Energy

Preparatory Studies for Eco-design Requirements of EuPs

(Tender TREN/D1/40-2005)

LOT 14: Domestic Washing Machines and Dishwashers

Final Report

Draft Version

Tasks 1 -2

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NOTE: according to international standards dealing with quantities and units, the numbers in this study are written according to the following rules:

- the comma "," is the separator between the integer and the decimal part of a number
- numbers with more than three digits are divided by a blank in groups of three digits
- in case of monetary values the numbers are divided by a dot in groups of three digits.

0 Brief summary of the Study Tasks

Washing machines and dishwashers, also known as "wash appliances", have been the second and most studied EuP in the European Union with the goal to reduce their energy consumption. In 1995, the study of the Group for Efficient Appliances (GEA, 1995) provided the technical basis for the energy labeling Directive, and later also partially for the Eco-label awarding criteria. Its results and methodology were the starting point for the second study on washing machines (NOVEM, 2000, known as the WASH-2 study) promoted by DG TREN in 1998, which took into consideration the methodological, technical, economical and market developments and proposed a new structure for a revised label and the possible setting of efficiency targets, which then for various reasons were not fully accepted by Member States.
Contemporarily, the European Eco-label Board started to address these two product groups more from the environmental impact point of view with other studies, which resulted in the definition of eco-labeling awarding criteria, the latest being:

- for washing machines: on December 1999[1] the Commission adopted the criteria valid until December 1st 2002. These criteria were then prolonged to November 30th 2005 (Decision 2003/240/EC);
- for dishwashers: on August 1998[2] the Commission adopted the criteria valid until January 20th 2003 through the extension given by Decision 2001/397/EC. Criteria were revised in August 2001 (AEAT, 2001) and are valid until August 26th 2006.

In the meantime, a series of monitoring studies were promoted by the SAVE Programme to evaluate the impact of the EU legislation on the market transformation of washing machines and their energy consumption (ADEME, 2000; ADEME, 2001). Dishwashers were monitored through the annual reports presented by the European Association of Household Appliance Manufacturers (CECED) to the EC and the Regulatory Committee responsible for the management of the EU energy labelling scheme, describing the effectiveness of the industry "Voluntary Commitment on Reducing the Energy Consumption of Household Dishwashers" issued in 1999 and ended in 2004. Also washing machine market was monitored through CECED annual reports under the two Voluntary Commitments issued in 1997 and in 2002 for this product group.

Since markets and technologies change continually, including in response to past policy settings, the present study proposal takes the results and methodology defined in the last decade of studies as the starting point to be updated and upgraded where necessary to evaluate the technical, economic and market developments of cold appliances and the new aspects of these products to be covered following the indications of the eco-design directive 2005/32/EC[3]. This is necessary in order to define the need of implementing measures and possible targets for voluntary or mandatory policies.

The study is divided in two working phases and seven Tasks or Chapters:

Part I: Present Situation that envisages the following five Tasks:

[1] Commission Decision of 17 December 1999 establishing the ecological criteria for the award of the Community eco-label to washing machines (2000/45/EC).
[2] Commission Decision of 20 July 1998 establishing the ecological criteria for the award of the Community eco-label to dishwashers (98/483/EC).
[3] Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of ecodesign requirements for Energy-Using Products and amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC of the European Parliament and of the Council.

- Task 1 - Definitions
- Task 2 - Economic and Market Analysis
- Task 3 - Consumer Behaviour
- Task 4 - Product System Analysis
- Task 5 - Definition of base case

Part II: Improvement Potential, with the following two Tasks:

- Task 6 - Technical Analysis
- Task 7 - Scenario, Policy, and Impact and Sensitivity analysis.

Within the first part (Present Situation) the project team will set the study boundaries (Task 1), collect and organise the data for the economic, market (Task 2) and consumers behaviour analysis (Task 3), analyse the interaction of the studied appliances on the energy system to which the product belongs (Task 4) and set up the reference parameters, material, energy and costs inputs to define the starting base case (Task 5). All the data and information analysed within the first part of the study will serve as an input for the second part (Improvement Potential) during which the project team will carry out the technical and economic analysis to set up the optimal eco-design options of the analysed appliance (Task 6) and finally suggest the most suitable policies to achieve the recommended energy and ecological improvements (Task 7). A Glossary and References will be also included in the study.

A summary of the tasks included in this second part of the interim report on the cold appliances study (tasks 1 and 2) is outlined in the following paragraphs

0.1 DESCRIPTION OF TASK 1

In the first Task of the study the product category is defined along with the "system boundaries" for the application of the eco-design concept. This definition in fact is relevant both for a realistic definition of the base-case in Task 5 and the design options and corresponding improvement potential in Task 6 and for the scenarios in Task 7.

0.1.1 Subtask 1.1: Product Groups, Product Categories and Performance Assessment

For dishwashers and washing machines the definition of the product group can be found in the relevant European measurement standard EN 60436 and EN 60456.

EU eco-label defines ecolabel awarding criteria for washing machine and dishwashers, but the product categories are referred to as given in the relevant energy labelling directives 95/12/CE & 96/89/CE and 97/17/CE & 99/19/CE. Wash appliances are not covered by the Energy Star Programme as set in Council Decision 2001/469/EC[4], but they are among the products covered in the US-EPA Energy Star. The relevant criteria will be therefore described in Subtask 3.1.3.

[4] Council Decision of 14 May 2001 concerning the conclusion on behalf of the European Community of the Agreement between the Government of the United States of America and the European Community on the coordination of energy-efficient labelling programs for office equipment, OJ L 172, 26.06.2001

Finally, EUROSTAT defines only macro-categories used for commercial trade purposes, so it is less useful in the context of this specific Task of the study.

The primary product performance parameter, the so called "functional unit" is the weight of the laundry washed per cycle (and knowing the number of washing cycles per year and the appliance lifetime the overall weight of laundry washed over lifetime) or the number of standard place settings washed per cycle (and over the lifetime). For both appliance types also the functional performance (secondary product performance parameters) is defined in the measurement standard:

- for washing machines, the cleaning and spinning performance
- for dishwashers, the cleaning and drying performance.

0.1.2 Subtask 1.2: Existing Standards

The main harmonised standards for washing machines is EN 60456 "*Clothes washing machines for household use-Methods for measuring the performance*" and for dishwashers EN 60436 "*Electric dishwashers for household use - Methods for measuring the performance*". The two standards include the measurement of the energy and water consumption and of the so called functional performance: washing, spinning, drying.

EN standards present a 15% uncertainty in the verification of the rated value for the energy consumption that is the maximum acceptable difference between the measured and the rated values. In case a higher difference is found, three extra samples should be measured for which on average a maximum difference of 10% is accepted. The same applies for functional performance measurement. Some stakeholders and Member States consider this percentage too high. The problem of the "uncertainty" in the verification of the declared energy consumption (and also of other parameters) will be addressed, taking into consideration the latest developments of the measurement uncertainty management under discussion within the preparation of the new of IEC 60456 5th edition.

In addition wash appliances should fulfil the requirements of safety standards (EN 60335 series).

As far as the stand-by issue is concerned, in 1999 the International Energy Agency published the document "*Things that go Blip in the Night – Standby Power and How to Limit It*", addressing the problem of the increasing standby power in the OECD Member countries and proposing some initiatives to decrease it. The standby consumption of household electrical appliances can be measured according to the European standard EN 62301:2005 recently prepared by Technical Committee CENELEC TC59X and including the common modification to the international standard IEC 62301:2005[5] prepared by TC59/WG9. The informative Annex A of EN 62301 provides some guidance on the other expected modes that would be found for various common appliance configurations and designs, including washing machines and dishwashers, even if the definition of such modes is demanded to the relevant standard of each product.

A short description of these and other relevant standards (such as noise measurement standard EN 60704 series) will be reported, along with the main modifications under study by the IEC SC59A for dishwashers and IEC SC59D for washing machines.

[5] IEC 60302: 2005 "Household Electrical Appliances – measurement of the standby power, 2005.

0.1.3 Subtask 1.3: Existing Policies & Measures

The legislation covering washing machines and dishwashers will be identified and briefly described for the three levels required: EU, Member States and extra-EU. Reference will be made to the WASH-2 study and IEA work within the Energy Efficiency Working Party and last publications where a comprehensive analysis of the worldwide (especially extra-EU) legislation and voluntary measures are reported and compared. Fiscal incentives, procurement actions, etc. will be also mentioned. Additional efforts will be carried out to identify new measures and countries addressing wash appliances. A detailed analysis of standby power policies will also be included.

The standard product quality requirements (failure rates, proven design, etc.) required by the market will be also analysed and taken into account.

0.2 DESCRIPTION OF TASK 2

0.2.1 Subtask 2.1: Generic Economic Data

Generic economic data (mainly production import and export) for refrigerators and freezers have been collected in this Subtask. Data are related to the latest full year (2005). To this respect, two portraits, one for the EU countries and the other for the rest of the word, concerning a detailed overview on the cold and wash appliances production and market situation of the analysed countries, have been also produced and posted in the studies web sites (see http://www.ecocold-domestic.org/index.php?option=com_docman&task=cat_view&gid=15&Itemid=49 or http://www.ecowet-domestic.org/index.php?option=com_docman&task=cat_view&gid=15&Itemid=49)

0.2.2 Subtask 2.2: Market and Stock Data

Market and stock have been provided for each of the defined product categories for the following years:

- 1970 - 1995 (aggregated data from the stock model),
- 2002-2004 (from the stock model and in deeper detail from the GfK data, see below)
- 2010-2012 (forecast, to be provided),
- 2020-2025 (forecast, to be provided)

The GFK panel data, analysed in paragraphs 2.2.1 (sales) and 2.2.2 (prices), provide the physical yearly sales by energy efficiency categories, volumes, energy star categories and corresponding values for the years 2002-2004 and for 21 EU countries, including the Baltic countries, Slovenia and Slovakia[6].

[6] Malta, Cyprus, Luxemburg and Ireland are missing. Moreover the coverage of the eastern countries is rather partial for the year 2002: data are provided for only 4 eastern countries for the refrigerators and for no countries for the freezers. See also paragraph 2.2.1.1

The historical and forecast data have been, and will be, provided by using the stock model developed within this project on the basis of the CECED and Wuppertal Institute models structure and data (see paragraph 2.2.3).
The stock model calculates the future stock, sales and energy consumption data for the years 1970–2025 on the basis of the following assumptions (endogenous inputs):

- Household growth rates;
- Appliances penetration rates (historical data till 2004, after estimates)
- Average Product Life (based on a symmetric spread of 15 ± 4 years)
- Appliances specific consumption (by unit and by energy efficiency category)
- Yearly sales by energy efficiency categories (observed data till 2002-2004 and then estimated on the basis of the historical trends

On the basis of these settings, the following data have been and will be provided (historical data and forecast)

- Installed base
- Penetration rates
- Annual sales (calculated in the forecast period according to the penetration rate trends)
- Replacement sales (calculated)
- New sales (calculated)
- Total (stock) energy consumption trend (base case, without technological improvements)
- Total sales/real EU-consumption in physical units and in values (the objective is to define the actual consumption as reliably as possible for the categories defined in Subtask 1.1, for the latest full year for which consistent data could be retrieved).

0.2.3 Subtask 2.3: Market Trends

Trends on the market have been analysed in different ways:

1. Identifying major trends by analysing product brochures and advertisements for new products.

2. Interviewing the sales or marketing directors of the major European refrigerator and freezer brands

3. Analysing all major consumer tests on refrigerators and freezers from the last 5 years and identifying changes in product design and features offered and tested.

4. Analysing questions included in the consumer survey (see Task 3) to identify consumer requirements and preferences.

The analysis provides the following outputs:

- Description of the market development
- General trends in product-design and product-features (from the marketing point of view)
- Specific trends of ecological relevant features
- Hypothesis on the duration of redesign cycle of the EuP.

0.2.4 Subtask 2.4: Consumer Expenditure Base Data

In this Subtask the following data concerning the appliances market price, the running costs and disposal tariffs, per EU Member State have been collected, to provide basic input to the LLCC analysis (see Subtask 6.2):

- Electricity rates (€/ kWh)
- Water (and sewage) rates (€/m3)
- Repair and Maintenance costs (€/product life)
- Installation costs (for installed appliances only) (€/product)
- Disposal tariffs/ taxes (€/product)
- Interest and inflation rates (%).

The consumer expenses like the repair and maintenance costs will be collected the consumers' specialised magazines and possibly through direct interviews to shops and service agencies.

The electricity rates as well as the disposal tariffs will be provided by the specialised literature and the interest and inflation rates by EUROSTAT.

1 Task 1: Definitions

1.1 SUBTASK 1.1: PRODUCT GROUPS, PRODUCT CATEGORIES AND PERFORMANCE ASSESSMENT

1.1.1 Product groups and product categories

The definition of the two product groups are included in the scope of the European standards used for the conformity assessment:

- dishwashers: prEN 50242:2007/prEN 60436:2007[7] "*Electric dishwashers for household use - Methods for measuring the performance (IEC 60436:2004, modified)*", as "**electric dishwashers for household use that are supplied with hot and/or cold water**", where the definition of **dishwasher** is "machine which cleans, rinses and dries dishware, glassware, cutlery, and, in some cases, cooking utensils by chemical, mechanical, thermal, and electric means. A dishwasher may or may not have a specific drying operation at the end of the programs".
- washing machines: EN 60456: 2005 "*Clothes washing machines for household use - Methods for measuring the performance (IEC 60456:2003, modified)*", as "**clothes washing machines for household use with or without heating devices and for cold and/or hot water supply**", where the definition of washing machine is then better specified in the "Scope" section of the standard as "appliance for cleaning and rinsing of textiles using water which may also have a means of extracting excess water from the textiles". EN 60456:2005 defines then different types of washing machines:
  - *agitator washing machine*: washing machine in which the textiles are substantially immersed in the washing water, the mechanical action being produced by a device moving about or along its vertical axis with a reciprocating motion (an agitator). This device usually extends above the maximum water level;
  - h*orizontal drum washing machine*: washing machine in which the textiles are placed in a horizontal or inclined drum and partially immersed in the washing water, the mechanical action being produced by rotation of the drum about its axis, the movement being either continuous or periodically reversed;
  - *impeller washing machine*: washing machine in which the textiles are substantially immersed in the washing water, the mechanical action being produced by a device rotating about its axis continuously or which reverses after a number of revolutions (an impeller). The uppermost point of this device is substantially below the minimum water level;
  - *nutator washing machine*: washing machine in which the textiles are placed in a vertical axis basket and partially immersed in the washing water, the mechanical action being produced by a nutation plate in the bottom of the basket, the movement being either continuous or periodically with or without reversion;
  - *washer-dryer*: washing machine which includes both a water extraction (spin) function and also a means for drying the textiles, usually by heating and tumbling.

[7] the draft standard will be published with a double numbering EN 50242/EN 60346 due to the need to maintain the first number for sake of compliance with the energy labelling scheme. The draft European Standard has been submitted to CENELEC members for formal vote. Deadline for vote is May 2007.

It should be taken into consideration that the definition of washing machine types will likely change due to the on-going of the IEC 60456 5th Edition[8] under preparation by IEC subcommittee 59D "home laundry appliances", which will be eventually reflected in the new EN 60456 4th Edition. The **proposed new definition**s are reported here for sake of completeness of information:

- *vertical axis washing machine*: washing machine in which the load is placed in a drum which rotates around an axis which is vertical or close to vertical. For the purposes of this international standard, vertical axis is where the angle of the axis of rotation is more than 45 degrees to horizontal. Where the drum does not rotate, the washing machine shall be classified as a vertical axis washing machine;
- *horizontal axis washing machine*: washing machine in which the load is placed in a drum which rotates around an axis which is horizontal or close to horizontal. For the purposes of this international standard, horizontal axis is where the angle of the axis is less than or equal to 45 degrees to horizontal;
- *manual* or *automatic washing machine*: an automatic washing machine is where the load is fully treated by the machine without the need for user intervention at any point during the programme prior to its completion. A manual washing machine is where the machine requires user intervention at one or more points during the programme to enable the machine to proceed to the next operation. Examples of user intervention could include manual fill (non automatic water level), transfer of the load between a washing drum and a spin extractor drum or manual draining.

The classification applied by PRODCOM 2007[9] and used by EU customs and Eurostat are included under the codes (1) **29.71** – Manufacture of electric domestic appliances, (2) **29.71.12** – Dish washing machines, of the household type, (3) 29.71.12.00 – Household dishwashing machines for the dishwashers, and under the codes (1) **29.71** – Manufacture of electric domestic appliances, (2) **29.71.13** - Cloth washing and drying machines, of the household type and (3):

- **29.71.13.30** – Fully-automatic washing machines of a dry linen capacity ≤10 kg (including machines which both wash and dry)
- **29.71.13.50** – Non-automatic washing machines of a dry linen capacity ≤10 kg (including machines which both wash and dry).

For the EU, the definition of product categories for dishwashers can be found in the energy labelling Directive 97/17/EC[10] (and 1999/9/EC) as "*electric mains-operated household dishwashers sold to the general public. Appliances that may also use other energy sources, such as batteries, or have no internal heat source, are excluded*". The same definition is adopted by the EU eco-label scheme with Commission Decision 2001/689/EC[11] of 28 August 2001, revising former Decision 98/483/EC. Labelling directive (and eco-label) defines two dishwashers "categories" - with 10 or more place settings and with 9 or less place settings - depending on the capacity of appliance in standard place settings.

The definition for washing machines can be found in energy labelling directive 95/12/EC[12] (and 96/89/EC) as "*electric mains operated household washing machines, excluding machines with no spin capability, - machines with separate washing and spin drying vessels (such as twin tubs), and combined washer-driers. Appliances that can also use other energy sources are excluded*". The

[8] The first DC (Document for Comments) of the IEC 60456 5th Ed. was circulated for comments beginning March 2007 as document 59D/332/DC.
[9] Source: List of PRODucts of the European Community, 2007 version, downloadable from: http://ec.europa.eu/eurostat/ramon
[10] OJ L 118, 07.05.1997, p. 1; and OJ L56, 04.03.1999, p.46.
[11] OJ L 242, 12.09.2001, p. 23.
[12] OJ L 136 , 21.06.1995, p. 1; and OJ L 338 , 28.12.1996 p. 85.

same definition is adopted by the EU eco-label scheme with Commission Decision 2005/384/EC of 12 May 2005, prolonging the criteria established in Decision 2000/45/EC[13].

A comparison of the different classifications is reported in Table 1.1 for dishwashers and in Table 1.2 for washing machines. In Table 1.2 only the definitions currently in force are reported.

[13] OJ L 16, 21.01.2000, p. 74.

Table 1.1: Comparison of the different classification scheme for dishwashers at European level

<table>
<tr><td>prEN 50242:2007 /
prEN 60436:2007</td><td colspan="3">electric dishwashers for household use that are supplied with hot and/or cold water</td></tr>
<tr><td colspan="2">Directive 97/17/EC; Decision 2001/689/EC</td><td>PRODCOM</td><td>prEN 50242:2007/prEN 60436:2007</td></tr>
<tr><td>Category</td><td>Electric mains-operated household dishwashers sold to the general public. Appliances that may also use other energy sources, such as batteries, or have no internal heat source, are excluded</td><td>29.71.12 - Dish washing machines, of the household type</td><td rowspan="3">Dishwasher: machine which cleans, rinses, and dries dishware, glassware, cutlery, and, in some cases, cooking utensils by chemical, mechanical, thermal, and electric means. A dishwasher may or may not have a specific drying operation at the end of the program</td></tr>
<tr><td>≥10 ps</td><td>Dishwashers with 10 or more place settings</td><td rowspan="2">29.71.12.00 – Household dishwashing machine</td></tr>
<tr><td>≤9 ps</td><td>Dishwashers with 9 or more place settings</td></tr>
</table>

Table 1.2: Comparison of the different classification scheme for washing machines at European level

<table>
<tr><td>EN 60456: 2005</td><td colspan="2">clothes washing machines for household use with or without heating devices and for cold and/or hot water supply</td></tr>
<tr><td colspan="2">Directive 95/12/EC; Decision 2005/384/EC</td><td>PRODCOM</td><td>EN 60456: 2005 (to be changed)</td></tr>
<tr><td colspan="2" rowspan="4">electric mains operated household washing machines, excluding machines with no spin capability, - machines with separate washing and spin drying vessels (such as twin tubs), and combined washer-driers. Appliances that can also use other energy sources are excluded</td><td>29.71.13 - Cloth washing and drying machines, of the household type</td><td>washing machine: appliance for cleaning and rinsing of textiles using water which may also have a means of extracting excess water from the textiles</td></tr>
<tr><td rowspan="3">29.71.13.30 – Fully-automatic washing machines of a dry linen capacity ≤10 kg (including machines which both wash and dry)

29.71.13.50 – Non-automatic washing machines of a dry linen capacity ≤10 kg (including machines which both wash and dry).</td><td>agitator washing machine: washing machine in which the textiles are substantially immersed in the washing water, the mechanical action being produced by a device moving about or along its vertical axis with a reciprocating motion (an agitator). This device usually extends above the maximum water level</td></tr>
<tr><td>horizontal drum washing machine: washing machine in which the textiles are placed in a horizontal or inclined drum and partially immersed in the washing water, the mechanical action being produced by rotation of the drum about its axis, the movement being either continuous or periodically reversed;</td></tr>
<tr><td>impeller washing machine: washing machine in which the textiles are substantially immersed in the washing water, the mechanical action being produced by a device rotating about its axis continuously or which reverses after a number of revolutions (an impeller). The uppermost point of this device is substantially below the minimum water level;</td></tr>
<tr><td>nutator washing machine: washing machine in which the textiles are placed in a vertical axis basket and partially immersed in the washing water, the mechanical action being produced by a nutation plate in the bottom of the basket, the movement being either continuous or periodically with or without reversion</td></tr>
</table>

1.1.2 Product Performance Assessment

The primary product performance parameter, the so called "functional unit", for dishwashers is the number of standard place settings washed per cycle (and over the lifetime) defined in prEN 50242:2007/prEN 60436:2007 as **rated dishwasher capacity**: "whole number of place settings together with the serving pieces stated by the manufacturer, which can be cleaned and dried when loaded in accordance with the manufacturer's instructions".
For washing machines the functional unit is the weight of the laundry washed per cycle (and knowing the number of washing cycles per year and the appliance lifetime the overall weight of laundry washed over lifetime).

For both appliance types also the functional performance (secondary product performance parameters) is defined in the measurement standard (and in the energy labelling directives):

- for dishwashers, the cleaning and drying performance;
- for washing machines, the cleaning and spinning performance.

1.2 SUBTASK 1.2: EXISTING STANDARDS

International standards exist for all major household appliances, typically originating with manufacturers' associations, government agencies, or professional societies, and are eventually adopted by a national or international standardisation bodies. The leading international standard-setting bodies for energy tests are the International Organization for Standardization (ISO) which mainly focuses on mechanical performance, and its sister organization, the International Electrotechnical Commission (IEC), which mainly focuses on electrical performance. Implementation and refinement of international standards is left to national and regional counterparts of ISO and IEC. Thus the European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC) have assumed responsibility for developing EU-wide standards, respectively for mechanical and electrical performance. The Japan Industrial Standards Association (JIS) is responsible for developing all appliance test methods in that country. In the United States several organisations are involved in developing standards: among these are the American National Standards Institute (ANSI), the Air-conditioning and Refrigerating Institute (ARI), and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), although final responsibility for the appliance energy standards in policy measures resides with the Department of Energy

Geographic, climatic and cultural differences among countries further complicate efforts to develop internationally standardised test procedures that are sufficiently flexible to reflect local conditions while still allowing results from different countries to be compared. Beyond these basic differences, appliances often vary greatly in their configurations and the range of options on offer. This variety in configurations and options, because it can affect energy efficiency and functional performance, often necessitates the creation of separate standards.

Interest in making measurement methods better reflect local conditions and available appliance models has on one side led many countries to develop national standards, but on the other side many other countries tend to align with ISO/IEC standards, with only minor differences. In general:

- European, including Russia, align their standards with ISO/IEC ones;
- African and most Asian countries including China align their standards with ISO/IEC ones;
- Japan and Korea are often aligned with ISO/IEC but some significant differences exist for certain products;

- India, the Philippines, and Sri Lanka base most of their national standards on ISO/IEC ones, but sometimes there are important differences;
- Chinese Taipei often uses similar test methods to ISO/IEC but frequently introduces significant variations;
- In the Americas, the United States uses its own test procedures, which occasionally align to ISO/IEC tests;
- Because of the economic dominance of the U.S. market in NAFTA, it is not surprising that standards used in Canada and Mexico are substantially similar to those used in the U.S.;
- Most South American countries including Brazil use ISO/IEC standards but some (e.g. Venezuela) use variants or U.S. standards;
- Australia and New Zealand use harmonised standards, which despite being loosely based on ISO/IEC ones often exhibit significant differences.

White goods such as refrigerators, washing machines and dishwashers tend to exhibit the largest differences in standards, product categorisation and energy performance requirements applied from one region to another, possibly because they were the first group of products covered by national policies and measure aimed at reducing their energy consumption. Individual countries have typically taken into consideration country-specific variables such as domestic energy prices and climatic conditions, as well as the features and configurations that describe the appliances sold in their markets. These differences are also reflected in the standards, many of which were first developed nationally and may have been established more than two decades ago.

In recent years there has been a tendency for countries developing new standards to harmonise them with existing ones, as have Argentina, China, Russia, South Africa, Tunisia and Turkey with the EN standards for refrigerators and freezers. In addition, regional activities directed at harmonizing energy efficiency requirements and labels, and the relevant standards that underlies both these measures, are being undertaken by the Asia-Pacific Economic Cooperation (APEC), the South Asia Regional Initiative for Energy Cooperation and Development (SARI), the Pan American Standards Commission (COPANT), the Asia and South East Asia Network (ASEAN), the North American Energy Working Group (NAEWG), and the first of several emerging UNDP/GEF projects in the Andean Region of South America. The European Union has a rich history of regional coordination from individual country requirements and labels to unified EU-wide programs. In particular:

- In Europe, the EU25 countries were working with new Member States (Bulgaria and Romania) and Accession Countries (Croatia and Turkey) to assist them in introducing EU appliance energy efficiency policies. This mirrors the process which previously took place in the 10 new EU member states prior to their becoming EU members.
- Australia and New Zealand have a formal arrangement to develop common energy efficiency requirements for energy using products and apply harmonised standards.
- ASEAN countries are working together to develop a common regional endorsement energy label for energy-using products.
- Six countries in and around the Indian sub-continent have been co-operating through the auspices of the South Asian Regional Initiative programme to share experiences and possibly co-operate in the development of regional appliance efficiency requirements.
- Members of the ANDEAN pact countries are co-operating in a regional initiative to develop energy efficiency labels and efficiency requirements for energy using appliances.

Standards for wash appliances developed at international, European and other non-European countries will be described and where possible compared.

1.2.1 The International Standards

1.2.1.1 The dishwasher performance standard

IEC 60436, 3rd edition, February 2004 "*Electric dishwashers for household use - Methods for measuring the performance*" has been prepared by SC 59A – "Electric dishwashers" of Technical Committee 59 – "Performance of household and similar appliances". The third edition cancels and replaces the second edition published in 1981 and constitutes a technical revision. Major changes introduced in the second edition include:

- changes made to the soils used in the standard;
- the use of an oven and microwave oven to dry the soils;
- the alternate 15 to 18 hour air dry method to dry the soils;
- the addition of a reference dishwasher;
- the recognition of alternate supply voltages and frequencies;
- the recognition of a cold or hot water supply to the dishwasher;
- the detergent and rinse aid compositions have been up-rated to reflect current technology;
- the addition of the US-style load;
- the evaluation of the filter systems.

The performance of the tested machines are measured by comparison with a reference machine (Miele G590 and the Miele G5953 dishwashers are examples, other machines with the same characteristics might be used). Two alternative loads are defined and described, the reference machine to be always loaded with the load set in Annex A (the non-AHAM style load).

Performance tests must be generally carried out on a new machine, with a reference machine running parallel with the machine(s) under test, i.e., at the same time under the same conditions using soil prepared at the same time from the same batch. The reference machine is always installed as a free standing machine independent of the type of machine under test. Dishwashers are tested as free standing except where they are designated as built–in or integrated. Before conducting the performance tests, the dishwasher is operated for at least 3 complete cycles using a clean load with reference detergent and without rinse agent. The following cycle(s) can be a noise test according to Clause 9. No additional cycles are carried out on the machine under test between the sequential steps specified in the following procedure.

The tests are performed in the following order: cleaning performance then drying performance. The determination of energy, water and cycle/program time is done in conjunction with the cleaning performance test. The first programme to be tested is the one recommended by the manufacturer for a normally soiled load. In some countries the manufacturer has to declare the programme to be used, for the purpose of energy labelling which may not be for a normally soiled load, in which case this programme is the one tested first. The same programme is used for measuring the cleaning performance, the drying performance, the energy and water consumption and time and the noise, if tested. The test conditions are specified:

- voltage and frequency
- ambient conditions
- water supply pressure, hardness and temperature both cold (at 15 ± 2 °C) and hot (at 60 ± 2 °C) water inlet
- the reference detergent is used, the quantity as recommended by the manufacturer but no more than 15,0g + 1,25g per place setting. If no recommendation is given by the manufacturer, use 12,0g + 1,0g per place setting

- the reference rinse agent is used, the type (acidic or neutral) is used according to the water hardness
- the reference salt is used.
- the following soiling agents are required: milk, tea, minced meat, egg, oat flakes, spinach, margarine. All food products, at the time they are used for the preparation of soiling agents for the standard, must be within the "use-by" date or before their expiry date stated on the product. The remains of newly opened packets of tea and oat flakes may be used for subsequent tests for a period of up to 60 days after opening, if the contents are stored in a sealed container. Specific directions are provided for storage and re-use of spinach after defrosting. The preparation and application of each soiling agent on the tableware is described. Then the soiled tableware are dried in an oven or air dried.

The standard foreseen the following measurements:

- the cleaning performance (Clause 6): the purpose of this test is to measure how well the appliance cleans normally soiled place settings and serving pieces. The tests are carried out in parallel with the reference machine; soiling of the test loads for the test machine(s) and the reference machine are prepared in parallel. One person must prepare each soil type for all loads and one person must apply each soil type for all loads. Perform at least 5 cleaning test cycles of the test programme without cleaning the dishwasher filters between the measurements; if necessary increase the number of cleaning test cycles until an acceptable defined standard deviation is fulfilled, to a maximum of 8 cleaning test cycles. Any soil residue is assessed and the score noted according to the following score system:

Number of small dot shaped soil particles	Total soiled area mm^2	Score
$N = 0$	$A = 0$	5
$0 < n \leq 4$	$0 < A \leq 4$	4
$4 < n \leq 10$	$4 < A \leq 20$	3
$10 < n$	$20 < A \leq 50$	2
Not applicable	$50 < A \leq 200$	1
Not applicable	$200 < A$	0
Each load item shall be awarded a score from the table according to the category of soil area or number of discrete soil particles adhering to the item. If the requirements for more than one score are met, the lowest applicable score shall be awarded.		

  The type of soil and total number of relevant items is noted and the cleaning index in calculated by comparing the results of the test and the reference machines as the average of the indexes of the run cycles;
- drying performance (Clause 7): to measure how well the dishwasher dries the load. The drying performance measurement is not determined in conjunction with the measurement of the cleaning performance and is undertaken using clean place settings and serving pieces. Drying effect is evaluated by visual inspection and judged to be "dry", "intermediate" or "wet". Inspection of the items in the machine under test and the reference machine are carried out by the same person.
  "Dry" is defined as an article being completely free of moisture. In this case, the article shall be given a score of 2; "Intermediate" is defined as an article having one or two drops of water, or one wet streak (run), the article shall be given a score of 1; "Wet" is defined as an article having more than two drops of water, or one drop and one streak, or two streaks, or water in glass or cup cavity, the article shall be given a score of 0. The single drying index, approximated to 2 decimal places, for the test and the reference machine is calculated as the average of the scores

of the single item types. The final drying index in calculated by comparing the results of the test and the reference machines as the average of the indexes of the run cycles;

– energy, water consumption and time (Clause 8): to determine the electrical energy, the energy contained in the hot water if an external source of hot water is used, and the quantity of hot and/or cold water consumed by the dishwasher and the time it takes to complete a particular programme used for measuring the cleaning performance. Total energy consumption is the sum of the electrical, cold water correction (if any), and hot water energy (if any). The average of the 5 or more cycles run for the test machine is given: the energy consumption is measured in kWh to three decimal places, water consumption in litres, to one decimal place, and time to the nearest minute. The energy and water consumption are not determined during a drying test
– airborne acoustical noise (Clause 9), determined according to IEC 60704-3.

Thirteen annexes are included in the standard:

- Annex A (normative) defines the place setting and serving piece specifications to be used in the test machines according to its capacity in terms of place settings.
- Annex B (normative) defines an alternative load, the AHAM style load, to be used for dishwashers not using load described in Annex A, such as U.S. style machines. Place setting and serving piece specifications are given according to the test dishwasher capacity, along with a table of concordance with load items:

Annex A item No.	Item description – Annex A	Annex B item No.	Item description – Annex B
1	Dinner plate	1	Dinner plate
2	Soup plate	2	Fruit bowl
3	Dessert dish	3	Bread & butter plate
4	Cup	4	Cup
5	Saucer	5	Saucer
6	Glass	6	Glass
7	Fork	7	Dinner fork
8	Soup spoon	8	Salad fork
9	Knife	9	Knife
10	Teaspoon	10	Teaspoon
11	Dessert spoon	11	Teaspoon (same as 10)
12	Oval platter (320 mm)	12	Oval platter (240 mm)
13	Medium serving bowl (160 mm)	13	Medium serving bowl (1 litre)
14	Small serving bowl (13 mm)	14	Fruit bowl (130 mm)
15	Two serving spoons	15	Two serving spoons
16	Serving fork	16	Serving fork
17	Gravy ladle	14	No equivalent item
18	Large serving bowl (200 mm) [a]	12	Medium serving bowl [a] (1 litre)
[a] In dishwashers of 7 or more place settings only. For an Annex B load there are 2 bowls (Item 12).			

- Annex C (informative) illustrates the soil distribution, i.e. the number of each item type soiled for a 12-place setting, a 9-place setting and a 6-place setting dishwasher
- Annex D (normative) specifies the characteristics of test materials: the detergents (two detergents are possible), the rinse agents (with two formulas, “acidic” and “neutral” type) and the salt
- Annex E (normative) describes the characteristics of the reference machine, the reference programme (Universal 65 °C), the installation and the calibration of the machine and the load plan

- Annex F(informative) gives a list of possible suppliers of the materials and reference equipment used in the standard
- Annex G (normative) specifies the characteristics of the microwave oven and through-circulation thermal cabinet to be used for the drying of the soiled tableware
- Annex H (informative) suggests that testing laboratories develop their own internal guidelines for the evaluation of soil and cleaning, to ensure that repeatable results are obtained. An example of guidelines for assessing cleaning performance taken from the Australian/New Zealand standard is also included in the annex.
- Annex I (normative) describes the test enclosure for built-in models
- Annex J (informative) presents a flow chart with the test sequence of the entire standard
- Annex K (normative) specifies the shade numbers for various colours to be used to assess the washing performance
- Annex L (informative) gives and example of the test report format
- Annex M (informative) provides guidance on how to adjust the water consumption of the reference dishwasher in order to achieve the target water consumption of 27,8 litre.

a) The future development for IEC 60436 4th Edition

Experience with the standard has been positive worldwide and the new test method provides a sound globally relevant basis for international testing and comparison of dishwashers. A number of possible changes have been discussed among international experts, none of which will affect the fundamental parameters specified in the standard nor the expected results. They are refinements of the current methodology and specifications. The main elements are:

- better illustrations o soils be considered for use in IEC60436, taken from the European standard
- inclusion of a new microwave oven model in the recommended list of products as the currently specified model is no longer available (production has ceased). The work to qualify at least one current model of microwave oven should be ready for inclusion into the standard revision, but no changes to generic microwave specification are foreseen;
- the statement of the tolerance in a parameter should not allow deliberate adjustment of laboratory parameters, as already specified in the draft of standard IEC 60456 for washing machines, since the tolerance has been chosen to allow for factors such as drift of ambient conditions, instrument error, reading error, uncertainty of instrument calibration and other influences;
- ambient temperature to be harmonised with washing machines and dryers standards at 23±2°C
- recommendation about the limitation on the life of the load to 200 cycles (as in European standard), with a note outlining the reasons for the recommended limit on cycles for the load items (possible degradation of glazing and the influence on wash performance results). A mandatory requirement is onerous as for larger labs this would require tracking of cycles for each load item;
- update the list of qualifying brand and model for the reference equipments and products;
- better qualification of the load temperature (ambient conditions). Important differences are that European tests are conducted at a fixed time after soiled load removal from the oven, making all test runs comparable. IEC loads can be stored for up to 4 days after oven drying so keeping oven dried loads in parity with loads stored at ambient conditions is important in the IEC test method. Measurement data has shown that a requirement of not less than 1 hour will ensure that current requirements in the standard are met (ambient temperature ± 2°C) and this is a simpler way of qualifying the temperature of the loads for laboratories;
- drying performance in IEC is currently specified to commence 30 minutes after the end of the cycle, the European standard commences drying performance evaluation 30 minutes after the completion of the program after the power is disconnected. IEC standard has a technical error to

be corrected to state that the waiting time is 30 minutes from the end of program (not cycle) before commencing drying evaluation;

- the specified reference dishwasher is no longer available. Other models should be included in the Annex with relevant performance and calibration data. However, old reference machines should be included as many testing laboratories still have these dishwashers as reference;
- inclusion of the measurement of the standby power following general approach prepared for the washing machine standard, where two modes "standby mode" and "left on mode" are defined. Also the technical requirements should be the same as for the washing machines;
- in some cases products may be able to sense that there is a clean load and there is concern that these may falsely increase the drying performance evaluation in response. It is recognised that smart machines may have numerous control strategies to adjust performance in response to load conditions and that this is not necessarily a problem but it may increase complexity of testing in some cases. The proposal is to record total program energy consumption for drying tests and the maximum heated water temperature for each operation (washing and drying) in the test report as part of the test report requirements in the next standard edition. Once a body of data has been collected over time, this could be assessed in future to see whether there is a need to modify how the energy is declared in further editions of the standard;
- remove ambiguity in the classification of self cleaning or not self cleaning dishwashers.

b) Elements for further editions of IEC 60436

Main elements to be studied for inclusion in a further edition of IEC 60436 are:

- the current soiling in IEC 60436 focuses more on adhered soil and does not have sufficient soil to assess re-deposition. Substantial development work needs to be undertaken. The issue is whether there needs to be a shift in the balance between adherence and re-deposition;
- there is a need to look at soil composition and quantity; heavy soil loads are often required to assess intensive wash programs;
- testing automatic (sensing or smart) programs: these products are becoming more common on the market and there is the need to asses how smart they are in real life (how they respond to variations in soil load in terms of performance and energy);
- a number of issues need to be resolved in the assessment of water marks as part of washing performance evaluation and whether these are assessed or ignored for drying performance evaluation;
- more realistic load composition: data from actual consumer loads indicates that the total number of items is typically much lower than the standard load for some load item types. Real loads also have plastic items. There is a need to balance a more representative load against manufacturer claims of capacity (maximum capability of the product). Part load and mixed load tests could provide some additional information;
- detergent type and rinse aid formulations: the need of a phosphate-free detergent to be investigated as result of possible EU and US requirements about phosphate content of detergents. In any case there is the need to maintain a stable formulation for reference detergents where possible. Although the dishwasher detergent market in Europe is now dominated by tablets, these are not suitable for use in the IEC standard, since the manufacturing of tablets is very complex and expensive. For shorter and lower temperature programs tablets result in significantly worse performance as they take longer to dissolve. Accurate dosing is not possible for tablets of a fixed size. To be investigated for the long term standard development.

1.2.1.2 The washing machine performance standard

The 4th Edition of IEC 60456 *Clothes washing machines for household use - Methods for measuring the performance* was published in October 2003, prepared by SC 59D – "Home laundry appliances" of Technical Committee 59 – "Performance of household and similar appliances".

Major changes introduced in the fourth edition include:

- Reproducibility and repeatability of the test results: improved by specifying tolerance limits for instrumentation, base loads and detergents; instrumentation of measuring optical reflectance has been specified;
- Loads: the specifications of cotton and easy-care base load have been revised to include suitable test materials which are currently available on the market. The three loads are named "cotton base load", "easy-care textile base load" and "polyester textile base load"; tolerances for size and mass per unit area of base load materials have been changed; procedures and conditions for pre-treatment, normalization and conditioning are defined more precisely;
- Reference washing machine: the water quantity can be adjusted and controlled more precisely by a special flow meter, which is available from the supplier of the reference washing machine;
- Other changes:
  - the composition of the reference detergent has changed; the detergent is named A*;
  - the formula for the correction of consumption for hot and cold water has been modified;
  - specifications of wool shrinkage specimens have been included;
  - ambient temperature is defined at (23 ± 2) °C.

The tests are performed in parallel with a defined reference machine. The test conditions are specified:

- voltage and frequency,
- ambient conditions:
  - ✓ ambient temperature 23 ± 2 °C
  - ✓ water hardness of 2,5 ± 0,2 mmol/l
  - ✓ water temperature for cold (at 15 ± 2 °C) and hot (temperature indicated by the manufacturer ±2 °C, or if no value is given 60 ± 2 °C) water inlet
- the reference detergent A* is used, the quantity specified in Annex F
- loads: base load for cotton (with composition of sheets, pillowcases and hand-towels as specified), for easy-care textile (consisting of an equal number of shirts and pillowcases) and polyester textile (consisting of specified double knitted polyester textile test pieces); an item must not be used for more than 80 test cycles with a weighted average age of the cotton load between 30 and 50 test cycles; the preparation and conditioning of the base load are defined
- different types of soiling are used to enable the measurement of different characteristics: the scouring effect, mainly due to mechanical and thermal action, with a mixture of carbon black and mineral oil, the removal of protein pigments with blood, the removal of organic pigments, with chocolate and milk and the bleaching effect, with red wine. Soiled test strips consist of square pieces carrying different types of the described artificial soil and joined together into a strip with the different kinds of soil in the order: unsoiled piece, carbon black/mineral oil, blood, chocolate and milk, red wine.

The standard foresees the following measurements:

- the washing performance (Clause 8): this clause contains specifications for the test procedure using standardised soiled test strips, which are washed together with a defined base load (i.e. the test load); the purpose is to evaluate the typical soil removal performance of the washing

machine under test, in relation to the reference washing machine; the standard detergent and its dosage are specified; at least five complete test cycles are run for the test and reference machines and the soiled strips are evaluated for each run and machine; the washing performance is calculated by the reflectance measures of the washed strips, by comparison with the reference machine;

- the rinsing performance (Clause 9): the test uses the residual alkalinity of the detergent solution in the base load after spin extraction as a measure of the rinsing performance. The purpose is to evaluate how well a typical textile load is rinsed; at least five complete test cycles are carried out using the selected programme;
- the spin extraction performance (Clause 10): contains specifications for the measurement of the residual water in the base load. The water extraction efficiency is expressed as the amount of moisture remaining in the base load after spinning relative to the conditioned mass of the same load. The purpose is to evaluate the effectiveness of water removal from a typical textile load at the end of a washing cycle; the spin extraction efficiency is the arithmetic mean of the five values obtained in the five cycles run, expressed as a percentage M
- Water and energy consumption and programme time (Clause 11): specifies the procedure and evaluation for the determination of water and energy consumption during typical operations of washing, rinsing and spin extraction; it also specifies the method for determination of the duration of the complete programme. At least five complete test cycles are carried out using the selected programme, and the arithmetic mean of the measured values is calculated: water volumes are expressed in litres, and rounded to the nearest whole litre, programme duration is rounded to the nearest minute, electrical energy is expressed in kWh rounded to two decimal places;
- Shrinkage during the wool wash programme (Clause 12): the specifications for measuring the shrinkage rate during the wool wash programme are given, using three wool specimen for each washing cycle together with a base load of polyester textiles. On completion of the wool wash programme, including spin extraction. Lengths and widths of the wool shrinkage specimens are measured and recorded. Six test cycles are run. The average of the percentage area felting shrinkage is calculated for the test and reference washing machine.

Ten annexes are included in the standard:

- Annex A (normative) describes the reference washing machine, the different programme types for and the method for its use, calibration and maintenance;
- Annex B (normative) specifies the characteristics of the base loads (cotton, easy care, polyester);
- Annex C (normative) describes the handling of load and calculation of average age of the cotton base load: the way of loading the machine influences the results especially for the washing performance; to get reproducible results it is necessary to define the way of loading the machine and the procedure to determine the weighted average age of the load;
- Annex D (normative): describes the bone-dry method used to determine the dry mass of the cotton and easy care textile loads;
- Annex E (normative) specifies the specimen with standardized soiling: the washing performance is the result of the combination of mechanical and chemical actions. Natural soils contain fatty matter, proteins and organic and inorganic pigments in complex mixtures, some soils are more sensitive to mechanical action and some to chemical action. The typical soil removal performance of a washing machine is determined by means of the different types of standard artificial soils: carbon black and mineral oil (enabling the scouring effect, mainly due to mechanical and thermal action), blood (enabling the removal of protein pigments), chocolate and milk (enabling the removal of organic pigments), and red wine (enabling the bleaching effect). The fabric supporting the soils, the artificial soil composition and the application of soil

to cloth are described. Each batch of soiled test pieces must be marked and delivered with information about the correct use;

- Annex F (normative) describes the composition of the reference detergents: A* and the amount to be used, given by: amount = 54 g + 16 g/kg of rated capacity; and reference detergent C is for use in agitator and impeller washing machines with the amount of 19 g/kg of rated capacity for water hardness 0,5 mmol/l
- Annex G (informative) describes in detail the procedure for the programming of the reference washing machines FOM 71 MP and FOM 71 MP/Lab. The possible programmes are described: cotton 60 °C, cotton 85 °C, easy-care textiles 40 °C, easy-care textiles 60 °C, and wool 40 °C. Due to the fact that the reference washing machines FOM 71 MP and FOM 71 MP/Lab, are no longer available, a new reference washing machine FOM 71 CLS is described in the *Corrigendum*, along with the description of the wash programme for cotton at 60°C;
- Annex H (informative): presents the data to be reported for the reference washing machine and the washing machine under test;
- Annex I (informative): a list of suppliers for the reference machines and test materials are given;
- Annex J (informative): givens an example for the exchange of load items for a 5 kg cotton load to achieve weighted average age of the load between 30 and 50 test cycles

a) The globalisation of IEC 60456

IEC 60456 started as a simple test procedure for clothes washers which focused mainly on horizontal axis (drum or front loading) machines and was first published in 1974. While many of the technical aspects of the standard have been substantially improved in subsequent revisions (Edition 2 in 1994 and Edition 3 in 1998), there are still some severe limitations to the application of this standard to other washing machine platforms such as impeller and agitator machines (in general vertical axis machines).

The 4th Edition of IEC 60456 contains many improvements over earlier editions of the standard. However, this edition still falls short of what many regard as a "globally acceptable" test procedure for machines with vertical axis wash systems. Upgrading IEC60456 to be a truly global test procedure required a huge amount of research and development work which had to be managed carefully during the recent years. In addition, it was critical that any changes to the standard were done in a way that ensured that current users of the standard are able to retain continuity and comparability with previous editions (as far as possible).

Issues and limitations of the 4th Edition are known to include:

- testing is currently limited to a single water hardness of 250 ppm which is too hard for many countries;
- cold water test temperature of 15^{o}C is unrealistically low (too cold) for some countries;
- current reference system needs revision / update / additions:
  - current programs are only reflective of drum machine types and may not be suitable as a vertical axis or impeller machine reference;
  - current range of reference program temperatures (40^{o}C, 60^{o}C, 85^{o}C) is not reflective of wash temperatures of 20^{o}C to 30^{o}C which are typical in some countries;
- the reference detergent specified for vertical axis and impeller machines (Detergent C) is a phosphate based detergent which may not be suitable for many countries and the dosage is only provided for soft water, which is not considered under the standard. As practical consequence, vertical axis and impeller machines have no test method under IEC 60456;

- the specified method of evaluation of the machine performance, while competent, is arbitrary and there are a range of post-test analysis methods that can validly address the different aspects of the washing performance;
- the alkalinity method of assessing rinsing performance is not sufficiently reproducible to allow robust inter-laboratory comparisons, although this method is known to be generally repeatable within a laboratory;
- there are reproducibility issues regarding the wool shrinkage method and the associated evaluation approach;
- Loading plan is only provided for a horizontal axis machine.

Not all users around the world have strong and explicit concerns with the issues listed here, but some of these are known to limit the potential application of IEC 60456 in some countries at present. Possible solutions have already been identified and many will be addressed in the IEC 60456 5th or even further Editions.

b) New items in IEC 60456 5th edition

Maintenance Team 15 is currently working on the new 5th Edition and is also planning for the preparation of a 6th edition in the medium term. A draft for comments of the 5th edition has been released end February for public comments[14]. Key changes and improvements included into the draft 5th Edition of IEC 60456 are:

- Improve the structure of the standard to assist users and improve clarity.
- Introduction of a new soil stain (sebum) in addition to the existing 4 soil stains. The current red wine stain will be replaced with additionally aged red wine. Smaller size of stain strips will be used to accommodate additional stain.
- The inclusion of two new low temperature reference programs Cotton 20°C and Cotton 30°C on the reference machine which are more suitable for use in conjunction vertical axis machines and lower washing temperatures.
- Introduction of soft water requirements, water hardness: soft 50ppm, and hard (current) 250ppm.
- Continued use of Detergent A* for all washing machines platforms and both water hardness values while establishing a new dosage regime (at 2/3 hard water dose) both for soft water as well as the new low temperature cycles. Solubility criteria for Detergent A* added.
- Improved folding and loading method to suit horizontal and vertical axis machines and twin tubs systems.
- Inclusion of two low power modes (“off mode” and " left on mode") and power measurement conditions (see paragraph 1.4.1.5.a).
- An improved alkalinity method for rinse performance assessment, based on extensive research and testing.
- Directions regarding placement of detergent in vertical axis machines, especially where there is no dispenser or the dispenser is inadequate for the specified dose.
- Elimination of the restriction that the rated capacity shall be the only load size to be used (as consequence allowing additional testing at lower load sizes).
- Expanded defined load size up to 15 kg with indefinite expansion beyond.
- Load item distribution modified for very small loads (single sheet eliminated for 2,5kg loads or less).
- Review of volume/capacity ratios for determination of rated capacity in case rated capacity is not declared by manufacturer or not based on clothes load mass (e.g. in North America).

[14] See document 59D/332/DC “Inquiry on draft of IEC60456 5th Edition”, information available at the SC 59D webpage within the IEC website www.iec.ch .

- New volume measurement methods for any machine types.
- Improved wool test procedure and modified wool reference program on the reference machine.
- Informative annex on uncertainty of clothes washing machine performance measurements and options for analysis of test results.
- Informative annex on the selection of reference programs for comparison of different programs and washing platforms.
- Introduction of the Wascator CLS machine (first introduced for cotton 60°C cycles only as IEC 60456 Corrigendum) as a suitable reference machine and improved maintenance and calibration procedures.
- Treatment of clothes washing machines within the test procedure where the manufacturer recommends the use of no detergent in the wash (or materials other than detergent).
- New annex on background to requirements of IEC60456 added to explain the reasons for the requirements in the standard and to explain the impact of deviations (for example, to reduce the testing cost).
- Informative annex on selection of reference programme when compared to typical household machine programmes.
- Guideline for good laboratory practice added.
- Mechanical action (textile damage): a separate Publicly Available Specification 62473 Ed. 1.0 was published in April 2007.

In June 2007, the discussion of the comments received on this first draft[15] of IEC 60456 5th Edition and the input from the experts in charge of the revision of the IEC 62301 lead to the refinement of the circulated text and to the partial modification of the definitions, where the "standby mode" has been substituted by "off mode" (see paragraph 1.4.1.5.a).

The CDV (Committee Draft for Vote) of the new standard, with the modified definitions, is expected to be circulate by IEC SC 59D for public enquiry, including the vote of the National Committees, in September 2007.

c) Future developments for IEC 60456 6th edition

The following issues are still under discussion, some are already under development to be included in the 6th Edition of IEC60456:

- Hygiene
- New reference program to reflect easy care wash items.(Development on CLS).
- New reference program to reflect Hand wash items.(Development on CLS).
- Higher spin speed with CLS on cotton reference programs
- Wool program - cleaning along with shrinkage
- New detergent for wool wash program.
- Mechanical action (gentleness of action): inclusion of a new test procedure to assess the gentleness of action of the washer on the load.
- Improve methods for the assessment of rinse performance (soluble and non-soluble components).
- Detergent: New detergent for 6th edition
- Potential for reducing test runs to 3 from 5 and impact on uncertainty.
- Soil re-deposition
- Fabric care (Tangling, wrinkling)

[15] The commenting period of the first Document for Comments was closed beginning June 2007.

- Rated Capacity requirements definition
- Inlet temperature harmonisation
- Foreign object handling
- Washer imbalance.

1.2.1.3 The standards about safety

Safety is dealt at IEC level through a set of standards: the general elements are defined in **IEC 60335-1 Household and similar electrical appliances - Safety - Part 1: General requirements** that it is common to all the electric motor appliances, while product-specific issues are addressed in a series of **Part 2** documents covering the different appliance types. Each Part 2 supplements or modifies the corresponding clauses in IEC 60335-1, so as to convert that publication into the IEC standard about safety requirements for the specific products. Part 1 and Parts 2 standards are prepared by Technical Committee 61 - Safety of household and similar electrical appliances.

In particular for wash appliances the following standards apply:

- **IEC 60335-2-5:2005**, *Household and similar electrical appliances - Safety - Part 2-5: Particular requirements for dishwashers*. Edition 5.1 (including Amendment 1) has been published in March 2005 and deals the safety of the deals with the safety of electric dishwashers for household use that are intended for washing and rinsing dishes, cutlery and other utensils, their rated voltage being not more than 250 V for single-phase appliances and 480 V for other appliances. This standard does not apply to commercial electric dishwashing machines[16].
- **IEC 60335-2-7:2006**, *Household and similar electrical appliances - Safety - Part 2-7: Particular requirements for washing machines*. Edition 6.2 (including Amendments 1 and 2) has been published in May 2006 and deals with the safety of electric washing machines for household and similar purposes, intended for washing clothes and textiles. The rate voltage is not more than 250 V for single-phase appliances and 480 V for other appliances. It includes washing machines for communal use in blocks of flats and in laundrettes. Appliances not intended for normal household use but which nevertheless may be a source of danger to the public, such as appliances intended to be used by laymen in shops, in light industry and on farms, are within the scope of this standard. Washing machines with a spin extraction function must also comply with IEC 60335-2-4, and with a drying function must also comply with IEC 60335-2-11.

As far as is practicable, both standards deal with the common hazards presented by appliances that are encountered by all persons in and around the home. However, in general, they do not take into account the use of appliances by young children or infirm persons without supervision and playing with the appliance by young children. The standards do not apply to appliances intended exclusively for industrial purposes and appliances intended to be used in locations where special conditions prevail, such as the presence of a corrosive or explosive atmosphere (dust, vapour or gas). For appliances intended to be used in vehicles or on board ships or aircraft, additional requirements may be necessary. In many countries additional requirements are specified by the national health authorities, the national authorities responsible for the protection of labour, the national water supply authorities and similar authorities.

[16] Safety of commercial dishwashers is dealt under IEC 60335-2-58 - Household and similar electrical appliances - Safety - Part 2-58: Particular requirements for commercial electric dishwashing machines.

1.2.1.4 Airborne acoustical noise

a) General requirements for noise measurement

In general, noise is measured according to the specifications given in IEC 60704-1, 2nd edition, 1997 *Household and similar electrical appliances – Test code for the determination of airborne acoustical noise – Part 1: General requirements*, prepared by IEC technical committee 59: "Performance of household electrical appliances". A series of Part 2 documents address the individual appliances describing specific test conditions. Finally, IEC 60704-3: 2006, Ed. 2, *Household and similar electrical appliances - Test code for the determination of airborne acoustical noise – Part 3: Procedure for determining and verifying declared noise emission values*, gives values of standard deviations of reproducibility for several categories of appliances.

IEC 60704-1 permits the use of "semi-anechoic rooms", "special reverberation test rooms" and "hard-walled test rooms" for the measurement of the sound power level of the appliance based on acoustic measuring methods described in ISO 3743-1[17], ISO 3743-2 and ISO 3744[18]. Within the measuring uncertainty specific to the three possible methods described in the standard, the results from the determination under free-field conditions over a reflecting plane are equal to those obtained in reverberant fields. This standards is concerned with airborne noise only, while in some cases, structure-borne noise, for example transmitted to the adjoining room, may be of importance. A classification of different types of noise is given in ISO 12001[19]. The methods specified in mentioned ISO standards are suitable for all types of noise, except for sources of impulsive noise consisting of short duration noise bursts, taken into account in Parts 2.

Part 1 of IEC 60704 applies to electric appliances (including their accessories or components) for household and similar use, supplied from mains or from batteries. By similar use is understood the use in similar conditions as in households, for example in inns, coffee-houses, tea-rooms, hotels, barber or hairdresser shops, launderettes, etc., if not otherwise specified in Part 2. It does not apply to appliances, equipment or machines designed exclusively for industrial or professional purposes, appliances which are integrated parts of a building or its installations, such as equipment for air conditioning, heating and ventilating (with some exceptions) oil burners for central heating, pumps for water supply and for sewage systems, separate motors or generators and appliances for outdoor use.

Generally, the determination of noise levels is only part of a comprehensive testing procedure covering many aspects of the properties and performances of the appliance. When preparing the standard it was therefore considered important to keep at a modest level the requirements for noise measurements such as test environment, instrumentation, and amount of labour involved; this resulted in Part 1 methods with an "engineering accuracy" (or "grade 2" according to ISO 12001). The resulting airborne acoustical noise is measured as sound power levels (L_W), expressed in decibels (dB) with reference to a sound power of one picowatt (1 pW), within the specified

[17] ISO 3743-1:1994, ed. 1, "Acoustics – Determination of sound power levels of noise sources - Engineering methods for small movable sources in reverberant fields – Part 1: Comparison methods for hard-walled test rooms" and ISO 3743-2, "Acoustics - Determination of sound power levels of noise sources using sound pressure – Engineering methods for small movable sources in reverberant fields – Part 2: Methods for special reverberation test rooms" (both prepared by ISO TC43/SC1).

[18] ISO 3744:1994, Ed. 2, "Acoustics – Determination of sound power levels of noise sources using sound pressure – Engineering method in an essentially free field over a reflecting plane" (prepared by ISO TC43/SC1).

[19] ISO 12001:1996, Ed. 1, "Acoustics – Noise emitted by machinery and equipment – Rules for the drafting and presentation of a noise test code" (prepared by ISO TC43/SC1).

frequency range of interest (generally including the octave bands with centre frequencies from 125 to 8 000 Hz), and for prescribed operating conditions of the appliance to be measured.

The estimated values of the standard deviations of reproducibility of sound power levels determined according Part 1 are given in ISO 3743-1, ISO 3743-2, and of ISO 3744. But for a particular family of appliances of similar size with similar operating conditions, the standard deviations of reproducibility may be smaller than these values. Hence, in Part 2 series, standard deviations smaller than those listed in ISO standards may be stated if substantiation is available from the results of suitable inter-laboratory tests. In case of discrepancies between the measurements where the results normally remain inside the foreseen standard deviation, it will be necessary to perform measurements according to the upper grade of accuracy (or "grade 1", laboratory or precision according to ISO 12001) as described in ISO 3741 or ISO 3745.

a) Specific requirements for dishwashers

IEC 60704-2-3, Edition 2.1 (including Amendment 1) "*Household and similar electrical appliances - Test code for the determination of airborne acoustical noise - Part 2-3: Particular requirements for dishwashers*", has been published in August 2005. These particular requirements apply to single-unit electric dishwashers for household and similar use, with or without automatic programme control, for cold and/or hot water supply, for detachable or permanent connection to water supply or sewage systems, intended for placing on the floor against a wall, for building-in or placing under a counter, a kitchen worktop or under a sink, for wall-mounting or on a counter.
The measuring conditions specified in this Part 2-3 provide for sufficient accuracy in determining the noise emitted, and comparing the results of measurements taken by different laboratories, whilst simulating as far as possible the practical use of dishwashers. In practice, to avoid unsteadiness caused by foaming, the tests are carried out with unsoiled loads and without detergents or rinsing aids. Compared to the first Edition (1987) of this Part 2, this second edition additionally considers the noise of water supply, drainage, pre-wash and intermediate rinse.

b) Specific requirements for washing machines

IEC 60704-2-4, Edition 2 "*Household and similar electrical appliances - Test code for the determination of airborne acoustical noise - Part 2-4: Particular requirements for washing machines*", has been published in July 2001. The relevant text of Part 1 as amended by this publication, establishes the test code for washing machines and spin extractors. These particular requirements apply to single unit electric washing machines, the washing and spinning function of combined appliances for household and similar use, and to spin extractors.
The measuring conditions specified in this part of IEC 60704 provide for sufficient accuracy in determining the levels of noise emitted and comparing the results of measurements taken by different laboratories, whilst simulating as far as possible the practical use of washing machines and spin extractors. The textile load is standardized on the basis of those used for measuring performance (IEC 60456). To avoid unsteadiness caused by foaming, the tests are carried out with unsoiled loads and without detergents or rinsing aids. Compared to the first edition (1989) of this Part 2-4, the second edition additionally considers the noise of water supply, drainage, pre-wash and intermediate rinse.

1.2.1.5 The standby measurement

The standby consumption of household electrical appliances is measured according to the standard IEC 60301, Ed. 1, 06.2005 "*Household Electrical Appliances – measurement of the standby power*,

2005. prepared by IEC TC59 "Performance of Household Electrical Appliances". Standby is defined as:

- **Standby mode:** the lowest power consumption mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when an appliance is connected to the main electricity supply and used in accordance with the manufacturer's instructions. The standby mode is usually a non-operational mode when compared to the intended use of the appliance's primary function.
- **Standby power:** average power in standby mode measured in Watts.

Since its publication, the standard has been used in Australia and Korea and now forms a fundamental element in the development of policies to influence standby power in these countries. The standard has also been adopted by the US EPA as the base method of test for determination of all low power modes for the International Energy Star program and is also cited under the US Presidential Executive Order for 1 Watt standby power levels as part of the Federal Energy Management Program. An IEA sponsored international conference on standby power in Seoul in November 2005 as a side event held a workshop on the use of IEC 62301.
As a result the worldwide living discussion about this standard and the EC founded study on standby[20] a number of recommendations were made regarding refinements to the IEC 62301 mainly regarding (i) the refinement of the definition of standby mode and (ii) data collection and analysis methods and defining stable conditions, which would improve its accuracy and practical application

A number of changes to both definitions and test conditions of IEC 62301 are under preparation by TC 59/WG 9 "Standby", which were only partially known when this Task Report was prepared.

The standard specifies methods of measurement of electrical power consumption in standby mode. It provides general conditions for measurements (configuration of the tested equipment, environment, power supply, supply-voltage waveform, power measurement accuracy, testing instrumentation, number of tests, and time of measurement) and the test procedure.

Annex A (informative) provides some guidance on the expected modes that would be found for various common appliance configurations and designs based on their circuitry and layout, but the standard does not define these modes.

a) The standby definition and measurement for wash appliances

Although washing machines and dishwashers are considered in IEC 62301, and examples are given on possible low power modes, the current edition of the product specific standards addressing the performance of the wash appliances does not contain any provision about "standby" and/or "low power modes". Therefore, at present, the standby consumption of such appliances is not defined and can not be measured.

Nevertheless, as mentioned in previous paragraph 1.4.1.2, the first draft of IEC 60456 5th Edition (March 2007) proposed a definition of "standby" and "left on" modes for **washing machines** as:

- ***standby mode***: is the lowest power consumption mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when an appliance is connected to the main electricity supply and used in accordance with the manufacturer's instructions. In user instructions, this state may be called "off" or "off mode".

[20] Tender TREN/D1/40/Lot 6, "Standby and Off-mode Losses, 2005.

This definition is identical to "standby mode" in IEC 62301:2005. It was anticipated that TC59/WG9 was discussing both adjustments to the above definition and additional definitions for other low power modes. If finalised by TC59 prior to the publication of IEC 60456 5th Edition, the appropriate revised definitions will be included in the new washing machine standard.

- ***left on mode***: is the lowest power consumption mode that may persist for an indefinite time after the completion of the programme and unloading of the machine without any further intervention of the user. In some products this mode may be an equivalent power to standby mode.

In June 2007, the discussion of the comments received on the April draft of IEC 60456 5th Edition and the input from the experts in charge of the revision of the IEC 62301 lead to the partial modification of the above definitions, where the "standby mode" has been substituted by "off mode" as:

- ***off mode***: off mode is where the product is switched off using appliance controls or switches that are accessible and intended for operation by the user during normal use to attain the lowest power consumption that may persist for an indefinite time while connected to a mains power source and used in accordance with the manufacturer's instructions. Where there are no controls, the washing machine is left to revert to a steady state power consumption of its own accord.

The definition of the *left on* mode has remained unchanged.

For **dishwashers** the standby issues is not considered in the current standard IEC 60346 but will be considered for inclusion in a new Edition following what already done for washing machines.

1.2.2 The European Standards

1.2.2.1 The measurement of energy consumption and other characteristics of wash appliances

The European standards for dishwashers and washing machines are EN 50242/A2 and EN 60456:2005 respectively.

a) The European standard for dishwashers

EN 50242 Ed.2/EN 60436, Electric dishwashers for household use - Test methods for measuring the performance, was published in October 2005. The standard contains the text of IEC60436, Edition 3 with the changes and added text as common modifications EN50242 Ed.2. The standard in Europe gets both numbers, EN60436 and EN50242 due to the labelling mandate of the European Commission.
This European Standard supersedes EN 50242:1998 and its amendments. It contains the first time as a complete version the text of IEC 60436 Ed.3 and additionally all common modifications necessary for application in Europe. The numbering was not changed, therefore it is not expected that this second edition of EN 50242 will influence energy label declaration in any way. The text of the International Standard IEC 60436 Ed.3:2003 was approved by CENELEC as a European Standard with some modifications:

– for energy labelling purposes the measurements are run only using cold water, the use of hot water is not permitted.

- the dishwasher manufacturer's instructions regarding installation and use of the dishwasher must be followed.
- the air dry method is not permitted for the preparation of the soiled place settings, only the microwave oven drying is allowed, using a standardised appliance;
- the cold water energy correction is not applied since the water temperature inlet at 15,0 °C is mandatory in Europe;
- the manufacturer has to declare the programme to be used for the purpose of energy labelling. It must be a programme for normal use, using normal table ware, excluding cooking utensils; .
- the water hardness, detergent (type B) type and quantity and rinse agent type (Formula III rinse aid, acid) are specified;
- better specification and preparation of soiling agents for the load and recommendation of not using a soiled load for more than 200 cycles;
- only the load specified in Annex A *Place settings and serving pieces (non-AHAM style load)* must be used for energy label purpose;
- if no other instruction by the manufacturer is given, the loading of the machine under test must be similar to the loading of the reference machine, especially in mixing the different soiling for the same kind of dishes. The dinner plates prepared with egg or mincemeat and the dessert dishes prepared with egg or spinach should be placed in the test machine alternating.
- when assessing the washing performance, only the cleaning index without machine filter cleaning is used;
- the drying performance tests are carried out in conjunction with the reference machine;
- running of a special normalization cycle of the load with 30 g of anhydrous fine granular citric acid after each cleaning performance and drying performance tests with five to eight cycles, in order to avoid residual scale formation on the test load. For a new test load, ten cycles using detergent and rinse aid are performed in order to avoid the deviations in the test results of tests performed with new load and used load;
- better specification of the assessment of the drying performance
- the standard deviation formulae have been added to evaluate the standard deviation of the measurements (cleaning and drying index) to be compared with a set threshold value;
- a specific Clause Z1 – *Data to be reported* has been set, describing the data to be reported for labelling compliance purposes;
- a specific Clause Z2 - *Tolerances and control procedure*, has been set, dealing with the control procedure of the declared values (cleaning performance, drying performance, energy consumption water consumption, cycle time) which is fundamental for the verification of the compliance to the energy labelling and other EU legislation on cold appliances.

a.1) Future development for EN 50242 Ed. 2/EN 60346

Further development of EN 50242 Ed. 2/EN 60346 will follow the evolution of the corresponding IEC standard.

b) European standard for washing machines

The text of the International Standard IEC 60456:2003 together with the common modifications prepared by the Technical Committee CENELEC TC 59X, "Consumer information related to household electrical appliances", was submitted to the formal vote and was approved by CENELEC as EN 60456 on 2004-10-01. EN 60456, *Clothes washing machines for household use -Methods for measuring the performance* (IEC 60456:2003, modified) published in March 2005 supersedes EN 60456:1999 and its Amendments: A11:2001, A12:2001, A13:2003. Many of the changes in the new IEC 60456:2003 had already been included in EN 60456:1999/A12:2001 and A13:2003.

Consequently, the only significant technical difference with the previous edition of the EN is the allowance of three alternative methods to condition the load.

The standard EN 60456 represents the basis of the current European energy labelling system and needs to be revised in parallel with the international standard IEC 60456, the latter will in fact include changes to the test procedure in its 5th edition. An impact on test results is expected, which will effect the European energy labelling of washing machines (and is possible revision as one of the outcome of the preparatory study of the eco-design directive 2005/32/EC. This directive states that harmonized standards are essential in establishing testing methods, being one of the main roles of harmonised standards to help manufacturers in applying the implementing measures adopted under the EuP directive, if any.

b.1) Future developments for EN 60456

A project[21] is planned for the years 2007 to 2009, in order to update the test standard with regard to Ed.5 of IEC 60456 and the expected update of the standardization mandate from European commission.

A project proposal was prepared by CENELEC TC59X WG1. This proposal was made in the context of the standardization mandate M/047 for the elaboration and adoption of a measurement standard concerning the energy labelling of electrical washing machines and related to Council Directives 92/75/EEC and 95/12/EC. TC59X/WG1 is responsible within CENELEC to update the harmonised standard for washing machines under the mandate from the Commission. The main specific objectives of this project are:

- to run measurements of the washing machines performance under the updated methods described in IEC 60456 5th Ed. and to evaluate the possible consequences on the European energy labelling values;
- to identify the impact of the modifications introduced by IEC 60456 5th Ed. and to check the level of uncertainty reached with regard to the European labelling scheme of washing machines
- to confirm the new reference machine based on new procedures introduced with the new edition of IEC 60456
- to confirm the evaluation methods for the washing performance with new stain strips based on the new procedures
- to check the uncertainty in the performance measurements, to achieve more reliable figures, especially in the case the 40°C cotton program is used
- to develop procedures to test other load sizes than full load (the so called “partial load”)
- to check the impact of reduced detergent dosage and clarify the possibility of a new approach for detergent dosing (which might have an influence on the washing performance)
- to check the improved rinsing method introduced in the new edition of IEC 60456 and to investigate further possibilities to evaluate the rinsing performance of washing machines (at present not taken into consideration in the European labelling scheme).

The tests planed under this project will pay particular attention to the analysis of the reproducibility of results with the 40°C washing cycle. This is considered a particularly important element since the relationship between achieved measurements and uncertainty is the basis for the repeatability and reproducibility of the test results

[21] Source: CLC TC59X/WG1, personal communication.

Testing for other than maximum load (partial load) has been under discussion for a long time and is considered by Consumer Organizations a possible improvement for further reduction of the energy consumption. Tests are needed to define how the appropriate test methods could be included in the washing machines standard.

Reduced detergent dosage for the standard tests is another field stressed by the detergent industry since long time. WG1 will check if an adjustment of the detergent dosage is acceptable at European level.

Finally, an improved procedure for rinsing performance (through alkalinity tests) will be introduced in IEC 60456 5th Ed. The reached level of uncertainty need to be checked before this test method could be considered in a future labelling scheme.

1.2.2.2 Safety Standards

Safety for wash appliances is mainly dealt by the following standards:

- the general part **EN 60335-1: 2002** *Household and similar electrical appliances - Safety* - **Part 1:** *General requirements* that it is common to all the electric motor appliances and a set of **Part 2** documents addressing the different specific products;
- for dishwashers, **EN 60335-2-5:2003** *Household and similar electrical appliances - Safety - Part 2-5: Particular requirements for dishwashers* applies plus **EN 61770:** *Electric appliances connected to the water mains - Avoidance of back-siphonage and failure of hose-sets* as far as the connection with the water supply is concerned;
- for washing machines, **EN 60335-2-7:2003** *Household and similar electrical appliances - Safety - Part 2-7: Particular requirements for washing machines* applies. If the washing machine includes also a spinning function, then **EN 60335-2-4:2002** *Household and similar electrical appliances - Safety - Part 2-4: Particular requirements for spin extractors* applies and if also a drying function in included in the appliance (the so called washer-dryer", the standard **EN 60335-2-11:2003/A2:2006** *Household and similar electrical appliances - Part 2-11: Particular requirements for tumble dryers* deals with the drying part. As far as the connection with the water supply, also washing machines shall comply with **EN 61770**: *Electric appliances connected to the water mains - Avoidance of back-siphonage and failure of hose-sets*" .

The mentioned standards address and implement an internationally accepted level of protection against hazards (such as electrical, mechanical, thermal, fire and radiation) when appliances are operated as in normal use, taking into account the manufacturer's instructions. The same standards cover also protection against further hazards deriving from abnormal situations that can be expected to happen during normal use.

Safety standards take also into account - as far as possible - the requirements of **IEC 60364**, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics*, to ensure compatibility with the wiring rules when the appliances are connected to the mains. Unfortunately, national wiring rules may differ. The main scopes of the LVD directive 73/23/EEC are also covered by the mentioned standards as well as the essential safety requirements of directives (which can be applied to some household and similar appliances), 98/37/EC (Machinery directive), 89/106/EEC (Construction products) and 97/23/EC (Pressure equipment).

Safety requirements include the definition of the characteristics of the product (rating plate), the construction verifications, the tests for compliance of plastic material with fire risks, and tests about electronic components. For example:

- heating tests for the electric components are run in a voltage range ± 6% of the nominal voltage, to take into consideration the possible variations in the supplied voltage;
- the tests for abnormal operation are performed simulating the lock of the components (locked rotor tests of motors and pumps) or simulating the mechanical lock of different switches (i.e. pressostat) and the closure of the water valve (practically simulating the operation without water in the appliance);
- appliances shall be constructed so that spillage of liquid in normal use does not affect their electrical insulation even if an inlet valve fails to close;
- appliances shall be constructed so that foaming does not affect electrical insulation. The verification of the possibility that water sprinkles penetrate inside the appliance and reduce the distances of insulation is run, to simulate appliances installation in a damp environment;
- the compliance of the materials to the temperatures and the resistance to fire is verified;
- the insulation distance between parts in tension and the mass, and between parts to double insulation is verified;
- tests are performed simulating the breakdown of the electronic components (used both for normal operation an for protection) in order to verify that also under these conditions appliances remain safe.

Future developments will probably include an amendment, where relevant of Part 1 and Parts 2, with respect to reasonably foreseeable situations where children, older people and people with disabilities come into contact with electrical household appliances. The Mandate on this matter was finalised in the European Commission and sent to CENELEC for discussion at the BT (technical bureau) meeting in December 2006. CLC TC61 WG4 "Use of appliances by vulnerable people, including children" has been created for this purpose. This working group studied and proposed the definition of specific categories of vulnerable people related to use of appliances:

1. *Very Young Children*: from 0 to 36 months. They are not expected to use appliances;
2. *Young Children*: older than 36 months and younger than 8 years. They are not expected to use appliances safely unless continuous supervision is given;
3. *Older Children*: age from 8-14 years. These children can use appliances safely after they have been given appropriate supervision or instruction concerning their use. The age of 8 years was taken considering the result of the ANEC report[22] that was the basis for starting the activity of the WG and that is mentioned in the Mandate;
4. *Children*: includes all the three above definitions
5. *Vulnerable people*: persons having reduced physical, sensory or mental capabilities (e.g. partially disabled, elderly having some reduction in their physical and mental capabilities), or lack of experience and knowledge (e.g. older children). These persons can use appliances safely after they have been given appropriate supervision or instruction concerning the use
6. *Very vulnerable people*: persons having very extensive and complex disabilities. These persons are not expected to use appliances safely unless continuous supervision is given or appliances are adapted accordingly with arrangements beyond those foreseen by the safety standards.

[22] E. Waller, Child protective products – protective function of socket protectors, hob guards, locks and locking devices, Study commissioned by: ANEC (European Association for Consumer Representation in Standardisation), SP REPORT 2004:23.

A proposal for a modification of EN 60335-2-7 for washing machines was prepared, in which the applicability clause has been modified to cover "the common hazards presented by appliances that are encountered by all persons in household and similar environments. However, in general, it does not take into account: (i) "children" playing with the appliance, (ii) the use of the appliance by "very young children" and "young children" without supervision It is recognized that "very vulnerable people" may have needs beyond the level addressed in the standard.

1.2.2.3 Noise measurement

Noise measurement for dishwashers is described in standard **EN 60704-2-3:2002/A1:2005** "*Household and similar electrical appliances - Test code for the determination of airborne acoustical noise -- Part 2-3: Particular requirements for dishwashers*". It applies to single-unit electric dishwashers for household and similar use, with or without automatic programme control, for cold and/or hot water supply, for detachable or permanent connection to water supply or sewage systems, intended for placing on the floor against a wall, for building-in or placing under a counter, a kitchen worktop or under a sink, for wall-mounting or on a counter.

For washing machines the standard is **EN 60704-2-4:2001** "*Household and similar electrical appliances – Test code for the determination of airborne acoustical noise – Part 2-3: Particular requirements for washing machine and spin extractors*". It applies to single unit electric washing machines, the washing and spinning function of combined appliances for household and similar use, and to spin extractors. The textile load is standardized on the basis of those used for measuring performance. To avoid unsteadiness caused by foaming, the tests are carried out with unsoiled loads and without detergents or rinsing aids. Compared to the previous edition, this standard additionally considers the noise of water supply, drainage, pre-wash and intermediate rinse, therefore the operating conditions during these operations need careful attention.

Both EN standards implement without any modifications the International Standard IEC 60704-2-3:2005 and IEC 607042-4:2001 (see previous paragraph).

1.2.2.4 Standby measurement

The standby consumption of household electrical appliances is measured according to the European standard **EN 62301:2005** including the common modification agreed at European level to the international standard IEC 62301:2005, prepared by Technical Committee CENELEC TC59X "Consumer information related to household electrical appliances". The latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) is 1st June 2006, the latest date by which the national standards conflicting with the EN have to be withdrawn (dow) is 1st July 2008. The common modification to IEC 60301 refer to the definition of the power supply and the control procedure:

- specification **power supply**: where the test voltage and frequency are not defined by an external standard, the test voltage and test frequency shall be 230V ± 1% and 50Hz ± 1%. If the appliances are to be connected to three phases and the test voltage and frequency are not defined by an external standard the test voltage and test frequency shall be 400V ± 1% and 50Hz ± 1%;
- addition of a specific clause on **tolerances and control procedure**: Where tolerances and control procedures are not defined by an external standard, the tolerances and control procedures are:

- for **power consumption >1W**: the standby power measured on the first appliance shall not be greater than the value declared by the manufacturer plus 15%. If the result of the test carried out on the first appliances is greater than the value declared plus 15%, the test for standby power shall be carried out on a further three appliances, which shall be randomly selected from the market. The arithmetic mean of the values of these three appliances for the standby power shall not be greater than the declared value plus 10%.
- for **power consumption ≤ 1W**: the measured standby power shall not be greater than the value declared by the manufacturer plus 0,15W. If the result of the test carried out on the first appliance is greater than the declared value plus 0,15W, the test shall be carried out on a further three appliances, which shall be randomly selected from the market. The arithmetic mean of the values of these three appliances shall not be greater than the declared value plus 0,1 W.

The standard clearly states that it is a specific measurement procedure to be normally used as a reference standard in a product performance standard. When data on standby power are needed for a product, a new clause must be incorporate in the relevant performance standard.

EN 62301 specifies methods of measurement of electrical power consumption in standby mode. It is applicable to mains powered electrical household appliances or equipment and to the mains powered parts of appliances that use other fuels such as gas or oil. It does not specify minimum performance requirements nor does it set maximum limits on power or energy consumption. The objective of the standard is to provide a method of test to determine the power consumption of a range of appliances and equipment in standby mode (generally where the product is not performing its main function). The test method is also applicable to other low power modes where the mode is steady state or providing a background or secondary function (e.g. monitoring or display). In this case the relevant low power modes (in addition to standby mode) to which the test procedure is applied should be defined by performance standards of appropriate appliances.

The power consumption is determined by recording the instrument power reading where the power value is stable or by averaging the instrument power readings over a specified period or by recording the energy consumption over a specified period and dividing by the time where the power value is not stable. The time period is not less than 5 minutes, except if there is an operating cycle.

General condition for measurement (including test room description, power supply, supply voltage waveform, power measurement accuracy) the selection and preparation of the appliance, the measurement procedure where the power value is – or is not – stable and the test report (including appliance details, test parameters, measured data, test and laboratory details) are described. General conditions about test conditions and equipment are applied unless otherwise specified.

Annex A (informative) provides some guidance on the expected modes that would be found for various common appliance configurations and designs based on their circuitry and layout, but the standard does not define these modes:

- ***Type A***: the appliance has no subsidiary load and no power switch. The appliance operates whenever plugged in. There may be some internal regulation of the load (e.g. thermostat or temperature control device). There is no standby power. Examples are: electric storage water heaters, refrigerators.
- ***Type B***: the appliance has a power switch. The appliance operates when it is manually turned on by the power switch and stops when turned off. Power switches can be the auto-off type (automatically turns off at the completion of the operation). There is no standby power. Examples are: electric heaters (with no thermostat), some major appliances (some **dishwashers**, **clothes washers** and clothes dryers) and some ovens.

- ***Type C***: the appliance has no (hard) power switch but has a subsidiary function that controls the operating load or performs some related function. There may be a remote control or electronic power switch. Standby power may be associated with the subsidiary function. Examples are: bread makers, some small kitchen appliances, some major appliances (some **dishwashers**, **clothes washers** and clothes dryers), some microwave ovens, any appliance with a remote control and no hard off switch, any appliance with a "soft" (electronic) power switch.
- ***Type D***: the appliance has a power switch that disconnects the operating load and has a subsidiary function that is permanently connected to the power. Standby power may be associated with the subsidiary function. Examples are: conventional ovens, some types of heaters, VCRs, any appliance that requires some power for a subsidiary function (clock, display, etc.).
- ***Type E***: the appliance has a power switch that disconnects the operating load. It may have a subsidiary function that is permanently connected to the power and/or one that is disconnected with the power switch. Standby power may be associated with the permanently connected subsidiary function. Other low power modes may be associated with the switched subsidiary function. Examples are: some microwave ovens, some major appliances (some **dishwashers**, **clothes washers** and clothes dryers), some types of heaters, any appliance that requires some power for a subsidiary function (clock, display, etc.), TVs, any appliance with permanently connected electronics or EMC filters.
- ***Type F***: the appliance has an external power supply that provides the appliance with power for its primary operation. Supply is usually extra low voltage (< 50V) and may be AC or DC and may be connected via a plug. Appliance configuration may be A to E above. Standby is associated with the power supply and there may be numerous low power modes. Examples are: any appliance with an external power supply required for normal operation, some toys, some phones and answering machines.
- ***Type G***: the appliance has an external power supply that provides the appliance with power mainly for battery charging. The appliance primary operation is normally performed disconnected from the power supply (battery operated and portable appliances), but some may be used with the power supply connected. Supply is usually extra low voltage (< 50V) and may be AC or DC and is connected via a detachable plug. Standby is associated with the power supply and there are low power modes associated with battery charging and use. Examples are: portable battery operated appliances such as battery shavers, electric toothbrushes and portable vacuum cleaners.

Annex A describes also the major components in the appliance that affect power consumption:

- *Subsidiary function(s)*: subsidiary functions, some function(s) that are ancillary to the primary load, will usually consume small amounts of power. Some subsidiary functions may have a separate switch to disconnect them from the supply. Examples of subsidiary functions are:
  - remote control of power to the operating load (effectively a remote power switch);
  - automatic disconnection of the load on completion (auto off power switch);
  - display (could be mode, program, state or clock etc.);
  - low voltage power supply for memory and clock functions;
  - low voltage power supply for electronic controls and switches;
  - electromagnetic compatibility (EMC) filters;
  - running a cooling fan or auxiliaries.
- *Power switch***:** this allows the user to turn an appliance (or the operating load) ON or OFF. There are a number of variations of a power switch as follows:
  - *All off power switch*: results in the same state as being unplugged from the power supply when the switch is turned OFF.
  - *Auto power off switch*: turns 'ON' manually and turns 'OFF' automatically after finishing operation.

- *Power control switch*: a power switch that incorporates some sort of power control device such as a dimmer or thyristor.
- *Operating load*: this is the main function of the appliance. Thermostats or temperature control devices to control the operating load are usually considered as part of the operating load and not as a power switch.

The standby consumption is not directly measured, but is indirectly calculated starting from the measurement of the standby power. In this respect, **Annex B** (informative) provides some guidance regarding the conversion of power measurements determined by the standard to energy consumption values and to solve a number of problems associated with power measurement of very small loads (typically less than 10W): non sinusoidal current waveforms, crest factor, harmonic components of the current waveform, cyclic or pulsing load effects, asymmetric current waveforms (DC components) and the characteristics of the instruments to be used for the power measurements.

Annex C (informative) provides some guidance regarding the conversion of power measurements determined under the standard to energy consumption values.
To convert power to energy (e.g. an annual energy consumption), the number of hours of operation in each mode must be assumed for a given period and the average power for each mode must also be known. As most appliances can operate in a number of modes and the usage patterns and profiles may vary considerably between countries, converting power values determined under this standard to energy values is potentially fraught with difficulty.
In the simplest case, an appliance that has only a single mode of operation can be converted to an annual energy value by assuming a constant power for a whole year. A year has 8.760 h (this ignores leap years),
Annual energy consumption can be determined can be determined for more complex user patterns by the sum of power × hours of use for each mode during one year.

Finally, **Annex D** provides information on the determination of uncertainty of measurement. To be meaningful, the uncertainty statement must have an associated confidence level: i.e. it is necessary to state the probability that the true value lies within the range given. A 95 % confidence level was chosen in the standard.

This European standard will follow the modifications of the corresponding IEC standard in due course.

1.2.3 The Standard used in Other Countries

Although an harmonisation process is on-going worldwide, still standards different from IEC ones are used in some regional markets.

1.2.3.1 The dishwasher standards worldwide

Few countries have developed standards for the measurement of dishwashers.

a) Australia and New Zealand

Dishwashers in Australia and New Zealand are measured according to the standard AS/NZS 2007:2005 "*Performance of household electrical appliances - Dishwashers*".

The dishwasher standard **AS/NZS 2007:2005**[23] "*Performance of household electrical appliances - Dishwashers*" was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-015, Quality and Performance of Household Electrical Appliances, to supersede the former standard AS/NZS 2007.1:2003. The AS/NZS 2007 series comprises two Parts:

1. AS/NZS 2007.1 Part 1: *Methods for measuring performance, energy and water consumption*, which includes performance test procedures and minimum performance criteria for dishwashers;
2. AS/NZD 2007.2 Part 2: *Energy efficiency labelling requirements*, which includes algorithms for the calculation of the energy efficiency star rating and projected energy usage, performance requirements, details of the energy label and requirements for the valid application for registration for energy efficiency labelling. It also includes the application form for registration for water efficiency labelling. It has been structured to be suitable for reference in regulatory legislation and to be used in conjunction with Part 1.

The overall objective of the AS/NZS 2007 series is to promote high levels of performance, energy efficiency and water efficiency in electric dishwashers.

AS/NZS 2007.1 standard includes a number of requirements derived from the 3rd Edition of IEC 60436: 2004, which will bring it closer to the IEC standard. It also incorporates the following significant changes in comparison to earlier editions:

i. Test methods have generally been made more repeatable and reproducible;
ii. It is intended to phase out the AS/NZS test load by December 2007, until that date, the AS/NZS test load (without serving utensils and bowls) is allowed as an alternative to the IEC test load;
iii. A "test program" has been defined and it has been clarified that any program can be tested to this standard, but the performance requirements in Section 4 only apply to the program recommended for a normally soiled load. The program for a normally soiled load is the program mandated for energy efficiency labelling in AS/NZS 2007 – Part 2;
iv. definitions in this Standard are now generally aligned with IEC definitions;
v. program time and cycle time have been added to the definitions;
vi. power measurements on a number of standby modes are now required. Standby modes have been added to the definitions and examples of the types of standby modes have been added in Appendix M (the impact of communication by appliances over a network is under consideration);
vii. there are improved instructions regarding the use of the reference machine;
viii. a recommendation to purchase all test materials from the same sources has been added to minimize variations in test results. These materials will be used for check testing.
ix. A number of performance requirements must be met by dishwashers during a test for energy consumption. These include:
    → *washing index*: the washing index of the test machine must exceed the specified value measured on the reference machine which is tested in parallel. The reference machine is a dishwasher which specially constructed and calibrated for this purpose;
    → *drying index*: the drying index of the test machine must exceed 50% (this is conducted as a separate test);
    → *rated capacity*: all specified load items shall be supported;
    → *water consumption*: shall not exceed 110% of the value stated by the manufacturer.
    → *water pressure*: machine shall be capable of operating at the maximum and minimum water pressure stated by the manufacturer;
    → *energy consumption* is determined on the program recommended by the manufacturer for energy labelling that is capable of meeting the above mentioned requirements. From

[23] Source: "Preface and Foreword from AS/NZS 2007:2005: Performance of household electrical appliances-Dishwashers Part 1: Energy Consumption and Performance – 2005", see: http://www.energyrating.gov.au/dw2.html .

April 2004, all dishwashers are to be re-labelled using the "normal" program when tested to the 2003 Edition of AS/NZS 2007.1;

x. the ambient air temperature is 20°C ± 2°C and the humidity is 60% ± 5%. All tests are undertaken with a power supply at 240 Volts and 50 Hz.

AS/NZS 2007:2005 is broadly based on the old Edition of the international standard IEC 60436:1981 and on the revised test method published in IEC 60436, Edition 3, February 2004. Still there are differences between the AU/NZS and the IEC 60436 Ed.3, which can be summarised as:

(a) IEC 60436, Edition 3 uses the "universal 65°C" as the reference program to determine a relative performance index for declaration by the manufacturer (wash and dry performance is included on the EU energy label). The reference program on the reference machine used in the AU/NZ standard is "gentle 45°C" which is used to set a pass/fail for wash performance, rather than a manufacturer declaration of wash performance. IEC 60436, Edition 3 also uses the reference machine to assess drying performance whereas it is not used for assessing drying performance in AS/NZS 2007:2005;
(b) AS/NZS 2007:2005 allows at present the use of an IEC load (without serving items) or the original AS/NZS load as an alternative. IEC also allows an AHAM (US) load as an alternative to the so called European load. The AS/NZS load is to be phased out by December 2007;
(c) there are slight differences in the ambient humidity requirements between AS/NZS (60%) and IEC (55% or 65% dependent on the soil drying method);
(d) the food items used for soiling the load in AS/NZS more closely resembles the soiling from IEC 60436:1981. AS/NZS still uses tomato juice while the IEC 60436, Edition 3 uses milk treated in a microwave as well as minced meat. Some soil items are slightly different (e.g. tinned spinach versus frozen spinach) and the preparation of some items and the allocation of soils to the load itself are also slightly different;
(e) AS/NZS cold water supply temperature is 20°C while IEC is 15°C;
(f) AS/NZS water hardness is soft (45 ppm) while IEC specify both soft (≤70 ppm) and hard (250 ppm) water alternatives; water pressure is 320 kPa in AS/NZS while IEC is 240 kPa;
(g) AS/NZS reference detergent is based on the old IEC type A (phosphate based with chlorine bleach), while IEC specifies type C detergent (phosphate based with oxygen bleach and enzymes). IEC also have new rinse agent formulations (types III and IV). In Europe, CENELEC still use detergent B and the older rinse aid formulations;
(h) AS/NZS requires the manufacturer to specify the amount of detergent to be used, whereas IEC specifies a default detergent quantity where an amount is not specified by the manufacturer. AS/NZS and IEC both specify maximum detergent quantities, which may be used for testing;
(i) In AS/NZS the reference machine water softener is de-activated while in IEC it is allowed to operate normally (noting that most IEC tests will be done with hard water and tests under AS/NZS use soft water). Most dishwashers in Australia and New Zealand do not have a water softener;
(j) AS/NZS use the reference machine only for assessing the washing performance while IEC use it for assessing washing and drying performance;
(k) IEC allows the use of either oven drying or air drying of the soiled load prior to washing while AS/NZS only allow air drying;
(l) AS/NZS and IEC now specify the lighting conditions for washing and drying evaluations. The viewing cabinet previously mandatory in AS/NZS, has been moved to an informative Appendix L;
(m) AS/NZS and IEC evaluation scoring systems are now aligned;
(n) AS/NZS requires filter cleaning between test runs while IEC specify that filters are not cleaned between runs. IEC classify filters into 3 main categories and require a minimum of 5 tests (but

could be as many as 10 tests) on each dishwasher, depending on variability and performance without filter cleaning;

(o) AS/NZS now requires standby power measurements on a number of modes (under consideration in IEC);

(p) IEC requires that the load be pre-conditioned in a dishwasher with IEC rinse aid prior to use in a performance test. AS/NZS does not specify any particular requirements other than the load is clean prior to use.

b) USA

In the USA dishwashers are measured under the US Department of Energy Code of Federal Regulations (CFR 10, Part 430, Subpart B, Appendix C - U*niform Test Method for Measuring the Energy Consumption of Dishwashers*), which incorporates and refers to the American National Standard, Household Electric Dishwashers, ANSI/AHAM DW-1-1992. This standard establishes a separate test for soil-sensing machines, compared to non-soil-sensing machines and considers 215 cycles per year compared to the previous edition in 2001 where 264 cycles per year were used. The test procedure for soil sensing dishwashers reflects the combined efforts of many stakeholders who have worked with the DoE to find a more accurate way of testing dishwasher models which use smart technology to sense and adjust the length of the wash cycle according to the soil level of the dish load.

The standard sets first a series of definitions:

- **Compact dishwasher**: a dishwasher that has a capacity of less than eight place settings plus six serving pieces as specified in ANSI/AHAM DW-1
- **Standard dishwasher**: a dishwasher that has a capacity equal to or greater than eight place settings plus six serving pieces as specified in ANSI/AHAM DW-1
- **Cycle type**: any complete sequence of operations capable of being preset on the dishwasher prior to the initiation of machine operation
- **Normal cycle**: the cycle type recommended by the manufacturer for completely washing a full load of normally soiled dishes including the power-dry feature
- **Non-soil-sensing dishwasher**: a dishwasher that does not have the ability to adjust automatically any energy consuming aspect of a wash cycle based on the soil load of the dishes.
- **Soil-sensing dishwasher**: a dishwasher that has the ability to adjust any energy consuming aspect of a wash cycle based on the soil load of the dishes.
- **Standby mode**: the lowest power consumption mode which cannot be switched off or influenced by the user and that may persist for an indefinite time when the dishwasher is connected to the main electricity supply and used in accordance with the manufacturer's instructions
- **Water-heating dishwasher**: a dishwasher which, as recommended by the manufacturer, is designed for heating cold inlet water (nominal 50°F/10°C) or designed for heating water with a nominal inlet temperature of 120°F/48,9°C. Any dishwasher designated as water-heating (50 °F or 120 °F inlet water) must provide internal water heating to above 120 °F in at least one wash phase of the normal cycle.
- **Truncated normal cycle**: the normal cycle interrupted to eliminate the power-dry feature after the termination of the last rinse operation.

The designation of dishwasher type determines whether a dishwasher will be tested with clean or soiled dishes. The two definitions use the ability, or lack of ability, to adjust automatically any energy consuming aspect of a wash cycle based on the soil load of the dishes as the determinant for distinguishing dishwasher type.

Non-soil-sensing dishwashers, tested at a nominal inlet temperature of 50°F/10°C or 120°F/48,9°C, must be tested on the normal cycle with a clean load of eight place settings plus six serving pieces. If the capacity of the dishwasher, as stated by the manufacturer, is less than eight place settings, then the test load must be the stated capacity.

Soil-sensing dishwashers, tested at a nominal inlet temperature of 50°F/10°C, 120°F/48,9°C or 140°F/60°C, must be tested first for the sensor heavy response, then tested for the sensor medium response, and finally for the sensor light response with the combinations of soiled and clean test loads defined for the compact and standard machine type.

Only water-heating dishwashers - that operate with a nominal inlet temperature of 50°F/10°C or 120°F/48,9°C - can be tested according to Appendix C.

Test procedures allow to measure:

- *Machine electrical energy consumption*: M, expressed as the number of kilowatt-hours of electricity consumed by the machine during the entire test cycle, using a water supply temperature and a watt-hour meter;
- *Water consumption*.: V, expressed as the number of gallons of water delivered to the machine during the entire test cycle, using a water meter;
- *Standby power*: for stable operation, standby power, S_m, can be recorded directly from the standby watt meter in Watts or accumulated using the standby Watt-hour meter over a period of at least 5 minutes. For unstable operation, the energy must be accumulated using the standby watt-hour meter over a period of at least 5 minutes and must capture the energy use over one or more complete cycles. Calculate the average standby power, S_m, expressed in Watts by dividing the accumulated energy consumption by the duration of the measurement period.

After the running of the tests, results are calculated from the test measurements:

- **Machine energy consumption**
  - *Machine energy consumption for non-soil-sensing electric dishwashers*, M, the value recorded as the per-cycle machine electrical energy consumption, expressed in kilowatt-hours per cycle;
  - *Machine energy consumption for soil-sensing electric dishwashers*, M, the machine energy consumption for the sensor heavy, normal and light cycle, as defined as:
    $M = (M_{hr} \times F_{hr}) + (M_{mr} \times F_{mr}) + (M_{lr} \times F_{lr})$, where:
    - M_{hr} = the value recorded for the test of the sensor heavy response
    - M_{mr} = the value recorded for the test of the sensor medium response
    - M_{lr} = the value recorded for the test of the sensor light response
    - F_{hr} = the weighting factor based on consumer use of heavy response, equal to 0,05
    - F_{mr} = the weighting factor based on consumer use of medium response, equal to 0,33
    - F_{lr} = the weighting factor based on consumer use of light response, equal to 0,62.

- **Drying energy**
  - *Drying energy consumption for non-soil-sensing electric dishwashers*, E_D, the amount of energy consumed using the power-dry feature after the termination of the last rinse option of the normal cycle, expressed in kilowatt-hours per cycle;
  - *Drying energy consumption for soil-sensing electric dishwashers*, E_D, for the sensor normal cycle is defined as:
    $E_D = (E_{Dhr} + E_{Dmr} + E_{Dlr})/3$, where:

- E_{Dhr}= energy consumed using the power-dry feature after the termination of the last rinse option of the sensor heavy response
- E_{Dmr}= energy consumed using the power-dry feature after the termination of the last rinse option of the sensor medium response
- E_{Dlr}= energy consumed using the power-dry feature after the termination of the last rinse option of the sensor light response

- **Water consumption**
  - *Water consumption for non-soil-sensing dishwashers* using electrically heated, gas-heated, or oil-heated water, V, the value recorded as the per-cycle water energy consumption, expressed in gallons per cycle
  - *Water consumption for soil-sensing dishwashers using electrically heated, gas-heated, or oil-heated water*, V, as the water consumption for the sensor normal cycle, defined as:
    $V = (V_{hr} \times F_{hr}) + (V_{mr} \times F_{mr}) + (V_{lr} \times F_{lr})$, where:
    - V_{hr} = the value recorded for the test of the sensor heavy response
    - V_{mr} = the value recorded for the test of the sensor medium response
    - V_{lr}= the value recorded for the test of the sensor light response
    - F_{hr} = the weighting factor based on consumer use of heavy response, equal to 0,05
    - F_{mr} = the weighting factor based on consumer use of medium response, equal to 0,33
    - F_{lr} = the weighting factor based on consumer use of light response, equal to 0,62.

- **Water energy consumption for non-soil-sensing or soil-sensing dishwashers using electrically heated water**

  - *Dishwashers that operate with a nominal 140 °F inlet water temperature, only*, W, for the normal and truncated normal test cycle, expressed in kilowatt-hours per cycle and defined as:
    $W = V \times T \times K$, where:
    - V = water consumption in gallons per cycle
    - T = nominal water heater temperature rise, equal to 90 °F,
    - K = specific heat of water in kilowatt-hours per gallon per degree Fahrenheit, equal to 0,0024.

  - *Dishwashers that operate with a nominal inlet water temperature of 120 °F*, W, for the normal and truncated normal test cycle, expressed in kilowatt-hours per cycle and defined as:
    $W = V \times T \times K$, where:
    - V = water consumption in gallons per cycle
    - T = nominal water heater temperature rise, equal to 70 °F,
    - K = specific heat of water in kilowatt-hours per gallon per degree Fahrenheit, equal to 0,0024.

- **Water energy consumption per cycle using gas-heated or oil-heated water**

  - *Dishwashers that operate with a nominal 140 °F inlet water temperature, only*, W_g, for each test cycle, the water energy consumption using gas-heated or oil-heated water, expressed in Btu's per cycle and defined as:
    $W_g = V \times T \times C/e$, where:
    - V = reported water consumption in gallons per cycle
    - T = nominal water heater temperature rise, equal to 90 °F,

- C = specific heat of water in Btu's per gallon per degree Fahrenheit, equal to 8,2,
- e = nominal gas or oil water heater recovery efficiency, equal to 0,75.

➢ *Dishwashers that operate with a nominal inlet water temperature of 120 °F.* For each test cycle, calculate the water energy consumption using gas heated or oil heated water, W_g, expressed in Btu's per cycle and defined as:
$W_g = V \times T \times C/e$, where:
- V = reported water consumption in gallons per cycle
- T = nominal water heater temperature rise, equal to 70 °F,
- C = specific heat of water in Btu's per gallon per degree Fahrenheit, equal to 8,2,
- e = nominal gas or oil water heater recovery efficiency, equal to 0,75.

- **Annual standby energy consumption**

To calculate the estimated annual standby energy consumption, first determine the number of standby hours per year, H_s, defined as:

$H_s = H - (N \times L)$

where:
- H = the total number of hours per year or 8 766
- N = the representative average dishwasher use of 215 cycles per year
- L = the average of the duration of the normal cycle and truncated normal cycle, for non-soil-sensing dishwashers with a truncated normal cycle; the duration of the normal cycle, for non-soil-sensing dishwashers without a truncated normal cycle; the average duration of the sensor light response, truncated sensor light response, sensor medium response, truncated sensor medium response, sensor heavy response, and truncated sensor heavy response, for soil-sensing dishwashers with a truncated cycle option; the average duration of the sensor light response, sensor medium response, and sensor heavy response, for soil-sensing dishwashers without a truncated cycle option;

then calculate the *estimated annual standby power use*, S, expressed in kilowatt-hours per year and defined as:

$S = S_m \times (H_s/1000)$, where S_m= the average standby power in Watts.

1.2.3.2 The washing machine standards worldwide

a) Australia and New Zealand

Washing machines in Australia and New Zealand are measured according to the standard: **AS/NZS 2040:2000**[24] *Performance of household electrical appliances - Clothes washing machines* prepared by the Joint Standards Australia/Standards New Zealand Committee EL-015, Quality and Performance of Household Electrical Appliances. The AS/NZS 2040 series comprises two Parts:

1. AS/NZS 2040.1 Part 1: *Energy consumption and performance*, includes performance test procedures and minimum performance criteria for washing machines. It has been structured to be suitable for reference in regulatory legislation and to be used in conjunction with Part 2;

[24] Source: Preface and Foreword from AS/NZS 2040:2000: Performance of household electrical appliances-Clothes washing machines Part 1: Energy Consumption and Performance - 2005, see: http://www.energyrating.gov.au/cw2.html

2. AS/NZD 2040.2 Part 2: *Energy labelling requirements*, includes algorithms for the calculation of the energy efficiency star rating and projected energy usage, performance requirements, details of the energy label and requirements for the valid application thereof.

The overall objective of the AS/NZS 2040 series is to promote high levels of performance and energy efficiency in electric clothes washers. It is based on IEC 60456:1994, *Electric clothes washing machines for household use-Methods for measuring the performance*. But it differs from IEC standard in a number of ways, as follows:

1. specific minimum performance requirements for washing, spinning and severity of washing are included (these are not specified by the IEC) in Part 2;
2. the water hardness is specified as 0,45 mmol/litre (in IEC 60456 is 2,5 mmol/litre);
3. the cold water temperature is 20°C (in IEC 60456 is 15°C);
4. a particular phosphate-based detergent is used for other than drum type machines (not specified by IEC);
5. only IEC Type B phosphate-based detergent is used for drum type machines (IEC nominates two detergents, with the stated intention of deleting Type B in the future);
6. AS9 soil swatches are used (IEC specifies four separate soil swatches which include carbon, blood, wine and chocolate);
7. a mixed cotton and polyester/cotton load is used (IEC specifies only sheets, towels and pillowcases for cotton);
8. Each AS9 soil batch is calibrated against a reference batch (soil batch calibration is not specified by IEC);
9. the laboratory reference machine is not used to normalize results (IEC specifies a Wascator reference machine to normalize results);.
10. the water extraction (spin) index is based on bone dry mass (IEC index is based on normalized mass with a nominal 8% moisture content);
11. whiteness retention test (informative) is included (not specified by IEC);
12. Tests for rinse performance is included in Annex N (added in Amendment 4, of August 2005, with a different method compared with IEC);
13. Tests for mechanical detergent loss in the sump and acoustical noise are not included (these are specified by IEC).

The standard **AS/NZS 2040-1, Amendment No. 4, August 2005** includes Appendix N - *Determination of rinse performance* and Appendix O – *Measurement of PBIS concentration in the supply water and extracted liquor samples*.

Appendix N sets out the procedure for determining the rinse performance of a clothes washing machine, through UV spectrophotometric measurement of a chemical marker (2-phenyl-5-benzimidazole-sulfonic acid or PBIS) in the rinse liquor extracted from the wet load at the end of the program.

The test for rinse performance is carried out in conjunction with tests to determine percentage soil removal, energy and water consumption, water extraction index, and severity of washing action index in accordance with Appendices D, E, F and G respectively of the standard AS/NZS 2040-1.

Rinse performance of a washing machine is determined by measuring the mass, per kilogram of rated load, of a marker (PBIS) present in the rinse liquor that is retained in the wet load at the end of the program. The marker, analytical grade 2-phenyl-5-benzimidazole-sulfonic acid (PBIS) with a purity of 98% or better, is dosed into the wash program in proportion to the rated load, the dosage being 100mg PBIS per kilogram of rated load. A standard percentage soil removal test is then

conducted in accordance with Appendix D of AS/NZS 2040-1, using a conditioned load. At the completion of this test (following the weighing of the load) the load is placed in a spin extractor and a sample of rinse liquor recovered. A spin extractor of any size may be used for the purpose of this test provided that it can generate sufficient G force to extract from the rinsed load sufficient rinse liquor (typically 100 ml, but no more than 150 ml) for the purpose of UV spectrophotometric measurement of the extracted sample. Ideally a spin extractor that can accommodate the entire load in a single run should be used. If a smaller spin extractor is used, the entire load will need to be divided into two or more equal parts.

Using UV spectrophotometry the concentration of retained PBIS is then determined by comparison with measurements from solutions of known PBIS concentration.

The rinse performance is then determined from the concentration of PBIS in the extracted rinse liquor multiplied by the mass of retained moisture in the load measured at the end of the program. As a check on the accuracy of the dosing of PBIS, a sample of the wash liquor is also collected during the test and measured for PBIS concentration.

The rinse performance score (in mg/kg of load) is determined from the following equation:

$$\text{Rinse performance score} = \frac{C_m \times m_r}{RC}$$

where:

- C_m = concentration of PBIS found in the rinse liquor adjusted as required for the apparent concentration of PBIS in the supply water (mg/l)
- m_r = mass of retained moisture in the load (kg)
- RC = rated load capacity claimed by the manufacturer for a normally soiled load (kg).

A test is not valid unless the following criterion is met:

$$PBIS_{wash} \geq 0{,}7 \times \frac{M_{PBIS}}{Q_{wash\cdot tot}}$$

where:

- $PBIS_{wash}$ = the concentration of PBIS found in the sample of wash liquor (mg/l)
- M_{PBIS} = the dose (mass) of PBIS used in the test (mg)
- $Q_{wash\ tot.}$ = the total volume of water, including any water added with the detergent, used in the initial wash operation (i.e. up until first pump out) (litres)

The procedure for measuring the concentration of PBIS in the supply water and extracted liquor samples is specified in Appendix O: the test procedure employs the measurement of the absorbance of ultraviolet light by a sample water at the absorbance maximum for PBIS (302 nm) and at a background point of 330 nm. The measurement of a background point at 330 nm enables correction for background absorbance due to turbid samples.

b) China

Energy consumption of clothes washers is specified in the standard GB/T 4288-1992, *Household electric washing machines*, but no other information are available about the measurement method.

c) Japan

Standard for washing machine in Japan is JIS C 9811:1999 "*Electric clothes washing machines for household use - Methods for measuring the performance*", IEC 60456:1994 (MOD). JIS standard reflects the structure of the IEC standard for washing machines, but changes in structure are permitted provided that the altered structure permits easy comparison of the content of the two standards.

d) USA

The test methods for domestic and commercial washing machines in force since January 2004 in USA is described in the Federal Register: 10 CFR Section 430.23(j), i.e. Appendix J1 to Subpart B of Part 430 (2005).

The US government established the first federal policy measure, including the relevant standard, for washing machines in 1977[25]. In the 1990's, concurrent with the development of new energy conservation policies for this appliance group, the Department of Energy began also revising the test method. The existing standard in fact did not cover a number of innovative washing machine technologies such as high spin speed and adaptive water fill control, and DoE published several proposals to address those innovations. Contemporarily, the Association of Home Appliance Manufacturers (AHAM) requested that DoE adopt an additional new standard that would also capture consumer habits that showed a reduction in the use of hot water and energy. AHAM proposed also that DoE incorporate this test method as part of the process of revising the washing machine energy conservation policies, and that the test go into effect concurrently with the issuance of new efficiency requirements.
On April 22, 1996, the DoE proposed such a new standard, described in Appendix J1, as well as certain additional revisions to the currently applicable test procedure, described in Appendix J to subpart B of 10 CFR part 430. Appendix J expired on 31st December 2003 and Appendix J1 became mandatory and replaced Appendix J when the energy conservation requirements (adopted on 12th January, 2001) took effect on 1st January 2004.

A key difference between the old Appendix J and the new Appendix J1 test method is the basic energy efficiency descriptor. Appendix J specifies an energy efficiency descriptor called the "**Energy Factor**" (EF). The Appendix J1 test method replaces the EF with an energy efficiency descriptor called the "**Modified Energy Factor**" (MEF). In contrast with the previous EF descriptor which only calculated the energy use of the washing machine itself, the MEF descriptor accounts for the remaining moisture content (RMC) of clothes leaving the washing machine. In order to calculate the RMC, Appendix J1 requires manufacturers to use a particular lot of standardized test cloth to simulate a washer load of clothes. Other substantive differences between the old and new standards include using different water temperatures for testing and using test cloth loads for all classes of washing machines in Appendix J1, but not in previous Appendix J. Nevertheless, still Appendix J1 does not provide a means for determining the energy consumption of a washing machine with an adaptive control system other than an adaptive water fill control.

To insure that the use of a specific manufacturer's product (i.e. a real washing machine) would not influence or bias the test results in any way, the DoE developed also a test using an extractor working at different gravitation forces (g forces) to remove moisture content, instead of using a washing machine. The cloth were also soaked in a tub at a controlled temperature to approximate the agitated soak cycle provided by a typical washing machine. The extractor-based test examined

[25] Source: US Federal Register / Vol. 68, No. 211 / Friday, October 31, 2003 / Rules and Regulations.

RMC values at different "g" forces so that new batches of test cloth could be compared to the RMC values of a standard reference test cloth. This comparison provided the basis for developing a correction methodology whereby the test results using any new lot of cloth could be ''corrected'' back to the test values of the base reference lot of cloth. This deviation is measured as the root mean square between the set of measured RMC values and the set of standard RMC values. If this absolute deviation is below 2%, then correction factors are unnecessary in MEF tests using that batch of cloth, if the deviation is above 2%, then correction factors are necessary when using the cloth to test the MEF of a washing machine. The range of test conditions (100, 200 and 350 spin g's, with warm (100°F/37,7°C) and cold (60°F/15,5°C) rinse water, and with spin times of 4 minutes and 15 minutes) brackets the actual conditions under which manufactured residential washing machines operate and will be tested according to the Appendix J1 standard. The 100–350g range bounds the lower and upper levels of spin speeds; the use of both warm and cold water temperatures serves to identify any changes in test results of the test cloth due to water temperature variation; the use of 4 and 15 minute spin times bounds the various spin cycle times in a real washing machine. Thus, by averaging of this combination of test cycles, the test procedure created a representative profile of the spin and extraction behaviour of the test cloth. In addition, a second statistical test (ANOVA analysis of variance) to validate new lots of energy test cloth was included.

The new standard, applied to test machines from 1st January 2004 sets the definition of washing machine (named cloth washer in US) and classifies residential ones in 5 main categories based on size and features, such as suds-saving. Main definitions are:

- **Adaptive control system**: a clothes washer control system, other than an adaptive water fill control system, which is capable of automatically adjusting washer operation or washing conditions based on characteristics of the clothes load placed in the clothes container, without allowing or requiring consumer intervention or actions. The automatic adjustments may, for example, include automatic selection, modification, or control of any of the following: wash water temperature, agitation or tumble cycle time, number of rinse cycles, and spin speed. The characteristics of the clothes load, which could trigger such adjustments, could, for example, consist of or be indicated by the presence of either soil, soap, suds, or any other additive laundering substitute or complementary product;
- **Adaptive water fill control system**: a clothes washer water fill control system which is capable of automatically adjusting the water fill level based on the size or weight of the clothes load placed in the clothes container, without allowing or requiring consumer intervention or actions;
- **Compact clothes washer**: a clothes washer which has a clothes container capacity of less than 45 litre (1,6 ft^3);
- **Standard clothes washer**: a clothes washer which has a clothes container capacity of 45 litre (1,6 ft^3) or greater;
- **Water-heating clothes washer**: a clothes washer where some or all of the hot water for clothes washing is generated by a water heating device internal to the clothes washer.
- **Non-water-heating clothes washer**: a clothes washer which does not have an internal water heating device to generate hot water;
- **Energy test cycle** for a basic model: means (A) the cycle recommended by the manufacturer for washing cotton or linen clothes, and includes all wash/rinse temperature selections and water levels offered in that cycle, and (B) for each other wash/rinse temperature selection or water level available on that basic model, the portion(s) of other cycle(s) with that temperature selection or water level that, when tested pursuant to these test procedures, will contribute to an accurate representation of the energy consumption of the basic model as used by consumers. Any cycle under (A) or (B) shall include the agitation/tumble operation, spin speed(s), wash times, and rinse times applicable to that cycle, including water heating time for water heating clothes washers;

- **Load use factor**: the percentage of the total number of wash loads that a user would wash a particular size (weight) load;
- **Temperature use factor**: for a particular wash/rinse temperature setting, the percentage of the total number of wash loads that an average user would wash with that setting;
- **Modified energy factor**: is the quotient of the cubic foot (or litre) capacity of the clothes container divided by the total clothes washer energy consumption per cycle, with such energy consumption expressed as the sum of the machine electrical energy consumption, the hot water energy consumption and the energy required for removal of the remaining moisture in the wash load;
- **Water consumption factor**: is the quotient of the total weighted per-cycle water consumption divided by the cubic foot (or litre) capacity of the clothes washer.

The test method is based on an **energy test cloth**, made from specified energy test cloth material, which is prepared (washed and dried) according to the standard specifications. It is then pre-conditioned in a clothes washer by performing 5 complete normal wash-rinse-spin cycles, the first two with AHAM Standard detergent 2A and the last three without detergent. The moisture absorption and retention characteristics are evaluated for each new lot of test cloth following the Standard Extractor Remaining Moisture Content (RMC) Test.

Test loads are prepared using conditioned energy test cloths. The test load sizes and corresponding water fill settings to be used when measuring water and energy consumptions of manual and adaptive water fill control machines are shown in Table 1.3. Test loads for energy and water consumption measurements are bone dry prior to the first cycle of the test, and dried to a maximum of 104% of bone dry weight for subsequent testing. The energy test cloths is load by grasping them in the centre, shaking them to hang loosely and then put them into the clothes container prior to activating the clothes washer.

Table 1.3: Test load sizes and water fill settings required

Manual water fill control system		**Adaptive water fill control system Max**	
Test load size	Water fill setting	Test load size	Water fill setting
Min Max	Min Max	Min Average Max	as determined by the clothes washer

Clothes washers are pre-conditioned before measuring the water and energy consumption:
- non water-heating clothes washer is pre-conditioned by running it through a cold rinse cycle and then draining it to ensure that the hose, pump, and sump are filled with water, if the machine has not been filled with water in the preceding 96 hours;
- water-heating clothes washer is pre-conditioned by running a cold rinse cycle and then draining it to ensure that the hose, pump, and sump are filled with water, if the machine has not been filled with water in the preceding 96 hours, or if it has not been in the test room at the specified ambient conditions for 8 hours. Test room temperature for water-heating clothes washers. Maintain the test room ambient air temperature at 23,9°C ± 2,8°C (75°F ± 5°F).

Clothes container capacity, C, in cubic feet (litres) is determined by measuring the entire volume which a dry clothes load could occupy within the clothes container during washer operation using water as:

$C = \frac{W}{d}$, where:

W = mass of water in pounds (kilograms)
d = density of water or 62,0 lbs/ft^3 for 100 °F (993 kg/m^3 for 37,8 °C); 62,3 lbs/ft^3 for 60 °F (998 kg/m^3 for 15,6 °C).

Procedure for measuring **water and energy consumption values** on all automatic and semi-automatic washers is performed under the energy test cycle(s) specifically defined for the different clothes washer types, based on the number of wash/rinse temperature selections available on the model, and also, in some instances, method of water heating. The procedures are applicable regardless of a clothes washer's washing capacity, loading port location, primary axis of rotation of the clothes container, and type of control system. In particular:

- for automatic clothes washers inlet water temperature and the wash/rinse temperature are set. The wash temperature can be: extra hot (>135 °F/57,2 °C), hot (135±5 °F or 57,2±2,8 °C)., warm (100±10 °F or 37,8±5,5 °C), or cold (60±5°F or 15,6± 2,8°C); rinse is always cold. Total water consumption during the energy test cycle is measured, including hot and cold water consumption during wash, deep rinse, and spray rinse;
- for clothes washers with adaptive water fill control system and alternate manual water fill control systems to be selected by consumers, then both manual and adaptive modes are tested and the average of the two values (one from each mode, adaptive and manual) for each variable is used;
- for clothes washers with not user adjustable adaptive water fill control system, the maximum, minimum and average water levels are interpreted to mean that amount of water fill which is selected by the control system when the respective test loads are used;
- for clothes washers with user adjustable adaptive water fill control system, four tests are conducted combining the possible combinations of test load and adaptive water fill control system;
- For clothes washers with manual water fill control system, the water fill selector shall be set to the maximum water level available on the clothes washer for the maximum test load size and set to the minimum water level for the minimum test load size.

A table specifies the test to be conducted for each machine type depending on the number of wash temperature selections available.

Water and electrical energy consumption is determined for each water fill level and/or test load size according to the standard. Then the **Remaining Moisture Content** is measured, using the wash temperature the same as the rinse temperature for all testing and the maximum test load, as the difference between the “bone dry” weight of the test load and the weight of the test load after the run of the “energy test cycle” according the specific conditions for clothes washers with cold rinse only and for clothes washers with cold and warm rinse options.

After the running of the test, results are calculated from the test measurements:

- **Hot water and machine electrical energy consumption** of clothes washers

  - *per-cycle temperature-weighted hot water consumption* for maximum, average, and minimum water fill levels using each appropriate load size, calculated for the cycle under test for the maximum water fill level, the average water fill level, and the minimum water fill level, expressed in gallons per cycle (or litres per cycle). The general formula is:

    $Vh = [Hm \times TUF_m] + [Hh \times TUF_h] + [Hw \times TUF_w] + [Hc \times TUFc] + [R \times TUF_r]$, where:

- Hm, Hh, Hw, Hc = reported hot water consumption values, in gallons per-cycle (or litres per cycle), at maximum, average, and minimum water fill, respectively, for the extra-hot, hot, warm and cold wash cycle with the appropriate test loads; .
- R = the reported hot water consumption values, in gallons per-cycle (or litre per cycle), at maximum, average, and minimum water fill, respectively, for the warm rinse cycle and the appropriate test loads
- TUF_m, TUF_h, TUF_w, TUF_c and TUF_r = tabulated temperature use factors for extra hot wash, hot wash, warm wash, cold wash, and warm rinse temperature selections, respectively

➢ *total per-cycle hot water energy consumption* for all maximum, average, and minimum water fill levels tested. Calculate the total per-cycle hot water energy consumption for the maximum, the minimum and the average water fill level, expressed in kilowatt-hours per cycle and defined as:

HE = [Vh × T × K] , where:
- T = Temperature rise or 75 °F (41,7 °C).
- K = Water specific heat in kilowatt-hours per gallon degree F=0,00240 (0,00114 kWh/L-°C).
- Vh = per-cycle temperature-weighted hot water consumption

➢ *total weighted per-cycle hot water energy consumption*, HE_T, expressed in kilowatt-hours per cycle and defined as:

$HE_T = [HE_{max} \times F_{max}] + [HE_{avg} \times F_{avg}] + [HE_{min} \times F_{min}]$, where:
- HE = total per-cycle hot water energy consumption
- F_{max}, F_{avg} and F_{min} = tabulated load usage factors for the maximum, average, and minimum test loads based on the size and type of control system on the washer being tested.

➢ *total per-cycle hot water energy consumption using gas-heated or oil-heated water*, HE_{TG}, using gas heated or oil-heated water, expressed in Btu per cycle (or mega-Joules per cycle) and defined as:

$HE_{TG}=H_T \times 1/e \times 3412$ Btu/kWh or $HE_{TG}=HE_T \times 1/e \times 3,6$ MJ/kWh , where:
- e = Nominal gas or oil water heater efficiency=0,75.
- HE_T = Total weighted per-cycle hot water energy consumption,

➢ *total per-cycle machine electrical energy consumption* for all maximum, average, and minimum test load sizes and for the maximum, the minimum and the average water fill level, expressed in kilowatt-hours per cycle and defined as:

$ME= [Em \times TUF_m]+ [Eh \times TUF_h]+ [Ew \times TUF_w]+ [Ec \times TUF_c]+ [ER \times TUF_r]$, where:

- Em, Eh, Ew, Ec = calculated electrical energy consumption values, in kilowatt-hours per cycle, at maximum, average, and minimum test loads, respectively, for the extra-hot, hot, warm and cold wash cycle
- ER = reported electrical energy consumption values, in kilowatt-hours per cycle, at maximum, average, and minimum test loads, respectively, for the warm rinse cycle.
- TUF_m, TUF_h, TUF_w, TUF_c, and TUF_r = tabulated temperature use factors for extra hot wash, hot wash, warm wash, cold wash, and warm rinse temperature selections, respectively.

- *total weighted per-cycle machine electrical energy consumption*, ME_T, expressed in kilowatt-hours per cycle and defined as:

  $ME_T=[ME_{max}\times F_{max}]+[ME_{avg}\times F_{avg}]+[ME_{min}\times F_{min}]$, where:
  - ME_{max}, ME_{avg}, and ME_{min} = total per-cycle machine electrical energy consumption
  - F_{max}, F_{avg}, and F_{min} = tabulated load usage factors for the maximum, average, and minimum test loads based on the size and type of control system on the washer being tested.

- *total per-cycle energy consumption when electrically heated water is used*, is the total per-cycle energy consumption for the energy test cycle, E_{TE}, using electrical heated water, expressed in kilowatt-hours per cycle and defined as:

  $E_{TE} = HE_T + ME_T$, where:
  - ME_T = total weighted per-cycle machine electrical energy consumption
  - HE_T = total weighted per-cycle hot water energy consumption

- **water consumption** of clothes washers[26]:

  - *per-cycle water consumption*: the maximum, average, and minimum total water consumption, expressed in gallons per cycle (or litre per cycle), for the cold wash/cold rinse cycle, defined as:

    Q = [Hc + Cc], where:
    Hc, Cc = measured values for the hot water consumption (Hc) and cold water consumption (Cc) respectively

  - *total weighted per-cycle water consumption*, Q_T, expressed in gallons per cycle (or litres per cycle) and defined as:

    $Q_T = [Q_{max} \times F_{max}] + [Q_{avg} \times F_{avg}] + [Q_{min} \times F_{min}]$, where:
    - Q = per-cycle water consumption
    - F_{max}, F_{avg}, and F_{min} = tabulated load usage factors for the maximum, average, and minimum test loads based on the size and type of control system on the washer being tested.

  - *water consumption factor*, WCF, expressed in gallon per cycle per cubic feet (or litre per cycle per litre), and defined as:

    WCF = Q_T / C , where:
    - Q_T = total weighted per-cycle water consumption,.
    - C = the clothes container capacity

- **per-cycle energy consumption for removal of moisture from test load**, D_E, expressed in kilowatt-hours per cycle and defined as:

  D_E = (LAF) × (Maximum test load weight) × (RMC - 4%)× (DEF) × (DUF) , where:
  - LAF = Load adjustment factor or 0,52
  - Test load weigh, expressed in lbs/cycle

[26] these calculations need not be performed to determine compliance with the energy conservation policies for clothes washers

- RMC = remaining moisture content.
- DEF = nominal energy required for a clothes dryer to remove moisture from clothes, which is 0,5 kWh/lb (1,1 kWh/kg)
- DUF = dryer usage factor, percentage of washer loads dried in a clothes dryer, which is 0,84.

- **modified energy factor**, MEF, expressed in cubic feet per kilowatt-hour per cycle (or litres per kilowatt-hour per cycle) and defined as:

  MEF = C / (E_{TE} + D_E), where:
  - C = the clothes container capacity
  - E_{TE} = total per-cycle energy consumption when electrically heated water is used
  - D_E = per-cycle energy consumption for removal of moisture from test load

- Energy factor, EF, expressed in cubic feet per kilowatt-hour per cycle (or litres per kilowatt-hour per cycle) and defined as:

  EF = C / E_{TE}, where:
  - C = the clothes container capacity
  - E_{TE} = total per-cycle energy consumption when electrically heated water is used.

1.3 SUBTASK 1.3: EXISTING POLICIES & MEASURES

1.3.1 The EU policies and measures

1.3.1.1 The EU energy labelling

The energy labelling scheme for dishwashers was put in place in 1999 with directives 97/17/EC and 99/9/EC. The scheme included three sets of A-G scale: one for the energy efficiency, one for the washing performance and the third for the drying performance. The energy efficiency is calculated as the ratio between the actual model energy consumption (C) and the energy consumption of the reference model (C_R) according to the following formulas:

(eq.1) $C_R = 1,35 + 0,025 \times S$ if $S \geq 10$
(eq.2) $C_R = 0,45 + 0,09 \times S$ if $S \leq 9$
(eq.3) $E_I = C/C_R$

where S is the number of place settings. The energy efficiency/washing performance/drying performance classes are defined in directive 97/17/EC as:

CLASS	ENERGY EFFICIENCY	WASHING PERFORMANCE	DRYING PERFORMANCE
A	$E_I < 0,64$	$P_C > 1,12$	$P_D > 1,08$
B	$0,64 \leq E_I < 0,76$	$1,12 \geq P_C > 1,00$	$1,08 \geq P_D > 0,93$
C	$0,76 \leq E_I < 0,88$	$1,00 \geq P_C > 0,88$	$0,93 \geq P_D > 0,78$

CLASS	ENERGY EFFICIENCY	WASHING PERFORMANCE	DRYING PERFORMANCE
D	$0,88 \leq E_I < 1,00$	$0,88 \geq P_C > 0,76$	$0,78 \geq P_D > 0,63$
E	$1,00 \leq E_I < 1,12$	$0,76 \geq P_C > 0,64$	$0,63 \geq P_D > 0,48$
F	$1,12 \leq E_I < 1,24$	$0,64 \geq P_C > 0,52$	$0,48 \geq P_D > 0,33$
G	$E_I \geq 1,24$	$0,52 \geq P_C$	$0,33 \geq P_D$

The energy labelling scheme for washing machines was put in place in 1995 with directives 95/12/EC[27] and amended by Commission Directive 96/89/EC of 17 December 1996. The scheme included three sets of A-G scales: one for the energy efficiency, one for the washing performance and the third for the spin drying performance.

CLASS	ENERGY EFFICIENCY	WASHING PERFORMANCE	WATER EXTRACTION EFFICIENCY
A	$C \leq 0,19$	$P > 1,03$	$D < 45\%$
B	$0,19 < C \leq 0,23$	$1,03 \geq P > 1,00$	$45\% \leq D < 54\%$
C	$0,23 < C \leq 0,27$	$1,00 \geq P > 0,97$	$54\ \% \leq D < 63\%$
D	$0,27 < C \leq 0,31$	$0,97 \geq P > 0,94$	$63\% \leq D < 72\%$
E	$0,31 < C \leq 0,35$	$0,94 \geq P > 0,91$	$72\ \% \leq D < 81\%$
F	$0,35 < C \leq 0,39$	$0,91 \geq P > 0,88$	$81\% \leq D < 90\%$
G	$0,39 < C$	$0,88 \geq P$	$90\% \leq D$

The energy efficiency class of an appliance is determined as the energy consumption "C" for kg of washed load for the standard 60°C cotton cycle. The washing performance index P is defined in standard EN 60456 as the ratio of the sum of the reflectance values for the stains of the machine under test and the reference machine after the standardised washing cycle. The drying efficiency is expressed as residual moisture content for the standard 60°C cotton cycle.

1.3.1.2 The Industry Voluntary Commitments

a) The voluntary commitment for dishwashers

In November 1999, CECED notified to the European Commission a Unilateral Industry Commitment[28] for the reduction of the energy consumption of household dishwashers. The commitment consists of a graded scenario of two different steps, coming into effect on or to be reached by 31 December 2000, 31 December 2002 and 31 December 2004.

[27] Commission Directive 95/12/EC of 23 May 1995 implementing Council Directive 92/75/EEC with regard to energy labelling of household washing machines, OJ L 136, 21.06.1995 p.1

[28] Voluntary Commitment on Reducing Energy Consumption of Household Dishwashers, Final November 19, 1999, downloadable from www.ceced.org .

By signing the Voluntary Commitment, participants commit themselves to reduce the total energy consumption of dishwashers and thereby CO_2 emissions caused by power generation. To reach this objective participants will reduce significantly the fleet energy consumption of their production and import range and will stop producing for and importing in the Community Market dishwashers that rank in the less efficient classes of the energy label scheme.

A general improvement of the product range and a ban of certain dishwashers from production and import (step 1) will result in a overall 20% saving by 31 December 2002 related to the base case figures of 1996. An additional elimination of less efficient dishwashers by 31.12.2004 (step 2) will contribute further to the energy saving. In particular:

- step one: participants will stop producing for and importing in the Community Market dishwashers which belong to the energy efficiency classes E, F and G (for ≥10 place settings) or F and G respectively (for <10 place settings) by 31 December 2000.
- step two: participants will stop producing for and importing in the Community Market dishwashers which belong to the energy efficiency class D (for ≥ 10 place settings) or E respectively (for <10 place settings) by 31 December 2004.

Furthermore, all participants engage themselves to strengthen their overall activities to achieve further energy savings and to educate consumer on the way to save energy, through a list of action. Finally, starting from the year 2000 each participant will provide the CECED notary consultant with production weighted energy consumption data in each place setting class for the previous calendar year.

b) The voluntary commitments for washing machines

Two Voluntary Commitments were put in place by industry for washing machines starting from 1997.
In April 1996 the European Committee of Manufacturers of Domestic Equipment (CECED) presented a first Commitment about energy saving to the European Commission. This Commitment was made on behalf of the European manufacturers of domestic washing machines[29] and was aimed at a considerable reduction of energy consumption of washing machines. The proposal was negotiated with the EU Authorities and notified, in October 1997, to EC DG IV. On 9.12.1998, the agreement was published in the official journal and the final approval was given on 24 January 2000 with a derogation to Art. 81 of the EU Treaty was granted by decision of the Commission for the period up to end of year 2001. The overall objective of this first Commitment was the achievement of an average Energy Consumption of 0,24 kWh/kg weighted on the volumes of production for our input in the Community market to be assessed during year 2000. This first commitment included a graded scenario of two different steps:

- Step one: participants will stop producing for and importing in the Community Market domestic washing machines which belong to the energy efficiency classes E, F and G after 31.12.1997. Domestic washing machines with load capacity equal or smaller than 3 kg which belong to class E, and vertical axes machines will still be allowed on the market;
- Step two: participants will stop producing for and importing in the Community Market domestic washing machines which belong to the energy efficiency classes D, E, after 31.12.1999. Domestic washing machines with load capacity equal or smaller than 3 Kg which belong to class D will still be allowed on the market. Domestic washing machines with spin speed lower than 600 rpm which belong to class D will still be allowed on the market.

[29] Voluntary Commitment on Reducing Energy Consumption of Domestic Washing Machines, Final September 24, downloadable from www.ceced.org .

In addition, each participant was engaged to contribute to the Commitment overall objective of achieving a European production weighted average of 0,24 kWh/kg for the year 2000. Starting from 1998 each participant provided also the CECED notary consultant with production weighted energy consumption data for the previous calendar year. All participants engaged also themselves to strengthen their overall activities to achieve further energy savings and to educate consumer on the way to save energy.

The first Voluntary Commitment successfully expired in December 2001 and was followed by a second phase. The Second Voluntary Commitment on Reducing Energy Consumption of Domestic Washing Machines (2002 - 2008) was notified on 31 October 2002, covering the period from 2002 to 2008. It foresees:

- *Hard target*: By 31.12.2003 participants will have stopped producing for, and importing (including under own brand and private labels) in, the Community Market domestic washing machines which belong to energy efficiency class D. Marginal models on the market (washing machines without heater and with vertical axes) are excluded from this target.
- *Fleet target*: each participant will commit himself to contribute to the Commitment overall objectives of achieving a European production weighted average of 0.20 kWh/kg for the year 2008. Each participant will provide the CECED notary consultant with production weighted energy consumption data for the previous calendar year;
- *Soft target*: all participants commit themselves to strengthen their overall activities to achieve further energy savings and to educate consumers on the way to save energy; in particular, they commit themselves to:
  - support the introduction of the A+ class on the revised energy label, identifying and promoting super efficient machines at a level of 0,17 kWh/kg by giving additional public awareness;
  - support at EU or national level, rebates schemes aiming at fostering the introduction of efficient washing machines, e.g. by replacing old and inefficient machines as long as the balance between energy and washing performance is maintained (minimum class B for washing performance);
  - co-operate in setting up targets and measures for achieving a high level of spinning efficiency for markets where tumble drying is relevant;
  - inform in their brochures about the advantages of a high spin speed washing machine when tumble drying is preferred and promote the energy efficient use of washing machines by giving information in the user manual;
  - co-operate with detergent industry on new energy saving detergents and promotion of an energy saving consumer behaviour;
  - push the development of a new standard for testing washing machines, taking into account the change of consumer behaviour, that is targeted to be used as a basis for a revised label in 2008.

In addition CECED established a list of participants and keep it updated to be provided to the European Commission and available to the public free of charge; Continue to operate a database for washing machines. This database contains an analysis of all models of washing machines placed on the Community market by all the participants and is updated yearly. For each single model all those data will be given which are mandatory on the energy label. The database is available to the European Commission, national authorities and, for study purpose, to experts appointed by them. The copyright is owned by CECED.

1.3.1.3 The EU eco-label

a) The EU eco-label scheme

The EU eco-label was initially set in Council Regulation (EEC) No 880/92 on a *Community eco-label award scheme*, revised by Regulation (EC) No 1980/2000 of the European Parliament and of the Council of 17 July 2000 *on a revised Community Eco-label Award Scheme*. The Eco-label scheme has to be seen together with five other decisions on procedures and fees (European Eco-labelling board - EUEB, Consultation Forum, Standard Contract, Fees, Eco-label working plan). The key elements of this new Regulation, which entered into force on 24 September 2000, include:

- widening the scope to cover services as well as products.
- reinforced stakeholder participation, in particular in developing the environmental criteria.
- the creation of the EU Eco-labelling Board, comprising of the Eco-label Competent Bodies and interest groups, whose main role is to develop the Eco-label criteria.
- reduced fees for SMEs and developing countries.
- introduction of a ceiling on the annual fee.
- reinforced transparency and methodology.
- renewed emphasis on the promotion of the scheme.
- reinforced co-operation and co-ordination with the national Eco-label schemes.
- more information on the label.
- possibility for traders and retailers to apply directly for their own brand products.
- possibility for non-EU producers to apply directly.

The application of the eco-label scheme has always been critical for household appliances, although the scheme has been successful for other non-EUP products. After very few models of cold and wash appliances being submitted and awarded the label in the first years of the eco-label life, then no supplier (manufacturer or importer) applied for the eco-label for such product groups. This situation is at present persisting, probably due to the complexity and costs of the required criteria/awarding procedure compared to the lack of market value of the ecological label compared to the energy label. Some studies[30] promoted by the Commission addressed this issue, which was also considered in the Community Eco–Label Working Plan set in Commission Decision 2002/18/EC[31].

The Regulation instituting the European Eco-label is at present under further review following the results of the EVER (Evaluation of EMAS and Eco-label for their Revision) study published in December 2005[32]. The study has been carried out on behalf DG Environment by a consortium of consultants. The fundamental aim of the EVER study has been to provide recommendations for the revision of the two voluntary schemes EMAS and the EU Eco-label. The options and recommendations proposed for the schemes are based on the evidence collected in the different phases of the study, presented, discussed and enriched through two workshops held in September 2005, that involved experts, institutions, companies, practitioners and NGOs. The whole process led to the defining of options and recommendations the revision process, where a major issue for the revision of both the schemes is integrating and linking them with existing legislation and environmental policies (to a wider extent).

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[30] Some of the studies are downloadable at http://ec.europa.eu/environment/ecolabel/documents/studies_en.htm

[31] Commission Decision 2002/18/EC of 21 December 2001 establishing the Community eco-label working plan, OJ L 7, 11.01.2002.

[32] The executive summary is downloadable at: http://www.ioew.de/home/downloaddateien/ever_executive%20summary.pdf .

b) The eco-label for dishwashers

The eco-labelling scheme for dishwashers was put in place for the first time in 1998 with Commission decision 98/483/EC, modified by Commission decision 2001/397/EC and finally by Commission decision 2001/689/EC. Criteria are valid until 28 August 2007[33]. The scheme includes a set of criteria for energy efficiency, water consumption, prevention of the excessive us of detergent, noise, recovery & recycle extension of the product life, design, washing performance and drying performance.

The thresholds for energy efficiency, washing performance and drying performance are:

PLACE SETTINGS	ENERGY EFFICIENCY	WASHING PERFORMANCE	DRYING PERFORMANCE
≥ 10	$E_I < 0{,}58$		
> 5	$E_I < 0{,}64$	$P_C > 1{,}00$	$P_D > 0{,}93$
≤ 5	$E_I < 0{,}76$		

The water consumption should be less or equal to the threshold given by the following equation:

$W_{(measured)} \leq (0{,}625 \times S) + 9{,}25$, where S is the number of place settings.

Noise should not exceed 53 dB(A) for free-standing models and 50 dB(A) for built-in models. For the other criteria see the Commission decision 2001/689/EC.

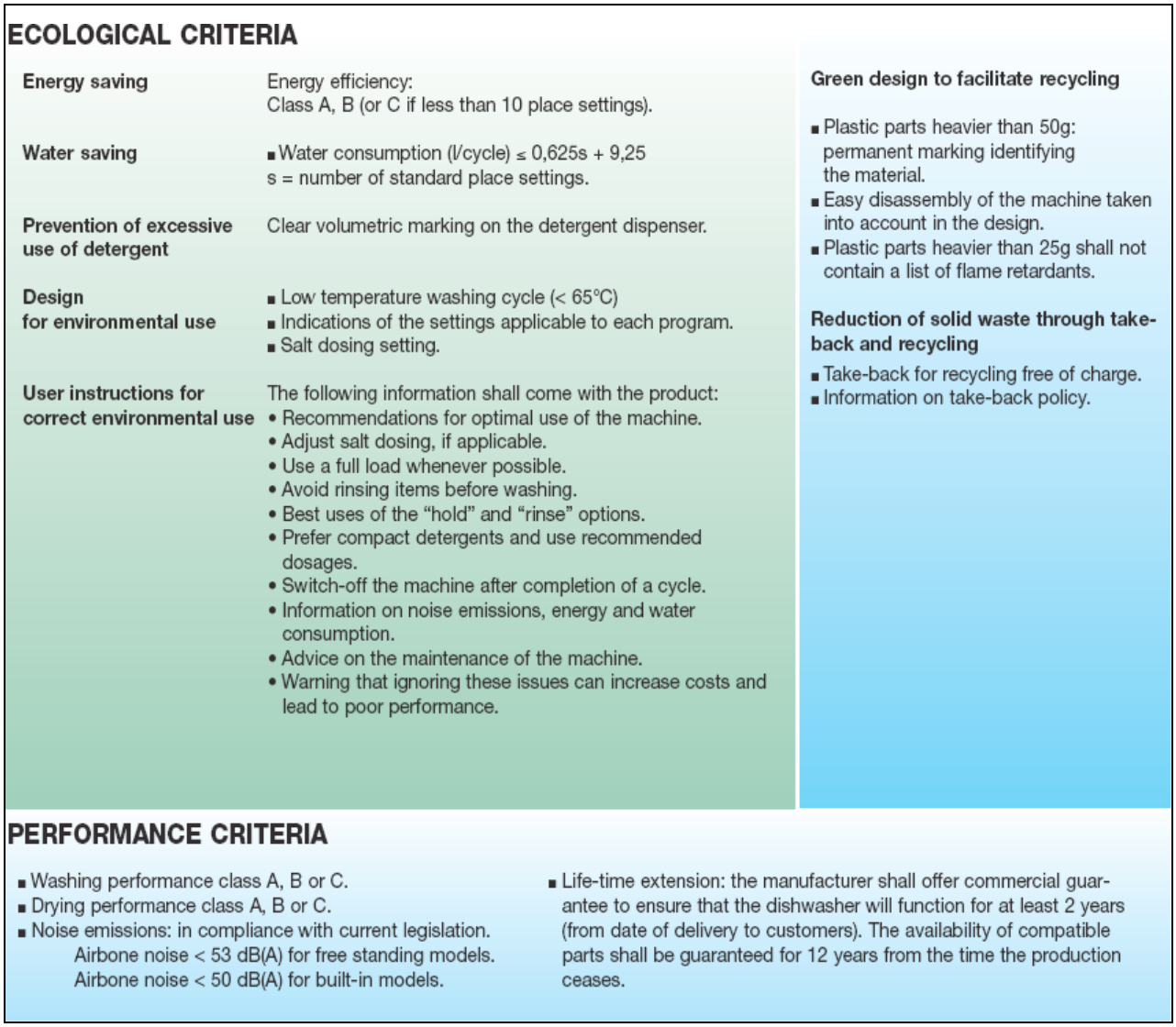
A compliant model for the 12 place settings should have:

- energy consumption: class A
- washing performance: not lower than B
- drying performance: not lower than B
- water consumption: not higher than 16,8 litre/cycle (or 20,16 litre for a 12ps machine)

A summary of the criteria is shown in Figure 1.1[34].

[33] See Commission Decision 2005/783/EC, of 14 October 2005, OJ L 295, p. 51.
[34] Source: "The European eco-label for dishwashers", downloadable from www.ec.europa.eu/environment/ecolabel/pdf/infokit/new_2002/fact_dishwashers_2002_en.pdf .

Figure 1.1: Ecolabel criteria for dishwashers



ECOLOGICAL CRITERIA

Energy saving	Energy efficiency: Class A, B (or C if less than 10 place settings).
Water saving	▪ Water consumption (l/cycle) ≤ 0,625s + 9,25 s = number of standard place settings.
Prevention of excessive use of detergent	Clear volumetric marking on the detergent dispenser.
Design for environmental use	▪ Low temperature washing cycle (< 65°C) ▪ Indications of the settings applicable to each program. ▪ Salt dosing setting.
User instructions for correct environmental use	The following information shall come with the product: • Recommendations for optimal use of the machine. • Adjust salt dosing, if applicable. • Use a full load whenever possible. • Avoid rinsing items before washing. • Best uses of the "hold" and "rinse" options. • Prefer compact detergents and use recommended dosages. • Switch-off the machine after completion of a cycle. • Information on noise emissions, energy and water consumption. • Advice on the maintenance of the machine. • Warning that ignoring these issues can increase costs and lead to poor performance.

Green design to facilitate recycling

- Plastic parts heavier than 50g: permanent marking identifying the material.
- Easy disassembly of the machine taken into account in the design.
- Plastic parts heavier than 25g shall not contain a list of flame retardants.

Reduction of solid waste through take-back and recycling

- Take-back for recycling free of charge.
- Information on take-back policy.

PERFORMANCE CRITERIA

- Washing performance class A, B or C.
- Drying performance class A, B or C.
- Noise emissions: in compliance with current legislation.
  Airbone noise < 53 dB(A) for free standing models.
  Airbone noise < 50 dB(A) for built-in models.
- Life-time extension: the manufacturer shall offer commercial guarantee to ensure that the dishwasher will function for at least 2 years (from date of delivery to customers). The availability of compatible parts shall be guaranteed for 12 years from the time the production ceases.

c) The eco-label for washing machines

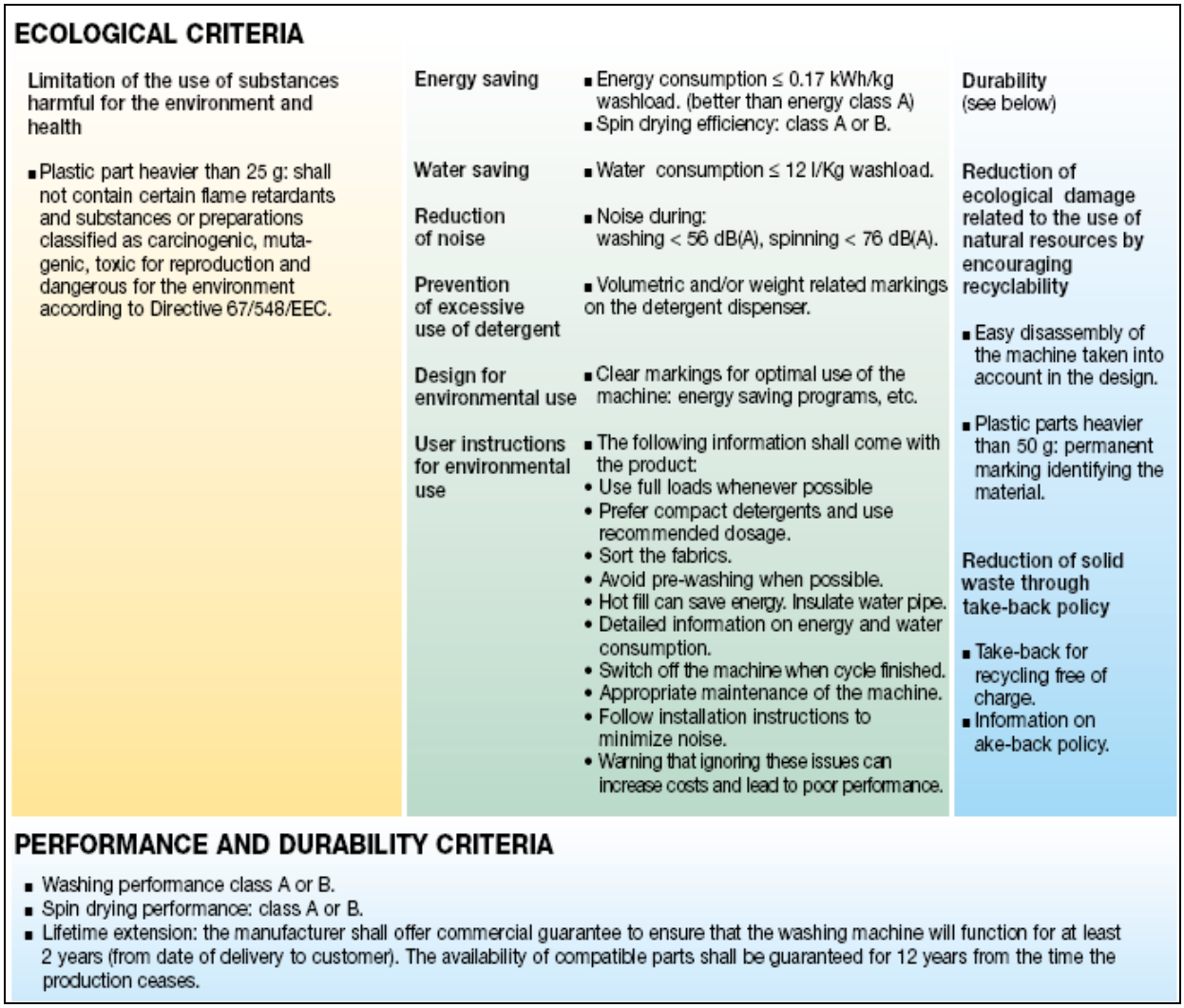
The eco-labelling scheme for dishwashers was put in place for the first time in 1998 with Commission decision 98/483/EC, modified by Commission decision 2000/45/EC of 17 December 1999.

The scheme includes a set of criteria for energy efficiency, water consumption, prevention of the excessive us of detergent, noise, recovery & recycle extension of the product life, design, washing performance and drying performance as shown in Figure 1.2[35]. Criteria are valid from 17 December 1999 until 30 November 2007[36].

[35] Source: "The European ecological label for washing machines", downloadable from www.ec.europa.eu/environment/ecolabel/pdf/infokit/washmach_en.pdf .

[36] See Commission Decision 2003/240/EC of 24.03.2003, OJ L 89, p. 16 and 2005/783/EC, of 14 October 2005, OJ L 295, p. 51.

Figure 1.2: Eco-label criteria for washing machines



ECOLOGICAL CRITERIA

Limitation of the use of substances harmful for the environment and health

- Plastic part heavier than 25 g: shall not contain certain flame retardants and substances or preparations classified as carcinogenic, mutagenic, toxic for reproduction and dangerous for the environment according to Directive 67/548/EEC.

Energy saving
- Energy consumption ≤ 0.17 kWh/kg washload. (better than energy class A)
- Spin drying efficiency: class A or B.

Water saving
- Water consumption ≤ 12 l/Kg washload.

Reduction of noise
- Noise during: washing < 56 dB(A), spinning < 76 dB(A).

Prevention of excessive use of detergent
- Volumetric and/or weight related markings on the detergent dispenser.

Design for environmental use
- Clear markings for optimal use of the machine: energy saving programs, etc.

User instructions for environmental use
- The following information shall come with the product:
  - Use full loads whenever possible
  - Prefer compact detergents and use recommended dosage.
  - Sort the fabrics.
  - Avoid pre-washing when possible.
  - Hot fill can save energy. Insulate water pipe.
  - Detailed information on energy and water consumption.
  - Switch off the machine when cycle finished.
  - Appropriate maintenance of the machine.
  - Follow installation instructions to minimize noise.
  - Warning that ignoring these issues can increase costs and lead to poor performance.

Durability (see below)

Reduction of ecological damage related to the use of natural resources by encouraging recyclability
- Easy disassembly of the machine taken into account in the design.
- Plastic parts heavier than 50 g: permanent marking identifying the material.

Reduction of solid waste through take-back policy
- Take-back for recycling free of charge.
- Information on ake-back policy.

PERFORMANCE AND DURABILITY CRITERIA

- Washing performance class A or B.
- Spin drying performance: class A or B.
- Lifetime extension: the manufacturer shall offer commercial guarantee to ensure that the washing machine will function for at least 2 years (from date of delivery to customer). The availability of compatible parts shall be guaranteed for 12 years from the time the production ceases.

1.3.2 The Policies & Measures in EU Member States

Legislation at Member States level has been replaced by the EU legislation for household appliances. Only in some national voluntary eco-labels and EPD specific criteria are set for this product group. In addition incentive schemes (run in The Netherlands and the UK) will be described along with the white certificates scheme in force in other countries.

1.3.2.1 The national (eco)label schemes

a) National eco-labelling schemes

A compilation of the product groups addressed in the different eco-labelling schemes in Member States and Accession countries in 2002 resulted (Table 1.4) in 6 schemes covering refrigerators (the Nordic Swann, the German, Austrian, Hungary, Slovakia and Poland), 6 schemes covering washing machines (the Nordic Swann, the German, Austrian, Slovakian, Czech and Polish schemes) and 2 schemes covering dishwashers (the Nordic Swann and the Polish scheme).

Table 1.4: Eco-labelling schemes product groups in the different schemes in the EU addressing household appliances in 2002[37]

Category	Subcategory	EU-Flower	Nordic Sw	Spain	Catalonia	France	Germany	Austria	Netherland	Good env choice	TCO	Croatia	Hungary	Slovakia	Czech Rep	Poland	Subtotal	Total (out of 379)
HouseholdM	Dishwashers	X	X													X	3	
HouseholdM	Dryer for wash						X										1	
HouseholdM	Hand dryers, hot air						X										1	
HouseholdM	Mechanical washaid					X											1	
HouseholdM	Refrigerators	X	X				X	X					X	X		X	7	
HouseholdM	Vacuum cleaners					X											1	
HouseholdM	Washing Machines	X	X				X	X						X	X	X	7	21

		washing machines	April 1997- Apr.1999 June 2001- June 2004	none	not available

[37] Source: Compilation of the eco-labelling product groups in the different schemes in the EU and Candidate Countries, downloadable from: http://ec.europa.eu/environment/ecolabel/pdf/work_plan/mtggroups/coop/pdgpsinotherschemes.pdf

A new research in the national scheme websites collected in the EU Ecolabel website page about other eco-labels[38] resulted in only the Nordic Swann, the Hungarian, the Czech Republic and the Slovak Republic schemes addressing cold and/or wash appliances in later years (2004-2007). The available information are summarised in Table 1.5. The awarding criteria for the different schemes are very close or overlapping with the criteria set in the EU eco-label, with some differences such as the rinsing performance requested to washing machines under the Nordic Swann.

In particular the Nordic Swann applies to washing machines[39] with spin function and a capacity not exceeding 10 kg, but washer dyers are excluded. Main criteria are:

– *Energy efficiency*: machines complying with the EU energy labelling must fulfil two requirements of energy consumption: one specific requirement for the standard 60°C cotton programme and one for the mean value of four different operating modes. Other machines must only meet one requirement. Energy consumption must not exceed the following limit values:

Type of machine	Energy consumption, washing, 60°C, cotton (kWh/kg washing)	Mean value of four different operating modes * (kWh/kg washing)
Machines comprised by the mandatory Energy Labelling Scheme	0,19	0,23
Other machines	-	0,23

* mean value of four operating modes: the standard 60ºC cotton programme at full load and 2 kg load, and the standard 40ºC cotton programme at full load and 2 kg load. Energy efficiency (E) is calculated as: E = (e1 + e2 + e3 + e4)/(m1+ m2 + m3 + m4), where "e" is electricity consumption in kWh and "m" is the mass of washing in kilograms, for each of the four individual operating modes.

– *Water consumption*: the machine must not consume more than 16 litres of water per kilogram of wash load, measured in accordance with the test method specified and using the same standard 60ºC cotton programme as used for measuring energy efficiency.
– *Spin performance*: machines with a capacity >3,5 kg must achieve a residual moisture content of less than 54% when tested according to the stated test method using the same standard 60ºC cotton programme as used for testing energy efficiency. Machines with a capacity ≤3,5 kg must achieve a residual moisture content of less than 60% when tested according to the stated test method using the same standard 60ºC cotton programme as used for testing energy efficiency.
– *Noise*: airborne acoustic noise from the machine, in terms of sound power level, must not exceed 56 dB(A) during the washing cycle, or 76 dB(A) during the spin cycle, measured in accordance with the test method specified and using the same standard 60ºC cotton programme as used for measuring energy efficiency.
– *Washing performance*: the machine must have a washing performance index greater than 1.00 when tested according to the specified test method and using the same standard 60ºC cotton programme as used for testing energy efficiency.
– *Rinsing performance*: the machine must pass a rinsing performance test:
  ✓ using the alkali method (detection of soluble components) with a score ≥ 5
  ✓ using the zeolite method (detection of the solid particles) with a score ≥ 3.

  The standards for the measurement of the rinsing performance are described in the document specifying the eco-label criteria.

[38] See http://ec.europa.eu/environment/ecolabel/other/int_ecolabel_en.htm .
[39] Source: Swan labelling of washing machines, Version 4.0, 18 March 2004 – 17 June 2009.

Table 1.5: National eco-labelling schemes addressing household appliances in 2004-2007

Ecolabel	Countries	EUP covered (type)	Validity period (from/to)	Licences (number)	Criteria
Nordic Swan	Finland, Sweden, Denmark, Norway, Iceland	refrigerators and freezers	19 October 2004 31 October 2008	none	Requirements almost identical to the EU eco-label with some differences and additional criteria
		washing machines (washer dyers excluded)	18 march 2004 19 June 2009	1	– electricity and water consumption – the reduced use of certain materials that are hazardous to health and the environment – the recycling of materials – washing and rinsing performance
Environmental Friendly products	Czech Republic	washing machines	not available	not available	not available
		dishwashers	not available	not available	not available
The Hungarian Eco-label	Hungary	refrigerators	06 April 2005 2007 and beyond	not available	The appliance must gradually reach the energy efficiency class of A+ or A++ as follows: - until 30.04.2007. the lower limit of energy efficiency shall be 47 % i.e. $I_\alpha < 47$. - from 30.04.2007. the lower limit of energy efficiency shall be 42 % i.e. $I_\alpha < 42$. Other criteria as in the EU Ecolabel
(NPEHOV)	Slovak Republic	refrigerators and freezers	September 1999 - September 2001 Final proposal, 2002	none	not available
		washing machines	April 1997- Apr.1999 June 2001- June 2004	none	not available

Other criteria about *marking of plastic parts*, *content of heavy metals in plastics*, *flame retardants*, *recycling*, *safety*, the *working environment* and the *external environment*, *instructions*, *settings*, *programme markings*, *warranty*, *spare parts*, *environment and quality control* and *marketing* apply.

The following requirements will be assessed in future criteria: requirement regarding the automatic dosage of detergent, heavy metals used in alloys and surface treatment, flame retardants in plastics and electronic components and provisions to connect the machine directly to a hot water source.

The application has to be sent to Nordic Ecolabelling in the country in which the washing machine is sold. The application documents comprise an application form and documentation demonstrating fulfilment of the requirements (specified in the criteria). Before a license is granted, normally an onsite inspection is performed to ensure adherence to the requirements.

An application fee is charged to companies applying for a license. There is an additional annual fee based on the turnover of the Swan labelled refrigerator/freezer.

The Nordic Swann ecolabel license is valid providing the criteria are fulfilled and until the criteria expire. The validity period of the criteria may be extended or adjusted, in which case the license is automatically extended and the licensee informed. Revised criteria shall be published at least one year prior to the expiry of the present criteria. The licensee is then offered the opportunity to renew their license.

b) The Energy Saving Recommended label in UK

The Energy Saving Trust (EST) is a non-profit organization funded by the British Government and the private sector. EST develops and runs programs (mostly awareness-raising campaigns) on behalf of the government and serves as a consultants. The goal is to give consumers verified and unbiased information about the advantages of energetically sustainable products and services. It is also in charge of efficient product/service accreditation.

EST issues the ”Energy Saving Recommended”[40] product labelling scheme (formerly known as Energy Efficiency Recommended scheme), a registered certification mark (shown in Figure 1.3) allowing consumers to spot the most energy-efficient products available on the market. Products carrying the mark meet or exceed the Energy Saving Trust’s established criteria.

Figure 1.3: The EST “Energy Efficiency Recommended” logo

The Energy Saving Recommended scheme covers 24 products groups, including the following major appliances:

- washing machines
- dishwashers

[40] See: www.energusavingstrust.co.uk/myhome/efficientproducts/recommended/.

- refrigerators, freezers and their combinations
- tumble dryers (including gas fired ones)
- appliances producing and storing hot water.

The scheme aims to review the criteria on an annual basis as the efficiency of appliances improves, to maintain 'best practice' recognition for recommended appliances. This mark is a guarantee that the product will help to reduce energy wastage in the home, as well as benefiting the environment and costing less to run. The Energy Saving Trust's criteria are set to award the label to the top 20% energy efficient products, using the energy efficiency classes set in the EU energy labelling directives as indicator.

For the large household appliances to which Energy Saving Recommended scheme applies, the requirements are:

- washing machines: models rated AAA rated (class A for energy consumption, class A for washing performance, and class A for spin drying efficiency)
- refrigerators, freezers and refrigerator-freezers: models rated class A+ or A++
- dishwashers: models rated class AAA (class A for energy consumption, class A for washing performance, and class A for drying efficiency) plus the eco-label requirement for water consumption
- tumble driers: models rated class B or better, and products that are rated class C if they feature an automatic drying function.

The EST website shows also an on-line database including products types and models complying with the set criteria

c) The Swedish EPD scheme for washing machines and dishwashers[41]

In Sweden, an official system for type III environmental product declarations called EPD (Environmental Product Declaration)[42] has been developed and established. The system is voluntary and can be used worldwide by all interested companies and organizations. At the moment, interested parties from 7 other countries have joined the EPD system at various levels[43]. The Swedish EPD system is the most developed type III product declaration type in the world. EPDs have been developed for the following products: freezers, refrigerators, washing machines, frequency converters, circuit breakers, transformers, waste collection services, landfills, production chemicals, ink, sink mixer taps, district heating, galvanising processes, steel production, pumps, copy- and fax machines, hydro power, nuclear power. Other countries have developed type III product declarations as well, typically used and developed within specific trades. Specifications for washing machines and dishwashers are included in document "Product-Specific Requirements. Household washing machines and household dishwashers, PSR 2001:2. The Swedish Environmental Management Council, Version 1.0, 2001-11-21.

An area, in which a direct comparison between the EU eco label and an environmental product declaration can be made, is washing machines. To compare the two sets of criteria, the EU eco label requirements (Decision 2000/45/EC) are listed together with the product specific requirements for washing machines The main data requirements for the two environmental performance criteria are presented in Table 1.6.

[41] Source: www2.mst.dk/udgiv/Publications/2006/87-7614-954-4/html/default_eng.htm
[42] http://www.environdec.com/
[43] Countries with existing EPD programs: Sweden, Belgium, Poland, Finland, Italy, Japan, Denmark and South Korea. In Norway, an EPD program is underway.

Table 1.6: Data inventory requirements for the EU eco label and PCR for washing machines

Category	EU eco-label	EPD
Manufacturer info		
Manufacturing Company	Yes	Yes
Manufacturing Site	Yes	Yes
Issuer and contact	Yes	Yes
Guarantee statement	Yes	No
Environmental performance declaration		
Refinement	No	Yes
Resource Consumption	No	Yes
Electricity use	No	Yes
Transportation		
Refinement Production	No	Yes
Production Sale	No	Yes
Sale Use	No	Yes
Use Disposal	No	Yes
Production		
Energy Consumption	No	Yes
Use of Chemicals	Yes, detailed	Yes, detailed especially for use of heavy metals as well as halogenated and brominated flame retardants
Material List	Yes, some specific materials, mainly chemicals	Yes, total list
Emission Estimation to air and water	Yes, name of components	Yes
Emissions	No	Yes
Resource Consumption	No	Yes
Use		
Energy Efficiency	Yes	Yes
Water Consumption	Yes	Yes
Spin Drying Efficiency	Yes	Yes
Noise	Yes	Yes
Control of Detergent use	Yes	No (not mandatory)
Criteria for users manual	Yes	No
Washing Performance	Yes	Yes
Estimated Lifetime	No, but a 2 year guarantee	Yes
Disposal		
Recycling rate	Yes, declaration	Yes, specification has to be made
Waste amounts	No	Yes
Hazardous waste amounts	Yes	Yes
Separable hazardous materials	Yes, declaration	No
Information from the company and certification body	Data is sent to the Eco-label secretariat. The label is issued, but the data is kept confidential.	Specific data is kept confidential depending of the PCR, but the environmental key figures and conclusion are to be stated in the EPD, which is public accessible

1.3.2.2 Economic incentives for efficient appliances

Economic incentives in the form of rebate schemes or tax deduction have been enforced in The

Netherlands[44,45]

Energy labels for household appliances were first introduced in the country in 1995. From the beginning the energy label in the Netherlands had a strong relation with the following energy policy instruments: the MAP (Environmental Action Plan from 1991 to 2000) and the EPR (Energy Premium Regulation from 2000 to 2003). Only a MAP or EPR subsidy could be received when the appliance had an A class label. The EPR started in 2000 and aimed to stimulate households to take energy saving measures and to buy energy efficient appliances. Until October 2003, consumers could get an EPR subsidy for appliances with an energy efficiency class A. For some appliances additional conditions where set to receive the subsidy. The EPR subsidy scheme is financed through the Regulating Energy Levy (Regulerende EnergieBelasting) REB, a levy on the electricity, natural gas and oil products sold to the households and SME's.

The MAP was aimed at a CO_2 reduction within households, governmental and the tertiary sector. Several actions where taken by energy distribution companies who where responsible for the implementation. The most important actions within consumers focussed on a change of behaviour and the purchase of energy efficient appliances by subsidising them (since 1995 linked to the energy label).

In total an amount of 25 million Euro subsidy was provided within the framework of MAP and about 159 million Euro EPR subsidy was provided. The total costs for the government for the implementation of the MAP and EPR were: 15 million Euro for MAP and 34 million Euro for EPR. As it is not exactly clear how much costs are made within MAP an estimation is made based on the amount of MAP subsidy received by consumers.

The first round of EPR - Energiepremieregeling (Energy Premium Regulation) scheme started 1 January 2000 and gives households and landlords the possibility to apply for a subsidy when purchasing an energy efficient household appliance or taking energy efficient actions such as roof-insulation. The goal of the EPR was to channel the funds from the Regulating Energy Tax or REB (Regulerende Energiebelasting) back to the citizen through subsidies on the purchase of energy efficient products and services.

In 2000 75% of REB-funds were thus used and in 2001 113%. The amount of funds available to the citizen for 2000 plus 2001 was 158.714.914 Euro, of which 97 % was actually spent. Certain groups of purchasers such as companies or people who buy the appliance for their holiday homes were excluded from the EPR subsidy.

The proportion between implementation costs and actual subsidies was 31% in 2000 (39% for appliances and 7% for other items). In the year 2001 it was 24% (37% for appliances and 6% for other items). The largest part of the subsidies (Table 1.7) went to refrigerators/freezers plus washing machines (46%), followed by insulation measures (25%) and High Efficiency (HR++) glazing (13%). After some initial hick-ups, utilities and the Tax Office did not encounter problems in handling the subsidy applications by the consumer and within 6 weeks all complete applications could be processed.

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[44] Source: Maxim Luttmer, Evaluation of Labelling of Appliances in the Netherlands, Case Study executed within the framework of the AID-EE project, FINAL DRAFT, contract number EIE-2003-114, April 2006.

[45] Source: "Evaluation of the Netherlands energy efficiency subsidy scheme EPR", Tax Office/Centre for process- and product development, 21 June 2002. English summary by VHK, René Kemna, 8 October 2002. Original title "Rapportage van Onderzoeksbevindingen in Het Kader van de Evaluatie van de Energiepremieregeling, Belastingdienst/Centrum voor proces- en productont-wikkeling, 21 juni 2002

Table 1.7: Energy saving measures for appliances to which a subsidy was given in 2001

EPR-measure	Subsidy		
	(number)	(Euro)	(%)
Refrigerators & Freezers	504 952	24.367.094	22
Washing machines	441 385	22.175.922	20
Dishwashers	145 768	6.614.664	6
Laundry driers	4 488	661.5	0,6
LCD-monitor	12 917	586.148	0,5
Domestic lighting fixture	17	771	<0,01
Simultaneous purchase	113 528	2.575.838	2

In November 2001, almost two years after the start of the EPR, one third of Dutch households had applied for the EPR, and of this, around two thirds concerned domestic appliances. The subsidy was requested for respectively 36%, 47% and 49% of all the sold A class dishwashers, fridge/freezers and washing machines.

The introduction of the EPR has led to an enormous growth of the supply of A labelled appliances (Table 1.8). The market share of A class washing machines grew from 40 to 71% over the 1999-2000 period and 26% to 55% for refrigerators. This increase is most likely due to the EPR and has led to a situation where retailers very often advice their customers to buy an A class appliance as the best on offer.

Table 1.8: Share of A labelled appliance: NL and EU (source GfK)

Appliance	1999	2000	2001
Refrigerators			
NL	26%	55%	67%
EU*	12%	19%	27%
Freezers			
NL	29%	55%	69%
EU*	12%	16%	n.a.
Washing machines			
NL	40%	71%	88%
EU*	15%	26%	45%
Dishwashers			
NL	27%	55%	73%
EU*	n.a.	n.a.	n.a.

*EU = Germany, UK, Ireland, France, Austria, Belgium, Netherlands, Portugal, Sweden, Spain

The 1999-2000 sales of A class refrigerators, freezers, washing machines and dishwashers (Table 1.9) have increased by 116%, 95%, 95% and 117% respectively, while in the second year (2000-2001) sales increases were 22%, 35%, 28% and 32% respectively. The absolute level of sales of these appliances has also increased, namely by 4%, 3%, 7% and 6% over the 1999-2000 period. For 2000-2001, when economic crisis set in, sales of refrigerators (-2%) and dishwashers (-0,3%) decreased, but sales of upright freezers (+8%) and washing machines (+3%) continued to rise.

Table 1.9: Sales of A class appliances in The Netherlands in 1999-2001 (units)

Appliances	1999	2000	2001
Refrigerators	645 000	671 000	658 000
of which A class	167 700	362 340	440 860
Freezers	200 000	206 000	222 000
of which A class	58 000	113 300	153 180
Washing machines	565 000	605 000	623 000
of which A class	220 350	429 550	548 240
Dishwashers	330 000	350 000	349 000
of which A class	89 100	193 600	254 770

In the consumer surveys the advice by the retailer was mentioned most often as reason for the purchase (36% of 1195 appliances bought by the sample group). Second reason (35%) was that the appliance or provision 'was best' (quality). Third reason was the energy saving (22%) and in 62 cases (5,3%) the EPR-subsidy was mentioned as the main reason to buy a particular appliance. In 77% of the cases the purchaser did not consider buying another appliance, after having applied for a subsidy. Some 84% of those purchasers claims the EPR-subsidy did not influence their buying decision (they say they would have bought the appliance anyway), and 83% of the purchasers who did take some time to reflect, decided that their first choice was the right one. These data appear to be pointing at a so-called 'freerider' effect, meaning that consumers would have bought the appliance or provision regardless of the subsidy. On the other hand this is not in line with the drastic rise – much more than in other EU countries - in market share of A class appliances. These high market shares of 70-80% in 2001, caused by the EPR, have led retailers to advice an A class appliance to their customers as being 'the best', which in turn led to the purchase of more efficient appliances.

Savings on CO_2 emissions were calculated for each EPR-item, using reference situations proposed by the Energie Onderzoek Centrum Nederland (ECN). The total calculated emission saving over 2000 and 2001 amounted to 210.333 ton (the total CO_2 saving over the lifetime of the appliances that were bought with an EPR-subsidy was not calculated), due to insulation-measures 30%, glazing 18%, PV systems 18% and condensing CH boilers 15%. Refrigerators/freezers plus washing machines contributed for 15%, although they took up 46% of funds. The savings did not lead to a general decrease of residential energy consumption: between 1999 and 2000 the average electricity consumption per household rose from 3 165 kWh to 3 197 kWh.

The average energy consumption of refrigerators, freezers, washing machines and dishwashers sold in 1999, 2000 and 2001 clearly decreased. Econometric studies have assessed that the Regulating Energy Tax (REB) has led to a lower energy consumption of households than in a Business-as-Usual scenario. These studies estimate that a 10% energy price rise leads to a 4% lower consumption. On the other hand there is a rebound-effect whereby people start using efficient appliances more. This takes away around one sixth of the energy saving achieved through the efficiency improvement, meaning that 5/6of the savings is effective. From 1st January 2002 a second step of EPR subsidy was launched. Subsidies for that year are given in Table 1.10. The REB generated a state income of 2 383 million Euro in 2002.

In Table 1.11 the overall market share of the energy efficiency classes A and better is presented for the period 1996-2004. The differences with the data presented in previous Table 1.8 depend from the different source of the information, which in any case are in good agreement. The market share for both refrigerators and freezers increased considerably since 1996. In the years 2003 and 2004

the market share of energy efficiency classes A, A+ and A++ decreased a little due probably to the fact that since 2003 no EPR subsidy is given anymore for these appliances.

Table 1.10: Subsidies for household appliances in the Dutch EPR 2002 scheme

Code	Item	Subsidy (€/unit)
1010	Fridge/freezer A-label	50
1011	Fridge/freezer A-label with EEI =0,42 (e.g. A+)	100
1020	Dishwasher A (energy), A or B for performance and drying	50
1030	Dishwasher A-label for energy	50
1031	Washing machine, A, A, A	100
1041	Electrical tumble drier A-label for energy	160
1050	Gas-fired tumble drier	160
1060	Washer-drier with A-label for energy	205
1080	Lighting fixture with dedicated CFL >30 Watt	50
1090	Stand-alone LCD-monitor with diagonal >35 cm	50

Table 1.11: Marker share of A and better classes for white goods in the Netherlands in 1996-2004

EE Classes	1996 (%)	1997 (%)	1998 (%)	1999 (%)	2000 (%)	2001 (%)	2002 (%)	2003 (%)	2004 (%)
Refrigerators									
A	7	10	14	23	54	70	71	75	68
A+	--	--	--	--	2	6	13	23	19
A++	--	--	--	--	--	--	1	0	1
Freezers									
A	3	13	18	26	53	n.a.	74	60	58
A+	--	--	--	--	--	--	14	22	21
A++	--	--	--	--	--	--	--	2	3
Washing machines									
A	0	3	19	37	67	91	95	99	99
Dryers									
A					0,5	0,5	0,4	0,3	0,3

source: VLEHAN 2005, VROM 2005, MilieuCentraal 2005

The effect of the subsidy scheme for washing machines has been specifically studied by GfK[46]. The EPR scheme positively affected the increase the share of the higher efficiency machines and an increase of the average machine price (see the increase in the sales and price of the A and A+ washing machines in Figure 1.4) in the period 1999-2002, followed by a decrease in 2003 when the subsidy ended.

In Figure 1.5, a comparison between the Dutch and the German market for washing machines in 2001 and 2002 is presented, where the effect of the subsidy can be appreciated from the difference in the units sold per 1000 households in the two countries.

[46] Source: Source: Friedemann Stoeckle, Trends of major domestic appliances sales in the various phases of energy efficiency legislation in Europe, EEDAL 06, London, June 2006.

Figure 1.4: The effect of the Dutch subsidy scheme for washing machines in 1999-2005

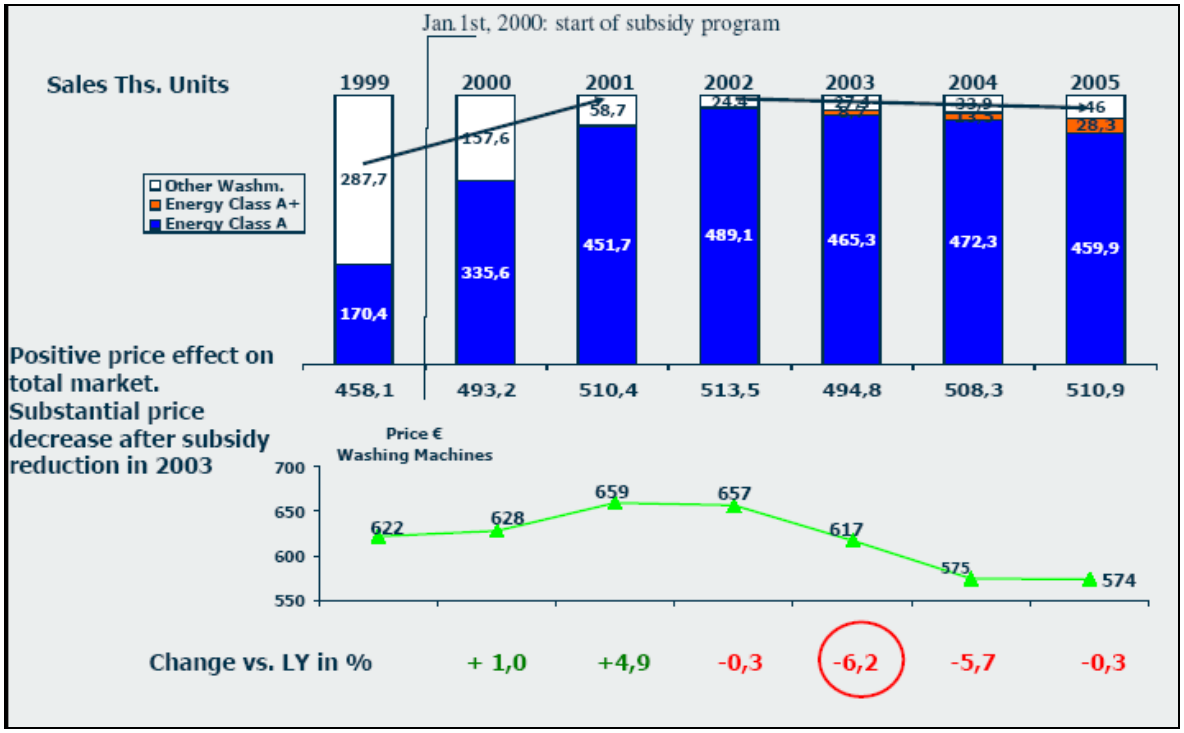
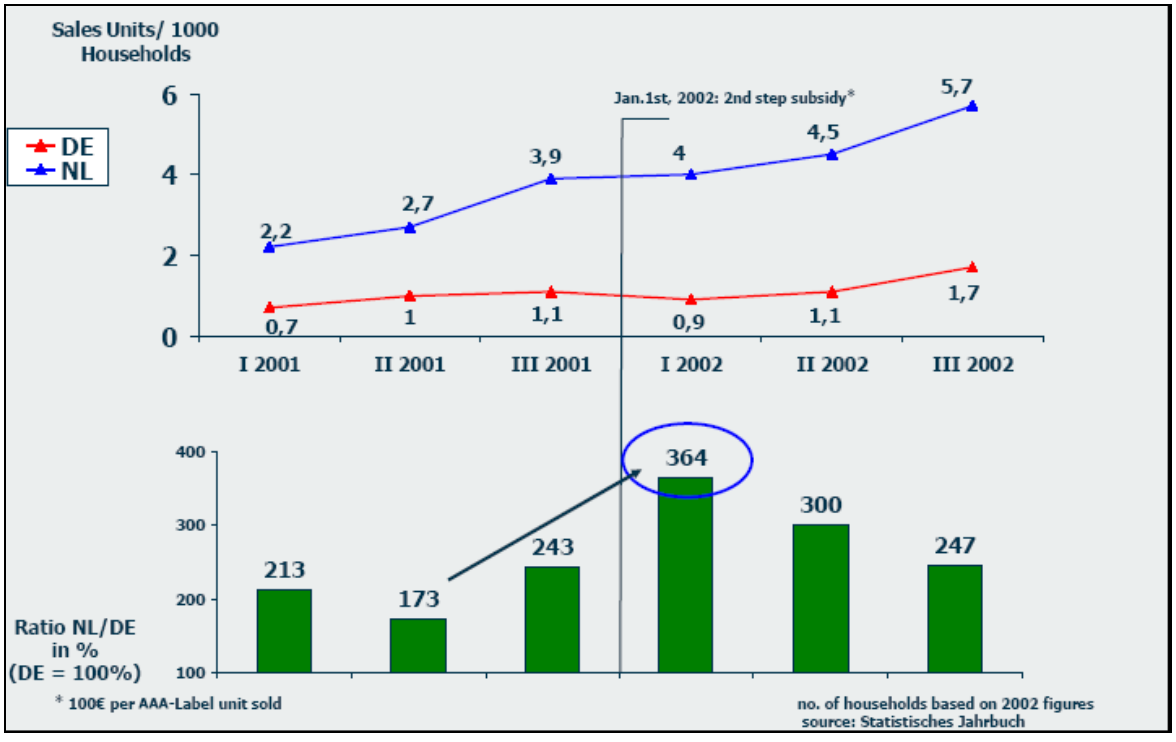


Figure 1.5: Comparison between the Dutch and the German market for washing machines in 2001 and 2002



1.3.2.3 Additional local legislation

a) The Water Conservation label of Dublin

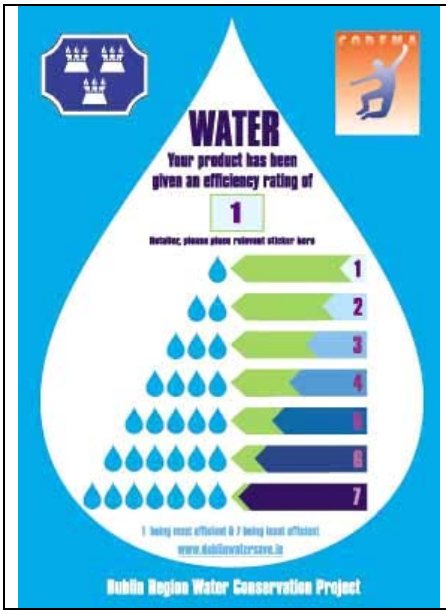
In Ireland, in support of the 276 million Euro water conservation programme, announced by the

Minister for the Environment, Heritage and Local Government in May 2003, Dublin City Council (DCC) started to promote the water conservation through the Dublin Region Water Conservation Project (DRWCP)[47]. CODEMA, the City of Dublin Energy Management Agency, together with DRWCP has developed an innovative label to help promote water conservation in the home and to facilitate the consumer to make a "better informed" decision when purchasing an appliance.

The new water label for white goods was developed in conjunction with the proposed Dublin City Council Water Bye-laws, designed to ensure that best practice is achieved to prevent water wastage and to ensure that practical, efficient and cost effective measures are in place to conserve water. Some of the measures proposed include an update of technical requirements in relation to white goods. In particular the laws require "... clothes washing machines, clothes washer-dryers and dishwasher ... be economical in the use of water."

The Water Conservation labels for dishwashers and washing machines (Figure 1.6) rates water consumption from 1 to 7, where "1" indicates best efficiency where less water is used and "7" indicates worst efficiency where more water is used. Rating is defined in terms of water consumed per 12 place settings and different load sizes are scaled proportionally. A database including dishwasher models and their water consumption is also available on the website.

Figure 1.6: Water conservation labels foe wash appliances in Dublin



Water Conservation Rating	Washing Machines* litres of water	Dishwashers** litres of water
1	≤40	≤13
2	41 - 45	14
3	46 - 50	15 - 16
4	51 - 55	17 - 18
5	56 - 60	19 - 20
6	61 - 135	21 - 24
7	136 - 240	25 - 54

*Based on a 5kg load and 60° cotton wash cycle
**Based on a dishwasher capacity of 12 place settings

Part 17 of the proposed Dublin Water Bye-laws refers specifically to washing machines, dishwashers and other appliances. In particular setting water consumption limits for washing machines, washer-dryers and dryers:

- Part 17.3 states that "domestic horizontal axis washing machines shall not have a water consumption per cycle greater than 27 litres per kilogram of wash load (EU Directive 95/12/EC);
- Part 17.4 states that "domestic washer-dryers shall not have a water consumption greater than 48 litres per kilogram of wash load (EU Directive 99/60/EC);
- Part 17.5 states that "domestic dishwashers shall not have a water consumption per cycle greater than 4,5 litres per place setting (EU Directive 97/17/EC)".

[47] See: www.dublinwatersave.ie/Water_Conservation/Home_Page/Navigation.html.

A number of retail outlets have, on a voluntary basis, agreed to participate in the new water conservation labelling scheme, demonstrating their commitment to a sustainable future in water quality and supply.

Rating is defined in terms of water consumed per 12 place settings for dishwashers and per a standard 5kg load for washing machines and different load sizes are scaled proportionally (Table 1.12).

Table 1.12: water rating for dishwashers and washing machines

Rating	litres per 12ps	litres per 1 ps	litres/5kg load	litres/kg load
1	< 13	< 1,083	< 40	< 8
2	14	1,084-1,24	41-45	8,1-9,9
3	15-16	1,25-1,40	46-50	10,0-10,99
4	17-18	1,41-1,57	51-55	11,0-11,99
5	19-20	1,58-1,74	56-60	12,0-12,99
6	21-24	1,75-2,0	61-136	13,0-27,0
7	25-54	2,1-4,5	137-240	27,1-48,00

1.3.3 International Policies & Measures

The number of nations adopting energy efficiency requirements and labels for EUPs is growing rapidly, from 9 in 1984 to 36 in 1994 to 56 in 2004. The number of regulations worldwide on individual appliances and equipment is growing even more rapidly, increasing from 543 to 878 between 2000 and 2004[48].

The most common policies and measure for wash appliances outside the EU are labelling (efficiency or other type) and efficiency requirements, implemented in many countries, as described in Table 1.13. (IEA and OECD Secretariats, based on various sources)

Table 1.13: Labelling schemes and energy requirements for dishwashers and washing machines around the world[49]

Country	Dishwashers			Washing machines		
	Min. eff. requirements	labelling		Min. eff. requirements	labelling	
		comparative	endorsement		comparative	endorsement
Algeria	--	--	--	UC	--	--
Argentina	--	UC	--	--	UC	--
Australia	**M**[3,5]	**M**[3,5]	V	**M**[3,5]	**M**[3,5]	V
Brazil	--	UC	--	V	**M**[2]	V
Canada	**M**[4]	**M**[4]	V[4]	**M**[4]	**M**[4]	V[4]
Chile	--	UC	--	--	UC	--
China	--	--	--	**M**	--	V
Chinese Taipei	--	--	--	--	--	V[4]
Colombia	--	--	--	--	UC	--
Egypt	--	--	--	**M**	**M**[3]	--
EU-25/27	**V**	**M**	V	**V**	**M**	V
Hong Kong (CN)	--	--	--	--	V	--
Indonesia	--	--	--	UC	--	--
Iran	--	--	--	--	**M**[3]	--

[48] Source: APEC," A Strategic Vision for International Cooperation on Energy Standards and Labeling", June 2006.
[49] Source: www.clasponline.org .

Country	Dishwashers			Washing machines		
	Min. eff. requirements	labelling		Min. eff. requirements	labelling	
		comparative	endorsement		comparative	endorsement
Israel	**M**	**M**	--	**M**	**M**	--
Jordan	--	--	--	--	**M**[3]	--
Korea	**M**	**M**	--	**M**	**M**	--
Malaysia	--	--	--	UC	--	--
Mexico	--	--	--	**M**[4]	**M**[4]	V
New Zealand	**M**[5]	**M**[5]	V	**M**[5]	**M**[5]	V
Peru	--	--	--	UC	UC	--
Russia	**M**	--	--	UC	--	--
Singapore	--	--	--	--	V[2]	--
Switzerland	**V**[2]	**M**[2]	V	**V**[2]	**M**[2]	V
South Africa	--	--	--	**V**[2]	--	--
Thailand	--	--	--	--	--	V
Turkey	**V**[2]	**M**[2]	--	**V**[2]	**M**[2]	--
United States	**M**	**M**	V	**M**	**M**	V
Vietnam	--	UC	--	--	UC	--

M = Mandatory, V = voluntary, UC = under consideration

[1] Framework legislation is passed but the implementing legislation is believed to still be under consideration.

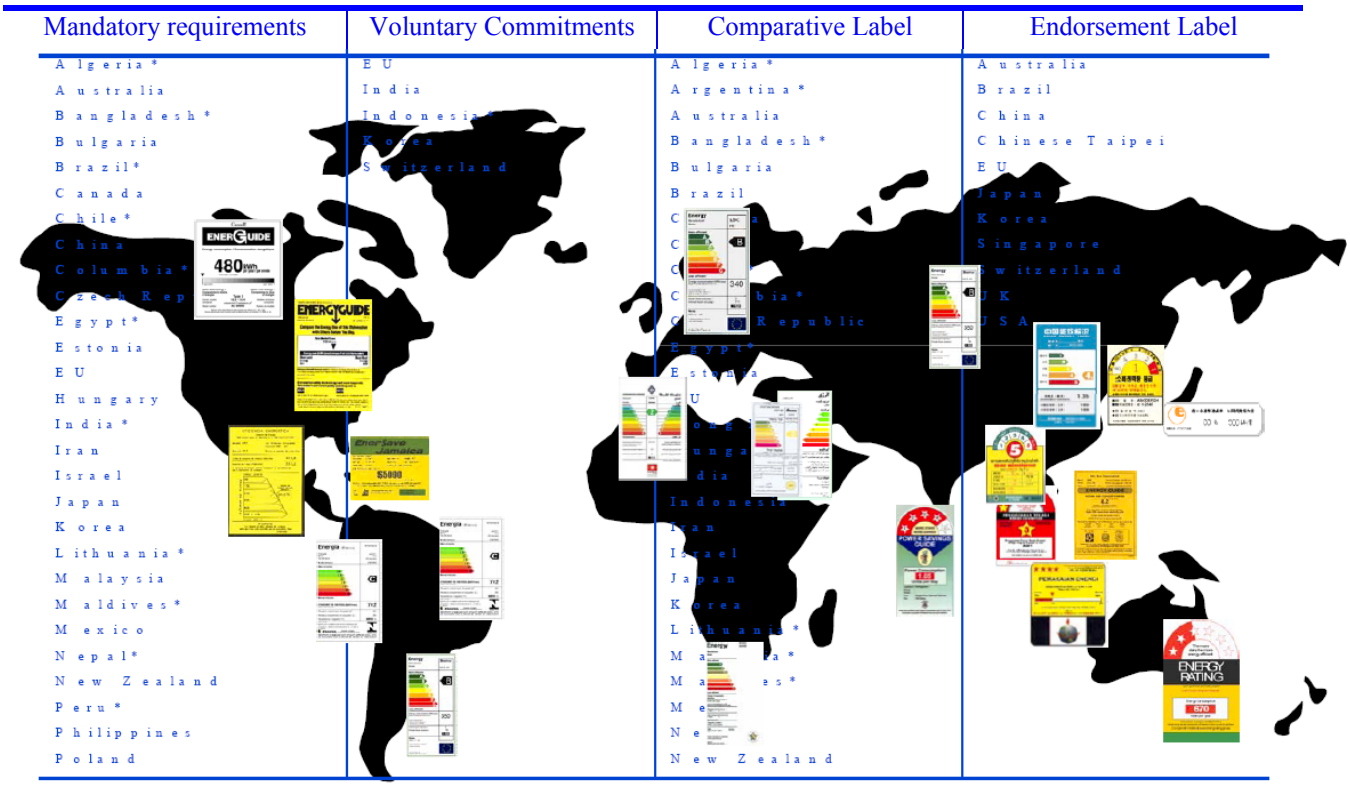
[2] Harmonised with EU;

[3] Partially harmonised with EU;

[4] Partially or fully harmonised with USA

[5] Harmonised between Australia and New Zealand.

Figure 1.7: International use of mandatory and voluntary policy instruments in 2004[50]



[50] Source: P. Waide, International use of policy instruments: country comparisons, Copenhagen, April 2006

1.3.3.1 Australia and New Zealand

Like other countries, Australia[51] has had a national end-use energy efficiency program with a mandatory energy labelling of appliances, that between 1992 and 2000 delivered cumulative abatement of 5 Mt CO_2-e. Since this was considered a small contribution to the national stationary energy emissions calculated as 295 Mt CO_2-e pa in 2000 a change in perspective was decided. From 2000, Australian governments agreed to a programme of regulation policy matching world-best regulated efficiency requirements (but not exceeding them). Products cannot be sold unless they comply with these minimum levels, stipulated in Australian standards, which are called in law. Industry is a partner, publicly committed to bringing only complying product to market.

Australia has a small manufacturing base and imports many products from Europe, Asia and North America. As a rule Australia is a technology taker rather than developer of consumer products. The key to the policy of matching world best regulatory policies is allowing reasonable time for that technology to filter into our marketplace. It was considered unrealistic to demand Australian industry develop technologies in advance of the rest of the world; it is more realistic to expect locally based industry to match existing, proven technologies within a reasonable timeframe. The focus of policy measures debate therefore was shifted from disputes about technical feasibility issues to discussions about introduction dates. A key benefit of matching an existing technical level is avoiding divisive debates about what the standard level should be: Europe, Asia or North America has determined that for Australia in the last years. The national debate is focused on taking account of any special Australian circumstance to modify those pre-determined efficiency levels.

This specificity should be taken into account when the evolution of the Australian/New Zealand energy efficiency policy measures is considered.

a) The energy efficiency requirements

Although no minimum energy efficiency requirements have been set for **dishwashers**, a number of requirements must be met by this product during the previously described test for energy consumption. These include:

- *washing index*: the washing index of the test machine must exceed the specified value measured on the reference machine which is tested in parallel. The reference machine is a dishwasher which specially constructed and calibrated for this purpose (Miele G590);
- *drying index*: the drying index of the test machine must exceed 50% (this is conducted as a separate test);
- *rated capacity*: all specified load items shall be supported;
- *water consumption*: shall not exceed 110% of the value stated by the manufacturer.
- *water pressure*: machine shall be capable of operating at the maximum and minimum water pressure stated by the manufacturer;
- *energy consumption* is determined on the program recommended by the manufacturer for energy labelling that is capable of meeting the above mentioned requirements. From April 2004, all dishwashers are to be re-labelled using the "normal" program when tested to the 2003 Edition of AS/NZS 2007.1;

The same occurs for **washing machines**, to be eligible for an energy label. Products are classified into either drum type (generally front loading) or non drum type (all other types such as top loaders

[51] Source: S. Holt, L. Harrington, Lessons learnt from Australia's standards & labelling program, ECEEE, 2003.

with impellers or agitators, twin tub machines). A number of performance requirements must be met by machines during a test for energy consumption. These include:

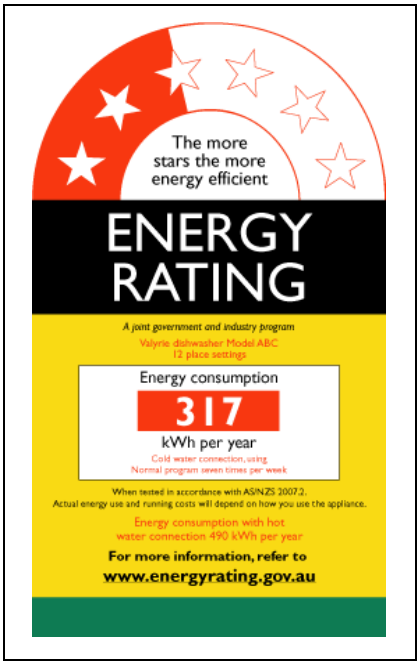
- *wash performance*: soil removal from soiled swatches which are attached to a clothes load of rated capacity, must exceed 80% (there are also limits on the variability of the wash)
- *spinning performance*: the water extraction index (defined as ratio of the remaining water in the load after the final spin to the bone dry mass) must not exceed 1,1
- *severity of washing*: the severity of washing index must not exceed 0,3 after a single run
- *water consumption*: shall not exceed 110% of the value stated by the manufacturer
- *water pressure*: machine shall be capable of operating at the maximum and minimum water pressure stated by the manufacturer;
- *rinse performance*: from July 2006 a rinse performance requirement was set (see paragraph 1.5.3.1.e).
- *energy consumption* is determined on the program recommended by the manufacturer for a normally soiled cotton load at the rated capacity; the minimum wash temperature for energy labelling tests is 35°C.

b) The energy rating labelling scheme

AS/NZS 2007: *Performance of household electrical appliances - Dishwashers Part 2: Energy labelling requirements* – 2003 includes algorithms for the calculation of the energy efficiency star rating and projected energy usage, performance requirements, details of the energy label and requirements for the valid application thereof. Compared to the previous edition of 2000 it has a new requirement for labelling on the program recommended for a "normally soiled" load. In addition, Part 1 has been substantially revised including a 15 hour soil drying time and the option of using an IEC load. The change to the program recommended for a normally soiled load and retesting to the revised Part 1 has been required for all dishwashers remaining on the market after 1st April 2004.
A new edition AS/NZS 2007:2005 has been published in 2005. It refers to AS/NZS 2007.1:2005 for test procedures. From the date of publication until 31 March 2007, regulatory authorities accepted registration of dishwashers in accordance with either AS/NZS 2007.2:2003 or 2005 edition. From 31 March 2007, it is expected that all new registrations or changes to existing registrations submitted in Australia and new records or changes to existing records kept in New Zealand, will need to meet the requirements of AS/NZS 2007:2005.

The energy consumption of a **dishwasher** is measured under conditions specified in AS/NZS 2007.1. Over a year, it is assumed that the dishwasher is used 7 times per week (365 times per year). This gives the Comparative Energy Consumption (CEC) shown in the Energy Rating label (Figure 1.8).

Figure 1.8: Energy rating for a 12 place settings dishwasher in Australia



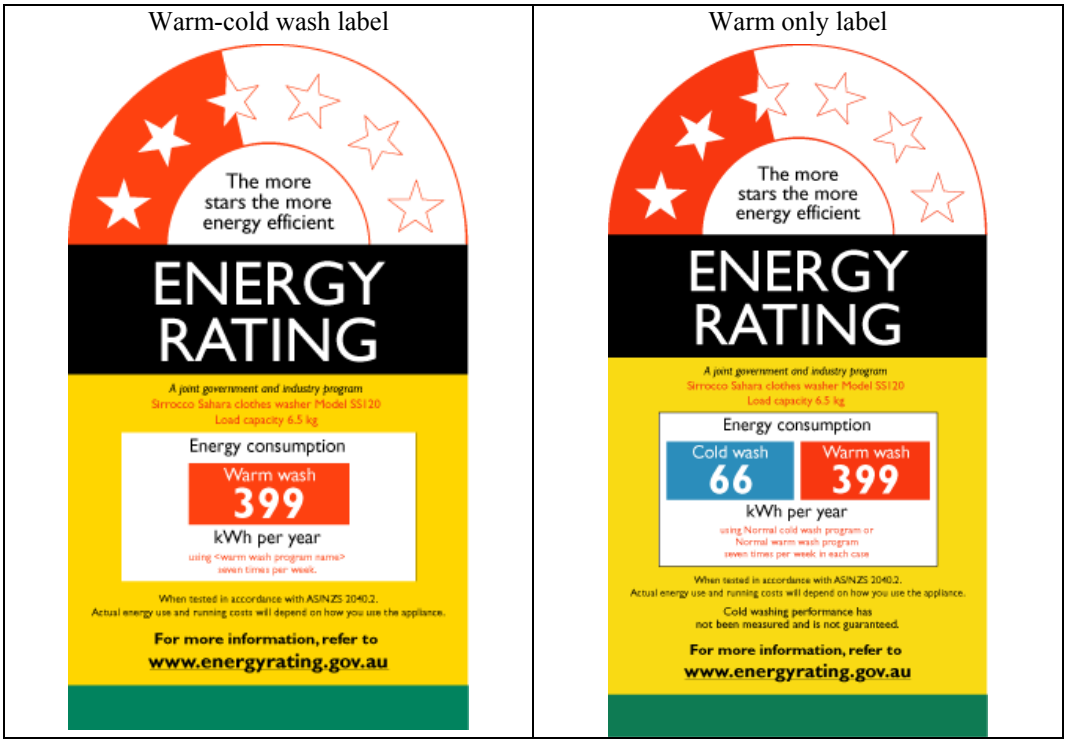
The program used for the energy labelling program is the "normal" program using the revised AS/NZS 2007 Part 1 test method. To be eligible for an energy label, a dishwasher must be able meet the specified wash and dry performance criteria (see previous point). The Base Energy Consumption (BEC) defines the "1 star" line for the specific product. An additional star is awarded when the CEC of the model is reduced by a defined percentage from the BEC. The energy reduction per star is 30% for dishwashers. For example, a model that had a CEC that was 0,70 of the BEC or less would achieve 2 stars. Similar, a CEC of 0,49 (0,70 x 0,70) of the BEC or less would achieve 3 stars and so on (Figure 1.8).

The energy consumption of a **washing machine** is measured under conditions specified in AS/NZS 2040.1. Over a year, it is assumed that the machine is used 7 times per week at rated capacity on a warm wash (warm Comparative Energy Consumption, in red in the label shown in Figure 1.9); a value for a cold wash energy of 7 times per week is also shown on the label (cold CEC in blue). The washing machine is labelled on the "normal" or "regular" program (program specified for a normally soiled cotton load).

The Base Energy Consumption (BEC) defines the "1 star" line for the particular product. An additional star is awarded when the CEC of the model is reduced by a defined percentage from the BEC. The energy reduction per star is 27% for clothes washers. For example, a model that had a CEC that was 0,73 of the BEC or less would achieve 2 stars (Figure 1.9). Similar, a CEC of 0,533 (0,73 x 0,73) of the BEC or less would achieve 3 stars and so on. For clothes washers, front and top loading models are rated on the same basis.

The warm wash energy consumption (warm CEC) and a component of residual moisture (spin performance) is used to define the star rating in comparison with the BEC. Therefore a model that has a good spin performance may get a marginally higher star rating than a model of the same capacity and CEC with a poor spin performance.

Figure 1.9: Energy rating for washing machines for machines with warm wash only and with warm and cold wash in Australia



c) The TESAW and the future Energy Star scheme

The Tower Energy Saver Award or TESAW[52] is an award system that Australian and State governments and the appliance industry have created in 2003, replacing the previous Galaxy Award system, to recognise the most energy efficient star rated products on the market. It applies to both electric and gas products that carry a star rating energy label. It is an award system that helps consumers quickly identify the most efficient products on the market. TESAW complements the mandatory labelling with an endorsement label. The TESAW label is about half the size of a normal electric energy label and is in the same colours.

Each year, the energy efficiency of all products on the market are reviewed. In consultation with industry, the Government sets energy efficiency criteria (usually the best star rating available) for TESAW awards for the coming year (each label specifies the year of the Award). From the start of the award period (November), manufacturers of existing products or new products that meet the set energy efficiency criteria will be eligible to apply for an award. Once an award is granted, the manufacturer is eligible to display the TESAW label on their products in retail stores.

The award eligibility criteria for TESAW award to electric products are:

- the product must be registered and approved by the relevant regulatory authority for electric products.
- the product must be available for sale in Australia at the time of applying for the award or at some time during the calendar year of the award specified by the applicant. (Note, at the time of registration, all new energy labelling applications have to nominate an "on market" date - this date is used to trigger the appearance of the registration onto the public energy rating website, which also shows whether the product has received an award).

[52] http://www.energyrating.gov.au/tesaw-main.html.

- the product must meet or exceed the performance requirements as set out in the performance criteria schedules. TESAW criteria for 2006 for wash appliances are[53]:
  - dishwashers: appliances which are registered for energy labelling to AS/NZS 2007.2 (Edition 2003 or 2005) and have achieve 3,5 stars or more
  - washing machines: appliances which are registered for energy labelling to AS/NZS 2040.2 (Edition 2000 or 2005) and achieve 4,5 stars or more.

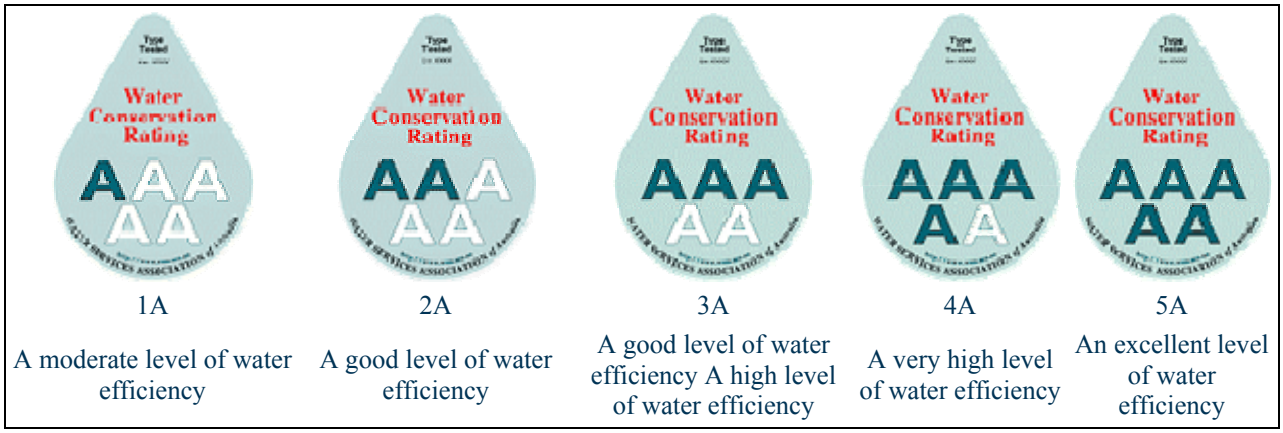
In 2005 detailed discussions and negotiations were held with the US Environmental Protection Agency and the US Department of Energy, resulted in an in-principle agreement that Australia and New Zealand could set local Energy Star criteria for products that were sold in the Australasian market (such as white goods, where the USA had their own domestic criteria), subject to detailed review by EPA and DOE on a product by product basis. This has been agreed on the basis that the energy star label would be available on products that are specifically for sale in Australia and New Zealand and would not appear on the US market. Possibly a version of the energy star that is unique to this region will be developed. On this basis, EEEC (Equipment Energy Efficiency Committee) decided to move towards the use of the Energy Star label as the primary endorsement label for appliances and equipment in Australia and to discontinue TESAW as an endorsement label.

A complete overview of the regulatory and endorsement framework in Australia and New Zealand is in preparation to facilitate further discussions. To allow a smooth transition from TESAW to Energy Star, EEEC has decided to continue the TESAW scheme for each product until suitable Energy Star criteria are finalised.

d) The water efficiency labelling scheme

A voluntary water efficiency labelling scheme has been in existence since 1988. It is now managed by the Water Services Association of Australia (WSAA). The scheme originally covered only shower heads and dishwashers, and offered two efficiency grades (A and AA). A third rating (AAA) was introduced in 1992, and two higher ratings (AAAA and AAAAA) in 2001 (Figure 1.10). The WSAA program covers shower heads, toilets, taps, clothes washers, dishwashers, urinal flushing devices and flow regulators. The test requirements for each product type, the water efficiency levels required for each rating and the label design are all specified in AS/NZS 6400, Water efficient products – Rating and labelling published in February 2003.

Figure 1.10: The national water conservation rating and labelling scheme[54]



[53] Source: Top Energy Saver Award Winner: Final Award Criteria for 2006 – January 2006.
[54] Source: http://www.wsaa.asn.au/ratings/ratingsabout.htm

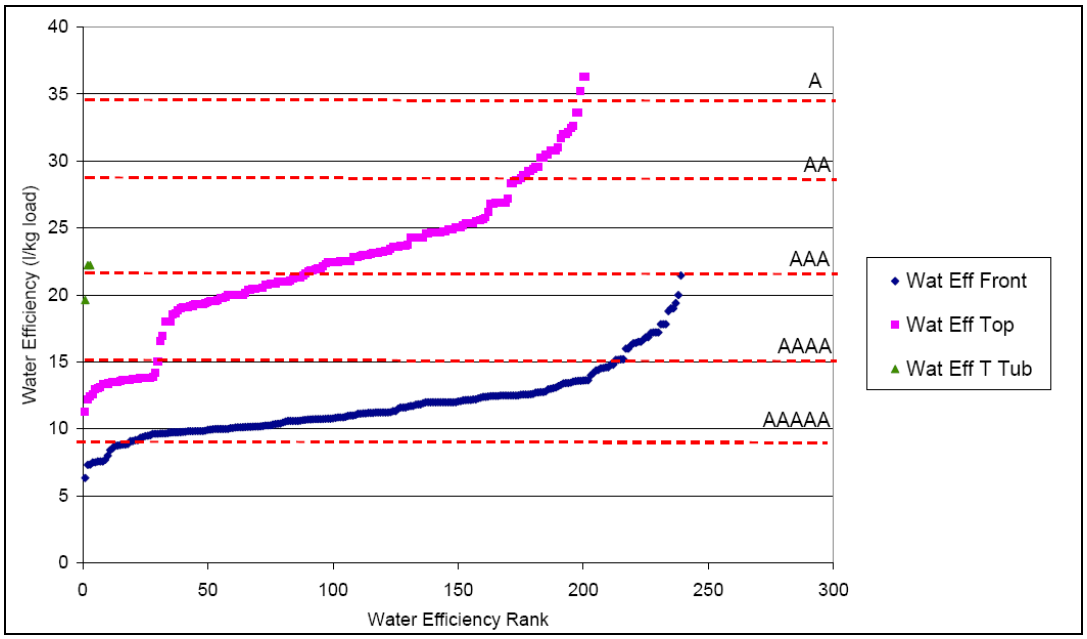
The technical criteria for water efficiency ratings for dishwashers and washing machines are presented in Table 1.14[55].

Table 1.14: Technical criteria for water efficiency ratings in Australia until 1 June 2006

Product	Units of measurement	water efficiency ratings				
		A	**AA**	**AAA**	**AAAA**	**AAAAA**
Dishwashers	litre/place setting	≤2,8 / >2	≤2 / >1,5	≤1,5 / >1	≤1 / >0,8	≤ 0,8
Washing machines	litre/kg load	≤34 / >28	≤28 / >22	≤22 / >15	≤9 / >15	≤ 9

The coverage of the existing program was considered limited for some of the products such as washing machines and good for other products such as dishwashers. The main incentive for labelling has been the support of the water utilities (the members of WSAA), many of whom have publicised the scheme, or offered cash rebates to their customers for the purchase of labelled appliances. Consequently, despite nominally being a *comparative labelling* program it has developed some of the attributes of an *endorsement label*, which assists water utilities and their customers to identify models for rebate purposes, rather than as an effective comparative label, which encourages and enables buyers to compare the water efficiency of different models. Consumer awareness of the existence of the voluntary label and label recognition were also considered low. The water efficiency of washing machines labelled in December 2004 is presented in Figure 1.11[56].

Figure 1.11: Water efficiency of labelled washing machines in December 2004



[55] Source: George Wilkenfeld and Associates, Regulation Impact Statement: Proposed National System of Mandatory Water Efficiency Labelling for Selected Products, prepared for the Department of the Environment and Heritage, Australia, May 2004

[56] Source: Energy Efficient Strategies, Method for the Determination of Rinse Performance in Clothes Washers, Summary Report, Report for The Department of Environment and Heritage – Australian Federal Government, June 2005

The Commonwealth Department of the Environment and Heritage introduced in 2003 a mandatory Water Efficient Labelling and Standards (WELS) Scheme that applies national mandatory water efficiency labelling and minimum performance requirements to household water-using products and replaces the voluntary Water Services Association of Australia's National Water Conservation Rating and Labelling Scheme (ceased 1st July 2006). Each state has also enacted its own legislation to complement the National scheme.

All products specified under the WELS Act must be registered, rated and labelled according to the requirements of **AS/NZS 6400:2005**[57] (with Amendments 1,2 and 3 December 2006) *Water-efficient products - Rating and labelling*. This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee WS-032, Water Efficient Appliances and was approved on behalf of the Council of Standards Australia on 14 April 2005 and on behalf of the Council of Standards New Zealand on 22 April 2005 and published on 1st June 2005.

From 1 July 2006, mandatory registration and labelling will apply to all of these products (apart from flow controllers, for which this will be optional). All registrations are to be made through the WELS Regulator, preferably via an online form at http://www.waterrating.gov.au/about/registration.html. Registration fees have to be paid. The specified products are: washing machines, dishwashers, lavatory equipment, showers, tap equipment and urinal equipment. Flow controllers may be voluntarily rated and labelled; however, if flow controllers are registered, rated and labelled, they are required to comply with all the relevant aspects of the standard. Lavatory equipment is also required to comply with minimum water efficiency requirements. Full details of the WELS scheme implementation dates are in Table 1.15. A registration fee has to be paid.

Table 1.15: Transition dates to phase in the WELS Scheme

Critical Dates	Products	Notes
From 1 July 2005	Products may be voluntarily registered and labelled	Unlabelled products and AAAAA-labelled products will co-exist with WELS labelled products. Voluntarily registered products will be subject to the mandatory requirements of the scheme
From 1 July 2006	Products must be registered and labelled. Toilet equipment subject to minimum water efficiency requirements	The AAAAA rating scheme will cease. All new products must comply with the WELS Scheme; however, pre-existing stock may still appear in the shops
Until 31 December 2006	Retail supply of pre-existing tap equipment, showers, toilet equipment and urinal equipment is allowed	Permitted to allow a reasonable timeframe to move existing stock , provided that the products were manufactured in Australia or imported before 1 July 2006
Until 31 December 2007	Supply of pre-existing washing machines and dishwashers with AAAAA labels or without WELS Water Rating labels is allowed	Permitted to allow a reasonable timeframe to move existing stock , provided that the products were manufactured in Australia or imported before 1 July 2006
From 1 January 2008	all products are required to display the WELS Water Rating labels, irrespective of their date of supply	

Throughout AS/NZS 6400 the requirements and dates that relate to the implementation of the WELS scheme apply in Australia only, for New Zealand, the exact details of the WELS process

[57] Published on 28 December 2006. Approved for publication in New Zealand on behalf of the Standards Council of New Zealand on 22 February 2007, see: http://www.waterrating.gov.au/index.html .

implementation date have yet t be finalised, but the date is intended to be 1st December 2007[58]. AS/NZS 6400 also requires that products that do not comply with specific performance requirements will be given a zero rating and labelled accordingly or, in the case of toilets, no label will be issued.

The requirements of the WELS scheme generally only apply to new products and not to second-hand products. However, products that are imported second-hand to be supplied in Australia will be subject to the requirements.

Dishwashers and washing machines are required to comply respectively with AS/NZS 6400:2005 Clause 2.2 (setting out requirements for the registration, rating, labelling, and performance of dishwashers) and Clause 2.3 (setting out requirements for the registration, rating, labelling, and performance, including rinse performance as specified in AS/NZS 2040.2:2005 for washing machines). The supply of washing machines and dishwashers without WELS scheme labels will only be permitted until 31 December 2007, if the products were manufactured in Australia or imported before the commencement day of the mandatory scheme on 1 July 2006. The SRI (Star Rating Index) for **dishwashers** and **washing machines** is calculated as:

$$\text{Star Rating Index} = 1 + \frac{\log_e\left(\frac{WC}{BWC}\right)}{\log_e(1 - WRF)}$$

where:

- Star Rating Index = fractional star rating used to determine the number of stars to appear on the label, rounded down to the nearest half star rating
- WC = water consumption of the model in litres
- BWC = base water consumption = 2,5 + P × 1,6 and P = number of place settings of the *dishwasher*
- BWC = base water consumption = 30 × C and C = rated load capacity of the *washing machine* (kg) as determined under AS 2040.1, rounded to the nearest 0,1 litre
- WRF = water reduction factor per additional star (17,5%) = 0,175.

If an appliance achieves less than 1 on the star rating index, the rating is considered zero stars.

The water consumption of a washing machine is the higher of (a) the claimed total water consumption of the warm-wash or (b) the claimed total water consumption of the cold-wash when each is determined under the conditions used for the energy consumption tests as specified in AS/NZS 2040.2.

In Figure 1.12 the water rating label for dishwashers is shown. A product will be considered labelled if a removable label is attached to the product (or attached to or printed on the packaging, if the product is displayed for sale in the package), and/or if an image of the label is used in any advertising and promotional material, which is intended to inform the prospective buyer of the water efficiency rating of the product and other relevant features.

[58] Source: Water Efficiency Labelling Standards (WELS), at: www.mfte.govt.nz.

Figure 1.12: Water rating label for a 12 place setting dishwasher under WELS scheme



e) The rinse performance requirements

Clause 2.3.3 of **AS/NZS 6400:2005** specifies that "a clothes washing machine shall comply with the performance requirements specified in AS/NZS 2040.2, when tested under the same conditions used to determine the energy consumption of the appliance. AS/NZS 2040.2:2005 requires compliance with minimum rinse performance requirements".

When measuring rinse performance the intention is to measure the effectiveness of the machine in removing from the load various components associated with a typical wash. Primarily these components are detergent and soil (both soluble and insoluble). Assessment of the rinse performance of a washing machine is based upon the measurement of the apparent mass of retained marker (PBIS) in the load at the completion of the program. The marker is dosed into the wash program in proportion to the rated load. A standard soil removal test is then conducted. At the completion of this test (following weighing of the load) the load is placed in a spin extractor and a sample of rinse liquor recovered. The rinse performance is then determined from the concentration of PBIS in the extracted rinse liquor multiplied by the mass of retained moisture in the load measured at the end of the program. The addition of the PBIS marker to the wash water had no discernable impact on the wash performance result or other performance parameters.

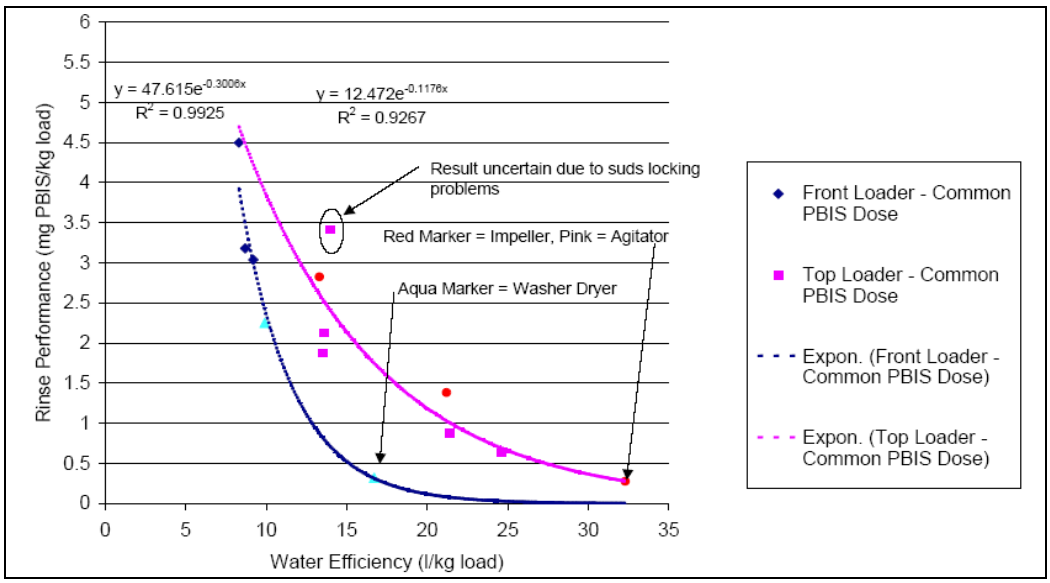
The pass mark for rinse performance has been set at 2,25 mg PBIS/kg load.

The introduction of a rinse performance requirement facilitated the introduction of mandatory water efficiency rating and labelling. Without a rinse performance requirement higher water efficiency rating could be achieved by reducing rinse performance levels that may not meet the needs of washing machine users. To assist the standards committee in determining an appropriate pass mark a total of 8 top loader machines and 5 front loader machines, a representative cross section of the

product available in 2004 in the Australian market and including a wide range of water efficiencies, were undertaken.

The results of the tests are presented in Figure 1.13[59], where the mass of retained PBIS is plotted against the water efficiency (l/kg load).

Figure 1.13: Rinse performance (PBIS) vs. water efficiency for a representative sample of washing machines in the Australian market in 2004



For each data series (front loading machines in blue and washer-dryers in light blue in one series and top loading impeller machines in red and agitator machines in magenta in the other series) an exponential trend line has been fitted. In all cases the fit was good. The trend lines show a clear relationship between water efficiency and rinse performance whereby an increase in water efficiency will result in a decrease in rinse performance. However, for a given water efficiency some significant variation in rinse performance between different models was found.

f) The standby requirements[60,61,62]

In 2000 the Australian Greenhouse Office (AGO) and the Equipment Energy Efficiency Committee (E3, formerly NAEEEC) commissioned the first major report into standby which involved an intrusive survey in Australian households; this exercise was repeated in 2005.

In 2002 the Ministerial Council of Energy (MCE) initiated a ten year policy on standby power entitled "Money isn't all you're Saving". This policy set out the "One Watt" target for appliances, with an overall goal that by 2012 all appliances would only use one Watt in their lowest standby mode, although the exact targets were to be determined on a product by product basis.

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[59] Source: Energy Efficient Strategies, Method for the Determination of Rinse Performance in Clothes Washers, Summary Report, Report for The Department of Environment and Heritage – Australian Federal Government, June 2005

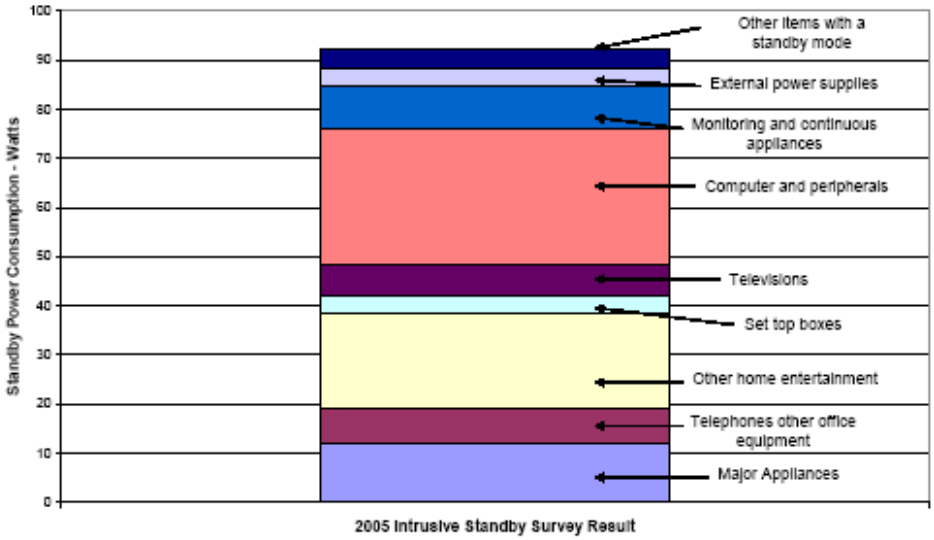
[60] Source: Report No 2006/10, Standby Power – Current Status, A report for the Equipment Energy Efficiency (E3) Committee – which documents the state of standby power in Australia and New Zealand, October 2006.

[61] Source: NAEEEC, Quantification of Residential Standby Power Consumption in Australia, NAEEEC, Final Report, 29 April 2001.

[62] Source: 2005 Intrusive Residential Standby Survey Report, Report for E3, March 2006.

The 2005 intrusive survey covered some 120 houses including 40 houses in Brisbane, 30 houses in Sydney and 50 houses in Melbourne and Gippsland, Victoria. Field work was undertaken in the period September to November 2005. A total of 8000 individual appliances were recorded during the survey. Appliances were recorded in all relevant standby modes, such as active standby, passive standby or off mode. This includes most appliances that have a continuous power draw which is not associated with their primary function. A small selection of products also had power consumption recorded in on mode (mainly televisions, computers and monitors). The contribution from each appliance group to the overall household standby power consumption was highlighted (Figure 1.14).

Figure 1.14: The contribution from each appliance group to the overall household standby power consumption in 2005



The most important product groups in terms of their total contribution to standby are computers and peripherals, home entertainment equipment (including televisions and set top boxes), major appliances and other office equipment. For major household appliances the average power consumption is 1,4 W per item with an average of 8,5 items per household.

The results for dishwashers and washing machines are:

- **Intrusive surveys**: 64 households were surveyed in 2000 and 120 households in 2005. Visits were made to conduct power measurements of all household appliances in off-mode, standby mode and in-use (as applicable). Every plug load in each house was identified and measured where possible. The "on", "standby" and "off" readings were collected. Information about each appliance, such as age, brand name and model number was also collected.

  Dishwasher ownership was found to be 0,31 and 0,57 per household in the two years, washing machine at 0,95 in the two surveys.

  In 2000, almost all models for both appliances were found in "off" mode when not in use, but as for dryers electronics are increasing therefore standby is becoming more common. The stock average in "off mode" for dishwashers was 0,5 W, increased since the late eighties coinciding with the introduction of "soft touch" technology. In use readings during the intrusive survey were hard to obtain as most models were "built in" or difficult to move. For washing machines just over half (56%) of all measured models had an off reading of zero watts – many of these are

older machines; the average off mode power consumption for washing machines increased since the late eighties (coinciding with the introduction of "soft touch" technology); the stock average for off mode is 2.0W and looked to be increasing.
In 2005, about 76% of the dishwashers were found to be switched off, with the rest found in active standby mode. About 66% of units were found to have a hard off switch, about 33% with a soft switch off. One unit was found to have no hard or soft off switch. About 28% of units were found to be hardwired or inaccessible. The average active standby was found to be 2,8 W and the average off mode was found to be 0,8 W. About 25% of dishwashers were found to have delay start capabilities, with 20% of participants with these machines indicating that they use this function. The average power consumption for delay start mode was found to be 3,8 W.

The average age was found to be 6,6 years. The active standby power consumption of dishwashers for 2005 was that about 29% of units had a power consumption of between 2 W and 3 W, 36% of units were found to use less than 2 W and the other 35% of units found to use more than 3 W. As far ad the off mode power consumption is concerned, in 2005 64% of the units had a power consumption of 0,0 W, with the rest of the sample having a range of consumptions up to 5,0 W. The summary of the dishwashers finding is presented in Table 1.16.

About 68% of washing machines were found to be off, 9% were in active standby and 24% were switched off at the power outlet or unplugged. Alarmingly, 25% of the front loaders were found to be left in active standby mode when not in use. About 67% of units were found to have a hard off switch, about 32% had a soft off switch. Two units were found to have no hard or soft off switch. The average active standby was found to be 5,8 W and the average off mode was found to be 1,9 W. About 22% of machines were found to have delay start capabilities, with about 24% of participants with these machines answering that they use this function. The average power consumption for delay start mode was found to be 7,1 W. The majority (75%) of the machines had an active standby power consumption between 2 W and 8 W. Just over half of the units (54%) consume 0,0 W in off mode, the rest of the readings are spread relatively evenly from less than 1 W to less than 10 W. The summary of the washing machines finding is presented in Table 1.17.

Table 1.16: Findings of the Australian 2005 household intrusive survey for dishwashers

Dishwashers	Statistic	Number of Readings
Ownership	0.57	68
Average Age	6.6 years	62
Average Active Standby	2.8 Watts	34
Minimum Active Standby	0.3 Watts	34
Maximum Active Standby	7.0 Watts	34
Average Off Mode	0.8 Watts	44
Minimum Off Mode	0.0 Watts	44
Maximum Off Mode	4.4 Watts	44
Average Delay Start Mode	3.8 Watts	17

Table 1.17: Findings of the Australian 2005 household intrusive survey for washing machines

Clothes Washers	Statistic	Number of Readings
Ownership	0.95	114
Average Age	7.0 years	110
Average Active Standby	5.8 Watts	65
Minimum Active Standby	0.5 Watts	65
Maximum Active Standby	17.3 Watts	65
Average Off Mode	1.9 Watts	112
Minimum Off Mode	0.0 Watts	112
Maximum Off Mode	9.3 Watts	112
Average Delay Start Mode	7.1 Watts	25

- **Market surveys**: as a key element of the MCE Standby Power Strategy, regular store surveys have been undertaken with the specific goal to "quantify the magnitude of electricity used in standby modes by new appliances offered for sale on the Australian market" since 2001. The methodology used has been to visit a number of large retail outlets and measure the relevant modes for all products that are on display for sale. Measurements are made on 500 to 1 000 new products during each survey. Data is recorded on brand, model, price, details of any energy labels or markings, features, product type and any other relevant features. Power consumption in defined modes is recorded, mostly passive standby and off modes, but also active standby and on mode in some cases. Initially, the surveys were conducted once annually, but since 2003, two to three surveys have been conducted per year. This has resulted in a database of more than 5 500 new products offered for sale in the period. It should be noted that the number and mix of products measured in each year of the survey were somewhat different so the results need to be taken as indicative and trends within each product need to be examined separately. For each appliance, power consumption was measured while the appliance was in use (mostly home electronics), in standby (passive and/or active) and off modes, where applicable. For many appliances such as washing machines and dishwashers, it was impractical to measure the appliance in use.

  Dishwasher results: 181 new products in store surveys 2001 to 2006. the measured value for off mode varies over time but is usually less than 1 W (affected by the sample size and mix of products measured). However, end of cycle mode is the most critical (especially for European products) and little data is available;

  Washing machines results: 380 new products in store surveys 2001 to 2006. There was a strong decline in off mode power from 2001 (3,8W) to 2004 (0,7W) probably in response to proposed reporting requirements and incorporation into the energy label. However, there appears to be a slight increase in both off mode and active standby mode for new products in 2004 and 2005 (1,2W) compared to earlier years. However, end of cycle mode is the most critical (especially for European products) and little data is available.

There is an important issue regarding washing machines and dishwashers: most European products have an off switch, which usually disconnects power to most parts of the machines and drops the power consumption close to zero Watts. However to achieve this, the consumer must manually turn the machine off when the cycle has been completed and the load removed. During the intrusive survey in 2005 around 40% of the European front loading machines were found left in active

standby mode when not in use (i.e. the users did not manually turn the machines off when the washing cycle was completed). These machines persist in active standby mode indefinitely with the current machine designs. This means that the off mode power consumption for many European machines is probably not all that relevant. A more relevant figure is the active standby power consumption (which in many cases is likely to be similar to end of cycle mode). In 2005 this averaged about 4 Watts, although individual values varied from 1 Watt to 7 Watts in this mode. All non European machines automatically revert to off mode automatically at the end of the cycle, so only off mode measurements for these machines are relevant.

The Standby Power Strategy 2002-2012 contains a wide range of possible policy measures to address excessive standby power. The document sets out the long-term strategy to address excessive standby energy used by consumer appliances and equipment. The strategy foresees:

1. outlines the measures that governments will use to address excessive standby;
2. identifies the products to be targeted in the first of three-year rolling plans under the strategy;
3. establishes the procedure whereby standby targets will be set for each of the targeted products (Stage 1 targets);
4. identifies the sanctions that will apply should suppliers not meet the targets for these products (Stage 2 targets).

The purpose is to provide that Australian products will meet the ultimate target, of one watt in 2012.

Under the strategy, product profiles for specific products were published over 2003-2005. The profiles provided a detailed assessment of current market, ownership levels, product attributes and the range of standby power typically found in new products on the market. The strategy envisaged as a first stage a range of voluntary targets for reductions in standby power on a product by product basis over the initial three year period (so called Stage 1). At a specified date, each product type or category would be assessed against the voluntary targets specified in the product profiles. If satisfactory progress was achieved towards or beyond the voluntary target, further long term voluntary targets would be confirmed. If adequate progress was not made by the target date, then the government would consider a range of possible actions, some of which may be mandatory or have mandatory components (so called Stage 2). Stage 1 and 2 targets for dishwashers and washing machines are:

- Stage 1 (2007): off mode power < 1W
  end of cycle mode power < 4W
- Stage 2 (2012): off mode power < 0,3W
  end of cycle mode power < 1W

where:

- off mode power = lowest power when connected to the mains. Limit is applicable to models which have an off mode;
- end of programme power = power consumed when the machine has ended the program or cycle, where the unit does not revert to off mode after a fixed period.

The strategy sets out a number of possible policy tools which were to be considered on a product by product basis as follows:

- Promotion of Energy Star
- Industry Codes of Conduct
- Publication of targets in Australian Standards
- Collection of data for new products

- Publication of standby data for products
- Inclusion of standby into the energy label for selected products
- Introduction of MEPS on standby for selected products
- Warning label for products with high standby.

Investigations regarding modes and the inclusion of standby power into the energy label have been concluded for dishwashers and washing machines and these were implemented in late 2005 with a transition period to April 2007. After this date all dishwashers and washing machines will have standby energy consumption included in the energy label value, which will also affect the product star rating.

The initially proposed algorithms for the calculation of the CEC (Comparative Energy Consumption) including standby for wash appliances was:

$$CEC = E_t \times C + [P_d \times 2 \times C + P_e \times 15 \times C + (8760 - T_c \times C - 2 \times C - 15 \times C) \times P_o]$$

where:

- E_t = the cycle energy consumption measured according to the AU/NZS Part 1 standard
- C = is the defined number of cycles per year, 365 for washing machines and dishwashers
- P_d = the measured power (in W) in the "delay start" mode, it is 0 where the appliance does not have a delay start function; the delay start mode is assumed 2 hours where present
- P_e = the measured power (in W) in the "end of programme" mode, it is 0 where the appliance does not have end of programme mode; end of programme mode is assumed for 15 hours when present
- P_o = measured power in off mode (W), for the remaining standby time after delay start and end of programme modes
- T_c = cycle time (in hours).

The value of CEC is in Wh and should be divided by 1000 for use on the energy label.

The proposal was subsequently modified, considering only an average of "off mode" and "end of cycle mode" for inclusion into the energy label CEC and deleting the "delay start mode" from the overall standby calculation, to avoid any penalisation of this mode, which was recognised to have a positive impact on the machine use by allowing the delay of the washing cycle to off-peak hours. In addition, the overall standby power is considered 100% the time in "off mode" where the "end of cycle" mode is not present (when products automatically revert to "off" after the end of cycle) [63]:

$$CEC = E_t \times C + [P_s \times (8760 - T_c \times C)]$$

where P_s = the average measured standby power, in Watts which is the average of end of cycle mode and off mode, (where this mode is present) where these have been determined in accordance with AS/NZS 2007.1:2005.
Again, the value of CEC is in Wh and should be divided by 1000 for use on the energy label.

Revised edition of AS/NZS 2040, Part 1 and Part 2 for washing machines were published in December 2005. The new standards include standby measurement, rinse performance test methods and registration requirements for mandatory water labelling. All products on the market will be required to register to the new standards by 1 April 2007.

[63] For sake of coherence, the shown algorithm is not the one eventually published in the standard, but is presented in the same form as the previous formula.

Revised edition of AS/NZS 2007, Part 1 and Part 2 for dishwashers were published in December 2005. The new standards include standby measurement and registration requirements for mandatory water labelling. All products on the market will require registration to the new standards by 1 April 2007.

1.3.3.2 USA (and Canada)

The US has both mandatory and voluntary policy measures for household appliances including dishwashers and washing machines.

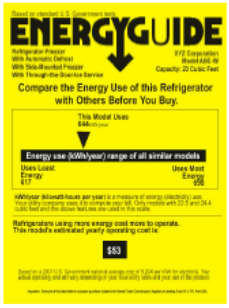
During the mid-1970s, several individual states in the United States had begun promulgating their own energy efficiency requirements. With the passage of the National Energy Policy and Conservation Act of 1978, Federal law in this area was given precedence over state laws - unless the Federal government determines that no efficiency requirements are warranted for a particular product, in which case states are then free to establish local requirements. The National Appliance Energy Conservation Act (NAECA) was signed into law in 1987 giving the US Department of Energy (DoE) the power to set federal standards for maximum energy consumption on household appliances. DoE currently imposes minimum efficiency requirements for 25 products including 15 used in the residential sector and manages the two US labelling schemes, the Energy Guide and the ENERGY STAR.
Since 2004, ten states (Arizona, California, Connecticut, Massachusetts, Maryland, New Jersey, New York, Oregon, Rhode Island, and Washington) have established new energy-saving requirements covering between 5 and 30 products, most through new state legislation. In August 2005, Congress took its cue from the states and made 15 of these state standards federal law through the "Energy Policy Act" of 2005. The new law includes two major energy efficiency provisions: it sets (1) manufacturer and consumer tax incentives for advanced energy-savings technologies and practices and (2) minimum energy efficiency requirements for 16 products, including household appliances and directs DoE to set requirements for several other products. The law also sets other provisions including the revision of the long lasting appliances labelling scheme.
Canada and Mexico adopted efficiency requirements identical or very similar to those set by the US DoE.

a) US Energy efficiency labelling programmes

The US has two primary federally funded labelling programmes for consumer products and appliances: "Energy Guide" and "ENERGY STAR". A comparison of the two schemes is presented in Table 1.18[64]

[64] Source: Ecos Consulting,, Policy Recommendations for Improving Energy-Efficiency Labeling in the United States, Report prepared for: National Commission on Energy Policy, October 2004.

Table 1.18: comparison of the Energy Guide and the Energy Star labelling schemes

	EnergyGuide	ENERGY STAR
Logo/Label		
Program type	Mandatory	Voluntary
Label type	Comparison (Continuous) – label compares the energy use of a given model to other similar models by providing a range (with a low-end and a high-end) of energy use of similar models	Endorsement – label indicates that product meets certain levels of performance.
Year Started	1980	1992
Responsible federal agency	FTC (labeling) and DOE (testing)	EPA and DOE[5]
Underlying legislation	Energy Policy and Conservation Act, 1975; National Energy Conservation Policy Act, 1979; FTC Appliance Labeling Rule, 1980	Voluntary government/industry partnership
Products covered	▪ Refrigerators ▪ Freezers ▪ Dishwashers ▪ Clothes washers ▪ Room air conditioners ▪ Water heaters ▪ Furnaces ▪ Boilers ▪ Central air conditions ▪ Heat pumps ▪ Pool heaters *Other products (e.g., lighting) are required to display energy-efficiency information directly on their product labels/packaging.	Products in more than 40 categories: ▪ Appliances (Clothes Washers, Dehumidifiers, Dishwashers, Refrigerators, Room Air Conditioners) ▪ Heating & Cooling (Air-source Heat Pumps, Boilers, Central AC, Ceiling Fans, Dehumidifiers, Furnaces, Geothermal Heat Pumps, Home Sealing (Insulation), Light Commercial, Programmable Thermostats, Room AC, Ventilating Fans) ▪ Home Electronics (Cordless Phones, Combination Units, DVD Products, Home Audio, Set-top Boxes, Televisions, VCRs) ▪ Lighting (Compact Fluorescent Lamps, Residential Light Fixtures, Ceiling Fans, Exit Signs, Traffic Signals) ▪ Office Equipment (Computers, Printers, Copiers, Faxes, Mailing Machines)

Note: the Energy Star logo has been modified in 2005.

a.1) The Energy Guide

Energy Guide is the second longest-running national energy efficiency-labelling program (after Canada's, which began in 1978). Its legislated goals are to improve energy efficiency and assist consumers in making purchase decisions.

It is a mandatory program run by the Federal Trade Commission and Department of Energy (DOE) in the framework of the FTC's Appliance Labeling Rule. Under the Rule, manufacturers must disclose specific energy consumption or efficiency information about their products at the point of sale in the form of an ''Energy Guide'' label affixed to each unit. The information on the Energy Guide label also must appear in catalogues and on internet sites from which covered products can be ordered. The FTC is responsible for the design, implementation and compliance of this program, the National Institute of Standards and Technology (NIST) is responsible for the test procedures.

The Rule directs manufacturers to derive the information from standard test methods issued by DOE. Required labels for appliances must also include a ''range of comparability'' (published by

the FTC) that shows the highest and lowest energy consumption or efficiencies for all similar appliance models, and intended to help consumers determine how a specific model compares to others available in the market. Labels for most appliances must provide the product's estimated annual operating cost, calculated by manufacturers using national average cost figures for energy (e.g., electricity, natural gas, etc.) published by DOE. For some products, such as dishwashers, the FTC has changed the applicable ranges several times over the last few years. When ranges are changed, manufacturers must amend their labels to reflect the new ranges and update the operating costs on the labels using a new national average cost of electricity.

The original Energy Guide label created in 1979 contained three energy-related information for most covered products:
(1) The estimated annual operating cost of the model,
(2) the range of operating costs for similar models displayed in the form of a bar graph
(3) a grid which provided the operating cost of the model at different energy costs.
In 1994, the FTC revised the label so that energy use or efficiency (as opposed to operating cost) appears as the primary descriptor on the label. The revised labels continued to display cost information (for most products), but the cost figures were moved to the bottom half of the label. As part of the 1994 review of the Rule, the FTC conducted consumer research and made certain format changes to the Energy Guide label as a result. These changes enhanced the appearance of the range and bar graph on the label in an effort to reduce consumer confusion. In 2000, the FTC issued an exemption allowing manufacturers to include the ''Energy Star'' logo on the Energy Guide label for covered appliances.

No systematic federal evaluation of the Energy Guide program or the efficacy of the current label design has been undertaken in the last 20 years. Small-scale studies and anecdotal evidence, as well as better results in other countries (in terms of consumer awareness, market impacts, and energy savings) suggest that improvements could be made to the Energy Guide program.

Two recommendations for the revision of the Energy Guide were made in 2004[65]:
- revise the current Energy Guide label format to increase clarity and usefulness, employing the categorical rankings that have been proven so effective internationally
- extend the Energy Guide label's coverage to a wider range of products.

The mentioned Energy Policy Act of 2005 directs FTC to review the effectiveness of its current Energy Guide label in assisting consumers in making purchasing decisions and improving energy efficiency and to make appropriate changes to the labelling rules (including categorical labelling) that would improve the effectiveness of consumer product labels. Currently FTC is preparing to conduct consumer research, the results of which will be used to propose amendments to the Energy Guide label. The regulatory review of the "Appliance Labeling Rule" had been scheduled for 2008.[66]

The Energy Guide label on **dishwashers** indicates how much electricity in kilowatt-hours (kWh) a particular model uses in one year. The program covers two dishwasher categories: compact capacity and standard capacity. The standby power consumption is included when calculating estimated annual energy use for all dishwashers.
The ranges of comparability for *standard dishwashers*, effective from 8 December 2004, are: *low energy consumption 176 kWh/year and high energy consumption 247 kWh/year*. Dishwasher

[65] Source: Ecos Consulting,, Policy Recommendations for Improving Energy-Efficiency Labeling in the United States, Report prepared for: National Commission on Energy Policy, October 2004.
[66] See: Federal Register / Vol. 70, No. 211 / Wednesday, November 2, 2005 / Proposed Rules.

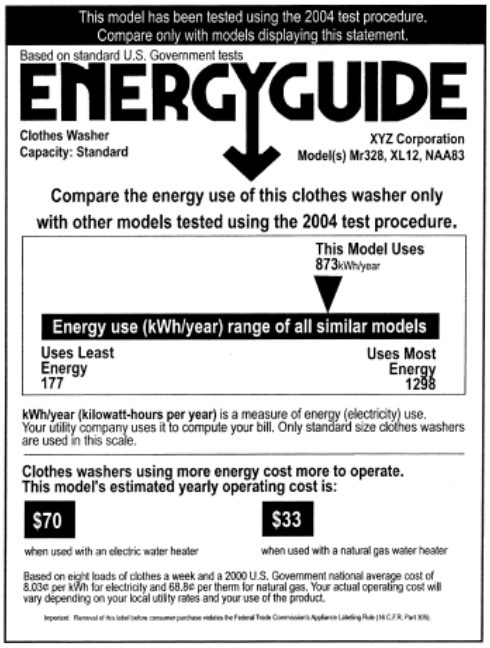
manufacturers must base the disclosures of estimated annual operating cost required at the bottom of EnergyGuide labels for dishwashers on the 2004 Representative Average Unit Costs of Energy for electricity (8,60 USD cents per kWh) and natural gas (91,0 cents per therm). These values were not changed in 2006.
The new ranges of comparability for *compact dishwashers*, effective from 23 January 2006 are: l*ow energy consumption 143 kWh/year and high energy consumption 320 kWh/year*. Compact dishwasher manufacturers must base the disclosures of estimated annual operating cost required at the bottom of Energy Guide labels for compact dishwashers on the 2005 Representative Average Unit Costs of Energy for electricity (9,06 USD cents per kWh) and natural gas ($1,09 per therm) that were published by DOE in March 2005.

The Energy Guide label on **washing machines** indicates how much electricity in kilowatt-hours (kWh) a particular model uses in one year. The program covers two machine categories: compact capacity and standard capacity, where ‘‘compact’’ includes all domestic washing machines washers with a tub capacity of less than 1,6 cu. ft. (45 litre).
On January 2006 required range of comparability for *compact washing machines* were amended[67] as: *low energy consumption 125 kWh/year and high energy consumption 462 kWh/year*. When the above range of comparability is used on Energy Guide labels for compact washing machines, the estimated annual operating cost disclosure appearing in the box at the bottom of the labels must be derived using the 2004 Representative Average Unit Costs for electricity (8,60 USD cent per kWh) and natural gas (91,0 USD cent per therm), and the text below the box must identify the costs as such.
The ranges of comparability for *standard washing machines*, have not been modified and the value in force since April 2005: low energy consumption 113 kWh/year and high energy consumption 680 kWh/year are currently valid. The Representative Average Unit Costs for electricity is the same as for the compact washing machines.

A black and white example of the label is shown in Figure 1.15. At the top of the Energy Guide label, there are the manufacturer name, model number, type of appliance, and capacity. In the middle, the label shows how a particular model compares in energy efficiency with other models on the market of comparable size and type. Using a line scale, the label indicates where the model falls within a range of most and least efficient units. Appliances such as refrigerators and dishwashers display annual energy consumption (e.g., kilowatt-hour/year). Central air conditioners and heat pumps list Seasonal Energy Efficiency Rating (SEER) or other similar efficiency measures. On the bottom of the label, an estimate of annual operating costs will appear for appliances that are rated by annual energy consumption. This estimate is based on the most recent national average of energy prices and assumes typical operating characteristics.

[67] See: Federal Register / Vol. 71, No. 20 / Tuesday, January 31, 2006 / Rules and Regulations.

Figure 1.15: Example (black and white) of Energy Guide for standard washing machines



a.2) The ENERGY STAR

ENERGY STAR, introduced in 1992, is a voluntary labelling program operated jointly by the Environmental Protection Agency (EPA) and Department of Energy (DOE). It is designed to reduce greenhouse gas emissions by identifying and promoting energy-efficient products. The program functions as a voluntary partnership between government and various businesses, including manufacturers and various trade allies like retailers, installers, utilities, and energy service companies. The programme logo has been updated in 2005 (Figure 1.16).

Figure 1.16: New US Energy Star logo



Labelled products receive preferential treatment in federal and state procurement processes and in various utility-funded incentive and marketing programs.

The Energy Star criteria for wash appliances are based on the federal NAECA appliance requirements.

Qualified **dishwashers** must have a minimum Energy Factor from 1st January 2007, expressed in cycles per kWh and is the reciprocal of the sum of the machine electrical energy per cycle plus the water heater energy consumption per cycle as described in the federal energy efficiency legislation. Qualified dishwashers use at least 41% less energy than the federal minimum standard for energy consumption. In detail criteria for dishwasher types are:

Product Type	**Federal EF**	**Energy Star EF**
Standard (≥ 8 place settings + six serving pieces)	≥ 0,46	≥ 0,65
Compact (< 8 place settings + six serving pieces)	≥ 0,62	≥ 0,88

Previous Energy Star criteria for residential dishwashers were in force since 1st January 2001 for standard dishwasher. Any product manufactured after January 1, 2007 must meet the new criteria efficiency levels to be designated as ENERGY STAR. Any product manufactured prior to January 1, 2007 may be labelled as ENERGY STAR at the factory and on the EnergyGuide label if the products meets the current or the January 1, 2007 ENERGY STAR criteria. Retailers will only be permitted to promote previous qualified products for the first three months of 2007.

Only standard sized (with a tub capacity larger than 1,6 ft^3 or 45 litre), front- or top-loading **washing machines** are eligible for the Energy Star clothes washer program. Qualified d machines must have a minimum Modified Energy Factor (MEF) of increasing from the current level of 1,42 to 1,72 plus a maximum water consumption factor (WF) of 8,0 according to Appendix J1 to Subpart B of Part 430 in Title 10 of the Code of Federal Regulations.

MEF is the quotient of the cubic foot capacity of the clothes container divided by the total clothes washer energy consumption per cycle, with such energy consumption expressed as the sum of the machine electrical energy consumption, the hot water energy consumption, and the energy required for removal of the remaining moisture in the wash load. The units are (ft^3/kWh/cycle). The higher the value, the more efficient the clothes washer. WF is the quotient of the total weighted per-cycle water consumption divided by the capacity of the clothes washer.

New qualifying levels for washing machines will be established not later than 1st January 2008, for clothes washers, effective beginning 1st January 2010.

b) The energy efficiency requirements

Efficiency requirements for **dishwashers** are described in the Code of Federal Regulations 10, Part 430, Subpart B of 2005, which adds standby energy consumption to the annual energy and cost calculation, but not to the energy factor calculation. Also, the average cycles per year has been lowered from 264 cycles per year to 215 cycles per year compared to the previous edition in 2001. The CFR defines the "dishwasher" a cabinet-like appliance that with the aid of water and detergent, washes, rinses, and dries (when a drying process is included) dishware, glassware, eating utensils, and cooking utensils by chemical, mechanical, or electrical means, and discharges to a plumbing drainage system.

The Energy Factor EF (in cycles/kWh) of consumer dishwashers must be not less than 0,62 for compact dishwashers and 0,46 for standard dishwashers, starting from 1st January 2004.

Energy efficiency requirements for residential **washing machines** are described in Code of Federal Regulations 10, Part 430, Subpart B of 2005, where the following appliance types are described:

- **Compact clothes washer**: a clothes washer which has a clothes container capacity of less than 45 litre (1,6 ft^3)
- **Standard clothes washer**: a clothes washer which has a clothes container capacity of 45 litre (1,6 ft^3) or greater

- **Front-loading clothes washer**: a clothes washer with the clothes container compartment access located on the front of the machine
- **Top-loading clothes washer**: clothes washer with the clothes container compartment access located on the top of the machine
- **Suds-saving**: a feature or option on a clothes washer which allows the user to store used wash water in an external laundry tub for use with subsequent wash loads.

The energy efficiency requirements for residential washing machines are described in Table 1.19. For top loading standard and compact washing machines and front loading washing machines the MEF Modified Energy Factor (in ft^3/kWh/cycle) must be higher than the value indicated in the Table

Table 1.19: Energy efficiency requirements for residential washing machines in USA in 2003-2007

Appliance	*Minimum Energy Factor [ft^3/(kWh/cycle)] Effective May 14, 1994 Through December 31, 2003*	*Minimum Modified Energy Factor [ft^3/(kWh/cycle)]**	
		Effective January 1, 2004	*Effective January 1, 2007*
Top-loading compact clothes washers	0.90	0.65	0.65
Top-loading standard clothes washers	1.18	1.04	1.26
Top-loading, semi-automatic	N/A[1]	N/A[1]	N/A[1]
Front-loading clothes washers	N/A[1]	1.04	1.26
Suds-saving	N/A[1]	N/A[1]	N/A[1]

[1]Must have an unheated rinse water option.

*The sum of the machine electrical energy consumption, the hot water energy consumption, and the energy required for removal of the remaining moisture in the wash load.

Top-loading semi-automatic and suds-saving washing machines do not need to meet the Modified Energy Factor standard but must have an unheated rinse water option. The MEF of a washing machine is the quotient of the ft^3 capacity of the clothes container divided by the total washing machine energy consumption per cycle, with such energy consumption expressed as the sum of the machine electrical energy consumption, the hot water energy consumption, and the energy required for removal of the remaining moisture in the wash load.

c) The 2006 Appliance Efficiency Regulations for California

The 2006 Appliance Efficiency Regulations, (California Code of Regulations, Title 20, Sections 1601 through 1608) dated December 2006, were adopted by the California Energy Commission on Oct 11, 2006, and approved by the California Office of Administrative Law on Dec 14, 2006.

The Appliance Efficiency Regulations replace all previous versions of the regulations[68] and include standards for both federally regulated appliances and non-federally-regulated appliances. Twenty-one categories of appliances are included in the scope of these regulations, including wash appliances: for dishwashers the federal requirements apply, for domestic washing machines the

[68]Downloadable at: http://www.energy.ca.gov/appliances/2006regulations/index.html .

federal requirements about energy efficiency apply, while for the water efficiency specific requirements have been set.

The WF Water Factor (in gallons per cubic foot) of washing machines must not be greater than the values shown in Table 1.20. The Water Factor is the quotient of the total weighted per-cycle water consumption divided by the capacity of the washing machine.

Table 1.20: Water efficiency requirements for washing machines in California in 2007 and 2010

Appliance	Maximum Water Factor (gallons/cubic foot)	
	effective 1st January 2007	effective 1st January 2010
Top loading	8,5	6,0
Front loading	8,5	6,0

d) The standby

Annual standby energy consumption for **dishwashers** and is calculated in kWh per year as:

$S = S_m \times (H_s/1000)$ and
$H_s = H - (N \times L)$

where:

- S_m = measured average standby power (in Watt) and
- H = the total number of hours per year, or 8.766
- N = the representative average dishwasher use of 215 cycle/year
- L = the average of the duration (in hours) of the normal washing cycle, measured for the different types of dishwashers addressed in the test procedure

In order to determine standby power usage, the energy use of each dishwasher in the Energy Star products database was calculated. Since EF (Energy Factor) is simply calculated by the average number of cycles per year (215) divided by kWh/year, the standby power can be calculated by finding any models where the kWh/year is above the range for each EF[69]. Of the 565 models in the Energy Star product database:

- 339 (or 60%) have some standby power usage, the other 40% of the models apparently have not;
- 148 models show standby power usage of less than 1 kWh/year
- 98 active models use more than one dollar per year in standby power (or 11,6 kWh/year assuming an electric rate of 8,6 cents per kWh).
- the highest standby power use is 25 kWh/year.

Since 60% of current qualified products use standby power and the trend for new products is to offer more features that will draw power in the standby mode, comments were required to stakeholders on the value of incorporating a standby power requirement into the new criteria for dishwashers. In addition, DoE is trying to determine whether it is preferable the (a) setting a

[69] For example, a dishwasher with an EF of 0,60 will have an average energy use of 358 kWh/year, but since EF is rounded to the hundredth, the model can have actual energy usages from 355 kWh/year to 361 kWh/year. Any energy use above 361 kWh/year must be standby power or the machine would have a lower EF.

maximum amount of standby power in terms of Watts or kWh/year or (b) setting the maximum total allowable Energy Star qualified product usage in terms of kWh/year instead of EF.

e) The tax incentives for manufacturers

The Energy Policy Act of 2005 offers incentives that promote the use of more efficient appliances. This legislation is expected to increase the market penetration of products meeting and exceeding the act's Energy Star criteria. The new legislation provides credits to the manufacturer for very efficient refrigerators, washing machines and dishwashers. The incentives are for products sold in 2006 and 2007, relative to *additional* sales by each manufacturer above the average of the previous three years (Table 1.21). This type of policy has the distinct advantage of minimizing the problem of free riders that would have purchased the new model in any case; and thus is more effective than such policies as rebate or reduction in value added taxes, which allow and pay for free riders.

For washing machines there is only one efficiency tier, a 100 USD credit for units meeting the 2007 Energy Star criteria. The same applies for dishwashers where the amount of credit is 3 USD for every percent beyond the Energy Star criteria in force in 2005.

All the appliance credits only apply to products produced in the USA, which could affect the foreign production plans of US manufacturers and also means that imported products are not eligible. There is also a total cap per manufacturer of 75 million USD, a figure some larger manufacturers may reach but the smaller manufacturers will not.

1.3.3.3 China

a) Appliance energy efficiency programmes

In 1980, there was little home appliance manufacturing in China: the total output of household refrigerators in that year was less than 50 000 units. By 2004, China's output of colour televisions, room air-conditioners, refrigerators, and clothes washers had each reached 73,3 million, 66,5 million, 30,3 million, and 23,5 million units, respectively. In early 1980s, it was rare to find major electric appliance in any Chinese households. By 2004, penetration levels have reached to 96% for clothes washers, 90% for refrigerators, and 70% for room air-conditioners, respectively, for 100 urban households.

In 1989, the former State Bureau of Technical Supervision (SBTS) issued the first set of standards related to energy efficiency. They included energy efficiency requirements for eight types of products: refrigerators, room air conditioners, clothes washers, television sets, automatic rice cookers, radio receivers, electric fans, and electric irons.

Since then, China has significantly expanded its efficiency requirement program, both covering more product categories and raising the stringency of the performance levels. At present, the Administration of Quality Supervision, Inspection, and Quarantine (AQSIQ) has succeeded SBTS as the requirements setting agency in China, with the China National Institute of Standardization (CNIS) providing much of the technical analyses in the development process.

Table 1.21: Summary of the Energy Efficiency Tax incentives in Energy Policy Act of 2005

Summary of Energy Efficiency Tax Incentives in Energy Policy Act of 2005

Product	Eligibility Level	Units	Amount of Incentive	Years Covered	Notes
Existing homes and other non-business applications					$500 per taxpayer cap for existing home credits
Central air conditioners (split systems)	15 12.5	SEER EER	$300 if meets SEER & EER	2006 & 2007	For list of qualified products, go to the Consortium for Energy Efficiency Product Directory-
Central air conditioners (package systems)	14 12	SEER EER	$300 if meets SEER & EER	2006 & 2007	www.ceehvacdirectory.org/continue.html Look for "Residential Tier 2" Air Conditioners
Heat Pumps (air cooled)	15 13 9.0	SEER EER HSPF	$300 if meets SEER, EER & HSPF	2006 & 2007	See CEE list (link noted above) for products that meet 15 SEER and 9 HSPF. There is no way to identify equipment that meets 13 EER without contacting manufacturer/distributor (or contractor).
Group-source heat pumps					All Energy Star labeled Geothermal Heat Pumps qualify for credit
Closed loop	14.1/3.3	EER/COP	$300	2006 & 2007	System must also provide water heating.
Open loop	16.2/3.6	EER/COP	$300	2006 & 2007	System must also provide water heating.
Direct expansion (DX)	15/3.5	EER/COP	$300	2006 & 2007	System must also provide water heating.
Water heaters (non-business applications)					See GAMA Web site for list of qualifying products:
Electric	2.0	EF	$300	2006 & 2007	www.gamanet.org/gama/inforesources.nsf/vContentEntries/Product+Directories?OpenDocument
Gas and oil	0.8	EF	$300		
Gas and oil furnaces and boilers					See GAMA Web site (link above) for list of qualifying products.
High combustion efficiency equipment	95%	AFUE	$150	2006 & 2007	Can earn either one or both incentive with the same unit.
High electric efficiency equipment	Meets CEE spec		$50	2006 & 2007	CEE spec requires electricity use to be <=2% of site use.
Envelope improvements to existing homes					
Insulation, exterior doors, duct sealing and infiltration reduction	Meet 2000/2003 IECC + supplements		10% up to $500	2006 & 2007	Includes duct sealing and infiltration reduction. All Energy Star windows and doors qualify for credits.
Windows and skylights	Same as above		10% up to $200	2006 & 2007	Credits cover cost of components only, and do not include
Pigmented metal roofs	Meet Energy Star spec		10% up to $500	2006 & 2007	costs of onsite prep, assembly or installation.
Appliances					All appliance incentives go to manufacturer, not consumer;
Refrigerators					manufacturers are expected to reduce prices accordingly.
Save 15-19.9% relative to federal standard	Look to left		$75	2006	
Save 20-24.9% relative to federal standard	Look to left		$125	2006 & 2007	
Save 25% or more relative to federal standard	Look to left		$175	2006 & 2007	
Clothes washers	1.72 MEF, 8.0 WF		$100	2006 & 2007	This is the 2007 Energy Star specification.
Dishwashers	2007 Energy Star		TBD -- based on final Energy Star	2006 & 2007	Incentive likely to be around $30.

Table 1.21: Summary of the Energy Efficiency Tax incentives in Energy Policy Act of 2005 (continued)

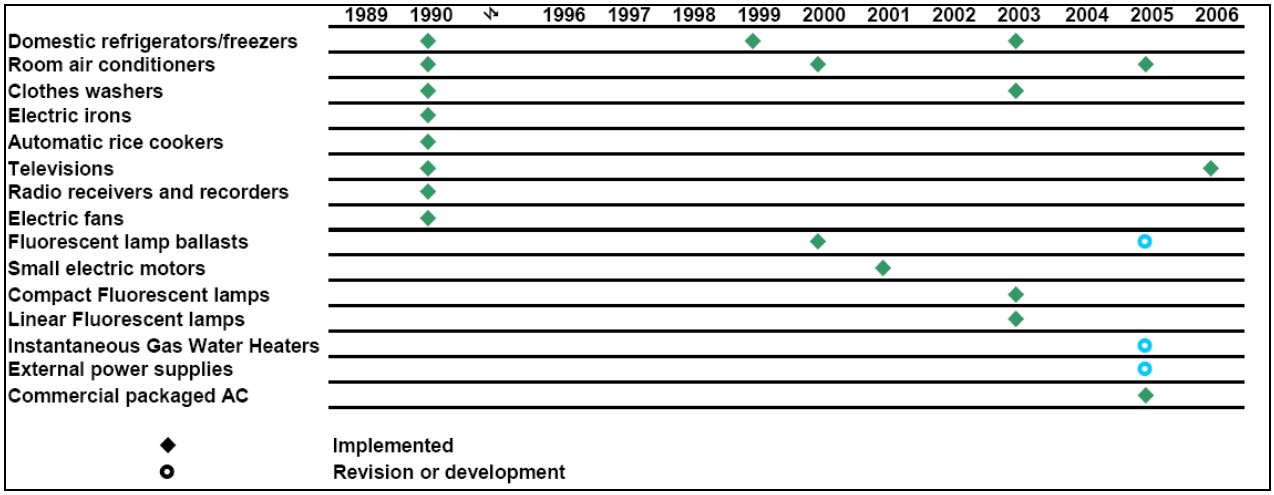
Summary of Energy Efficiency Tax Incentives in Energy Policy Act of 2005

Product	Eligibility Level	Units	Amount of Incentive	Years Covered	Notes
New homes					Incentives go to the builder, not the homebuyer.
Site-built or manufactured homes	50%	savings	$2,000	2006 & 2007	Savings relative to 2004 IECC.
Manufactured homes	30%	savings	$1,000	2006 & 2007	Savings relative to 2004 IECC.
	or meets Energy Star			2006 & 2007	
Commercial buildings					Max. is $0.60/sq.ft. per system or $1.80/sq.ft. for whole bldg.
Whole building	50%	savings	Deduction of $1.80/sq.ft.	2006 & 2007	Savings relative to ASHRAE 90.1-2001.
Lighting, HVAC or envelope	50%	savings	Deduction of $0.60/sq.ft. per system	2006 & 2007	Savings relative to ASHRAE 90.1-2001.
Lighting savings of at least 25%	25-50%	savings	Sliding scale: $.30/sq.ft. for 25% svgs	Unclear	Term of this provision depends on Treasury rulemaking.
Fuel cells and microturbines					
Fuel cells (business or individual credit)	30%	efficiency	30% up to $1000/kW	2006 & 2007	Systems >=0.5 kW for business credit. No size floor or efficiency requirements for individual credit.
Microturbines (only business credit)	26%	efficiency	10% up to $200/kW	2006 & 2007	Systems < 2000 kW.
Passenger vehicles	Complicated formula -- see http://aceee.org/press/0508hybridtaxcr.htm				
Heavy-duty vehicles	Complicated formula -- a description of the credit will be put on www.aceee.org shortly.				

Key: AC= air conditioner; AFUE= annual fuel utilization efficiency; ASHRAE = American Society of Heating, Refrigerating & Air-Conditioning Engineers; CEE = Consortium for Energy Efficiency
COP= coefficient of performance; EER= energy efficiency ratio; EF= energy factor; HP= heat pump; HSPF= heating season performance factor; IECC= International Energy Conservation Code
kW= kilowatt; MEF= modified energy factor; SEER= seasonal energy efficiency ratio; WF= water factor.

In 2004 (Table 1.22) China had minimum efficiency requirements for refrigerators and freezers, room air conditioners (windows and split types), TVs, fans, rice cookers, radios and audio receivers, fluorescent lamp ballasts, clothes washers, motors and irons. Requirements for external power supplies were under development. The first fuel efficiency requirements were enacted the same year.

Table 1.22: Summary of minimum efficiency requirements in China



The stringency of the requirements has also been raised: for example, the requirements for room air-conditioners has been raised in 2005 from a coefficient of performance (COP) of 2,2 to 2,6 in the most popular category (4 500 Watt and below); a further rise is due in 2009 as well[70].

China is one of relatively few countries that have both an endorsement label and an information label. In March 2005 a categorical energy information label was launched, aimed at assisting consumers with their purchasing decisions. The label classifies appliances into five efficiency categories, with level one being the most efficient, and level five set at the minimum efficiency requirements level. At the moment, the information label is only applied to refrigerators and room air-conditioners, and is likely to be extended to other appliances in the future. In addition, China Standard Certification Centre (CSC) runs since 1999 a voluntary endorsement label, granted to products that are certified to meet both quality assurance and energy performance specifications.

China's standards are mostly harmonised with ISO/IEC procedures.

b) Efficiency requirements for wash appliances

GB 12021.4-2004 includes the maximum allowable values of the energy consumption and Energy efficiency grade for household electric washing machines. The mandatory efficiency requirements covers all household electric washing machines (pulsator type and drum type) and spin dryer and are based on a maximum value of the energy consumption (in Wh) per kg of load, as shown in Table 1.23. The requirements are effective since 1st May 2005.

No efficiency requirements are set for dishwashers.

[70] Jiang Lin, LBNL - Environmental Energy Technologies Division, Mitigating Carbon Emissions: the Potential of Improving Efficiency of Household Appliances in China, July 2006.

Table 1.23: Minimum efficiency requirements for washing machines in China

Washing machine (type)	Machine technology	Maximum energy consumption (Wh/kg)
Pulsator type	Single-tub	24,0
	Twin-tub	28,0
	Half-automatic single-tub	29,0
	Half-automatic twin-tub	32,0
	Automatic	38,0
Drum type	Automatic without water heating	Not set
	Automatic with water heating	Not set
	Spin dryer	4,0

c) Voluntary endorsement label for energy efficiency

The State Economic and Trade Commission (SETC) and the China State Bureau of Quality and Technical Supervision (CSBTS) together established the China Certification Centre for Energy Conservation Product (CECP) to promote advanced energy conservation technology and the wide use of high efficiency products on October 1998. The first batch of energy efficient products were certified on April, 1999 and the first energy product certified on September, 1999. Products under this certification program now include 41 types of consumer appliances, including washing machines (but dishwashers are not covered) since November 2003, as well as selected industrial equipment. The criteria used for the associated endorsement label (Figure 1.17) were developed in parallel with the efficiency requirements, allowing any manufacturer to apply for efficiency certification and labelling if a model consumed 75% or less energy than the minimum requirements. The vast majority of Chinese product manufacturers have voluntarily decided to use the label since it can enhance the attractiveness of their products in the Chinese consumer marketplace.

Figure 1.17: Voluntary endorsement label for energy efficiency in China



d) Appliance noise limits

In 2005[71], a new appliance noise regulation "*Noise Limit Value for Household and Similar Electrical Appliances* went into effect in China on 1st August. Appliance manufacturers are required to mark the noise value on the product label or instruction booklet. Products that exceed the noise limits will not be allowed on the market. In addition, China intends to compulsorily withdrawn products that are already on the market. The Chinese government may start checking products on the market in the next several months.

The first phase impacts refrigerators, freezers, air conditioners, washing machines, microwave ovens, kitchen ventilation hoods and fans. For washing machines the noise limits are: wash 62 dBA,

[71] V. Han, China Implements Appliance Noise Standard, Appliance, October 2005, p.18

spin cycle 72dBA; microwave oven noise limits: 68 dBA. The new noise legislation has three aims: (i) to standardise the market and provide consumers with guidance; (ii) to control imports of appliances that do not meet noise regulations, specifically imported low-end products and second-hand appliances that could not previously be rejected for noise problems due to a lack of a standard ; and (iii) to increase the technical level of Chinese appliances by causing appliance makers to address relevant technical issues. China has had ongoing appliance noise issues for years, but they were never addressed because of the lack of noise standard. The new standard, designated *China National Standard GB4214.1*, was issued jointly by the China Quality Surveillance Examination Quarantine Bureau and the National Standardisation Management Committee.

1.3.3.4 Brazil

Brazil has developed voluntary efficiency requirements and two types of energy label: one is a comparative energy label, mandatory for some products and voluntary for others and grades the efficiency of appliances from A to G as in the EU, the other is a voluntary endorsement energy label. Labels are currently in place for room air conditioners, freezers, refrigerators and refrigerator-freezers, ballasts, clothes-washers and lamps. The Brazilian government also recently passed legislation allowing the imposition of mandatory efficiency requirements for a broad range of equipment and these are currently under development.

The Brazilian energy labelling program or PBE (*Programa Brasileiro de Etiquetagem*) started to address household appliances in mid '80s, as shown in Table 1.24.

The Brazilian Energy Conservation Program, PROCEL, is managed by Eletrobras, the Brazilian government holding of the power sector. PROCEL has granted the "*Stamp Procel de Economia de Energia*" annually, since 1993 (Figure 1.18). It is awarded to the electric equipment that is the most energy efficient in its category in the given year. Its duel purpose is to stimulate the national manufacture of more efficient products and guide the consumer to purchase the most efficient appliance.

Figure 1.18: The PROCEL Stamp Procel de Economia de Energia for appliances



Table 1.24: Brazilian INMETRO PBE, summary as per beginning 2004

	Product	Working Group Initiation Date	Specific Regulation	Standard-Type	Type of Label	Endorsement Label
1	Refrigerators	Nov-84	RESP-01	ISO	comparison	yes
2	Combined Refrigerators	Nov-84	RESP-01	ISO	comparison	yes
3	Vertical Freezers	Nov-84	RESP-01	ISO	comparison	yes
4	Horizontal Freezers	Nov-84	RESP-01	ISO	comparison	yes
5	Water Coolers	Mar-01			comparison	
6	Commercial Freezers	Mar-01			comparison	
7	Commercial Refrigerators	Aug-03	RESP-01	ISO	comparison	
8	Electric Instant Showers-Chuveiros	May-92	RESP-02	NBR/IEC	comparison	
9	Electric faucets *(torneiras)*	May-92	RESP-02	NBR/IEC	comparison	
10	Instant Water Heaters (Passagem)	May-92	RESP-02	NBR/IEC	comparison	
11	Storage Water Heaters	Dec-03		NBR/IEC	comparison	
12	Hybrid Storage Water Heaters	Dec-03		NBR/IEC	comparison	
13	Hidro. Heaters	May-92	RESP-02	NBR/IEC	comparison	
14	Intelligent Instant Water Heater -Chuvei	Sep-98			comparison	
15	Room Air Conditioner (domestic)	Oct-00	RESP-03	NBR	comparison	yes
16	Split Air Conditioner	Jun-00	RESP-03		comparison	
17	Electric Motors - Tri-Phase	Aug-92	RESP-04	NBR	approval	yes
18	Electric Motors - one phase	Sep-98			approval	
19	Centrifugal Pumps	Jul-01				
20	Washing Machine	Jul-95	RESP-05	IEC	comparison	
21	Centrifugas Machine	Aug-04			comparison	
22	Dryer				comparison	
23	Dishwasher				comparison	
24	Flat panel solar collectors - bathroom	Mar-96	RESP-06	NBR/ASTM	comparison	yes
25	Flat panel solar collectors - pool	Mar-96	RESP-06	NBR/ASTM	comparison	yes
26	Termicos Reservatorio	Oct-00	RESP-06	NBR/ISO/IEC	approval	yes
27	Acoplados Coletores	Oct-00	RESP-06	ISO	comparison	yes
28	Installation Project	Mar-00			approval	
29	Installation Approved				approval	
30	Compact Fluorescent Lamps	May-99	PROCEL 01	NBR	approval	yes
31	Incandescent Lamps	Sep-99	RESP-07	NBR	comparison	
32	Decorative Incandescent Lamps	Jan-02	RESP-07		comparison	
33	Dicroicas Lamps	Jan-02	RESP-07		comparison	
34	Flourescent Tube Lamps				comparison	
35	Sodium Vapor Lamps				comparison	
36	Electromagnetic Reactors	Apr-00	RESP-11		approval	
37	Electrical Reactors	Apr-00			approval	
38	Magnetic p/Sodium Reactors	Apr-00	RESP-10		approval	
39	Public Lighting fixtures w/components					
40	Fixtures and components					
41	Residential Gas Stoves	Apr-01	RESP-08	NBR	comparison	
42	Residential Gas Furnace	Apr-01	RESP-08	NBR	comparison	
43	Heaters - Passagem	Apr-01	RESP-09		comparison	
44	Storage Heaters	Apr-01	RESP-09		comparison	
45	Transformers	Aug-04				
46	Vehicle Emissions	Mar-81	IBAMA	NBR	approval	
47	Vehicle Consumption	Mar-81				
48	Microwaves	Aug-01	RESP-12		comparison	
49	Electrics Stoves				comparison	
50	Electric Ovens				comparison	
51	Photovoltaic Panels	Dec-02	RESP-13	ISO	comparison	
52	Photovoltaic Storage Devices	Dec-02	RESP-13	NBR	approval	
53	Inversores CC/CA	Dec-02	RESP-13	IEC	approval	
54	Load Controlers	Dec-02	RESP-13	IEC	approval	
55	Photovoltaic Energy Systems	Dec-02	RESP-13		approval	
56	Wind Energy Systems	Jul-03	RESP-13	ISO	approval	
57	Solar Exhaust	Dec-03	RESP-13	ISO	approval	
58	Televisions		RESP-13		stand-by	
59	Monitors		RESP-13		stand-by	
60	Ventilator *de teto*		RESP-13		comparison	
61	Industrial Ventilators					
62	Tire Compresors - Pneumaticos					

products with labels (25)
products that already have working groups initiated (22)
proposed labels/programs (15)

a) Energy labelling for washing machines

INMETRO (Instituto Nacional de Metrologia, Normalizao e Qualidade Industria) and

Procel/Eletrobras have jointly launched on September 2005, in Sao Paulo, the PBE scheme for washing machines. Requirements are described in the "*Regulamento Específico para Uso da Etiqueta Nacional de Conservação de Energia – Ence: Edição nº 01 - Revisão 01 - Máquinas de Lavar Roupa*". The reference standards is IEC 60456. The labelling is mandatory since 1st January 2006. The label is shown in Figure 1.19.

Figure 1.19: PBE label for automatic washing machines in Brazil



The energy efficiency and the spinning performance are respectively expressed in kWh per kg of load and as percentage of residual moisture and classified in an scale with 5 classes only, from A to E. The energy efficiency for the warm wash and for the cold wash for automatic and semi-automatic machines and the spinning performance are expressed in kWh/cycle/kg load in Table 1.25

Table 1.25: Warm and cold wash for the washing machine labelling in Brazil

Classes	Warm wash	Cold wash		Spinning performance
		automatic	semi-automatic	
	(kWh/cycle/kg)			(%)
A	0,190	0,031	0,019	60
B	0,230	0,035	0,022	68
C	0,270	0,039	0,025	76
D	0,310	0,043	0,028	84
E	0,350	0,047	0,031	94

The washing performance is expressed as a continuous scale (Figure 1.20) between a minimum and a maximum values (Table 1.26) and where the position of the specific machine is indicated by an arrow. The scale is defined for the three types of machines: with heating, automatic without heating and semi-automatic with specific values for the more performing and less performing models.

Figure 1.20: washing performance scale for automatic washing machines without heating

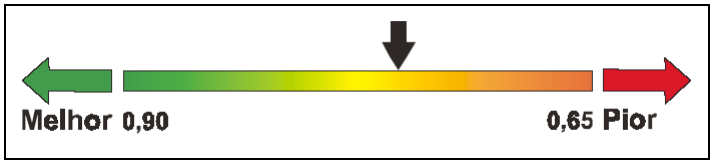


Table 1.26: Warm and cold wash for the washing machine labelling in Brazil

Washing machine types	Better	Worse
automatic with heating	1,00	0,65
automatic without heating	0,90	0,65
semi-automatic	0,80	0,55

The program is conducted by PROCEL (*Programa Nacional de Conservacao de Energia Electrica*), the national energy efficiency program and the government agency INMETRO (*Instituto Nacional de Metrologia, Normalizacao e Qualidade Industrial*) which is responsible for verifying the manufacturers data. Class A models can also bear the PROCEL endorsement label (Figure 1.18).

1.3.3.5 Other countries

The **Korean** government set both minimum efficiency requirements and a more stringent "target energy performance requirements". The former establishes the bottom (a rating of 5) of Korea's mandatory comparative energy labels, and the latter value (a rating of 1) the top. When minimum efficiency requirements are revised upwards (typically every three to five years) also the targets are. In 2005 Korea also announced mandatory 1 Watt targets for a wide range of products[72].

Russia first implemented minimum efficiency requirements in 1983 and between then and 1991 introduced regulations for room and other types of air conditioners, audio signal amplifiers, computers, dishwashers, refrigerators, refrigerator-freezers, freezers, graphical input devices, monitors, printers, ranges & ovens, TVs and electric water heaters. Most of these standards have not been updated and hence have since become largely obsolete; however, in 2001 Russia passed a general law allowing the issuing of efficiency requirements and labels for a large range of appliance types.

Other countries: a summary and description of mandatory and voluntary policy measures for cold appliances worldwide can be also found at:

- Energy Labelling and Standards Programs Throughout the World, NAEEEC Report 2004/04[73];

[72] Standby Korea 2010: Korea's 1-Watt Plan, Korea Energy Management Corporation and Ministry of Commerce, Industry and Energy, Korea. See: www.mocie.go.kr and www.kemco.or.kr .

[73] See document L. Harrington, Energy Efficient Strategies, Australia, "Energy Labelling and Standards Programs Throughout the World", NAEEEC Report 2004/04. Downloadable from www.energyrating.gov.au/library /publications2004.html .

- CLASP (Collaborative Labeling and Appliance Standards Programme)[74];
- APEC (Asia-Pacific Economic Cooperation) energy standards information system (ESIS)[75].

1.3.3.6 Seal-of-approval and other voluntary environmental labels worldwide

A part from the EU eco-label award scheme, seal-of-approval labels[76] are voluntary and selective, and are awarded only to products that meet relatively strict environmental requirements, including requirements related to energy performance. Many of these labels are administered by governments and are closely co-ordinated with their corresponding mandatory energy labelling programmes. Examples include the China "Great Wall" energy certification label, India "Ecomark" scheme, Korea "Energy Boy" label, Singapore "Green Labelling Scheme", Chinese Taipei "Greenmark", and the USA "ENERGY STAR" programme. In addition there are several voluntary labelling schemes administered by non-profit organisations, such as Japan "Eco Mark" scheme, Korea "Energy winner", the USA "Green Seal" and Thailand "Green Labelling Scheme". Canada third-party multi-criteria "Environmental ChoiceM Programme" is owned by the Federal Government and licensed to a "for profit" organisation to administer. In Australia and Thailand, associations of respectively gas and electric utilities sponsor their own voluntary energy-labelling schemes.

1.3.4 The RoHS and the WEEE directives in Europe and worldwide

In the past five years, the EU has developed and adopted major electric and electronic equipment directives, which member states will begin to implement during 2007. The WEEE and the RoHS directives require electric/electronic equipments manufacturers to offer free disposal of consumers' used equipment and also to prohibit the export of hazardous waste to developing countries for disposal. The rules affect a list of 10 product categories including household appliances, toys, computers and many more. Meanwhile, the just approved REACH regulation on chemical safety will introduce requirements for importers of products and for information flow in the supply chain (the description of the REACH regulation is out of the scope of the present study).

The United Nations Environment Programme estimates that the world's population discards 20 to 50 million tons of electrical and electronic waste each year and predicts the amount will increase by 3% to 5% each year. Much of that waste ends up in China.

1.3.4.1 The RoHS and WEEE directives provisions

Directives on Waste Electrical and Electronic Equipment (WEEE), 2002/96/EC, aims to prevent WEEE arising, to encourage reuse, recycling and recovery of WEEE and to improve the environmental performance of all operators involved in the lifecycle of electrical and electronic equipment, especially those dealing with waste management. The directive sets requirements relating to criteria for the collection, treatment, recycling and recovery of WEEE and makes

[74] See: www.clasponline.org/main.php .
[75] See: www.apec-esis.org/home.php .
[76] Source: R. Steenblik, S. Vaughan, P. Waide, Can Energy-Efficient Electrical Appliances be considered "Environmental Goods"? OECD Trade and Environment, Working Paper No. 2006-04.

producers responsible for financing most of these activities. Retailers/distributors also have responsibilities in terms of the take-back of WEEE and the provision of certain information[77].

The main requirements and obligations were scheduled to become mandatory from 13 August 2005 onwards and some specific actions, e.g. producer registration and reporting of data on equipment placed on the market, were scheduled to be started from January 2005 onwards. However, many EU Member States have encountered major practical difficulties in meeting the directive's legal deadline of 13 August 2005 for implementation of their obligations on producers and retailers. Before the WEEE Directive came into force several European countries (e.g. Belgium, the Netherlands, Sweden and Denmark as well as Norway and Switzerland) defined national regulations and organised management schemes for WEEE. These systems respond to sometimes very different national situations and philosophies. Some of these countries will have to adapt their national laws when implementing the WEEE Directive. Other countries that have not developed any management systems are developing new ones in order to comply with the Directive.

The key aims of the WEEE Directive are:

- reduce WEEE disposal to landfill;
- provide for a free producer take-back scheme for consumers of end-of-life equipment from 13 August 2005;
- improve product design with a view to both preventing WEEE and to increasing its recoverability, reusability and/or recyclability;
- achieve targets for recovery, reuse and recycling of different classes of WEEE;
- provide for the establishment of collection facilities and separate collection systems of WEEE from private households;
- provide for the establishment and financing of systems for the recovery and treatment of WEEE, by producers including provisions for placing financial guarantees on new products placed on the market.

The WEEE directive covers a list of 10 product categories:

1. Large household appliances (refrigerators, washing machines, stoves)
2. Small household appliances (vacuum cleaners, toasters, hair dryers)
3. Information and telecommunications equipment (computers and peripherals, cell phones, calculators)
4. Consumer equipment (radios, TVs, stereos)
5. Lighting (fluorescent lamps, sodium lamps)
6. Electrical and electronic tools (drills, saws, sewing machines)
7. Toys, leisure, and sports equipment (electric trains, video games)
8. Medical devices (ventilators, cardiology and radiology equipment)
9. Monitoring instruments (smoke detectors, thermostats, control panels)
10. Automatic dispensers (appliances that deliver hot drinks etc).

Producers are responsible for the costs of picking up waste electrical and electronic equipment from collection facilities and for refurbishing waste products for reuse or for recycling and recovery. For "historical" products (i.e., those put on the market before August 13, 2005), the costs of waste management are to be shared by all producers in existence at the time those costs are incurred. These producers may impose a separate "visible fee" (one that is explicitly designated) to cover these costs for eight years (ten years for large household appliances). End users other than households may be made partly or totally responsible for financing the management of historical

[77] Source: EC, DG-JRC, Institute for Prospective Technological Studies, "Implementation of the Waste Electric and Electronic Equipment Directive in the EU", EUR 22231 EN, 2006.

products. For new products (i.e., those put on the market after August 13, 2005), producers have "individual responsibility." That is, they must pay the cost of managing their own products. They can do this through programs set up by individual companies or through participation in collective schemes. No visible fees are permitted to fund the management of waste from new electrical and electronic products. When producers put a new product on the market, they must provide a financial "guarantee" that waste management of the product will be paid for. Producers can make good on this guarantee by participating in a producer responsibility organization (PRO), paying recycling insurance, or setting up a special bank account for this purpose.

Every "new" product must bear a label that verifies that it was put on the market after August 13, 2005, verifies that it will be separately collected, and bears the name of the producer according to an EU standard. Producers must provide information to consumers on the collection systems available and on the environmental and health impacts of hazardous substances contained in waste electrical and electronic products. Producers must also provide information to facilitate the environmentally sound reuse, recycling, and treatment of waste electrical and electronic products. Such information includes the identity of components and materials and the location of dangerous substances inside a product.

Member States must establish a register of producers and collect annual information on the amounts of electrical and electronic equipment that are put on the market, collected, reused, recycled, and recovered. They must transmit this information to the EU Commission every two years according to an established a standard format for the reporting. The first set of information will cover the years 2005 and 2006. Member States must establish inspection and monitoring systems and impose effective penalties for lack of compliance. The recovery and recycling targets to be met by EU Member States (excluding those who have received derogation[78]) at 31 December 2006 is outlined in Table 1.27. It should be noted that for medical equipment the target will be established by the end of 2008.

Table 1.27: Targets for recovery and reuse/recycling, by weight at 31 December 2006

Product category	Recovery target (%)	Recycling target (%)
Large household appliances	80	75
Small household appliances	70	50
Information and telecoms	75	65
Consumer equipment	75	65
Lighting	70	50
Tools	70	50
Toys, Leisure, Sports	70	50
Medical Equipment	n.a.	n.a.
Monitoring instruments	70	50
Dispensers	80	75

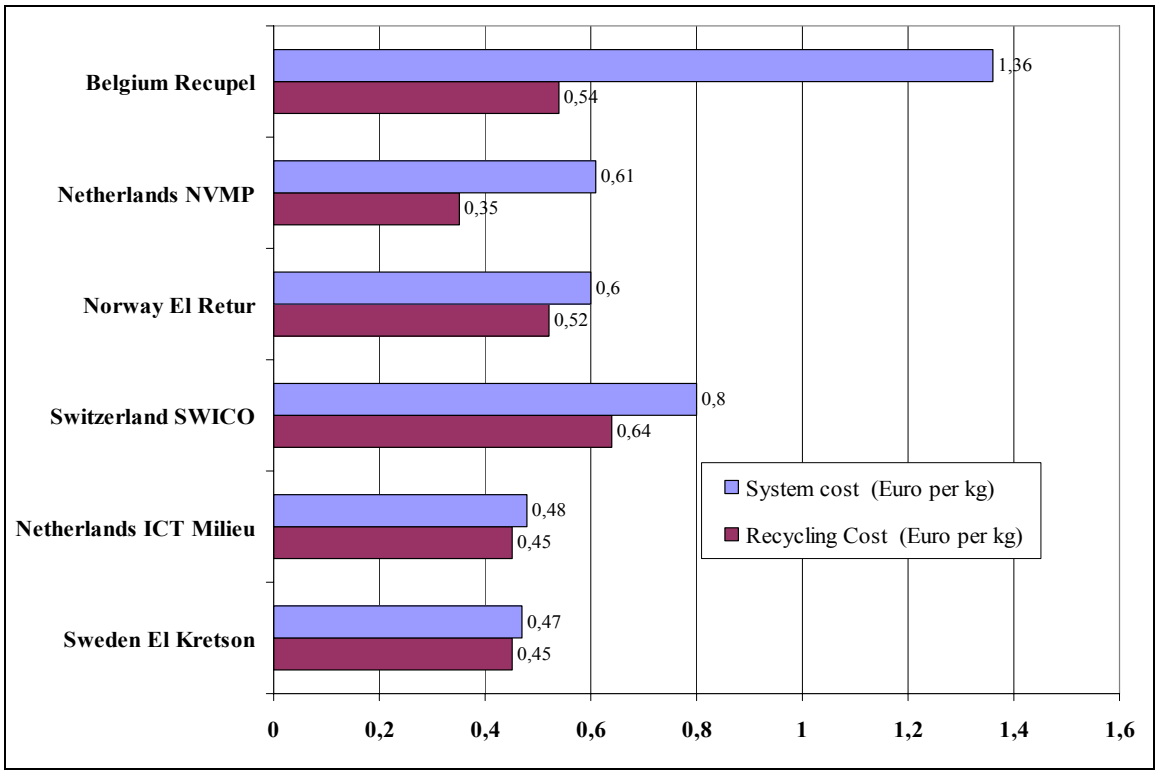
There are two clear generic categories of national organisation, the "national collective system" (monopoly) and the competitive "clearing house system". National legislators as well as producers have different views on the preferred system: some support the laws of the competitive market while others see the benefits of managing risk collectively. There are advantages and disadvantages with both systems. National collective schemes properly managed are considered by many stakeholders as providing the simplest and most effective route to collecting and recycling WEEE.

[78] Greece, Ireland and Slovenia had a 12-month extension, Cyprus, Czech Republic, Estonia, Hungary, Malta, Latvia, Lithuania, Poland and Slovakia has a 24-month extension.

Additionally, collective systems as run in the Netherlands, Belgium and Sweden are "tried and tested" and represent the only approach that has so far been shown to work in practice. The clearing house model, on the other hand, lacks experience and data to make good analyses and comparisons with existing collective schemes. Before the WEEE Directive came into force several European countries (e.g. Belgium, the Netherlands, Sweden and Denmark as well as Norway and Switzerland) defined national regulations and organised management schemes for WEEE.

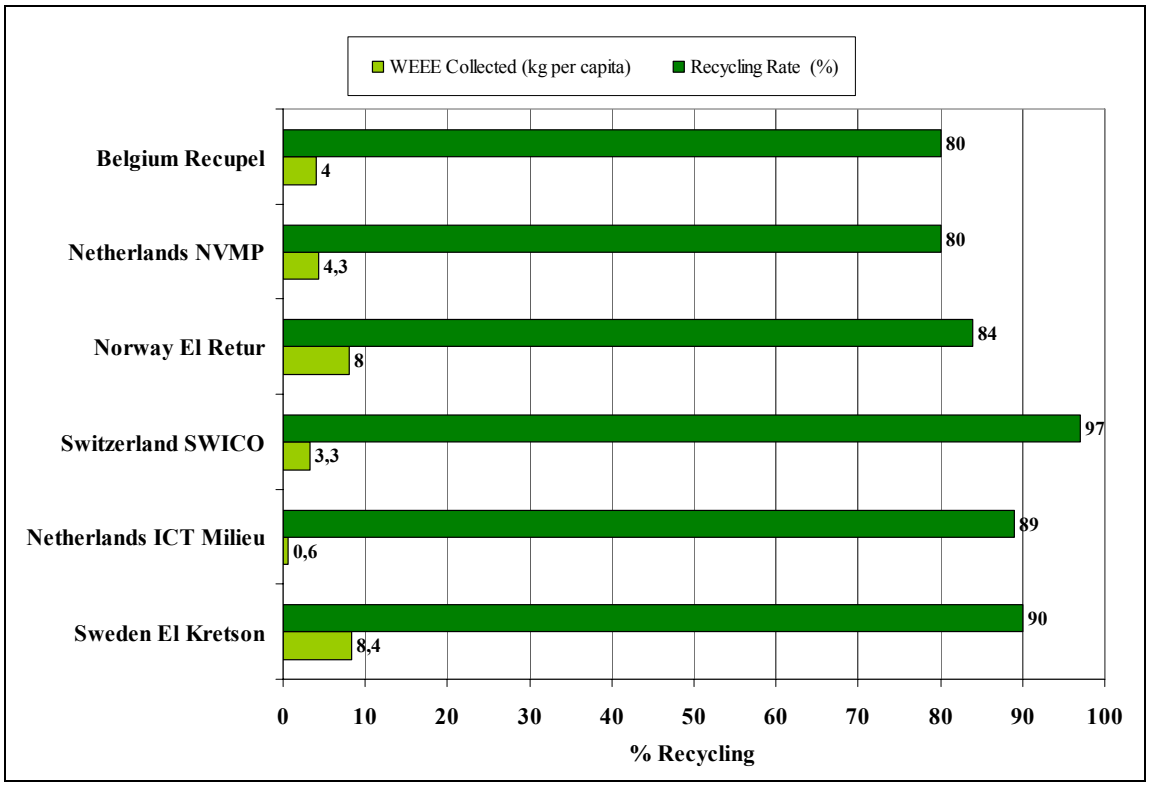
In Figures 1.21-1.22 the costs and the recycling rates of the existing systems in Belgium, Netherlands, Norway, Sweden and Switzerland are compared[79].

Figure 1.21: Economic costs of existing disposal systems for electric and electronic equipment



[79] Source: M. Dempsey , The WEEE Directive: The UK Experience, APSWG, 2006.

Figure 1.22: Recycling rates of existing disposal systems for electric and electronic equipment



These systems respond to sometimes very different national situations and philosophies. Some of these countries will have to adapt their national laws when implementing the WEEE Directive. Other countries that have not developed any management systems are developing new ones in order to comply with the Directive. The clearing house model is the preferred industry route where the market is large and the potential cost savings are substantial. For smaller markets, including those countries with existing schemes, the benefits of market mechanisms are not big enough to outweigh the greater simplicity of structure and financing of collective models.

The development of legislation and compliance structures for the WEEE directive is an ongoing process in all EU countries. The final national legislative and operational situation was defined by the end of 2006 but its effectiveness will remain unclear for a considerable period of time. The interaction and overlap with other areas of legislation, e.g. hazardous waste regulations, transfrontier shipment regulations, health and safety related marking etc., may have delayed the process of transposition and development of national legislation. In addition, where countries experience significant cross-border trade and imports, the efforts devoted to coordinate the implementation of the legislation between neighbouring countries and the tendency to resist first-mover disadvantage, have caused further delay.

While legislators in Member States have spent considerable time studying the legal and operational approach in those countries with established WEEE schemes, all have indicated the importance of building systems that meet local specifics of culture, geography and industry, and that take into account existing practices of waste collection.

Cooperation between Member States is already taking place. In the WEEE technical committee, discussions are on-going regarding whether details provided by producers for registers can be harmonised (i.e. the same type of information for all registers). Work is also being done at the European level on financial guarantees and how they will work. The quality of recycling facilities

will be another area for cooperation. Recycling may be concentrated at a few facilities for the whole EU.

The Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive (2002/95/EC) affects manufacturers, sellers, distributors and recyclers of electrical and electronic equipment containing lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls or polybrominated diphenyl ethers. The RoHS directive covers the same scope as the WEEE Directive except for medical devices and monitoring and control instruments. It also applies to electric light bulbs and light fittings in households. It aims to protect human health and the environment by restricting the use of certain hazardous substances in new equipment and to complement the WEEE Directive.
From 1 July 2006, producers of new electrical and electronic equipment must demonstrate that their products do not contain more than the maximum permitted levels of:

- lead, including lead/tin solder,
- mercury,
- cadmium,
- hexavalent chromium,
- polybrominated biphenyls (PBBs) or
- polybrominated diphenyl ethers (PBDEs).

These substances must be replaced by other substances. Certain applications are exempt from the requirements of the directive, including mercury in certain types of fluorescent lamps, lead in the glass of cathode ray tubes, electronic components and fluorescent tubes, lead in electronic ceramic parts, lead in certain types of solder and hexavalent chromium as an anti-corrosion treatment of the carbon steel cooling system in absorption refrigerators. The exemptions will be reviewed every four years.

1.3.4.2 The WEEE directive implementation worldwide, a comparison

The exact nature of national WEEE legislation, in terms of elements such as the scope of products covered and the range of instruments used, varies from country to country. For example, the political culture in some countries or regions might mean that extensive market intervention is regarded as a viable and desirable policy alternative whereas legislation in other areas might be more heavily influenced by a value system that promotes deregulation. The EU, China, and to a lesser extent Japan might be characterised by the former, while Australia, Canada and the US prefer to develop initiatives at a state or regional level, on a voluntary basis where possible, and to avoid legislative solutions, considered to have a lower impact upon economic competitiveness.

Australia[80]: Activity in Australia remains voluntary. The main electrical and electronic industry associations are developing voluntary product stewardship initiatives. The Australian, State and Territory Governments are working with industry to develop product stewardship schemes for televisions and computers, primarily because of the CRT which contains large quantities of lead. Once schemes have been developed for these products, these may serve as models for a broader range of products. With the support of major television manufacturers, state environment ministers in Australia are considering a plan to impose an 18,75 USD recycling fee on the sale of new TVs. The collected funds would be used to develop and operate a nationwide recycling scheme.

[80] Source: US DoE, TECHNICAL REPORT: Analysis of Amended Energy Conservation Standards for Residential Refrigerator-Freezers, October 2005.

Canada[81,82]: at the national level, the Canadian Council of Ministers of the Environment (CCME) adopted landmark national stewardship principles for electronics products in June 2004. The principles are intended to provide a framework to help develop and deliver WEEE programmes in each Canadian province and territory and also to ensure harmonisation of key elements that are necessary for balancing environmental and economic considerations. In October 2004 Alberta started its WEEE management scheme, the first regulated electronics recycling programme in the country. The initial phase includes computer monitors, laptops and notebook computers, CPUs (including keyboards, cables, speakers), printers and televisions, and more products may be added later. Since 1st February 2005 retailers have applied a visible fee to those products, ranging from C$5 for laptops/electronic notebooks to C$45 for televisions. Under the Ontario Waste Diversion Act of 2002, the government of the province of Ontario has recently requested the development of a waste diversion program for WEEE materials, including refrigerators. Although the process for WEEE recovery and required recovery rates have yet to be established, it also requires manufacturers to take responsibility for diversion of WEEE. A study was completed mid-2005 including recommendations on the adequacy of a year-long timeline for developing the program with a launch possible in 2007.

China[83]: the State Development and Reform Commission (SDRC) drafted the "Management Regulations on the Recycling of Used Household Electronic Products and Electronic Products" in 2004 using the Chinese translation of the EU 2002/96/EC directive as a key reference document. The State Council issued the so called "China WEEE" in late 2005. Its objective was to regulate the recycling and treatment of waste and used household electrical and electronic appliances and promoting resource recycling and reuse, environmental protection and human health. China WEEE would initially cover the following product categories: televisions, washing machines, refrigerators, air conditioners and computers. The Regulations focuses on household products and computer related and only covers product disposal. Household appliance producers are responsible for: adopting product design favourable to recycling and reuse, selecting non-hazardous and non-toxic materials and substances, and materials favourable to recycling and reuse, and providing major components and other information in the instruction manual. They must also undertake their own treatment of waste and used household appliances or entrust this treatment to qualified treatment enterprises and provide the provincial authorities with information on the categories, quantities, sales volumes and export volumes of the household appliances they produce. Issues of financing and producer responsibility remain poorly defined and the recycling system is largely unorganised. In 2004, China's State Development Reform Commission announced that Zhejiang province and the city of Qingdao would be the first two locations in the country to set up recycling systems for scrap electronics. China's top state-owned electronics manufacturers Haier and Hisense are located in Qingdao, while Zhejiang is an affluent province that is thought to have a high diffusion of electronics. Large enterprises and volunteer environmentalists are also involved in the recycling of electrical and electronic wastes, mainly mobile phones with their batteries and other accessories. Meanwhile, the country's largest electrical and electronic waste disposal plant using non-polluting processes - the Citiraya Environment Industry - is already under construction in Wuxi of Jiangsu Province, at a cost of 65 million USD. When the first phase of the project is completed, it will have the capacity to dispose of 30.000 tons of electrical and electronic wastes annually. This capacity will eventually be raised to 60.000 tons per year.

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[81] Source: EC, DG-JRC, Institute for Prospective Technological Studies, "Implementation of the Waste Electric and Electronic Equipment Directive in the EU", EUR 22231 EN, 2006.
[82] Source: US DoE, TECHNICAL REPORT: Analysis of Amended Energy Conservation Standards for Residential Refrigerator-Freezers, October 2005.
[83] Source: EC, DG-JRC, Institute for Prospective Technological Studies, "Implementation of the Waste Electric and Electronic Equipment Directive in the EU", EUR 22231 EN, 2006.

Japan[84]: the Japanese Home Appliance Recycling Law, enacted in 1998 and fully enforceable in 2001, requires industry to establish a recovery and recycling system for used products. The law allows for financing through end-user fees and the collection of used products by municipalities and retailers. The law initially covered 4 products (televisions, air conditioners, refrigerators, and washing machines) as obligatory items, but was extended to electronic products such as personal computers and copiers on a voluntary basis. The recycling goals contained in the law are lower than those of the WEEE directive and they do not escalate over time. Japanese legislation tends to follow EU legislation (thereby ensuring conformity and enabling exports to Europe), but whereas the EU uses environmental legislation, Japan often uses advanced technical specifications to achieve the same objective. Manufacturers are obligated to finance the recycling of their own products and every time they sell a new product, they must take back from the consumer either a similar used product or some other product that they sold in the past. The level of fees in Japan tends to be slightly higher than those in the EU. However, Japan's law does impose specific obligations on individual producers which have individual responsibility for their own products. The end-of-life fee financing system, while effective in meeting the law's recycling goals, has proven to be very expensive for individual consumers (18-24 Euro for TVs, 30-38 Euro for refrigerators and 16-22 Euro for washing machines) and for the system as a whole, since the law provides few incentives to pursue a more efficient model.
Japanese government estimates that the four product categories targeted by the law account for 80% by weight of all discarded electrical and electronic equipment.

New Zealand[85]: *The New Zealand Waste Strategy* sets out the proposed long-term approach to reducing waste, improving recycling and reuse of waste materials, and better management of residual waste. Released in 2002 in partnership with Local Government New Zealand, the strategy sets the overarching strategic direction of solid, liquid, gaseous and hazardous wastes in New Zealand. The Waste Strategy signalled the Ministry for the Environment's preference for product stewardship solutions for the country's waste problems. For some wastes, a product stewardship regime can be an extremely effective solution. The volume or toxicity of certain wastes can be cut significantly by steps taken throughout the product's life cycle, from manufacture through to disposal. The New Zealand approach to product stewardship is set out in the discussion document *Product Stewardship and Water Efficiency Labelling* released last year. It outlines product stewardship options to deal with wastes that are particularly hard to manage or dispose of, such as electronic waste, end-of-life vehicles, used oil. The preferred option is voluntary agreements by industry, with legislation as a backstop only if required. The discussion document can be found on the Ministry for the Environment's website[86], where a summary of the submissions on it are also available[87].

USA[88]: WEEE management varies from state to state within the USA and is focused on electronic wastes such as CRT. At the national level the EPA is active in shaping WEEE management. Under its Resource Conservation Challenge the EPA work with retailers and manufacturers of electronic products, as well as with government agencies, to reduce the environmental impacts of the production, use and disposal of electronic products. Goals include increasing the national recycling rate to 35%. One of the main issues facing the US is the challenge of establishing effective governance structures to deal with the waste electronics issue due to the specific political structure

[84] Source: EC, DG-JRC, Institute for Prospective Technological Studies, "Implementation of the Waste Electric and Electronic Equipment Directive in the EU", EUR 22231 EN, 2006.
[85] Helen Bolton, Ministry for the Environment, NZ
[86] http://www.mfe.govt.nz/publications/waste/product-stewardship-water-labelling-jul05/.
[87] http://www.mfe.govt.nz/publications/waste/product-stewardship-water-labelling-aug06/.
[88] Source: US DoE, TECHNICAL REPORT: Analysis of Amended Energy Conservation Standards for Residential Refrigerator-Freezers, October 2005.

of the country. At present, there are not waste disposal or recycling requirements for refrigerator-freezers and other white goods. Some manufacturers indicated that they believe similar requirements as in the Ontario Waste Diversion Act of 2002 could be extended to all of Canada and, in the future, potentially to the U.S. This could cause manufacturers to alter product re-designs to facilitate product recycling. At this point in time, DoE is not familiar with any similar legislation in the United States, but acknowledges that the Ontario legislation could have an impact on refrigerator-freezer design because of the tight integration of the U.S. and Canadian white goods markets.

1.3.4.3 The RoHS directive implementation worldwide, a comparison

The major implementations of RoHS[89] to date have been the EU, China, Japan and California and Korea. There are numerous aspects of RoHS that can be legislated differently leading to non-harmonization. Main aspects include:

- Scope
- The Restricted Substances
- Restriction or disclosure only.
- Maximum Concentration Values (allowable limits)
- The level at which the restriction is applied (Component or Homogeneous material
- Exemptions

Scope: the EU RoHS provided a list of 10 categories listed in the WEEE Directive plus a number of exclusions, listed in both the WEEE Directive and the RoHS Directive. This was a comprehensive approach but led to a number of "grey areas" that have caused much confusion and uncertainty not only in industry.
China has produced a 35 page, detailed list of products split into 11 broad categories. They have described the list as fully comprehensive, however at the end of each category is the catch-all "other". The notable exclusion from the China scope is the major category of white goods such as washing machines, clothes dryers, refrigerators etc. The motivation for this is still unclear. They have included medical devices, which are out of scope of EU RoHS until 2012, and as a result have created a very difficult situation for many medical device manufacturers.
Japan has 7 categories that do not directly relate to either the EU or China categories, although the equipment would all be covered by the EU categories in some manner.
Korea has 10 products but intend to implement the EU's scope in the long term. They are beginning with only 10 items: TVs, refrigerators, air conditioners, laundry machines, personal computers, audio devices, cellular phones, printers, copy machines, fax machines.
California covered electronic devices with a LCD, CRT or Plasma screen of greater than 4 inches measured diagonally. However they are proposing adopting EU ROHS in its entirety in 2010.

Restricted Substances: the EU Restricted lead, cadmium, mercury, hexavalent chromium, PBB (polybrominated biphenyls) and PBDE (polybrominated diphenyl ethers). All other countries have followed, except California who has a pre-existing legislation which effectively performs the same function. The net effect is that banned substances are consistent across all implementations.

Restriction or Disclosure only: the EU and California physically restrict the substances in the products. China, Japan and Korea are disclosure only. "Disclosure only" means that companies still

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[89] Source: Roland Sommer, Newsletter No. 9, November 2006, RoHS and WEEE Specialists International. The newsletter and the www.electronicssouth.com RoHS and WEEE website are made possible by an initiative and funding from New Zealand Trade and Enterprise

have to collect all the material composition data on their components, but instead of designing out non compliant components they have to declare, usually in the users manual, where any of the restricted substances are. This is generally being used as a soft introduction for industry, with China certainly intending to physically restrict the substances in the future. So, there is a pretty even split between the two approaches, with the EU and California enacting physical restrictions and China, Japan and Korea following the "disclosure only" approach.

Maximum Concentration Values (allowable limits): the EU set a limit of 0,1% for all substances except Cadmium which is set at 0,01%. This has been universally adopted, but with a couple of improvements. The major use of hexavalent chromium is in corrosion protection passivation (chromating) on metals. The way the limits are applied in the EU (weight/weight) makes it impossible to accurately measure the amount of hexavalent chromium. China bans all intentionally added hexavalent chromium in metal treatment, which very nicely gets around the issue and meets the original aim of the ban which was to prohibit the chromate treatment.
The other issue was with small parts which again are practically impossible to test. China improved on the EU RoHS by introducing a category for components smaller than 4 mm^3. Components of this size and smaller, under certain conditions, will be considered one homogeneous material and will be tested as a whole. Subsequent to this the EU *Enforcement Authorities Informal Network* announced similar measures, no doubt for very pragmatic reasons. So, apart from the issue of hexavalent chromium in chromate conversion coatings, the "Maximum Concentration Values" are consistent across all legislations.

Component or Homogeneous material (the level at which the restriction is applied): the EU applies the prohibitions at the homogeneous level, but found difficulties to define "homogeneous material" which, in simple terms, is any material that cannot be mechanically disjointed into sub- materials by unscrewing, cutting, grinding or abrasive actions. The rest of the world has followed this verbatim. The Chinese translation to English comes back with the same phraseology and examples. The original definition has now been tempered by the limitations of testing technology, with the emergence of the Chinese category of components of 4mm^3 or less under certain conditions.

Exemptions: only the EU and California so far have enacted an actual restriction of the substances, with California adopting the EU exemptions. California is planning to fast track exemptions locally, to overcome the lengthy process that the EU exemptions need to follow. China is also expected to follow suit. They previously had a category of materials called EIP-D which was the list of EU exemptions; this has been withdrawn but is expected to be reintroduced when China go ahead with phase 2, which involves the actual restriction of the substances rather than just disclosure. Interestingly this country will continue to require disclosure of any substance above the limit irrespective of whether it is in an exempt application or not.

There are some aspects of RoHS which are not harmonizing well at a global level such as scope, but the fundamentals such as the banned substances, the limits applied and how they are applied are harmonized. Whether to start with a straight ban or to take a phased approach appears to be very much a country by country decision.

1.4 ANNEX 1: SOUND, NOISE AND HOUSEHOLD APPLIANCES

Sound power: is the amount of energy per unit time that radiates from a source in the form of an acoustic wave. The unit of measurement is the Watt, like the electric power. This distribution of sound power over the area of the propagating wave is designated as **sound intensity** and is measured in W/m^2 (Watts per square meter). Sound power cannot be measured directly. It is possible to measure intensity, but the instruments are relatively expensive and must be used carefully. Under most conditions of sound radiation, sound intensity is proportional to the **sound pressure**.

Sound power level: indicated with SWL or L_w is a measure of the sound power in comparison to a specified reference level. Since in the case of sound, the amount of power is very small, the reference selected for comparison is the picoWatt (10^{-12} Watt), which is the lowest sound persons of excellent hearing can discern. Sound power levels are connected to the sound source and **independent of distance** and are measured in decibel (dB). The sound power level is defined as :

$L_w = 10 \log (W / W_0)$, where W_0 = reference power

Sound pressure: the instantaneous difference between the actual pressure produced by a sound wave and the average or barometric pressure at a given point in space. It is measured in Pa.

Sound pressure level: Sound Pressure Level (SPL or L_p) is 20 times the logarithm, to the base 10, of the ratio of the pressure of the sound measured to the reference pressure, which is 20 mN/m^2. In equation form, sound pressure level is expressed as:

$SPL\ (dB) = 20 \log p/p_0$

Although a decibel scale is actually a means for comparing two sounds, a decibel scale of sound level by can be defined by comparing sounds to a reference sound with a pressure level of :

$p_0 = 2 \times 10^{-5}\ (N/m^2)$

assigned to a sound pressure level of 0 dB. SPL quantifies in decibels the intensity of given sound sources. It **varies substantially with distance** from source, and also diminish as a result of intervening obstacles and barriers, air absorption, wind and other factors.

There is a significant advantage to using decibel notation rather than the wide range of pressure (or power): a change in sound pressure by a factor of 10 corresponds to a change in sound pressure level of 20 dB:

- p = 40 µPa: $L_p = 20 \log (40/20) = 6$ dB
- p = 400 µPa: $L_p = 20 \log (400/20) = 26$ dB

Sound pressure can be measured more easily, so sound measuring instruments are built to measure the sound pressure level in dB.

Correlation between sound power and sound pressure: the sound power is proportional to the square of sound pressure and $10 \log p^2 = 20 \log p$.

Correlation between sound power level and sound pressure level: doubling the sound pressure level increases the sound power level by 3 decibels (dB) as described in the first row of Table 1.28.

Table 1.28: Correlation between sound power level and sound pressure level

Increase magnitude (times)	**Increase in sound power level** (dB)	**Increase in sound pressure level** (dB)
2	3	6
3	4,8	9,6
4	6	12
5	7	14
10	10	20
15	11,8	23,6
20	13	26

A-Weighted sound level: a measure of sound level designed to reflect the acuity of the human ear, which does not respond equally to all frequencies. The ear is less efficient at low and high frequencies than at medium or speech-range frequencies. Therefore, to describe a sound containing a wide range of frequencies in a manner representative of the ear's response, it is necessary to reduce the effects of the low and high frequencies with respect to the medium frequencies. The resultant sound level is said to be A-weighted, and the units are dB(A). **The A-weighted sound level is also called the "noise level".**

The A-weighted sound level L_A is widely used to state acoustical design goals as a single number, but its usefulness is limited because it gives no information on spectrum content. A-weighted comparisons are best used with sounds that sound alike but differ in level. They should not be used to compare sounds with distinctly different spectral characteristics; that is, two sounds at the same sound level but with different spectral content are likely to be judged differently by the listener in terms of acceptability as a background sound. One of the sounds might be completely acceptable, while the other could be objectionable because its spectrum shape was rumble like, hissing, or tonal in character. A-weighted sound levels correlate well with human judgments of relative loudness, but give no information on spectral balance. Thus, they do not necessarily correlate well with the annoyance caused by the noise.

Therefore, many different-sounding spectra can have the same numeric rating, but have quite different subjective qualities

Comparing decibel A, B and C:

Relative response (dB)	Frequency (Hz)								
	31,5	63	125	250	500	1000	2000	4000	8000
dB(A)	-39,4	-26,2	-16,1	-8,6	-3,2	0	1,2	1	-1,1
dB(B)	-17	-9	-4	-1	0	0	0	-1	-3
dB(C)	-3	-0,8	-0,2	0	0	0	-0,2	-0,8	-3

If the frequency weighting employed (A, B or C) is not indicated, the A-weighting is implied.

The noise chart below gives an idea of average decibel levels for everyday sounds:

- Painful:
  - 150 dB = rock music peak
  - 140 dB = firearms, air raid siren, jet engine
  - 130 dB = jackhammer
  - 120 dB = jet plane take-off, amplified rock music, car stereo, band practice
- Extremely loud:
  - 110 dB = rock music, model airplane
  - 106 dB = timpani and bass drum rolls
  - 100 dB = snowmobile, chain saw, pneumatic drill
  - 90 dB = lawnmower, shop tools, truck traffic, subway
- Very loud:
  - 80 dB = alarm clock, busy street
  - 70 dB = busy traffic, vacuum cleaner
  - 60 dB = conversation
- Moderate:
  - 50 dB = moderate rainfall, quite office
  - 40 dB = quiet room, bedroom
- Faint:
  - 30 dB = whisper, quiet library
  - 20 dB = very quiet room
  - 10 dB = calm.

2 Task 2: Economic and market analysis

2.1 GENERIC ECONOMIC DATA

2.1.1 Production and import export of wash appliances in Europe

Production of wash appliances is estimated through the data collected in Task 1[90] for the household appliance industry and market in the EU27 and more in general in Europe. According to the available data (Table 2.1), about 33,2 million units were produced in EU27 in 2005, of which 18 million washing machines, 9,7 dishwashers and 5,5 million dryers . However, since data relevant to some producing countries are missing this number is likely underestimated.

The European non-EU countries for which data were collected (Turkey, Iceland, Norway, Switzerland, Russia) are responsible for 1,4 million wash appliances. The estimated overall European production of wash appliances is about 33,9 million units, of which roughly 18,6 washing machines, 9,7 dishwashers and 5,6 million dryers Again, the uncertainty of these figures in not known.

When Turkish production is added to the EU27 figures, the total production rises to about 39 million wash appliances.

Table 2.1: Production of washing machines, dishwashers and dryers in Europe in 2005 (10^3 units)

Country	Washing machines	Dishwashers	Dryers	Total
AT				
BE				
BG (1997)	n.a	n.a	n.a	n.a
CY				
CZ	75			75
DE	315	3.763	1.000	5.078
DK (2004)			150	150
EE (2003)	240			240
EL	100	72		172
ES	1.907	900	440	3.247
FI				
FR	1.285	200	760	2.245
IE				0
IT	8.527	294	293	9.114
LV	n.a	n.a	n.a	n.a
LT				
LU				
HU				
MT				
NL				
PL	124	1	104	229
PT (2006)				
RO (2006)				
SI (2003)	600		150	750
SK	n.a	n.a	n.a	n.a
SE	110	170	50	330
UK	710	650	1.678	3.038

[90] Task 1 document "A Portrait of the Household Appliance Industry and Market in Europe", rev. 3.0, March 2007.

Country	Washing machines	Dishwashers	Dryers	Total
EU27	**17.944**	**9.695**	**5.561**	**33.200**
TR	4.382	783	80	5.245
IS	n.a	n.a	n.a	n.a
NO				
CH	58		83	141
RU	630			630
non-EU	**507**	**783**	**163**	**1.453**
Total	**23.014**	**10.478**	**5.724**	**39.216**

Note: in bold 2005 information from a US specialised magazine.

The import/export information is provided by Eurostat. Unfortunately only a part of these data are available and so it is no possible to properly evaluate the apparent market at European level. In particular the data on the "Dishwashers" and "Drying machines of a dry linen capacity < = 10 kg" (according to the Eurostat/NACE classification) are missing.

Table 2.2 and Table 2.3 show the data provided by EUROSTAT.

Table 2.2 Importation of wash appliances in Europe in 2005 (units)

Country	Dishwashers	Fully-automatic washing machines of a dry linen < = 10kg (including machines which both wash and dry)	Non-automatic washing machines of a dry linen < = 10kg (including machines which both wash and dry)	Drying machines of a dry linen capacity < = 10 kg
AT	:	322.519	4.098	:
BE	:	355.027	16.516	:
DE	:	2.220.481	61.960	:
DK	:	272.798	2.185	:
GR	:	348.149	1.507	:
ES	:	793.157	113.088	:
FI	:	617.895	1.428	:
FR	:	2.169.212	26.335	:
IE	:	177.234	46.813	:
IT	:	1.000.329	16.970	:
LU	:	25.761	764	:
NL	:	785.083	98.021	:
SE	:	548.899	6.148	:
UK	:	1.679.301	111.386	:
PT	:	332.786	10.027	:
CY	:	36.437	310	:
CZ	:	377.109	19.514	:
EE	:	39.221	4.407	:
SI	:	46.751	782	:

Country	Dishwashers	Fully-automatic washing machines of a dry linen < = 10kg (including machines which both wash and dry)	Non-automatic washing machines of a dry linen < = 10kg (including machines which both wash and dry)	Drying machines of a dry linen capacity < = 10 kg
SK	:	141.399	4.538	:
HU	:	484.217	3.300	:
MT	:	13.549	4.240	:
LV	:	67.201	8.877	:
LT	:	141.656	4.109	:
PL	:	1.169.330	62.663	:
EU25 *	**:**	**17.073.143**	**4.636.716**	**5.098.487**

*The row "EU25" shows the **net intra EU import values** and not the sum of the units imported by each country

Table 2.3 Exportation of wash appliances in Europe in 2005 (units)

Country	Dishwashers	Fully-automatic washing machines of a dry linen < = 10kg (including machines which both wash and dry)	Non-automatic washing machines of a dry linen < = 10kg (including machines which both wash and dry)	Drying machines of a dry linen capacity < = 10 kg
AT	:	45.707	3.410	:
BE	:	67.061	10.783	:
DE	:	3.455.363	19.106	:
DK	:	41.176	1.270	:
GR	:	11.140	7.276	:
ES	:	1.671.772	247.520	:
FI	:	443.389	4.576	:
FR	:	1.001.678	60.027	:
IE	:	7.969	350	:
IT	:	7.641.817	28.341	:
LU	:	7.266	34	:
NL	:	178.979	21.568	:
SE	:	324.970	3.027	:
UK	:	313.630	800.491	:
PT	:	3.409	304	:
CY	:	23	0	:
CZ	:	196.587	13.286	:
EE	:	542	633	:
SI	:	385.410	123	:
SK	:	2.285.426	15	:

Country	Dishwashers	Fully-automatic washing machines of a dry linen < = 10kg (including machines which both wash and dry)	Non-automatic washing machines of a dry linen < = 10kg (including machines which both wash and dry)	Drying machines of a dry linen capacity < = 10 kg
HU	:	223.218	2.780	:
MT	:	0	160	:
LV	:	6.651	100	:
LT	:	46.797	41	:
PL	:	1.331.234	1.997	:
EU25 *	**:**	**10.422.046**	**166.995**	**:**

*Also in this case the row "EU25" shows the **net intra EU import values** and not the sum of the units imported by each country

2.2 TASK 2: MARKET AND STOCK DATA

2.2.1 Market data: Sales analysis

2.2.1.1 Content of this paragraph

This paragraph illustrates the sales data of the wash appliances for the years 2002 and 2004. The data have been provided by the German firm GfK. The regional coverage is rather good for the western EU countries but it is partial for the Eastern Countries. For these last countries the data concern only 4 countries for the year 2002 and 8 for the year 2004 for the washing machines and only 4 countries for the year 2002 and 5 for the year 2004 for the dishwashers

The following table shows the Western and Eastern countries taken into account by this data set:

	Washing Machines		Dishwashers	
Country	**2002**	**2004**	**2002**	**2004**
Austria (AT)	X	X	X	X
Belgium (BE)	X	X	X	X
Germany (DE)	X	X	X	X
Denmark (DK)	X	X	X	X
Spain (ES)	X	X	X	X
Finland (FI)	X	X	X	X
France (FR)	X	X	X	X
UK (GB)	X	X	X	X
Greece (GR)	X	X	X	X
Italy (IT)	X	X	X	X
The Netherlands (NE)	X	X	X	X
Portugal (PT)	X	X	X	X
Sweden (SE)	X	X	X	X

Czech Republic (CZ)	X	X	X	X
Estonia (EE)		X		
Hungary (HU)	X	X	X	X
Lithuania (LT)		X		
Latvia (LV)		X		
Poland (PL)	X	X	X	X
Slovenia (SI)		X		X
Slovakia (SK)	X	X	X	X

The sales data are broken down by energy efficiency classes and, per each of these sales partition, the 2002/2004 data are compared and discussed.

2.2.1.2 The sales break down by energy efficiency classes

a. Washing Machines

Table 2.4and table 2.5 as well Figure 2.1 and Figure 2.2 that follow, show the washing machines sales repartition by energy efficiency classes for the years 2002 and 2004.

The first four columns of Table 2.1(units) and Table 2.2 (percentages) compare the 2002 sales with those of 2004. For the Eastern countries, only the four nations taken into account in the 2002 data are compared. The fifth columns of tables 2.4 & 2.5 carries out the 2004 sales data of all the 8 countries considered by GfK. Overall the 2004 western plus eastern sales (8 countries) exceed the 13 millions. The increment of the 2004 sales with respect those of 2002 (4 countries) is around the 10,4 %, of which the 8,6 % is attributable to the western countries and at least the 26 % to the eastern ones. This remarkable increment shows, if confirmed for these last years and in the future, that this market is very rapidly renewing.

For what concerns the data break down by energy efficiency classes (Figure 2.1 and Figure 2.2), the sales show in both the eastern and western markets a strong penetration of the A class (very strong for the eastern countries), the appearance of the A+ class, the decreasing share of the B and C classes and the disappearance of the other low efficiency classes. This trend seems to be consolidated (see also the next chapter 2.3 of the market trends) and should bring to the phase out of even the class B (that in two years has lost the 34 % of the market) in few years.

Finally figures 2.3 and 2.4 provide the percentage variation of the 2004 sales with respect those of the year 2002 by EU western and eastern countries and by EE classes. To facilitate the analysis the EE classes have been grouped in three categories: A+[91], A and B plus C. Figures 2.3 and 2.4 provide the percentage variation of the 2004 sales with respect those of the year 2002 by EU western and eastern countries and by EE classes. These figures clearly show the dynamic of the market for each EU country: the longer histogram, the faster the market transformation of a country. Overall, with the exception of Greece, all classes A (A+ and A) are increasing while class B plus C are decreasing. In the Netherlands and Germany even the class A has started decreasing.

[91] The GfK data report the sales of 2 washing machines of class A++ in Italy

Table 2.4 Washing machines sales for the years 2002 – 2004 (units)

	TOTAL WEST		TOTAL East (cz hu pl sk)		TOTAL East
	January 2002 - December 2002	January 2004 - December 2004	January 2002 - December 2002	January 2004 - December 2004	January 2004 - December 2004
<Grand Total>	11.198.889	12.166.433	1.253.348	1.579.762	1.621.560
A ++	0	2	0	0	0
A +	9.699	929.225	30	24.816	19.060
A	6.749.547	8.549.715	556.986	1.243.710	1.265.422
B	2.235.786	1.441.018	365.304	184.230	200.284
C	1.412'140	909.048	214.610	55.020	54.044
D	150.126	88.656	16.280	6.327	11.326
E	25.926	15.649	2.347	296	361
F	52.447	56.923	79	13	0
G	5.744	1.438	8	0	0
UNKNOWN	557.472	174.759	97.704	65.350	71.065

Table 2.5 Washing machines sales for the years 2002 – 2004 (%)

	West EU	East EU	West EU	East EU (4 countries)	East EU (5 countries)
	2002		2004		2004 *
A ++	0,00	0,00	0,00	0,00	0,00
A +	0,09	0,00	7,64	1,57	1,18
A	60,27	44,44	70,27	78,73	78,04
B	19,96	29,15	11,84	11,66	12,35
C	12,61	17,12	7,47	3,48	3,33
D	1,34	1,30	0,73	0,40	0,70
UNKNOWN	5,73	7,99	2,04	4,16	4,40
Total	100,00	100,00	100,00	100,00	100,00

Figure 2.1 Washing machines sales by energy efficiency classes in Western Europe

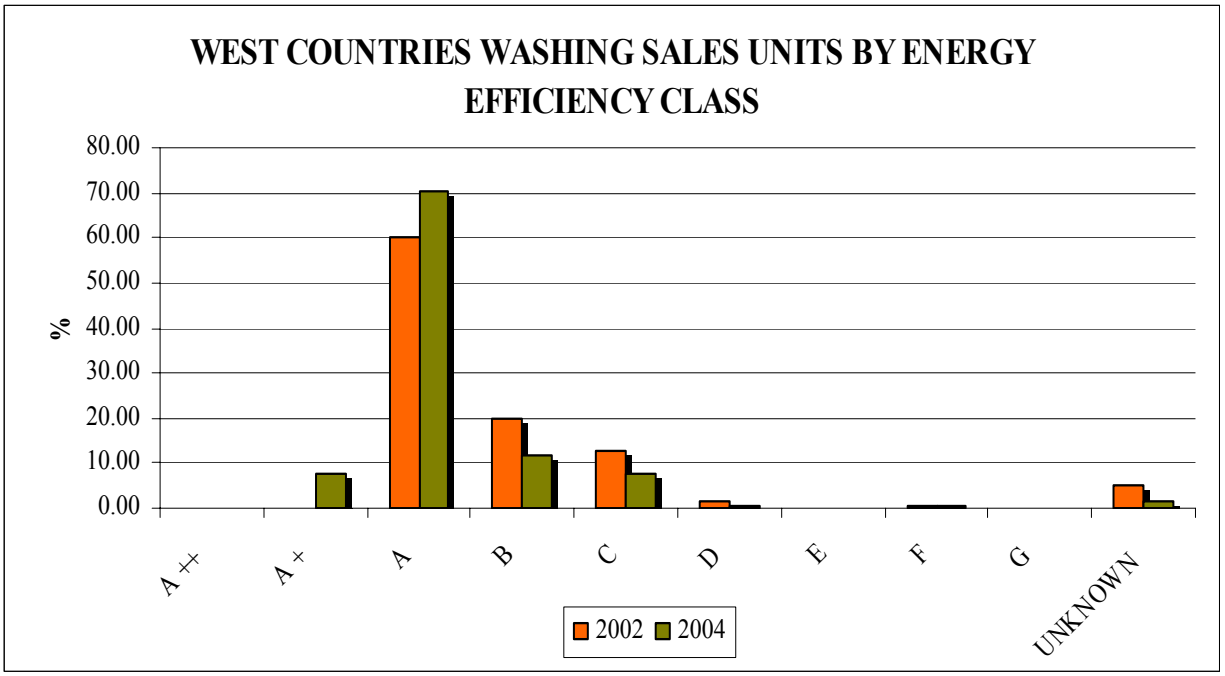


Figure 2.2 Washing machines sales by energy efficiency classes in Eastern Europe (4 countries)

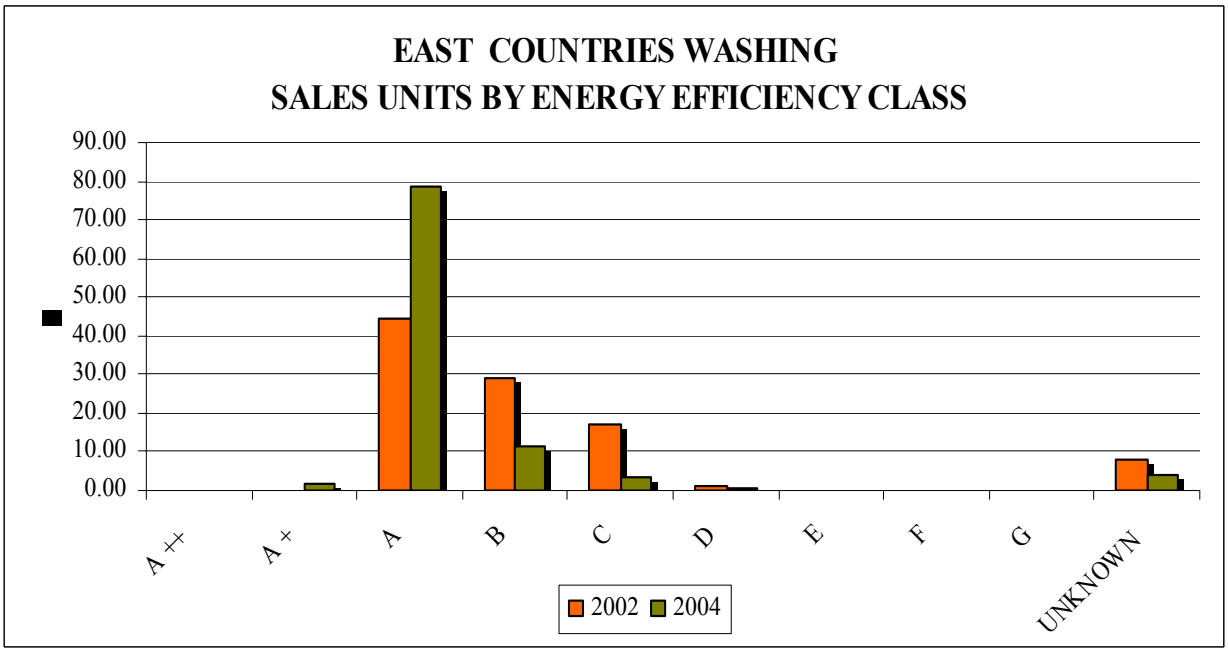


Figure 2.3 Washing machines West EU- Sales Variation of the major EE classes in the years 2002 - 2004

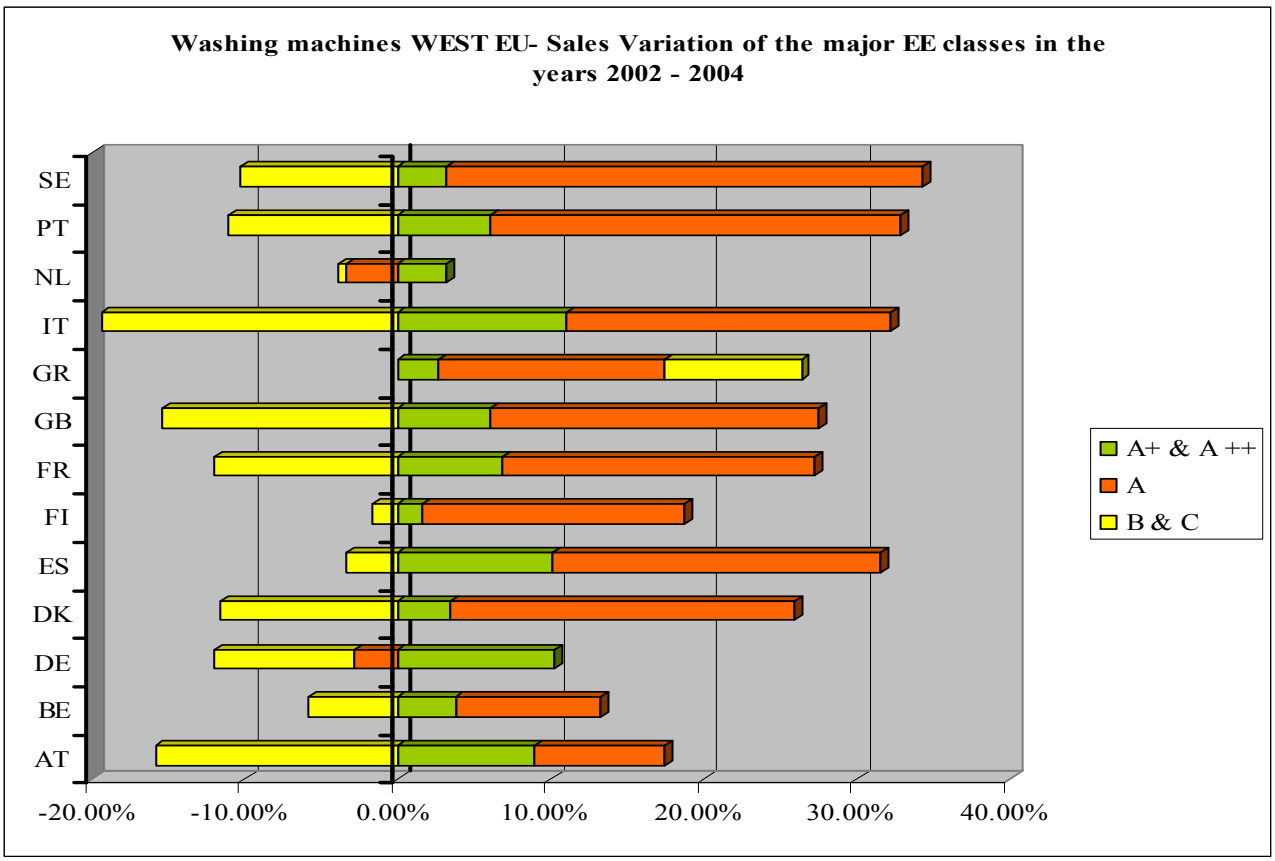
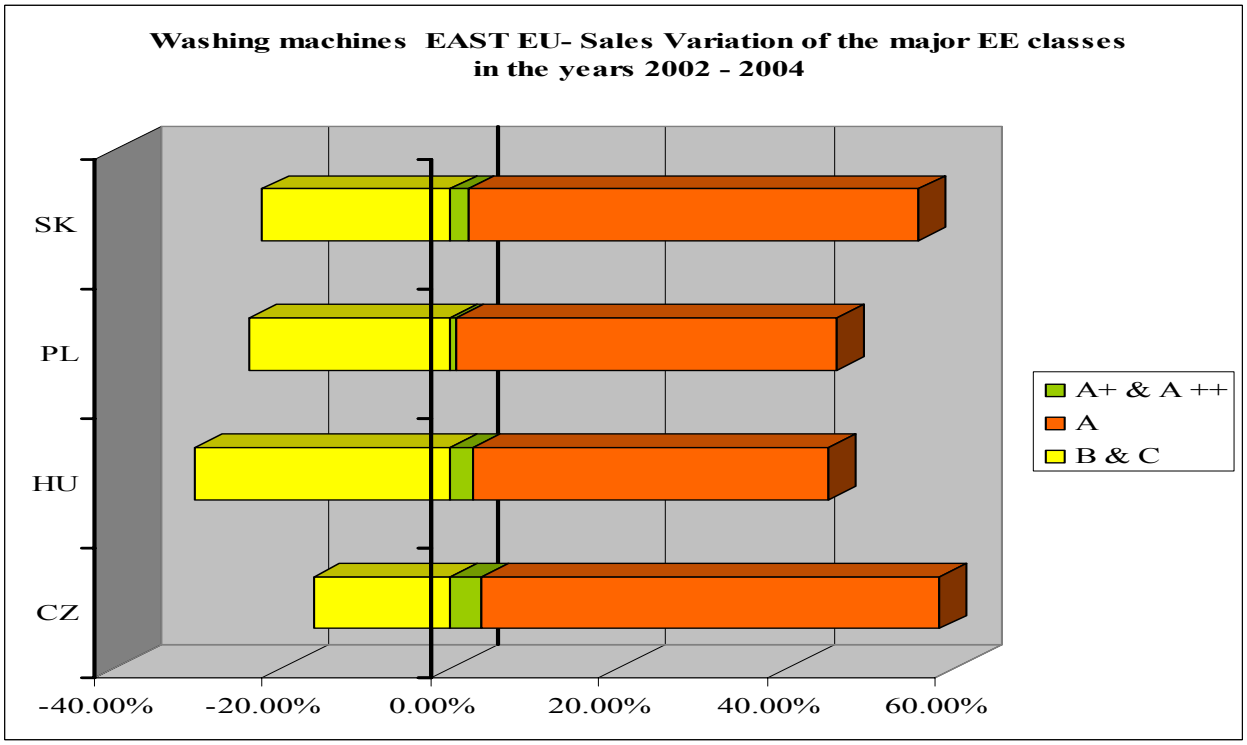


Figure 2.4 Washing machines East EU- Sales Variation of the major EE classes in the years 2002 - 2004



b. Dishwashers

The following Table 2.6 (units) and Table 2.7 (percentage) and figures 2.5-2.6, show that the 2004 western and eastern sales (countries) exceed the 5 millions of units.

Overall the 2004 western plus eastern sales (4 countries) exceed the 13 millions. The increment of the 2004 sales with respect those of 2002 is around the 12 % of which the 11 % is attributable to the western countries and at least the 51 % to the eastern ones. This remarkable increment shoes, if confirmed for these last years and in the future, that this market is very rapidly renewing.

For what concerns the data break down by energy efficiency classes (Figures 2.5-2.6), the sales show in both the eastern and western markets a strong penetration of the A class (very strong for the eastern countries), the appearance of the A+ class for the western countries (but few thousand of appliances) and the decreasing share of the C&B classes for western and eastern countries. This trend seems to be consolidated (see also the next chapter 2.3 of the market trends) and should bring to the phase out of even the class C (that in two years has lost the 55 % for western countries and 34 % for eastern countries of the market) in few years.

Finally Figures 2.7 and 2.8 provide the percentage variation, by the EU western countries and by EE classes, of the 2004 sales with respect those of the year 2002.

This figures show the dynamic of the market for each EU country: also in this case, the longer histogram, the faster the market transformation of a country. Overall, with the exception of Finland the Netherlands and Poland, all classes A (A+ and A) are increasing while classes B&C are decreasing. The Dutch data are anomalous as show an increasing of the classes B&C (in particular C) and a decreasing, even if very limited, of the class A. Overall the Dutch sales have also decreased. It should be interesting to follow the dishwasher market of this country in the last two years.

It is worth noting that in the eastern countries there have been a strong increment of the dishwasher sales (+ 33 %, while only 9 % in the western countries, see Table 2.6) that should correspond to a notable increment of the dishwasher ownership rate in this part of Europe[92].) Practically in all the four analysed countries, the large majority of this increment has been taken by the A class (90 %), less than the 1 % has been taken by the B class while the C class has decreased (- 1 %).

[92] We are not able, at least for the moment, to calculate the dishwasher ownership rate by country but it is likely that at the beginning of the years ’90 this rate was close to 0 and that now is around the 10-15 % (see also paragraph 2.3). Moreover the average age of the dishwasher stock in these countries is relatively low and so the majority of the yearly sales go to the stock increase and not to the substitution of old machines.

Table 2.6 Dishwashers sales for the years 2002 – 2004 (units)

	TOTAL WEST		TOTAL East (cz hu pl sk)		TOTAL East
	January 2002 - December 2002	January 2004 - December 2004	January 2002 - December 2002	January 2004 - December 2004	January 2004 - December 2004
<Grand Total>	5.011.760	5.552.461	170.086	257.001	269.791
A ++	0	0	0	0	0
A +	1.995	2.347	0	0	0
A	2.679.701	4.095.146	64.346	173.064	183.414
B	943.484	874.658	40.146	49.068	50.259
C	992.555	446.986	38.074	25.277	26.428
D	145.640	32.946	14.155	2.893	2.938
E	9.026	2.875	476	46	46
F	620	4	8	0	0
G	0	165	0	0	0
UNKNOWN	238.738	97.333	12.828	6.583	6.635

Table 2.7 Dishwashers sales for the years 2002 – 2004 (percentage)

	West EU	East EU	West EU	East EU	East EU
	2002		2004		2004 *
A +	0,04	0,00	0,04	0,00	0,00
A	53,47	37,86	73,75	67,37	68,01
B	18,83	23,60	15,75	19,09	18,63
C	19,80	22,39	8,05	9,84	9,80
D	2,91	8,32	0,59	1,13	1,09
E	0,18	0,28	0,05	0,02	0,02
F	0,01	0,00	0,00	0,00	0,00
G	0,00	0,00	0,00	0,00	0,00
UNKNOWN	4,76	7,54	1,75	2,56	2,46
Total	100,00	100,00	100,00	100,00	100,00

Figure 2.5 Dishwashers sales by energy efficiency classes in Western Europe

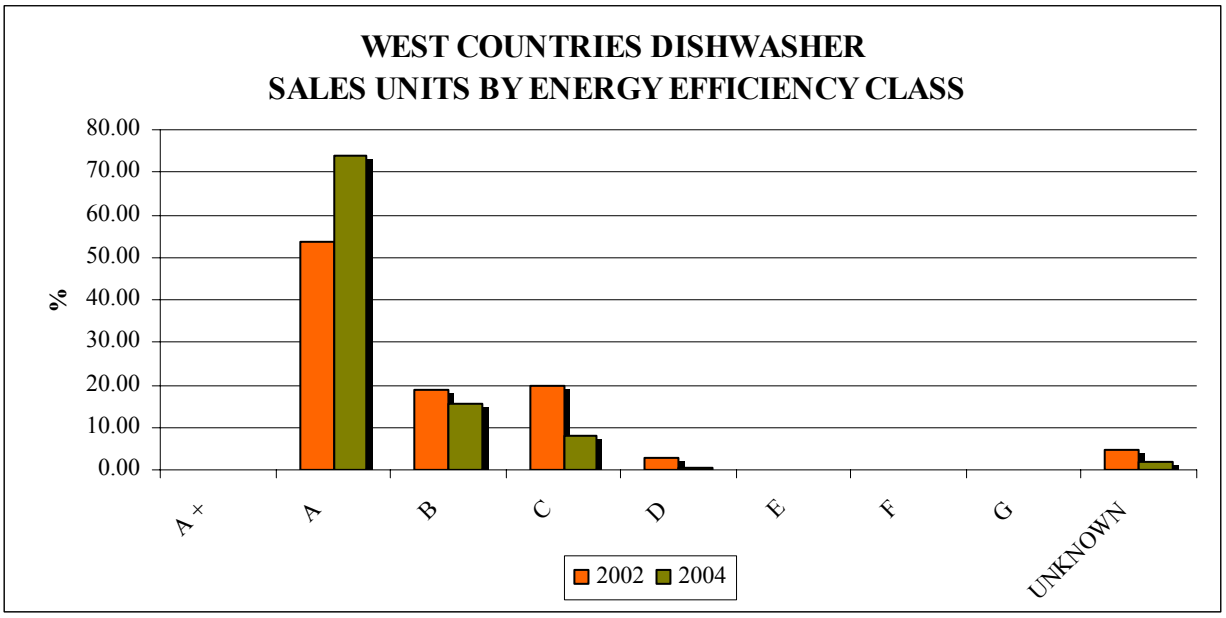


Figure 2.6 Dishwashers sales by energy efficiency classes in Eastern Europe (4 countries)

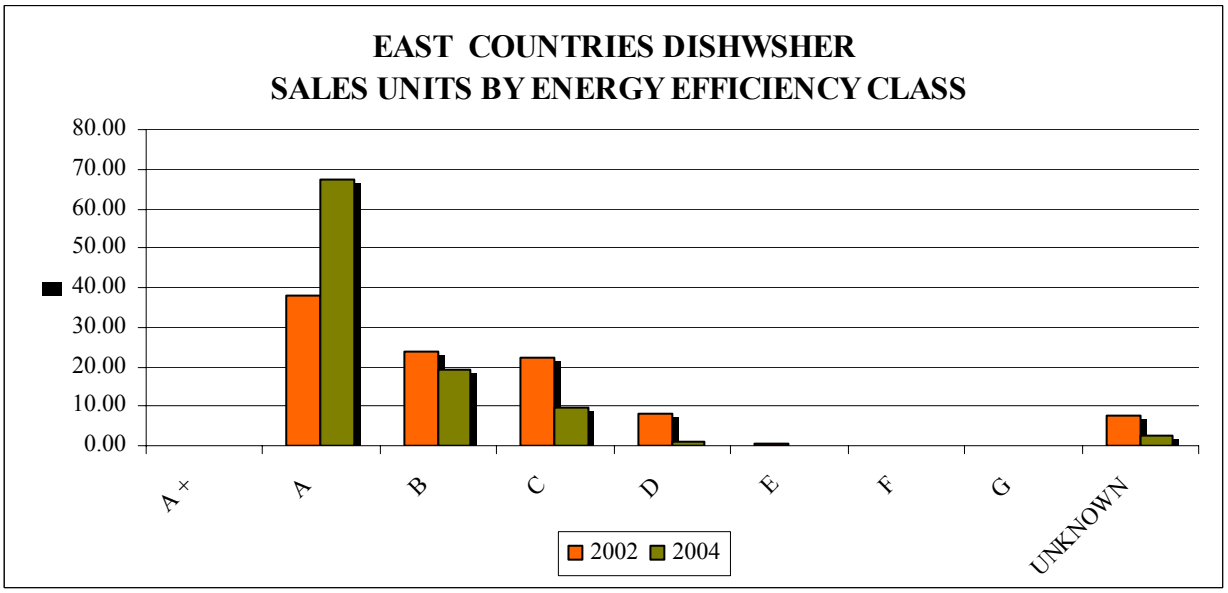


Figure 2.7 Dishwasher West EU- Sales Variation of the major EE classes in the years 2002 - 2004

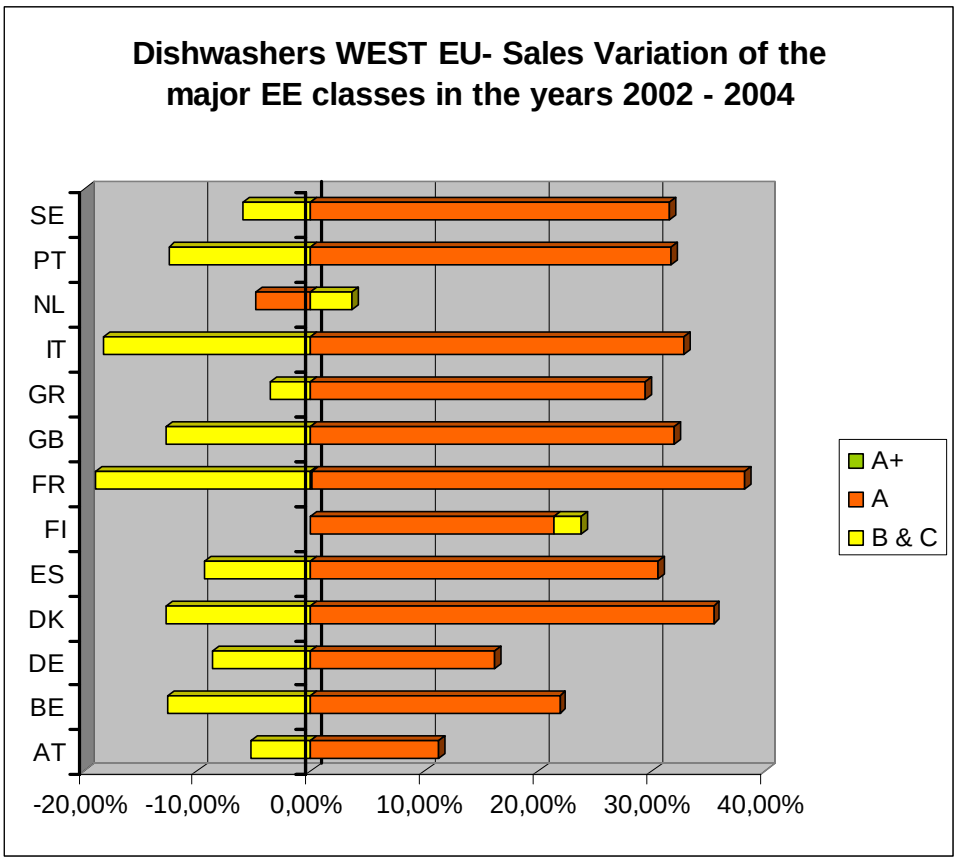
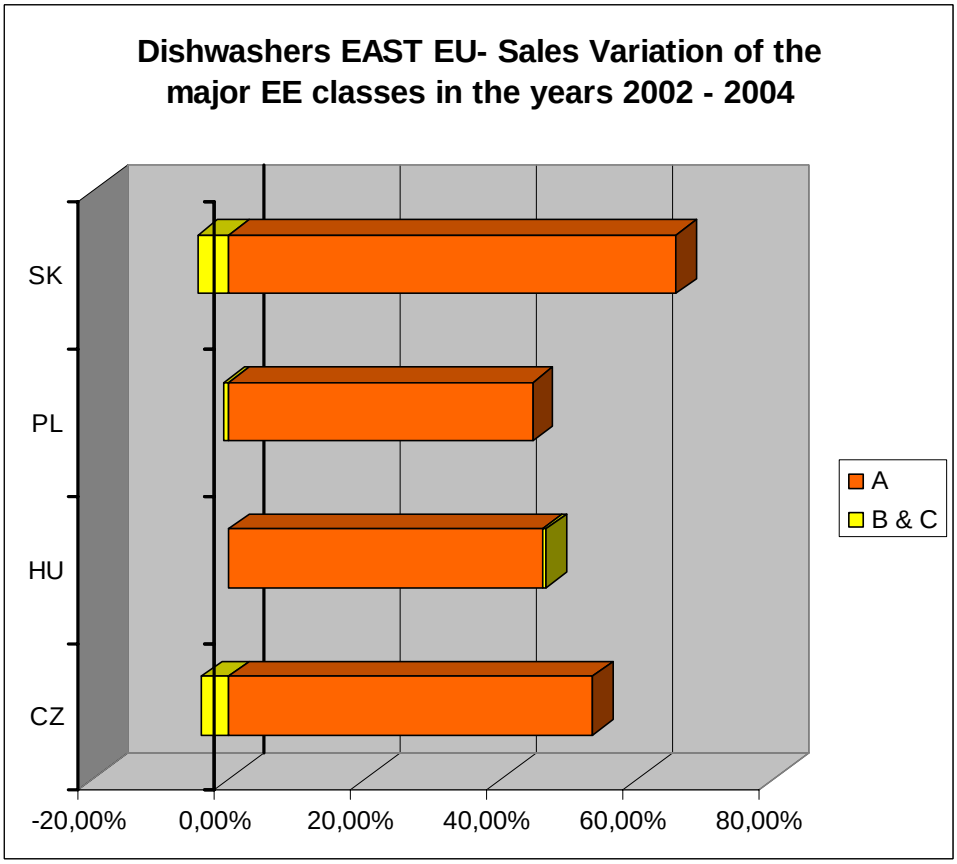


Figure 2.8 Dishwasher East EU- Sales Variation of the major EE classes in the years 2002 - 2004



2.2.2 Market data: Price analysis

The following analysis of the wash appliances prices is developed in three steps:

- the 2002-2004 (weighted) average EU prices comparison of the main EE categories (from A++, where available, to C);
- the global price trend of the whole washing machines and dishwashers compartments from 1996 to 2004;
- and finally a by country overview on the 2004 price difference between the EE categories (min, max and average).

All the prices are expressed in value 2004[93] and, as usual, the data source is the German firm GfK.

2.2.2.1 2002-2004 EU prices comparison

Mashing machines

Table 2.8 and Table 2.9 as well Figure 2.9 and 2.10 provides the price comparison between the years 2002 and 2004. As usual, for the Eastern countries, only the four nations taken into account in the 2002 data are compared. The average washing machines prices decline (13 % in Western Europe and in Eastern Europe), in fact in Western Europe the A++ and A+ prices have notably decreased with respect the 2002, respectively the 38 % and 21 in the western countries and of 30 % and 22 % in the eastern countries. It is moreover worth noting here the substantial difference of price between the Western and Eastern prices (43 % 2004). This difference is probably the result of a particular price policy carried out by the manufacturers in the new accession countries. Figure 2.11 shows, for instance, the West/East price comparison among the cold and wet appliances.

Finally Figure 2.9shows the price trend by some western EU countries of the entire washing machines compartment from the year 1996 up to the year 2004. It is interesting to see here that at the beginning, till the year 2002, the prices trend were rather different among the EU countries: in some of them the prices steadily decreased in other increased as in Italy, and, particularly, Spain. After the 2002 all the prices decline confirming the data reported in Table 2.8 and Table 2.9 as well in Figure 2.10. The initial price increasing of the above mentioned countries is probably the consequence of the deep market transformation occurred during the years 90' in that nations.

Table 2.8 Washing machines prices comparison by EE categories for the years 2002 – 2004

	West EU		East E. 4	
	2002	2004	2002	2004
Weighted Average	534	463	372	323
A +	983	607	628	441
A	598	473	426	333
B	440	387	329	261
C	379	346	306	274

Table 2.9 Washing machines prices comparison by EE categories, % variation 2004 /2002

[93] The prices have been rescaled to 2004 by using the "Harmonised Indices of Consumers Prices" figures provided by Eurostat

	% 2004/2002	
	West EU	East EU
Weighted Average	-13,30%	-13,03%
A ++	-38,21%	-29,84%
A +	-20,85%	-21,84%
A	-11,95%	-20,64%
B	-8,69%	-10,56%
C	-13,30%	-13,03%

Figure 2.9 West EU: Washing machines prices comparisonby EE categories for the years 2002 – 2004

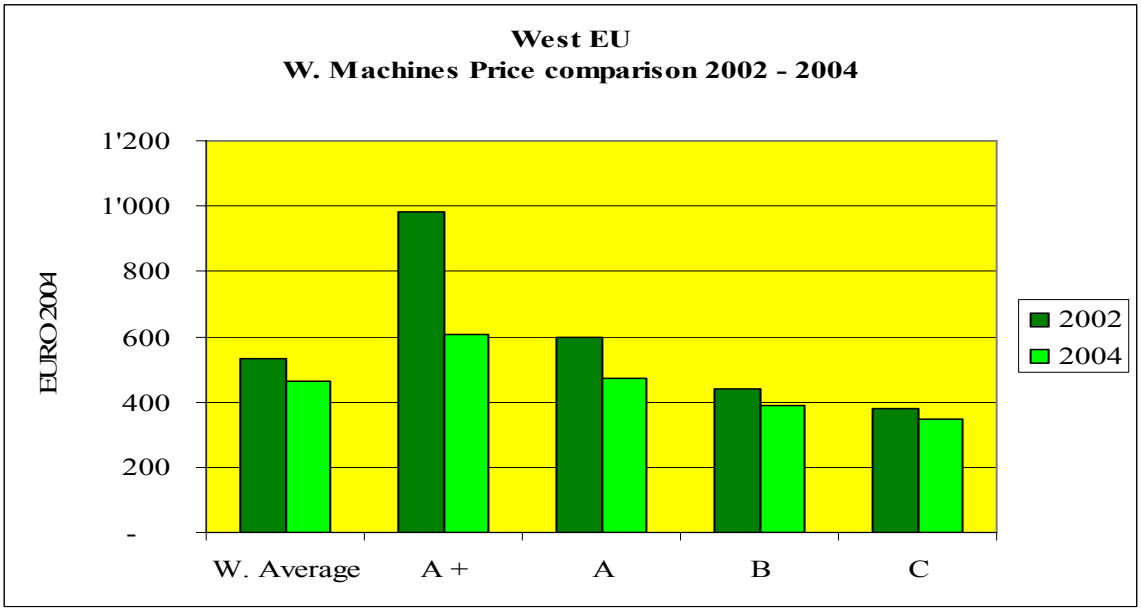


Figure 2.10 East EU: Washing machines prices comparison by EE categories for the years 2002 – 2004

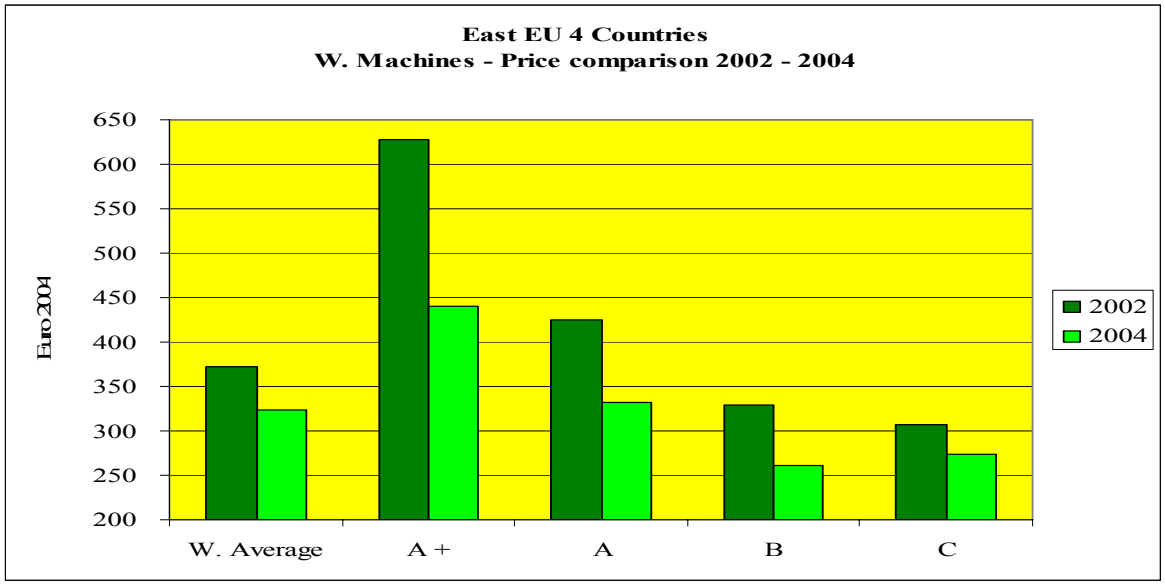


Figure 2.11 Prices West-East comparison for the cold and wet appliances.

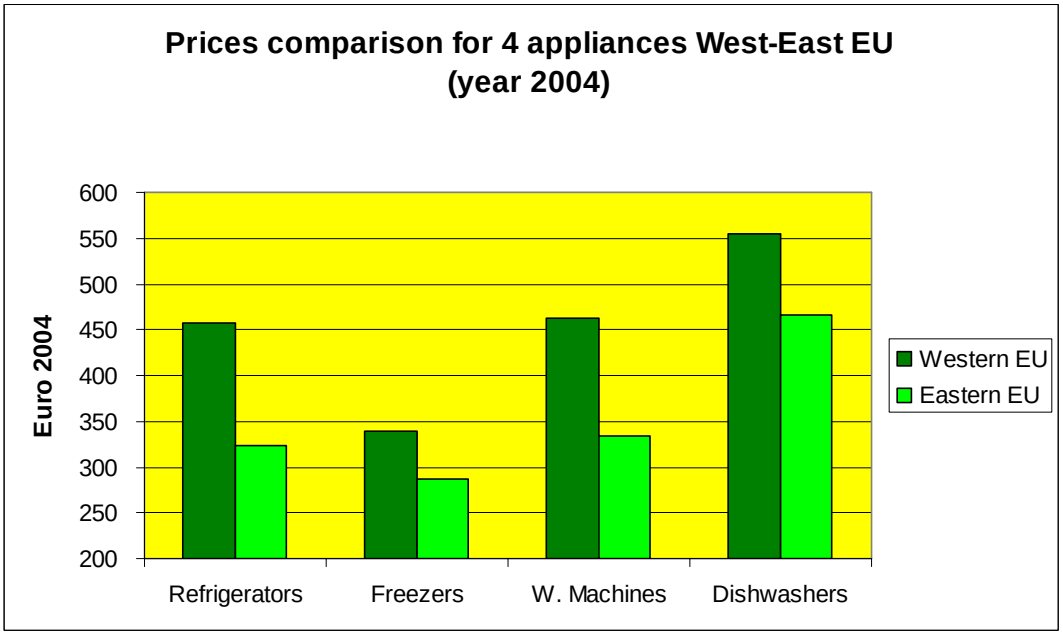
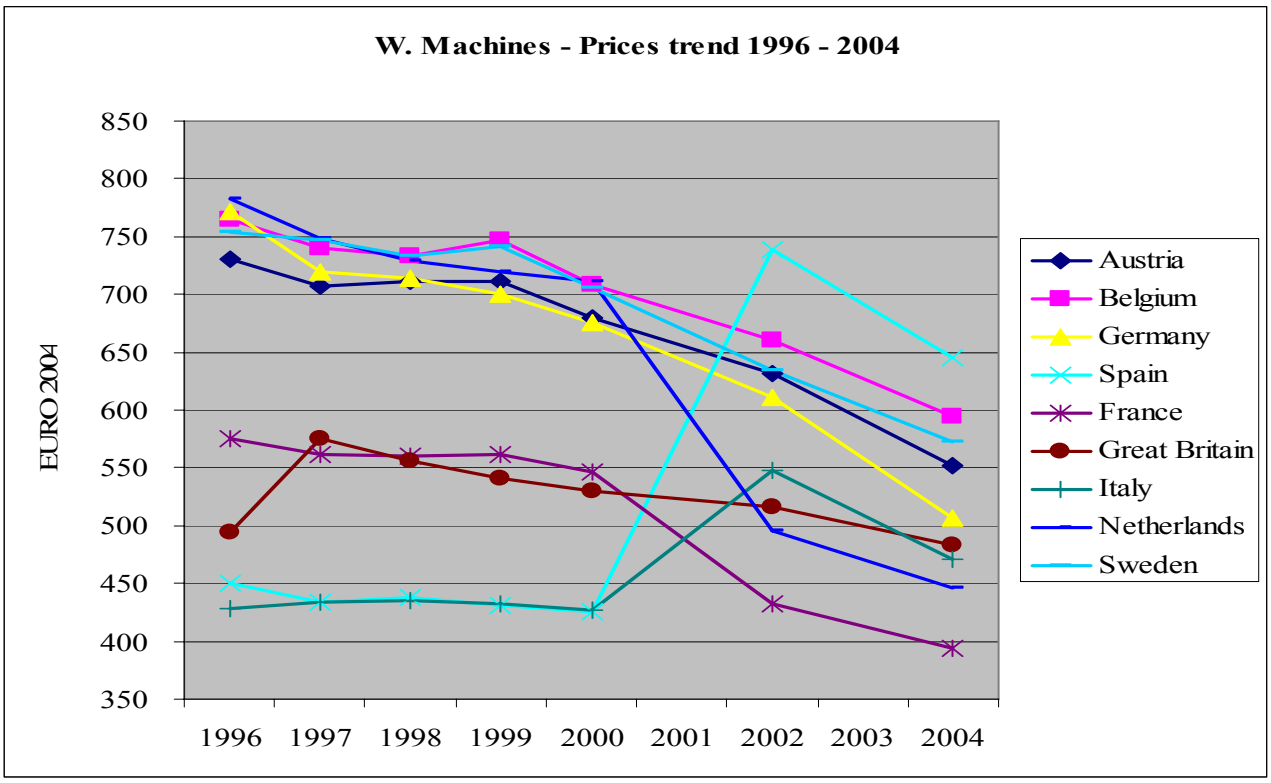


Figure 2.12 EU western countries: 1996 – 2004 prices trends for washing machines.



Dishwashers

Table 2.10 and Table 2.11 as well Figure 2.13 and Figure 2.15 provide the price comparison between the years 2002 and 2004 for the dishwashers compartment. The dishwashers prices decline considerably in all the considered EE categories (with the exception of the A+ category for Western countries). It is worth noting that, in both West and East EU countries, the prices difference among the EE categories seems to be linearly scaled up. Finally, also in this case there is no substantial difference of price between the Western and Eastern prices.

Table 2.10 Dishwashers prices comparison by EE categories for the years 2002 – 2004; absolute values

	West EU		East EU (4 Countries)	
	2002	2004	2002	2004
W. Average	618	555	577	463
A +	570	677	-	-
A	687	594	679	506
B	559	446	516	371
C	488	407	469	350

Table 2.11 Dishwashers prices comparison by EE categories for the years 2002 – 2004; % variation

	% 2004/2002	
	West EU	East EU
W. Average	-10,23%	-19,66%
A +	+18,79%	
A	-13,51%	-25,37%
B	-20,20%	-28,17%
C	-16,70%	-25,44%

Figure 2.13 East EU: Dishwashers prices comparison by EE categories for the years 2002 – 2004

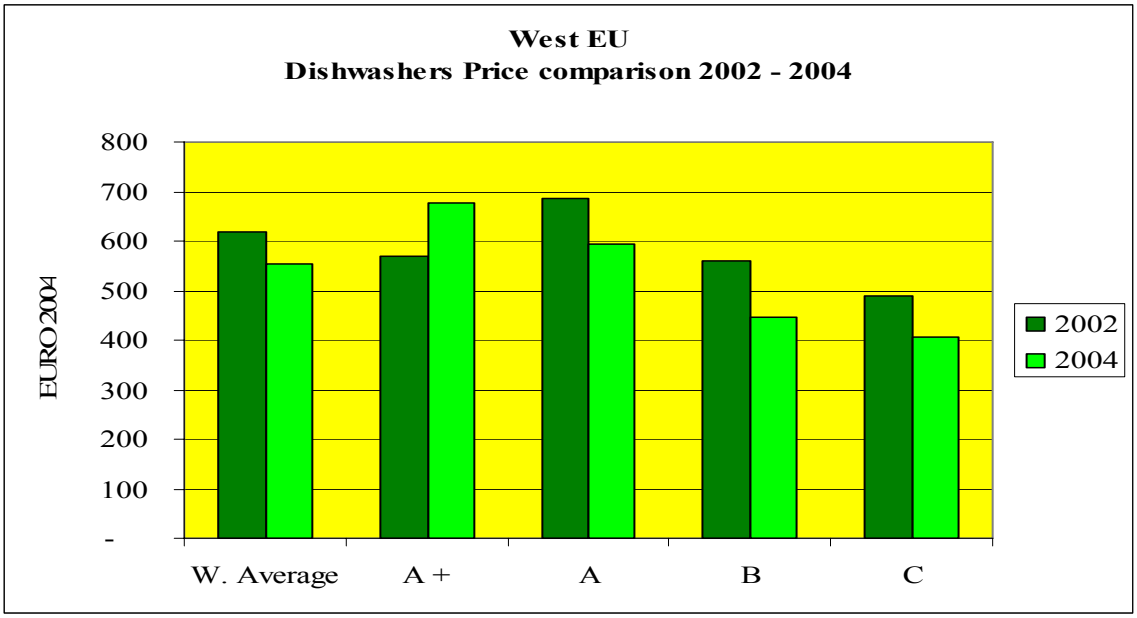
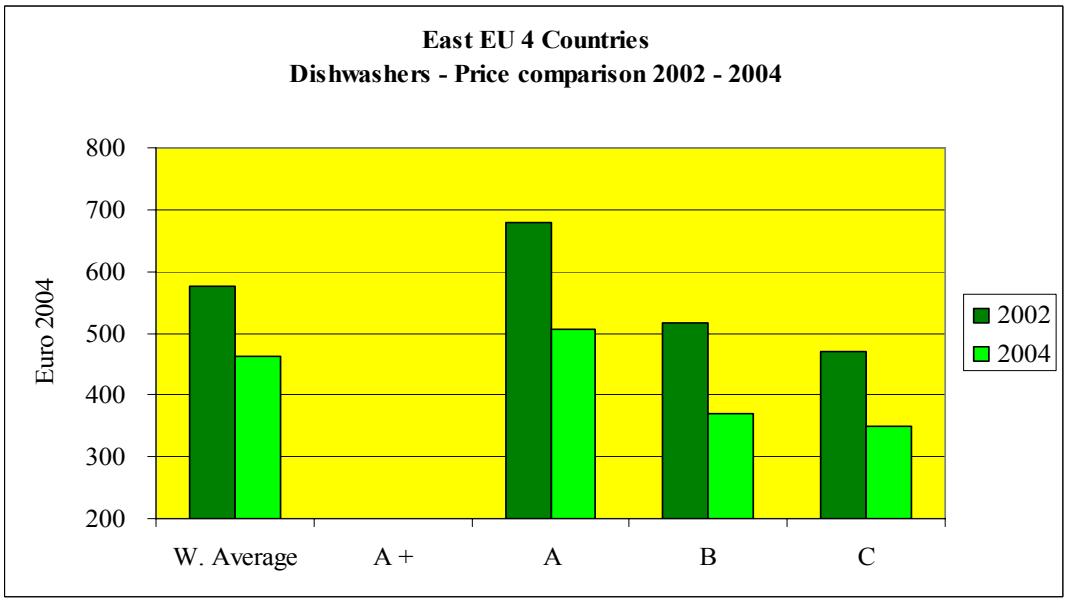


Figure 2.14 East EU: Dishwashers prices comparison by EE categories for the years 2002 – 2004

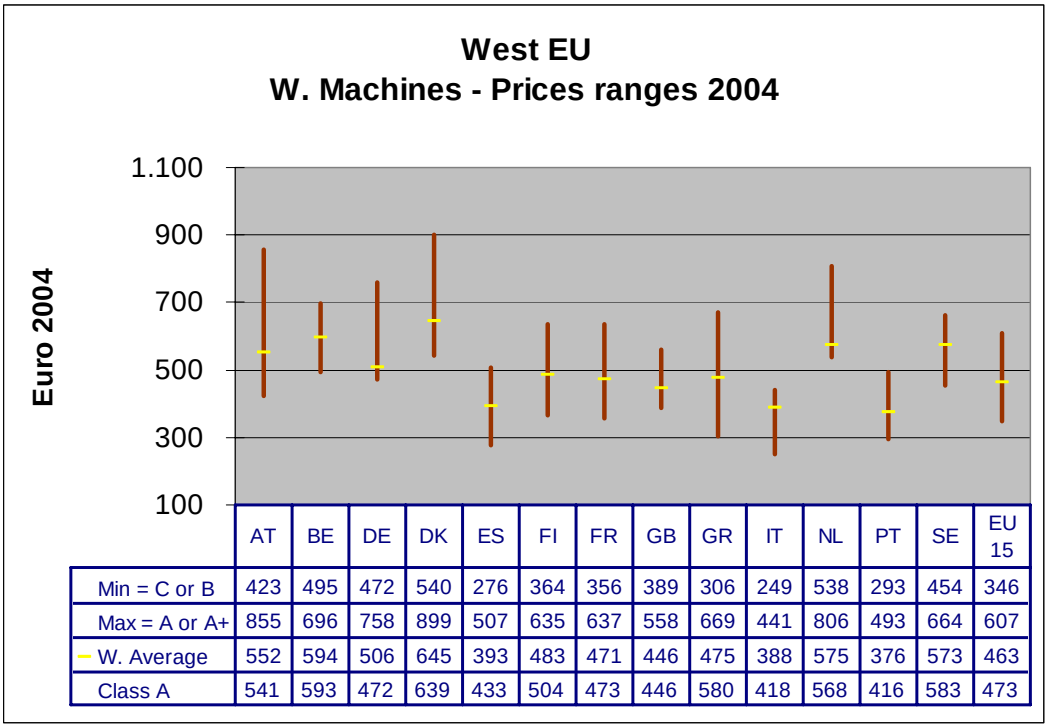


2.2.2.2 2004 EU prices analysis

Washing machines

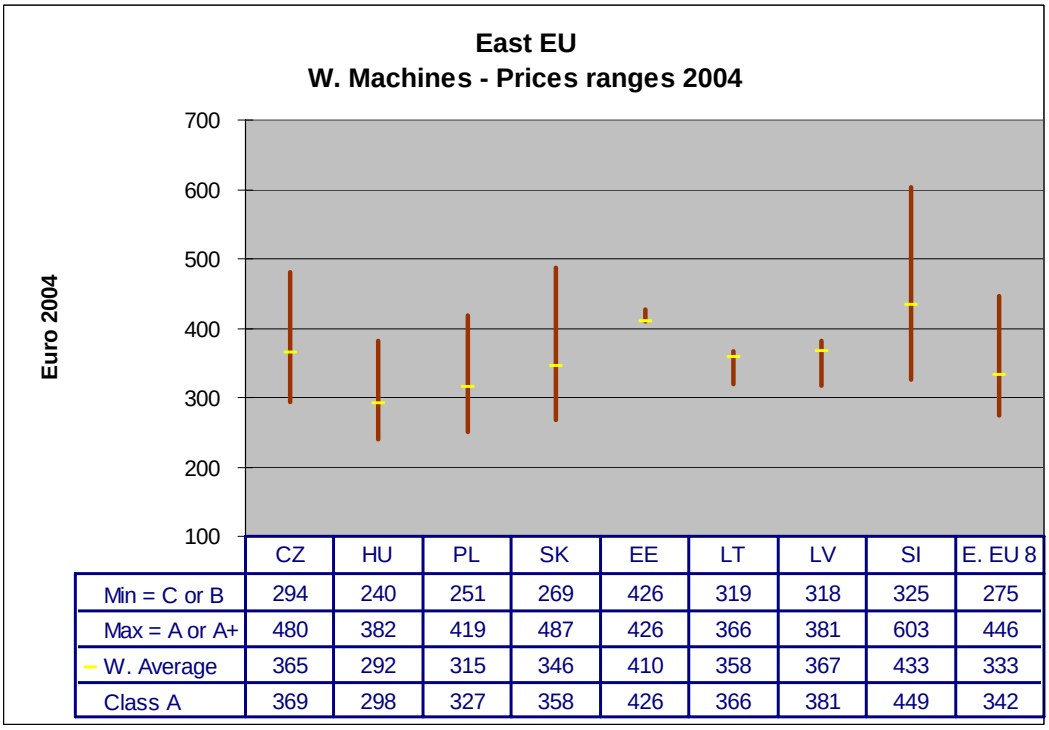
Figures 2.15-2.16 show the prices interval of the appliances sold in the West and East EU markets ranked by the highest and the lowest EE classes. The horizontal mark between the vertical bars indicates the average washing machines price. As the table below the graph indicates, in general the average price coincide or is very close to the A class appliances. At first glance the closer is this mark to the top of the bars, the fastest is the corresponding market transformation speed. In Figure 2.15 the minimum for the Germany corresponds to the A class while in all the other cases to the C or B classes.

Figure 2.15 EU western countries: 2004 prices ranges for washing machines.



	AT	BE	DE	DK	ES	FI	FR	GB	GR	IT	NL	PT	SE	EU 15
Min = C or B	423	495	472	540	276	364	356	389	306	249	538	293	454	346
Max = A or A+	855	696	758	899	507	635	637	558	669	441	806	493	664	607
W. Average	552	594	506	645	393	483	471	446	475	388	575	376	573	463
Class A	541	593	472	639	433	504	473	446	580	418	568	416	583	473

Figure 2.16 EU eastern countries: 2004 prices ranges for washing machines.



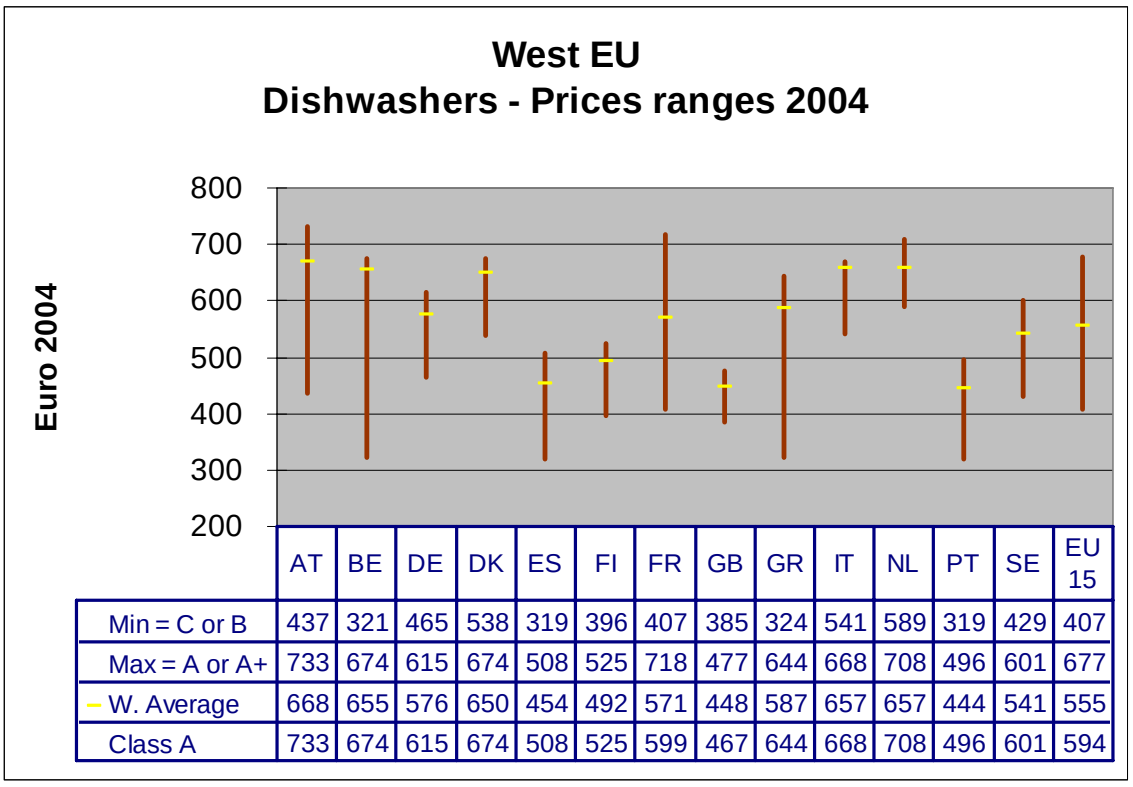
	CZ	HU	PL	SK	EE	LT	LV	SI	E. EU 8
Min = C or B	294	240	251	269	426	319	318	325	275
Max = A or A+	480	382	419	487	426	366	381	603	446
W. Average	365	292	315	346	410	358	367	433	333
Class A	369	298	327	358	426	366	381	449	342

Dishwashers

As in the washing machines case, also here the prices interval of the appliances sold in the West and East EU markets, ranked by the highest and the lowest EE classes, are provided by Figure 2.17 and Figure 2.18. The horizontal mark in between the vertical bars indicates the average dishwasher price. For dishwashers the average price is generally close but lower than the A class price that in

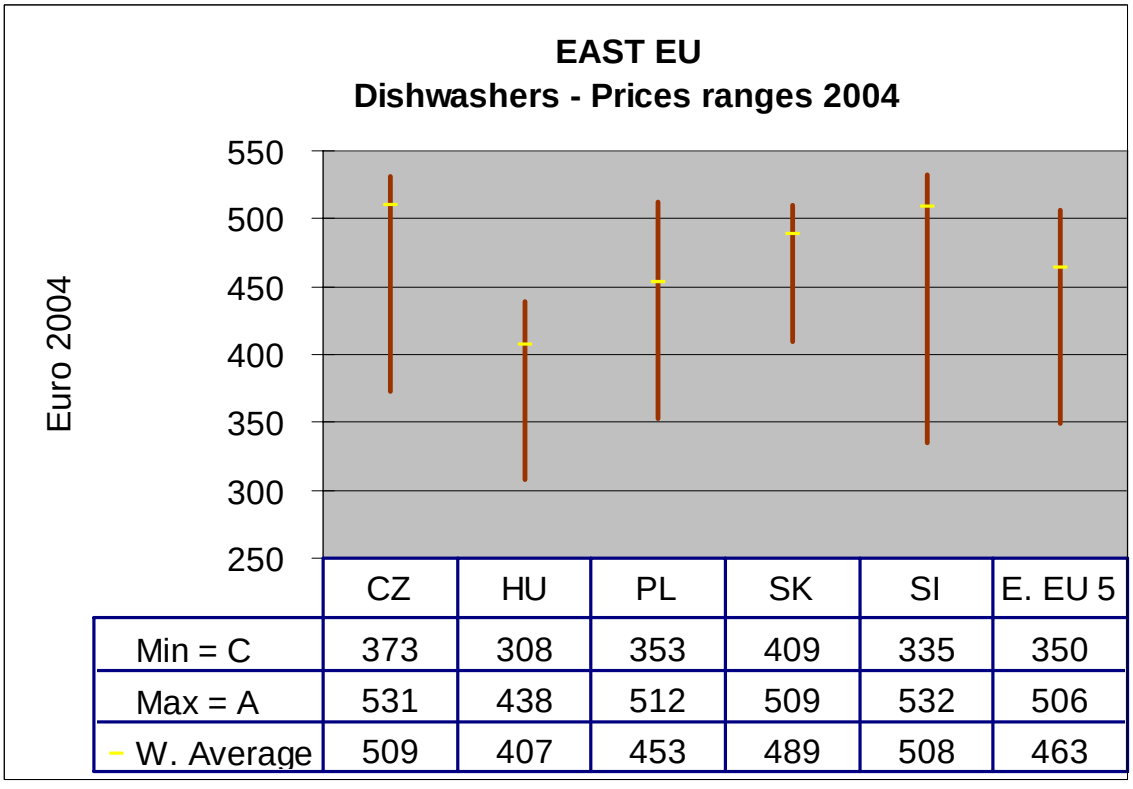
most of the cases (in all cases for the eastern countries) coincides with the top edge of the histograms. Overall the graphs confirm the impression, already provided by the sales analysis of this compartment, of a market that's transforming rather rapidly (actually, the majority of the average prices are closer to the lower edge of the vertical bars, indicating a concentration of the EE classes around the A/B categories).

Figure 2.17 EU western countries: 2004 prices ranges for dishwashers.



	AT	BE	DE	DK	ES	FI	FR	GB	GR	IT	NL	PT	SE	EU 15
Min = C or B	437	321	465	538	319	396	407	385	324	541	589	319	429	407
Max = A or A+	733	674	615	674	508	525	718	477	644	668	708	496	601	677
W. Average	668	655	576	650	454	492	571	448	587	657	657	444	541	555
Class A	733	674	615	674	508	525	599	467	644	668	708	496	601	594

Figure 2.18 EU eastern countries: 2004 prices ranges for dishwashers.



	CZ	HU	PL	SK	SI	E. EU 5
Min = C	373	308	353	409	335	350
Max = A	531	438	512	509	532	506
W. Average	509	407	453	489	508	463

2.2.3 Stock data

2.2.3.1 Description of the Stock Model

A "stock model" is defined as a mathematical representation of one or more characteristics of the products in use ("the stock") in a specified time period, as a function of the age of these products.[94] The model uses a bottom-up approach to energy consumption based on the number households and the energy average consumption by household appliance.

In order to build up the "stock model" it needs:

- A set of sales (actual or estimated through market evaluation) and the so called "Remain" that is the share of devices sold in the year j that are working in the year k;

$$Stock\ (j, k) = Sales\ (j) \times Remain\ (j, k)$$

- Or a Household succession and the related "ownership" that is the market share.

$$Stock\ (k) = Households\ (k) \times Ownership\ (k)$$

As the "ownership" does not exist for all the years it should be estimated through a not linear interpolation, as linearity enhances the miscalculation (the difference between the actual value and the estimation). More realistic is to adopt the Gompertz function, where the growth speed is always proportional to the real event, but the scale decreases exponentially according to the time.

The formula is:

$$Y = A \exp(-\exp(-B(X-C)))$$

The asymptotic value depends on the starting point, which is different from a simple logistics model where, independently from N(0), the "entire group" tend to the M value (highest value of the function). The function is estimated through a non linear regression. Its parameters, B, C are estimated through the minimum square Gauss- Newton method.

After having estimated the Stock(k) is possible to estimate the sales through the following formula:

$$ESTsales\ (k) = Stock\ (k) - \sum_{i=i0}^{k-1} ESTsales\ (i) * \mathrm{Re}\ main\ (i, k)$$

where the "remain" is a probabilistic function like this:

[94] Rainer Stamminger " Energy consumption of domestic appliances in European households CECED

$$Remain\ (i,k) \quad = \quad Prob(\ Sales\ (i) \in Stock\ (k)) \Rightarrow \quad P_n(x) = \frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^{x} e^{\frac{(x-\mu)^2}{2\sigma}}\, dx$$

In the above formula μ is the average appliances lifetime[95] and σ the lifetime standard deviation.

The "Remain" function (j,k) provides the share of appliances sold in the year j that are still working in the year k. For calculating "remain" (j,k) we assume the appliances average lifetime as a normal distribution with average and standard deviation known .

Finally, to calculate the annual energy consumption of an appliance stock over a range of future years, the following the formula is used:

$$ENERGY(k) = \sum_{k=1953}^{2005} \sum_{j=1953}^{k} Sales(j) * \mathrm{Re}\,main(j,k) * EnergyAverageConsumption(j)$$

Where:

- *Energy(k)* is the estimated Total Energy Consumption of appliances in year k;
- *Sales (j)* is the number of appliances sold in year j;
- *Remain (j, k)* is the probability that the appliances sold in year j are still remaining in the stock in year k;
- *Energy Average Consumption (j)* is the unitary average energy consumption of the appliances sold in year j.

2.2.3.2 Stock model results for Washing machines in EU15

The input parameters that are required for the period 1953-2005 are:

- the *energy average consumption* of the product in the year of built or import (kWh /cycle at 4,7 kg and 60° cotton cycle) [96];
- the *number cycles /machines/year*
- the *number households* in EU15 ;
- the *ownership rate*

The unitary energy consumption data used by the models are shown in the following table:

[95] The average lifetime is the duration when 50% of the devices sold in a given year are no longer in the stock

[96] Source: CECED databases and stock model [ref 6]

Table 2.12 Energy Average Consumption (kWh/cycle) and Number Cycles /Machines/Year of Washing machines in EU 15

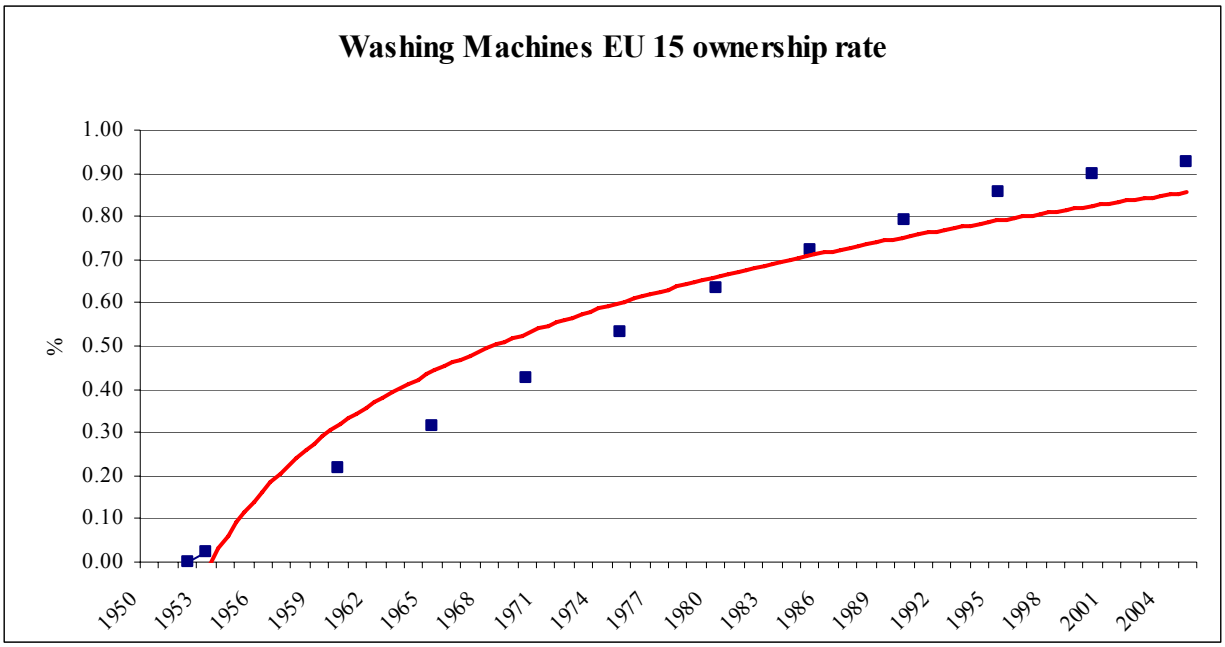
Year	Energy Average Consumption (kWh/cycle)	Number Cycles /Machines/Year
1953-1981	3,250	277
1982-1992	1,830	256
1993-1996	1,350	251
1997	1,177	251
1998-1999	1,177	245
2000	1,081	245
2001-2002	1,081	245
2003-2004	1,081	234
2005	0,997	234

In Table 2.12 the energy consumption data till the year 1997 and the yearly number of washing cycles have been provided by V.H Kemna and Rainer Stamminger in their paper "Energy consumption of domestic appliances in European households, CECED". After 1997 the energy consumption data have been calculated on the basis of the CECED databases.

The number of households in EU15 has been calculated summing up the data of each relevant country

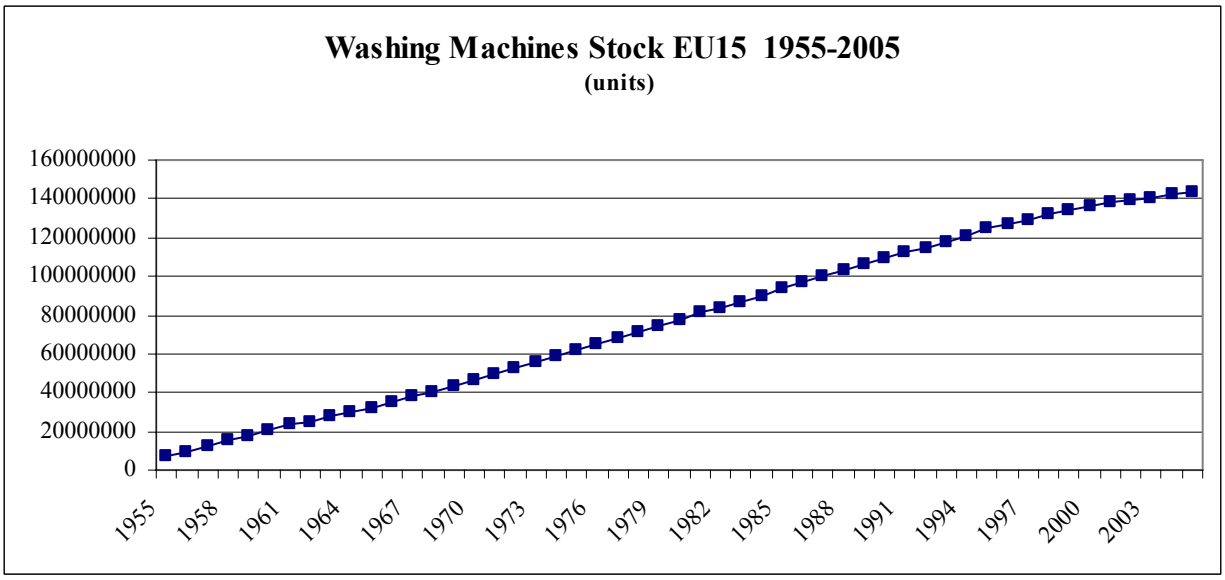
The ownership rate is estimated assuming:

1. before year 1953 there were no washing machines ;
2. the growth is depicted through a linear logistic function. In the case of the washing machines the stock is steadily and slowly saturating to an ownership rate of 90 %. Probably it will never reach the 100 % of saturation because of the habit of many household to make use of collective laundries.



From the above data it has been estimated the washing machines stock trend for the years 1950 – 2005 (Figure 2.19).

Figure 2.19 Washing machines stock trend for EU 15 (1955 – 2005)

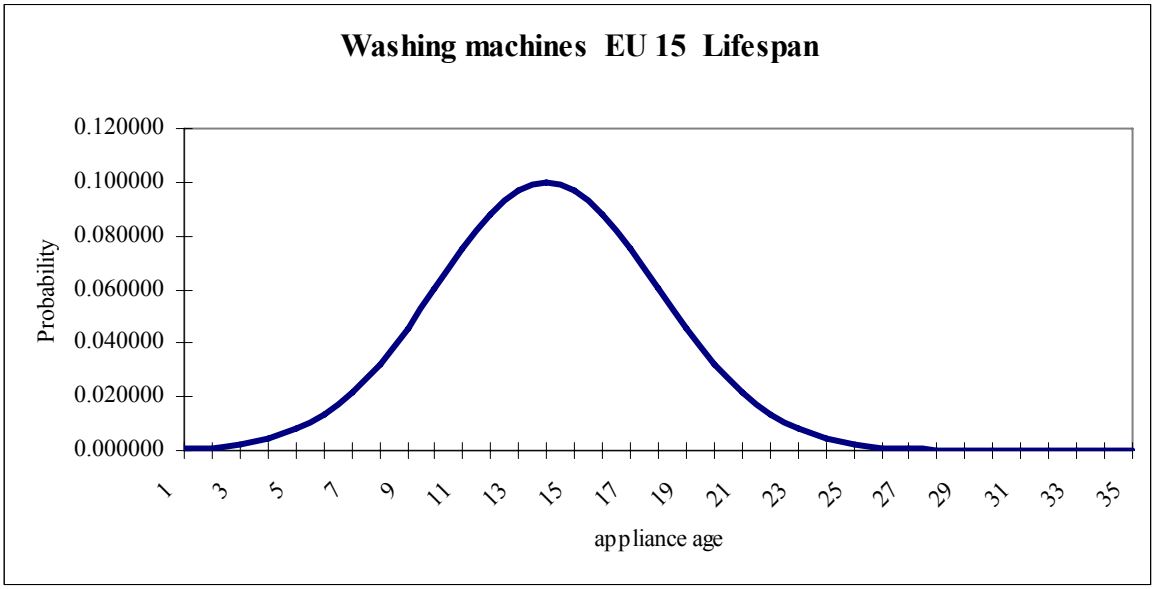


After estimation of the stock, the sales have been thus calculated through the following formula.

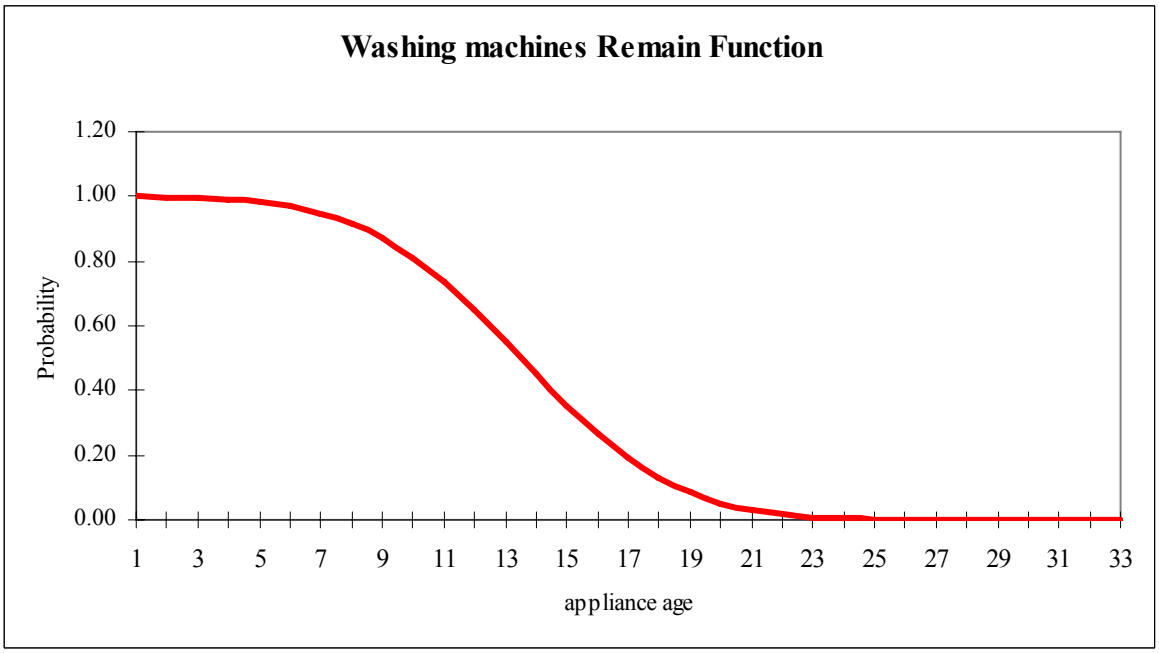
(1)

$$ESTsales(k) = Stock(k) - \sum_{i=i0}^{k-1} ESTsales(i) * \mathrm{Re}main(i,k)$$

The Remain (i,k) function has been calculated assuming that the probability of life average is distributed as a normal function with average and standard deviation known (14 years and 4 years)[97].



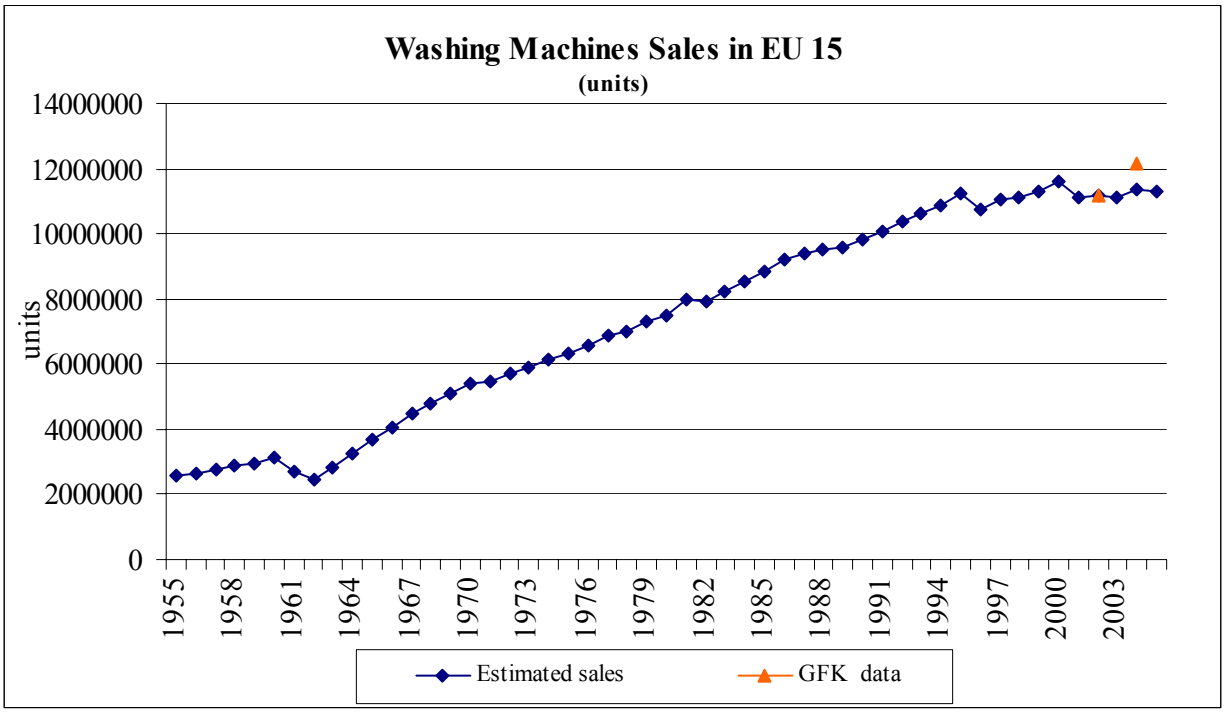
The trend of the function *Remain (j, k)*, that is the probability that the appliances sold in year j and are still remaining in the stock in year k, is shown in the following graph:



The estimated sales are shown in Figure 2.20 where the results have been calibrated (see note 97) by considering the actual sales data of the years 2002 and 2004 (the orange triangles, GfK).

[97] Actually the lifetime data has been used to calibrate the sales function with the 2002/2004 data provided by GfK. and a life time of 14 year ± 4 is the period that best fits with these figures.

Figure 2.20 Washing machines sales trend for EU 15 (1955 – 2005)



Finally the formula:

(2)
$$ENERGY(k) = \sum_{k=1953}^{2005} \sum_{j=1953}^{k} Sales(j) * \mathrm{Re}main(j,k) * EnergyAverageConsumption(j)$$

has been used to calculate the total energy consumption of the washing machines stock for the years 1955 – 2005 as shown in Figure 2.21 .

Figure 2.21 Washing machines total stock energy consumption trend for EU 15 (1955 – 2005)

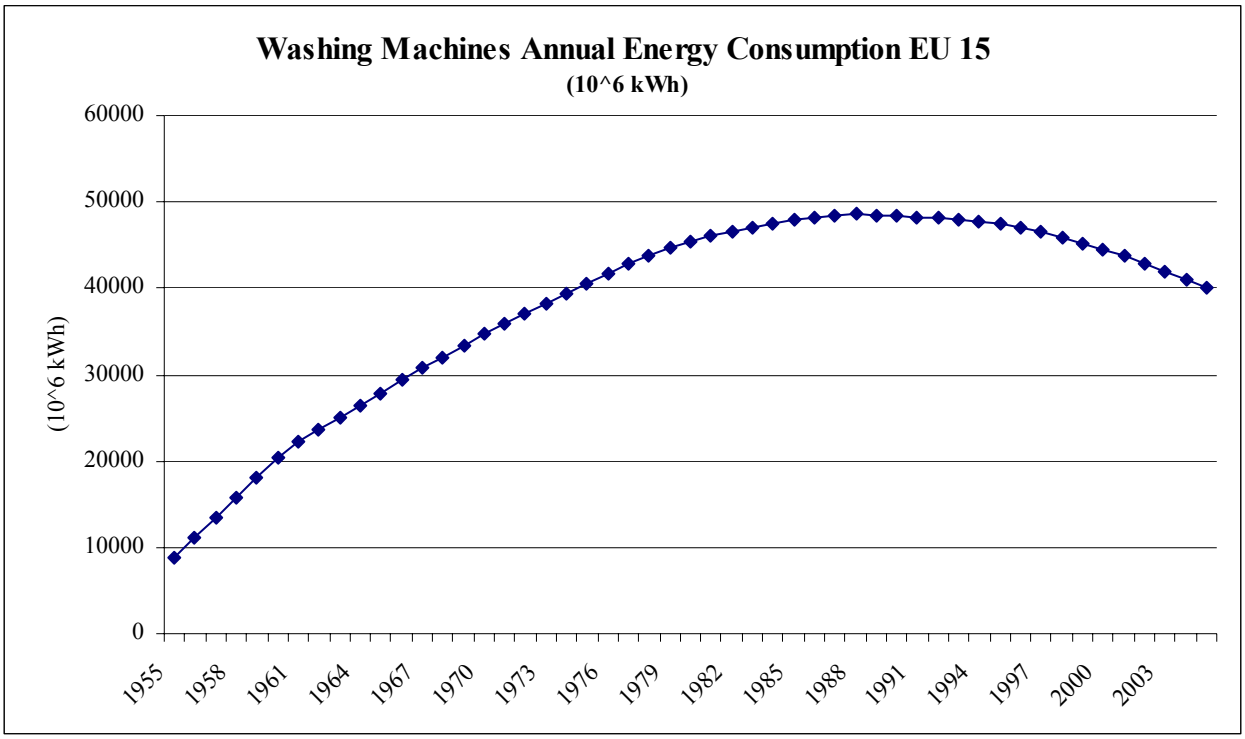


Figure 2.22 shows the unitary energy consumption trend of the refrigerator stock for the same period of time, obtained by dividing the energy consumption data by the corresponding stock data. The EU 15 stock unitary consumption passes from the 969 kWh/app of 1955 to the 304 kWh/app of 2005 with an efficiency gain of the 69 %.

Figure 2.22 Washing machines unitary stock energy consumption trend for EU 15 (1955 – 2005)

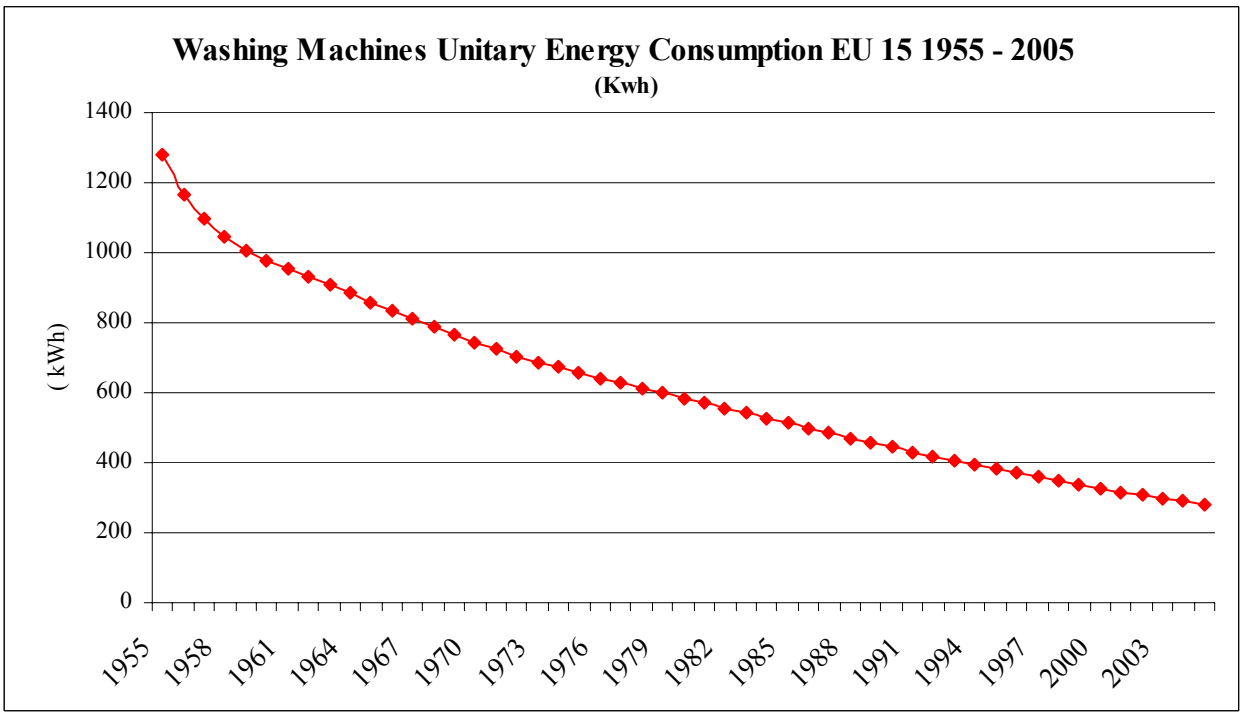


Table 2.13 shows the appliances stock and the corresponding total and unitary energy consumption as provided by the stock model. Table 2.14 shows the corresponding five-year variation rates.

Table 2.13 Main figures from the stock model; absolute values

Year	Washing machines Stock	Total stock Energy Consumption	Unitary stock Energy Consumption
	thousand	*GWh/ year*	*kWh/year*
1990	109.042	66.463	610
1995	124.425	58.280	468
2000	136.424	50.684	372
2005	143.193	43.525	304

Table 2.14 Main figures from the stock model; five-years variation rates

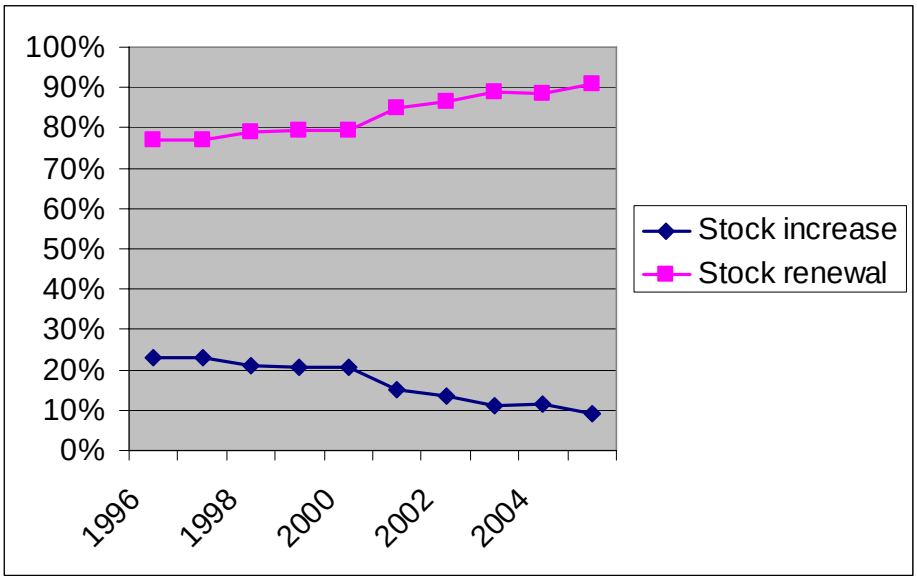
Year	Washing machines Stock	Total stock Energy Consumption	Unitary stock Energy Consumption
	%	%	%
1990-1995	14,11	-12,31	-23,15
1995-2000	9,64	-13,03	-20,68
2000-2005	4,96	-14,12	-18,18

From the pattern of the variation rates it is possible to conclude that:

- The stock growth rate is rather high till the year 2000 after which has started the saturation phase even if the ownership rate has not arrived at the 100 % and probably will never achieve this point due to the habit of some European consumers to use the public laundries (and it is likely that this choice will even increase and not decrease in the future, see paragraph 2.3.1.1)
- Despite the stock absolute growth, the energy consumption decreases steadily along the entire period (1990 – 2005) but the residual energy efficiency potential is decreasing rather rapidly.
- The combined phenomena of the stock growth rate saturation and the little expected energy consumption improvement may lead to a future flattening of the energy consumption of these appliances (and even to an energy consumption increase when the stock is entirely renewed, if the current washing technology and habits will not change)

Finally, knowing the sales and stock trends it is possible to estimate the sales split between the net stock increase and the stock renewal. At the year 2005 only the 10 % of the sales (the total sales were around 12 millions of appliances) contributes to the stock increase while the 90 % goes to the stock renewal. Figure 2.23 shows the sales split trend for the last 10 years. Being the stock totally saturated, in the future the portion of the sales that will go to the net stock increase will only depend to the household growth rate.

Figure 2.23 Sales split trend for the Washing machines in the EU 15 countries



2.2.3.3 Stock model results for Dishwashers in EU15

The calculation procedure is obviously the same applied to the washing machines. The required input parameters for the analysed period (1968-2005) are:

- the *energy average consumption* of the product or import in the year of built (kWh /year) [98];
- the *number households* in EU15 ;
- the *ownership rate*

The average unitary energy consumption data are then the following:

Table 2.15 Unitary Energy Average Consumption and cycle /year of Dishwashers in EU 15 (kWh/app year)

Year	Energy Average Consumption (kWh/year)	Cycle / year (numbers)
1968-1979	2,57	208
1980-1984	2,35	208
1985-1989	2,13	208
1990-1994	1,91	208
1995-1997	1,69	208
1998-1999	1,434	208
2000-2004	1,268	208
2005	1,035	208

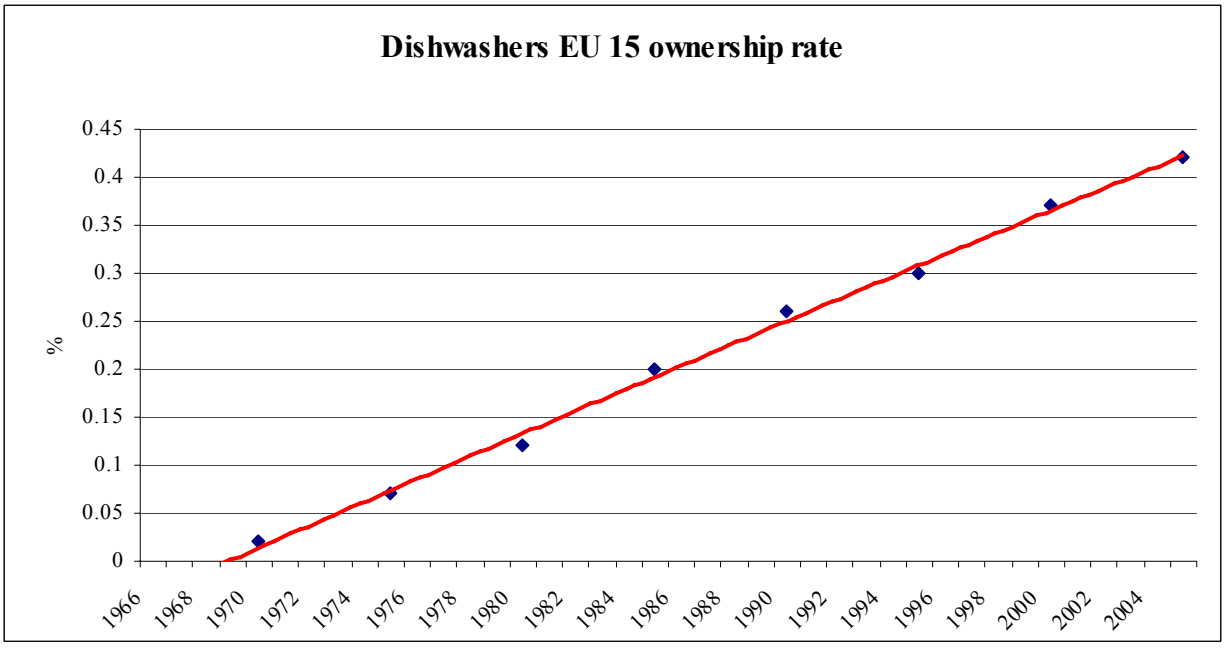
[98] Source: CECED databases and stock model [ref 6]

Also in this case the energy consumption data till the year 1997 and the yearly number of washing cycles have been provided by V.H Kemna and Rainer Stamminger and after this year the energy consumption data have been calculated on the basis of the CECED databases.

The number households in EU15 has been calculated summing up the data of each relevant country

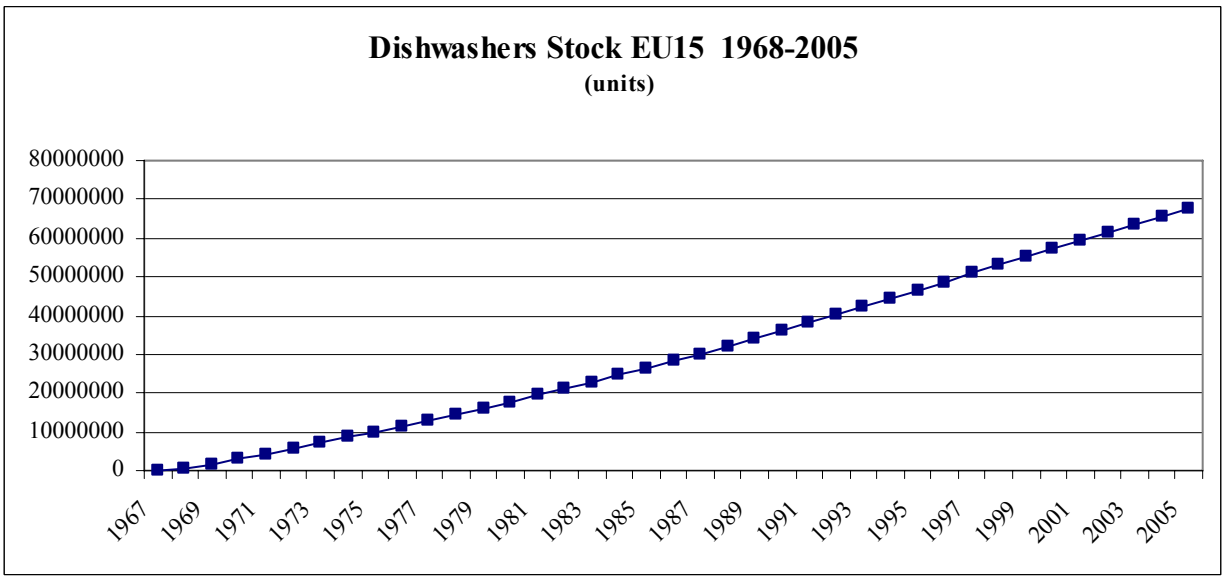
The ownership rate is estimated, assuming that:

1. before year 1968 there were no dishwashers ;
2. the growth is depicted through a linear function. In the case of the dishwasher the ownership rate is steadily growing up and there is no evidence of saturation in the stock.



From the above data it has been estimated the dishwashers stock trend for the years 1968 – 2005 (Figure 2.24).

Figure 2.24 Dishwashers stock trend for EU 15 (1968 – 2005)



By using the formula (1) at page 28 we obtain the trend of the estimated sales as shown in Figure 2.24. Also in this case the results are compared with the actual sales data of the years 2002 and 2004 (the orange triangle, GfK) in order to calibrate the model output by modifying the average lifespan. Then, by applying the formula (2) at page 30, we obtain the total energy consumption trend of the dishwashers stock for the years 1968 – 2005 as shown in Figure 2.26:

Figure 2.25 Dishwashers sales trend for EU 15 (1968 – 2005)

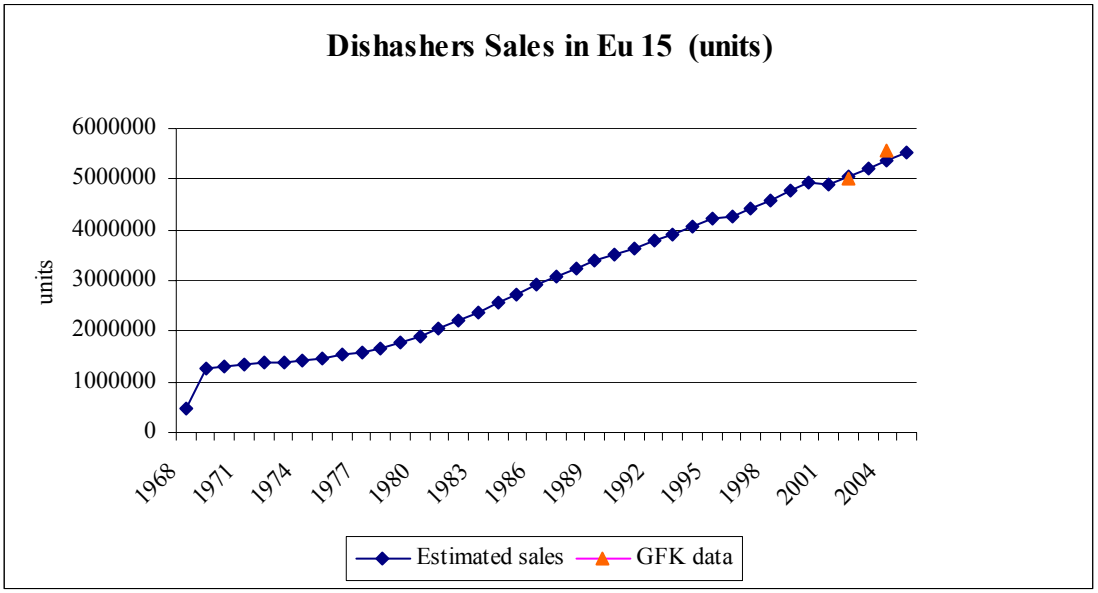
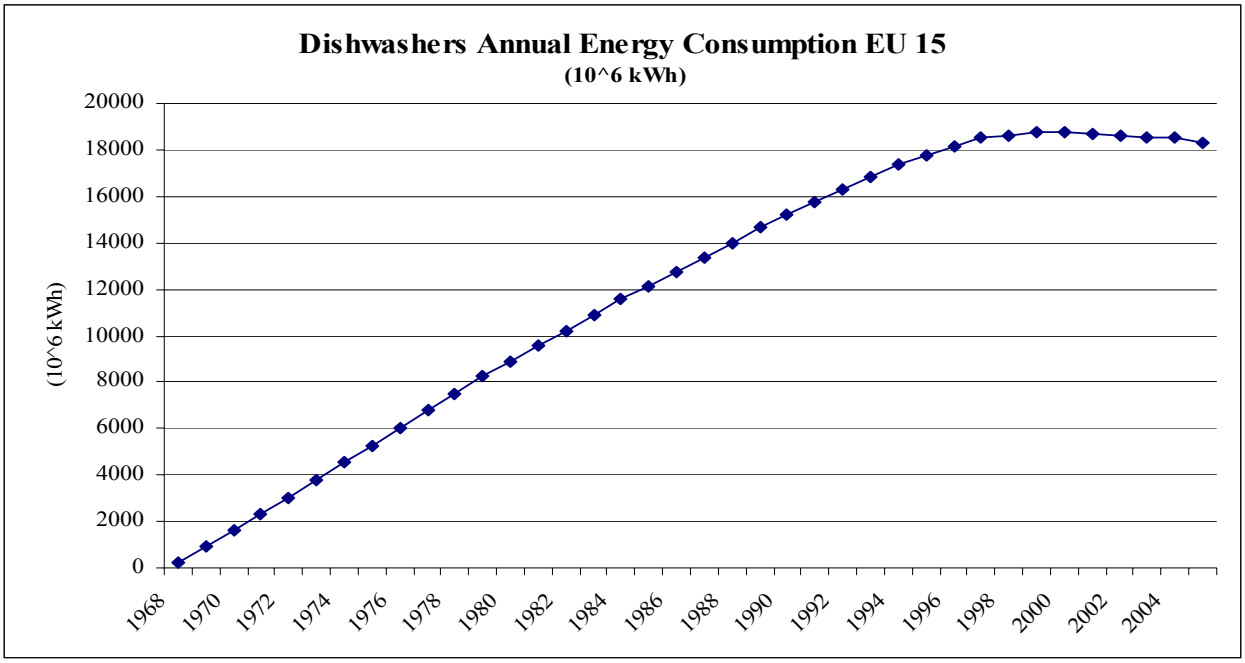


Figure 2.26 Dishwashers total stock energy consumption trend for EU 15 (1968 – 2005)



Finally Figure 2.26 shows the unitary energy consumption trend of the refrigerator stock for the years 1968 – 2005 obtained by dividing the energy consumption data by the corresponding stock data. For the dishwashers the EU 15 stock unitary consumption pass from the 534 kWh/app of 1968 to the 271 kWh/app of 2005 with an efficiency gain of the 49 %.

Figure 2.27 Dishwashers unitary stock energy consumption trend for EU 15 (1968 – 2005)

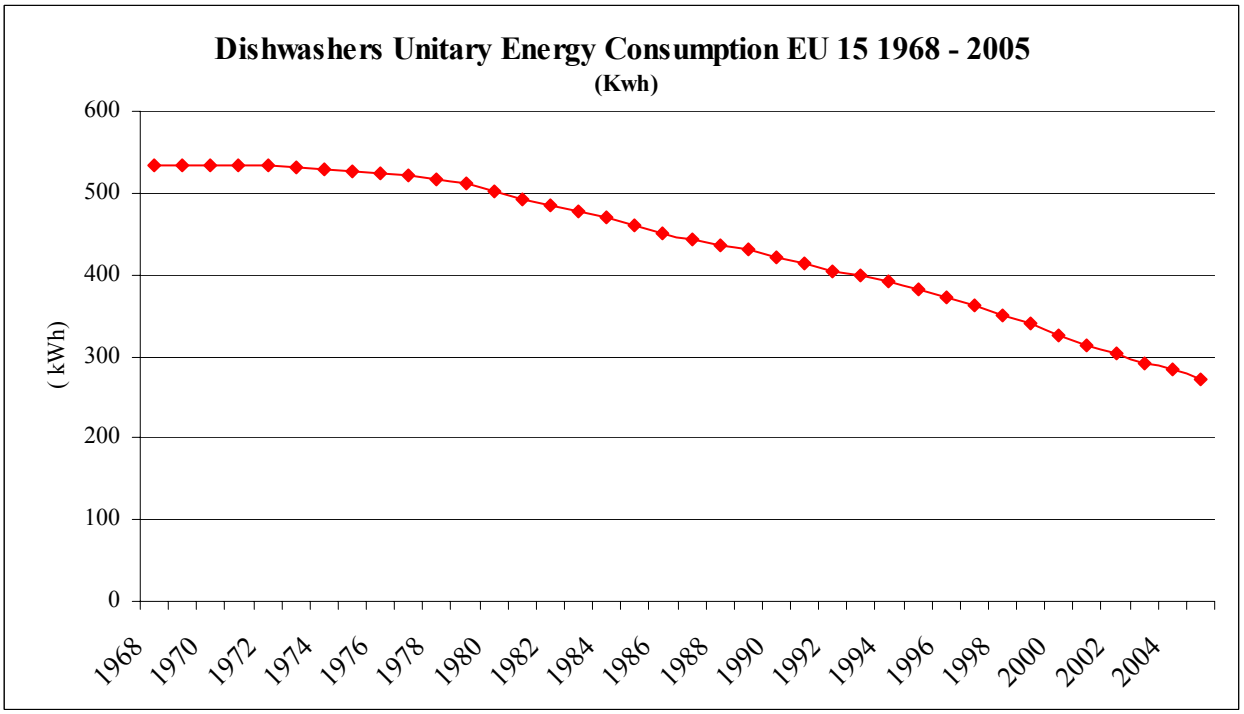


Table 2.16 shows the appliances stock and the corresponding total and unitary energy consumption as provided by the stock model and Table 2.17 shows the corresponding five-year variation rates.

Table 2.16 Main figures from the stock model; absolute values

Year	Dishwashers Stock	Total Stock Energy Consumption	Unitary Sstock Energy Consumption
	thousand	*GWh/ year*	*kWh/year*
1990	36.031	15.198	422
1995	46.640	17.785	381
2000	57.411	18.742	326
2005	67.569	18.285	271

Table 2.17 Main figures from the stock model; five-years variation rates

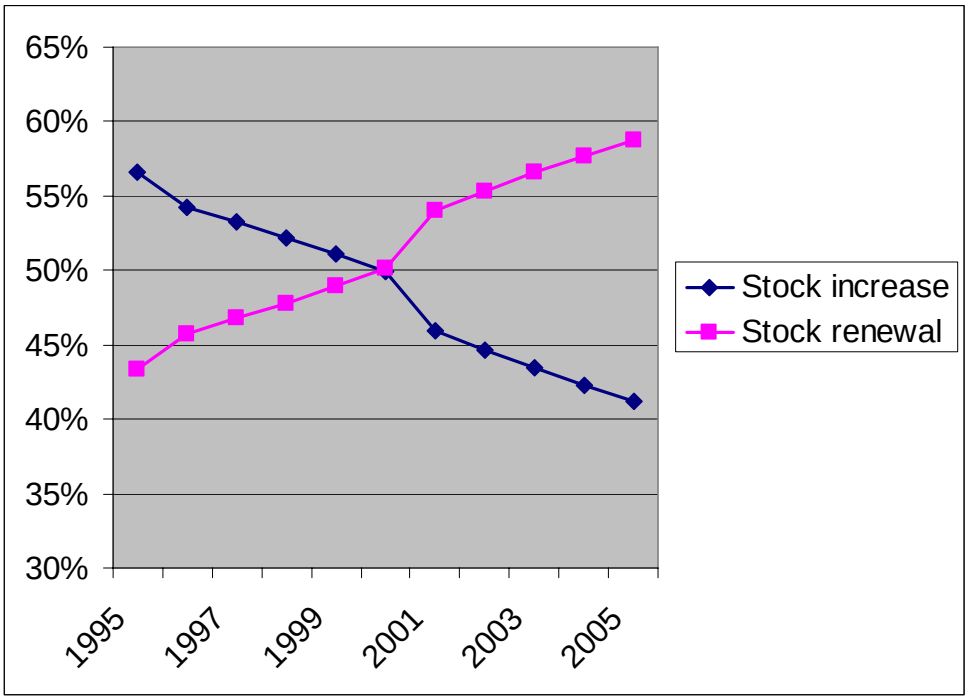
Year	Dishwashers Stock	Total Stock Energy Consumption	Unitary Stock Energy Consumption
	% variation	*% variation*	*% variation*
1990-1995	29,45	17,02	-9,60
1995-2000	23,09	5,38	-14,39
2000-2005	17,69	-2,44	-17.11

From the pattern of the variation rates it is possible to conclude that:

- the stock growth rate decreases, even if the market is far from its saturation (but it is likely that we are close to the economic saturation);
- the energy consumption increases till the year 2000 and then start decreasing due to the introduction of more efficient models;
- the appliances energy efficiency has notably increased during the last 15 years even if, also in this case, it is likely that the residual potential for further energy consumption improvement is decreasing.

Finally, also for the dishwashers, knowing the sales and stock trends it is possible to estimate, even if with less accuracy than in the washing machines case, the sales split between the net stock increase and the stock renewal. At 2005 the sales portion responsible for the stock renewal arrived at the 60 % (the sales of that year are estimated around 5 millions of units in EU 15) and it is very possible that it will further increase even if will never reach the washing machines level. Figure 2-28 shows the sales split trend for the dishwashers as provided by the stock model.

Figure 2.28 Sales split trend for the Dishwashers in the EU 15 countries



2.2.3.4 Stock model results for Washing Machines and Dishwashers in EU10

The data for the New Accession Countries are less reliable than those for EU 15, especially for what concerns the ownership rates of the Dishwashers and the share of the sales by energy efficiency classes. Here we refer to the data provided by the CECED stock model, the database of the Wuppertal Institute stock model and to the sales figures provided by GfK for the years 2002 and 2004. On the basis of these sources the main reference input data for the EU 10 stock model are:

Table 2-18 Washing Machines EU 10: ownership rates and sales energy average consumption for the years 1995, 2000, 2005

	Ownership rate	Stock- thousand	Number of washing cycles per year	Sales energy consumption (kWh/year
1995	61%	16.461	251	339
2000	72%	20.205	208	265
2005	83%	24.140	208	233

Table 2-19 Dishwashers EU 10: ownership rates and sales energy average consumption for the years 1995, 2000, 2005

	Ownership rate	Stock- thousand	Number of washing cycles per year	Sales energy consumption (kWh/year
1995	0,4%	101	208	427
2000	0,5%	139	208	351
2005	3,6%	1.039	208	279

It is worth noting here that the figure on the ownership rate of the washing machines is rather reliable. Actually, also during the socialist period, most households of the eastern countries were equipped with a washing machines and so, also in accordance with the data gathered by the SACHA projects[99], it is possible to affirm that the penetration rate of this appliances was around the 60-70 % already from the years 70'/80'. For the Dishwashers the situation is totally different and the data are less reliable. From the assessment carried out within the SACHA project during the second half of the years 90' we know that practically no dishwashers were installed up to the year 1995. Anyhow the sales of these appliances, even if concentrated on few countries, seems to have a good vivacity (i.e plus 50 % in three years in four Eastern countries, see page 14) and so we could expect this appliances to penetrate rather rapidly the eastern countries.

On the basis of these input, the stock models outputs are:

Table 2-20 Washing Machines EU 10: yearly sales, total stock energy consumption and unitary stock energy consumption for the years 1995, 2000, 2005

	Yearly sales Thousand	Total Stock energy consumption GWh/year	Unitary Stock energy consumption kWh-appliance/year
1995	1.368	8.283	503
2000	1.562	7.927	392
2005	1.679	7.747	321

Table 2-21 Dishwashers EU 10: yearly sales, total stock energy consumption and unitary stock energy consumption for the years 1995, 2000, 2005

	Yearly sales Thousand	Total Stock energy consumption GWh/year	Unitary Stock energy consumption kWh-appliance/year
1995	9	43	427
2000	13	52	375
2005	263	272	262

For the washing machines the energy consumption data for the EU 10 countries confirm the trend already observed for EU 15. For dishwashers there isa strong increase of the stock energy consumption due to the penetration in the market of these appliances, but the figures of the unitary stock energy consumption have more or less the same values and follow the same trend observed in the EU 15 countries.

For what concerns the sales split by stock increase and stock renewal, the washing machines show a trend very similar to the EU 15 countries but a little bit postponed due the lower ownership rate of these appliances in the EU 10 market. (at 2005 25 % of the sales go to the stock increase and 75 %

[99] The SACHA 1 and SACHA 2 projects (SAVE programme, years 1995-1998) evaluated the refrigerators and washing machines state of art in 7 Eastern countries.

to the stock renewal). The behaviour of the dishwasher sales is, as expected, totally different. Actually, starting from the year 2000, practically all the sales go to increase stock and very little to his renewal (97 % versus 3 % at 2005, seeFigure 2.29). This particular dynamics can be understood by observing the stock and sales trend of this appliance, as provided by the stock model (Figure 2.30): after the year 2000 the logistic curve enters in the phase of the maximum dynamics of the market where all the sales contribute to the stock increase. It should be necessary to have more data from the market to assess the robustness of this stock trend hypothesis, mainly based on a good guessing of the initial point and the observed data of the final point. But, if we trust on the capacity of the logistic curves to describe the market trends, what plotted here provides a convincing representation of what is nowadays happening in the Eastern countries for this appliance.

Figure 2.29: Sales split for dishwashers in the EU 10 countries

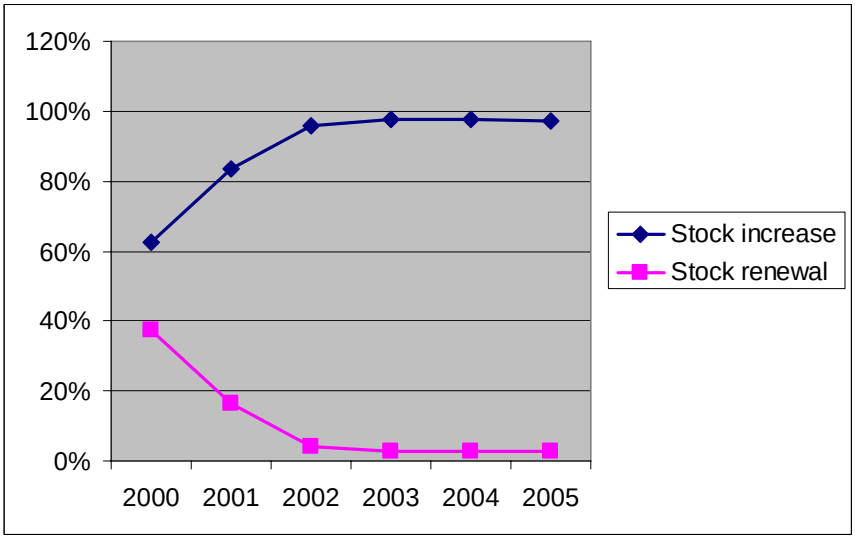
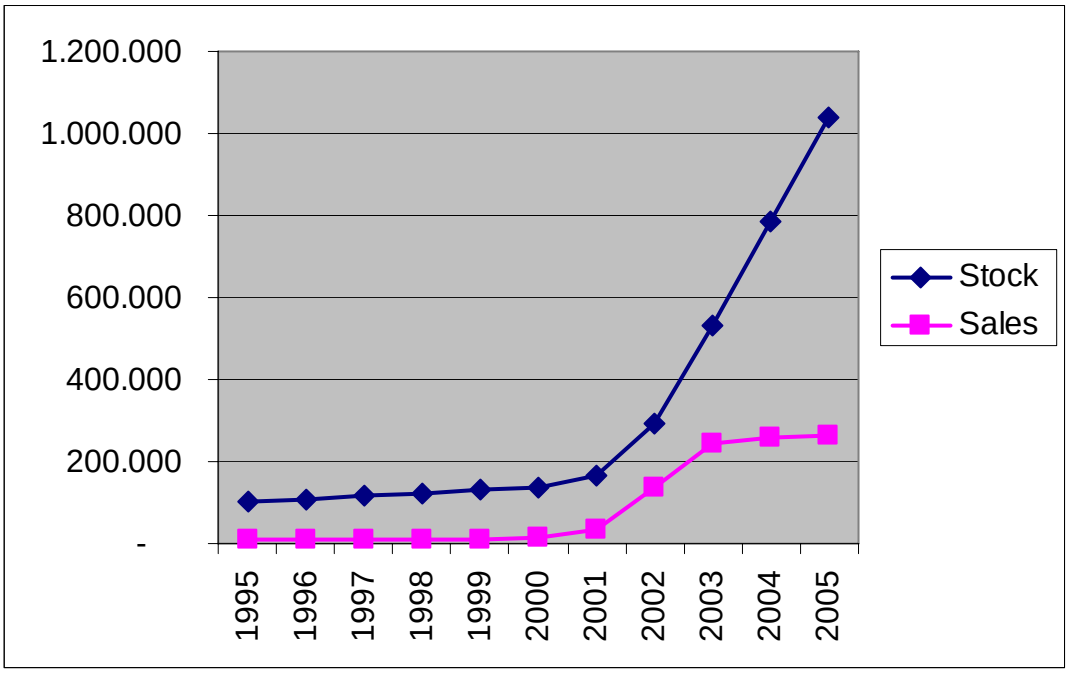


Figure 2.30: Stock and sales trend of the dishwashers in the EU 10 countries



2.2.3.5 Stock model results for Washing Machines and Dishwashers in EU25

Summing up the results obtained from the stock model for EU 15 and EU 10 we obtain the figures shown in tables 2-22 and 2-23. There are no more to add here to the analysis carried out on the two separated cases. Practically the 91 % of the households in the EU 25 owns at least one washing machine (of which the 70 % of class A) and approximately the 37 % possess a Dishwasher. The overall final energy consumption to wash clothes and dishes with these appliances is close to 70 TWh that have to be provided by power plants having an overall installed capacity of 20 GW (assuming a primary/final energy coefficient of 2,5).

Table 2-22 Washing machines EU 25: Stock, total stock energy consumption and unitary stock energy consumption for the years 1995, 2000, 2005

Year	Washing machines Stock *thousand*	Total stock Energy Consumption *GWh/ year*	Unitary stock Energy Consumption *kWh/year*
1995	140.886	66.563	472
2000	156.629	58.611	374
2005	167.333	51.272	306

Table 2-23 Dishwashers EU 25: Stock, total stock energy consumption and unitary stock energy consumption for the years 1995, 2000, 2005

Year	Dishwashers Stock *thousand*	Total Stock Energy Consumption *GWh/ year*	Unitary stock Energy Consumption *kWh/year*
1995	46.741	17.828	381
2000	57.550	18.794	327
2005	68.608	18.557	270

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3. Pernille Schiellerup. (1995) *DECADE : Domestic Energy and Carbon Dioxide Emissions* .University of Oxford (UK)
4. Kevin Lane (2000) *Lower Carbon Future Appendix O: Modelling approach* Environmental Change Institute , Oxford (UK)
5. Market Transformation Programme *BNC08 Assumption underlying the energy projections for domestic cold appliances* www.mtprog.com
6. R. Stamminger, R. Kemna *Report on Energy Consumption of Domestic Appliances in European Household* CECED
7. Personal Communication Wuppertal Institute

2.3 MARKET TRENDS

In this subtask the possible market tendencies and trends on the dishwashers and the washing machine market will be highlighted, along with the developments and opinions of industry and consumers. On the manufacturer side the product data of the last 10 years, current product presentations (brochures, web presences) and the results of an opinion poll between the main manufacturers will be analysed. In order to estimate possible trends of the consumer, European consumer magazines and the results of the European consumer survey will be analysed.

The target of this analysis is to evaluate the present dominant and future trends on the market of these two wash appliance products.

2.3.1 Market trends for washing machines

2.3.1.1 General market trends

The household appliance market of washing machines is characterised by a high saturation. In the future it will be expected that the market is mainly driven by a substitution of old appliances. For Europe it was evaluated that 188 million household appliances are older than 10 years (Figure 2.31), whereof 40 millions are washing machines.

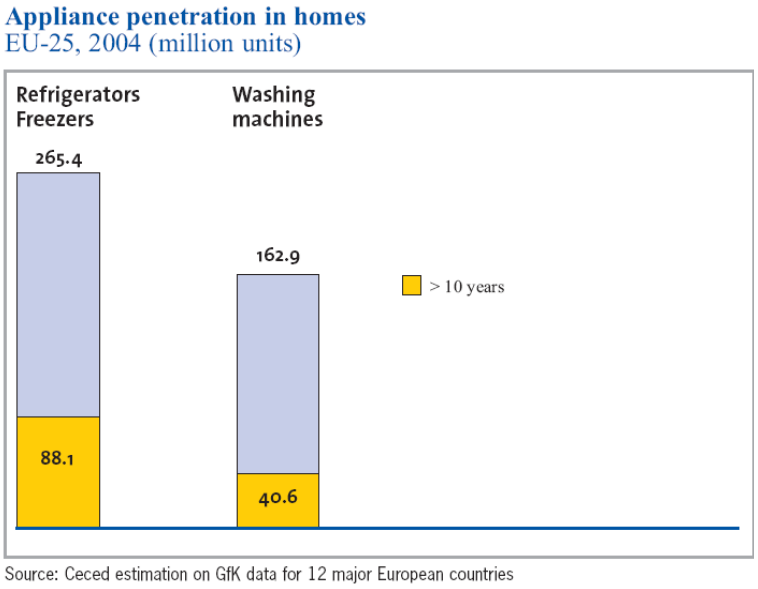


Figure 2.31 Household appliances penetration in homes EU-25, 2004 (source: CECED[100])

2.3.1.1.1 a) Washing machines market saturation development

Detailed data of the development of washing machine penetration in European households are only available for specific countries:

[100] CECED (2006): White Paper: Energy efficiency a shortcut to Kyoto targets. The vision of European home appliance manufacturers, S.18 Online: http://www.ceced.org/IFEDE//easnet.dll/GetDoc?-APPL=1&DAT_IM=20429D&DWNLD=White Paper_Energy efficiency_Feb 2006_Final.pdf

Czech Republic

In the last 12 years the share of washing machines in Czech households showed an average yearly increase of 3 %. In the year 2005 the saturation level reached a value of over 90 %.

CZ: PUBLIC SPENDING, SOCIAL SPHERE, CULTURE, LIVING STANDARD													
Consumer durables per 100 households	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
refrigerator	13,8	18,4	25	29,4	35,2	39,2	45,1	50,5	54,8	58,1	61,7	66,3	.
automatic washing machine	63,7	65,6	69,7	73,5	78,1	80,1	81	84,1	86,4	88,7	89,9	91,2	94,9

Figure 2.32: Household appliances in households, 1993-2005 – CZECH REPUBLIC[101]

Finland

In comparison with other European countries, like France or Germany, the washing machines level in Finnish households is lower, with only 87 % (2002) (Figure 2.33). Between 1998 and 2001/2002 washing machines showed an increase of 4 %.

Table 4.1. Households' ownership of consumer durables, 1966-2003, % of households

Consumer durable	1966	1971	1976	1981	1985	1990	1995	1998	2001/02	2003*)
	%	%	%	%	%	%	%	%	%	%
Refrigerator	44	74	93	94	96	96	97	97	..	..
Freezer	1	7	40	54	70	78	83	85	87	..
Microwave oven	..	..	..	..	..	52	72	78	84	..
Washing machine	53	61	74	71	67	80	83	83	87	..
Dishwasher	..	1	5	10	17	33	41	43	50	..
Vacuum cleaner	48	63	86	88	93	96	..	..	..	..

Source: Statistics Finland, Household Budget Survey and Consumer Survey

**) Data based on Statistics Finland's Consumer Survey (02/2003). Data collection differs from that of the Household Budget Survey*

.. data not available

Figure 2.33: Household appliances in households, 1966-2001/02 – FINLAND[102]

France

The average saturation of washing machines in French households reached a value of 94,7 % in the year 2007 (Figure 2.34), a growth of 2,5 % in comparison with the saturation level in 2004 (92,2 %)[103].

Rate of equipment	in %
washing machine	94,7

Figure 2.34: Household appliances in households, 2007 – FRANCE[104]

[101] http://www.czso.cz/eng/redakce.nsf/i/table_3_public_spending_social_sphere_culture_living_standard_bf/$File/3bf_pub.xls

[102] http://www.stat.fi/index_en.html)

[103] http://www.insee.fr. Online: http://www.insee.fr/en/ffc/figure/NATSOS05106P.XLS

Germany

96 % of all German households possess a washing machine (Figure 2.31), having slightly increased over the last decades.

Saturation of the German market in % of the households											
Houshold appliances											stock (in mio. units)
source: GfK	1980*	1985*	1990*	1995	2000	2002	2003	2004	2005	2006	2006
washing machine	88	90	92	94	93	93	94	94	95	**96**	**37,6**
laundry dryer	8	13	20	25	34	36	38	39	41	**44**	**17,3**
automatic dishwasher	21	27	35	40	52	57	57	58	59	**61**	**24,1**
cookers/oven	77	78	79	80	83	84	84	84	85	**85**	**33,4**
refrigerator	95	95	96	96	99	99	99	99	99	**99**	**39,0**
freezer	49	54	58	67	62	57	55	55	55	**54**	**21,4**
number of households (in millions)	25,0	26,4	28,2	36,9	38,1	38,7	38,9	39,1	39,2	**39,2**	**199,6**
other household appliances											stock (in mio. units)
microwave oven	1	4	33	52	59	63	65	66	67	68	26,8
*until 1999 old Germany											

Figure 2.35: **Saturation of the German market (source: ZVEI (2006)[105])**

[104] http://www.gifam.fr/pages/lemarche/lemarche.html

[105] ZVEI (central association electro-technology and electronic industry registered association / Zentralverband Elektrotechnik und Elektronikindustrie e.V.) (2006/7): Zahlenspiegel des deutschen Elektro-Hausgerätemarktes. Der Inlandsmarkt der Elektro-Hausgeräte-Industrie/ Verkäufe von Elektro-Großgeräten/ Verkäufe von Elektro-Kleingeräten/ Marktsättigung. See: http://www.zvei.de/index.php?id=585&no_cache=1&tx_ZVEIpubFachverbaende_pi1[download]=681&type=98

Hungary

The level of washing machines in the Hungarian households is comparable with Poland, with 88 %. Also there was an increase of nearly 7 % over the period of 2000 to 2004 (Figure 2.36).

háztartásokban, 2000–2004 – *Average yearly stock of consumer durables in the lowest and in the highest deciles, 2000–2004*

Megnevezés *Denomination*	Év									
	2000		2001		2002		2003		2004	
	Decilisek – *deciles*									
	1.	10.	1.	10.	1.	10.	1.	10.	1.	10.
Tartós fogyasztási cikkekel rendelkezők aránya, % – *Share of households with consumer durables, %*										
Hűtőszekrény – *Refrigerator*	81,3	75,0	84,2	71,3	81,2	77,8	79,4	66,7	75,4	62,1
Fagyasztógép – *Deep freezer*	34,7	52,3	42,1	53,2	46,0	52,7	43,0	51,6	42,4	46,3
Hűtő- és fagyasztógép – *Refrigerator and deep freezer*	13,6	31,0	10,9	33,1	14,6	27,7	16,7	41,7	20,4	45,6
Mikrohullámú sütő – *Microwave oven*	26,4	72,6	29,1	75,5	36,6	77,4	44,4	83,3	54,8	85,3
Mosogatógép – *Dishwasher*	..	..	0,7	6,1	1,5	7,8	0,5	13,0	3,1	13,5
Mosógép, automata és félautomata – *Washing machine, automatic, semi-automatic*	35,1	81,7	38,9	81,7	43,2	84,5	43,2	89,2	52,2	88,0
Szárítógép – *Drying machines*	..	..	1,9	1,2	0,8	1,0	0,1	1,1	0,6	1,0
Porszívó – *Vacuum cleaner*	..	..	69,5	89,4	71,8	92,4	69,8	91,9	75,0	91,0
Takarítógép – *Cleaning machine*	..	..	4,5	17,6	5,6	14,7	7,1	21,0	5,5	16,9
Varrógép – *Sewing machine*	..	..	23,4	33,4	23,3	35,6	22,6	36,8	22,9	35,5
Színes televízió – *Television set, colour*	82,9	95,8	85,5	95,5	89,7	97,2	89,6	98,8	92,2	97,7
CD-lejátszó – *CD player*	..	..	5,8	23,2	8,6	23,4	13,5	30,3	16,6	35,3
Magnó, magnós rádió – *Tape-recorder with radio*	..	..	54,9	59,6	59,7	63,3	58,8	66,0	58,9	60,7
Hifitorony – *HI-FI set*	..	..	15,2	46,0	23,6	48,4	25,0	57,3		
Videomagnó – *Video-recorder*	35,2	67,4	32,8	68,8	41,2	67,7	40,7	73,5	46,1	70,7
DVD – *DVD*	..	..	0,4	3,2	0,4	5,5	4,2	15,2	10,4	24,6
Személyi számítógép – *Personal computer*	4,4	26,3	5,9	35,0	12,4	38,2	17,9	52,3	20,6	57,4
Légkondicionáló – *Air conditionset*	..	..	0,7	3,6	0,1	2,3	0,5	5,4	0,2	7,3

Figure 2.36: Household appliances households, 2000-2004 – HUNGARY (source: Hungarian Central Statistical Office)

Poland

Poland belongs to the group of countries which does not show a high saturation of washing machines in the households, as e.g. in Germany. About 86 % of all Polish households had a washing machine in 2005[106] (Figure 2.37). Within five years (2000-2005) the saturation of washing machines showed an increase of 5% (Figure 2.37).

[106] GUS (www.stat.gov.pl)

http://www.stat.gov.pl/urzedy/opole/publikacje/rocznik_woj/budzety_gospodarstw_domowych/04w08_05.pdf

TABL. 5 /98/. **GOSPODARSTWA DOMOWE WYPOSAŻONE W NIEKTÓRE PRZEDMIOTY TRWAŁEGO UŻYTKOWANIA** [a]

HOUSEHOLDS FURNISHED WITH SELECTED DURABLE GOODS [a]

WYSZCZEGÓLNIENIE	2000	2004	2005	*SPECIFICATION*
	w % ogółu badanych gospodarstw domowych *in % of total households*			
Chłodziarka	98,8	98,2	98,54	*Refrigerator*
Zamrażarka	54,2	34,8	34,85	*Freezer*
Automat pralniczy	82,2	85,9	86,45	*Automatic washing machine*
Zmywarka do naczyń	2,7	4,7	7,23	*Dishwasher*
Kuchenka mikrofalowa	x	34,6	43,49	*Microwave oven*
Samochód osobowy	51,0	47,4	49,53	*Passenger car*
Odbiornik radiofoniczny	59,6	54,8	49,67	*Radio set*
Zestaw do odbioru, rejestracji i odtwarzania dźwięku (wieża)	37,5	43,1	45,58	*Hi-fi stereo music system*
Odbiornik telewizyjny	99,0	98,3	98,66	*Television*
Magnetowid	54,5	45,3	43,33	*Videorecorder*
Urządzenie do odbioru telewizji satelitarnej [b]	58,1	53,7	58,32	*Satellite television equipment* [b]
Komputer osobisty	14,0	31,6	36,35	*Personal computer*
w tym z dostępem do Internetu	x	13,1	19,27	*of which with access to the Inter*

a Opracowano na podstawie stanu w końcu poszczególnych kwartałów. *b* Łącznie z telewizją kablową.
a Compiled on the basis of data at the end of individual quarters. b Including cable television.

Figure 2.37: Household appliances in households, 2000-2005 – POLAND (source: GUS)

Spain

In Spain the level of saturation of washing machines reached nearly 95 % in the year 2005, similar to other western European countries, like Germany or France.

Spain: 2005 Living Conditions Survey

Housing, facilities and equipment

	Total	Telephone	Colour television	Personal computer	Washing machine	Car
Total	15141,3	97,4	99,3	50,3	98,5	75,4

Figure 2.38: Household appliances in households, 2005 – SPAIN[107]

Sweden

In the year 2002 only 72 % of all Swedish households possessed a washing machine[108]. This low value can be explained by the high level of washing machines available in laundry rooms of apartment blocks, used by more than one family.

[107] Fuente: National Statistics Institute www.ine.es

[108] STATISTICS SWEDEN (2004): Living condition report No.107: the way we live in Sweden homes, The living environment and transportation 1975-2002. Online: WWW.SCB.SE/STATISTIK/_PUBLIKATIONER/LE0101_1975I02_BR_LE107SA0401.PDF S.177

Equipment in Swedish homes	
	2002
Dishwasher	56
Washing machine	72
Microwave oven	83

Figure 2.39: Household appliances in households, 2002 – SWEDEN (Source: Statistics Sweden)

UK

The development of the saturation level of washing machines shows a continuous rising during the last 30 years from 65 % (19970) up to 91 % (1995-96). During the following years only a low increase can be noticed (Figure 2.40).

	9.3 Percentage of households with durable goods 1970 to 2002-03			
	Washing machine	Tumble Dryer	Dishwasher	Internet connection
1970	65	--	--	--
1975	72	--	--	--
1980	79	--	--	--
1985	83	--	--	--
1990	86	--	--	--
1994-95	89	50	18	--
1995-96	91	50	20	--
1996-97	91	51	20	--
1997-98	91	51	22	--
1998-99	92	51	24	9
1998-99*	92	51	23	10
1999-	91	52	23	19
2000-01*	92	53	25	32
2001-02[3] *	93	54	27	39
2002-03*	94	56	29	45

-- Data not available.
* Based on weighted data and including children's expenditure
1 Full or partial.
2 Includes digital and cable receivers
3 From 2001-02 onwards, weighting is based on the population figures from the 2001 census
ONS, Family Spending 2002-03, © Crown copyright 2004

Figure 2.40: Household appliances in households, 1970-2002-03 – UNITED KINGDOM[109]

2.3.1.1.2 b) The energy label for washing machines

The Energy label played a decisive role for development of the market of household appliances in the last decade. It provides the consumer with the opportunity to compare different appliances. The label informs about relevant consumption values concerning energy and water and informs on the most relevant performance criteria like capacity, cleaning/washing performance or noise emissions.

[109] Source: http://www.statistics.gov.uk/StatBase/ssdataset.asp?vlnk=7611&Pos=4&ColRank=1&Rank=272

This leveraging of the information provided to the customer has forced "manufacturers … to introduce new, more efficient products", to be on a competitive basis[110].

On the contrary to refrigerators and freezers, in 2002 to introduction of a new energy efficiency class "A+" in the energy labelling scheme for washing machines, to further differentiate the machines which are beyond the level of energy efficiency class A, was not accepted by the European Commission and the Member States[111]. Industry has then agreed unilaterally to regulate the claims of better energy efficiency then class A, through the creation of a commercial label "A+" to specific energy consumptions of ≤ 0,17 kWh/kg (class A has an energy consumption ≤ 0,19 kWh/kg) and to require that washing performance to be in class A as well[112].

2.3.1.1.3 c) Buying criteria

86 % of all German consumers choose the energy label as a source of information when they purchase a new appliance[113]. Some studies, e.g. the Swiss SAMMER/WÜSTENHAGEN[114] or the German INNOFACT AG[115] about the consumer "buying" behaviour result that some criteria listed on the Energy label are the primary attention points for the consumer when they have to choose a new appliance.

The German study of the INNOFACT AG in the year 2005 asked customers which criteria will affect the purchase decision for a new household appliance. Over 23 % of the consumers mentioned (Figure 2.37) that energy and water consumption are the main buying criteria which influence the purchase, followed by the price (18 %) and the performance date, which also are listed on the energy label.

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[110] World energy council (2005): Energy Efficiency Policies and Indicators Online: http://www.worldenergy.org/wec-geis/publications/reports/eepi/policy_evaluation/labelling.asp

[111] see www.CECED.org, text dated 27.6.2006

[112] CECED: Energy declaration of washing machines. Online http://www.ceced.org/IFEDE/easnet.dll/GETDoc?APPL=1&DAT_IM=202A9C&DWNLD=Revised%20Unilateral%20Industry%20Commitment%20on%20washing%20machines

[113] http://www.greenlabelspurchase.net/Licht_EU_Energie_Label.html

[114] Katharina Sammer and Rolf Wüstenhagen (2004): The Influence of Eco-Labelling on Consumer Behaviour – Results of a Discrete Choice Analysis for Washing Machines Institute for Economy and the Environment (IWOe-HSG), University of St. Gallen, Switzerland; Business Strategy and the Environment 15, 185–199 (2004). Published online in Wiley InterScience (www.interscience.wiley.com) DOI: 10.1002/bse.522

[115] www.markt-studie.de: Purchase decision – washing machines (2005): summary of the study. Publisher: Innofact AG. Online: HTTPS://WWW.MARKT-STUDIE.DE/STUDIEN/KAUFENTSCHEIDUNG-WASCHMASCHINEN-2005-VIEW-8288.HTML#STUDIE. FIG.ONLINE: HTTP://WWW.WERKSSCHLIESSUNG.ELECTROLUX-PRESSE.DE/UPLOAD/6A0AB4EEX1096C430144X545E/1212694187_-627750027_GRA_GRAFIK_3_KAUFKRITERIEN_4C_091205.JPG

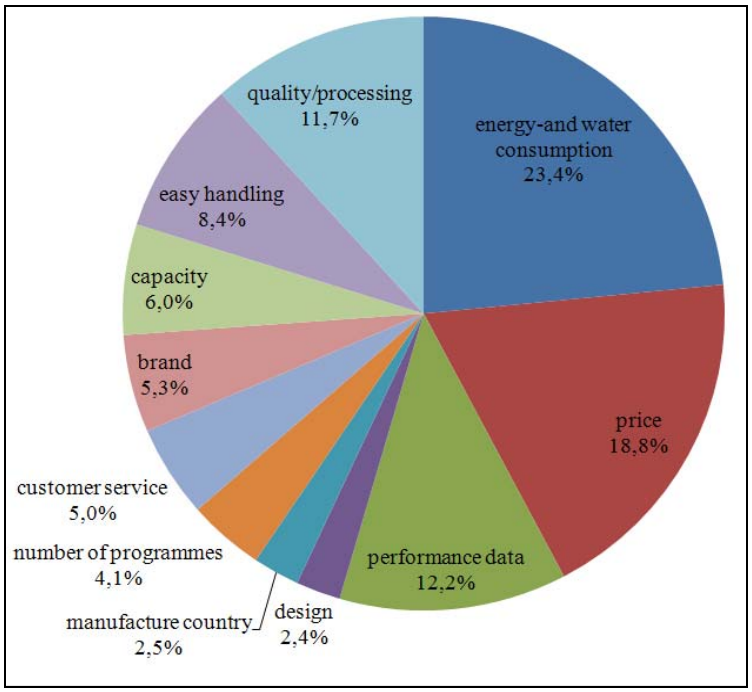


Figure 2.41: Innofact study: buying criteria – washing machine 2005

But also other criteria are important for the customers. For example the mentioned Swiss study of the Institute for Economy and the Environment (University of St. Gallen) in the year 2004 analysed the results of the interviews of 302 customers (n = 151 purchase a washing machine) about their purchase criteria. The first priority mentioned by the consumers when buying a new appliance was *the price of the appliance*, followed by *equipment* and then *the energy consumption*. The criteria *energy and water consumption* mostly take the leading position in the second and third priority level for the consumer (Figure 2.42).

Criteria	1. Priority	2. Priority	3. Priority
Price	**31.8%**	**21.2%**	**15.9%**
Equipment	**19.2%**	7.3%	8.6%
Energy Consumption	**11.9%**	**25.2%**	**17.2%**
Brand	9.3%	8.6%	8.6%
Water Consumption	7.9%	**11.9%**	**13.9%**
Wash Load Capacity	5.3%	10.6%	6.0%
Dimensions	4.6%	6.0%	4.0%
Design	1.3%	1.3%	3.3%
Short Wash Time	0.7%	3.3%	9.3%
Low Noise	0.7%	2.0%	7.3%
Dryer integrated	0.0%	0.7%	0.7%
Other	7.3%	1.3%	4.0%
Total	**100.0**	**99.3%**	**98.7%**
N	151	150	149

Figure 2.42: most important criteria when buying a washing machine (Sammer/Wüstenhagen (2004))

2.3.1.2 Market trends: models offered on the market

This analysis uses the database of all models of washing machines offered in the European market as provided by CECED. Databases are available for all years from 1997 to 2005 for washing machines. It is worth mentioning, that during this period, the European Union has been enlarged from 15 countries to 25 countries, or from some 380 million inhabitants to 480 million inhabitants.

This increase in market size has not caused a significant change in the number of models of washing machines as seen in these databases (Figure 2.43).

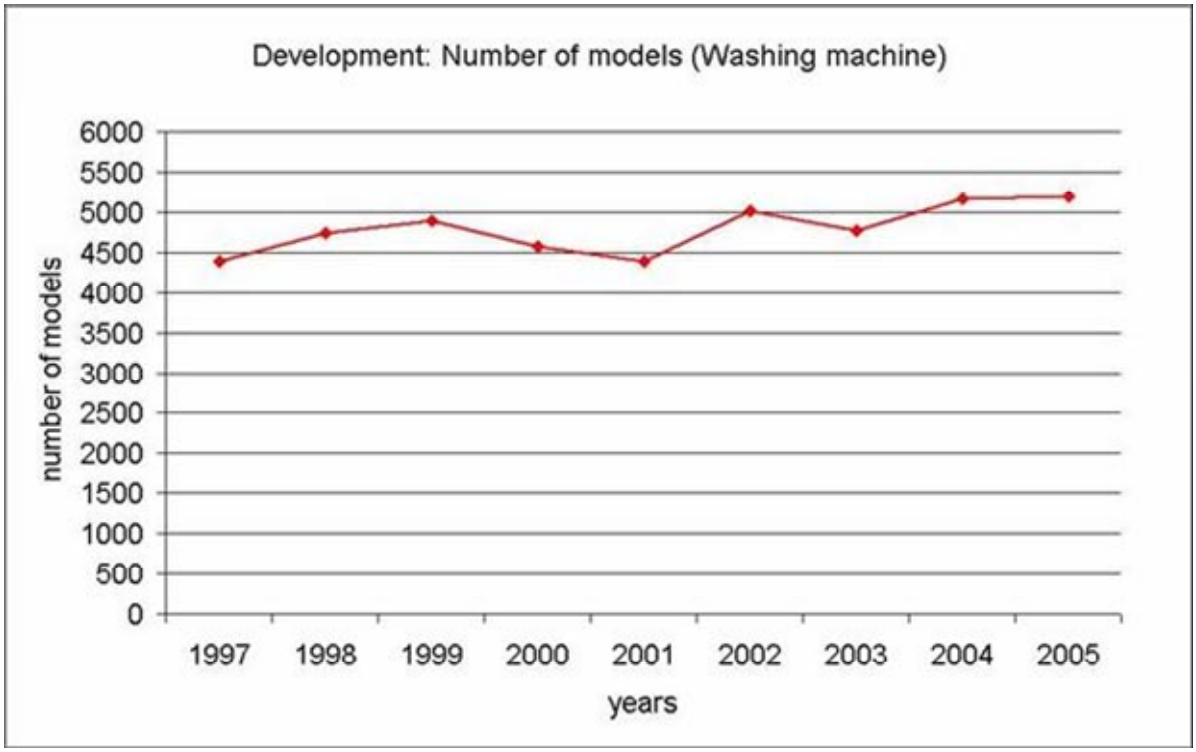


Figure 2.43- 1 development of number of models of washing machines in CECED databases

The average capacity (Figure 2.44) of the machines offered has changed from about 4,8 kg in 1997 to less that 5,4 kg in 2005. This tendency seems to have just started in 2002 (Figure 2.45) and is increasing its trend. As average household size is getting smaller, there must be other then demographic explanations for this development. Taking a more detailed look at the data, two reasons can be identified (Figure 2.46): first, models of capacities from 4 to 5 kg are substituted by models of 5 to 6 kg and second, new models with 7 kg capacity or even higher are introduced in the market. Small washing machines with 3 kg are available, but are almost unchanged in their market presentation (Figure 2.47).

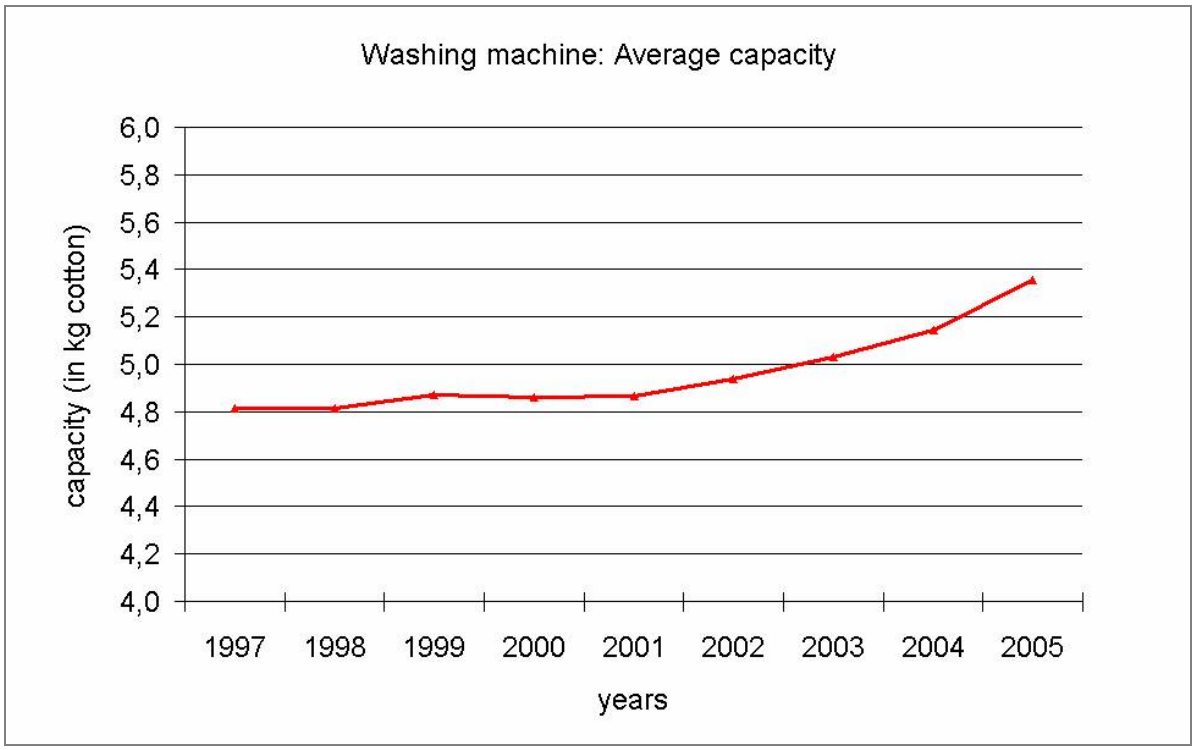


Figure 2.44: average rated capacity of washing machines

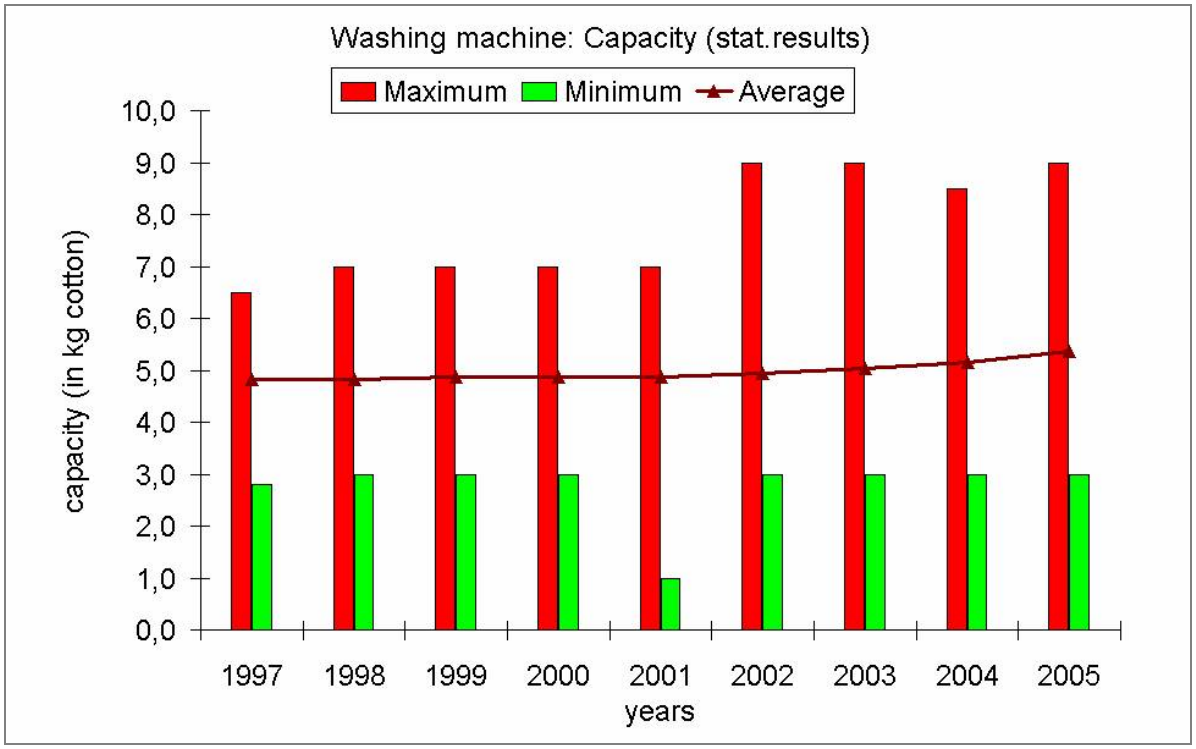


Figure 2.45: minimum, maximum and average rated capacity for washing machines

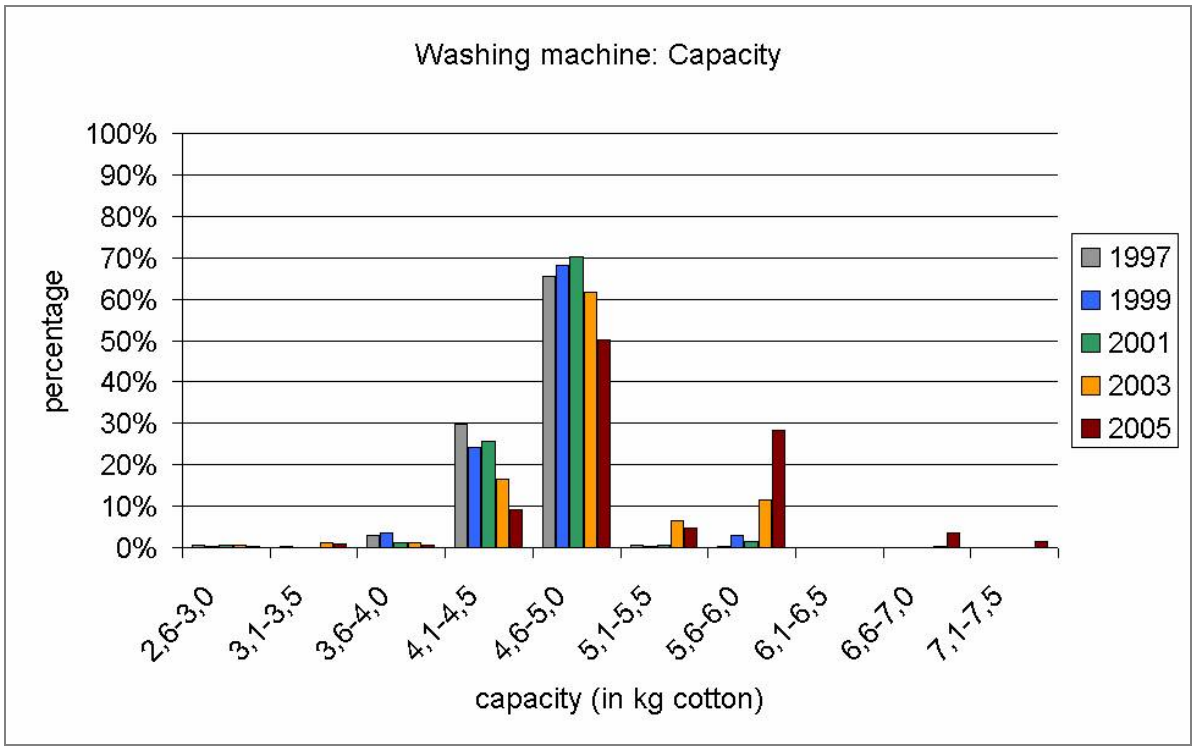


Figure 2.46: distribution of washing machines models at various capacities

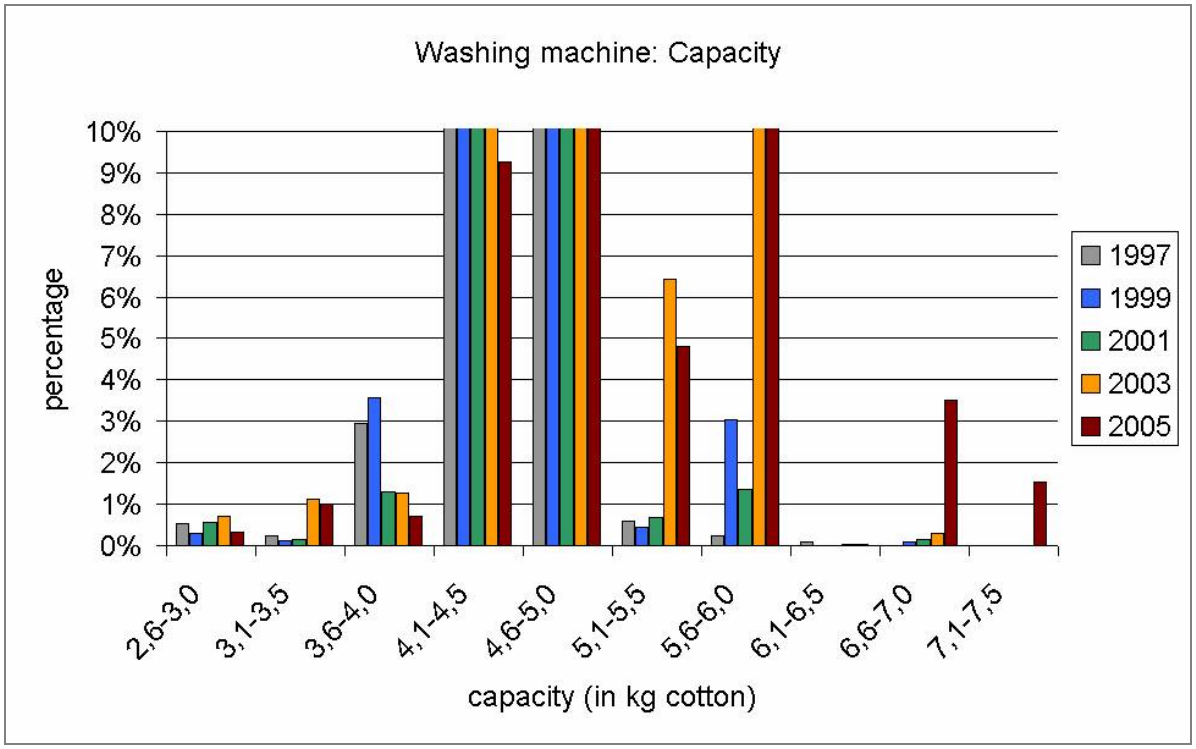


Figure 2.47: distribution of washing machines models at various capacities (enlarged scale)

Regarding the development of the energy efficiency in terms of energy consumption per kg of capacity a continuous and almost linear improvement can be observed (Figure 2.44). Compared to

the base case of 1992 (GEA study) an improvement of 37 % can be noted. The decrease of the specific energy consumption is at a rate of 0,0077 kWh/kg per year.

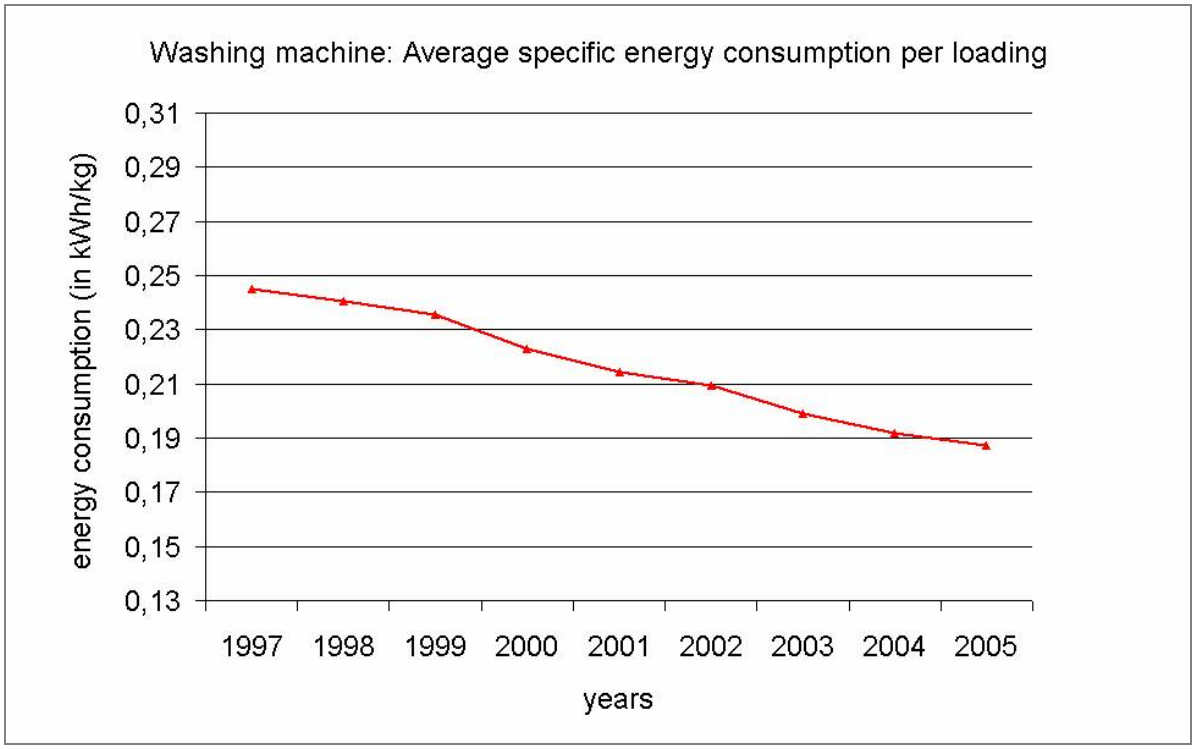


Figure 2.48: average specific energy consumption for washing machines

When comparing the distribution of the specific energy consumption (Figure 2.49) of year 1997– (broad distribution) with 2005 (sharp lines) it gets obvious, that industry has optimised the washing machines models to comply with the energy consumption requirements of the energy efficiency class thresholds.

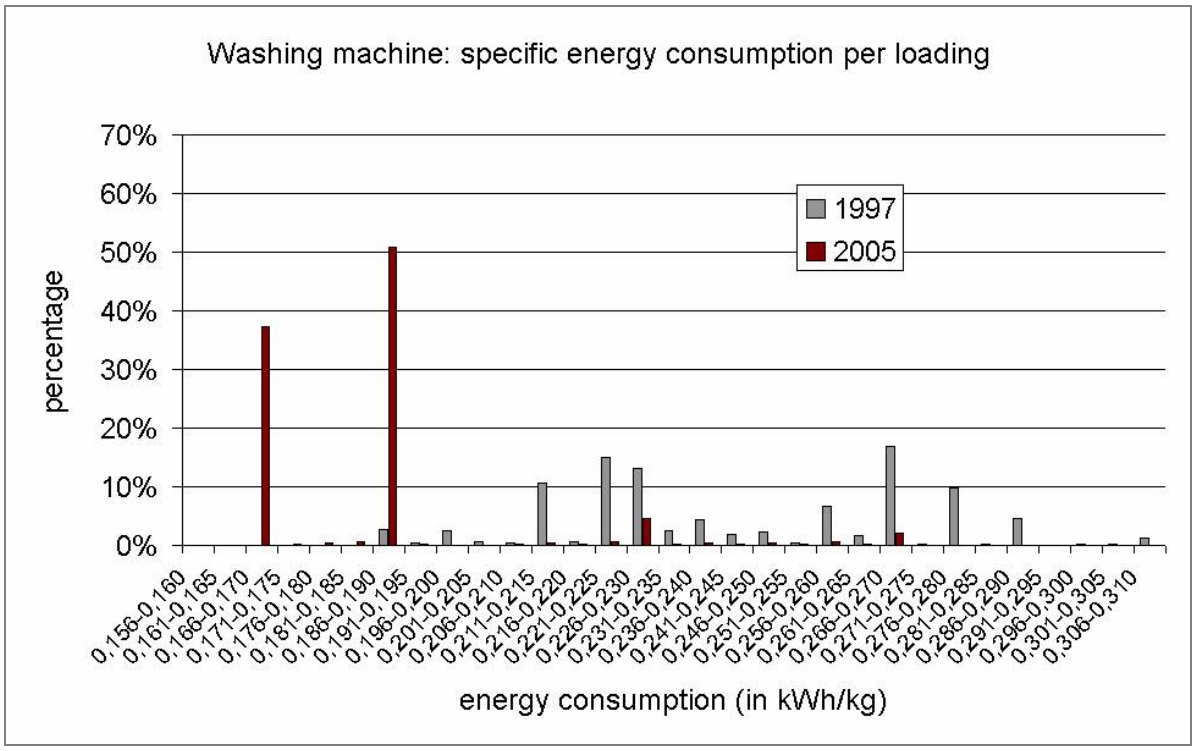


Figure 2.49: distribution of washing machines models at various specific energy consumptions

Looking at the distribution of the energy efficiency classes, a continuous improvement is observed (Figure 2.50) resulting in about 90 % of the machines in class A or better in 2005. Almost 40 % of the models qualify for the class A+. This class is somehow driving the development of washing machines towards more efficient models, also explaining why there is not an asymptotic trend of the average specific consumption (Figure 2.48). In 2005 no machines worse than class C were registered in the database, showing the unilateral industrial agreement of CECED is properly followed.

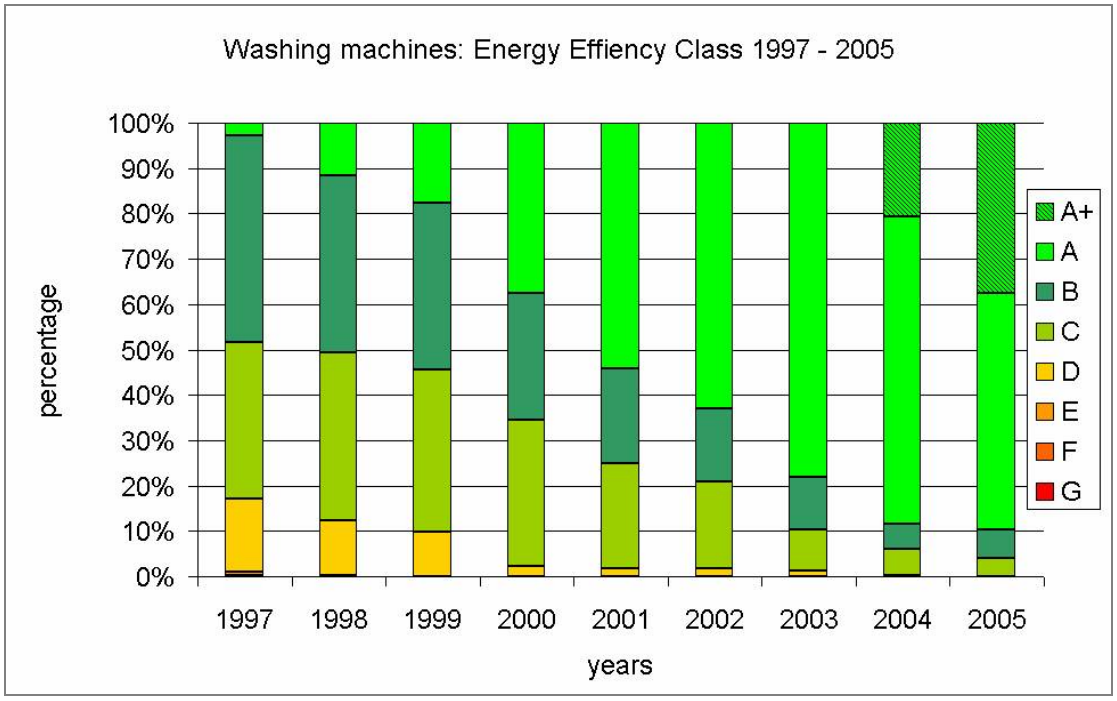


Figure 2.50: distribution of energy efficiency classes for washing machines in 1997-2005

At almost the same rate the washing performance was improved (Figure 2.51). Here too, class D or worse is no longer offered in the market in 2005. The development of the spin drying efficiency is less evident over the years (Figure 2.52): the majority of products offered in 2005 are in class B and all classes are still represented in the market.

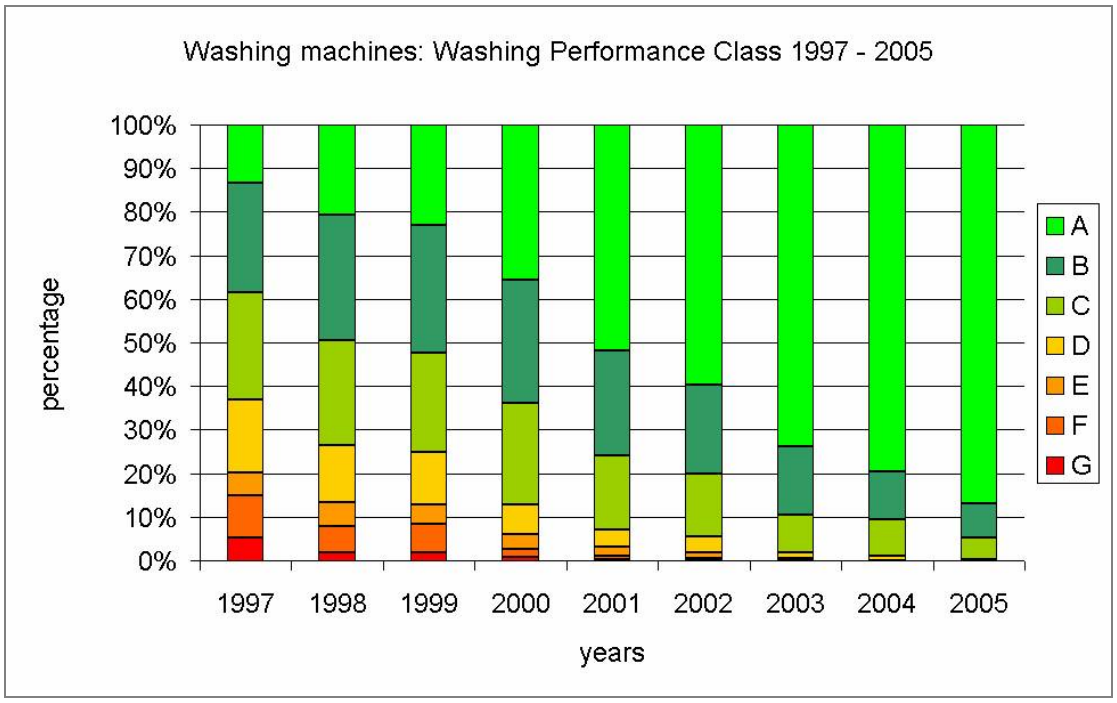


Figure 2.51: distribution of washing performance classes for washing machines in 1997-2005

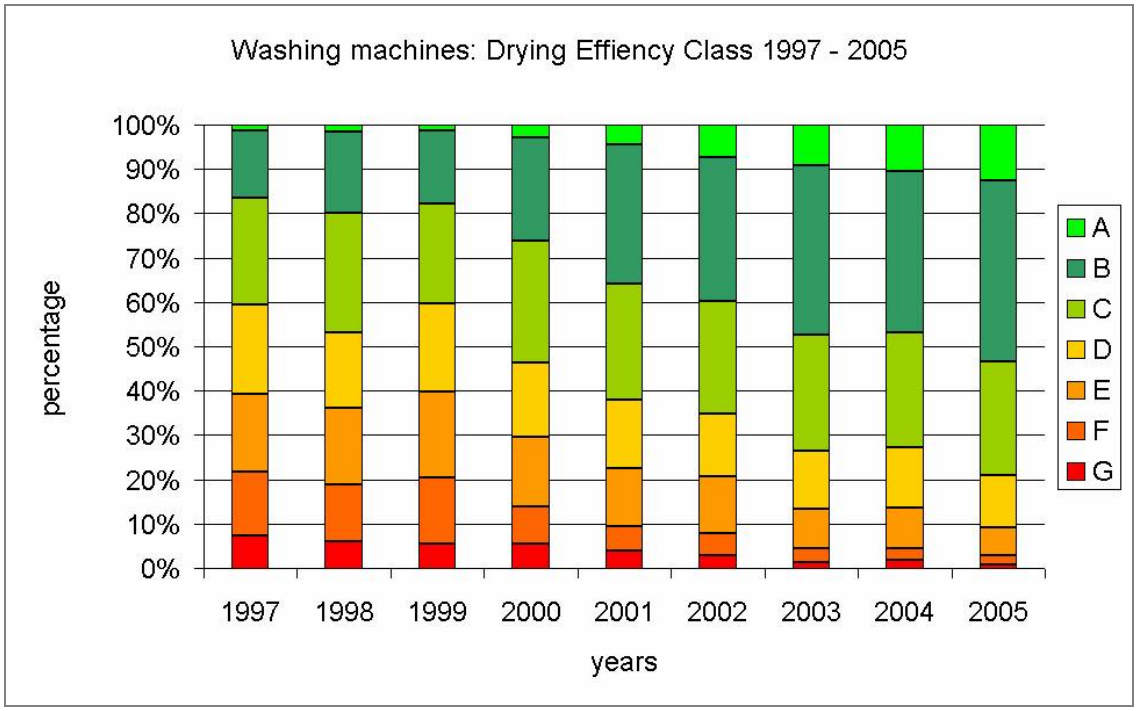


Figure 2.52: distribution of drying performance classes for washing machines in 1997-2005

Looking at the spin speed as the main driver for the drying efficiency value a clear tendency of substituting low spin speed machines (at 900 rpm or lower) by higher spinning machines is observed (Figure 2.53). This results in a steady increase of the average spinning speed by about 40 rpm per year (Figure 2.54), reaching 1 129 rpm in 2005, from about 830 rpm in 1997.

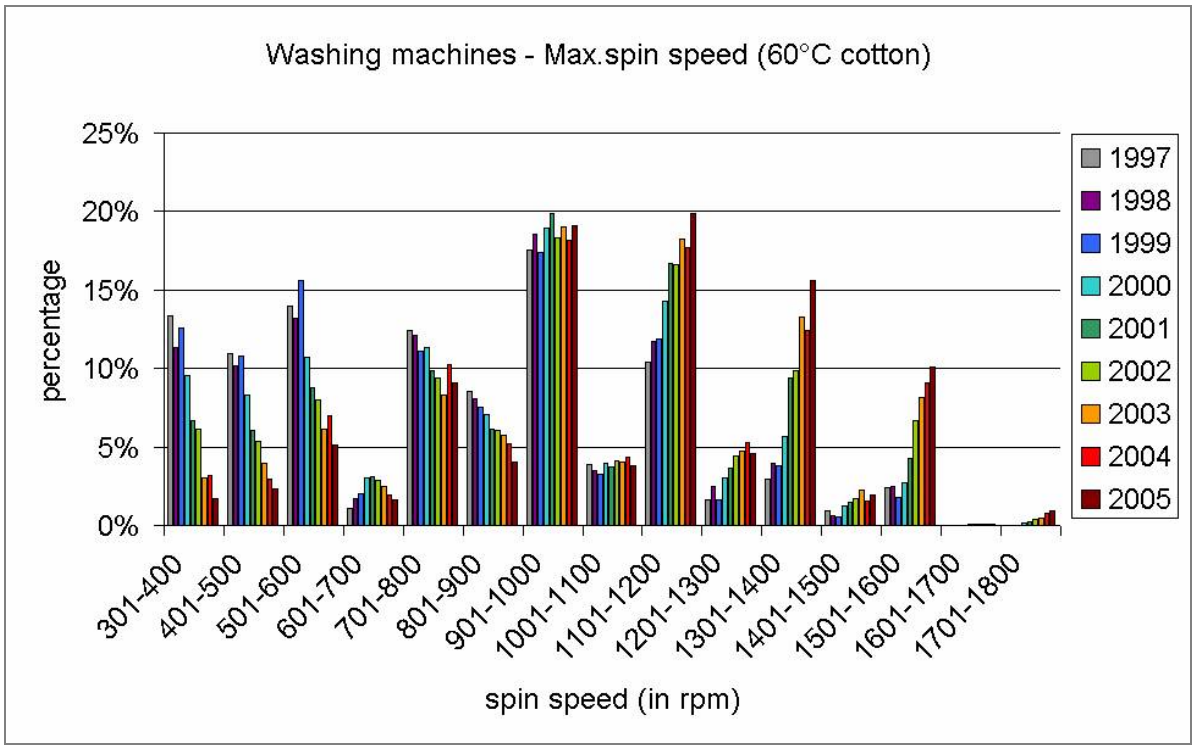


Figure 2.53: distribution of maximum spin speeds

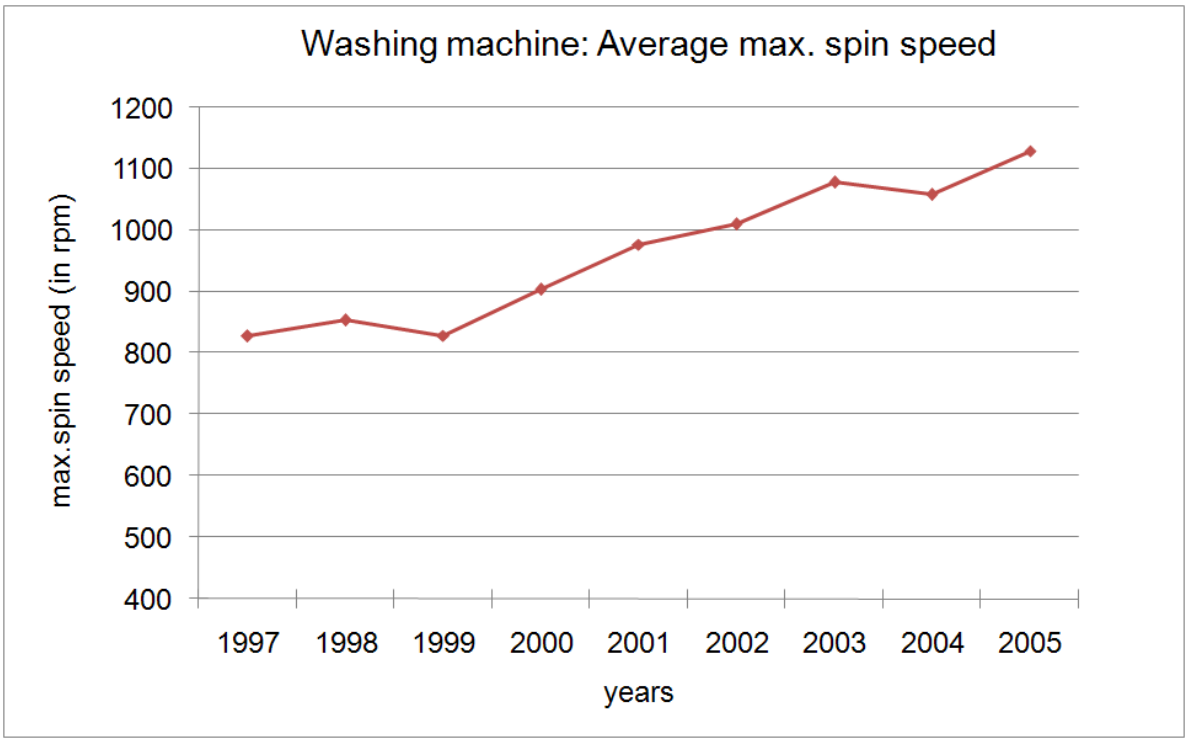


Figure 2.54: development of average spin speed

Correlating drying performance class with spin speed shows that there are broad ranges of spin speeds possible for a certain drying performance class (Figure 2.55). Limited to machines with equal drum size (5 to 6 kg capacity), the spinning speed is between 300 and 500 rpm for getting into

class G for drying performance, between 501 and 900 for class D, between 1 101 and 1 600 rpm for class B and between 1 301 and 2 000 for class A. As it gets harder and harder to reach a higher class, this may explain why the best performing classes are not as frequently observed in drying performance.

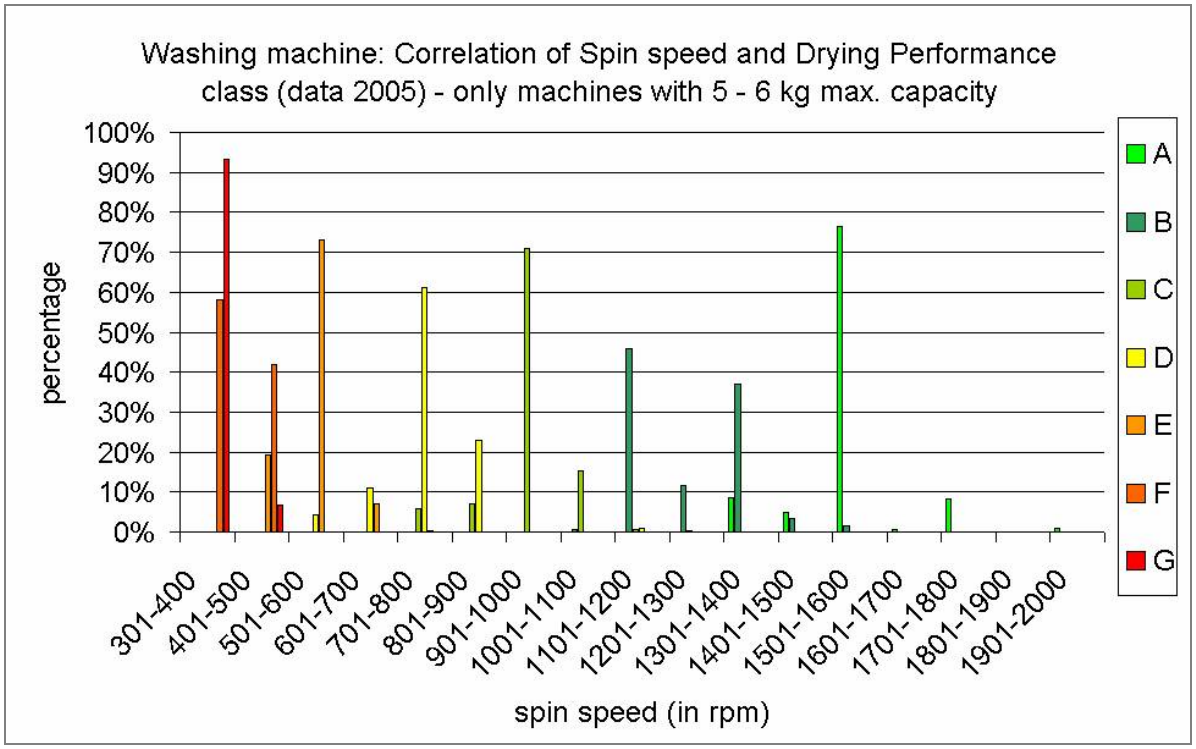


Figure 2.55: correlation of spin speed and drying performance class

Water consumption of washing machines has been reduced as well, in average from 66,6 to 50,7 litres per cycle (Figure 2.56), but remained almost constant in the last three years. While in 1997 the majority of machines was reported at a water consumption of 75 litres (Figure 2.57), this value is now at 50 litres per cycle. When comparing the average specific water consumption (per kg) ongoing improvement can be observed (Figure 2.58). This improvement down to 9,6 l/kg is 31 % compared to the average of 1997. This difference in the results of the absolute versus specific consumption values is explained by the increase of the average capacity of the machines.

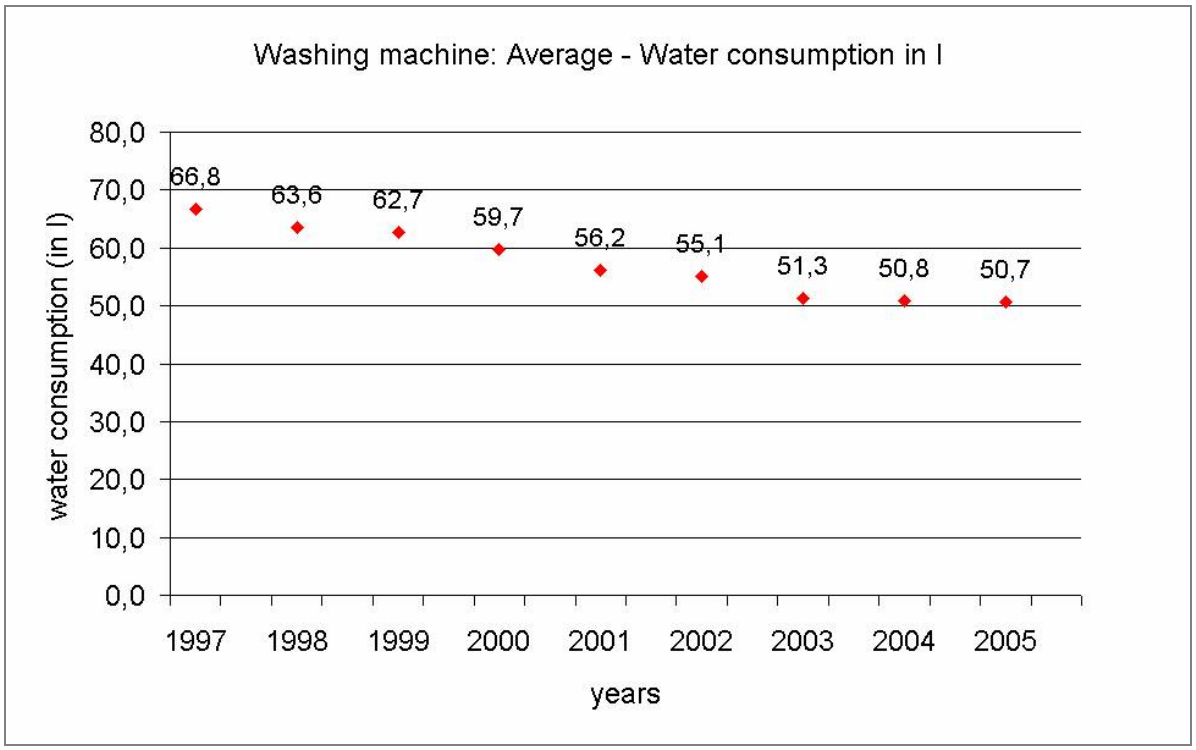


Figure 2.56: development of the average water consumption per cycle in washing machines

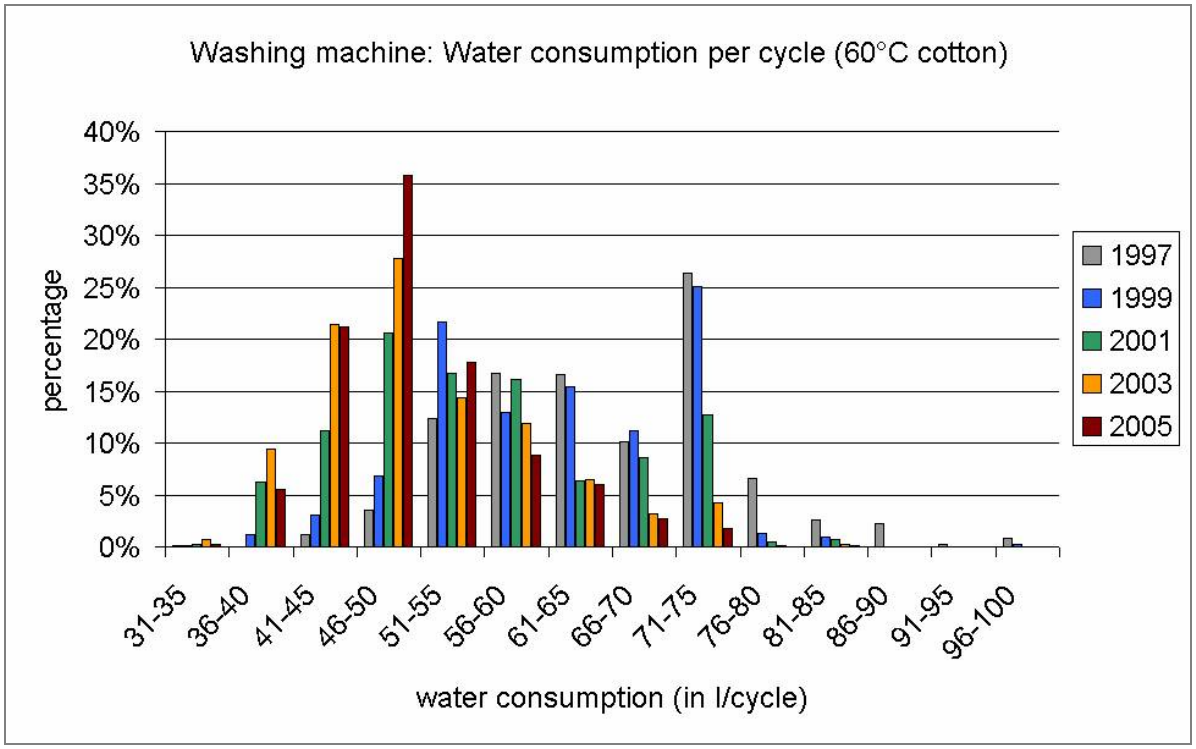


Figure 2.57: distribution of the water consumption values per cycle in washing machines

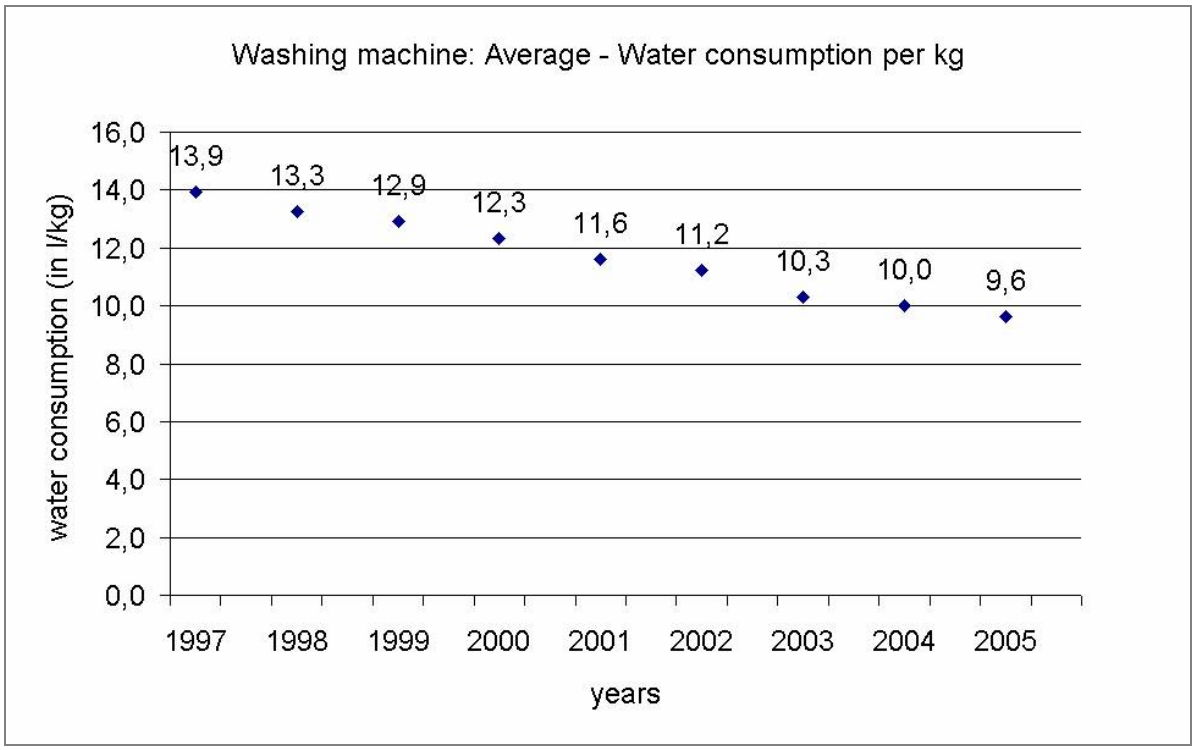


Figure 2.58: development of the average specific water consumption in washing machines

As not only the consumption at the rated capacity is of relevance, some information on the ability of the machines to adjust to lower loads (e.g. by 'fuzzy'-control) can be found by analysing the presence of the 'automatic load detection' feature, which is included in the reporting. This feature has gained importance and is available in about 90 % of the machines offered in 2005 (Figure 2.59). No data are available on the actual machine energy consumption when a lower amount of load is used.

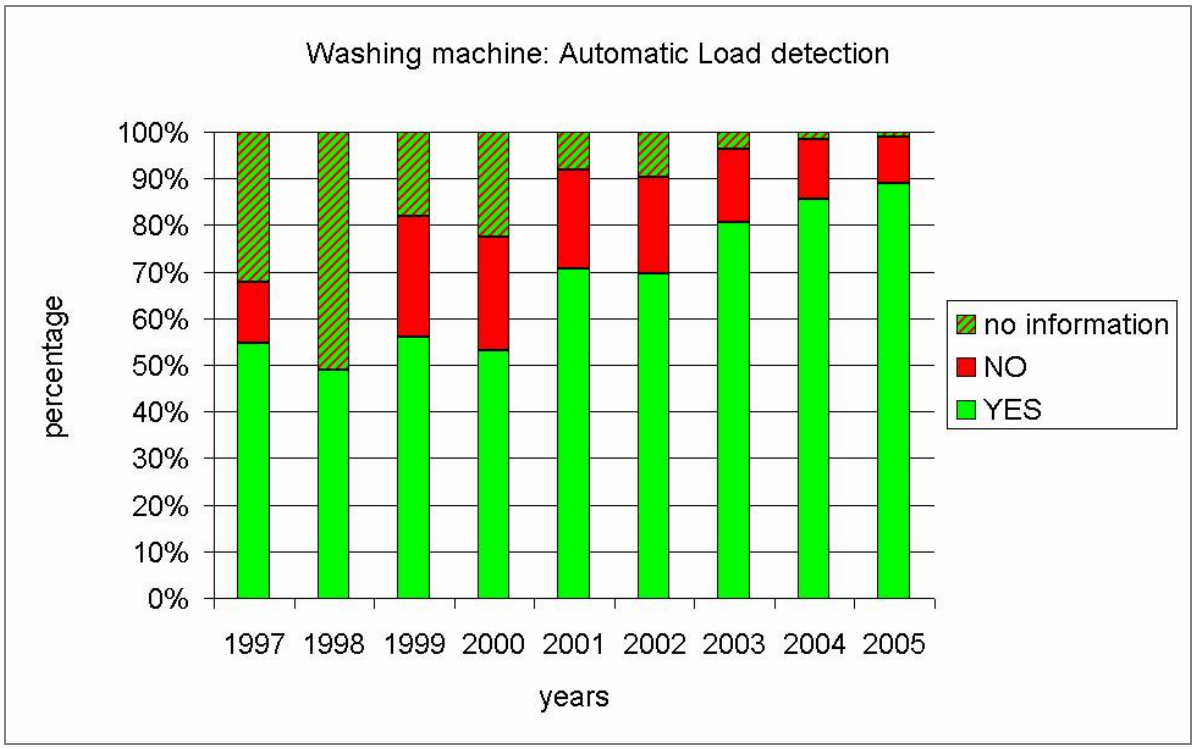


Figure 2.59: development of the automatic load detection in washing machines

The following main market trends for washing machines could be identified analysing the available information:

- increasing load capacity in recent years
- small machines (i.e. 3 kg) represent a niche but stable amount of the total available models
- 37 % improvement in energy efficiency compared to base case with an annual improvement of 0,0077 kWh/kg
- industry has optimised the products design to meet the energy consumption of the energy efficiency class thresholds
- the market development is at present driven by the (commercial) energy efficiency class A+, as before it was by class A
- no deterioration of washing performance has occurred as consequence of energy efficiency improvement
- spinning efficiency has improved, but still machines belonging to all classes are available on the market
- average spin speed has improved from about 830 rpm in 1997 to 1 129 rpm in 2005, at an average rate of 40 rpm/year
- class A and B in spinning efficiency are achievable by a wide range of spinning speeds at almost the same loading capacity.
- 31 % improvement in specific water consumption from 1997 to 2005 with an annual improvement of 0,28 l/kg
- in 2005 the majority of the models have a water consumption is below 50 litre per cycle
- automatic load detection is offered in 90 % of machines and may provide washing cycle parameters adjustment when smaller loads than the maximum (rated) capacity are washed

2.3.1.3 Market trends: the manufacturers

2.3.1.3.1 a) Analysis of the product brochures

Within the market trend analysis, current presentations of washing machines in manufacturer brochures are analysed, in order to draw conclusions about possible trends.

Primarily web information and product brochures of the household appliance market leaders in Europe[116] are analysed, evaluating the appliance options most frequently mentioned and emphasised to the potential customers.

It must be pointed out that the analysed material is the results of the marketing strategies of the single companies, aimed to reach a multitude of different consumer types, with different wishes and expectations. Nevertheless, a set of common features for each appliance type is generally advertised by the manufacturers.

Taking into consideration these three general assumptions, a general trend about appliance features can be derived. The analysis of the published brochures and web information shows that the trend of washing machines follows several specific directions: generally machines seem to become more intelligent, have a larger capacity, shorter programmes duration and new special programmes.

[116] Countries: Germany, United Kingdom, Spain, Italy, France, Poland, Czech Republic, Finland

A number of common related features are presented by almost all manufacturers, which can be grouped in five categories, as shown in Figure 2.60.

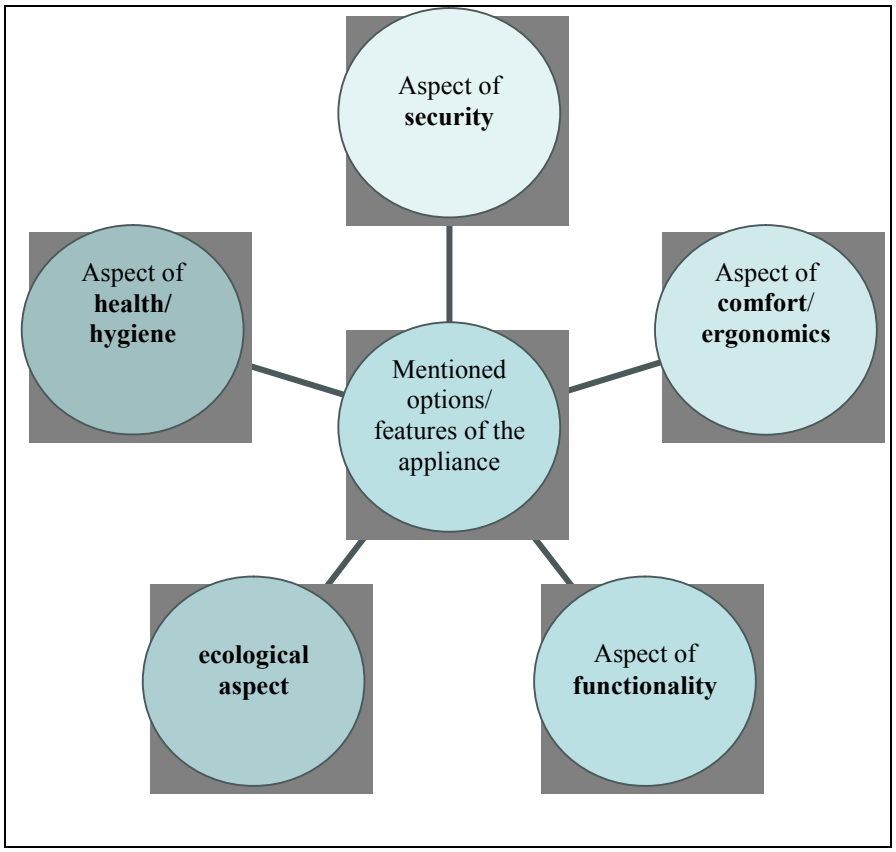


Figure 2.60: grouping criteria of the washing machines options

A list of aspects and attributes for washing machines emphasized by manufacturers can also be drawn (Table 2.24). One of the most emphasised features seems to be large machines with larger loading capacity: the load capacity is going from 6 kg up to max. 9 kg (depending on the manufacturer). In this context simplified filling is also emphasised with design improvements such as wider drum diameter, wide door opening (e.g. 180° degrees) and an inclined drum. "Slim" washing machines are not primarily promoted, but nevertheless all manufacturers advertise also this kind of appliance.

Other highlighted elements are the high performance of the machines in terms of less water and energy consumption as well as superior cleaning and drying performance (e.g. improvements and adaptability of the machine in terms of spin-dry effect); new intelligent sensor systems (load detection, turbidity sensors, foam sensors, etc.) as well as innovations in the appliance design such as novel lifters or new fast wetting technologies. Accordingly the market is going toward very economical and energy efficient machines.

A further trend is towards intelligent machines, which are able to adapt to consumer habits. A number of new washing programmes are presented which are suited for new textiles (e.g. sport- and functional clothes) or special, delicate garments (particularly hand wash/wool programmes). New sensors automatically detect loading, staining, etc. and can control programme options as well as adjust water/energy consumption accordingly. The consumer is also able to save frequently used programmes for a quicker later selection. New programmes are also available via (electronic) updating the appliance.

Furthermore the consumer will be able to make the machine comply with his/her daily life programme through new machine time functions: time/start delay options (up to 23 h), time left/remaining, time digital displays which may help in managing the consumer available time. In this context also the reduction of programmes duration is mentioned, either in promoting quick/fast programmes (15 up to 30 min.) or in shortening of programme duration by 50 %.

Table 2.24: results – washing machines: mentioned appliance options/features

a. ecological aspect	- high energy efficiency (A / A+) - low water consumption - low energy consumption - good energy efficiency rating evaluation (e.g. label AA/AAA) - good test results and/or results published in consumer magazines, design-awards, etc…
b. functionality	- new form of the washing drum; fast wetting; special drum lifters (textile protection) - new sensor technology (turbidity sensors; foam sensors, etc.) - mix load / combi programmes (coloured + easy cares; 40 + 60°C) - special programmes (e.g. for delicates; sportswear/shoes programmes; easy/free iron; hand wash programmes; night programmes, … - intensive programmes - half/small load programmes - predefined and/or individual saveable programmes (automatically the right programme dependent on the type of laundry, etc) - high spin efficiency
c. comfort/ergonomics	- low noise level, less vibrations (from 30 to less that 60 dB) - quick/fast programmes: e.g. 30 min at 30°C/3 kg; 15-20 min (for refreshing small loads) & time saving options (up to 50 % saving) - delay start / timer (1 to 23 h) - time left/remaining time digital display - bigger load capacity (at >6 kg to 9 kg) - wider diameter of the drum, inclined drum, wide door openings (e.g. 180° degrees for amore simple loading) - modern LCD/LED - display - networking features; possible programme update - small, “slim” appliances - drum lighting - integrated drawer for detergent storage - automatic (liquid) detergent dispensing system
d. health/hygiene	- hygienic programmes (longer washing duration at 80°C) - allergy programmes: extra rinse (to 5 times) to better remove detergent residues - drum with antibacterial surface
e. safety	- aqua control/stop - detergent over dosing warning - child safety (door lock, door cooling)

The decrease of noise emission and the reduction are promoted as ways to make night washing or if the machine is installed in a living area (i.e. kitchen) to wash without too high noise exposure. Particular attention is also paid to the hygiene and health: among intensive/hygiene programmes, high temperature and antibacterial surfaces of the wash drum (for reducing the formation and growth of germs) are offered. Special allergy programmes, with up to five additional rinse cycles, are advertised, to remove almost completely the detergent residues.

In terms of safety, all washing machines are claimed to have the highest level of installed safety features: aqua control and child safety, along with information supporting the consumer for the correct textile loading and dosing of detergent, to avoid unnecessary unbalanced mass, foam formation and bad cleaning performances.

The manufacturers also give a high value to new aesthetics and special comfort features, such as storage drawers, automatic (liquid) detergent dispensing systems, lighted wash drum or coloured cover panels, so that the machine can better reflect (and satisfy) the consumer's lifestyle.

2.3.1.3.2 b) Manufacturers questionnaire

Manufacturers were interviewed about their opinions on current wishes and preferences of final customers and on identified future trends. This analysis was developed by asking to marketing managers of leading appliance manufacturers to rank several appliance features in a given scoring scale - from 1 (low priority) to 10 (high priority). For washing machines the following options/features were presented through an ad-hoc questionnaire:

- network connectivity; communication between household appliances
- better rinse-effect
- lower running costs
- lower water consumption
- lower noise
- lower price of the appliance
- shorter programme times
- bigger capacity of loading
- better washing-performance
- lower energy consumption.

The answers of eight manufacturers could be analysed. Considering the average score value, in the view of the manufacturers the *lower energy consumption* (7,5) and the *bigger capacity of loading* (7,3) are the present most important options for the final customers (Figure 2.61). A *better washing-performance* (7,3) achieved the same average value, but with a high standard deviation (stand. dev.=3,15) (Table 2.25) highlighting that manufacturers have different opinions about this feature; *shorter programme times*, *lower price of the appliance*, *lower noise* and *lower water consumption* follow in the ranking. But, with the exception of *'lower noise'*, a high opinion variation among manufacturers (stand. dev. between 2,10 and 2,55) is also present. According to manufacturers *lower running costs* (5,5) and *better rinse-effect* (4,9) have a medium priority for the customers (Table 2.25), while the lowest importance was achieved *network connectivity/ communication between household appliances* (2,3).

When the present priority level is compared to the future one (Table 2.27), *lower water consumption* (+1,1) become even more important from the manufacturers point of view; *better washing performance* (+0,6) and *lower energy consumption* (+0,5) are also getting higher importance. The priority level of the least important feature today (*network connectivity; communication between household appliances*) rises by 0,4 points too; *better rinse- effect* and *lower noise* do not show any changes in the future priority level with a score between 5 and 6 (

Table 2.26). Options like l*ower price of the appliance* (-1,0), bigger capacity of loading (-0,9) and *shorter programme times* (-0,8) loose priority for the final customers in the future.

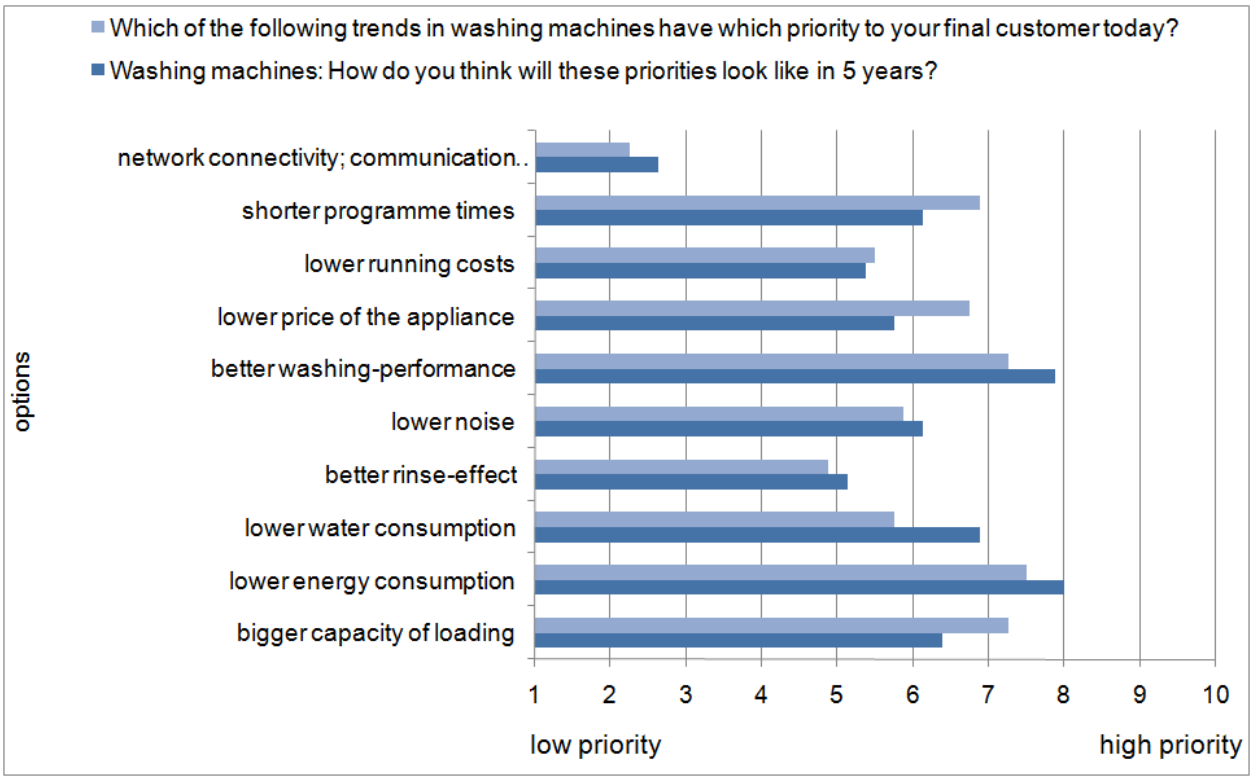


Figure 2.61: washing machines: priority ranking (comparison: today – future) asked to manufacturer

Table 2.25: trends in washing machines today – by manufacturers point of view

Which of the following trends in washing machines have which priority to your final customer today: *1 (low priority), 2, 3,…, 10 (high priority)?*					
Descriptive statistic					
	N	Minimum	Maximum	Average	Standard deviation
network connectivity; communication between household appliances	8	1	7	2,3	2,38
better rinse-effect	8	2	8	4,9	2,23
lower running costs	8	2	9	5,5	2,56
lower water consumption	8	3	9	5,8	2,55
lower noise	8	3	9	5,9	2,10
lower price of the appliance	8	1	10	6,8	2,96
shorter programme times	8	4	10	6,9	1,89
bigger capacity of loading	8	5	10	7,3	1,67
better washing-performance	8	2	10	7,3	3,15
lower energy consumption	8	4	9	7,5	1,60
Valid data (by list)	*8*				

Table 2.26: trends in washing machines in 5years – by manufacturers point of view

Washing machine: How do you think will these priorities look like in 5 years? *1 (low priority), 2, 3,…, 10 (high priority)?*					
Descriptive statistic					
	N	Minimum	Maximum	Average	Standard deviation
network connectivity; communication between household appliances	8	1	6	2,6	1,92
better rinse-effect	8	2	10	5,1	3,04
lower running costs	8	1	8	5,4	2,77
lower price of the appliance	8	1	9	5,8	2,55
lower noise	8	5	9	6,1	1,55
shorter programme times	8	3	9	6,1	2,23
bigger capacity of loading	8	3	10	6,4	2,33
lower water consumption	8	4	9	6,9	1,81
better washing-performance	8	2	10	7,9	2,85
lower energy consumption	8	3	9	8,0	2,07
Valid data (by list)	*8*				

Table 2.27: difference: trends in washing machines (comparison: future – today) according to manufacturers point of view

	Δ Rating Priority "Future - Today" Washing Machines
bigger capacity of loading	-0,9
lower energy consumption	0,5
lower water consumption	1,1
better rinse-effect	0,3
lower noise	0,3
better washing-performance	0,6
lower price of the appliance	-1,0
lower running costs	-0,1
shorter programme times	-0,8
network connectivity; communication between household appliances	0,4
Valid data (by list)	*8,0*

2.3.1.4 Market trends: consumer magazines

Consumer Associations frequently test household appliances, including washing machines, and publish the results in their magazines, to give advise for consumers' buying decisions. Via these magazines CAs can be considered one of the driving forces of the market; but they also get frequent feedback from their readers, used to define which product needs to be tested and published and how the testing procedure is done. It may therefore be assumed, that consumer magazines somehow reflect consumer expectations and market trends in their testing/publication work.

Through the analysis of the publications about washing machines over the last five years, an - at least rough - overview of present and future consumer requirements and trends can be attempted. A systematic analysis of the criteria and functions tested and how they have changed over the last five years was performed using the publications as listed in Table 2.28.

Table 2.28: magazines and publications which featured a test of washing machines

Publications	2001	2002	2003	2004	2005	2006
‚test' (Stiftung Warentest - D)	10/2001	8/2002	9/2003	9/2004	9/2005	9/2006
Konsument (A)	10/2001	10/2002	10/2003	3/2004	5/2005	-
Which (UK)	-	-	1/2003	1/2004	1/2005	-
Consumentengids (NL)	4/2001	11/2002	3/2003	3/2004 10/2004	3/2005	2/2006
Compra maestra (E)	7-8/2001	1/2002	7-8/2003	1/2004 7-8/2004	1/2005 7-8/2005	2/2006
Pro Teste (P)	-	1/2002	7-8/2003	1/2004 7-8/2004	1/2005	1/2006
Altroconsumo (I)	8/2001	1/2002	1/2003 7-8/2003	1/2004	-	1/2006
Que Choisir (F)	-	3/2002	1/2003	-	1/2005	-
60 Millions de Consommateurs (F)	-	-	3/2003	3/2004	-	-
Test-Achâts (B)	3/2001 10/2001	10/2002	4/2003 10/2003	10/2004	3/2005	-
Kuluttaja (FI)	-	2002	1/2003	-	-	-
Råd & Rön (S)	-	-	9/2003	-	1/2005	-
Tænk + Test (DK)	12/2001	11/2002	-	7/2004	-	-

Tested criteria and functions were collected for each country, priority criteria were also taken into account. The next step was to evaluate which criteria were tested in each publication in each country, whether priorities were shifted, which criteria were added and which were deleted through the years. Finally all countries were compared looking for similarities and differences. All criteria and functions were then sorted and listed by frequency of testing in all publications.

2.3.1.4.1 a) Frequency of criteria/functions tested in the last 5 years

Germany

"Stiftung Warentest" indicates testing priorities by giving the proportion of certain criteria from the final test score. A larger proportion/percentage indicates a higher priority of that criterion.

Highest priority is given to the functionality of the tested machines: 40 % of the final test score is based on the results of the functionality test; this includes washing, rinsing and spinning performance using a colour/cotton programme at 40°C and an easy care programme at 40°C throughout all five years. Since 2003 the test has been expanded to a 40°C short programme. In 2006 the programme duration was added to the criterion 'functionality'.

Second priority is given to the economic life-time of the tested machines: 20 % of the final score is based on this.

The test for ease-of-use has third priority (15 %): this includes testing of operating elements, loading and unloading, cleaning and the user manual. Another combined criterion has third priority also: it includes noise, water and energy consumption. The consumption is tested for the 40°C colour/cotton programme as well as the 40°C easy care programme throughout all observed years. As with functionality, the 40°C short programme is tested since 2003. Since 2005 energy consumption is also tested on stand-by.

10 % of the final score is based on safety of the machines where anti-flooding mechanisms are tested.

Throughout all years information is given on price, dimensions, maximum capacity and programme duration. Since 2002 it is mentioned whether a machine has an option to delay the wash cycle starting time.

Austria

"Konsument" indicates testing priorities by giving the proportion of certain criteria from the final test score. A larger proportion/percentage indicates a higher priority of that criterion. Priorities of the tested criteria have changed throughout the observed years.

From 2001 to 2003 first priority was ease-of-use and programme quantity (40 %). Second priority (30 %) was washing and spinning performance using a 60°C cotton programme. In 2003 combined washing and spinning performance made up 40 % of the final score and shared first priority with ease-of-use. Since 2004 priority shifted to washing and rinsing performance and programme duration which combined counted up to 50 % of the final score.

In 2001 and 2002 second priority was the water and energy consumption, noise, anti-flooding safety and programme duration combined to a proportion of the final score of 30 %. In 2003 this grouping only made up 20 % of the final score.

Since 2004 the proportions of the criteria in the final score changed completely. As mentioned before, washing and rinsing performance and programme duration combination was responsible up to 50 % of the final score. Washing performance was tested for a 40°C cotton programme, 40°C easy care as well as 40°C short programme. Spinning performance, energy and water consumption and noise combination accounted for up to 35 % of the final score Ease-of-use importance sharply decreased to 10 % and was separated from the user's manual which made up 5 % of the final score.

In 2005, ease-of-use criterion was also evaluated for disabled people.

Throughout all observed years information is given on price, spinning speed, maximum capacity, number of extra rinses as well as presence of special programmes, i.e. an energy saving programme.

UK

"Which" indicates testing priorities by giving the proportion of certain criteria from the final test score. A larger proportion/percentage indicates a higher priority of that criterion. The proportion of criteria in 2004 varied from the proportion in 2003.

In 2003 washing performance using a 40°C cotton programme had first priority (40 %), followed by ease-of-use with 25 %; 10 % of the final score is based on each water consumption using a 40°C cotton programme and the annual running cost; 5 % is based on each spinning performance using a 40°C cotton programme, noise and unbalance.

In 2004 first priority was washing performance (40 %) but for different programmes, including cotton, delicates and short programme, each at 40°C; 15 % of the final score is based on energy consumption using a 40°C cotton programme, 10 % on ease-of-use and 5 % on each water consumption using a 40°C cotton programme, user manual and noise. Because this only adds up to

80 % it is possible that there is an error in the publication and that spinning performance has a proportion of 20 %.

In 2005 first priority lay on washing performance (40 %), for the same programmes as in 2004. Second priority was annual running cost (30 %), third (20 %) was ease-of-use and noise combined; 10 % of the final test score is based on spinning performance using the 40°C cotton programme.

Throughout all observed years information is given on price, dimensions, rinsing performance, energy label, programme duration, and maximum capacity.

The Netherlands

"Consumentengids" indicates testing priorities by giving the proportion of certain criteria from the final test score. A larger proportion/percentage indicates a higher priority of that criterion.

In the Netherlands proportions of the tested criteria from the final score have slightly changed throughout the observed years. The priority ranking is not distinctly affected by these changes.

Washing performance using a 40°C cotton programme has first priority followed by the consumption of energy and water; ease-of-use and spinning performance share third priority; noise and the user's manual each make up 5 % of the final score.

In 2002 shrinking of wool after washing was considered with 5 % of the final score.

Since 2003 rinsing performance and programme duration is considered in combination with the washing performance.

In 2004 and 2005 the ease-of-use has also been evaluated for disabled people.

Throughout all observed years information is given on price, dimensions, existence of an aqua stop mechanism, as well as the possibility to delay the starting time. Information on availability of an energy saving programme was only given until 2003.

Spain

"Compra maestra" does not indicate testing priorities.

The following criteria have been tested throughout all observed years: washing performance using a 60°C cotton programme, a 30°C cotton programme and a 40°C easy cares programme, rinsing and spinning performance, ease-of-use, and anti-flooding safety. Since 2002 energy and water consumption and noise have also been tested. From July/August 2005 on energy and water consumption are specified for the different programmes.

Since January 2005 the ease-of-use for handicapped people has been evaluated.

Throughout all years information is given on price, spinning velocity, maximum capacity, and existence of special programmes, such as a short wash programme, reduced or variable spinning velocity or variable temperature settings. 88 % of the publications indicate whether a machine offers an energy saving programme, extra rinses, rinse hold and an option to exclude spinning. Since 2003 the programme quantity of the tested machines is given. Until 2003 the cost of the machine per usage was given, from 2004 on the cost per kilogram of laundry is given.

Portugal

"Proteste" does not indicate testing priorities.

Following criteria have been tested throughout all observed years: washing performance using a 60°C cotton programme and a 30°C cotton programme, rinsing and spinning performance, energy and water consumption, ease-of-use and noise. Anti-flooding safety was tested until 2005. Except in

2003 washing performance of the 40°C easy care programme was evaluated. In 2006 ease-of-use for handicapped people was appraised.

Throughout all observed years information is given on price, cost per kilogram of laundry and presence of special programmes, such as a short wash programme, variable temperature settings, rinse hold and an option to exclude spinning. New in 2006 is the declaration of the possibility for delaying the starting time. Programme quantity was given until 2005.

Italy

"Altroconsumo" does not indicate testing priorities.

The following criteria have been tested throughout all observed years: washing performance using a 60°C cotton programme, a 30°C cotton programme as well as a 40°C easy care programme, rinsing and spinning performance, energy and water consumption, ease-of-use, anti-flooding safety and noise.

Information is given on price, dimensions, maximum capacity, programme duration and presence of special programmes, such as variable temperature settings throughout all observed years; 83 % of the publications indicate the cost per usage, programme quantity, spinning velocity and whether the machine gives the possibility to delay starting time and rinse hold. In 2006 instead of testing the cost per usage the annual running cost for the period of ten years is given. Also in 2006 ease-of-use for handicapped people was appraised.

France

France has two different consumer information magazines.

"Que Choisir" indicates testing priorities, but percentages are given in 2005 only. Washing performance using 40°C cotton and easy cares programmes had first priority. In 2002 and 2003 rinsing performance using the same programmes has first priority also. Second priority was the energy and water consumption, which was measured for the two mentioned programmes. Spinning performance and ease-of-use rank third in priority. Shrinking of wool and noise were tested also.

In 2005, 50 % of the final score was based on washing performance using 40°C cotton, easy care and short programmes combined with programme duration. Rinsing and spinning performance, consumption of energy and water, ease-of-use and noise made up 10 % or 5 %, respectively.

Throughout all observed years information was given on price, dimensions, spinning velocity and maximum capacity. In 2002 and 2003, the possibility of variable temperature settings and delaying the starting time was indicated. In 2002 aqua control, programmes for half capacity, reduced spinning velocity and extra rinses were additionally declared.

"60 Millions de Consommateurs" indicates testing priorities by giving the proportion of certain criteria from the final test score.

In 2003, 30 % of the final test score was based on washing and rinsing performance of the 60°C cotton programme, 20 % on energy and water consumption, 15 % on washing and rinsing performance of the 40°C easy cares programme, 15 % on ease-of-use and 10 % on each spinning performance and noise.

In 2004, 65 % of the final score was based on washing, rinsing and spinning performance using 40°C cotton, 60°C cotton and 40°C easy care programmes as well as programme duration. Energy

and water consumption combined made up 15 % and noise and anti-flooding safety combined made up 10 %. Another 10 % was based on the ease-of-use. In both years information is given on price, dimensions, maximum capacity, spinning velocity, and possibility of delaying the starting time, extra rinses and a programme for half capacity. In 2003 the indication of the variable temperature settings, reduced spinning velocity and rinse hold was given. In 2004 it was looked for an energy saving programme, short wash and the programme quantity altogether.

Belgium

"Test-Achats" does not indicate testing priorities.

The following criteria have been tested throughout all observed years: washing performance of the 40°C cotton programme, rinsing and spinning performance, energy and water consumption, ease-of-use and noise. In 63 % of the publications washing performance of the 40°C easy care programme and the user manual was appraised. In 2004 the ease-of-use for disabled people was also tested. Throughout all observed years information was given on price, cost per usage and programme duration. Special programmes were only indicated until 2003.

Finland

"Kuluttaja" does not indicate testing priorities.

Energy and water consumption were tested both years. Washing and spinning performance were evaluated in 2002 only. The energy label and availability of special programmes were indicated only in 2002 also. In 2003 ease-of-use, price, annual running cost and spinning velocity were tested or indicated.

Sweden

"Råd & Rön" does not indicate testing priorities.

The following criteria have been tested both observed years: washing and rinsing performance of the 60°C cotton programme, energy and water consumption, ease-of-use and programme duration.

In 2003, washing and rinsing performance and energy and water consumption were evaluated for a 60°C short programme additionally. In 2005, the noise of the machines was rated.

In both years information was given on dimensions, maximum capacity, spinning velocity and residual moisture after spinning. In 2005, the availability of energy saving programme was indicated.

Denmark

"Test + Tænk" only indicated testing priorities in 2004.

The following criteria have been tested throughout all observed years: washing and spinning performance, energy and water consumption and ease-of-use.

In 2004, 40 % of the final test score was based on washing performance, 15 % on rinsing performance, 10% on each energy and water consumption, 7,5 % on each ease-of-use and the user manual and 5 % on noise.

Information is given on the energy label, price, maximum capacity and programme duration. Until 2002 the residual moisture after spinning was mentioned.

EU Summary

The analysis of consumer magazines in the EU shows that for washing machines the most frequently tested criteria are ease-of-use and washing performance. Considering that washing performance is often separately indicated for different programmes, it was tested in 98 % of the publications. Within the last years the number of tested programmes has increased. The programme most frequently used to evaluate the washing performance is the 40°C cotton programme (81 % of all publications) followed by the 40°C easy care programme. Especially in Spain, Portugal, Italy and partly in Austria the washing performance was tested for the 60°C cotton programme. In 47 % of all publications the 40°C short programme was evaluated too.

Water and energy consumption as well as spinning and rinsing performance are also often tested for a variety of programmes. All these criteria rank first priority. Here too, the 40°C cotton programme is the one used mostly. As with washing performance, the number of tested programmes has increased during the observed years.

Tested or indicated frequently are price, noise and maximum capacity. The indication of the maximum capacity of washing machines has increased during the past years, but so has the frequency of mentioning whether the machine has a programme for a half load of laundry, especially in Spain and Portugal.

Evaluated in 50 to 75 % of the analysed publications was the programme duration. Tested to the same extent were washing performance of the 40°C easy care, the 60°C cotton programme and special programmes.

Indicated mostly are dimensions, spinning speed, time shift/delay start and extra rinses options.

2.3.1.4.2 b) Criteria priority level

The frequency of the tested criteria throughout the observed years and countries has been classified to four priority levels (PL) according to how often they have been evaluated. For this purpose the frequency of a tested feature is given as percentage of all publications.

Priority level 1 (**PL 1**) for more than 75 %

Priority level 2 (**PL 2**) for 50 % - 75 %

Priority level 3 (**PL 3**) for 25 % - 50 %

Priority level 4 (**PL 4**) for less than 25 %

In Table 2.29 the tested criteria are ranked according to the priority level (in percentage), starting with the highest. The same results are shown in Figure 2.62 to Figure 2.65.

Table 2.29: washing machines: ranking of criteria per priority level

PL 1	ease-of-use	98.3 %
	washing performance (global)	98.3 %
	price	96.6 %
	water consumption (global)	96.6 %
	energy consumption (global)	94.9 %
	spinning performance (global)	94.9 %

	noise	91.5 %
	maximum capacity	89.8 %
	rinsing performance (global)	86.4 %
	washing performance using a 40°C cotton programme	81.4 %
PL 2	programme duration	74.6 %
	dimensions	74.6 %
	spinning velocity	71.2 %
	spinning performance (total)	64.4 %
	washing performance using a 40°C easy cares programme	62.7 %
	time shift/ delay	61.0 %
	energy consumption (total)	57.6 %
	water consumption (total)	57.6 %
	extra rinses	55.9 %
	rinsing performance (total)	55.9 %
	washing performance using a 60°C cotton programme	50.8 %
	special programmes	50.8 %
PL 3	anti-flooding mechanism	49.2 %
	short wash	45.8 %
	variable temperature setting	44.1 %
	energy saving programme	42.4 %
	reduced/ variable spinning	40.7 %
	rinse hold	39.0 %
	programme quantity	37.3 %
	energy consumption using a 40°C cotton programme	35.6 %
	water consumption using a 40°C cotton programme	35.6 %
	user manual	35.6 %
	spinning performance using a 40°C cotton programme	33.9 %
	rinsing performance using a 40°C cotton programme	28.8 %
	cost per usage	25.4 %
PL 4	only the seven criteria with highest percentage of this priority level are mentioned	
	energy label	23.7 %
	energy consumption using a 40°C easy cares programme	22.0 %
	water consumption using a 40°C easy cares programme	22.0 %
	half capacity	20.3 %
	rinsing performance using a 40°C easy cares programme	20.3 %
	spinning performance using a 40°C easy cares programme	18.6 %
	cost per kilogram of laundry	18.6 %

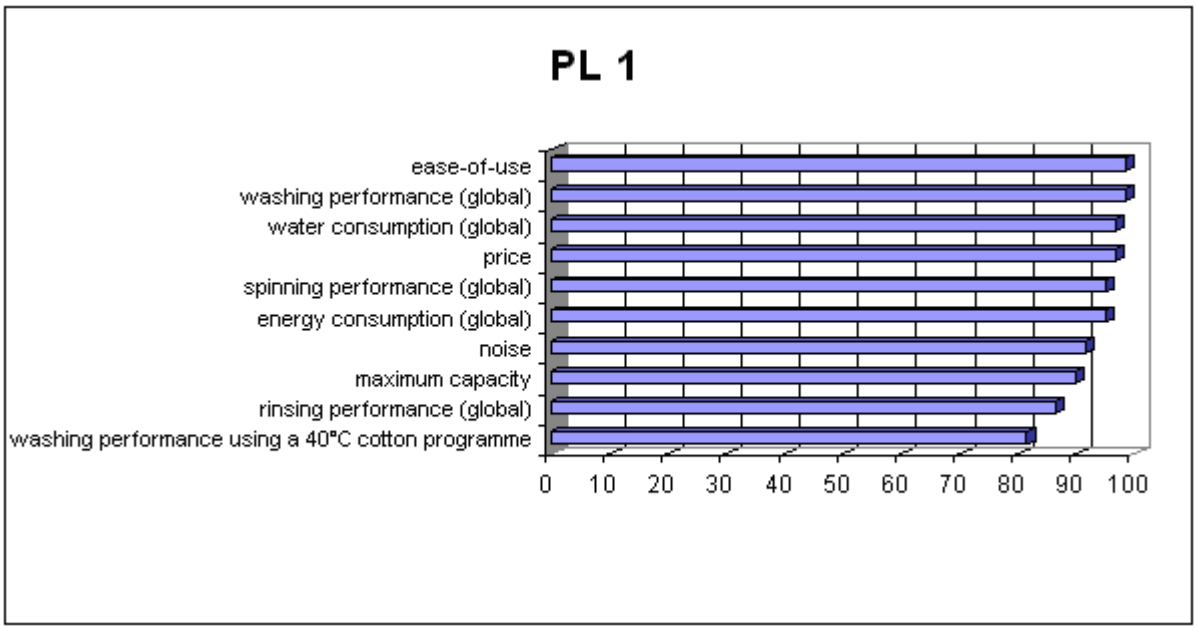


Figure 2.62: washing machines - priority level 1 (PL): frequency of the tested criteria

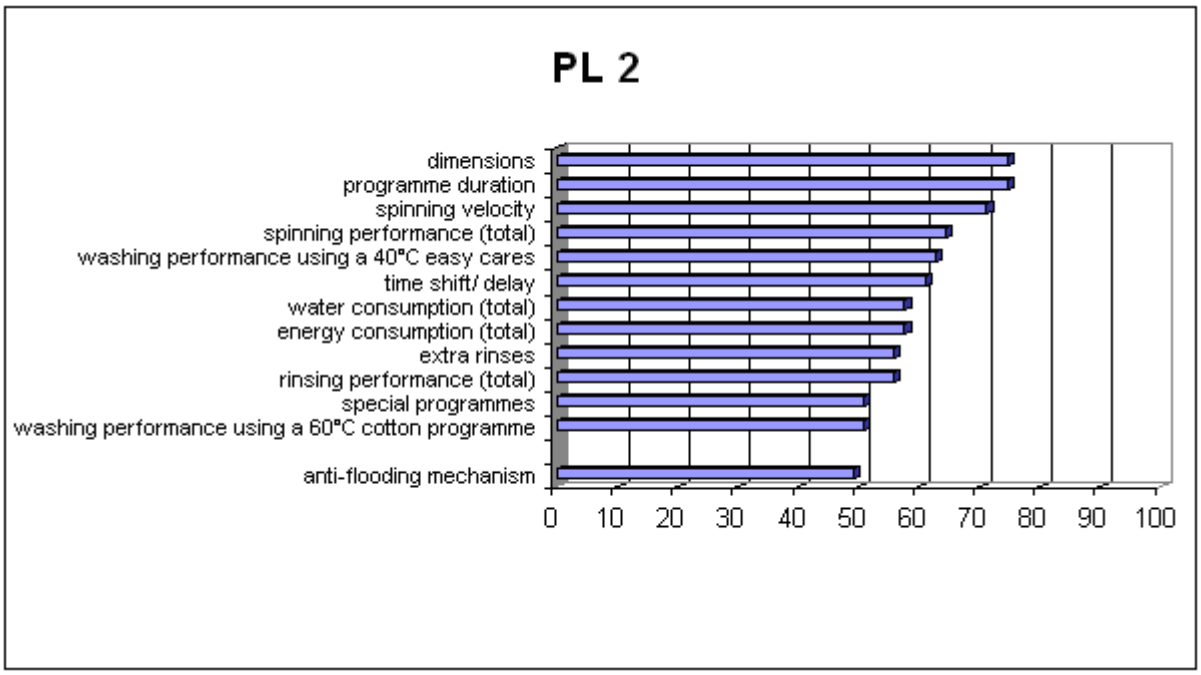


Figure 2.63: washing machines - priority level 2 (PL): frequency of the tested criteria

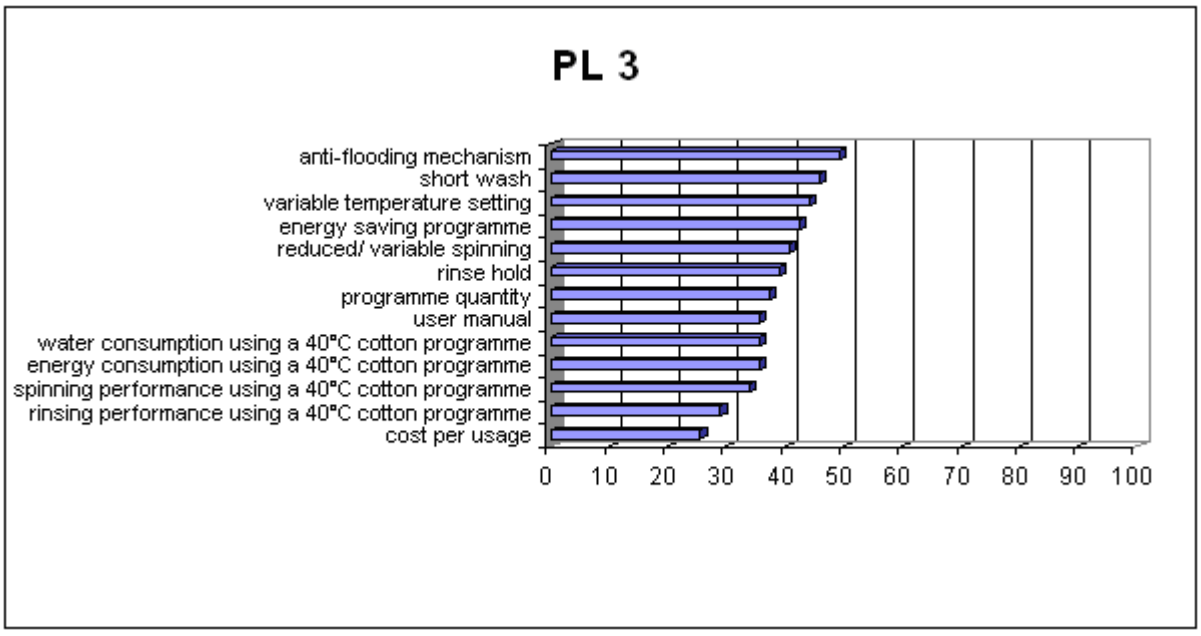


Figure 2.64: washing machines - priority level 3 (PL): frequency of the tested criteria

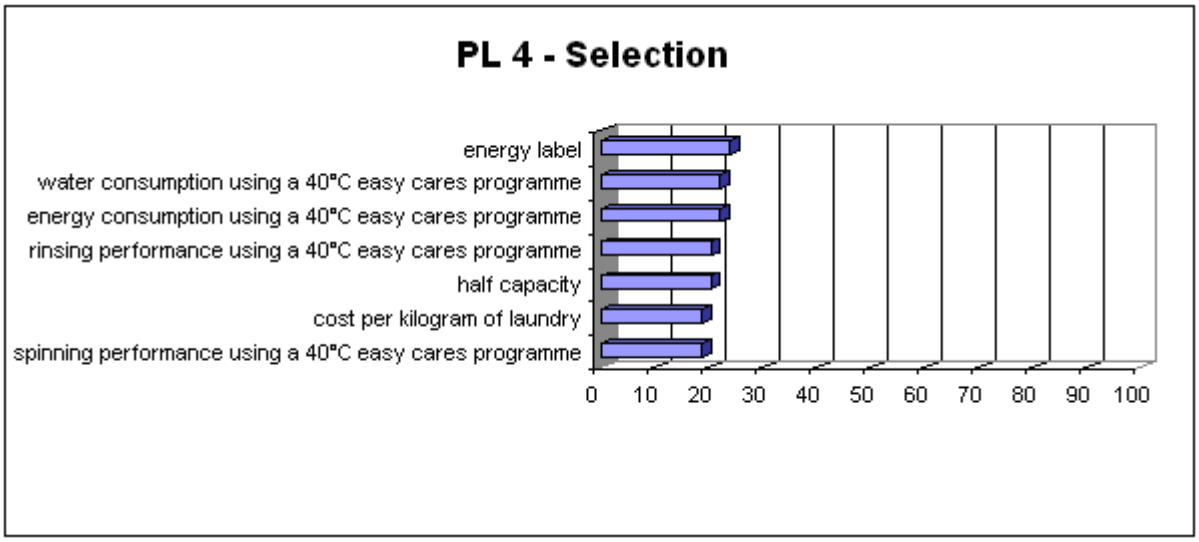


Figure 2.65: washing machines - priority level 4 (PL): frequency of the tested criteria

2.3.1.5 Market trends: the consumers survey

In order to estimate possible trends by the consumer point of view, the 2 497 households interviewed within the consumer survey (see Task 3) were asked about important option/feature for washing machines and the relevant today priority level.

Consumers were asked to rank several features in a given scoring scale - from 1 (low priority) to 10 (high priority). For washing machines following options/features were presented through the questionnaire:

- larger load capacity
- lower energy consumption
- lower water consumption

- better rinse effect
- lower operating noise
- better washing performance
- better spin-drying performance
- lower price of the appliance
- lower running costs
- shorter programme durations
- network connectivity; communication between household appliances.

For all interviewed consumers, the highest priority option was *lower energy* (8,5), *lower water consumption* (8,4) and *lower running cost* (8,3) (Figure 2.62). Also *better washing performance* has almost the same priority level for a washing machine (8,2). Other options which affect the performance are important for the consumer too: *better spin-drying performance* and *better rinse effect* (7,6). With in average 6,4 points *shorter programme duration* was rated in the lower part of the ranking list just followed by the wish to get a *greater load capacity* (6,3). The lowest priority for the consumer, with only 4,1 points, are the options of possible *network connectivity* or the *communication between other appliances*.

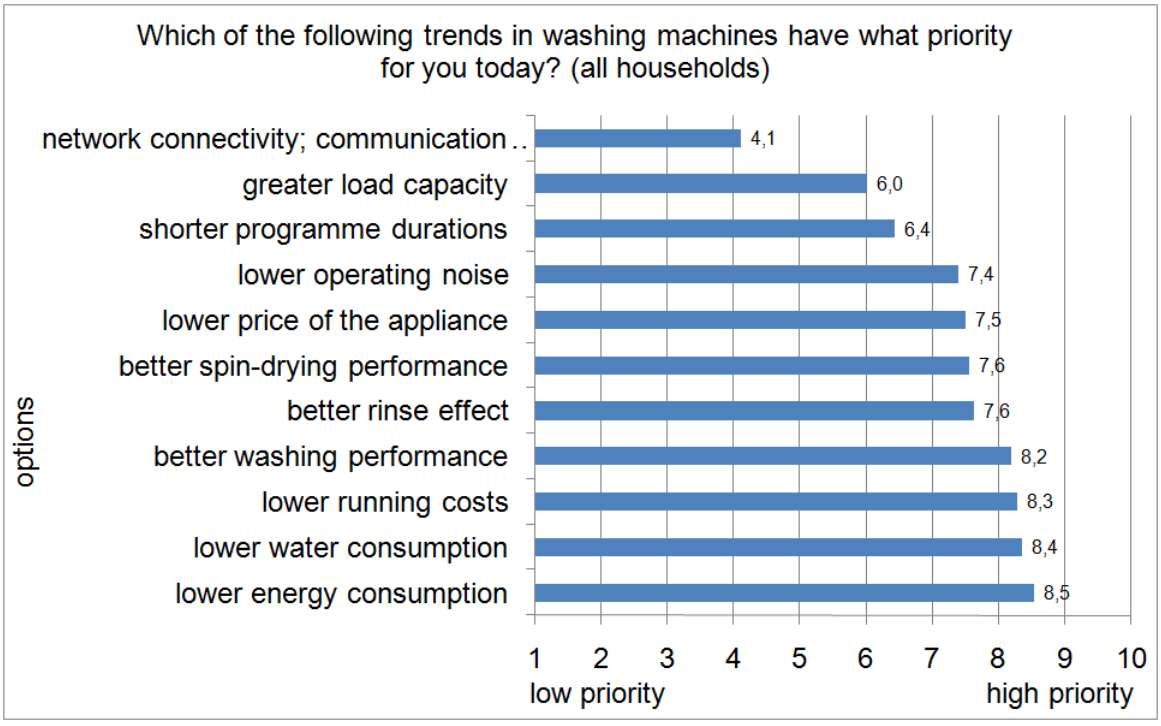


Figure 2.66: washing machines: ranking of appliance options by the consumer

Comparing the manufacturers and the consumers priority level, the ranking of the consumers presents some differences: *greater load capacity* and *shorter programme durations* seem to be more important for the manufactures than for the consumer (Figure 2.67).

Manufacturers and consumers evaluated the options *lower energy consumption* and *better washing performance* as the most important features.

The options *network connectivity* and *possible communication between the appliances* are again evaluated in the same way by consumers and manufacturers: both see these options as the most unimportant, but the manufacturers evaluated then as even less important than the consumers.

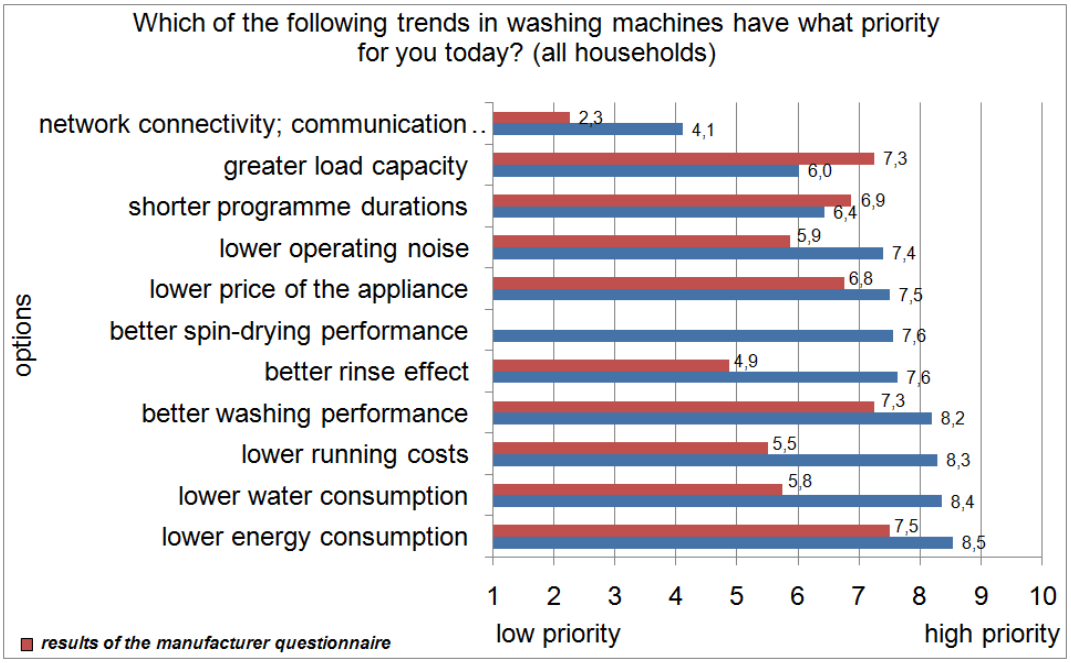


Figure 2.67: washing machines: ranking of appliance options (consumer vs. manufacturers)

The analysis of the priority ranking between the European countries shows some differences (Table 2.30): the option *lower price of the appliance* has a lower priority in Sweden (6,6) and Czech Republic (6,8) when compared with other countries (over 7 points) (Table 2.30). A *greater load capacity* is more important for consumers in the south European countries such as Italy or Spain (6,8), while in Sweden (5,1), Finland (5,2) or Poland (5,3) and the Czech Republic (5,4) this option is less important.

Table 2.30: washing machines: ranking of appliance options by the consumer (per country)

Washing machine: Ranking appliance options/features (average)											
countries	**UK**	**DE**	**IT**	**FR**	**ES**	**SW**	**PL**	**HU**	**FI**	**CZ**	**total**
greater load capacity	6,5	6,1	6,8	6,5	6,8	5,1	5,3	6,5	5,2	5,4	6,0
lower energy consumption	8,0	9,1	8,2	8,9	8,3	7,8	9,0	8,9	8,4	8,7	8,5
lower water consumption	7,9	9,1	8,0	8,8	8,3	7,1	8,8	8,8	8,1	8,5	8,4
better rinse effect	7,2	8,0	7,6	7,9	7,8	7,0	8,1	8,0	7,6	7,2	7,6
lower operating noise	7,0	7,2	7,8	7,8	7,9	7,1	7,4	7,4	7,2	7,3	7,4
better washing performance	8,1	8,4	8,1	8,5	8,4	7,5	8,6	8,7	7,9	7,8	8,2
better spin-drying performance	7,7	7,8	7,2	8,1	7,9	7,1	7,9	8,3	7,5	6,1	7,6
lower price of the appliance	7,6	8,1	7,2	7,7	8,2	6,6	7,9	7,9	7,0	6,8	7,5
lower running costs	8,1	8,8	7,8	8,5	8,2	7,8	8,7	8,6	8,1	8,2	8,3
shorter programme durations	6,7	6,6	6,6	6,4	6,9	6,1	6,4	6,7	6,3	5,6	6,4
network connectivity; communication between household appliances	3,6	3,4	4,9	3,9	4,6	3,4	4,4	4,4	3,9	4,4	4,1

2.3.1.6 Summary of market trends for washing machines

The **washing machine** market in Europe is characterised by a very high penetration in the households with almost saturation in western former EU15 countries. In Eastern new EU Member states the penetration is increasing continuously. As washing machines are a long living product with replacements happening after 10 years or more, this situation leads to a high level of market competition, usual for saturated markets. This competition was somehow "addressed" by the introduction of the EU energy labelling scheme in 1996, focusing the attention of the consumers and the manufacturers to the elements included in the label and the fiche. Since the labelling scheme is mainly focused on energy efficiency, it got the highest importance in the development of the new products offered on the market. Impressive improvements of the models offered to the market could be achieved (specific energy reduced by 37 % compared to the base case of 1992), without deterioration of the washing performance parameters and water savings.

This development was not possible without a high level of awareness and acceptance by the consumer. Despite all these achievements, the consumer still expects further reduction of the energy and water consumption of washing machines, along with further technological improvements of other machine features: for example the optimisation of offered programmes, the programme duration, the rinsing performance or the ease of use. This is backed up by reports from consumer organisations which tend include more and more functional parameters into the assessment of washing machines. Especially the assessment of 40°C washing programmes is done frequently by consumer organisations, while the test programme used for the energy labelling declaration is only at 60°C.

2.3.2 Market trends for dishwashers

2.3.2.1 General market trends

The penetration of dishwashers in European household is analysed more in detail in this paragraph. Dishwashers show a lower saturation compared to washing machines (Figure 2.68).

Selected characteristics of the standard of living and the living quality in European countries

Household possesses…	A	B	D	DK	E	F	FIN	GR	I	IRL	L	NL	P	S	UK
Dishwasher	60	43	n.a.	53	30	47	50	26	32	39	65	39	31	44	29

A: Austria, B: Belgium, D: Germany, DK: Denmark, E: Spain, F: France, FIN: Finland, GR: Greece, I: Italy, IRL: Ireland, L: Luxembourg, NL: The Netherlands, P: Portugal, S: Sweden, UK: United kingdom.

Data basis: European household panel 2001 (UK,Germany, Luxembourg: national households panels); European Social Survey 2003, 2004/2005; Euro barometer 62.1 (2004).

Figure 2.68: equipment of households by countries, DISHWASHER (source: GESIS[117])

2.3.2.1.1 a) Dishwashers market saturation development

Detailed data of the development of dishwasher penetration in European households are only available for specific countries:

[117] Gesis (2006): http://www.gesis.org/sozialindikatoren/Publikationen/Datenreport/pdf2006/2_22.pdf

Germany

61 % (Figure 2.69) of all German households possess a dishwasher, in comparison to 96 % households which possess a washing machine. The penetration of dishwashers has increased in the past at a rate of about 2 % per year.

Saturation of the German market in % of the households											
Houshold appliances											stock (in mio. units)
source: GfK	1980*	1985*	1990*	1995	2000	2002	2003	2004	2005	2006	2006
washing machine	88	90	92	94	93	93	94	94	95	**96**	**37,6**
laundry dryer	8	13	20	25	34	36	38	39	41	**44**	**17,3**
automatic dishwasher	21	27	35	40	52	57	57	58	59	**61**	**24,1**
cookers/oven	77	78	79	80	83	84	84	84	85	**85**	**33,4**
refrigerator	95	95	96	96	99	99	99	99	99	**99**	**39,0**
freezer	49	54	58	67	62	57	55	55	55	**54**	**21,4**
number of households (in millions)	25,0	26,4	28,2	36,9	38,1	38,7	38,9	39,1	39,2	**39,2**	**199,6**
other household appliances											stock (in mio. units)
microwave oven	1	4	33	52	59	63	65	66	67	68	26,8
*until 1999 old Germany											

Figure 2.69: saturation of the German market (source: ZVEI (2006)[118])

Finland

The Finnish ownership of dishwashers is 50 % (2002) (Figure 2.70). In the period of 1998-2002 the penetration level of dishwashers shows a growth of 7 %.

Table 4.1. Households' ownership of consumer durables, 1966-2003, % of households

Consumer durable	1966	1971	1976	1981	1985	1990	1995	1998	2001/02	2003*)
	%	%	%	%	%	%	%	%	%	%
Refrigerator	44	74	93	94	96	96	97	97	..	..
Freezer	1	7	40	54	70	78	83	85	87	..
Microwave oven	..	..	..	..	..	52	72	78	84	..
Washing machine	53	61	74	71	67	80	83	83	87	..
Dishwasher	..	1	5	10	17	33	41	43	50	..
Vacuum cleaner	48	63	86	88	93	96	..	..	..	..

Source: Statistics Finland, Household Budget Survey and Consumer Survey

**) Data based on Statistics Finland's Consumer Survey (02/2003). Data collection differs from that of the Household Budget Survey*

.. data not available

Figure 2.70: equipment of households, 1966-2001/02 – FINLAND[119]

[118] ZVEI (central association electro-technology and electronic industry registered association / Zentralverband Elektrotechnik und Elektronikindustrie e.V.) (2006/7): Zahlenspiegel des deutschen Elektro-Hausgerätemarktes. Der Inlandsmarkt der Elektro-Hausgeräte-Industrie/ Verkäufe von Elektro-Großgeräten/ Verkäufe von Elektro-Kleingeräten/ Marktsättigung. Online: http://www.zvei.de/index.php?id=585&no_cache=1&tx_ZVEIpubFachverbaende_pi1[download]=681&type=98

France

The average penetration level with dishwashers in France reached a value of 50 % (2007). Since the last 5 years only a small increase of 3 % can be mentioned (Figure 2.71).

Rate of equipment	in %
washing machine	94,7
dishwasher	**50,6**

Figure 2.71: household equipment, 2007 (online published) – FRANCE[120]

Hungary

The penetration level of dishwashers in Hungarian households is still very low, but has increased from 6,1 % in 2000 to 13,5 % in 2004 [121] (Figure 2.72).

Poland

Only about 7 % of all Polish households had a dishwasher in the year 2005[122], but this is almost thrice the number compared to year 2000 (Figure 2.73).

Spain

In Spain the level of saturation with dishwashers lays at nearly 33 % in the year 2005 and shows no large changes since 2001 (Figure 2.74).

[119] http://www.stat.fi/index_en.html)

[120] http://www.gifam.fr/pages/lemarche/lemarche.html

[121] Hungarian Central Statistical Office (2006): Hungary in Figures 2005 S.11. Online: http://portal.ksh.hu/pls/ksh/docs/hun/xftp/idoszaki/pdf/hungary_in_figures_2005.pdf

[122] GUS (www.stat.gov.pl)

http://www.stat.gov.pl/urzedy/opole/publikacje/rocznik_woj/budzety_gospodarstw_domowych/04w08_05.pdf

háztartásokban, 2000–2004 – *Average yearly stock of consumer durables in the lowest and in the highest deciles, 2000–2004*

Megnevezés *Denomination*	Év									
	2000		2001		2002		2003		2004	
	Decilisek – *deciles*									
	1.	10.	1.	10.	1.	10.	1.	10.	1.	10.
Tartós fogyasztási cikkekel rendelkezők aránya, % – *Share of households with consumer durables, %*										
Hűtőszekrény – *Refrigerator*	81,3	75,0	84,2	71,3	81,2	77,8	79,4	66,7	75,4	62,1
Fagyasztógép – *Deep freezer*	34,7	52,3	42,1	53,2	46,0	52,7	43,0	51,6	42,4	46,3
Hűtő- és fagyasztógép – *Refrigerator and deep freezer*	13,6	31,0	10,9	33,1	14,6	27,7	16,7	41,7	20,4	45,6
Mikrohullámú sütő – *Microwave oven*	26,4	72,6	29,1	75,5	36,6	77,4	44,4	83,3	54,8	85,3
Mosogatógép – *Dishwasher*	..	..	0,7	6,1	1,5	7,8	0,5	13,0	3,1	13,5
Mosógép, automata és félautomata – *Washing machine, automatic, semi-automatic*	35,1	81,7	38,9	81,7	43,2	84,5	43,2	89,2	52,2	88,0
Szárítógép – *Drying machines*	..	..	1,9	1,2	0,8	1,0	0,1	1,1	0,6	1,0
Porszívó – *Vacuum cleaner*	..	..	69,5	89,4	71,8	92,4	69,8	91,9	75,0	91,0
Takarítógép – *Cleaning machine*	..	..	4,5	17,6	5,6	14,7	7,1	21,0	5,5	16,9
Varrógép – *Sewing machine*	..	..	23,4	33,4	23,3	35,6	22,6	36,8	22,9	35,5
Színes televízió – *Television set, colour*	82,9	95,8	85,5	95,5	89,7	97,2	89,6	98,8	92,2	97,7
CD-lejátszó – *CD player*	..	..	5,8	23,2	8,6	23,4	13,5	30,3	16,6	35,3
Magnó, magnós rádió – *Tape-recorder with radio*	..	..	54,9	59,6	59,7	63,3	58,8	66,0	58,9	60,7
Hifitorony – *HI-FI set*	..	..	15,2	46,0	23,6	48,4	25,0	57,3		
Videomagnó – *Video-recorder*	35,2	67,4	32,8	68,8	41,2	67,7	40,7	73,5	46,1	70,7
DVD – *DVD*	..	..	0,4	3,2	0,4	5,5	4,2	15,2	10,4	24,6
Személyi számítógép – *Personal computer*	4,4	26,3	5,9	35,0	12,4	38,2	17,9	52,3	20,6	57,4
Légkondicionáló – *Air conditionset*	..	..	0,7	3,6	0,1	2,3	0,5	5,4	0,2	7,3

Figure 2.72: equipment of households, 2000-2004 – HUNGARY (source: Hungarian Central Statistical Office[123])

HOUSEHOLDS FURNISHED WITH SELECTED DURABLE GOODS [a]

WYSZCZEGÓLNIENIE	2000	2004	2005	*SPECIFICATION*
	w % ogółu badanych gospodarstw domowych *in % of total households*			
Chłodziarka	98,8	98,2	98,54	*Refrigerator*
Zamrażarka	54,2	34,8	34,85	*Freezer*
Automat pralniczy	82,2	85,9	86,45	*Automatic washing machine*
Zmywarka do naczyń	2,7	4,7	7,23	*Dishwasher*
Kuchenka mikrofalowa	x	34,6	43,49	*Microwave oven*
Samochód osobowy	51,0	47,4	49,53	*Passenger car*
Odbiornik radiofoniczny	59,6	54,8	49,67	*Radio set*
Zestaw do odbioru, rejestracji i odtwarzania dźwięku (wieża)	37,5	43,1	45,58	*Hi-fi stereo music system*
Odbiornik telewizyjny	99,0	98,3	98,66	*Television*
Magnetowid	54,5	45,3	43,33	*Videorecorder*
Urządzenie do odbioru telewizji satelitarnej [b]	58,1	53,7	58,32	*Satellite television equipment* [b]
Komputer osobisty	14,0	31,6	36,35	*Personal computer*
w tym z dostępem do Internetu	x	13,1	19,27	*of which with access to the Inter*

a Opracowano na podstawie stanu w końcu poszczególnych kwartałów. *b* Łącznie z telewizją kablową.
a Compiled on the basis of data at the end of individual quarters. b Including cable television.

123 Hungarian Central statistical office (2006): Electricity consumption of households, Budapest. Online: http://portal.ksh.hu/pls/ksh/docs/hun/xftp/idoszaki/pdf/haztvillenergia.pdf

Figure 2.73: equipment of households, 2000-2005 – POLAND (source: GUS[122])

	Spain: 2005 Living Conditions Survey Housing, facilities and equipment						
	Total	Telephone	Colour television	Personal computer	Washing machine	**Dishwasher**	Car
Total	15141,3	97,4	99,3	50,3	98,5	**32,6**	75,4

Figure 2.74: equipment of households, 2005 – SPAIN[124]

Sweden

For Sweden different values of dishwasher penetration in households are reported. While it is reported that in the year 2002 56 % of all Swedish households did possess a dishwasher (Figure 2.75) and in the year 2004 57 %, GESIS data show a value of only 44 % for the same period. This difference cannot be verified.

Equipment in Swedish homes	
	2002
Dishwasher	56
Washing machine	72
Microwave oven	83

Figure 2.75: equipment of households, 2002 – SWEDEN (source: Statistics Sweden[125])

United Kingdom

The dishwasher market of United Kingdom is characterised by a low penetration rate of approximately 35 % (2005-2006) (Figure 2.76). But the equipment level shows continuous raising in the last 30 years (18 % (1995) to 29 % (2003), Figure 2.77). It may be expected that this trend will go on[126], because of social-demographic changes, like more new young households and changes in consumer awareness[127].

[124] Fuente: National Statistics Institute www.ine.es

[125] STATISTICS SWEDEN (2004): Living condition report No.107: the way we live in Sweden homes, The living environment and transportation 1975-2002. Online: WWW.SCB.SE/STATISTIK/_PUBLIKATIONER/LE0101_1975I02_BR_LE107SA0401.PDF S.177

[126] BFAI (2004): Hausgeräte in Großbritannien mit moderatem Wachstum Geschirrspüler noch nicht ausgereizt / Dual-fuel-Einheiten beliebt (2004). Online: http://www.bfai.de/ext/Einzelsicht-Export/DE/Content/__SharedDocs/Links-Einzeldokumente-Datenbanken/fachdokument,templateId=renderPrint/MKT20040226104109.pdf FAI (2004).

[127] Source: http://www.statistics.gov.uk/cci/nugget.asp?id=868

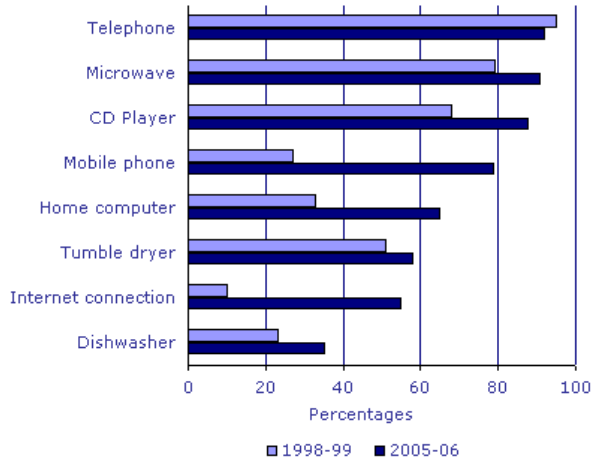


Figure 2.76: equipment of households, 1998-2006 (UK)

	9.3 Percentage of households with durable goods 1970 to 2002-03			
	Washing machine	Tumble Dryer	Dishwasher	Internet connection
1970	65	--	--	--
1975	72	--	--	--
1980	79	--	--	--
1985	83	--	--	--
1990	86	--	--	--
1994-95	89	50	18	--
1995-96	91	50	20	--
1996-97	91	51	20	--
1997-98	91	51	22	--
1998-99	92	51	24	9
1998-99*	92	51	23	10
1999-	91	52	23	19
2000-01*	92	53	25	32
2001-02[3] *	93	54	27	39
2002-03*	94	56	29	45

-- Data not available.
* Based on weighted data and including children's expenditure
1 Full or partial.
2 Includes digital and cable receivers
3 From 2001-02 onwards, weighting is based on the population figures from the 2001 census
ONS, Family Spending 2002-03, © Crown copyright 2004

Figure 2.77: equipment of households, 1970-2002-03 – UNITED KINGDOM[128]

2.3.2.1.2 b) The energy label for dishwashers

The Energy label, introduced in 1999 for dishwashers played a decisive role decisive role for development of the market of for this product.

2.3.2.1.3 c) Buying criteria

86 % of all German consumers choose the energy label as a source of information when they purchase a new appliance[129]. Some studies, e.g. the Swiss SAMMER/WÜSTENHAGEN or

[128] Source: http://www.statistics.gov.uk/StatBase/ssdataset.asp?vlnk=7611&Pos=4&ColRank=1&Rank=272

[129] http://www.greenlabelspurchase.net/Licht_EU_Energie_Label.html

INNOFACT AG, about the consumer "buying" behaviour result that some criteria listed on the Energy label are the primary attention points for the consumer when they have to choose a new appliance. The German study of the INNOFACT AG in the year 2005 asked customers which criteria will affect the purchase decision for a new household appliance. Over 23 % of the consumers mentioned that energy and water consumption are the main buying criteria which influence the purchase, followed by the price (18 %) and the performance date, which also are listed on the energy label. Although these data are gathered regarding washing machines (see the previous paragraphs), similar results for dishwashers may be expected.

2.3.2.2 Market trends: models offered on the market

This analysis uses the database of all models of automatic dishwashers offered in the European market as provided by CECED. Databases are available for all years from 1998 to 2005.

The number of models offered in the market has considerably increased over the reporting period (Figure 2.78). This is aligned to the increase of the size of the market due to the higher population and penetration of dishwashers.

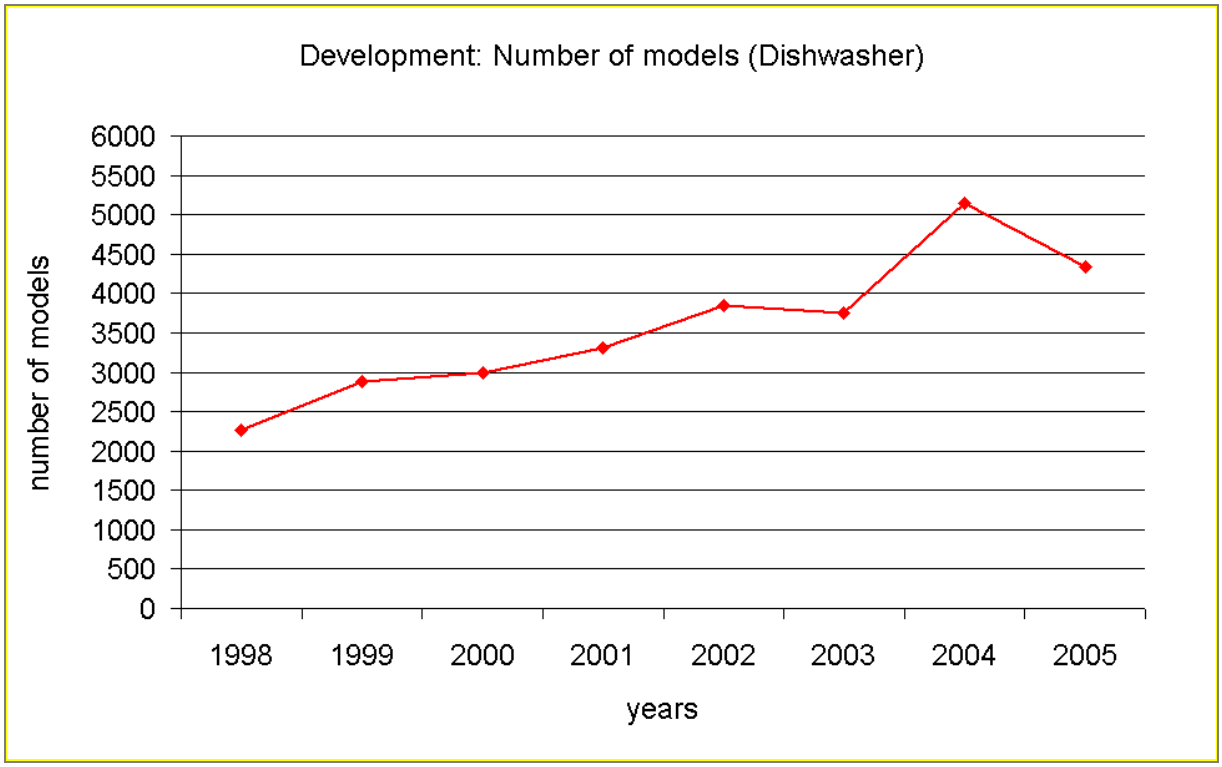


Figure 2.78: number of models in CECED database on dishwashers

About 80 % of the models have space for 12 place settings (ps) of dishes (Figure 2.79) and normally have a width of 60 cm. This figure was constant over the years. More dynamic is (Figure 2.80) the market for smaller or compact machines, width 45 cm, showing a clear replacement of 8ps capacity machines by 9 ps machines. Smaller machines for 4 or 5 ps play a very minor role in the market with a share below 1 %, unchanged over the years. Only slightly more relevant are larger machines (about 2 % of the market share) for 15ps, replacing machines for 14 ps.

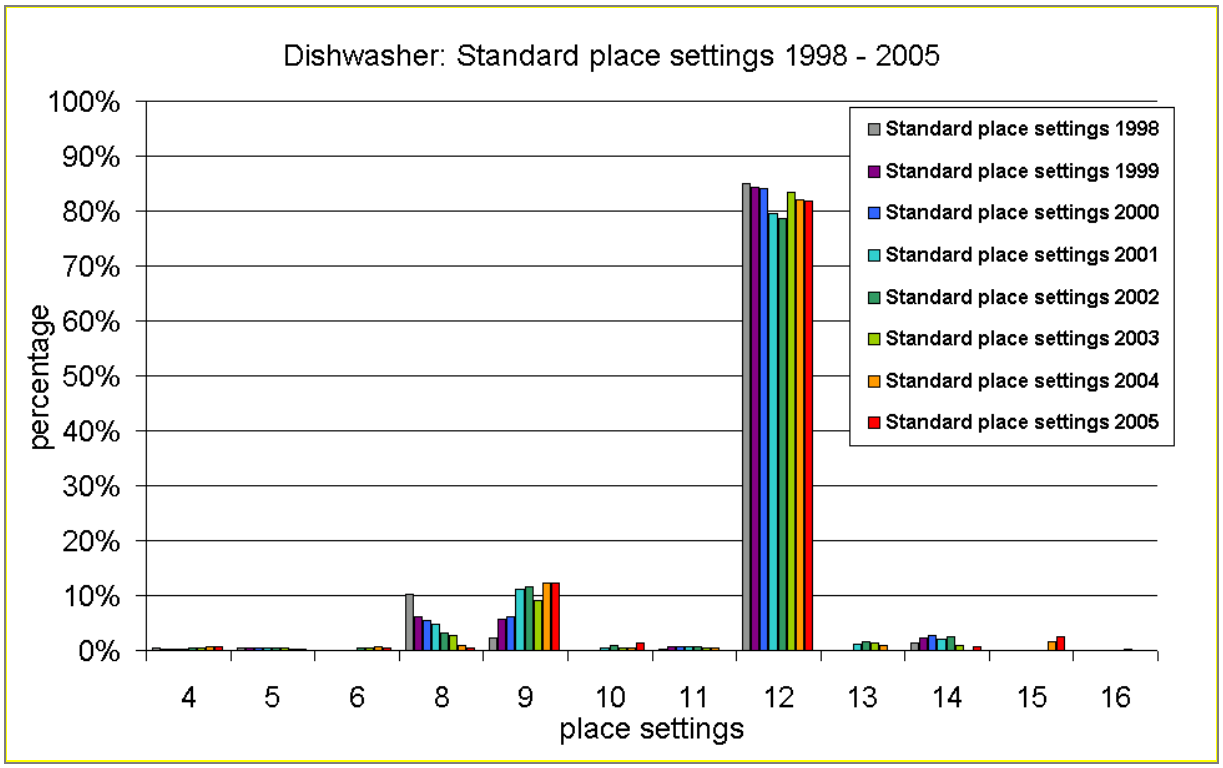


Figure 2.79: distribution of dishwasher models capacity in terms of place settings

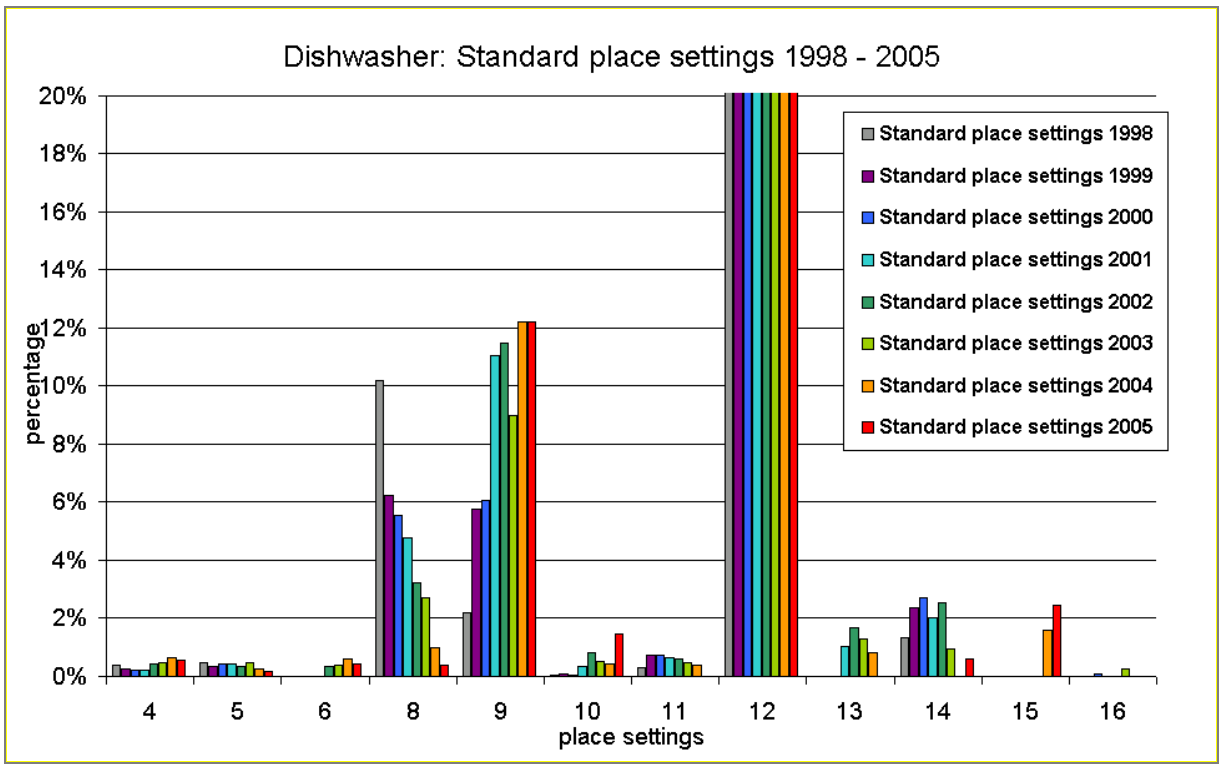


Figure 2.80: distribution of dishwasher models capacity in terms of place settings (ordinate enlarged)

Considering the energy consumption per cycle and per place setting (Figure 2.77), a drastic decrease over the years occurred, showing a clear asymptotic behaviour in recent years. This phenomenon can be explained when considering the different machine size, since the energy efficiency index is calculated through different algorithms in the energy labelling scheme, depending if the machines have a capacity larger or smaller than 10 place settings. For 12 ps

machines the average energy consumption (Figure 2.81) is now at 1,07 kWh per cycle, very close to the limit of class A (at 1,05 kWh/cycle). For the 9 place setting machines, the second most important capacity, the average energy consumption in 2005 was 0,83 kWh/cycle with the class A threshold at 0,81 kWh.

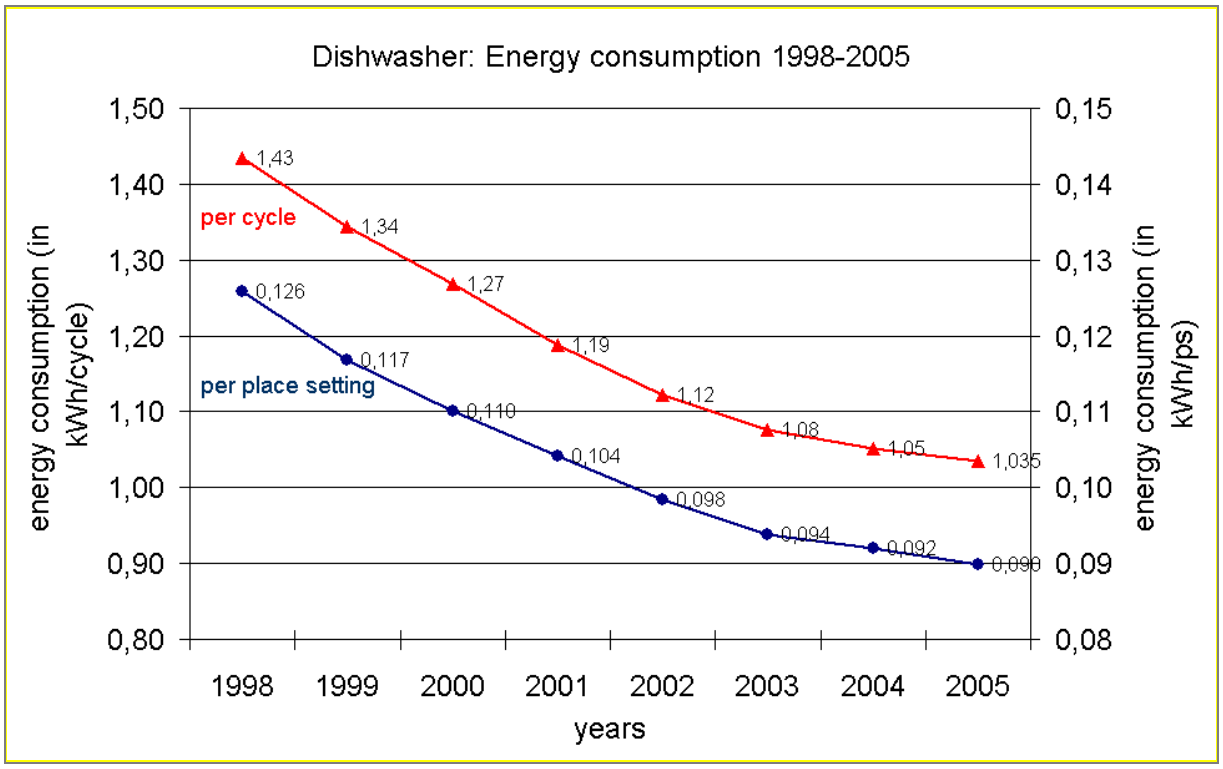


Figure 2.81: development of the average energy consumption per cycle and per place setting

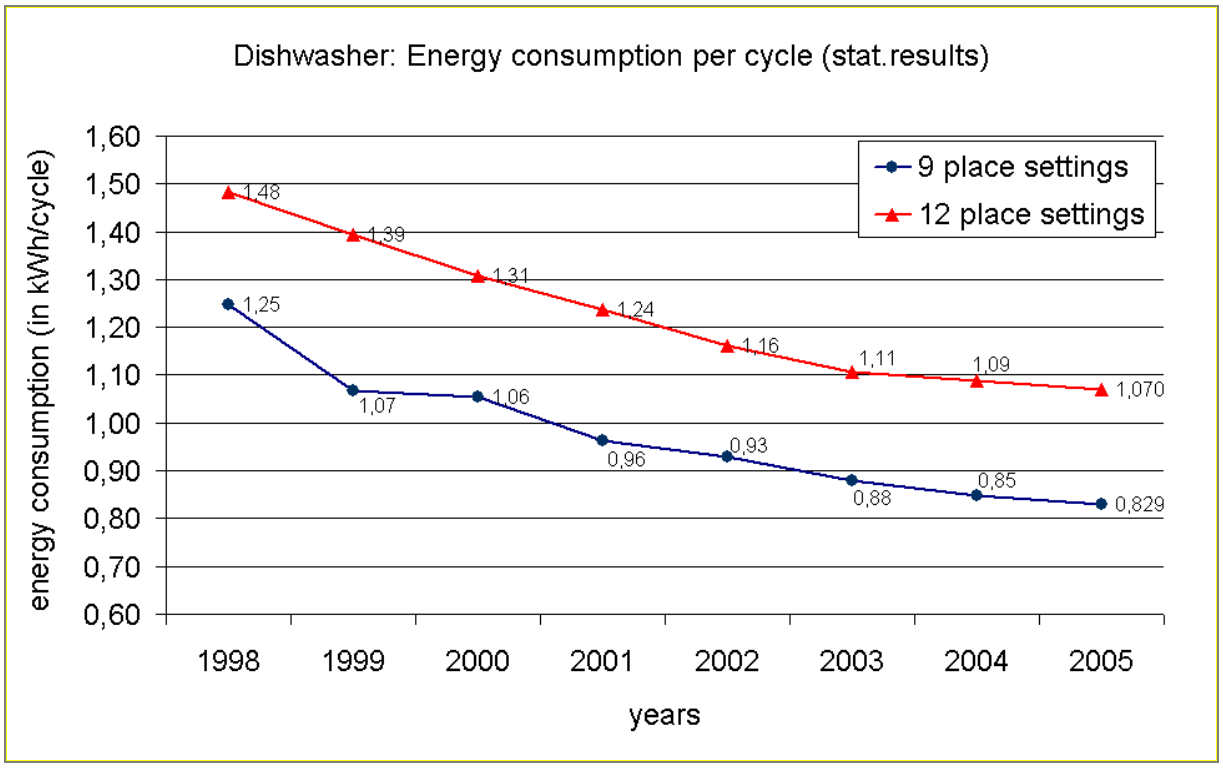


Figure 2.82: development of the average energy consumption for 9 and 12 place setting machines

Looking at the distribution of the energy consumption, for 12 ps more than 90 % of the market offer belongs to class A and none is below (Figure 2.83). Compared to the base case of the energy labelling[130] (1,692 kWh for 12 ps and 1,485 kWh for 9 ps) in 2005 a reduction of 37 % (12ps) and 44 % (9 ps) in the energy consumption could be achieved.

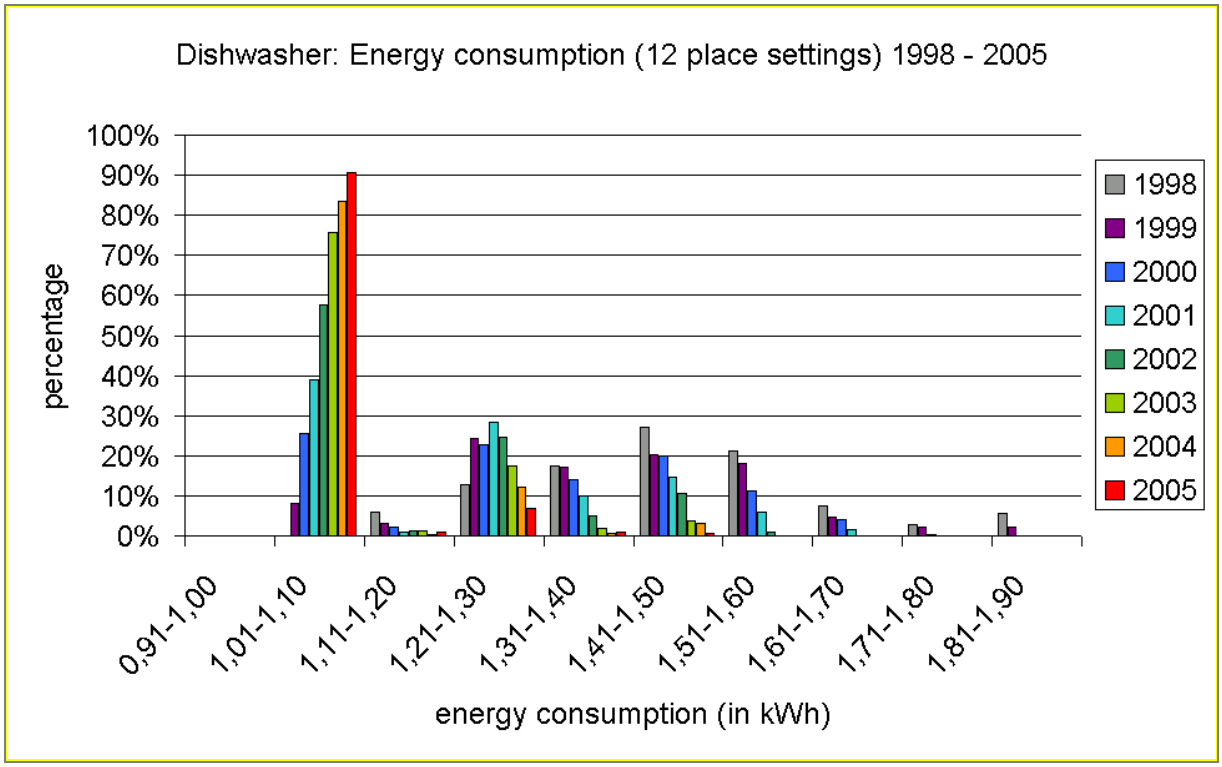


Figure 2.83: distribution of the energy consumption values for 12 place setting machines

This drastic improvement also finds its expression in the distribution of the energy efficiency classes as shown on the energy label, where in 2005 about 90 % of the machines are in class A (Figure 2.84) and no machines are worse than class C.

This improvement was achieved without deteriorating the relevant performance (cleaning and drying) of dishwashers (Figure 2.85 and Figure 2.86), where on the contrary a continuous improvement can be observed, more pronounced for the cleaning performance than for the drying performance. Drying performance seems to have improved more rapidly only recently. This may be linked to the asymptotic behaviour of the energy consumption improvement: without a better target for energy efficiency than class A, the technological innovation may have been devoted to improve the drying performance.

Water consumption of dishwashers has also been reduced, with an improvement of the average consumption of about 22 % in 2005, compared to 1998 (Figure 2.87). Also the rate of improvement has been decreasing in recent years, showing some asymptotic behaviour at about 15 litre/cycle. Although the majority of machines for 12 ps. are already below 15 litres (Figure 2.88), there are still machines with a water consumption of 20 litres per cycle.

[130] "Technical/economic analysis of dishwashers"; van Holsteijn en Kemna; Delft July 96

- "Energy consumption of dishwashers (4–16 settings)"; van Holsteijn en Kemna; Delft October 97

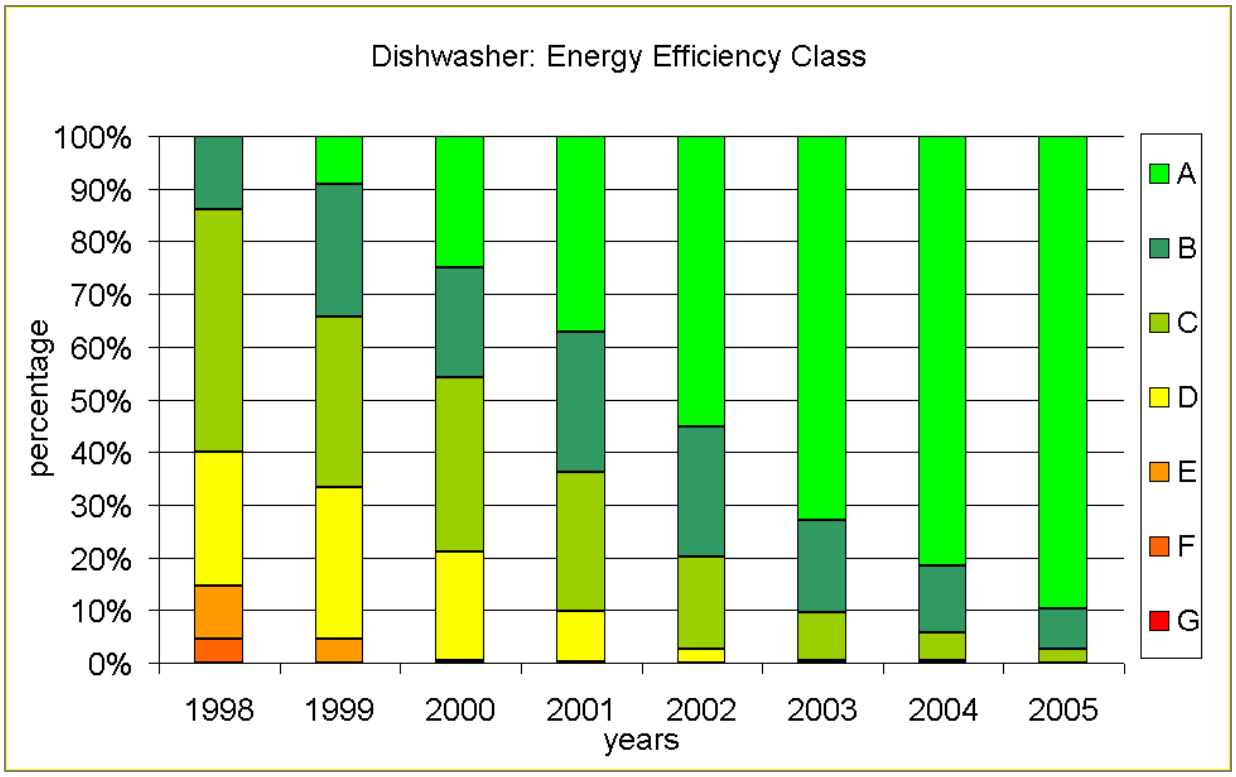


Figure 2.84: distribution of energy efficiency classes for dishwasher

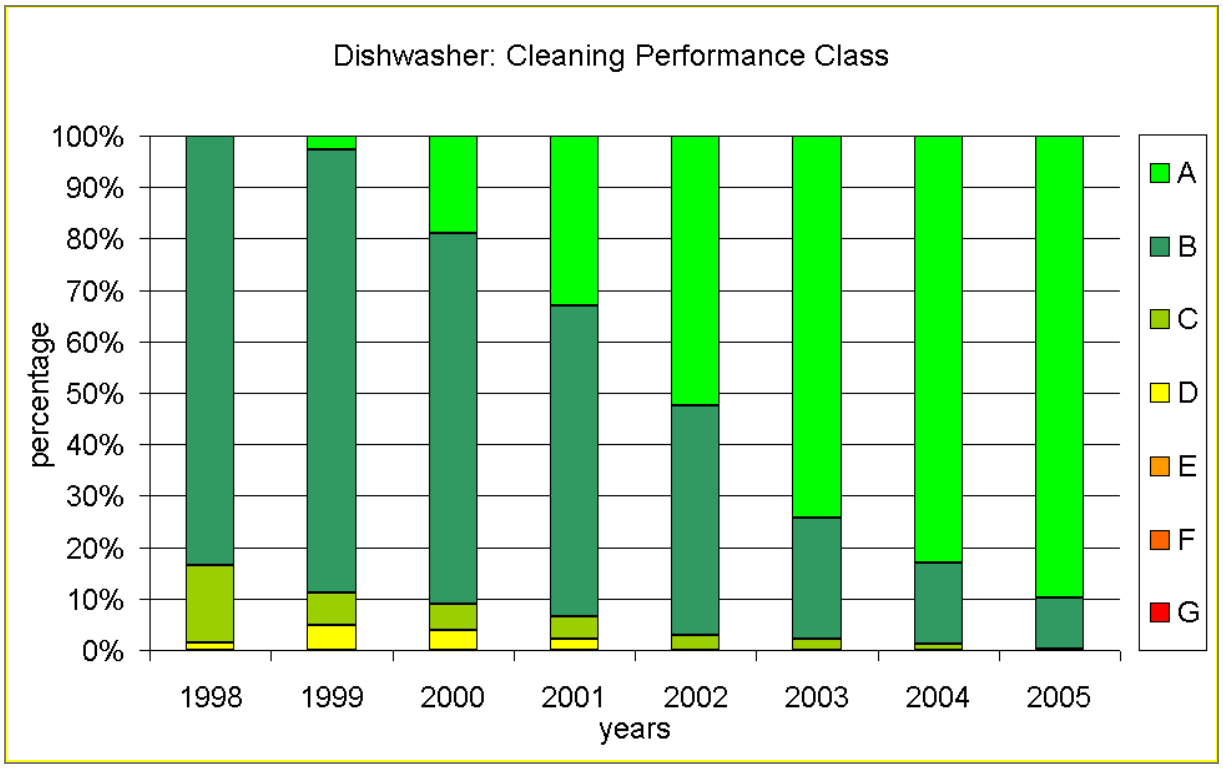


Figure 2.85: distribution of cleaning performance classes for dishwasher

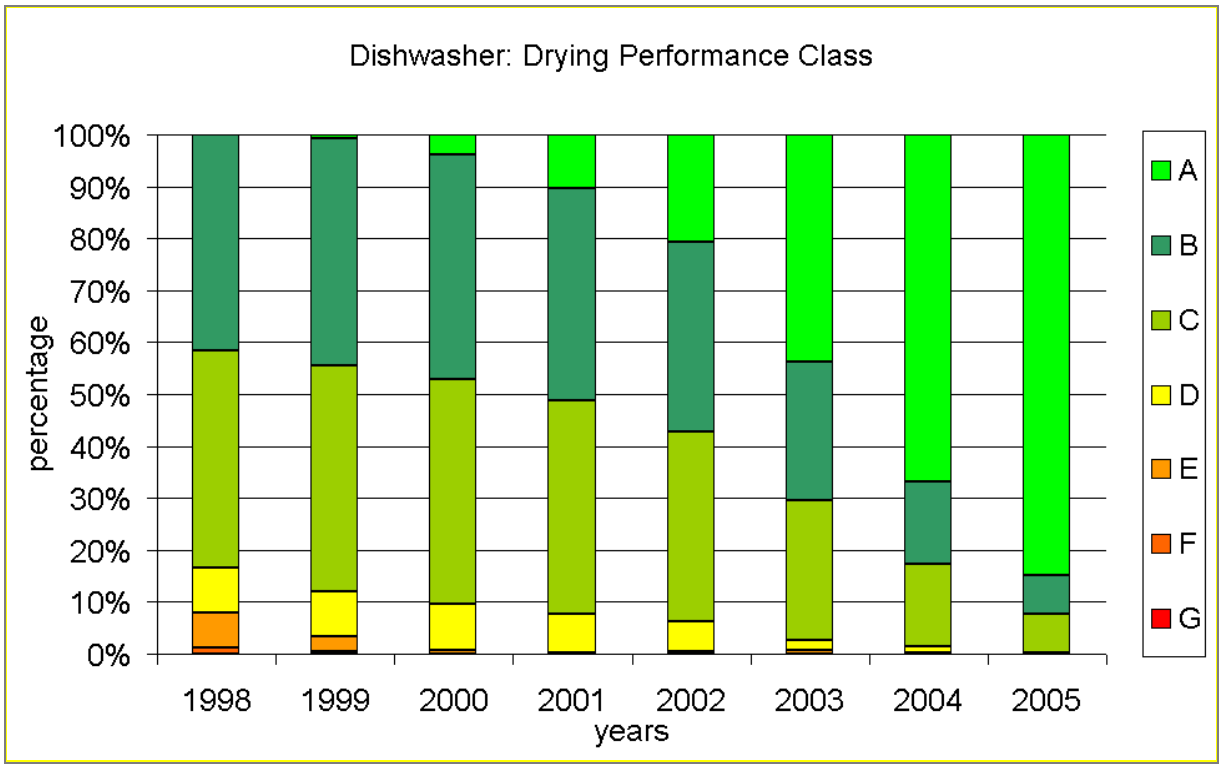


Figure 2.86: distribution of drying performance classes for dishwasher

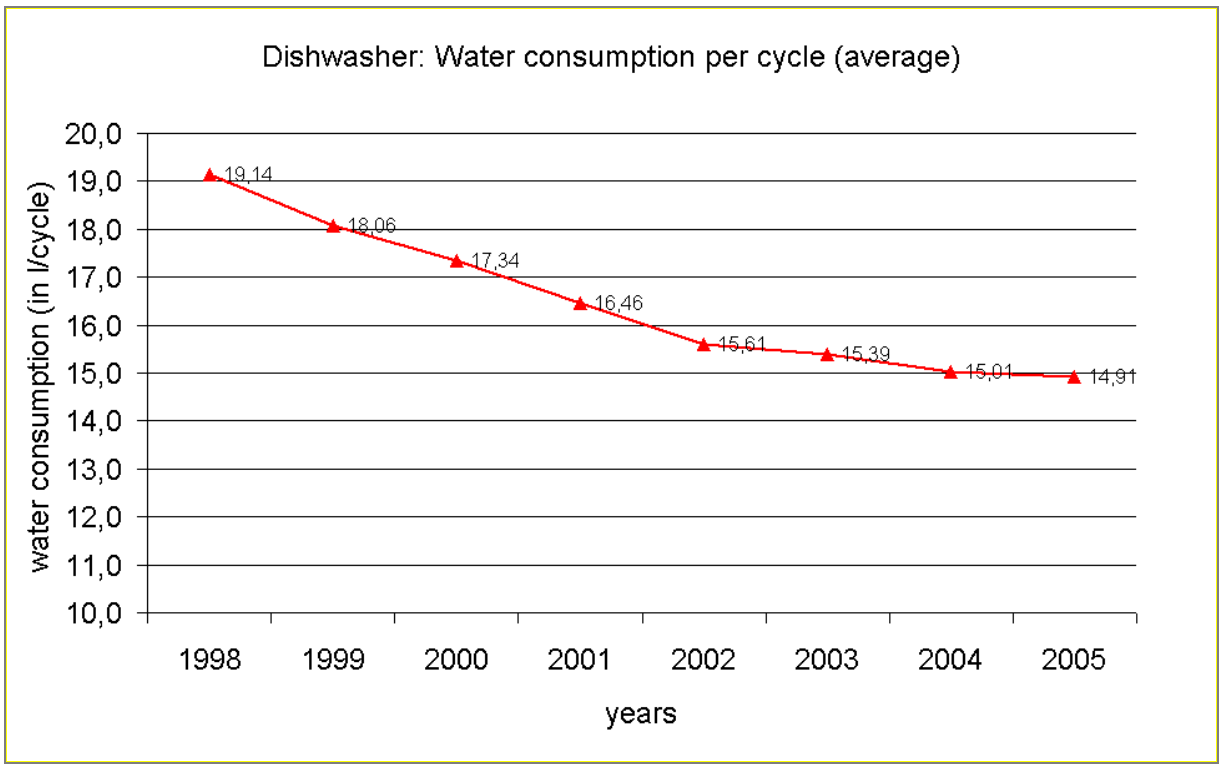


Figure 2.87: development of the average water consumption for dishwashers

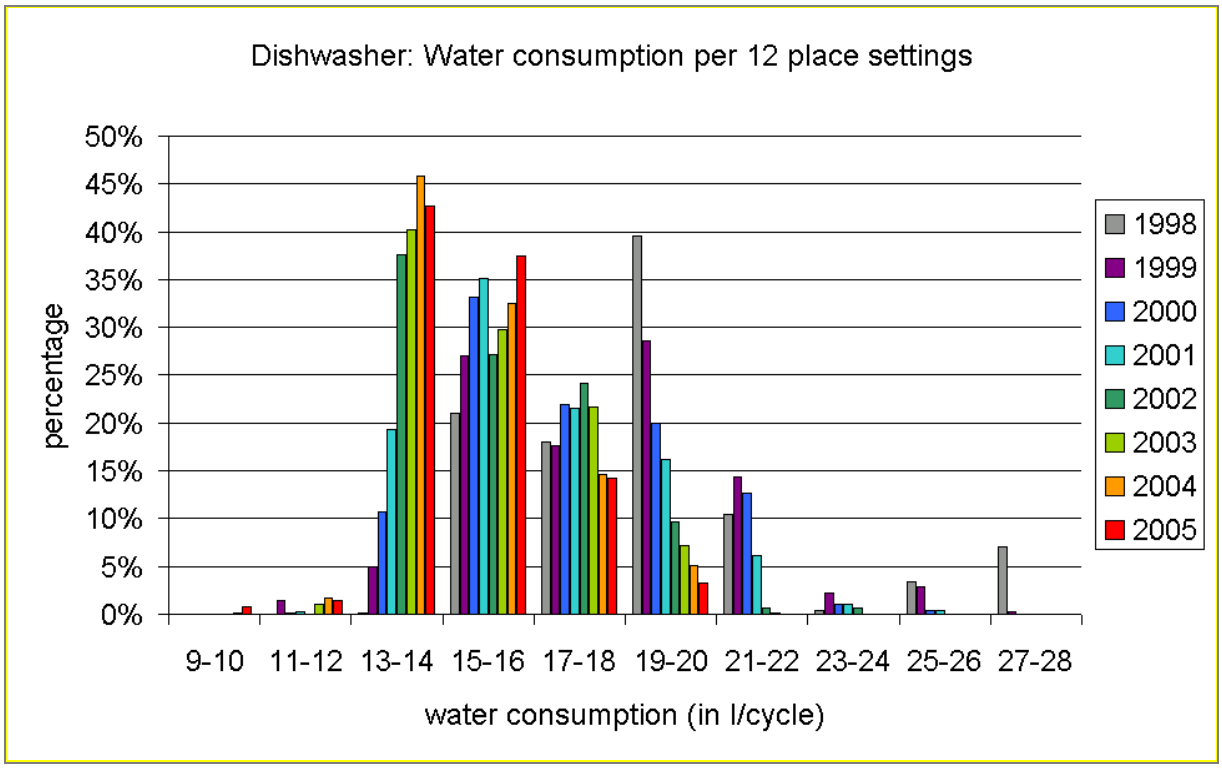


Figure 2.88: distribution of the water consumption for 12ps machines

The following main market trends for dishwashers could be identified analysing the available information:

- slight increase in load capacity in recent years, but 80 % of the models have a capacity of 12 place settings, constant over years
- 8 place settings machines were substituted by 9 place settings. machines
- the market share of small compact machines (45 cm, below 10 ps capacity) is constant their market share
- very small and large machine are almost unimportant (1-2 % of the market)
- 37 % (12 ps) and 44 % (9 ps) improvement in energy efficiency compared to base case, with an asymptotic behaviour
- 90 % of the models are in class A, but no better classes are available
- no deterioration of cleaning and drying performance
- drying performance improved more recently
- 22 % improvement in water consumption from 1998 to 2005 with asymptotic behaviour
- majority of water consumption is below 15 litre/cycle for 12 place settings machines

2.3.2.3 Market trends: the manufacturers

2.3.2.3.1 a) Analysis of the product brochures

Within the market trend analysis, current presentations of washing machines in manufacturer brochures are analysed, in order to draw conclusions about possible trends.

Primarily web information and product brochures of the household appliance market leaders in Europe[131] are analysed, evaluating the appliance options most frequently mentioned and emphasised to the potential customers.

It must be pointed out that the analysed material is the results of the marketing strategies of the single companies, aimed to reach a multitude of different consumer types, with different wishes and expectations. Nevertheless, a set of common features for each appliance type is generally advertised by the manufacturers.

Taking into consideration these three general assumptions, a general trend about appliance features can be derived. The analysis of the published brochures and web information shows that the trend of washing machines follows several specific directions: generally machines seem to become more intelligent, have a larger capacity, shorter programmes duration and new special programmes. A number of common related features are presented by almost all manufacturers, which can be grouped in five categories, as shown in previous Figure 2.60 for the washing machines. A list of aspects and attributes for washing machines emphasized by manufacturers can also be drawn (Table 2.31).

Table 2.31: results – dishwasher: mentioned appliance options/features

a. ecological aspect	- high energy efficiency - low water consumption - low energy consumption - good evaluation by the energy label (e.g. AAA) - good evaluation by consumer magazines - energy saving programmes - heat exchanger
b. functionality	- very good cleaning performance - very good drying performance (reduction of condensed water / no steam) - automatic programmes - new sensor technology (automatic identification of loading, turbidity, degree of staining) - adaptation to dishwashing detergent (2,3,4,5 in 1 option/programme) - combined cleaning programmes (e.g. "DUOWASH" glasses + pots) - special "care" programmes (plastics, china-, delicate-, beer glasses, etc.) - improved/additional spray arms
c. comfort/ergonomics	- low noise (30 - < 60 dB) - shorter programme times (e.g. 30 min programmes) - start time delay / timer / pre-selection - flexible, adjustable, big baskets - easy loading/handling - “Slim machines” (small size / space-saving appliances) - display (LCD); Touch control - bigger capacity - interior lighting - networking features - easy installation
d. health/hygiene	- hygienic-/intensive programmes (e.g. for sterilisation of baby bottles, utensils etc. for heavily soiled crockery)
e. safety	- water control options (e.g. Aqua stop) - fault analysis - self cleaning option - child safety locks

[131] Countries: Germany, United Kingdom, Spain, Italy, France, Poland, Czech Republic, Finland

Primarily technical and functional innovations and improvements are highlighted by manufacturers: the trend goes toward an improved autonomy and adaptability combined with high performance of the dishwasher.

At the same time the possible improvement in quality of life as well as the possible financial advantage for the consumer are highlighted, e.g. the reduction of the costs for water or energy. The very good performance of the appliance, with marginal water and energy consumption values, (characterised by the energy label, e.g. with the classification A/A/A: energy efficiency, cleaning, drying), are emphasised as well as good test results in consumer magazines (Table 2.31 a).

A particular attention is given to the presentation of new, intelligent functions: improved sensor systems and functions are presented, which automatically detect the loading, the type of tableware and the degree of soiling and efficiently adjust the water and energy consumption as well as the programme duration. Generally, new special programmes for different consumer needs are presented: e.g. ability to clean very sensitive dishes, china and crystals, different loading capacity or the separation of different tableware in the baskets; also improved drying performance, with the reduction or prevention of steam- and/or condensation are highlighted as well (Table 2.31 b).

A further point in many product presentations is the hygiene aspect: the consumer will be able to sterilize tableware with high temperature programmes (e.g. baby-bottles, …). But also in the future the appliance will come with self-cleaning functions (Table 2.31 d).

Highlighting the advanced machine design, new larger and adjustable baskets are mentioned, pointing out the adaptability of the machine to future needs..

Generally manufacturers prefer to advertise larger capacity machines. Slim compact machines are also presented but not emphasised, therefore a future trend cannot be confirmed.

Another point which is mentioned by all manufacturers is the reduction of noise of new appliances (from 30 to less than 60 dB), although the declared values are apparently not consistent (sound power levels and sound pressure levels are declared together), to allow the integration of the (silent) dishwashers in everyday life events to increase the quality of life of the consumer. Also the reduction of the washing cycle time (up to 50 %) and time pre-selecting options will play a major role in the future, because this provides the consumer with more leisure time and autonomy (Table 2.31 c).

Safety options (aqua stop systems, children safety, etc), already exist today and will be guaranteed in future too, but these basic features will be supplemented with intelligent options like self fault analysis, self cleaning options, etc (Table 2.31 e.).

The comfort of handling (e.g. touch screen, new displays) or the new modern design (e.g. inner lighting, glass door, etc.) of the appliances are mentioned as the less important features (Table 2.25-c).

2.3.2.3.2 b) Manufacturers questionnaire

Manufacturers were interviewed about their opinions on current wishes and preferences of final customers and on identified future trends. This analysis was developed by asking to marketing managers of leading appliance manufacturers to rank several appliance features in a given scoring scale - from 1 (low priority) to 10 (high priority). For dishwashers the following options/features were presented through an ad-hoc questionnaire:

- larger capacity of loading
- smaller capacity of loading
- lower energy consumption
- lower water consumption

- shorter programme times
- better drying effect
- better cleaning performance
- hygienic programmes/effects
- lower running costs
- lower price of the appliance
- lower noise
- network connectivity; communication between household appliances.

The opinions of eight manufacturers could be used again for dishwashers. According to manufacturers *shorter programme times* is the today most important feature for the consumers, with nearly 8 points. Comparable are the results for *better cleaning performance* (7,6), *lower energy consumption* (7,4) and *lower water consumption* (7,4) (Figure 2.89). The standard deviation of the point *better cleaning performance* is very high (stand. dev. = 2,56) showing different opinions of the manufacturers (; *bigger capacity of loading*, *lower price of the appliance*, *lower noise* and *better drying effect* follows in the order, with 6,1 – 6,5 points (Figure 2.89), but also show a high standard deviation. The option with the lowest priority level is *network connectivity; communication between household appliances* with 1,9 points.

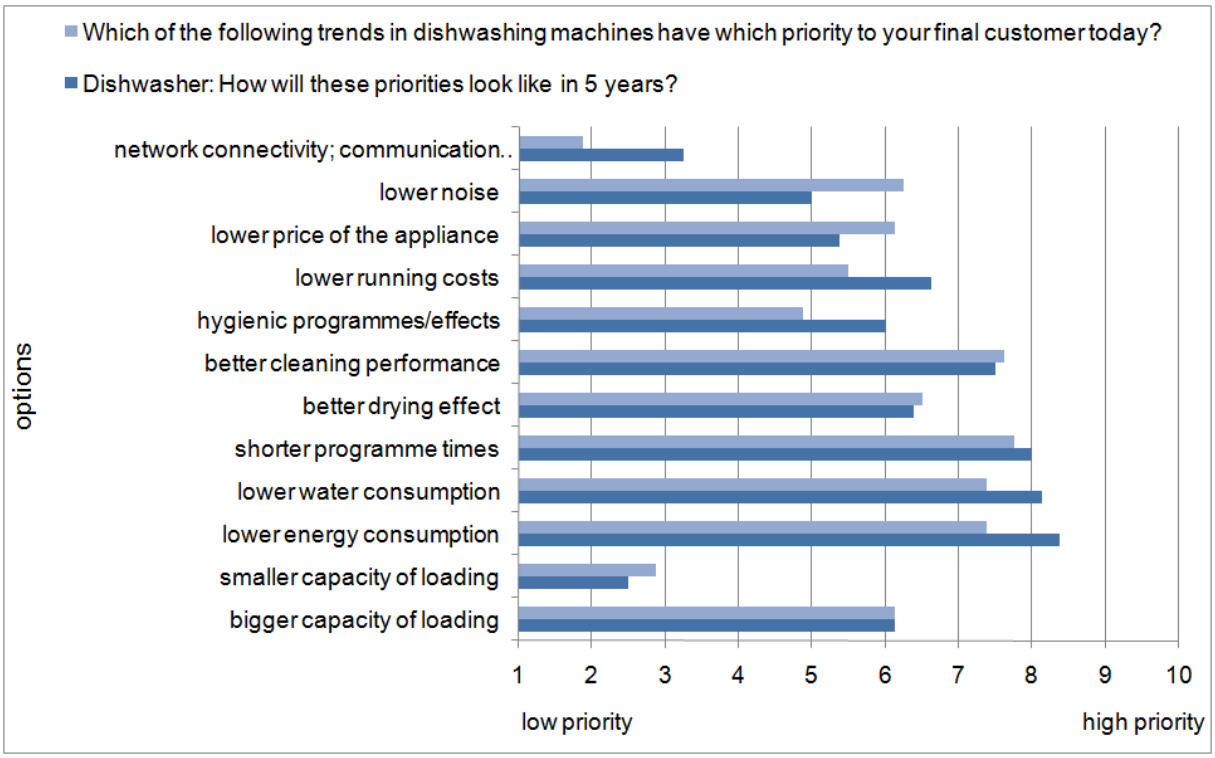


Figure 2.89: dishwasher: priority ranking (comparison: *today – future*) asked to manufacturers

Table 2.32: trends in dishwashers today – by manufacturers point of view

Which of the following trends in dishwashers have which priority to your final customer today: *1 (low priority), 2, 3,…, 10 (high priority)?*					
Descriptive statistic					
	N	Minimum	Maximum	Average	Standard deviation
network connectivity; communication between household appliances	8	1	5	1,9	1,46
smaller capacity of loading	8	1	8	2,9	2,90
hygienic programmes/effects	8	2	7	4,9	1,89
lower running costs	8	3	8	5,5	1,60
bigger capacity of loading	8	3	10	6,1	2,53
lower price of the appliance	8	1	9	6,1	2,59
lower noise	8	2	10	6,3	2,71
better drying effect	8	4	8	6,5	1,85
lower energy consumption	8	4	10	7,4	1,77
lower water consumption	8	5	10	7,4	1,85
better cleaning performance	8	4	10	7,6	2,56
shorter programme times	8	5	10	7,8	1,98
Valid data (by list)	*8*				

Table 2.33: trends in dishwashers in 5 years – by manufacturers point of view

Dishwasher: How do you think will these priorities look like in 5 years? *1 (low priority), 2, 3,…, 10 (high priority)?*					
Descriptive statistic					
	N	Minimum	Maximum	Average	Standard deviation
smaller capacity of loading	8	1	8	2,5	2,39
network connectivity; communication between household appliances	8	1	5	3,3	1,67
lower noise	8	2	7	5,0	1,85
lower price of the appliance	8	1	9	5,4	2,45
hygienic programmes/effects	8	3	9	6,0	2,07
bigger capacity of loading	8	2	9	6,1	2,47
better drying effect	8	3	9	6,4	2,20
lower running costs	8	5	9	6,6	1,19
better cleaning performance	8	4	10	7,5	2,56
shorter programme times	8	2	10	8,0	2,73
lower water consumption	8	6	10	8,1	1,55
lower energy consumption	8	6	10	8,4	1,30
Valid data (by list)	*8*				

For dishwashers, the highest priority increase forecast (1,4 points) in the next 5 years is for *network connectivity; communication between household appliances* (Table 2.34). The following options which will become more important for consumers in the future are *hygienic effects/programmes*, *lower running costs*, *lower energy consumption* and *lower water consumption* (with a difference of 1,1 - 0,8 points). According to the manufacturers' opinion the importance of the option *bigger capacity of loading* will remain unchanged, as for *better drying effect* and *better cleaning performances* (-0,1) (Table 2.34). Because of the high decrease in the priority level of the option *lower noise* (-1,3) it can be derived that manufacturers foresee no need of further development there. Also the option "*small capacity*" shows a decreasing importance in the next 5 years (-0,4) (Table 2.34).

Table 2.34: difference: trends in dishwashers *(future – today)* – by manufacturers point of view

	Δ Rating Priority "Future - Today" Dishwasher
bigger capacity of loading	0,0
smaller capacity of loading	-0,4
lower energy consumption	1,0
lower water consumption	0,8
shorter programme times	0,3
better drying effect	-0,1
better cleaning performance	-0,1
hygienic programmes/effects	1,1
lower running costs	1,1
lower price of the appliance	-0,8
lower noise	-1,3
network connectivity; communication between household appliances	1,4
Valid data (by list)	*8,0*

2.3.2.4 Market trends: consumer magazines

Consumer Associations frequently test also dishwashers and publish the results in their magazines, to give advise for consumers' buying decisions. Via these magazines CAs can be considered one of the driving forces of the market; but they also get frequent feedback from their readers, used to define which product needs to be tested and published and how the testing procedure is done. It may therefore be assumed, that consumer magazines somehow reflect consumer expectations and market trends in their testing/publication work.

Through the analysis of the publications about washing machines over the last five years, an - at least rough - overview of present and future consumer requirements and trends can be attempted. A systematic analysis of the criteria and functions tested and how they have changed over the last five years was performed using the publications as listed in Table 2.29. Tested criteria and functions were collected for each country, priority criteria were also taken into account. The next step was to evaluate which criteria were tested in each publication in each country, whether priorities were shifted, which criteria were added and which were deleted through the years. Finally all countries were compared looking for similarities and differences. All criteria and functions were then sorted and listed by frequency of testing in all publications.

Table 2.35: magazines and publications which featured a test of dishwashers

Publications	2001	2002	2003	2004	2005	2006
‚test' (Stiftung Warentest -DE)	-	-	3/2003	10/2004	-	7/2006
Konsument (A)	-	-	5/2003	10/2004	-	8/2006
Which (UK)	1/2001 9/2001	12/2002	8/2003	-	4/2005 11/2005	3/2006
Consumentengids (NL)	-	-	2/2003	12/2004	11/2005	-
Compra maestra (E)	-	3/2002	3/2003 6/2003 9/2003	4/2004 11/2004	4/2005	-
Pro Teste (P)	-	2/2002 9/2002	3/2003 6/2003 9/2003	4/2004	4/2005 11/2005	-
Altroconsumo (I)	-	2/2002 9/2002	3/2003 6/2003 9/2003	4/2004	11/2005	4/2006
Que Choisir (F)	5/2001	11/2002	-	11/2004	-	-
60 Millions de Consommateurs (F)	-	-	2/2003	-	-	-
Test-Achâts (B)	1/2001	2/2002 9/2002	3/2003 9/2003	11/2004	4/2005	4/2006
Kuluttaja (FI)	-	1/2002	-	5/2004	-	-
Råd & Rön (S)	10/2001	-	-	1/2004	3/2005	-
Tænk + Test (DK)	8/2001	-	-	-	2/2005 6/2005	-
Forbruker-Rapporten (N)	-	8/2002	-	-	-	-

2.3.2.4.1 a) Frequency of criteria/functions tested in the last 5 years

Germany

"Stiftung Warentest" indicates the testing priorities by giving the percentage of certain criteria in the final test score. A larger percentage means a higher priority of that criterion/function.

Highest priority is given to the functionality of the tested machines: 35 % (2003) or 40 % of the final test score is based on the results of the functionality test. This includes cleaning performance of the main, intensive and (except in 2003) automatic programmes, drying performance, programme grading/structuring, self cleaning and (except in 2003) programme duration. In 2006 programme duration was evaluated separately for main and eco programme.

Second priority is given to the consumption of energy, water, salt and detergent as well as noise: 30% of the final score is based on it.

The test for ease-of-use has third priority (20 %): it includes testing of operating elements, loading and unloading, cleaning and the user manual. In 2003 the adjustability of the basket was also included.

The test of safety of the machines has the forth priority. In 2003, 15% of the final score was based on safety (flooding and risk of injury), as well as programme duration. In 2004 and 2006 anti-flooding control (or aqua stop mechanisms) combined with safety and quality of production/processing were combined to give the 10 % of the final score.

Throughout all years information is given on programme quantity and the option for variable temperature settings.

Austria

"Konsument" indicates the testing priorities by giving the percentage of certain criteria in the final test score. A larger percentage means a higher priority of that criterion/function. The percentages have changed during the observed years.

In 2003, first priority (35 %) was cleaning performance of the main and intensive programmes, drying performance, programme grading/structuring and self cleaning. Second priority (30 %) was energy and water consumption of both main and intensive programmes as well as noise and salt usage/consumption. 20 % of the final test score was based on ease-of-use, 15 % on safety (including anti-flooding, risk of injury and information in case of malfunctioning) as well as the duration of main and intensive programmes and the quality of production/process.

In 2004, first priority (40 %) was cleaning performance of the main, intensive and automatic programmes, duration of the main and intensive programmes, drying performance, programme grading/structuring and self cleaning. Second priority (30 %) was energy and water consumption of both main and intensive programmes, energy consumption in stand-by mode as well as noise, salt usage/consumption and tablet detergent consumption of the intensive programme. 20 % of the final score was based on ease-of-use, 10 % on safety including anti-flooding, risk of injury, stability and information in case of malfunctioning as well as the quality of production/process.

In 2005, first priority (40 %) was the cleaning performance of the eco, intensive and automatic programmes, duration of the main and intensive programme, drying performance, programme grading/structuring, self cleaning and adjustability of the automatic programme. Second priority (30 %) was the energy and water consumption of eco, intensive and automatic programmes, energy consumption on stand-by mode as well as noise and salt usage/consumption. 20 % of the final score was based on ease-of-use, 10 % on safety including anti-flooding and risk of injury as well as quality of production/process.

Throughout all observed years information is given on price, programme quantity and variable temperature settings.

UK

"Which" indicates the testing priorities by giving the percentage of certain criteria in the final test score. A larger percentage means a higher priority of that criterion/function. The percentages used until 2003 are different from those given from 2005.

Until 2003, 40% of the final test score was based on clearing performance using the main programme; 30% was based on ease-of-use; 10% is based on each annual energy consumption, water consumption per usage and programme duration.

From 2005, first priority (50 %) was given to the combination of the cleaning performance of the main and eco programmes and the water marks. Second priority was ease-of-use (25 %), third the combination of the energy and water consumptions (15 %); 10 % of the final score is based on noise.

The Netherlands

"Consumentengids" indicates the testing priorities by giving the percentage of certain criteria in the final test score. A larger percentage means a higher priority of that criterion/function.

In 2003 priorities were not indicated. In 2004 and 2005, 50 % of the final test score is based on the combination of the cleaning performance of the main and eco programmes. Ease-of-use accounted for up 20 % of the final score, energy and water consumption together up to 15 %; 10 % of the final score is based on noise, 5 % on the user manual.

Price is indicated throughout all observed years.

Spain

"Compra maestra" does not indicate testing priorities.

The following criteria have been tested throughout all observed years: cleaning performance either overall or of the main programme, ease-of-use, noise, programme duration of the main programme as well as safety – once in total, in all other publications anti-flooding safety only.

Throughout all years information is given on price and whether the machines have a half load programme. In 86 % of the publications it is indicated whether the machine leaves water marks, has an adjustable basket, time shift/ delay as well as the dimensions.

Portugal

"Proteste" does not indicate testing priorities.

Cleaning performance, energy and water consumption are either indicated in total or for the main programme.

Following criteria have been tested throughout all observed years: ease-of-use, noise, anti-flooding/ aqua control and programme duration. In 88 % of the publications water marks are tested.

Price is indicated throughout all observed years.

Italy

"Altroconsumo" does not indicate testing priorities.

Following criteria have been tested throughout all observed years: noise, running cost for ten years, duration of the main programme.

Until March 2003 cleaning and drying performance, as well as energy and water consumption are indicated in total, from June 2003 on these criteria are subdivided into main and eco programme. Anti-flooding/ aqua control is tested in 88 % of the publications.

Throughout all years information is given on dimensions, the price is indicated through 88 % of the observed years.

France

France has two different consumer information magazines.

"Que Choisir" indicates testing priorities, but percentages are not given.

In 2001, first priority was drying performance, the second was ease-of-use.

In 2002, first priority was the overall cleaning and drying performance including their correct labelling, second priority was ease-of-use, third was energy consumption and the energy label combined with water consumption.

In 2004, first priority lay on cleaning and drying performance of the main and eco programmes, second was ease-of-use as well as energy and water consumption of the main and eco programmes.

Anti-flooding/ aqua control is tested throughout all observed years.

Throughout all years information is given on price, annual running cost, dimensions, programme duration, programme quantity, child safety and display, options for half load and time shift/delay.

"60 Millions de Consommateurs" indicates testing priorities by giving the percentage of certain criteria in the final test score. Dish washers were only tested once during the last five years: 55 % of the final test score was based on cleaning and drying performance, energy and water consumption and programme duration of the main programme; 15 % was based on ease-of-use, 10 % on cleaning and drying performance, energy and water consumption and programme duration of the short programme and 10 % on each noise and anti-flooding/ aqua control.

Belgium

"Test-Achats" does not indicate testing priorities.

Overall cleaning and drying performance were given until February 2002, from September 2002 on the main programme was tested. Since 2004 the eco programme is included.

The following criteria have been tested throughout all observed years: ease-of-use, noise, anti-flooding/aqua control and running cost for 15 years. In 88 % of the publications the running cost for 10 years and price are also indicated.

Finland

"Kuluttaja" indicates testing priorities by giving the percentage of certain criteria in the final test score. The percentages have changed throughout the observed years.

In 2002, first priority (25 %) was on ease-of-use/operating characteristics; 15 % on programme quantity and programme structuring, 15 % on user manual, 10 % on each cleaning performance, programme duration and difference between wash cycles; 5 % on each energy consumption/energy label, water consumption and drying performance.

In 2004, first priority (33 %) was on each ease-of-use and safety from risk of injury; 17 % of the final test score is based on cleaning performance, 7 % on programme duration, 5 % on energy consumption, 3 % on drying performance and 2 % on water consumption.

Throughout all observed years information is given on price, noise and cleaning performance of the short programme.

Sweden

"Råd & Rön" does not indicate testing priorities.

The programme of choice for testing cleaning performance changed through the years. First it was the 65°C programme, then the eco programme and finally the main programme. Overall drying performance was tested in all years. Ease-of use, noise and programme duration were tested each time. Overall energy consumption was given until 2004; in 2005 it was given per usage. Water consumption is tested per usage since 2004.

Throughout all years information is given on price, annual running cost and dimensions.

Denmark

"Test + Tænk" indicates testing priorities by giving the percentage of certain criteria in the final test score.

First priority (40 %) was on cleaning performance, second (20 %) on drying performance, third (15 %) on the combination of ease-of-use and user manual; 10 % was based on energy consumption; water consumption had a percentage of 10 % in 2001, and 5 % from February 2005. Noise was considered up to 5 % in all publications. From February 2005, 5 % of the final score is based on the programme duration.

Throughout all years information is given on price and labelling for cleaning performance, drying performance, energy and water consumption.

Norway

"Forbruker-Rapporten" indicates testing priorities by giving the percentrage of certain criteria in the final test score.

Dishwashers were only tested once during the last five years: first priority (20 %) was the cleaning performance; 15 % on each shine, drying performance and ease-of-use, 12,5% on noise, 10 % on each extra/special features and interruptions, and 2,5 % on programme duration.

EU summary

The analysis of consumer magazines in the EU for dishwashers shows that the global cleaning performance has been tested in all publication. The second most tested features (98,3 %) are ease-of-use and noise. In most of the tests the cleaning performance of the programme recommended by the manufacturer is used, this programme can be the eco programme, but in the last years the number of tested programmes has increased. In recent years cleaning performance was mainly evaluated for the eco programme. Especially Germany and Austria test a wide variety of programmes such as automatic and intensive programmes.

Also tested or indicated with first priority in the EU are the global energy consumption, the global drying performance, price, global water consumption and programme duration of the main programme. Drying performance as well as the energy and water consumption has also been indicated for different programmes in recent years. Germany and Austria also tested the energy consumption of the machine while in standby mode.

Evaluated in 50 to 75 % of the analysed publications are: anti-flooding/aqua control and drying performance. Indicated frequently are: dimensions and whether the machine has an option for time shift/delay start and half load.

2.3.2.4.2 b) Criteria priority level

The frequency of the tested criteria throughout the observed years and countries has been classified to four priority levels (PL) according to how often they have been evaluated. For this purpose the frequency of a tested feature is given as percentage of all publications.

Priority level 1 (**PL 1**) for more than 75 %

Priority level 2 (**PL 2**) for 50 % - 75 %

Priority level 3 (**PL 3**) for 25 % - 50 %

Priority level 4 (**PL 4**) for less than 25 %

In Table 2.36 the tested criteria are ranked according to the priority level (in percentage), starting with the highest. The same results are shown in Figure 2.90 to Figure 2.93.

Table 2.36: dishwashers: ranking of criteria per priority level

PL 1	cleaning performance (global)	100,0 %
	ease-of-use	98,3 %
	noise	93,3 %
	energy consumption (global)	91,7 %
	drying performance (global)	91,7 %
	price	91,7 %
	water consumption (global)	88,3 %
	programme duration of the main programme	86,7 %
PL 2	anti-flooding/ aqua control	68,3 %
	cleaning performance using the main programme	65,0 %
	drying performance total	58,7 %
	dimensions/ size	55,0 %
	time shift/ delay	55,0 %
PL 3	half load	48,3 %
	programme quantity	43,3 %
	water marks	41,7 %
	energy consumption using the main programme	40,0 %
	water consumption using the main programme	40,0 %
	extras/ specials	40,0 %
	energy consumption total	38,3 %
	water consumption total	36,7 %
	adjustable basket	36,7 %
	cleaning performance using the eco programme	36,7 %
	cleaning performance total	36,7 %

	drying performance using the main programme	31,7 %
	running cost for ten years	31,7 %
	energy consumption using the eco programme	30,0 %
	water consumption using the eco programme	30,0 %
	programme duration using the eco programme	30,0 %
	drying performance using the eco programme	25,0 %
PL 4	only the six criteria with highest percentage of this priority level are mentioned	
	energy label	21,7 %
	water consumption per usage	21,7 %
	cost per usage	21,7 %
	user manual	20,0 %
	power rating	20,0 %
	adjustable amount of rinse-aid	20,0 %

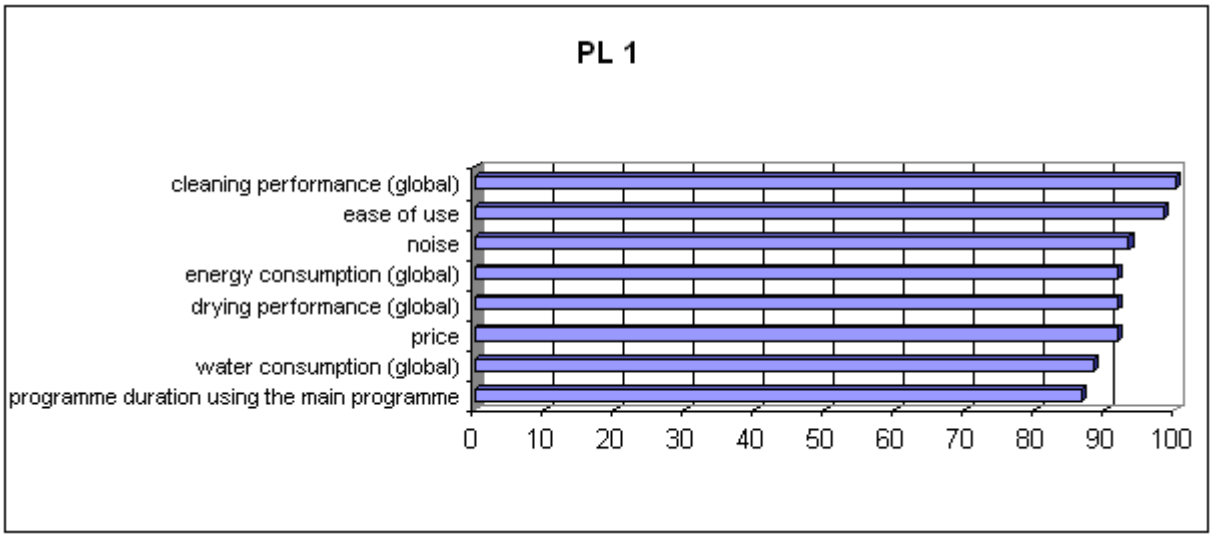


Figure 2.90: dishwasher - priority level 1 (PL): frequency of the tested criteria

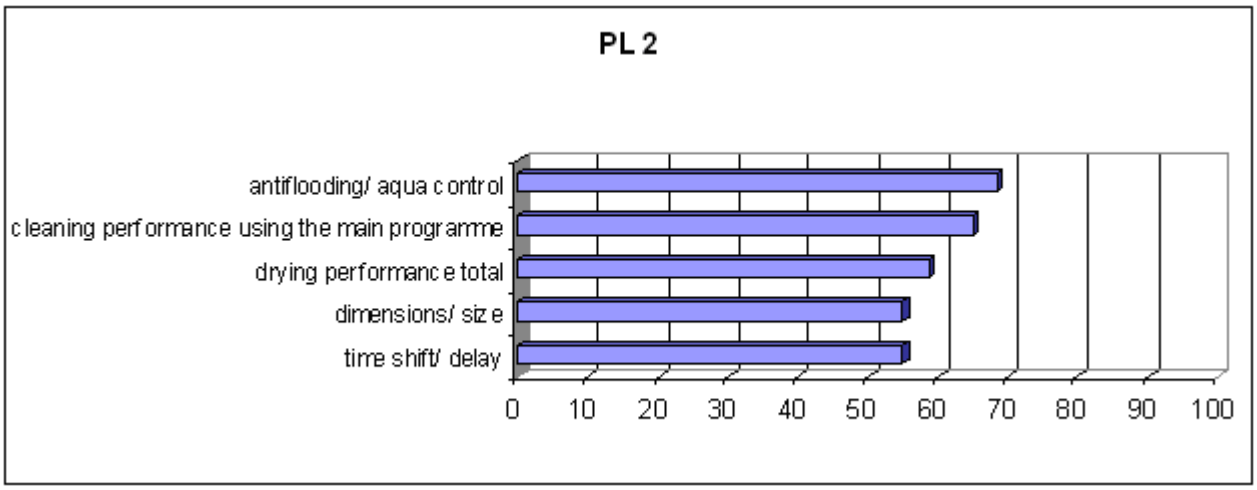


Figure 2.91: dishwasher - priority level 2 (PL): frequency of the tested criteria

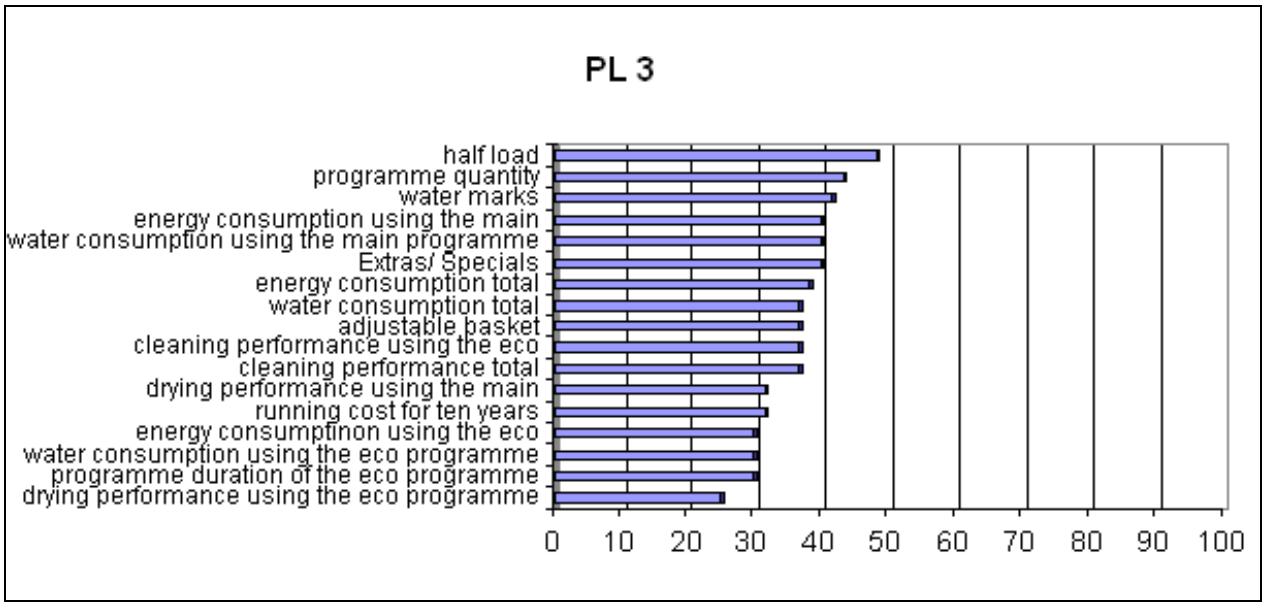


Figure 2.92: dishwasher - priority level 3 (PL): frequency of the tested criteria

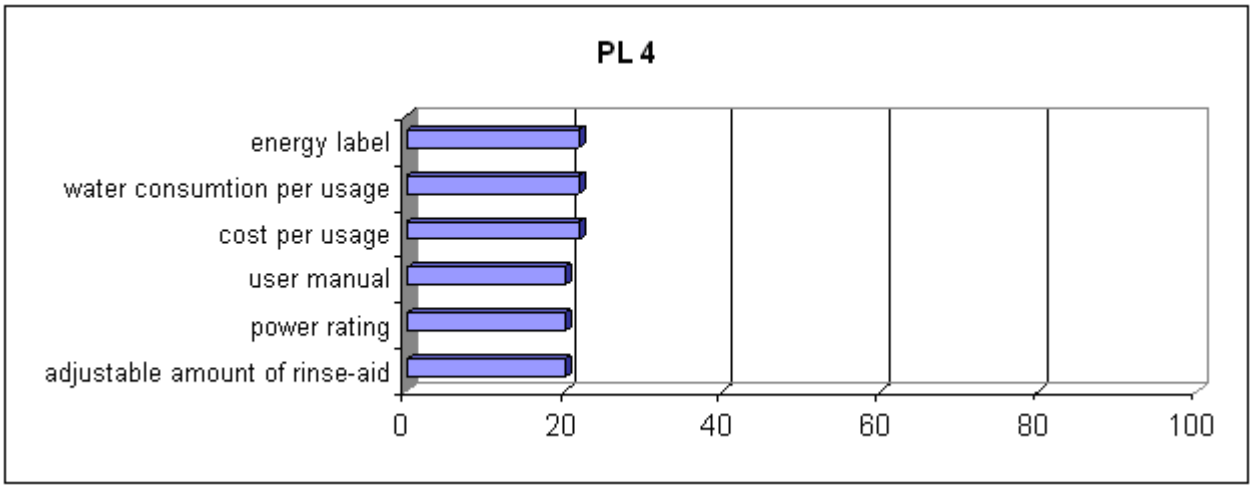


Figure 2.93: dishwasher – priority level 4 (PL): frequency of the tested criteria

2.3.2.5 Market trends: the consumers survey

In order to estimate possible trends by the consumer point of view, the 2 497 households interviewed within the consumer survey (see Task 3) were asked about important option/feature for washing machines and the relevant today priority level.

Consumers were asked to rank several features in a given scoring scale - from 1 (low priority) to 10 (high priority). For dishwashers the following options/features were presented through the questionnaire:

- smaller load capacity
- network connectivity; communication between household appliances
- greater load capacity
- shorter programme durations
- better drying effect
- hygienic programmes/effects
- lower price of the appliance
- lower operating noise
- better washing performance
- lower water consumption
- lower running costs
- lower energy consumption.

The highest priority options for consumers, with a score between 8,5 and 8,0 points, were the options *lower energy* and *water consumption* and *better cleaning/washing performance* (Figure 2.94). Also the financial aspect *lower running costs* (8,4) and *lower price of the appliances* (7,3) are very important. Also options which improve the quality of life such as *lower operating noise* (7,5) show a high priority level. *Hygienic programmes*, *better drying effect* and *shorter programme durations* reached values from 6,0 to 6,9, while the *great load capacity* plays a minor role today (5,9), comparable with the feature *smaller load capacity* (3,4). The option *network connectivity* is also rather unimportant for the consumers (4,2).

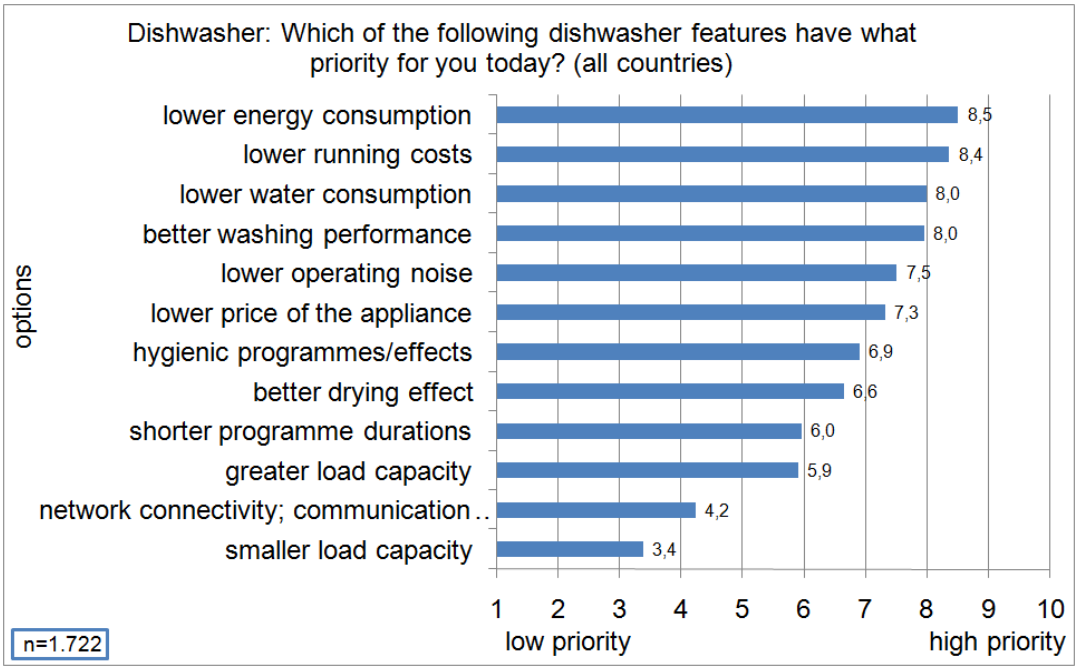


Figure 2.94: dishwasher: ranking of appliance options by the consumer

The comparison of the results of the consumers and the manufacturers survey shows that the consumers considered most of the options more important than the manufactures: especially the options *lower running cost* or *hygienic programmes/effects* show a difference from 1 to 2 points (Figure 2.95). The feature *shorter programme durations*, with a difference of nearly 2 points, has a higher priority for the manufactures than for the consumers.

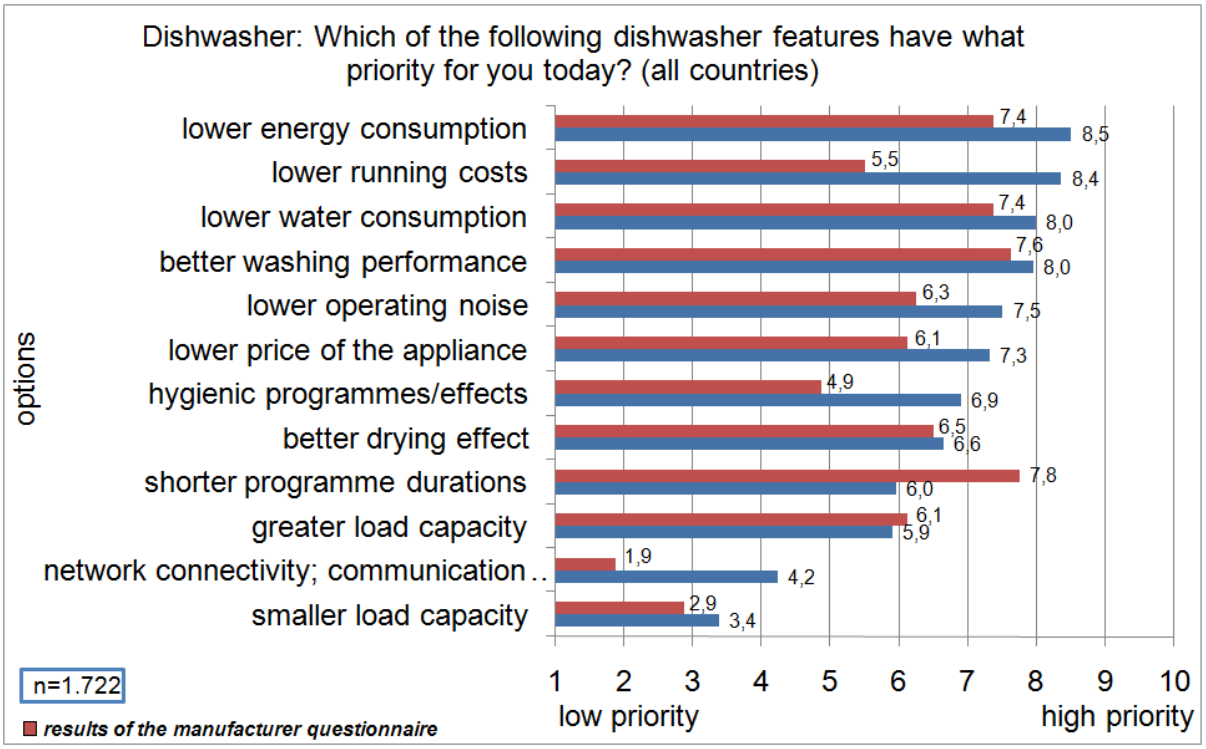


Figure 2.95: dishwasher: ranking of appliance options (consumer vs. manufacturers)

The analysis of possible differences between the European countries shows little differences in the priority level: the option *greater load capacity* for Swedish consumers has a lower priority (5,2) than for other countries; for Hungarian consumers this option is the most important with 6,7 points. Also the option *lower water consumptions* shows the lowest priority (6,4) for the Swedish consumers, but has the high priority for German, French and Hungarian consumers (8,8). Also for the option *hygienic programmes/effects* differences in the priority could be seen: it is the most important for Spanish consumers (with 7,9 points) and the lowest for Swedish consumers (5,6) (Table 2.37)

Table 2.37 dishwasher: ranking of appliance options by the consumer (per country)

Dishwasher: Ranking appliance options/features (average)											
countries	**UK**	**DE**	**IT**	**FR**	**ES**	**SW**	**PL**	**HU**	**FI**	**CZ**	**total**
greater load capacity	5,9	5,7	6,3	6,2	6,2	5,2	5,6	6,7	5,5	5,7	5,9
lower energy consumption	7,9	8,9	8,2	8,9	8,3	7,9	8,9	8,9	8,6	8,7	8,5
smaller load capacity	3,4	3,2	3,6	3,7	3,6	2,3	3,5	3,2	3,6	3,9	3,4
lower water consumption	7,0	8,8	7,3	8,8	8,0	6,4	8,7	8,8	8,0	8,4	8,0
shorter programme durations	5,6	6,1	6,3	6,0	6,5	5,3	6,2	6,4	6,0	5,1	6,0

Dishwasher: Ranking appliance options/features (average)											
better drying effect	6,2	7,4	6,6	7,2	7,1	5,6	6,7	7,4	6,1	6,2	6,6
better washing performance	7,4	8,0	7,6	8,4	8,2	7,1	8,4	8,8	8,0	7,8	8,0
hygienic programmes/effects	6,9	6,6	7,2	7,2	7,9	5,6	6,7	7,9	6,1	6,9	6,9
lower running costs	8,1	8,9	8,0	8,6	8,1	7,6	8,9	8,9	8,2	8,5	8,4
lower price of the appliance	7,2	7,9	7,4	7,9	7,7	6,3	7,5	7,7	6,8	6,5	7,3
lower operating noise	6,5	7,3	7,4	8,2	7,9	7,4	7,5	7,5	7,7	7,5	7,5
network connectivity; communication between household appliances	3,4	3,4	5,0	4,4	5,0	3,4	4,9	4,6	3,9	5,1	4,2

2.3.2.6 Summary of market trends for dishwashers

The **dishwashing machine** market in Europe is characterised by a very different penetration in the households of the European countries: especially in the new Eastern Member States the penetration of dishwashers is quite low, with a steady increase of the penetration in almost all countries. Since dishwashers machines are a long living product, with replacements happening after 10 years or later, there is also quite a strong substitution of installed dishwashers.

With the introduction of the energy labelling scheme in 1999 the attention of the consumer and the manufacturer was focused on the elements included in the label and the fiche. Since the labelling scheme is mainly addressing the energy efficiency, it got the highest importance in the development of the new products offered on the market. Impressive improvements of the models offered on the market could be achieved (specific energy reduced by 37 % for standard 12 place settings machines compared to the base case of 1995), without deterioration of the cleaning and drying performance parameters and contemporary water savings.

This development was not possible without a high level of awareness and acceptance by the consumer. Despite all these achievements, the consumer still expects further reduction of the energy and water consumption of dishwashers along with further technological improvements of other machine features: such as the optimisation of all programmes, the programme duration or ease of use of the machines. This is backed up by reports from consumer organisations which tend to include more and more parameters into the assessment of dishwashers. The assessment of different washing programmes is not reflected in the test method used for the energy labelling scheme.

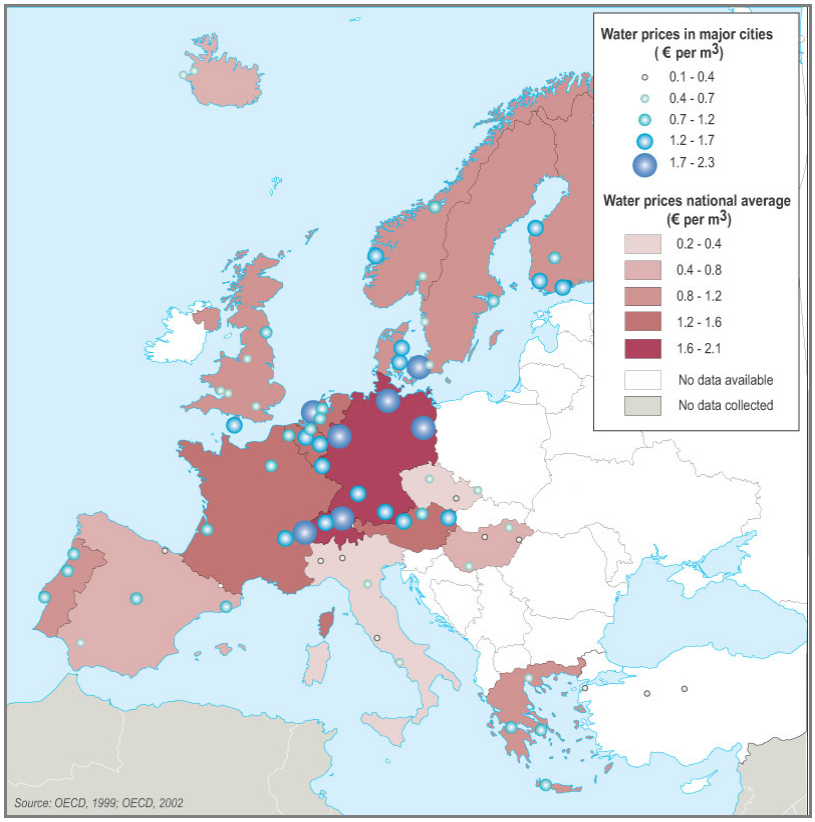
2.4 CONSUMER EXPENDITURE BASE DATA

These data constitute the economic parameters for the Life Cycle Cost Analysis.

2.4.1 Household Water Prices

Some prices of household water are given in Figure 2.96 for various European counties and cities as shown. City data is for year 1998 and national data for 1996.

Figure 2.96: Household water prices for various European counties and cities



According to most economists, and also the EU Water Framework Directive, water prices will evolve towards full cost recovery. This is now occurring in Holland and Germany and these two countries should be taken as a guideline for future European prices. The cost of full recovery itself will also likely increase due to the higher prices of key inputs such as the energy cost of producing, purifying and pumping and disposing of household water.

Table 2.38 illustrates the difference among European countries of water prices in the late 1990's, clearly with Germany and the Netherlands in the lead.

In Germany the average price (excluding sewage) was 1,46 Euro/m^3 in 1998 and 1,81 Euro/m^3 in January 2005. For The Netherlands the price in 1998 was similar to that of Germany at 1,38 Euro/m^3.

Instead in Table 2.39 an estimate of the costs of the water supply and sewage disposal for Europe in year 2000 is reported. Using the maximum values of cost we have 2,54 and 2,29 Euro/m^3 for the two types of sewage disposal.

Table 2.38: Comparison of European Water Prices[132]

Drinking Water Prices in DM/m3			Average Annual Bill in DM/year		
Country	**Year**	**Range**	**Average**	**Per household**	**Per capital**
Denmark	**1993**	**0,25/1,65**	**0,80**	**n.a.**	**55,00**
Based on unit rates relating to consumption and not including fixed tariff component. The above mentioned data does not accurately represent the current situation in Denmark. Less than half of all Danish households have water meters. A water abstraction tax has been in place since 1994 as part of an ecological tax reform. Drinking water can be inexpensively produced using ground water. Data availability is poor					
Germany	**1996**	**1,81 /3,96**	**2,85 / 2,63**	**255,00**	**140,00**
For the purposes of this chart, price ranges for Germany have been calculated on the basis of weighted and un-weighted Länder averages; the actual range is in much wider. Averages, weighted/un-weighted; are based on data from BGW. The majority of Länder have water abstraction taxes which vary considerably in regulative detail and tax rate levels.					
England and Wales	**1995**	**1,00 /2,80**	**1,70**	**270,00**	**115,00**
Consumption-related tariffs are the exception. As a result of the 1989 privatisation the cost basis has been distorted. A relatively high number of existing lead pipe connections, about 8.6 million, need to be refitted. Water (and sewerage) prices include administrative fees imposed by the Environment Agency for abstraction (and discharges). Depreciation periods for large-scale investment are relatively long: 50 years to unlimited (no depreciation). Price comparisons are affected by currency fluctuations					
France	**1994**	**0,12 /3,63**	**2,00**	**260,00**	**105,00**
Available data for France is not representative. Existing data relates to a selection of major towns and cities; with values of up to FFr 37,00 (DM 11,00) per m3 being reported for remaining regions. In France, there is a water abstraction levy and a special charge earmarked for the expansion of water supply infrastructure in rural regions. Until recently, subsidy levels were relatively high. As a consequence of decentralisation, subsidy mechanisms are currently being restructured. As a rule, cost structures are not known (delegation).					
Italy	**1992**	**0,20 /1,31**	**0,70**	**220,00**	**75,00**
Available data relates to major cities only. The water supply system is characterised by a marked dependence on subsidies. In Italy, water tariffs and prices are used as instruments to conduct social policy and as a method of fighting inflation. Data availability is poor, difficult to calculate and often irrelevant.					
The Netherlands	**1995**	**[0,80 /2,55]**	**2,70**	**340,00**	**135,00**
For the Netherlands, only unit rates for consumption are shown in the 'range' column. Fixed price components (connection fees, meter rentals) range from DM 21,23 to 121,96 per connection. Groundwater abstraction taxes and groundwater charges exist in the					

[132] Source: Andreas Kramer and Ralph Piotrowski, April 1998, Comparison of Water Prices in Europe, Summary Report, Center for International and European Environmental Research, Berlin Germany.

Netherlands. Meter use is widespread. Two-part tariffs as well as contributions and charges for new connections make accurate comparisons difficult. Thanks to a well developed statistical system, he data basis for the Netherlands is good.

Spain	**1992**	**0,01 /2,50**	**0,40**	**n.a.**	**n.a.**

In parts of Spain, water supply requires costly long-distance transfers. Data for 1993 is calculated on the basis of an average annual consumption of 50 m3. Regional governments levy 'sewerage taxes' on water prices to finance subsidies for sewerage services. Depreciation over 25 to 50 years is usually covered by the state. In Spain, there are manifold subsidy mechanisms which, combined with the ongoing regionalisation and subsidies from the EU (e.g., cohesion funds), impede detailed analysis. Data availability is poor.

Table 2.39: Costs of water supply and wastewater infrastructure for centralized systems[133] in Europe in 2000

Costs (using upper range value)	Services				Total
	Water Supply	Sewage Disposal		Separate storm water	
		Combined sewer	Separate sanitary sewer		
	(€/m^3)	(€/m^3)	(€/m^3)	(€/m^3)	(€/m^3)
Financing costs	0,40	0,25	0,16	0,15	
Maintenance costs	0,45	0,25	0,15	0,13	
Operating costs	0,60	0,40	0,35	0,18	
Taxes	0,15	0,04	0,03	0,02	
Total	1,60	0,94	0,69	0,48	
Water supply + Combined sewer					2,54
Water Supply + Separate sanitary sewer					2,29

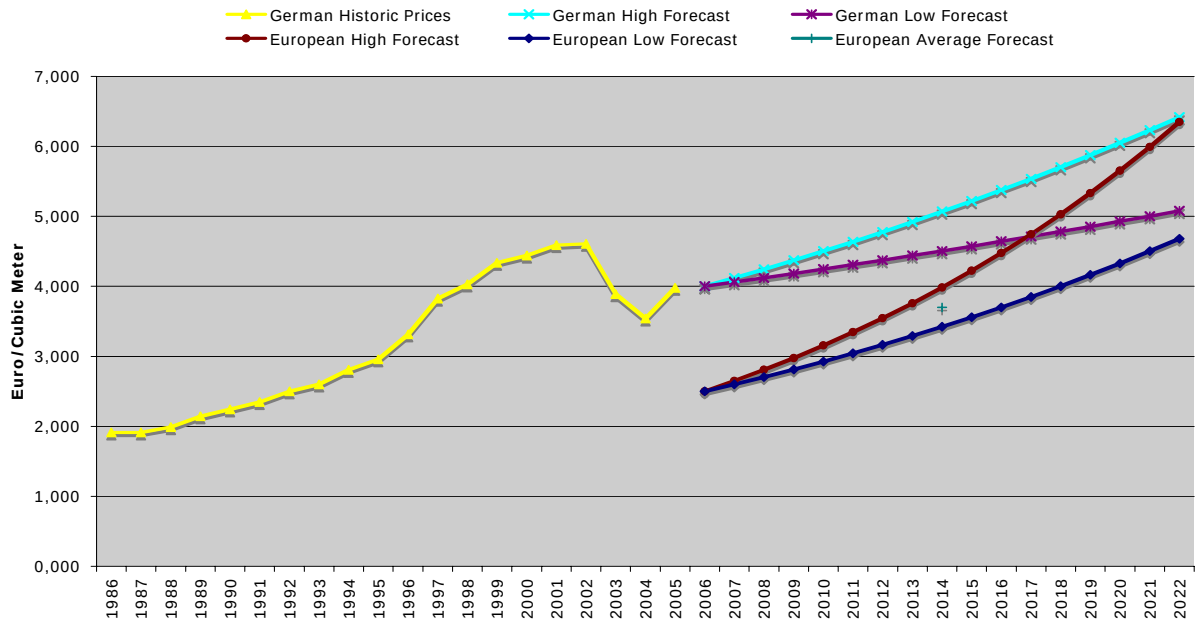
Given the likely increase of input costs over next 15 years and possibility of higher quality standards, the full cost is very likely to increase. Also water supply is more limited than demand, thus the price of water itself is certain to rise. Based upon German historic data for prices of water and sewage[134], it is hypothesized that these water plus sewage prices will reach a range between 6,5 and 5,0 Euro/m^3 in Germany over the next 15 years, as shown.

EU25 prices are believed to be much lower than the German average as most countries do not yet follow full cost pricing. It estimated that the European average price is currently about one-half the German value, or 2,5 Euro/m^3. This would be consistent with the cost data in Table 2. It will begin to catch up with the German complete full cost price; we hypothesize 6 % and 3 % annual high and low real growth rates as illustrated in Figure 2.97. An average European household water plus sewage price of 3,7 Euro/m^3 is proposed for the study. Sensitivity analysis will be made around this value.

[133] Source: OECD 2006, Infrastructure to 2030: Telecom, Land Transport, Water and Electricity, ISBN 92-64-02398-4..

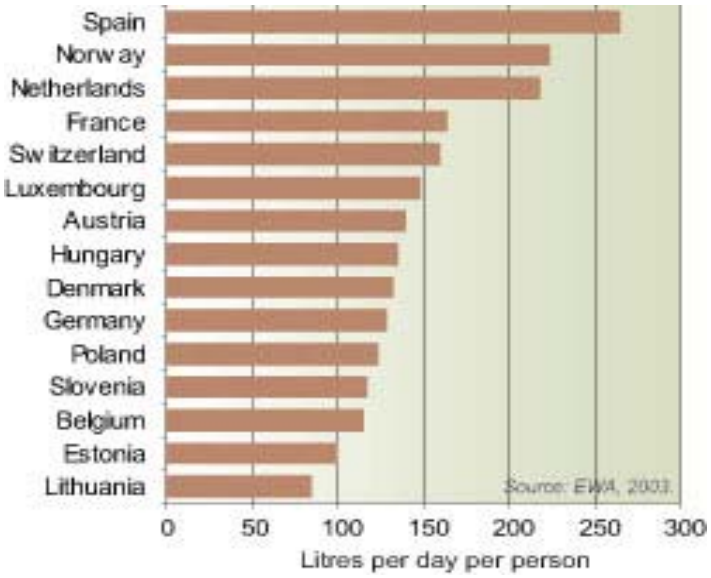
[134] Source: Stiftung Warentest and ZVEI Arbeitskreis Maschinelles Geschirrspülen.

Figure 2.97: Household water plus sewage prices, European high, low and average forecast to 2022



Comparative rates of consumption are illustrated for the same period in **Errore. L'origine riferimento non è stata trovata.**.

Figure 2.98: Comparative rates of water consumption to 2022 in some Member States



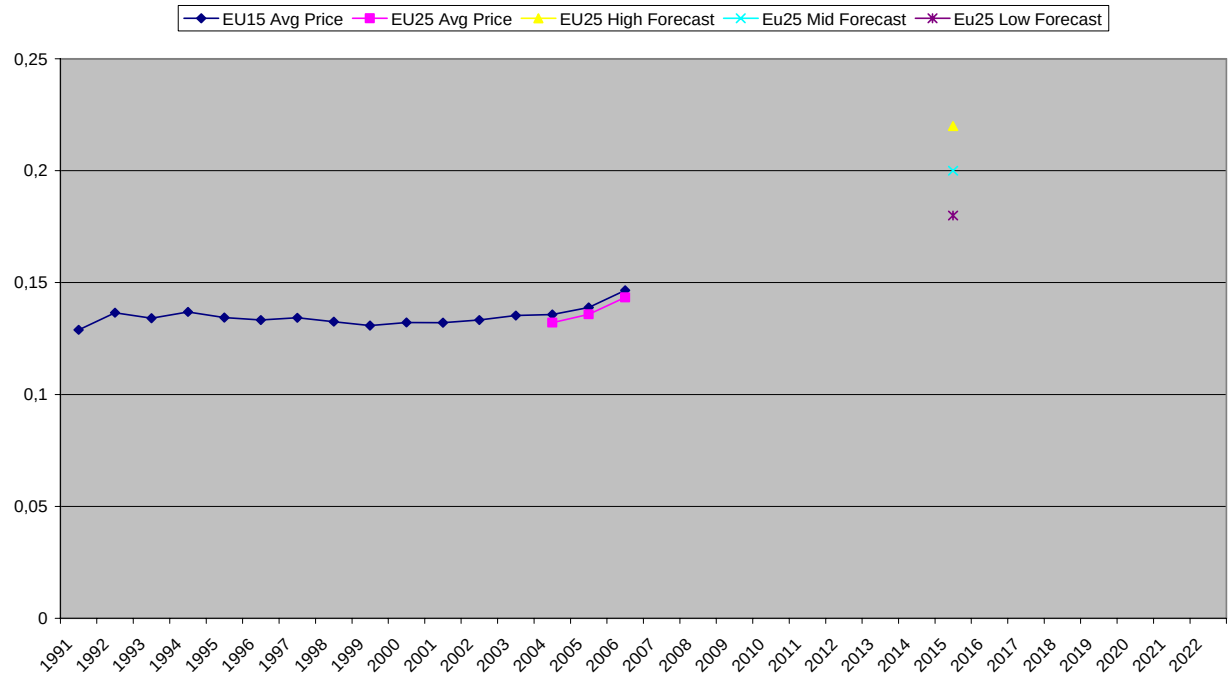
2.4.2 Electricity Prices

The evolution of the electricity prices including all taxes for the group EU15 and EU25 is shown in

Figure 2.99[135]. Hypotheses of high and low forecasts are made for the EU25 average price of the future period of 0,22 and 0,18 Euro/kWh respectively.

[135] Source: Eurostat, January 2007.

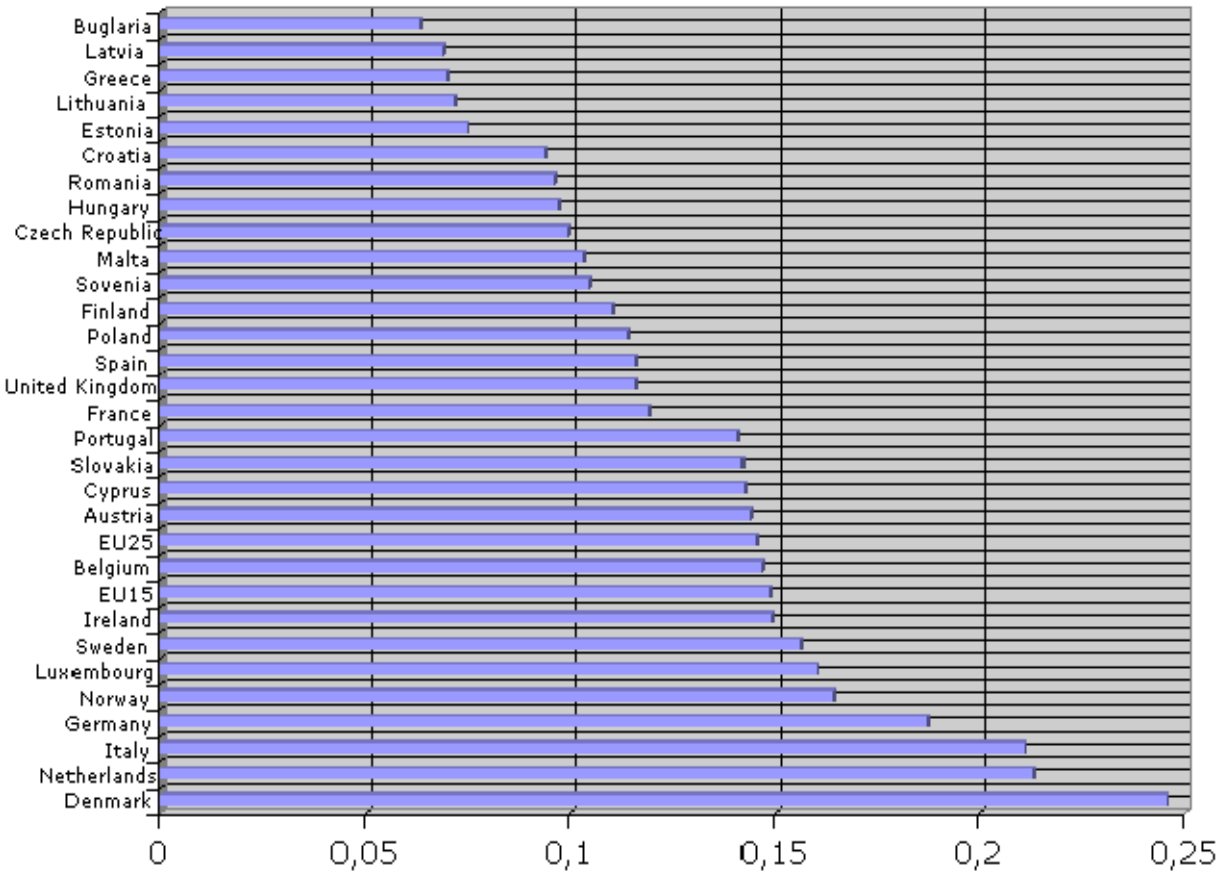
Figure 2.99: The evolution of the weighted average electricity prices including all taxes for EU15 and EU25



On the high side, this represents the scenario of continued energy price increases and moderate progress in rationalization and efficiency improvements within the sector. The low price scenario represents the contrary, stable energy prices and more progress in rationalization and efficiency improvements. These are the extremes; actually higher prices should stimulate more efficiency and thus favour a mid-range value. In fact, the middle range forecast price, in nominal terms, is €0,20/kWh. **This in real terms is €0,17/kWh, the value proposed for the study.**[1] Sensitivity analysis will be performed around this value. Note, average Europe 25 prices are presently €0,14/kWh as shown below.

The second semester 2006 prices (in Euro/kWh) of member countries are shown in Figure 2.100 for comparison.

Figure 2.100: Household electricity prices (2006 2H, all taxes included, 3 500 kWh)



It is interesting to compare the differences in electricity prices for the new twelve countries recently joining the EU with respect to the EU15, as shown in Table 2.40 Electricity Prices in the EU15 and the EU 'New 12' (€cents/kWh) for the second semester of the last three years.

Table 2.40 Electricity Prices in the EU15 and the EU 'New 12' (€cents/kWh)

				2006/2004
	2004 2nd S.	2005 2nd S.	2006 2nd S.	Change
Bulgaria	6,14	6,54	6,34	3,3%
Czech Rep.	8,05	8,71	9,95	23,6%
Estonia	6,78	7,13	7,5	10,6%
Cyprus	10,49	12,03	14,26	35,9%
Latvia	6,82	8,29	6,9	1,2%
Lithuania	6,32	7,18	7,18	13,6%
Hungary	10,5	11,47	9,71	-7,5%
Malta	6,74	7,69	10,34	53,4%
Poland	9,54	10,59	11,9	24,7%
Romanial	9,47	9,47	9,62	1,6%
Slovania	10,33	10,49	10,48	1,5%
Slovakia	12,43	13,3	14,2	14,2%
the New 12 (1)	8,63	9,41	9,87	14,3%
EU15	13,54	13,91	14,85	9,7%
(1) Arithmetic average of the 12 country prices, not weighted for value of electricity sold.				

The prices on average are significantly lower in the 'New 12' countries, 9,87 vs. 14,85 €cents/kWh, one-third less during the latest semester. This is important because it implies that that unless the purchase prices are also one-third less, the returns on the same type of energy savings investment will be less in the 'New 12' countries. However, as expected prices are tending to converge with the 'New 12' Member States growing at 14 percent per year versus 10 percent per annum for the EU15.

2.4.3 Price of detergents, softeners, and rinsing agents

For dishwashers the following values are hypothesized, with no growth in real terms, these prices will grow the same as general prices or inflation.

Table 2.41: Cost of Dishwasher Supplies

Dishwasher Cost of Supplies		12 place setting		9 place setting	
	Price/kg	kg/wash	Cost /wash	kg/wash	Cost /wash
Normal Detergent	€1,80	0,03	€0,054	0,027	€0,049
Softner (Salt)	€0,60	0,02	€0,012	0,02	€0,012
Rinsing Agent	€2,40	0,004	€0,010	0,004	€0,010
Total Cost / Wash			**€0,076**		**€0,070**
		talblet/kg			
Tablet 3 in 1:	€5,07	68	€0,075		€0,075

The values used are: €0,076/wash for 12 place settings and €0.070/wash for 9 place settings. Unfortunately to date there are no technological options that allow for variable amounts of detergent, for half loads for example, and thus these costs contribute to the total life cycle cost, but do not play a role in the optimization process. Prices were taken from the ZVEI working group for Germany.

In the case of washing machines the detergent cost of 0,22 Euro/cycle is used, in real terms, as calculated below.

Table 2.42: Cost of Washing Machine Detergent

Clothes Washer Detergent Cost	
Normal Detergent (€/kg.)	€ 1,60
Rated Capacity (kg.)	5,36
Required Detergent (g.)	139,76
Detergent Cost / Wash	**€ 0,22**

The normal detergent prices were taken from average prices for Germany in year 2005 provided informally by GfK. It is outside the scope and possibility of this study to estimate average European prices. However, as in the case of dishwasher, these detergent costs are constant and do not influence the calculation of the least life cycle cost. It is interesting to note, that in the US where there is more Internet commerce and purchasing in bulk (40 pound boxes) the lowest price for powder is 0,12 to 0,14 Euro per dose. This appears to be a lower floor for powder prices, although it does not include transportation costs to the home.

2.4.4 Recycling and System Costs

On Figure 1.21 of Task 1 (page 110), we recall that recycling and system costs are given for six European countries that have experience in recycling of electric and electronic equipment. The range is from 1,90 to 0,92 Euro/kg with an average of 1,21 Euro/kg. According to this data, a household appliance having a weight of 50 kilograms has an average recycling and system cost of 61 Euro at the time of recycling

2.4.5 Maintenance and Repair

Like the previous parameters of the chemicals used in washing, if they do not vary with different technical options, they are irrelevant to the design and optimization calculations. They are included to show total costs to the consumer and to compare to other studies. An average cost of repair and maintenance is estimated to be 5,5 Euro/year. Naturally in real life this is non-linear in time and is eventually the reason for replacing the appliance.

2.4.6 Discount Factor

A real discount factor of 5 % as used in previous studies for the Commission is maintained. This represents a mid value between the cost of capital for the firm and the consumer and the opportunity costs for both. The real cost of borrowing for large firm may be considered, for example, the cost of issuing corporate bonds minus inflation, which is around three to four percent. The consumer may borrow from his savings account, which pays even less. Whatever their opportunity costs, what they can obtain on other new investments is considerably higher and they demand more because of the risks inherent in new investments. Firms typically use a real discount rate on new investments above 10 %. Also in explaining consumer purchasing behaviour, consumers often expect rather short payback times (with discount rates even above 10 %) and refuse purchases with longer paybacks. Thus 5 % real discount rate is probably biased on the low side. However from a social and political point of view it may be preferable to keep it as such.

2.4.7 Real price growth, nominal price growth and the net present value

Given a certain reference year, such as 2007, one may imagine the price of a general basket of goods that is defined by the national statistical office as the consumer price index and is taken as a measure of inflation. If the price at the beginning of year is 100 and this general price index should grow at a rate of two percent each year for the next two years then we would have at the beginning of third year a price:

$P_{2009} = P_{2007}*(1+2\%)^2 = 100*(1,0404) = 104,04$

Now consider a specific good/service such as electricity that is growing faster, at a compound rate, than the general price index. Let us suppose that it is growing 1%/year faster than the above rate of inflation. We represent this as follows:

$P_{2009} = P_{2007}*(1+2\%)^2 *(1+1\%)^2 = 100*(1,0404)*(1,0201) = 104,04*(1.0201)=106,131204$

We refer to the compound growth rate in excess (or in deficit) of the general rate of inflation as the **real price growth** rate, one percent/year in our example above. Every specific good/service may have possible real price growth rate different above or below that of inflation and in general we may write for reference year i and subsequent year i+n.

$P_{i+n} = P_i*(1+\text{rate of inflation}\%)^n *(1+\text{real price growth rate}\%)^n$

These rates together are referred to as the nominal price growth rate:

(1+nominal price growth rate) =(1+rate of inflation)*(1+real price growth rate)

Nominal price growth rate ≅ rate of inflation +real price growth rate.

This is the price rate that we normally observe without removing the impact of inflation.

With the net present value (NPV) equation or (life cycle cost) we have usually a sum of economic benefits and costs, which are characterized by a price, say of price of electricity, multiplied times the amount saved. All these benefits and costs refer to specific years in the future and must be discounted by a cost of capital, which also is in excess of the inflation rate.

NPV= Investment cost + annual benefits discounted – annual costs discounted

$\text{NPV=investment cost} - Q\sum_{j=1,2...n} (P_0*(1+\text{rate of inflation}\%)^j *(1+\text{real price growth rate}\%)^j)/ ((1+\text{rate of inflation}\%)^j *(1+\text{real cost of capital}\%)^j)$

Where Q is the quantity of the good or service for example the annual kWh saved, P_0 is the price at the reference year or year zero, and the real cost of capital is defined as the cost of capital in excess of the inflation rate. The above NPV is shown for only one specific annual benefit and the actual equation includes others such as water savings, but each annual benefit or cost has the same form, only with different Q's and P_0 's.

Notice that the 1+rate of inflation is in the numerator and denominator, thus we can simplify the equation and cancel this term. This simplifies our task in that we do not have to estimate long-term inflation. We must remember always that this simplified equation refers only to the real price growth rate and real cost of capital. We have:

$\text{NPV=investment cost} - Q\sum_{j=1,2...n} (P_0 *(1+\text{real price growth rate}\%)^j)/(1+\text{real cost of capital}\%)^j$

If a good/service has a real price growth equal to zero, that is it is growing with inflation, then the price is equal to P_0 in all the years. In fact we have hypothesized average future electricity prices with a P_0 equal to 0,17 Euro/kWh, with a zero real growth rate.