embraco (Brazil), Aspera(I), Besco(China)</td>
<td>18.5 million</td>
<td>96 sales US $ 690</td>
</tr>
<tr>
<td>Danfoss</td>
<td>production in D, Slov., Mexico</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>Matsushita</td>
<td>production in US and Japan</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>Copeland</td>
<td>production in US (7 plants), Canada,</td>
<td>23 million</td>
<td>97 sales US $ 1000</td>
</tr>
<tr>
<td></td>
<td>Mex., China, India, Thialan, Czech Rep., Belgium, UK,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Germany, N. Ireland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TEE</td>
<td>Turkey: Tecumseh-licensed compressors</td>
<td>2 million</td>
<td></td>
</tr>
</tbody>
</table>

Total world HVAC & refrigerator compressor market approx. 100 million

Fig. 8. Table of compressor manufacturers, brands and characteristics

Likewise, there are a handful of manufacturers of thermostats, evaporators, condensers, insulation, etc. Also the interior elements (shelves, lights, baskets) and the doors of the refrigerator are manufactured by OEM's, usually on specification of the manufacturers. Most brand-manufacturers concentrate on the manufacture of the steel casing, assembly of the various components and testing, as well as staff functions (marketing, R&D).

2.2.3 Industry and Importers Associations

Manufacturers and importers of refrigerators are united in the European association of appliance manufacturers CECED, with members in each country (see Fig. ).

Fig. 9. Whitegoods industry associations in Europe
2.2.4 Importers and retailers

Every manufacturer works with national subsidiaries or independent importers per country. These national subsidiaries take care of the national marketing and the physical distribution to the retailers.

The shape in the refrigerator retail sector is different in each European country. In the South (Italy, Spain) there are many small retailers (e.g. Italy 35,000), whereas in the North the retail sector is typically dominated by 5 or 6 large retail or franchising chains, which supply more than 80% of the national market.

| Store densities across Europe (outlets per 10,000 population) |
|---------------------------------|----------------|
| Portugal                        | 192 |
| Greece                          | 184 |
| Italy                           | 171 |
| Belgium                         | 141 |
| Spain                           | 134 |
| Luxembourg                      | 116 |
| Denmark                         | 100 |
| France                          | 97  |
| Sweden                          | 94  |
| Norway                          | 92  |
| Ireland                         | 90  |
| Germany                         | 85  |
| UK                              | 81  |
| Netherlands                     | 80  |
| Finland                         | 77  |

*source: Eurostat, Retailing in the Single Market, 1993*

**Fig. 10. Sales outlets per 10,000 habitants per country in Europe 1993**

Specific market segments are bulk-buyers such as mail-order companies (e.g. Otto Versand, Quelle in Germany) and building corporations buying appliances to be pre-installed in social housing. For instance in Sweden these building corporations constitute 40% of the market.

Apart from these exceptions, the refrigerator market is a heterogeneous market where ultimately the consumer decides. In this decision he/she is led by “brand” and “price”, but increasingly also environmental aspects and the quality of the product play an important role. In this context, utilities and especially consumer associations, which test the product, can be important. This is particularly true in Scandinavia (S: Konsumentverket, FIN: e.g. TTS), Germany (Stiftung Warentest), the UK (CA) and the Netherlands (Consumentenbond).

In Southern Europe, consumer’s associations are small and not a dominant market force. On a European level, many of these smaller groups are represented by Belgium based Conseur.

The table below gives some names of important retailer in Europe.

<table>
<thead>
<tr>
<th>European Whitegoods retailers (examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>France chains</td>
</tr>
<tr>
<td>buying groups</td>
</tr>
<tr>
<td>Spain buying groups</td>
</tr>
<tr>
<td>Portugal structure</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>UK structure</td>
</tr>
<tr>
<td>Country</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>Germany</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Italy</td>
</tr>
<tr>
<td>Netherlands</td>
</tr>
<tr>
<td>Belgium</td>
</tr>
<tr>
<td>Finland</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Norway</td>
</tr>
<tr>
<td>Denmark</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**source: Cool labels, 1998**

**Fig. 11. Examples of whitegoods retailers in Europe**

### 2.3 Trends

Summarizing European trends:

- Stagnating prices and sales volume; in important parts of Northern Europe decreasing sales.
- Concentration in the production sector through mergers and take-overs. At the moment there are only some 10 important producers in Europe and this number is expected to drop even further. Largest takeover in the 1995-1999 period: Takeover of German AEG Hausgeräte by Swedish Electrolux AB.
- Restructuring of the retail sector continues, with ever bigger retail chains and buying groups.
- Production over-capacity for refrigerators is in the order of magnitude of 10 to 15%. Over-capacity is still increasing, also due to Asian manufacturer’s entering the EU market from Eastern-Europe based plants.
- Plants are being reorganised and workers are being made redundant. Example Electrolux: Closing European plants and opening new plants in Eastern European growth markets with cheap labor (Hungary).

---

Chapter 3

Technology Update

3.1 Compressor design

In the last 3 years CFC’s (chlorofluorcarbons) such as R12 were phased out as a refrigerant in the EU, so that is no longer an issue. More important is the shift from their first substitute, namely hydrofluorocarbons (R134a), to hydrocarbons (R600a). The latter are now more than 30% of the European market, especially in Northern Europe. The redesign of the compressor for hydrocarbons has led to —on average—efficiency-improvements of 8 to 15% in resp. the medium and small sizes (100 and 50 W), whilst the efficiency of the larger compressors is not affected (e.g. 150 W and higher) with respect to the average R134a compressor.

Another recent development is the appearance of the variable speed compressors (e.g. by ZEM and Danfoss) for top-of-the-range products. The extra costs of the variable speed (estimated extra costs 200 to 300 Euro) are not yet believed to be economical in terms of payback for the consumer and still unattractive to the bulk of the market. Nonetheless, the efficiency improvements of refrigerators with these compressors are —combined with suitable electronic controls— in the order of magnitude of 30 to 40% with respect to an ordinary compressor. Many manufacturers expect the prices for variable speed compressors to drop, once the production will go up.

Intermediate compressor solutions are ordinary compressors with a run capacitor (efficiency +4%), “improved or high efficiency” compressors with better motors (efficiency +9%).

Long-term developments, which may have difficulties in proving themselves economical, are the Stirling motor, linear compressors and acoustic compressors. Much will depend on OEM’s brave enough to produce the first serious (mass)production-line for these products.

3.2 Cabinet design

The Appliance Efficiency newsletter reports that recently various solutions have arisen to improve cabinet insulation. Increasing the wall thickness is the simplest: Increasing wall thickness from 30 to 60 mm will theoretically halve the thermal load, but at the expense of either storage space or the external dimension. Nonetheless, wall insulation thicknesses of up to 90 mm seem to be quite acceptable in the European market. However, attention also needs to be paid to appropriate design of seals, gaskets and wall penetration. With the decline in popularity of the standard 60-cm width for cold appliances, increasingly more manufacturers are offering either wider models of, for example, 66 and 75 cm (e.g. Bosch-Siemens, Liebherr and Goldstar) to compensate for net-volume loss. Interestingly, there are also more narrower machines (45 to 55 cm) on the market now for smaller households with good energy efficiency (B and C level).

Polyurethane foam remains by far the most common insulation material, but some manufacturers have started to use vacuum insulation panels with conductivity a fraction that of polyurethane foam. Until recently these were considered prohibitively expensive or of doubtful long-term integrity. But technology improves. The best-performing vacuum panels are made of an evacuated steel casing with a fiberglass in-fill. These can lead to dramatic cuts in energy consumption. Unfortunately, manufacturer Owens Corning has withdrawn the product from the market as a result of insufficient interest from industry. Other designs seem a bit more succesful, but it still appears extremely difficult to run an economical production line for vacuum panels.


6 Domesticating the cold appliance, Appliance Efficiency, issue 1, vol. 1, 1997.

7 Fair blows the wind for Confortec ‘98, Appliance Efficiency, issue 1, vol. 2, 1998
ICI manufactures a low-weight vacuum panel using evacuated open-cell foam sealed in an aluminum/polymer laminate casing that can be inserted into standard refrigerator walls prior to foaming and hence can be easily incorporated in the present production process. Conductivity of these panels is just 0.007 W/m K, compared to 0.020 W/m K for normal polyurethane foam. Reportedly they lead to 20% energy saving for a 60% cabinet surface area coverage. The German company Degussa makes silica vacuum panels and is licensing the technology to refrigerator manufacturers. Use of these panels can lower the thermal load by over 30%. Bayer is licensing a vacuum panel production method to Telwest Recycling that uses compressed recycled polyurethane fluff, taken from old refrigerators, which is then vacuum-sealed between two gas-impermeable foils.

All in all, although the use of vacuum panels is a bit more frequent, the optimism about widespread use of vacuum panel is less than three years ago, due to past (economical/commercial) experience.

3.3 Controls
Traditionally, the refrigerator compressor operation is operated by an on-off thermostat control. Although this is still the most widely used system, more intelligent electronic controls are used in top-range models to improve efficiency. Compressor performance can be tuned to optimal efficiency, by anticipating habits of their owners (e.g. loading pattern, pattern of door openings). The objective being to run the compressor at its best efficiency point and to minimize temperature overshoots; the latter e.g. by PID (Proportional Integral Differential) type of controls. Needless to say, that with the use of variable speed compressors and cooling circuits with electrovalves the possibilities for efficiency optimization through controls increases. Also when the control has the option to “play” with more parameters, such as in a refrigerator-freezer, its influence increases. The net effect of the controls depends on the rest of the system, but it is estimated that with already a good refrigerator-freezer efficiency can be increased by 10 to 15%.

3.4 Heat exchangers
A simple, but very exciting energy saving option was introduced last year in fridges and freezers by the Groupe Brandt (brands: Thomson, Ocean, Blomberg, etc.) at the Confortec 1998 Trade Fair in Paris. The patented solution8 foresees a heat exchanger integrated with the evaporator (heat transfer through conduction). In the heat exchanger there is a phase-change material, used to periodically store the heat/cold. The eutectic material that is used is water for a refrigerator and water + glycol (or 40 to 60 g monopropylglycol as the environmentally friendly alternative) for the freezer.

Fig. 12. Groupe Brandt patent with eutectic material

The idea behind it is relatively simple. Normally, a compressor is designed to run for 25 to 40% of the time. It operates on-off with a certain frequency, depending mostly on standing losses and load pattern (“warm” food brought into the compartment). The load/time diagram, however, is not a real block-diagram, because at the start up of each “on” cycle the compressor suffers from start up losses (inertia, oil viscosity, etc.) which level off in a few minutes and then stay steady at a 15 to 20% lower level.

With the existence of the heat exchanger an energy buffer is built at the level of the evaporator, allowing the compressor to operate longer per “on” cycle, but less frequent. This gives an energy saving of around 15% and, as the heat exchanger can be easily integrated with the evaporator in the roll bond technology, at hardly any extra costs. Contrary to more exotic options mentioned earlier, this would make it applicable also to the medium and lower end of the market.

At the 1999 Domotechnica trade fair Groupe Brandt-subsidiary Blomberg presented an upright freezer with an energy efficiency 30% better than the EU energy label A-level. Another subsidiary, Ocean, claims their refrigerators to be 15% better than A-level.

Exciting though it may be, the concept still shows some minor : A defrosting cycle may take up to 24 hours, in order not only to defrost the cabinet but also the buffer.

3.5 Miscellaneous

Finally, there are a number of design measures which benefit the traditionally inefficient side of the market:
- Anti-sweat heaters (heaters in the door gasket to prevent condensation) for freezers can be eliminated
- Partial no-frost appliances take a part of the no-frost market
- Some manufacturers of the US-type fridge/freezer (side-by-side) have succeeded in reaching energy efficiency level “B” or “C”, whilst only a few years ago the best available reached no more than the “F” energy efficiency class.

9 Comm. Birgitte Holm Christensen, Ecolabelling Denmark
Chapter 4

**Energy Efficiency Update**

### 4.1 CECED database

Over the last 3 years there has been a considerable effort to monitor the trends in the energy efficiency of the so-called “cold appliances”. The reason for this is the introduction of the EU energy label and the minimum efficiency standard directive in 1995.

Since 1995 the European manufacturers association CECED has collected data on the efficiency (and other characteristics) of the models brought on the market. The assumption here is, that the distribution of the models on offer is also a good indicator of the models sold. The graph below shows the trend lines over the period 1995-1997 for all cold appliances, compared to the trend line found in the GEA study (Group for Efficient Appliances), which was the basis for the energy classes en related to models in 1991-1993. The overall trend is, that there has been a considerable shift of more than one-and-a-half energy class (ca. 15 % efficiency improvement) over the 1992-1997 years. In 1997 roughly 33% of the cold appliances can be found in energy classes A and B (the Ecolabel criterium). In 1995 20% of the models fell into these two classes and in 1993 only 10%. This trend is expected to continue as in 1999 manufacturers can no longer bring E-F-G class appliance on the market and also most of the D-class appliances will be banned by the EU minimum efficiency standard. The effect of the recently improved efficiency of new refrigerators will not yet be very visible in the average electricity consumption per household, as it still relates to a small portion of the stock. To evaluate the final effect, a stock model should be used, which is not readily available.

![Graph showing trend lines for cold appliances energy efficiency](image)

**Fig. 13. Evolution of Cold Appliance Energy Efficiency (source: CECED 1999)**

Looking at the individual energy label categories (see Appendix III) this is true for all refrigerators and the large class of refrigerator freezers. But especially in the field of upright and chest freezers (categories 8 and 9) trend lines are more fuzzy, with bumps both in the higher and lower efficiency classes. Also the shift between 1993 and 1997 is not evident. There are technical reasons for this (e.g. superinsulated versus normal freezers). In the miscellaneous category 10 (multidoor appliances) trend lines are even less clear, but this is a highly heterogeneous class.

CECED has presented their database with over 7000 models to the European Commission, DG XVII (SAVE programme), annually since 1995.
4.2 PWC study (commercial data)
As this reason and also to have an independent review of market trends, Paul Waide Consulting (PWC) was asked to perform an extensive statistical analysis on the basis of sales data over the 1994-1996 period. The main source was sales data from GfK and Nielsen combined with technical databases (ELDA, NEI, etc.). As the study is now (March 1999) close to completion, the most significant findings can be cited from the draft version.

Basically, the PCW-study confirmed the general trend of a significant efficiency improvement with respect to GEA-data. For the cold appliances as a whole, this is shown in the graph below.

**Figure 14.** EU cold appliance sales share by energy label class for 1994 to 1996 (also showing the distribution of GEA models by label class)

![Graph showing EU cold appliance sales share by energy label class for 1994 to 1996](image)

**Fig. 15.** Cold appliance sales-weighted annual average energy efficiency indices by Member State for 1994 to 1996 (%)\(^1\)

<table>
<thead>
<tr>
<th></th>
<th>EU</th>
<th>Aus</th>
<th>Bel</th>
<th>Den</th>
<th>Fra</th>
<th>GB</th>
<th>Ger</th>
<th>Ita</th>
<th>Nl</th>
<th>Por</th>
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<tbody>
<tr>
<td>1994</td>
<td>92.6</td>
<td>88.1</td>
<td>97.0</td>
<td>-</td>
<td>102.2</td>
<td>96.0</td>
<td>83.3</td>
<td>101.1</td>
<td>91.5</td>
<td>-</td>
<td>89.6</td>
<td>-</td>
</tr>
<tr>
<td>1995</td>
<td>92.5</td>
<td>87.2</td>
<td>95.2</td>
<td>91.5</td>
<td>100.3</td>
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<td>87.7</td>
<td>-</td>
<td>94.2</td>
<td>90.1</td>
</tr>
<tr>
<td>1996</td>
<td>90.7</td>
<td>85.0</td>
<td>93.4</td>
<td>89.8</td>
<td>97.4</td>
<td>101.7</td>
<td>77.8</td>
<td>96.9</td>
<td>84.1</td>
<td>101.2</td>
<td>92.9</td>
<td>87.4</td>
</tr>
</tbody>
</table>

GEA:
|       | 100.2| -    | -    | 94.0 | 103.9| 107.5| 95.4 | 107.5| 99.3 | 125.5| 101.7| -    |

\(^1\)The data does not include sales of cold appliances with unknown efficiency indices and thus the cited EU average values are the sales-weighted values based on those countries where data is available. The 1994 data for France, GB and Germany is for branded models only and does not include appliances sold under private label. By contrast the 1995 and 1996 values for these countries includes private label sales. The GEA data is not sales-weighted and includes appliances available for sale on the national markets indicated between 1990 and 1992. Danish data is not sales-weighted.

On the European level there seems to be an improvement of almost 10% in 1996 with respect to 1990-1992 (GEA). But, given the fact that the GEA data are not sales-weighted and from a different source,

it is probably more significant to look at the improvement in the 1994-1996 period, which is a mere 2%.

On a national level, we see considerable improvements over the 1994-1996 period in the Netherlands (-7.3%) and Germany (-5.5%), whereas in the UK the efficiency of the average refrigerator has worsened (+5.7%). A possible explanation of the British performance in this respect is the dominance of only a few very big retail chains, which obviously do/did not give a high priority to energy efficient appliances. Most countries see a moderate efficiency improvement.

4.3 Energy consumption
Improved energy efficiency does not necessarily translate into reduced energy consumption. Paul Waide reports that sales-weighted average EU cold appliance energy consumption was 406.1 kWh/year in 1996, 410.9 kWh/year in 1995 and 409.5 kWh/year in 1994 (Table 3).

Fig. 16. Cold appliance sales-weighted annual average energy consumption for 1994 to 1996 (kWh/year)

<table>
<thead>
<tr>
<th>Year</th>
<th>EU</th>
<th>Aus</th>
<th>Bel</th>
<th>Den</th>
<th>Fra</th>
<th>GB</th>
<th>Ger</th>
<th>Ita</th>
<th>Nl</th>
<th>Por</th>
<th>Spa</th>
<th>Swe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>406.1</td>
<td>333.0</td>
<td>427.0</td>
<td>406.7</td>
<td>445.5</td>
<td>441.0</td>
<td>313.5</td>
<td>465.2</td>
<td>368.8</td>
<td>488.9</td>
<td>511.5</td>
<td>422.5</td>
</tr>
<tr>
<td>1995</td>
<td>410.9</td>
<td>340.0</td>
<td>433.1</td>
<td>413.5</td>
<td>455.7</td>
<td>443.6</td>
<td>317.5</td>
<td>483.1</td>
<td>380.6</td>
<td>-</td>
<td>526.8</td>
<td>423.1</td>
</tr>
<tr>
<td>1994</td>
<td>409.5</td>
<td>343.1</td>
<td>440.2</td>
<td>-</td>
<td>458.7</td>
<td>411.6</td>
<td>328.8</td>
<td>485.6</td>
<td>398.1</td>
<td>-</td>
<td>516.8</td>
<td>-</td>
</tr>
<tr>
<td>GEA</td>
<td>449.8</td>
<td>-</td>
<td>415.0</td>
<td>473.4</td>
<td>468.7</td>
<td>403.5</td>
<td>529.1</td>
<td>429.0</td>
<td>642.7</td>
<td>538.1</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

1 The data does not include sales of cold appliances with unknown energy consumptions, while the cited EU average values are the sales-weighted values based on those countries where data is available. The 1994 data for France, GB and Germany is for branded models only and does not include appliances sold under private label. By contrast the 1995 and 1996 values for these countries includes private label sales. The GEA data is not sales-weighted and includes appliances available for sale on the markets indicated between 1990 and 1992. Danish data is not sales-weighted.

With respect to the GEA database (1990-1992 models) there appears to have been a significant reduction of around 40 kWh and few percent per year improvement in the 1994-1996 period. If the analysis is corrected for models “missing” from the databases, particularly in earlier years, energy consumption figures show a more continuous line with an improvement of 13.4% between 1990-’92 and 1996.

The comparatively static sales-weighted annual average energy consumption of cold appliances between 1994 and 1996 is partly explained by a corresponding increase in their sales-weighted average volume. Between 1994 and 1996 the average adjusted volume of the cold appliances sold in the EU increased by 10.4 litres from 284.3 litres to 294.7 litres. Almost all this increase was attributable to an increase in the sales-weighted average volume of fresh food storage space as frozen food volume scarcely changed.

All in all, PW Consulting concludes that aggregate EU energy savings of almost 3.5 TWh were realised from 1994 to 1996 and that were the efficiency of the cold appliance market to remain at 1996 levels from 1996 onwards that total savings would have reached 7.1 TWh by the end of 1998. These values represent savings equivalent to ~8.5% of the cumulative energy consumption of the appliances sold over this period.

Needless to say, that these savings are based on the EN153 standard energy consumption. Depending on climate (humidity, ambient temperature) real-life annual energy consumption may be up to 20% lower than indicated by the standard.
Chapter 5

Environmental Aspects Update

5.1 Market penetration hydrocarbons vs. R134a (refrigerant, foaming agent)
As mentioned in Chapter 3, isobutane (R600a) is used as a refrigerant in over 30% of all cold appliances sold in the EU, especially because of sales in the Northern part of Europe. The most common refrigerant and foaming agent is R134a. It has a market share of 60-70%, but is expected to phase out in the Northern part of Europe in a few years, due to the environmental policy. Compressor manufacturers are working on the development of compressors for propane (R290), another hydrocarbon, which might give a slight energy efficiency improvement over isobutane.

In its report from the first Ecolabel working group, ENEA reports:

HFC-134a has ODP=0 and a GWP=1200 for the time horizon of 100 years. The average amount in a refrigerator is about 120g as refrigerating fluid and about 280g in the expanded foams.

As far as Hydrocarbon are concerned, they have ODP=0, GWP=11 and PCOP=0.4-0.42. The average amount of HC in a refrigerator is about 50g in the circuit and about 320g in the foams.

At the time of the first Ecolabel working group, 1995, hydrocarbons were used on a very small scale (<10% market share). With the present market share of 30% hydrocarbon refrigerants there has been a major improvement in the reduction of GWP, also because the new hydrocarbon compressors proved to be more energy efficient on average than the R134a alternative (see also Chapter 3). For foaming agents the present market share of hydrocarbons is higher: The majority is hydrocarbon based.

In short, the ecolabel-requirement that hydrocarbons should be used as refrigerants and foaming agents still seems accurate, although in Northern Europe it is no longer a distinguishing feature.

5.2 Noise
The noise level of refrigerators is not a broadly advertised issue. Most manufacturers do not mentioned it in their catalogue, with the exception of Turkish manufacturer Arcelik. From this manufacturer, that mainly produces ‘B’ and “C” level appliances, we learn that their normal refrigerators/freezers come in noise levels between 42 and 38 dBa (41 dBa). Their no-frost appliances, due to the fan, produce between 45 and 46 dBa.

All this indicates that the maximum sound level of 42 dBa, which is set as a requirement in the present ecolabel scheme, is still well chosen.

5.3 Packaging
Especially in Germany there has been a debate on standardization of packaging of whitegoods with the ultimate aim to enhance re-use and recycling possibilities. In the initial stages, cardboard boxes appeared to be the most favored, but as the recycled paper market is very saturated and prices very low, packaging a fridge on a wooden panel with polystyrene angle-pieces and a transparent polyethylene foil wrapping seems now an environmentally acceptable alternative.

But apart from this, whether the packaging of a refrigerator should be part of an ecolabel scheme for refrigerators also depends on the relative environmental impact. Even in a relatively unfavourable example, using 5 kg of cardboard or 3 kg of thermoplastics, the global-warming potential (or the Gross Energy Requirement for production) of the packaging material is less than 10% of the total GWP for production of the refrigerator. And the GWP for production is roughly only 16% of the GWP ‘from cradle to grave’. So the relative importance of the packaging for the environment is 1.6%. (see also par. 6.4). For these reasons "packaging" was not included in the ecolabel criteria.

12 GWP=Global Warming Potential, ODP=Ozone Depletion Potential
13 PCOP is the Photochemical Ozone Creation Potential, also called "smog effect".
14 Comm. Shpresa Kotaji (ICI)
15 Comm. manufacturers
5.4 Re-use
There are various stages of re-use. The most common “re-use” on arrival of a new refrigerator in a household, is to use the old appliance in the cellar, e.g. for long term storage of frozen food (freezer) and/or the cooling of drinks (refrigerator). This explains the more than 100% market penetration in most EU countries, implying a significant number (up to 10%) of households owning more then one cold appliance.

After that, a second-hand market for refrigerators are student-houses and starters on the housing market. They use the refrigerator for another 4 or 5 years, before buying a new appliance.

Finally, it is no secret that a part of the refrigerators discarded in Western Europe is being repaired, sold and re-used in Third World countries. Given the fact, that the energy use of these old appliances can be up to 50% higher than the energy consumption of an average new refrigerator and the refrigerant is usually freon (R12), this is not a desirable situation from the environmental point of view. Also for local refrigerator manufacturers in those countries it is not a good development. At the moment there are not enough quantitative data to establish whether this is an important or merely a marginal phenomenon. In some countries, like the Netherlands (since 1.1.1999), the commercial trade of second hand refrigerators is explicitly forbidden for the reasons described above.

What is true for the re-use of refrigerators in Third World countries is true for re-use of refrigerators in general. Due to outdated technology and wear (leaking door-gaskets, etc.), as well as the use of freon (R11 as a foaming agent and R12 as a refrigerant), a re-use of old refrigerators should not be encouraged from the environmental point of view. Rather, governments and manufacturers are frequently debating the environmental merits and possible policy instruments to shorten product-life for refrigerators instead of prolonging it.

All in all, optimization of refrigerator design for re-use is not an appropriate topic for the ecolabel-scheme at the moment. Second-hand trade of refrigerators should, if it is not already forbidden through national legislation, be discouraged rather than encouraged.

5.5 Flame Retardants
Flame retardants may be used in the PCB's16 of electronic refrigerator controls, if indeed electronics are being used for temperature/compressor controls. This is a component weighing less than 25 grams and, if we apply the same standards as in the Eco-label for Personal Computers, admissible. Furthermore, the issue of flame retardants will be dealt with in the "WEEE" Directive which is now in being prepared and should be in place in the year 200017.

In insulation materials (polyurethane) no flame retardants are being used.18 For plastic materials, e.g. used for the inner-lining and containers, the EU Directive on materials in contact with food applies, which allows no halogenated flame retardants19.

It is proposed to use the same criteria regarding halogenated flame retardants as were employed in the Personal Computer Ecolabel scheme, namely that they should not be used in components heavier than 25 grams. This is to be seen as a precautionary criterion in order to avoid possible future use for structural components. This may become particularly relevant as, as was reported by the European

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16 Printed Circuit Boards
17 The European Commission’s DG XI has recently distributed the 2nd draft of the "Proposal for a Directive on Waste from Electrical and Electronic Equipment" (WEEE). In this draft, a proposal is made to phase out Halogenated Flame Retardants (HFRs) by 1 January 2004 if alternative flame retardants can meet minimum fire safety standards.
18 Comm. Mrs. Shpresa Kotaji for ISOPA.
manufacturers organisation CECED, certain safety issues regarding refrigerators are currently under debate.

5.6 Take-back
In some EU Member States the take-back of refrigerators and other appliances is mandatory through national legislation. It is proposed to include a "best practice" criterion intended to ensure that also for countries where legislation is not in place, the manufacturer guarantees the take-back of the refrigerators and of components being replaced in order to allow appropriate disposal.

5.7 Recycling
Environmentally friendly waste disposal and recycling of refrigerators has been studied from various angles over the last years. In Germany and Switzerland, it has been a topic for many years (D.: "Entsorgung") and experiments were set up in this field. Italy, the largest producer of refrigerators in the EU, is debating a new law regarding the recycling of refrigerators.

Despite the law, debates and experiments, it is still not clear to the industry what is the right way to go. On average, a refrigerator is made up of an epoxy-coated steel casing and door, a polystyrene inner lining (food quality) and a roll-bonded or Z-bonded aluminum evaporator all bonded with polyurethane foam. At the back of the refrigerator there is the aluminum condenser-part of the cooling circuit and the compressor (a mix of steel and copper). Inside the refrigerator we find the thermostat (also with the capillary foamed in), lighting and all sorts of mainly ABS containers for butter, eggs, vegetables, etc.. Shelves of new refrigerators are often made of glass, but the traditional refrigerator shelf is made of steel wire with a PVC dip coating. Electronic controls are beginning to have a significant market share in refrigerators. At the 1999 Domotechnica trade fair Electrolux even introduced a refrigerator with a computer and an (LCD) monitor in the fridge-door to improve on domestic food planning (recipes, shopping lists, etc.).

For recycling, the interior elements are not a problem as they can easily be removed. Also the waste disposal of the refrigerant is in most parts of Europe a known procedure (see figure 17), with a relatively low cost. The problem is the recuperation of the foaming agent and the recuperation of the various materials fractions which are "glued" together by the polyurethane foam. Industry estimates that the recuperation of the foaming agent (only 25/50% is easily recuperated) and the mechanical division of cabinet components (sawing out the polyurethane) costs some 50 to 60 DM per appliance. To this, the costs of refrigerant disposal (DM 7,-) and the transportation to a special recycling plant (DM 20,-) have to be added, resulting in a full recycling cost of DM 80,- to DM 90,- per appliance. In whatever form, this cost will be added to the consumer price.

Clearly, the industry sees incineration in a special plant as a more economical alternative, but most of all the industry would like more clarity on the ultimate way-to-go so they can take it into consideration e.g. in their design and marketing strategy.

At present, in design for disassembly the bottleneck is the insulation. Yet, no environmental group is proposing polystyrene blocks or a return to the glass wool blankets. These would take care of the recycling problem, but any Life Cycle Analysis will show that this positive effect is in no comparison to the negative effect of decreased insulation value. A completely vacuum cabinet is a solution for both recycling and energy efficiency but is not going to be economical in the foreseeable future (see also Chapter 3).

All in all, there are no clear-cut recommendations for design for disassembly, other than the ones already mentioned in the present ecolabel scheme (e.g. marking of plastics).

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20 Recent example: The Netherlands since 1.1.1999
21 The low recovery rate after dismantling (25 to 50%) is basically related to the recovery/shredding process. To recover the remaining 50-75% extra heating/condensation is required and probably more complex equipment (cost).
5.8 Coating
The issue of coating of steel products was raised in consultations.

For refrigerators, the environmental impact of the coating will be very limited indeed with respect to other environmental aspects of this product (see also LCA analysis in par. 6.4). Most refrigerators are epoxycoated (no solvent). In case of wet-coating in the whitegoods-sector there is generally an almost complete VOC-recovery rate.

The EU Council Directive 99/13/EC for VOC-emissions due to the use of organic solvents in installations and "certain activities" is in force since February 1999. In theory it applies also to wet-coated refrigerators, but from the relatively mild limits imposed by the Directive it appears --as far as coating of steel parts is concerned-- to have been designed more for the coating of cars, trucks, etc. not necessarily in a modern industrial, mass-production environment.

For the two reasons mentioned above, incorporating criteria for coating in the Ecolabel for refrigerators would therefore add very little, if anything, to reduce the environmental impact of this appliance.

On the contrary, an effective implementation would pose considerable barriers to manufacturers which comply with the other criteria to apply for the Ecolabel. We are dealing with a quality which cannot be measured by the product but only by the way it is being produced. A wet-coated surface produced with a high level of emissions is identical to a wet-coated surface produced with a low emission level. Self-declaration by the applicant is therefore not sufficient, but would have to incorporate also declarations by OEM's. To verify compliance by an applicant (in case of doubt), Competent Bodies would have to require independent expert reports on coating installations throughout the production column.

Conclusion: Because of 1) its relatively (to other criteria) extremely low environmental impact with the refrigerator, 2) the lack of official standards which would really make a difference in a modern industrial environment, and 3) the almost impossible task (prohibitive costs) of a really effective implementation, no Ecolabel criterion for the coating of refrigerators is recommended.

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22 Volatile Organic Compounds
23 Whitegoods would fall in the category "Other coating, including metal, etc.." which allows emissions in waste gases of 100 mgC/Nm³ plus fugitive emissions of 25% (!) of solvent input. Existing installations will have to comply in the year 2007.
24 Original Equipment Manufacturers, such as suppliers of refrigerator-doors, condensers, compressors and others using steel parts.
Chapter 6

Life Cycle Costs Update

6.1 Product price
The most relevant source available on refrigerator prices in the EU market is PWC\(^{25}\), describing price-trends correlated to energy label classes on the basis of mainly GfK sales data.

The sales-weighted average price of cold appliances increased by 5.4% from 408.7 ECU in 1994 to 430.8 ECU in 1996. The price per litre of adjusted volume only grew by 2.7% over the same period, indicating that the average cold appliance has grown bigger. For the European market as a whole and within most Member States there appears to be a significant positive correlation between average price and average efficiency such that an average A class appliance was 160 ECU more expensive than the average of all appliances sold in the EU and an average B class appliance was 46.5 ECU more expensive. An adjusted volume normalised price indicator called the *price index* was developed to confirm that these trends were not the result of volume and category biases among the labelling classes. The findings, shown in Figure 3, reveal that in 1996 G class appliances with the same adjusted volume as A class appliances were on average 55% of the price, furthermore there is a reasonably linear relationship between the price index and the label class.

Interestingly, the differential between average A and G class normalised appliance prices increased by 41% between 1994 and 1996 suggesting that manufacturers and retailers may have been using the energy label as a tool to increase product differentiation and high end margins. It is unlikely that all or even most of the observed increase in cold appliance price with labelled efficiency is attributable to real costs associated with the manufacture of efficient products. There will undoubtedly be a strong correlation between branding and labelling policy such that high quality expensive brands will tend to have better than average label ratings as one of many aspects contributing to the positioning of the product image. As there is a very strong link between brand and price it is likely that a large part of the apparent link between price and efficiency is in fact the result of a link between brand and efficiency and brand and price.

**Figure 18** Sales-weighted annual average cold appliance price index by energy label class for the EU

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6.2 Electricity rates and other operating costs
Over the last three years and due to the future liberalisation of the EU energy market, electricity rates in the last 3 years have not increased and in many countries even slightly decreased. As an average rate, 0.13 ECU per kWh is still a valid average. Also there is no evidence of a significant increase in other operating costs (repairs, etc.). European inflation and interest rates have fallen in recent years because of the formation of the EMU (European Monetary Union). At present, European inflation is around 4% and the average interest rate is approximately 7 to 8%, both figures resulting in a net discount rate of around 3 to 4 % (say 3.5%).

6.3 Total Life Cycle Costs
The table below estimates the average economical Life Cycle Costs for 1994 and 1996, showing a slight increase in total Life Cycle Costs, but –also taking into account the increased adjusted volume— a slight decrease per unit of adjusted volume.

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
</tr>
<tr>
<td>Adjusted volume (litres)</td>
</tr>
<tr>
<td>Product Life</td>
</tr>
<tr>
<td>Discounted product-life (taking into account inflation and interest)</td>
</tr>
<tr>
<td>Electricity rate in Euro/kWh</td>
</tr>
<tr>
<td>Annual electricity consumption in kWh/yr.</td>
</tr>
<tr>
<td>Product price (Euro)</td>
</tr>
<tr>
<td>Electricity costs over discounted product life (Euro)</td>
</tr>
<tr>
<td>Repair costs estimate (Euro)</td>
</tr>
<tr>
<td>Total Life Cycle Costs (Euro)</td>
</tr>
<tr>
<td>Life Cycle Costs/litre adjusted volume</td>
</tr>
</tbody>
</table>

Fig. 19. Life Cycle Costs in Euro for the average EU cold appliance, 1994 and 1996.

6.4 Environmental Life Cycle Analysis
A complete environmental Life Cycle Analysis was not performed by the first Ecolabel Working Group, so there is no 1995 reference. Nevertheless there have been some older LCA's 26 which can serve as a basis for a fairly rough LCA. The result of this global analysis is shown in figures 20 to 22.

From that rough analysis, it is clear that the market penetration of hydrocarbons (30%) and the decreased electricity consumption have had their positive effect on the “cradle to grave” assessment of relevant emissions (GWP) in the last 3 to 4 years. It is estimated that the impact on the Global Warming Potential over its lifetime of an average cold appliance sold in 1997 is some 6% less than an average cold appliance sold in 1994, for the most part due to the refrigerant-switch. At the same time, the average cold appliance has grown bigger (see chapter 4).

The lifetime GWP saving of the cold appliances sold over the 1994-1997 period is estimated at around 7 million tonnes with respect to a BAU-scenario (Business As Usual, meaning a continuation of 100% market share for R134a).

The LCA can be refined, methodological uncertainties can be exposed and an extra effort can be made to update the basic LCA data. However, this will in all likelihood not influence the order of magnitude of the outcome.

26 For example, Van Holsteijn en Kemna for Greenpeace Netherlands (1992) or Paul Waide for Greenpeace UK (1993), to name just a few.
<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>St</th>
<th>Al</th>
<th>Cu</th>
<th>PS</th>
<th>Misc.</th>
<th>Subtotal</th>
<th>Refrigerant/foaming agent</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R134a</td>
<td>R600a</td>
</tr>
<tr>
<td>per kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R134a</td>
<td>R600a</td>
</tr>
<tr>
<td>Energy</td>
<td>kJ/g</td>
<td>34,4</td>
<td>228</td>
<td>81</td>
<td>82</td>
<td>100</td>
<td>1200</td>
<td>3</td>
</tr>
<tr>
<td>CO2</td>
<td>g/g</td>
<td>3</td>
<td>25</td>
<td>8,8</td>
<td>6</td>
<td>7</td>
<td>1200</td>
<td>3</td>
</tr>
<tr>
<td>CO</td>
<td>mg/g</td>
<td>1,4</td>
<td>17,7</td>
<td>n.a.</td>
<td>3,0</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SO2</td>
<td>mg/g</td>
<td>8,5</td>
<td>75,8</td>
<td>n.a.</td>
<td>9,4</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOx</td>
<td>mg/g</td>
<td>2,7</td>
<td>27,7</td>
<td>n.a.</td>
<td>8,5</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>per appliance (example 35 kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R134a</td>
<td>R600a</td>
</tr>
<tr>
<td>weight</td>
<td>%</td>
<td>75</td>
<td>5</td>
<td>5</td>
<td>9</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>weight</td>
<td>kg</td>
<td>26</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>0,4</td>
<td>0,37</td>
</tr>
<tr>
<td>Energy</td>
<td>MJ/fridge</td>
<td>903</td>
<td>399</td>
<td>142</td>
<td>258</td>
<td>245</td>
<td>1947</td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>kg/fridge</td>
<td>79</td>
<td>44</td>
<td>15</td>
<td>19</td>
<td>17</td>
<td>174</td>
<td>480</td>
</tr>
<tr>
<td>CO</td>
<td>g/fridge</td>
<td>36</td>
<td>31</td>
<td>0</td>
<td>9</td>
<td>7</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>SO2</td>
<td>g/fridge</td>
<td>222</td>
<td>133</td>
<td>0</td>
<td>30</td>
<td>25</td>
<td>408</td>
<td></td>
</tr>
<tr>
<td>NOx</td>
<td>g/fridge</td>
<td>72</td>
<td>48</td>
<td>0</td>
<td>27</td>
<td>25</td>
<td>171</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 20. Approximate Energy Requirement and Emissions to Air for Production of an average cold appliance in Europe, either with R134a or R600a as refrigerant/foaming agent.

<table>
<thead>
<tr>
<th>per kWh emission</th>
<th>electricity</th>
<th>index multiplier</th>
<th>(kg-&gt;GWP, etc.)</th>
<th>resources</th>
<th>GWP production/fridge</th>
<th>Total life cycle (i.e. over next 15 years) saving:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kWh/yr</td>
<td>400 kWh/yr</td>
<td>410 kWh/yr</td>
<td>15 years</td>
<td>15 years</td>
<td>Total EU sales 1994-1997: 67 million units</td>
</tr>
<tr>
<td></td>
<td>410</td>
<td>400</td>
<td>10</td>
<td>typical 1997</td>
<td>typical 1994</td>
<td>Total GWP saving over fridges sold 1994-1997:</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>15</td>
<td>0</td>
<td></td>
<td></td>
<td>7 million tonnes CO2 (effect to be felt over next</td>
</tr>
<tr>
<td>kWh/yr</td>
<td>R134a</td>
<td>100</td>
<td>-30</td>
<td></td>
<td></td>
<td>15 years)</td>
</tr>
<tr>
<td>Product Life</td>
<td>15</td>
<td>15</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% R134a</td>
<td>100</td>
<td>70</td>
<td>-30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% R600a</td>
<td>0</td>
<td>30</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GWP production/fridge</td>
<td>654</td>
<td>510</td>
<td>-144</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GWP use/fridge</td>
<td>2741</td>
<td>2674</td>
<td>-67</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GWP total</td>
<td>3395</td>
<td>3184</td>
<td>-211(6.2%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 21. Approximate Energy Requirement and Emissions to Air per kWh electricity and in total for the Use of an average cold appliance over its life time (15 years). Scenario for typical 1994 (400 kWh/yr) and 1997 (410 kWh/yr).

Fig. 22. Global Warming Potential comparison 1994-1997 for an average cold appliance in the EU.
Chapter 7

EU Policy

7.1 EU Energy Label
The EU Energy Label has been one of the most successful policy instruments in achieving energy efficiency in domestic appliances. It is also the basis for one of the key criteria for the present Ecolabel. For these reasons we will give a short description of the categorization and classification scheme.

The Commission Directive 94/2/EC (21.1.1994) on energy labelling of household electric refrigerators, freezers and their combinations, describes a complex system of energy rating in energy efficiency classes A (most efficient) to G (least efficient).

Schematically the efficiency class for a certain appliance is arrived at through the following procedure:

- categorization (10 main categories, subcategories a.o. nofrost)
- calculation of “standard annual energy consumption” (adjusted volume based on different multipliers per subcategory)
- calculation of energy efficiency index “I” calculation of energy efficiency index “I” (on basis of standard and measured energy consumption)
- determination of efficiency class (table with reference values)

Categorization
The system distinguishes 10 categories of cold appliances:

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Household refrigerators, without low temperature compartment (larder fridge)</td>
</tr>
<tr>
<td>2</td>
<td>Household refrigerators/chillers, with compartments at 5 and/or 10 °C</td>
</tr>
<tr>
<td>3</td>
<td>Household refrigerators, with no-star low temperature compartments</td>
</tr>
<tr>
<td>4</td>
<td>Household refrigerators, with low temperature compartments *</td>
</tr>
<tr>
<td>5</td>
<td>Household refrigerators, with low temperature compartments **</td>
</tr>
<tr>
<td>6</td>
<td>Household refrigerators, with low temperature compartments ***</td>
</tr>
<tr>
<td>7</td>
<td>Household refrigerator/freezers, with low temperature compartments <em>(</em>**)</td>
</tr>
<tr>
<td>8</td>
<td>Household food freezers, upright</td>
</tr>
<tr>
<td>9</td>
<td>Household food freezers, chest</td>
</tr>
<tr>
<td>10</td>
<td>Household refrigerators and freezers with more than two doors, or other appliances not covered above</td>
</tr>
</tbody>
</table>

Fig. 23. Categories cold appliances (source: Official Journal of the European Commission No. L45/16 17.2.1994)

For each of these categories a series of multipliers is prescribed, which help define a reference value (a sort of average in that category from statistical data in a particular year). The value of these multipliers is given in the table on the next page (table footnotes are direct citations from the Official Journal).
<table>
<thead>
<tr>
<th>No.</th>
<th>Category</th>
<th>Ω</th>
<th>M</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Larder fridge</td>
<td>-</td>
<td>0.233</td>
<td>245</td>
</tr>
<tr>
<td>2</td>
<td>Refrigerator/chiller</td>
<td>0.75</td>
<td>0.233</td>
<td>245</td>
</tr>
<tr>
<td>3</td>
<td>Refrigerator no star</td>
<td>1.25</td>
<td>0.233</td>
<td>245</td>
</tr>
<tr>
<td>4</td>
<td>Refrigerator *</td>
<td>1.55</td>
<td>0.643</td>
<td>191</td>
</tr>
<tr>
<td>5</td>
<td>Refrigerator **</td>
<td>1.85</td>
<td>0.450</td>
<td>245</td>
</tr>
<tr>
<td>6</td>
<td>Refrigerator ***</td>
<td>2.15</td>
<td>0.657</td>
<td>235</td>
</tr>
<tr>
<td>7</td>
<td>Fridge/Freezer <em>(</em>**)</td>
<td>(28)</td>
<td>0.777</td>
<td>303</td>
</tr>
<tr>
<td>8</td>
<td>Upright freezer</td>
<td>2.15</td>
<td>0.472</td>
<td>286</td>
</tr>
<tr>
<td>9</td>
<td>Chest freezer</td>
<td>2.15</td>
<td>0.446</td>
<td>181</td>
</tr>
<tr>
<td>10</td>
<td>Multi-door or other appliances</td>
<td>(5)</td>
<td>See note</td>
<td>See note</td>
</tr>
</tbody>
</table>

**Fig. 24. Prescribed multipliers**

Note: For appliances in category 10 the values of M and N will be determined by the temperature and star rating of the compartment with the lowest temperature, as follows:

<table>
<thead>
<tr>
<th>Temperature of coldest compartment</th>
<th>Equivalent class</th>
<th>M</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; - 6 °C</td>
<td>1/2/3 Larder fridge/no-star/ fridge chiller</td>
<td>0.233</td>
<td>245</td>
</tr>
<tr>
<td>≤ - 6 °C</td>
<td>* Refrigerator (*)</td>
<td>0.643</td>
<td>191</td>
</tr>
<tr>
<td>≤ - 12 °C</td>
<td>** Refrigerator (**)</td>
<td>0.450</td>
<td>245</td>
</tr>
<tr>
<td>≤ - 18 °C</td>
<td>*** Refrigerator (***)</td>
<td>0.657</td>
<td>235</td>
</tr>
<tr>
<td>≤ - 18 °C with freezing capacity</td>
<td><em>(</em><strong>) Fridge/freezer <em>(</em></strong>)</td>
<td>0.777</td>
<td>303</td>
</tr>
</tbody>
</table>

**Fig. 25**

So, it turns out that categories 7, 8 and 9 can be subdivided into 2 subcategories, depending on ‘no frost’. Category 10 can be subdivided into at least 5 subcategories, depending on the temperature of the coldest compartment alone, per subcategory a few practical subcategories can be distinguished for different combinations plus ‘no frost’. So category 10 accounts for at least some 20 subcategories. On the next page you will find an (incomplete) summary of combinations of category, Ω, M and N.

---

27 For refrigerator/chillers Adjusted Volume = Net volume of fresh food compartment + Ω x net volume of chiller (10 °C) compartment (expressed in litres).

28 Adjusted net volume 𝑉𝐴𝑉 is calculated by the formula

\[ 𝑉𝐴𝑉 = \left(\frac{Ω}{Ω - T_c}\right) x V_c x F_c \]

Where \( T_c \) is design temperature (in °C) of each compartment, \( V_c \) is the net volume (in litres) of each compartment, and \( F_c \) is a factor 1,2 for ‘no frost’ compartments and 1 for other compartments.

29 For ‘no frost’ appliances this index is increased by a provisional factor 1,2, giving a value of 2,58. (This allows for the possible bias of the measurement method, which does not allow for the lack of ice build up on ‘no frost’ appliances. In practical use ice build up will somewhat increase the consumption of ‘conventional’ appliances.)
Fig. 26. Summary table of multipliers for categories and subcategories (based on design temperature: fridge =+5, no star = 0, *= -6, ** = -12, *** = -18 °C).

Calculation of ‘standard annual energy consumption’

With these values of $\Omega$, $M$ and $N$ plus the net volume of each type of compartment of the cold appliance to be labelled, it should now be possible to establish the reference value or -as the directive calls it - the ‘standard annual energy consumption of the appliance’ (expressed in kWh/year):

$\text{‘standard annual energy consumption of the appliance’} = M \times AV + N$, where

$AV$ (adjusted net volume) = net volume of fresh food compartment + $\Omega$ * net volume of frozen food compartment

Or, in case of fridge/freezers and multi-door appliances:

$AV = \sum \frac{(25 - T_C)}{20} \times V_C \times F_C$

Where $T_C$ is design temperature (in °C) of each compartment, $V_C$ is the net volume (in litres) of each compartment, and $F_C$ is a factor 1.2 for ‘no frost’ compartments and 1 for other compartments.

Calculation of ‘energy efficiency index $I$’

Once this ‘standard annual energy consumption’ is found, it has to be compared to the energy consumption according to EN 153 of the specific product at hand, to obtain the ‘energy efficiency index ($I$)’ (expressed as a percentage):
I = annual energy consumption / standard annual energy consumption of appliance.

**Determination of efficiency class**

With this energy efficiency index the energy label rating can be found using the following universal table (the same for all categories):

<table>
<thead>
<tr>
<th>Energy efficiency index I</th>
<th>Energy efficiency class</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I \leq 55$</td>
<td>A</td>
</tr>
<tr>
<td>$55 &lt; I \leq 75$</td>
<td>B</td>
</tr>
<tr>
<td>$75 &lt; I \leq 90$</td>
<td>C</td>
</tr>
<tr>
<td>$90 &lt; I &lt; 100$</td>
<td>D</td>
</tr>
<tr>
<td>$100 \leq I &lt; 110$</td>
<td>E</td>
</tr>
<tr>
<td>$110 \leq I &lt; 125$</td>
<td>F</td>
</tr>
<tr>
<td>$125 &lt; I$</td>
<td>G</td>
</tr>
</tbody>
</table>

![Fig. 27. Determining the energy efficiency class through the energy efficiency index.](image)

Please note, that the class-width is not the same in each class, but runs from 10 (in class D) to 20 (in class B).

The EU Energy Label scheme for refrigerators has recently been evaluated. In terms of market acceptance it has been a success, in terms of concrete energy savings the results so far are moderate (see chapter 4). A problem is the occurrence of inaccurate/false declarations, also in connection with the allowed tolerances. Studies of the Commission are underway to harmonise/optimise laboratory procedures and the European manufacturers association has set up an auto-policing system to tackle deliberately false declarations.

**7.2 Minimum Energy Efficiency Standards**

Another known policy instrument from the EC, DG XVII (SAVE program) is the Minimum Efficiency Standard for Refrigerators. 

This mandatory standard will be enforced by the end of 1999, practically banning all E, F, G labelled cold appliances and most of D-labeled appliances (EU Energy Label classes). Roughly speaking only A, B and C refrigerators will be allowed on the market next year (2000). The aim of this instrument is to eliminate the lower-end –in terms of energy efficiency-- of the market.

**7.3 EU Fridge/Freezer Procurement**

In a recent SAVE study, the procurement of a fridge freezer with an energy index of 40 (although there is debate to raise the limit to 43) will serve as a first example of EU procurement. This is 15 index points better than the present energy label class “A”. The call for proposals will be issued this year. The competition results are expected in a few years.

**7.4 EN Standards**

In the First Ecolabel Working Group ENEA identified a set of preliminary conditions for the ecolabel, including the relevant EN test standards, which are listed below:

APPLIANCES CHARACTERISTICS:

- household applications;
- electrically powered;
- compressor refrigerating circuit;
- total net capacity ranging up to 1,000 liters.

---


Official journal NO. L 236, 18/09/1996 P. 0036 - 0043
COMPLIANCE WITH EC REGULATION GOVERNING:

- health;
- safety;
- environment;
- materials in contact with foodstuffs.

COMPLIANCE WITH THE FOLLOWING EU REGULATIONS:

- EN 153, 1995 - Electric energy consumption
- EN 60335-2-24, 1994 - Safety
- TS CENELEC BTTF 95006, 1995, for hydrocarbons, within the framework of CCA (CENELEC Certification Agreement)
- pr EN 27371 - 0 to 3 stars refrigerators
- EN 28187, 1991 - Combined
- pr EN 28561 - No-Frost
- pr EN 25155 - Freezers
- EN 28960, 1993 - Noise

[For the final report this list has to be updated.]

7.5 Rebate programs
Taking the EU Energy Label scheme as a basis, many utilities and government organisations have developed rebate programs for refrigerators, usually involving the return of the old appliance for appropriate waste disposal combined with the purchase of an “A” or “A, B or C” class appliance. These rebate programs have been particularly useful in making the energy label known to a wide audience, especially in the Northern part of Europe. Rebates are in the order of 25 to 75 Euro per appliance.
Chapter 8

Ecolabels Update

8.1 EU Ecolabel Refrigerators

The full text of the Commission Decision of 26 November 1996 establishing the ecological criteria for the award of the Community eco-label to refrigerators is given in Appendix IV.

“Key criteria” mentioned in the Commission decision are.

1. Save energy. The appliance must have an energy efficiency index lower than 75% as defined in Directive 94/2/EC, Annex V, using the same test method EN 153 and the same classification in 10 categories. The appliance will thus qualify for either energy efficiency class ‘A’ or ‘B’ as defined in Directive 94/2/EC, Annex V.

2. Reduce ozone depletion potential (ODP) (1) of refrigerants and foaming agents. The refrigerants in the refrigerating circuit and foaming agents used for the insulation of the appliance shall have an ozone depletion potential equal to zero.

3. Reduce global warming potential (GWP) (2) of refrigerants and foaming agents. The refrigerants in the refrigerating circuit and foaming agents used for the insulation of the appliance, shall have a global warming potential equal to, or lower than, 15 (rated as CO2 equivalents over a period of 100 years).

Apart from this a series of “Best Practice Criteria” which relate to the information to be provided in the product manual, is defined:

4. Instruct the user. The appliance shall be sold with an instruction manual which provides advice on the correct environmental use and, in particular:
   1. recommendations for optimal use of energy in the operation of the appliance, including:
      1.1. Guidelines concerning the placing or installation of the refrigerator stating the minimum dimensions of free space around the appliance needed to ensure sufficient circulation of air;
      1.2. advice that the consumer should avoid placing the appliance next to any heat source (such as ovens, radiators, etc.) or in direct sunlight;
      1.3. advice that the thermostat setting should be dependent on the ambient temperature and should be checked by using an appropriate thermometer (explanation on how to proceed should be provided);
      1.4. advice that the door or lid should not be opened more often than needed and no longer than necessary, especially with regard to upright freezers;
      1.5. advice that hot foodstuffs should be allowed to cool down before placing in the appliance, as the steam from the foodstuffs contributes to the icing up of the evaporator unit;
      1.6. advice that the evaporator unit should be kept clean from thick layers of ice and that frequent defrosting facilitates the removal of the ice cover;
      1.7. Advice that the sealing of the door should be replaced when not functioning properly;
      1.8. advice that the radiator on the back of the appliance and the space underneath the appliance should be kept clean from dust or kitchen smoke;
      1.9. information that ignoring the issues mentioned above will lead to higher energy consumption.
   2. Advice that any damage to the radiator (heat-exchanger) on the back of the appliance, or other events leading to exposure of the refrigerant to the environment, should be avoided because of potential environmental and health risks.

The manual shall specifically mention that sharp objects (such as knives, screwdrivers, etc.) should not be used for removing ice as they could damage the evaporator unit.

3. Information that the appliance contains fluids and is made of parts and materials which are reusable and/or recyclable.

4. Advice that when disposing of the appliance the consumer should enquire about and follow the applicable waste-management routes.

5. Encourage recycling Plastic parts weighing more than 50 g must have a permanent marking identifying the material. The correct material abbreviations to be used are:
   1. PET
   2. HDPE
3. PVC
4. LDPE
5. PP
6. PS
7. all other plastics to conform to ISO 1043.
Also the type of refrigerant, and foaming agent used for the insulation, must be indicated on the appliance, near to or on the rating plate, to facilitate possible future recovery.

And finally the Commission text defines criteria for performance, testing and the type of consumer information which is to be provide clearly visible to the consumer.

6. Limit noise emission
   This criterion applies to the whole product group, except chest freezers indicated as category 9: ‘household food freezers, chest’ in Annex IV to Commission Directive 94/2/EC.
   Airborne noise from the appliance, counted as sound power, shall not exceed 42 dB(A) (re 1pW). The measurement of the noise level shall be in accordance with Council Directive 86/594/EEC (1) using EN 28960 standard.
7. Provide information on noise
   Information about the noise level of the appliance shall be provided in a way clearly visible to the consumer. This shall be done by the incorporation of this information in the energy label for refrigerators.

TESTING
8. Testing laboratories
   The testing shall be performed at the expense of the applicant by laboratories that meet the general requirements stressed in the EN 45001 standards.

CONSUMER INFORMATION
   The following text shall be provided in such a way as to be clearly visible for consumers (next to the label, whenever possible):
   - This product qualifies for the European Union eco-label because it is energy efficient, safeguards the ozone layer and has minimized contribution to the greenhouse effect.
   - Additional information on how to minimize environmental impact is given in the instruction manual.

In terms of number of applicants, the Ecolabel for refrigerators has not been very successful. So far, only Danish manufacturer Vestfrost has applied for the label and succeeded in obtaining it (in 1998). Vestfrost is using it on one particular model in their product range.
8.2 National Ecolabels for refrigerators in EU member states

A brief tour of the websites of national ecolabels revealed, that at the moment Milieukeur (The Netherlands) does not have its own ecolabel for refrigerators. Scandinavia (Nordic Swan), Germany (since 1995, Blaue Engel) and Austria (since 1997, Umweltzeichen) do have their own ecolabel for refrigerators. Their criteria are listed in Appendix IV.

As far as is known, neither the Blaue Engel nor the Austrian ecolabel have any applicants for the label.

The most important differences in criteria of Blaue Engel and Umweltzeichen with the EU ecolabel are, that
- both labels require an EU energy class “A” level as a minimum requirement (Ecolabel: “A” and “B”),
- both labels are more explicit regarding the information the manufacturer has to provide regarding the energy efficient operation of the appliance.
- The German label does not specify a required maximum noise level.
- The German label refers to general (German) VDI-guidelines (Verein Deutscher Ingenieure) for recycling-conscious product design (first edition 1982).

Whereas for the energy criterion, Blaue Engel and Umweltzeichen comply completely with the classification of the EU Energy Label, the Nordic Swan is different as it distinguishes only three classes. Full details of the Nordic Swan scheme are given in the appendix.

Figure 28. Blaue Engel (D), Umweltzeichen (AU), Milieukeur(NL), Nordic Swan (Scandinavia)

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31 VDI-Richtlinie 2243 “Konstruieren recyclinggerechter technischer Produkte”
32 Refrigerators, fridge/freezers, freezers. The EU Energy Label has 10 classes.
Chapter 9

**Opportunities for the new Ecolabel**

Except for the energy efficiency criterion and perhaps some minor adjustments to the best practice criteria, there is little need for revising the 1996 Ecolabel criteria. The requirement of an ODP of zero and a GWP of no more than 15 is fulfilled by 30% of the products on the market, meaning that hydrocarbons are being used as refrigerant and foaming agent. There are no indications that the requirements for refrigerants or foaming agents can realistically be made more strict, nor that they are too severe in their present form. The same can be said of the present noise level requirement of 42 dBA maximum, which is neither too much nor too little. The present requirements for instruction manuals ("Best practise criteria") are also fulfilled by many manufacturers.

Only the present requirement of complying with the “A” or “B” energy efficiency class is too lenient in 1999. Already 33% of all cold appliances comply with this criterion and it is expected that after the EU minimum efficiency standards will be applied by the end of 1999, perhaps as much as 50% of all appliances will be “A” or “B”. Already in the German and Austrian national ecolabel scheme a minimum requirement of “A” energy efficiency class is set and it lies in the line of reason that the new EU Ecolabel criteria will do the same.

But perhaps, there is an opportunity here...

Throughout Europe, not only with the EU Ecolabel, ecolabel schemes for refrigerators have been very unsuccessful in attracting manufacturers (or retailers for that matter). The only applicant, Vestfrost, still finds itself alone and cannot be expected to “carry” the ecolabel by itself on the long term.

An important reason is of course the financial scheme of fees behind the EU Ecolabel, but probably even more important is the fact that for refrigerators, which already have to carry the EU Energy Label, the Ecolabel is hardly adding any information to the consumer. Also for the utilities and governments promoting energy efficiency by giving rebates to “A” or “A/B/C” appliances, the EU Energy Label has proven to be a popular and adequate instrument. All this has led to a result where many manufacturers and some retailers actually start to like the EU Energy Label—and as is shown in chapter 6—actually find that they make more profit on efficient appliances. At a recent workshop, one manufacturer revealed that through a more product-oriented accounting system they were now able to establish that “A”-labeled contributed to 16% of their turnover, but to a full 23% of their profits. Also the market surveys by manufacturers start to show, that an increasing part of the customers find “energy efficiency” and “environment” important buying criteria (after “price” and “brand”). To a large extend, they say, this is due to the rebate programs which have made the consumers more aware.

The EU Energy Label classes are thus recognized as an important part of the marketing and R&D strategy and practically every manufacturer can boost one or a whole range of “A” labeled cold appliances in their catalogue. In the Italian newspaper La Republicca, the president of refrigerator manufacturer Ocean (part of Groupe Brandt), Mr. Gianfranco Nocivelli declares that he is in favor of rebates, but only for important issues like energy efficiency and only for the best. His appliances using the Alto Plus system (see patent, chapter 3) are supposedly 15% better than the “A” level and should become even better. In fact, another member of the Groupe Brandt, Blomberg, using this system, proposed an upright freezer at the 1999 Domotechinca claiming to be even 30% better than “A”.

Unfortunately, it will be difficult for these manufacturers to have the full commercial benefit from their super-efficient appliances, as there is no European or national yardstick which places such high demands on energy efficiency. Worse still, after 1999, when there are mainly A, B and C level cold appliances on the market, many utilities and governments may find it difficult to continue the rebate programs, because they will soon run out of money as many appliances will meet the toughest efficiency standards known in the EU (the “A” level). How big the market share of “A”-labeled

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33 comm. Vestfrost
34 which is under revision at the moment.
37 Frigo, si agli incentivi, ma solo per i migliori, La republicca, 8 Dec. 1998, p. 31.
appliances will be, is hard to say at the moment. And to a large extend it will also depend on how much manufacturers expect their customers to value the efficiency aspect and of course how much help they will get from rebate programs and promotional activities. But for the “Super-A” appliances the incentives will probably be very low.

Due to the long lead times for technical preparation and the political discussions after that a revised EU Energy Label scheme is expected to be in place only in 2002. This gives an opportunity for the EU Ecolabel scheme to step in and fill the gap between the end of 1999 and the year 2002. If the Ecolabel criteria, otherwise complying with EU Energy Label criteria, would put the threshold at 15% better than “A”38 the ecolabel would provide the manufacturers with an accepted European yardstick, allowing them to show off their most energy efficient products. Also the rebate programs would have a new target, which is easier to maintain on the long term financially than the present “A”-level. For the manufacturers, the target would not be too high as there are sufficient technical solutions, also besides the Groupe Brandt patent, to realize this type of efficiency (see chapter 3). In fact the Ecolabel might be exactly the marketing tool that is needed to further support the introduction of other options such as variable speed compressors.

38 meaning an energy efficiency index of 40 or 35, see chapter 7
APPENDIX I: Ecolabel criteria for refrigerators

- EU Ecolabel
- Blaue Engel (D)
- Austria Umweltzeichen
- Nordic Swan
EU ECOLABEL

Commission Decision of 26 November 1996 establishing the ecological criteria for the award of the Community eco-label to refrigerators (Text with EEA relevance)
Official journal NO. L 323, 13/12/1996 P. 0034 - 0037

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Community,

Having regard to Council Regulation (EEC) No 880/92 of 23 March 1992 on a Community eco-label award scheme (1), and in particular the second subparagraph of Article 5 (1) thereof,

Whereas the first subparagraph of Article 5 (1) of Regulation (EEC) No 880/92 provides that the conditions for the award of the Community eco-label shall be defined by product group;

Whereas Article 10 (2) of Regulation (EEC) No 880/92 states that the environmental performance of a product shall be assessed by reference to the specific criteria for the product groups;

Whereas it is appropriate to establish criteria expressing test methods and classification for energy consumption in conformity with Commission Directive 94/2/EC of 21 January 1994 implementing Council Directive 92/75/EEC with regard to energy labelling of household electric refrigerators, freezers and their combinations (2) and, moreover, to adapt the energy-consumption requirements to technological innovation and market developments;

Whereas in accordance with Article 6 of Regulation (EEC) No 880/92 the Commission has consulted the principal interest groups within a consultation forum;

Whereas the measures set out in this Decision are in accordance with the opinion of the Committee set up pursuant to Article 7 of Regulation (EEC) No 880/92,

HAS ADOPTED THIS DECISION:

Article 1
The product group ‘refrigerators’ (hereinafter referred to as ‘the product group’) shall mean: Electric, mains-operated household refrigerators, frozen food storage cabinets, food freezers and their combinations. Appliances that may also use other energy sources, such as batteries, are excluded.

Article 2
The environmental performance and the fitness for use of the product group shall be assessed by reference to the specific ecological criteria set out in the Annex.

Article 3
The product group definition and the specific ecological criteria for the product group shall be valid for a period of three years from the date on which this Decision takes effect.

Article 4
For administrative purposes the product group code number assigned to this product group shall be ‘012’.

Article 5
This Decision is addressed to the Member States.
Done at Brussels, 26 November 1996.
For the Commission Ritt Bjerregaard Member of the Commission

ANNEX

FRAMEWORK
In order to be awarded an eco-label, the appliance shall comply with the criteria of this Annex which are aimed at promoting:

- reduction of environmental damage or risks related to the use of energy (global warming, acidification, depletion of non renewable energy sources) by reducing energy consumption,
• reduction of environmental damage or risks related to the use of potentially ozone-depleting substances by reducing the use of these substances,
• reduction of environmental damage or risks related to the use of substances which may have a global-warming potential.

Additionally, the criteria encourage the implementation of best practice (optimal environmental use) and enhance consumers' environmental awareness. Furthermore the recycling of the machine is encouraged by marking of plastic components.

**KEY CRITERIA**

1. **Save energy** The appliance must have an energy efficiency index lower than 75% as defined in Directive 94/2/EC, Annex V, using the same test method EN 153 and the same classification in 10 categories.

   The appliance will thus qualify for either energy efficiency class 'A' or 'B' as defined in Directive 94/2/EC, Annex V.

2. **Reduce ozone depletion potential (ODP)** (1) of refrigerants and foaming agents The refrigerants in the refrigerating circuit and foaming agents used for the insulation of the appliance shall have an ozone depletion potential equal to zero.

3. **Reduce global warming potential (GWP)** (2) of refrigerants and foaming agents The refrigerants in the refrigerating circuit and foaming agents used for the insulation of the appliance, shall have a global warming potential equal to, or lower than, 15 (rated as CO2 equivalents over a period of 100 years).

**BEST PRACTICE CRITERIA**

4. **Instruct the user** The appliance shall be sold with an instruction manual which provides advice on the correct environmental use and, in particular:

   1. recommendations for optimal use of energy in the operation of the appliance, including:
      1.1. Guidelines concerning the placing or installation of the refrigerator stating the minimum dimensions of free space around the appliance needed to ensure sufficient circulation of air;
      1.2. advice that the consumer should avoid placing the appliance next to any heat source (such as ovens, radiators, etc.) or in direct sunlight;
      1.3. advice that the thermostat setting should be dependent on the ambient temperature and should be checked by using an appropriate thermometer (explanation on how to proceed should be provided);
      1.4. advice that the door or lid should not be opened more often than needed and no longer than necessary, especially with regard to upright freezers;
      1.5. advice that hot foodstuffs should be allowed to cool down before placing in the appliance, as the steam from the foodstuffs contributes to the icing up of the evaporator unit;
      1.6. advice that the evaporator unit should be kept clean from thick layers of ice and that frequent defrosting facilitates the removal of the ice cover;
      1.7. Advice that the sealing of the door should be replaced when not functioning properly;
      1.8. advice that the radiator on the back of the appliance and the space underneath the appliance should be kept clean from dust or kitchen smoke;
      1.9. information that ignoring the issues mentioned above will lead to higher energy consumption.

   2. Advice that any damage to the radiator (heat-exchanger) on the back of the appliance, or other events leading to exposure of the refrigerant to the environment, should be avoided because of potential environmental and health risks.

   The manual shall specifically mention that sharp objects (such as knives, screwdrivers, etc.) should not be used for removing ice as they could damage the evaporator unit.

3. Information that the appliance contains fluids and is made of parts and materials which are reusable and/or recyclable.

4. Advice that when disposing of the appliance the consumer should enquire about and follow the applicable waste-management routes.

5. Encourage recycling Plastic parts weighing more than 50 g must have a permanent marking identifying the material. The correct material abbreviations to be used are:

   1. **PET**
   2. **HDPE**
   3. **PVC**
   4. **LDPE**
   5. **PP**
   6. **PS**
   7. **all other plastics to conform to ISO 1043**.
Also the type of refrigerant, and foaming agent used for the insulation, must be indicated on the appliance, near to or on the rating plate, to facilitate possible future recovery.

**PERFORMANCE CRITERIA**

6. Limit noise emission
   This criterion applies to the whole product group, except chest freezers indicated as category 9: ‘household food freezers, chest’ in Annex IV to Commission Directive 94/2/EC.
   Airborne noise from the appliance, counted as sound power, shall not exceed 42 dB(A) (re 1pW). The measurement of the noise level shall be in accordance with Council Directive 86/594/EEC (1) using EN 28960 standard.

7. Provide information on noise
   Information about the noise level of the appliance shall be provided in a way clearly visible to the consumer. This shall be done by the incorporation of this information in the energy label for refrigerators.

**TESTING**

8. Testing laboratories
   The testing shall be performed at the expense of the applicant by laboratories that meet the general requirements stressed in the EN 45001 standards.

**CONSUMER INFORMATION**

The following text shall be provided in such a way as to be clearly visible for consumers (next to the label, whenever possible):

- This product qualifies for the European Union eco-label because it is energy efficient, safeguards the ozone layer and has minimized contribution to the greenhouse effect.
- Additional information on how to minimize environmental impact is given in the instruction manual.
BLAUE ENGEL (GERMANY) CRITERIA FOR REFRIGERATORS:

Energiesparende Kühl- und Gefriergeräte
RAL-UZ 75
*Ausgabe: Juni 1995*

Anforderungen
Mit dem oben abgebildeten Umweltzeichen können die unter Geltungsbereich genannten Produkte gekennzeichnet werden, wenn sie folgende Anforderungen erfüllen:

1. Das verwendete Kältemittel darf nicht unter Zusatz halogenorganischer Stoffe hergestellt werden.
2. Das verwendete Schmiermittel des Kältemittelverdichters darf nicht unter Zusatz halogenorganischer Stoffe hergestellt werden.
4. Die Geräte müssen die Anforderungen der Energieeffizienzklasse A gemäß Anhang 5 der Richtlinie 94/2 EG der Europäischen Kommission erfüllen.
7. Das Gerät muß mit einer Kennzeichnung versehen sein, die Auskunft über das enthaltene Kältemittel und die Art des Wärmedämmstoffes gibt. Ferner müssen in der Kennzeichnung und der Gebrauchsanweisung folgende Hinweise zur Entsorgung des Gerätes enthalten sein:
   - Eine Beschädigung des Kältemittelkreislaufs, insbesondere des Wärmetauschers auf der Rückseite des Gerätes, ist zu vermeiden,
   - Auskunft über Art der Entsorgung, Abholtermine oder Sammelplätze gibt die örtliche Stadtreinigung, die Gemeindeverwaltung oder der Fachhandel.
8. Die Gebrauchsanweisung muß darüber hinaus folgende Hinweise enthalten:
   - Das Gerät sollte nicht in unmittelbarer Nähe von Heizkörpern und Kochherden aufgestellt werden;
   - ein Standort mit direkter Sonneneinstrahlung sollte vermieden werden;
   - Hinweise zum optimalen Aufstellungsort.

1) Entsprechende Hinweise sind der VDI-Richtlinie 2243 "Konstruieren recyclinggerechter technischer Produkte" zu entnehmen.
Einleitung


Produktgruppedefinition

Elektrisch betriebene Kühl-, Tiefkühl- und Gefriergeräte sowie Kombinationen daraus. Geräte für den Haushaltsbereich, die < 1,5 kg Kältemittel enthalten.

Anmerkung:

Wenn in dieser Richtlinie auf Gesetze oder Normen verwiesen wird, ist die jeweils aktuell gültige Fassung gemeint.

Umweltkriterien

Energieverbrauch

Betriebsmittel und Produktionshilfsstoffe
Für alle eingesetzten Betriebsmittel (Kältemittel, Schmiermittel) sowie für die zur Herstellung der Isolierschäume eingesetzten Treibmittel gelten folgende Anforderungen:
• keine halogenorganischen Stoffe.
• Das Ozonabbaupotential (ODP) muß Null betragen.
• Das Potential zur Erwärmung der Erdatmosphäre (GWP) darf höchstens 15 betragen.

Geräuschemission
Der Geräuschpegel darf 42 dB(A) (re 1pW) nicht überschreiten (Messung nach ÖNORM EN 28960).

Materialien
• Kennzeichnung aller Kunststoffteile mit einem Gewicht ≥ 50 g gemäß ISO 11469 in Verbindung mit ISO 1043-1.
• Halogenierte Kunststoffe sind ausgeschlossen. Ausnahme: Funktionell benötigte Kleinteile; die technische Notwendigkeit des Einsatzes solcher Kunststoffe ist zu belegen und vom Gutachter zu bewerten.

Produktion
Als Produktionsstätte gilt der Betrieb, in dem die Geräte assembliert werden.

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• Die Einhaltung der aktuellen nationalen gesetzlichen und normungstechnischen Anforderungen bzw. behördlichen Auflagen ist nachzuweisen. Für im Ausland befindliche Produktionsstätten sind die entsprechenden, dort geltenden nationalen Bestimmungen einzuhalten, wenn diese mindestens den Anforderungen der jeweiligen EU-Regelungen genügen. Andernfalls sind die EU-Vorgaben zu erfüllen.


Dies ist dem Gutachter durch entsprechende Unterlagen und Prüfzeugnisse darzustellen.

**Verpackung**

• Einsatz von wiederverwendbaren oder stofflich verwertbaren Materialien.

• Keine halogenierten oder unter Verwendung halogenierter Produktionshilfsmittel hergestellten Kunststoffe.

**Pflichten der Hersteller und Vertreiber von Verpackungen**

Hersteller und Vertreiber von Verpackungen haben für deren geordnete Entsorgung entweder selbst zu sorgen oder sich nachweislich bestimmter Dritter zu bedienen. Es gelten die Bestimmungen der Verpackungs-Verordnung.

**Aspekte der Langlebigkeit und Entsorgung**

• Reparaturfreundliche und recyclinggerechte und Konstruktion.

• Ersatzteilgarantie des Herstellers für mindestens 10 Jahre.

• Die Einhaltung jeweils geltender gesetzlicher Regelungen zur Geräterücknahme und Entsorgung ist nachzuweisen.

Die für die Bewertung bzw. Beurteilung der Punkte 2.1 - 2.7 notwendigen Daten müssen dem Gutachter mitgeteilt werden und sind in das Gutachten aufzunehmen [z. B.: aktuelle Sicherheitsdatenblätter aller eingesetzten Betriebsmittel und Produktionshilfsmittel (z. B. Treibmittel), vollständige Materiallisten, Konstruktionspläne)].

**Gebrauchstauglichkeit**

**Allgemeine Kriterien**

Es gelten die Anforderungen der ÖNORM EN 153. Für Tiefkühl- und Gefriergeräte gelten darüber hinaus folgende Anforderungen (ausgenommen Kühl/Gefrierkombinationen):

• Temperaturanstieg im Störungsfall von \(-18^\circ C\) auf \(-9^\circ C\) ≥ 25 Stunden.

• Gefriervermögen ≥ 10 kg/24 Stunden und 100 l Nutzinhalt.

**Elektrotechnische Sicherheit und elektromagnetische Verträglichkeit**


** Deklaration und umweltschonende Benutzung**

• Energieetikett gemäß Richtlinie 94/2/EG bzw. BGBl 569/1994; die Angabe des gemessenen Geräuschpegels (siehe Punkt 3.3) am Energieetikett ist obligat.

• Das verwendete Kältemittel (Art und enthaltene Menge), Art des verwendeten Treibmittel für Isolierschäume sowie Entsorgungshinweise sind anzugeben.

• Dem Gerät muß eine Information (z. B. Gebrauchsanweisung, Benutzerhandbuch) mit folgenden Ratschlägen für eine umweltgerechte Nutzung beiliegen:

  ⇒ Hinweis, daß der Verbraucher das Gerät nicht neben einer Wärmequelle (z. B. Herd, Heizzkörper, Geschirrspüler) aufstellen und nicht unmittelbarer Sonnenstrahlung aussetzen soll.

  ⇒ Leitfaden zum Aufstellen und Anschließen des Gerätes unter Angabe, wieweil Freiraum um das Gerät herum mindestens erforderlich ist, um eine hinreichende Luftzirkulation zu gewährleisten.

  ⇒ Hinweis, daß die Thermostatinstellung von der Raumtemperatur abhängig sein sollte und mit Hilfe eines geeigneten Thermometers zu überprüfen ist (Anweisungen zur richtigen Vorgehensweise sind beizulegen).

41 Verpackungsverordnung BGBl 648/1996.
⇒ Hinweis, daß Tür oder Deckel nicht häufiger und nicht länger geöffnet werden sollten als notwendig.

⇒ Hinweis, daß warme Speisen abkühlen sollten, bevor sie in das Gerät gestellt werden, da der von den Speisen ausgehende Dampf zur Vereisung des Gerätes beiträgt.

⇒ Hinweis, daß die Verdampfereinheit von einer dicken Eis schicht freizuhalten ist und häufiges Abtauen die Entfernung der Eis sicht erleichtert. Zur Entfernung von Eis dürfen keine scharfen Gegenstände (z. B. Messer, Schraubenzieher) verwendet werden, da durch diese der Verdampfer beschädigt werden kann.

⇒ Hinweis, daß die Dichtung der Tür zu erneuern ist, wenn diese nicht ordnungsgemäß funktioniert.

⇒ Hinweis, daß der Wärmetauscher auf der Rückseite des Gerätes sowie der Raum unterhalb des Gerätes von Staub und Küchendämpfen freizuhalten sind.

⇒ Hinweis, daß die Beachtung der Ratschläge den Energieverbrauch reduziert.

Wünschenswert sind prägnante Hinweise auf Ratschläge zur umweltschonenden Benutzung des Gerätes, damit diese einfach aufzufinden sind (z. B. eigenes Kapitel in der Gebrauchsanleitung, extra Hinweis mit entsprechendem Symbol oder markante Kurzfassung auf einem Papier höherer Grammatur).

Alle Elemente der Deklaration sind dem Gutachten beizulegen.
5. Criteria for ecolabelling

A corrected net volume $V_{eq}$ is calculated for refrigerated domestic appliances using a calculation method obtained from the EC energy labelling scheme in which all of the Nordic countries participate (Commission Directive 94/2/EC). This makes it easier to compare the data between the mandatory energy labelling and the Nordic environmental labelling.

The net volume ($V$) of all refrigerated compartments are re-calculated using a quality factor $f$, and are then added together.

$$ V_{eq} = \sum Vf $$

If compensates for the temperature difference of every compartment in relation to the room temperature, and give a bonus to the energy consumption of self-defrosting freezers, since the test standard for the electricity consumption of refrigerated appliances, i.e. EN 153, does not reflect appropriately the energy consumption of these appliances in practice. This gives the quality factor $f$ as shown below. $T$ is the temperature of the compartment.

<table>
<thead>
<tr>
<th>Type of refrigerated compartment</th>
<th>$T(\circ C)$</th>
<th>$f$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiller</td>
<td>10</td>
<td>0.75</td>
</tr>
<tr>
<td>Refrigerator</td>
<td>5</td>
<td>1.00</td>
</tr>
<tr>
<td>Ice-making compartment</td>
<td>0</td>
<td>1.25</td>
</tr>
<tr>
<td>Frozen food compartment *</td>
<td>-6</td>
<td>1.55</td>
</tr>
<tr>
<td>Frozen food compartment **</td>
<td>-12</td>
<td>1.85</td>
</tr>
<tr>
<td>Frozen food compartment ***, Freezer compartment * ***</td>
<td>-18</td>
<td>2.15</td>
</tr>
<tr>
<td>Freezer, separate or in a combination * ***</td>
<td>-18</td>
<td>2.15</td>
</tr>
<tr>
<td>Freezer, as above, self-defrosting * ***</td>
<td>-18</td>
<td>2.58</td>
</tr>
</tbody>
</table>

All of the following environmental criteria shall be met by the applicant if a licence is to be granted.

5.1 Performance

All compartments of the refrigerated appliance shall maintain the specified temperature well when subjected to a standard test (see section 7.3).

5.2 Operating data
5.2.1 Electricity consumption

The electricity consumption limits for the three sub-groups during operation are as follows:

1. Refrigerator with freezer compartment \( E_1 \leq 230 + 0.36 \text{ V}_{eq} \)
2. Refrigerator \( E_2 \leq 130 + 0.24 \text{ V}_{eq} \)
3. Freezer \( E_3 \leq 280 + 0.30 \text{ V}_{eq} \)

where \( \text{V}_{eq} \) is the corrected net volume in litres and \( E \) is given in kWh per full year of operation, i.e. 365 days.

No requirements are made on the energy efficiency of appliances powered by their own solar cells or equivalent.

Note that measurement is subject to certain tolerances, as specified in section 7.1.

5.2.2 Noise

Airborne noise from the appliance, reckoned as sound power level, must not exceed 40 dB(A). The noise level shall be measured when the compressor is running and shall be specified as a mean value of several measurements, with the specified time interval.

5.3 Materials and handling of residues

5.3.1 Refrigerant and foaming agent

The refrigerant and other chemicals used in the production process and the foaming agent used in the production of the insulating foam or other plastic parts shall have no known effects on the stratospheric ozone layer in accordance with IPCC\(^1\). The greenhouse effect of the same chemicals, measured as GWP\(_{100\text{ year}}\), shall be less than 5.

5.3.2 Plastic parts

Substances based on cadmium, lead, mercury or their compounds or the following flame-retardant must not be added to plastic materials:

PBB (polybrominated biphenyls):
- decabromo biphenyl \(13654-09-6\)

PBDE (polybrominated diphenyl ethers):
- monobromo diphenyl ethers \(101-55-3\)
- dibromo diphenyl ethers \(2050-47-7\)
- tribromo diphenyl ethers \(49690-94-0\)
- tetrabromo diphenyl ethers \(40088-47-9\)
- pentabromo diphenyl ethers \(32534-81-9\)
- hexabromo diphenyl ethers \(36483-60-0\)
- heptabromo diphenyl ethers \(68928-80-3\)
- octabromo diphenyl ethers \(32536-52-0\)
- nanobromo diphenyl ethers \(63936-56-1\)
- decabromo diphenyl ethers \(1163-19-5\)

Chloroparaffin with a chain length of 10 - 13 C atoms and chlorine content >50% \(85535-84-8\)

Other halogenated flame retardant are acceptable in other plastic parts, provided that they can be documented as being necessary for electrical and fire safety reasons according to the Low Voltage Directive (EN 603 35-1).

Printed circuit boards are excepted from the requirement about halogenated flame retardant.
To enable plastic parts to be recovered when the machine is scrapped, all plastic components weighing more than 50 g shall be durably marked. The abbreviations used shall be PET, HDPE, PVC, LDPE, PP and PS. For other plastics, in accordance with DIN 7728/ISO 1043.

5.3.3 Equipment

All refrigerators and freezers that have no permanently mounted thermometer shall be accompanied, when sold, by a loose thermometer, which is well suited for measuring the temperature.

5.3.4 Surface treatment

Plastic coating performed in the assembly factory shall be carried out by means of a solvent-free method. Paints must not contain pigments or additives based on lead, cadmium, chromium, mercury or their compounds. Paints must not contain more than 5% by weight of organic solvents.

Metals must not be coated with cadmium, chromium, nickel or their compounds. In exceptional cases, small parts such as screws and hinges may be coated with chromium, nickel or their compounds.

Surface coated metal sheet shall be specified as regards the size of the coated area and the thickness of the surface coating.

5.3.5 Residual product plan

A plan shall be prepared to describe a method and estimate the costs of disposing of the appliances at the end of their useful life. The method shall include a procedure for neutralising the hydrocarbons in the refrigerant circuit and in the insulation. The estimate shall be made in current monetary value and shall be based on current price information for dismantling, shredding, disposal and sale of usable parts, or whatever else the handling may involve.

5.4 Packaging

Packaging shall not contain chlorine-based plastics.

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1 Intergovernmental Panel on Climate Change, World Meteorological Organisation.
5.5 Environmental information

Environmental information shall be included in the installation and user instructions for the appliance. The text shall contain the following information and suggestions:

- locate the appliance so that the heat exchanger can be kept clean and cool, e.g. a separate freezer in a basement. The information should also include detailed instructions concerning distances and ventilation facilities in adjacent cabinets

- keep the heat exchanger clean by removing dust and kitchen deposits

- measure the temperature and adjust the thermostat, if necessary

- defrost the appliance when a layer of ice which is about 5 mm thick has formed, unless this is done automatically

- replace the seals as necessary

- avoid leaving the door open, particularly on a freezer

- hand in the refrigerator/freezer for recovery at the end of its useful life

- particulars of the reasons for the Swan marking of refrigerators and freezers.

A text suggestion is given in the appendix.

6. Other demands

6.1 Official requirements

The holder of a Nordic ecolabelling licence is responsible for ensuring that environmentally labelled products, their production and the manufacture of the raw materials used and other components conform to all provisions of the relevant legislation and official requirements in each place and in each country as regards environment protection and industrial safety. This applies, for instance, to the emissions to atmosphere and watercourses, and further processing of sludge.

The licensee shall ensure that the provisions of the legislation on corporate liability for products and packages are met in the Nordic countries in which the environmentally labelled product is marketed.

6.2 Quality assurance and environmental assurance

A manufacturer, who applies for an environmental labelling licence, either on his owns behalf or through the seller/importer, shall draw up documented routines and instructions for:

- safeguarding that the requirements for environmental labelling are met

- safeguarding the standard of quality of environmentally labelled products included in the licence, so that their raw material always conforms to the information submitted

- reporting on how the organisational structure for the internal quality assurance and environmental assurance is made up, to ensure that the environmental labelling requirements are met

- ensuring that sub-contractors also have documented routines and instruction related the environmental labelling requirements

- ensuring that the internal inspection is co-ordinated by a liaison person
This takes place by the manufacturer/applicant giving all particulars specified in section 7.4 in a file entitled "Collected documentation for Nordic environmental labelling". The documents shall be stored together and shall be available until the validity period of the criteria has expired.

6.3 Marketing

In the "Collected documentation", the applicant shall also give particulars of:

1. A plan for training the marketing staff concerning the requirements in the ecolabelling criteria and the principles of ecolabelling.

2. Distribution of responsibility in the marketing as regards the principles of ecolabelling and the conditions specified in the "Regulations for Nordic ecolabelling of products".

7. Testing

7.1 Scope of type testing

One appliance selected at random under the supervision of an independent body shall be submitted for testing the performance, operating data and labelling of plastic parts. If the appliance does not meet the criteria specified in section 5 within a tolerance of 10% as regards energy consumption, testing shall be repeated on a further three appliances selected at random. In this case, the average of the three shall meet the requirements within a tolerance of 7%.

The applicant shall meet the costs of type testing.

7.2 Test laboratories

The applicant may choose between impartial and competent test laboratories that regularly employ EN 153. Advice concerning suitable laboratories can be obtained from the environmental labelling authority in the country in which the application is submitted.

The environmental labelling authority ensures that the analysis laboratory conforms to the general requirements of the EN 45 0001 standard or ISO-IEC Guide 25 or has official GLP approval.

7.3 Test methods

The following standards are applicable to the testing of refrigeration data, volume measurement of compartments of various types, and conformance to official requirements on health, safety and materials in contact with foods: EN 60335-2-24, 1994 (safety), TS CENELEC BTTF 95006, 1995 (safety, alkanes), EN 27371 (refrigerators with zero to three star freezer compartments), EN 28187, 1991 (combined refrigerators/freezers), EN 28561 (self-defrosting refrigerators and freezers) and EN 25155 (freezers).

The electricity consumption shall be tested in accordance with EN 153 and noise in accordance with EN 28960, 1993.

Scientifically assessed literature references may be employed for demonstrating that chemicals conform to the requirements.
APPENDIX II: CECED DATABASE

Models per Energy Efficiency Class (10 categories)
APPENDIX III: Draft Criteria for the 1999 Refrigerator Eco-label
Draft COMMISSION DECISION
of ___ __________ 1999
establishing the ecological criteria for the award of the Community eco-label to refrigerators
(Text with EEA relevance)

(99/__/EC)

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Community,

Having regard to Council Regulation (EEC) No 880/92 of 23 March 1992 on a Community eco-label award scheme, and in particular the second subparagraph of Article 5 (1) thereof,

Whereas the first subparagraph of Article 5 (1) of Regulation (EEC) No 880/92 provides that the conditions for the award of the Community eco-label shall be defined by product groups;

Whereas Article 10 (2) of Regulation (EEC) No 880/92 states that the environmental performance of a product shall be assessed by reference to the specific criteria for product groups;

Whereas it is appropriate to establish criteria expressing test methods and classification for energy consumption in conformity with Commission Directive 94/2/EC of 21 January 1994 implementing Council Directive 92/75/EEC with regard to energy labelling of household electric refrigerators, freezers and their combinations, and, moreover, to adapt the energy-consumption requirements to technological innovation and market developments;

Whereas, by Decision 96/703/EC, the Commission established ecological criteria for the award of the Community eco-label to refrigerators, which, according to Article 3 thereof, expire 13 December 1999;

Whereas it is appropriate to adopt a new Decision establishing ecological criteria for this product group, in order to allow for the participation in the Community eco-label award scheme of manufacturers and importers of refrigerators;

Whereas in accordance with Article 6 of Regulation (EEC) No 880/92 the Commission has consulted the principal interest groups within a consultation forum;

Whereas the measures provided for in this Decision are in accordance with the opinion of the Committee set up pursuant to Article 7 of Regulation (EEC) No 880/92,
HAS ADOPTED THIS DECISION:

Article 1

The product group ‘refrigerators (hereinafter referred to as 'the product group’) shall mean:

Electric, mains-operated household refrigerators, frozen food storage cabinets, food freezers and their combinations.

Appliances that may also use other energy sources, such as batteries, are excluded.

Article 2

The environmental performance and the fitness for use of the product group shall be assessed by reference to the criteria set out in the Annex.

Article 3

The product group definition and the criteria for the product group shall be valid from 13 December 1999 until 1 December 2001. If revised criteria have not been adopted before the end of this period, their validity shall be extended for a further year or until the date of adoption of the new criteria, whichever is sooner.

Article 4

For administrative purposes the product group code number assigned to this product group shall be '012'.

Article 5

This Decision is addressed to the Member States.

Done at Brussels, ______________1999.

For the Commission
Ritt BJERREGAARD
Member of the Commission
ANNEX

ECOLOGICAL CRITERIA
FRAMEWORK

In order to be awarded an eco-label, the appliance shall comply with the criteria of this Annex, which are aimed at promoting:

– reduction of environmental damage or risks related to the use of energy (global warming, acidification, depletion of non-renewable energy sources) by reducing energy consumption,

– reduction of environmental damage or risks related to the use of potentially ozone-depleting and other hazardous substances by reducing the use of these substances,

– reduction of environmental damage or risks related to the use of substances which may have a global-warming potential.

Additionally, the criteria encourage the implementation of best practice (optimal environmental use) and enhance consumers' environmental awareness.

Furthermore, marking the plastic components encourages the recycling of the machine.

The Competent Bodies are recommended to take into account the implementation of recognised environmental management schemes, such as EMAS or ISO 14001, when assessing applications and monitoring compliance with the criteria in this Annex (note: it is not required to implement such management schemes).

KEY CRITERIA

1 Energy savings

The appliance must have an energy efficiency index lower than 40% as defined in Directive 94/2/EC, Annex V, using the same test method EN 153 and the same classification in 10 categories.

The applicant shall provide a copy of the technical documentation referred to under article 2 paragraph 1 of Commission Directive 94/2/EC.

In case of verification, which is not required on application, Competent Bodies shall apply the tolerances and control procedures laid down in EN 153. The latter implies, that in a situation where one (1) randomly chosen refrigerator is being tested to verify compliance with an "Energy Index of 40", the measured energy consumption should be within 15% from the Energy Index of 40. In other words: The Energy Index should be at least 46. If the Energy Index is higher than 46, the test institute should then proceed to measure three (3) randomly chosen refrigerators of the same model. The average of the measured energy consumption figures should then not deviate more than 10% from an Energy Index of 40. In other words: The (average) Energy Index should be at least 44. If this is not the case, the refrigerator does not comply with this Ecolabel criterion. [Note: This text is an amendment not included in the proposal to the consultation forum, but discussed in the last Competent Body meeting.]
2 **Reduction of ozone depletion potential (ODP) of refrigerants and foaming agents**

The refrigerants in the refrigerating circuit and foaming agents used for the insulation of the appliance shall have an ozone depletion potential equal to zero.

3 **Reduction of global warming potential (GWP) of refrigerants and foaming agents**

The refrigerants in the refrigerating circuit and foaming agents used for the insulation of the appliance, shall have a global warming potential equal to, or lower than, 15 (rated as CO2 equivalents over a period of 100 years).

**BEST PRACTICE CRITERIA**

4 **Life-time extension**

The manufacturer shall offer a commercial guarantee to ensure that the appliance will function for at least 3 years. This guarantee shall be valid from the date of delivery to the customer. The availability of compatible replacement parts and service shall be guaranteed for 5 years from the time of shipment.

5 **Take-back and recycling**

The manufacturer shall offer, free of charge, the take-back for recycling of the refrigerator and of components being replaced, except for items contaminated by users (e.g. refrigerators originating from medical or nuclear establishments).

In addition, the refrigerator shall meet the following criteria:

1. Plastic parts heavier than 50 grams shall:
   - not contain flame retardants that contain organically bound bromine or chlorine;
   - not contain flame retardant substances or preparations containing substances, that are assigned or may be assigned any of the risk phrases R45 (may cause cancer), R46 (may cause heritable genetic damage), R50 (very toxic to aquatic organisms), R51 (toxic to aquatic organisms), R52 (harmful to aquatic organisms), R53 (may cause long-term adverse effects in the aquatic environment), R60 (may impair fertility) or R61 (may cause harm to the unborn child), as defined in Council Directive 67/548/EEC\(^2\) as last amended by Commission Directive 98/98/EEC\(^2\);
   - have a permanent marking identifying the material, in conformity with ISO 11469. Excluded from this criterion are extruded plastic parts;
   - have no lead or cadmium intentionally added.

2. The type of refrigerant and foaming agent used for the insulation shall be indicated on the appliance, near to or on the rating plate, to facilitate possible future recovery.

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\(^1\) OJ No 196, 16.8.1967, p.1.
6 User instructions

The appliance shall be sold with an instruction manual, which provides advice on the correct environmental use and, in particular:

1. recommendations for optimal use of energy in the operation of the appliance, including:
   1.1. Guidelines concerning the placing or installation of the refrigerator stating the minimum dimensions of free space around the appliance needed to ensure sufficient circulation of air;
   
   1.2. Advice that the consumer should avoid placing the appliance next to any heat source (such as ovens, radiators, etc.) or in direct sunlight;
   
   1.3. Advice that the thermostat setting should be dependent on the ambient temperature and should be checked by using an appropriate thermometer (explanation on how to proceed should be provided);
   
   1.4. Advice that the door or lid should not be opened more often than needed and no longer than necessary, especially with regard to upright freezers;
   
   1.5. Advice that hot foodstuffs should be allowed to cool down before placing in the appliance, as the steam from the foodstuffs contributes to the icing up of the evaporator unit;
   
   1.6. Advice that the evaporator unit should be kept clean from thick layers of ice and that frequent defrosting facilitates the removal of the ice cover;
   
   1.7. Advice that the sealing of the door should be replaced when not functioning properly;
   
   1.8. Advice that when moving the appliance sufficient time should be allowed before switching it on again;
   
   1.9. Advice that the condenser on the back of the appliance and the space underneath the appliance should be kept clean from dust or kitchen smoke;
   
   1.10. Information that ignoring the issues mentioned above will lead to higher energy consumption.

1. Advice that any damage to the condenser (heat-exchanger) on the back of the appliance, or other events leading to exposure of the refrigerant to the environment, should be avoided because of potential environmental and health risks. The manual shall specifically mention that sharp objects (such as knives, screwdrivers, etc.) should not be used for removing ice as they could damage the evaporator unit.

2. Information that the appliance contains fluids and is made of parts and materials which are reusable and/or recyclable.
3. Advice on how the consumer can make use of the manufacturers take-back offer.

FITNESS FOR USE CRITERIA

7 Limit noise emission

Airborne noise from the appliance, counted as sound power, shall not exceed 42 dB(A) (re lPWh).

Information about the noise level of the appliance shall be provided in a way clearly visible to the consumer. This shall be done by the incorporation of this information in the energy label for refrigerators.

The measurement of the noise level and the information relating to noise shall be provided in accordance with Council Directive 86/594/EEC, using EN 28960 standard.

This criterion does not apply to chest freezers indicated as category 9: “household food freezers, chest” in Annex IV of Commission Directive 94/2/EC.

TESTING

8 Testing laboratories

The testing shall be performed at the expense of the applicant by laboratories that meet the general requirements stressed in the EN 45001 standards.

CONSUMER INFORMATION

The following text shall be provided in such a way as to be clearly visible for consumers (next to the label, whenever possible):

– This product qualifies for the European Union eco-label because it is economical with energy, safeguards the ozone layer and has minimised contribution to the greenhouse effect.