Energy

Preparatory Studies for Eco-design Requirements of EuPs

(Tender TREN/D1/40-2005)

LOT 14: Domestic Washing Machines and & Dishwashers

Part I – PRESENT SITUATION

Task 2:
Economic and Market Analysis
Rev. 1.0

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1 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 labelling 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-labelling 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:

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[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.

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

Part I: Present Situation, which envisages the following five Tasks:

- Task 1 - General Situation
- 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, 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.

This report refers to Task 2: Economic and Market Analysis.

1.1 BRIEF DESCRIPTION OF TASK 2

1.1.1 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).

1.1.2 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[4].

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).

1.1.3 Subtask 2.3: Market Trends

In this subtask possible market tendencies and trends on the washing machine and dishwasher market are pointed out. Furthermore the developments and opinions regarding these market trends on the side of industry and on the side of consumers are analysed.

The **washing machine** market in Europe is characterised by a very high penetration of washing machines in the households with almost saturation in EU-15. In CEE-countries the penetration is increasing continuously. As washing machines are a long living product with replacements happening after 10 years or later, this situation leads to a high level of competition as usual for saturated markets. This competition was somehow canalised by the introduction of the Energy Label for washing machines in 1996 focusing the attention of the consumer and the manufacturer to

[4] 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 arguments printed on the label. As the focus of the Energy Label is set on energy efficiency, this also got the highest importance for the development of the products offered on the market. Impressive improvements of the market offer 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 acceptance of these changes by the consumer. Despite all these achievements, the consumer still expects to see further reduction of the energy and water consumption of washing machines to happen. But he/she also expects further improvements to come in many other areas, e.g. regarding optimisation of other programmes, the programme length, the rinsing performance or ease of use of the machines. This is backed up by reports from consumer organisations which tend to more and more include parameters into the assessment of washing machines. Especially the assessment of 40 °C washing programmes, done most frequently by consumer organisations, is not reflected in the test programme used for the Energy Label.

The **automatic dishwashing machine** market in Europe is characterised by very different levels of availability of these machines in households. Especially in CEE-countries the penetration is very low, but increasing. With the introduction of the Energy Label for automatic dishwashers in 1999 the focus has been set primarily to the energy efficiency of dishwashers, but - at the same time - the cleaning and drying performance has kept its relevance and has even improved over the years. But most impressive are the improvements in energy efficiency achieved up to 2005, which are calculated to be at 37 % and 44 % for 12 and 9 place setting machines, respectively. This development was not possible without a high level of acceptance of these changes by the consumer. Despite all these achievements, the consumer still expects to see further reduction of the energy and water consumption of dishwashing machines to happen. But he/she also expects further improvements to come in many other areas, e.g. regarding optimisation of other programmes, the programme length or ease of use of the machines. This is backed up by reports from consumer organisations which tend to more and more include parameters into the assessment of dishwashers. Especially the assessment of automatic dishwashing programmes, done frequently by consumer organisations, is not reflected in the test programme used for the Energy Label.

1.1.4 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 (€/m^3)
- 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.

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[5] 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

[5] 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
UK	710	650	1.678	3.038
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 2.4 and 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+[6], 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.

[6] 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

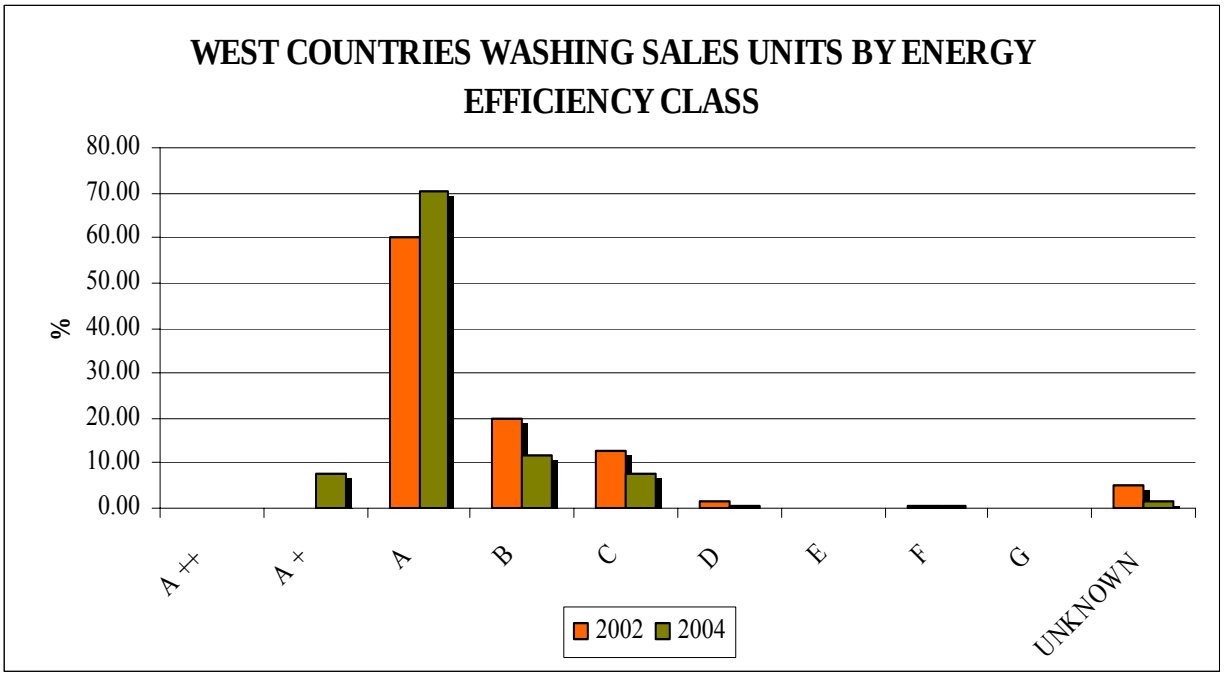


Figure 2.2 Washing machines sales by energy efficiency classes in Eastern Europe (4 countries)

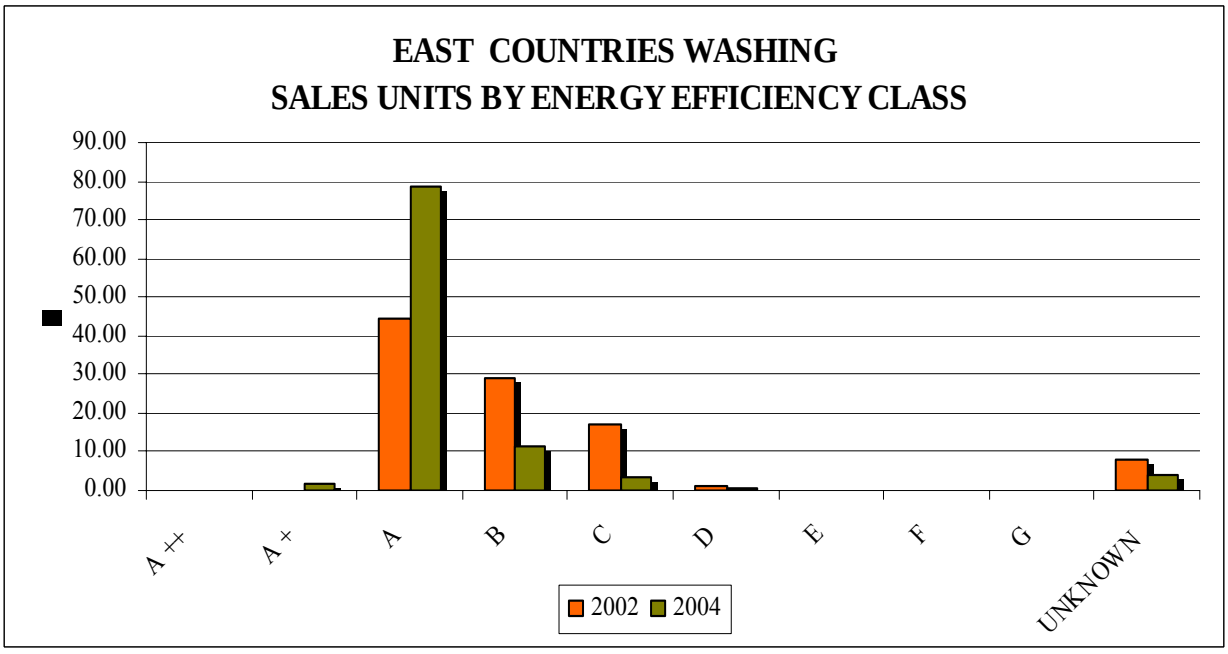


Figure 2.3 Washing machines West EU- Sales Variation of the major EE classes in the years 2002 - 2004

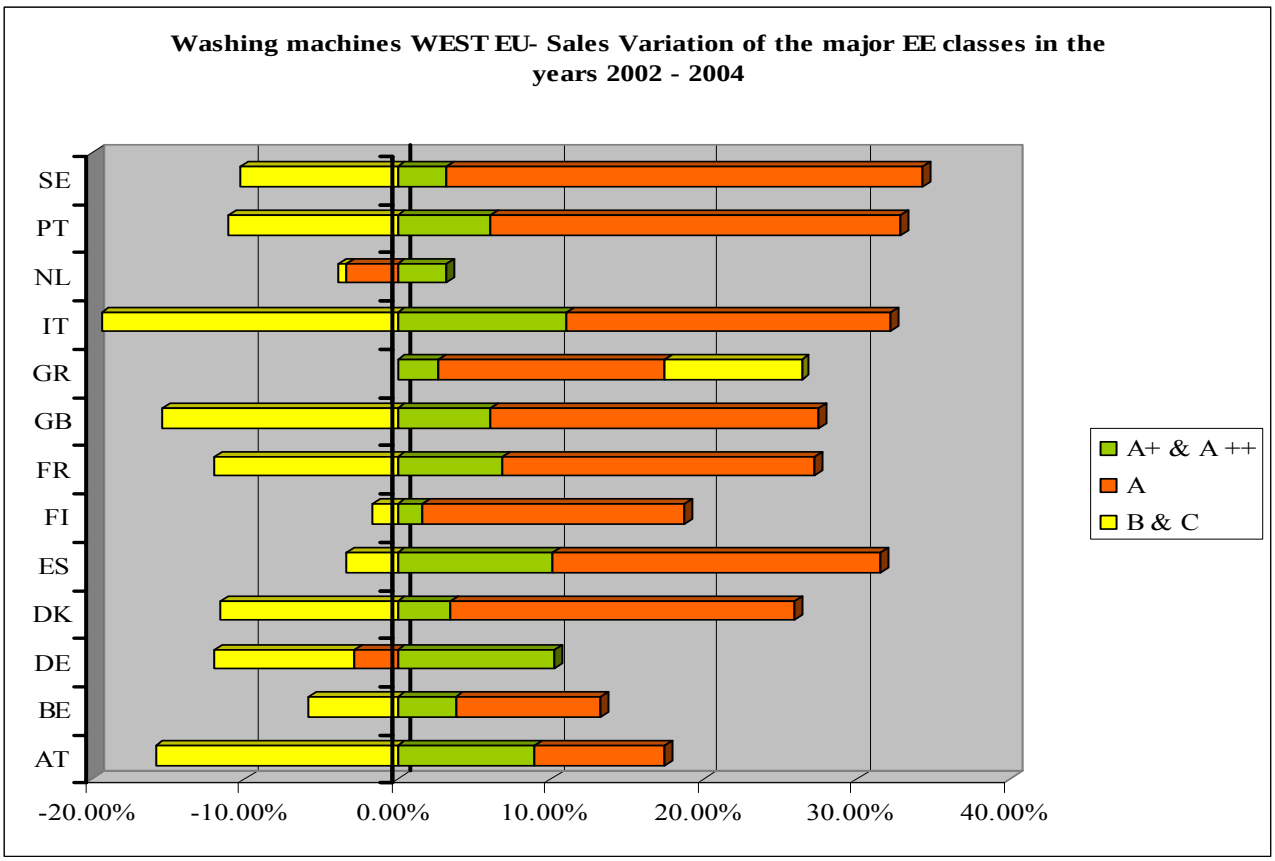
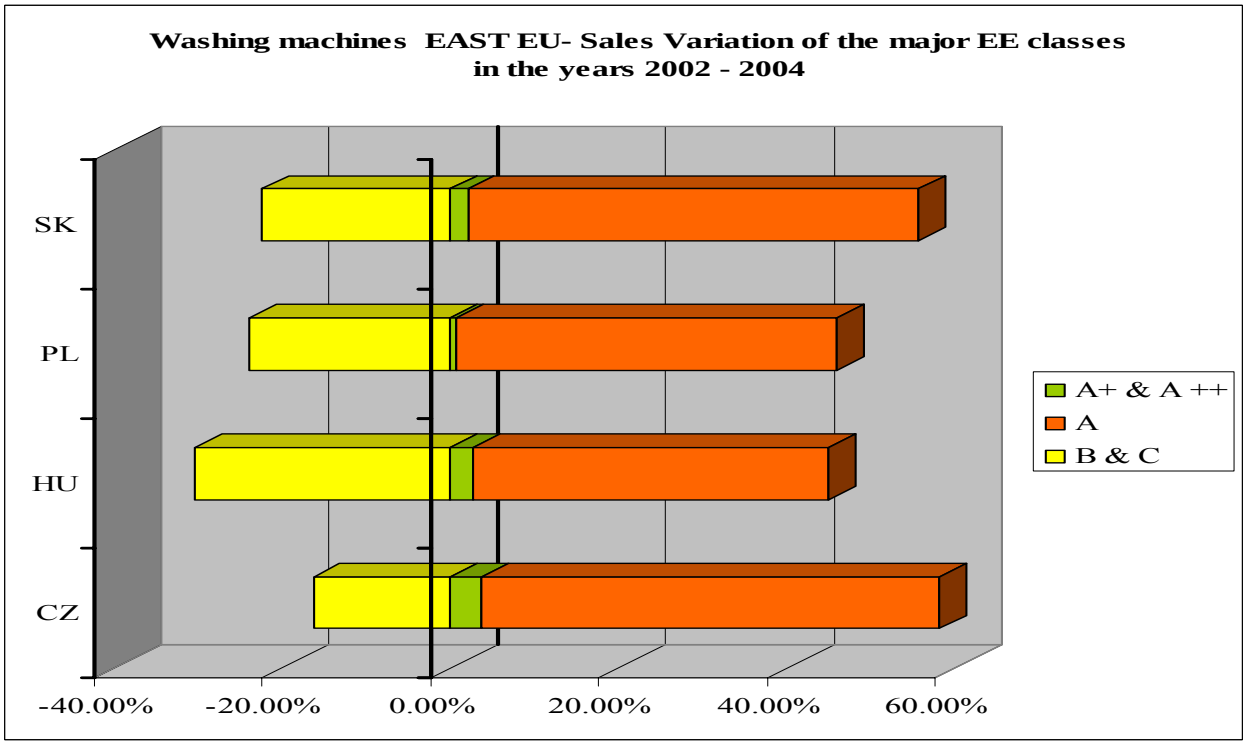


Figure 2.4 Washing machines East EU- Sales Variation of the major EE classes in the years 2002 - 2004



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[7].) 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 %).

[7] 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

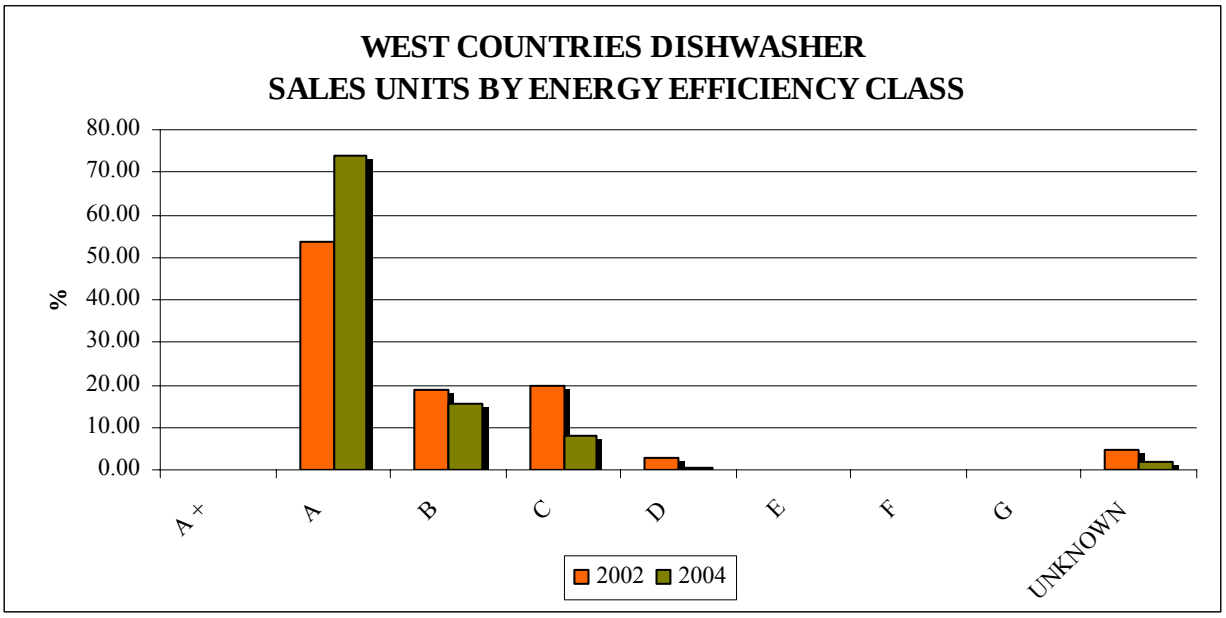


Figure 2.6 Dishwashers sales by energy efficiency classes in Eastern Europe (4 countries)

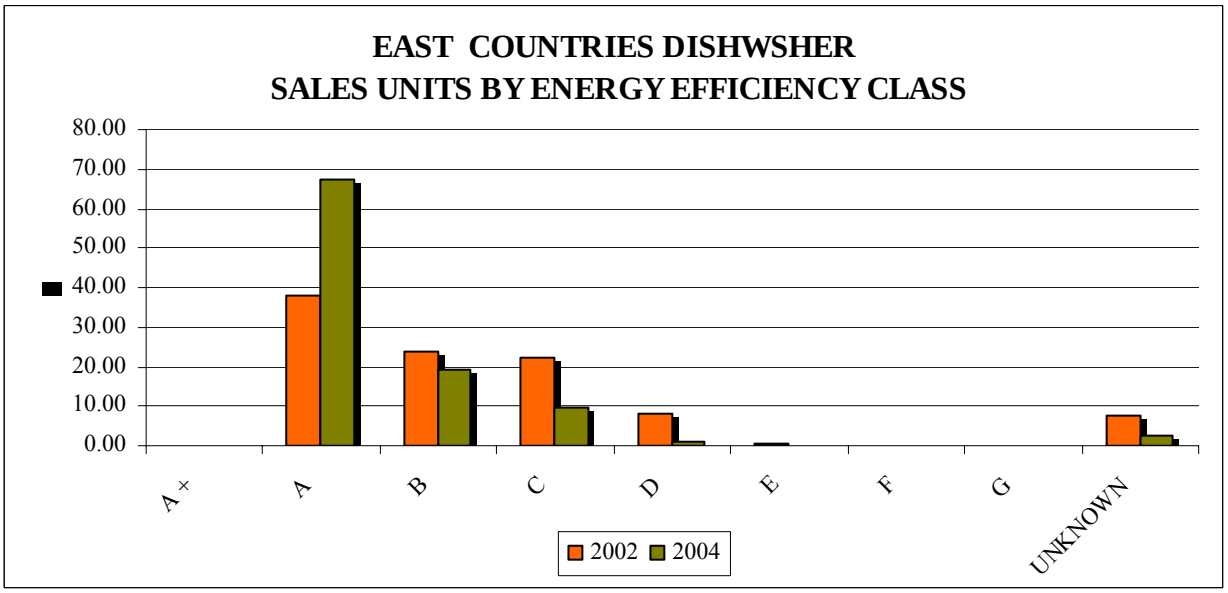


Figure 2.7 Dishwasher West EU- Sales Variation of the major EE classes in the years 2002 - 2004

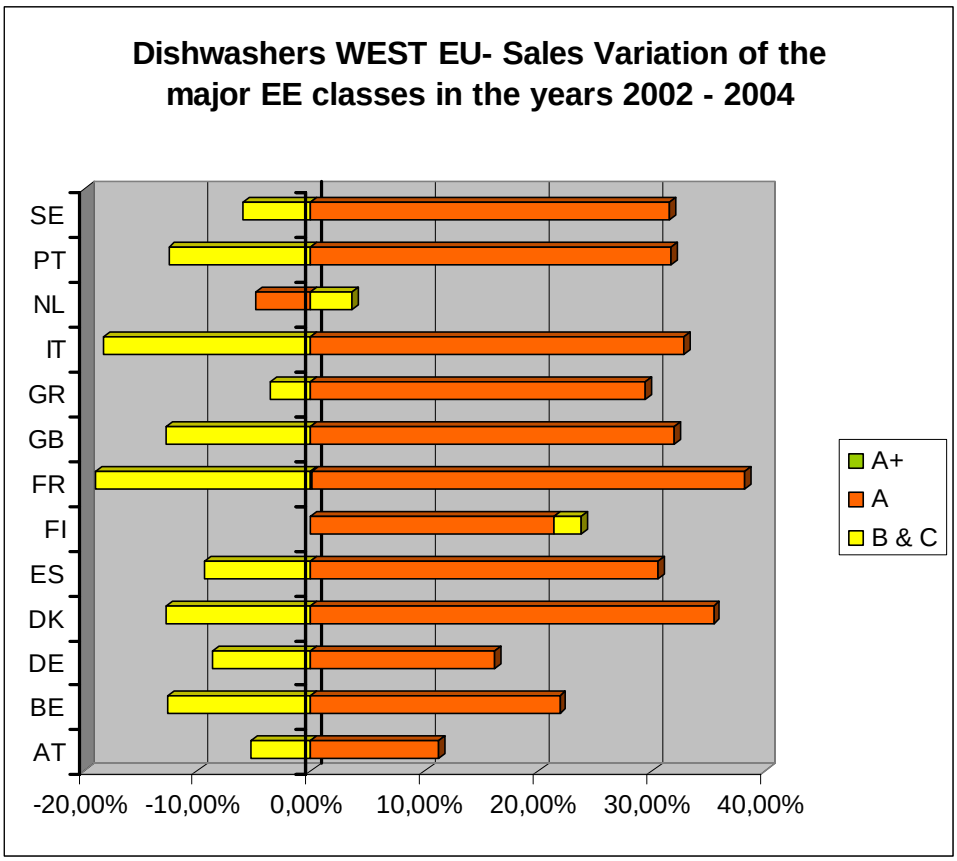
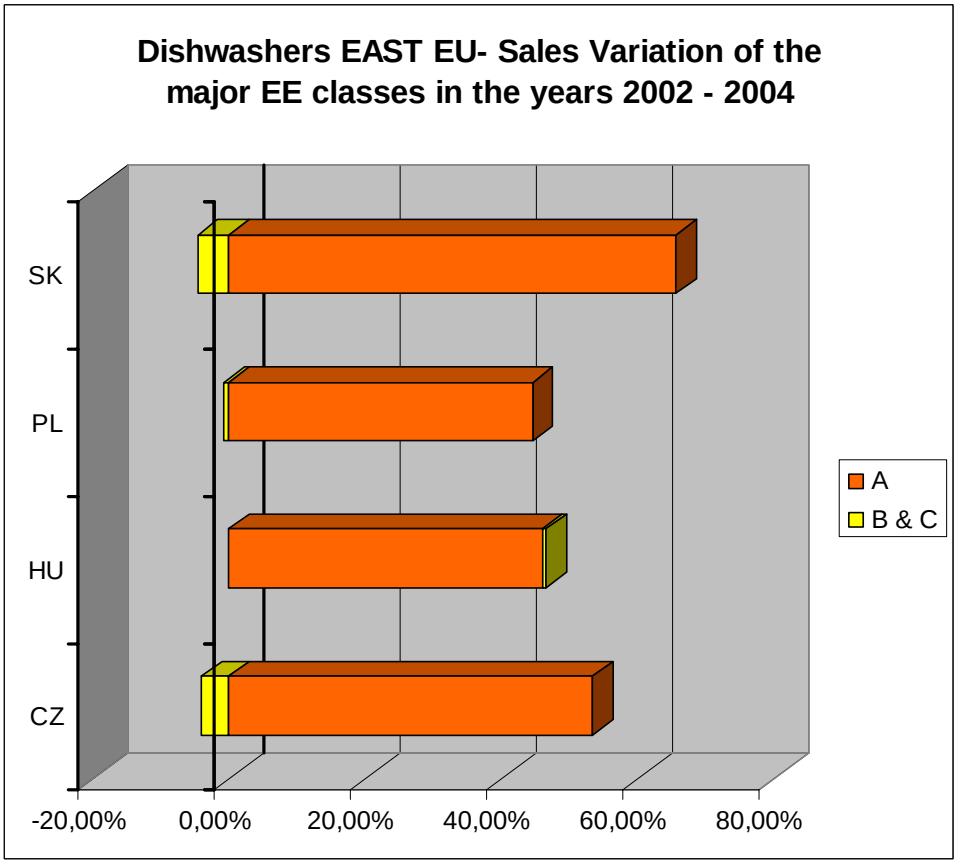


Figure 2.8 Dishwasher East EU- Sales Variation of the major EE classes in the years 2002 - 2004



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[8] 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

[8] 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

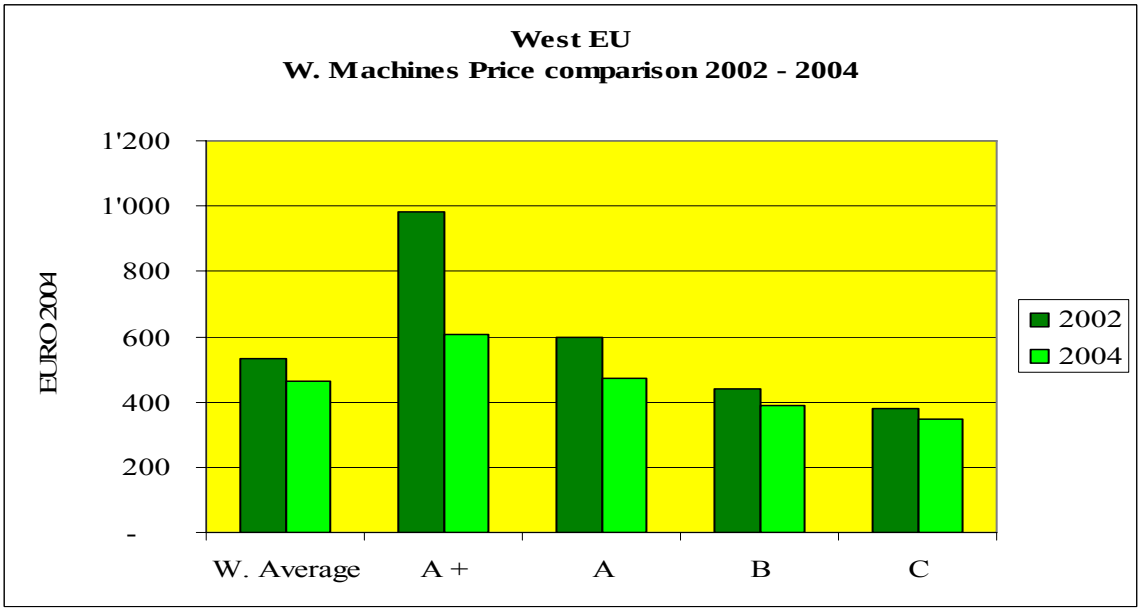


Figure 2.10 East EU: Washing machines prices comparison by EE categories for the years 2002 – 2004

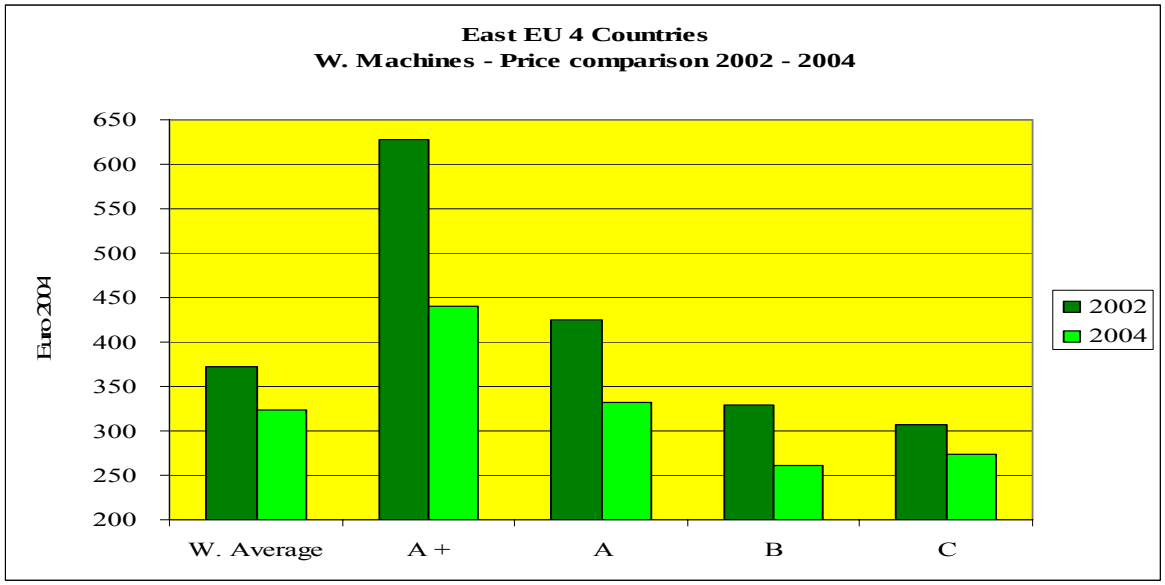


Figure 2.11 Prices West-East comparison for the cold and wet appliances.

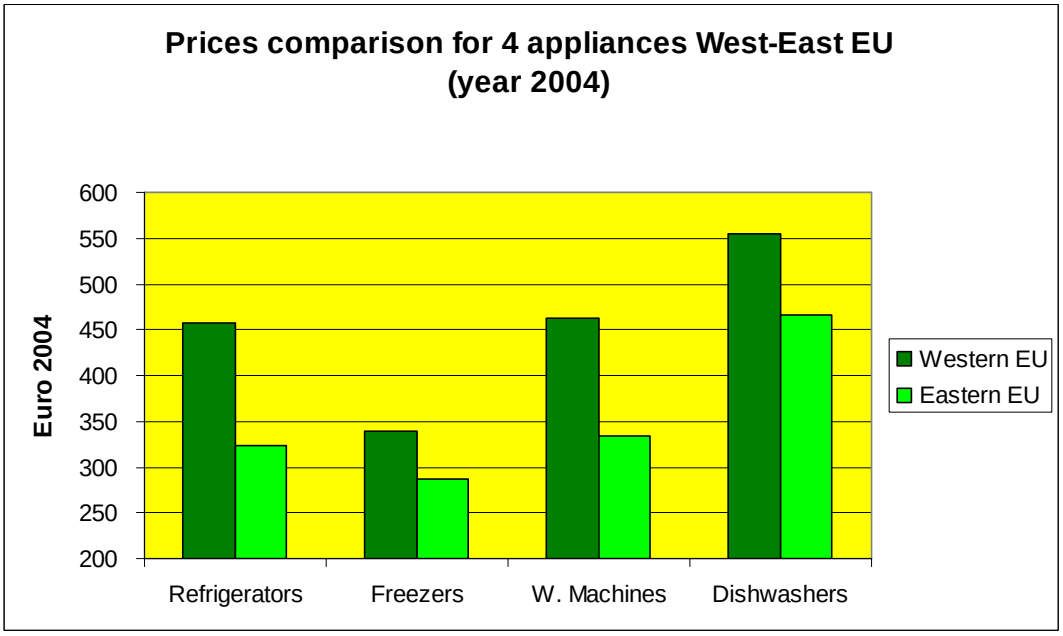
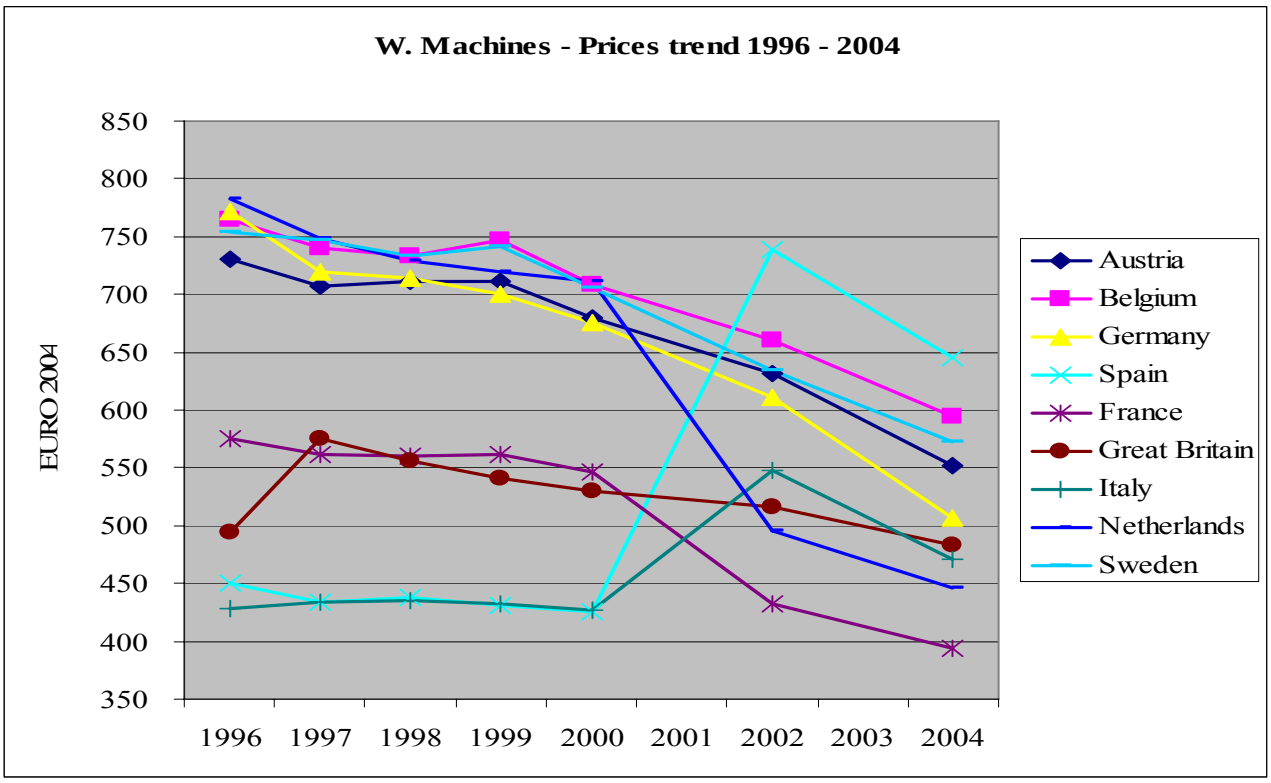


Figure 2.12 EU western countries: 1996 – 2004 prices trends for washing machines.



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

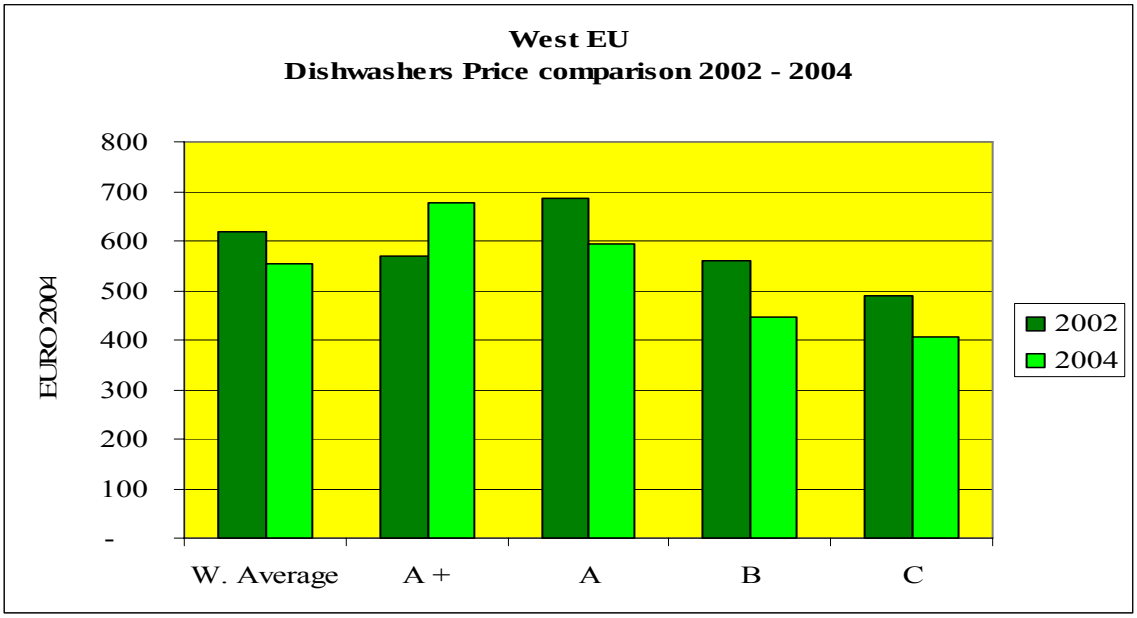
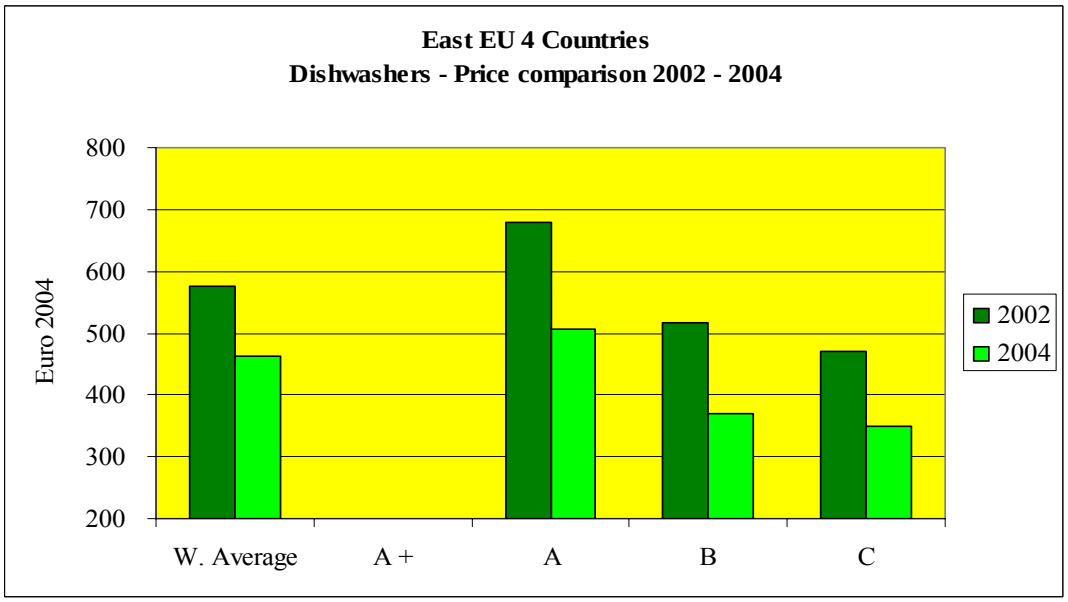


Figure 2.14 East EU: Dishwashers prices comparison by EE categories for the years 2002 – 2004

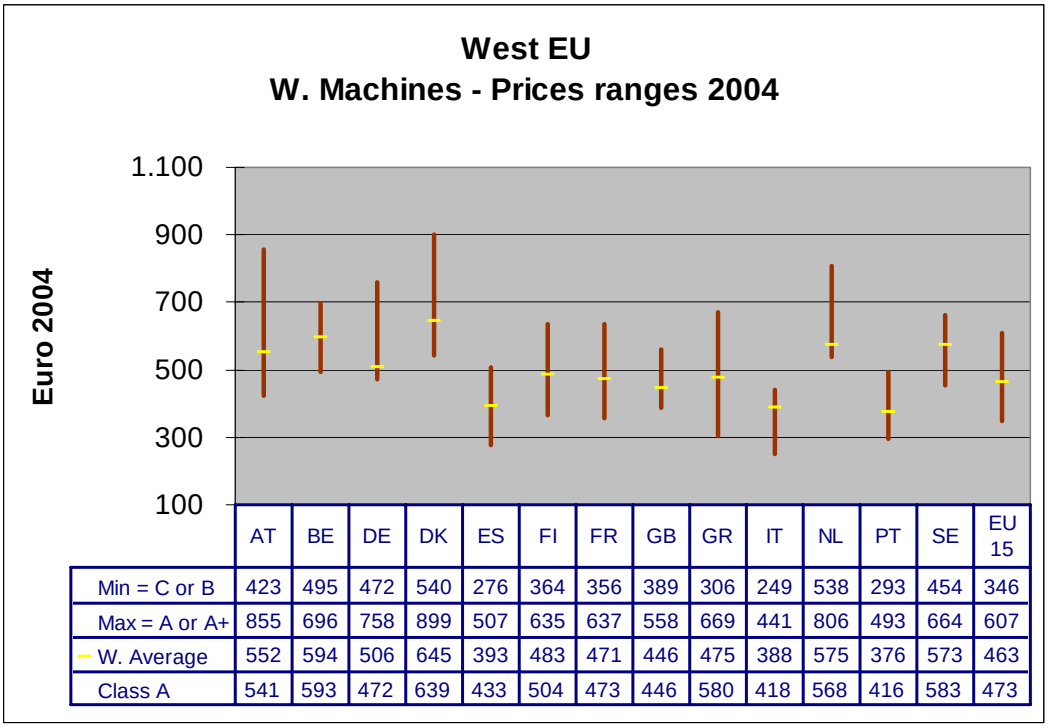


2.2.2.2 2004 EU prices analysis

Washing machines

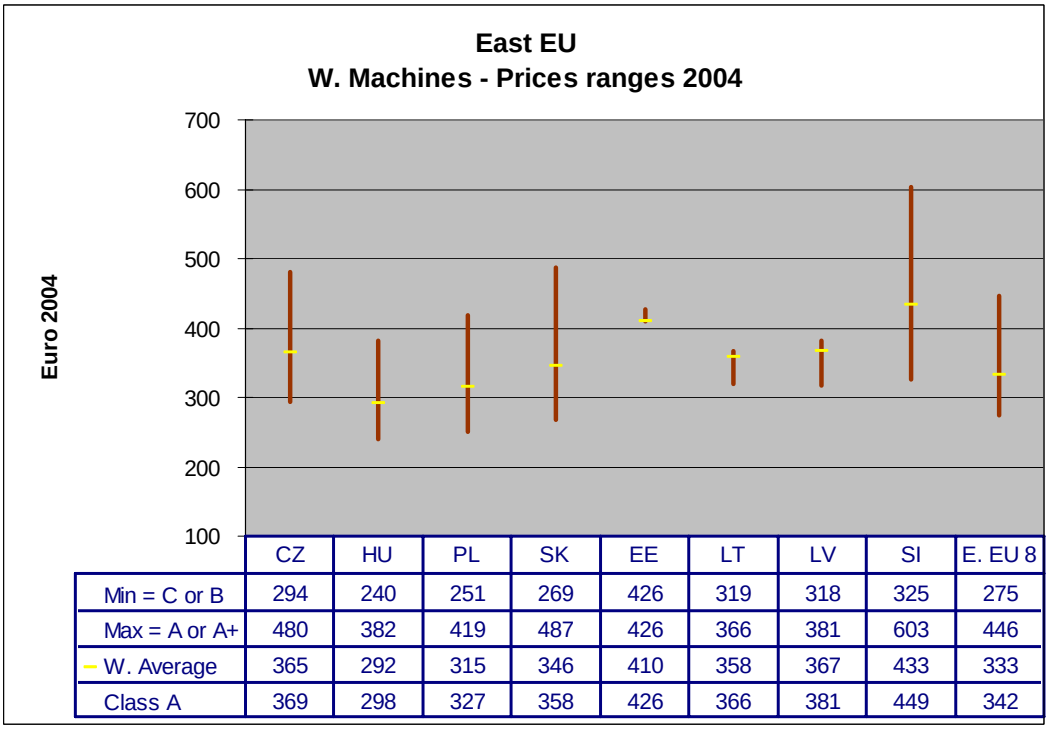
Figures 2.15-2.16 show the prices interval of the appliances sold in the West and East EU markets ranked by the highest and the lowest EE classes. The horizontal mark between the vertical bars indicates the average washing machines price. As the table below the graph indicates, in general the average 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.



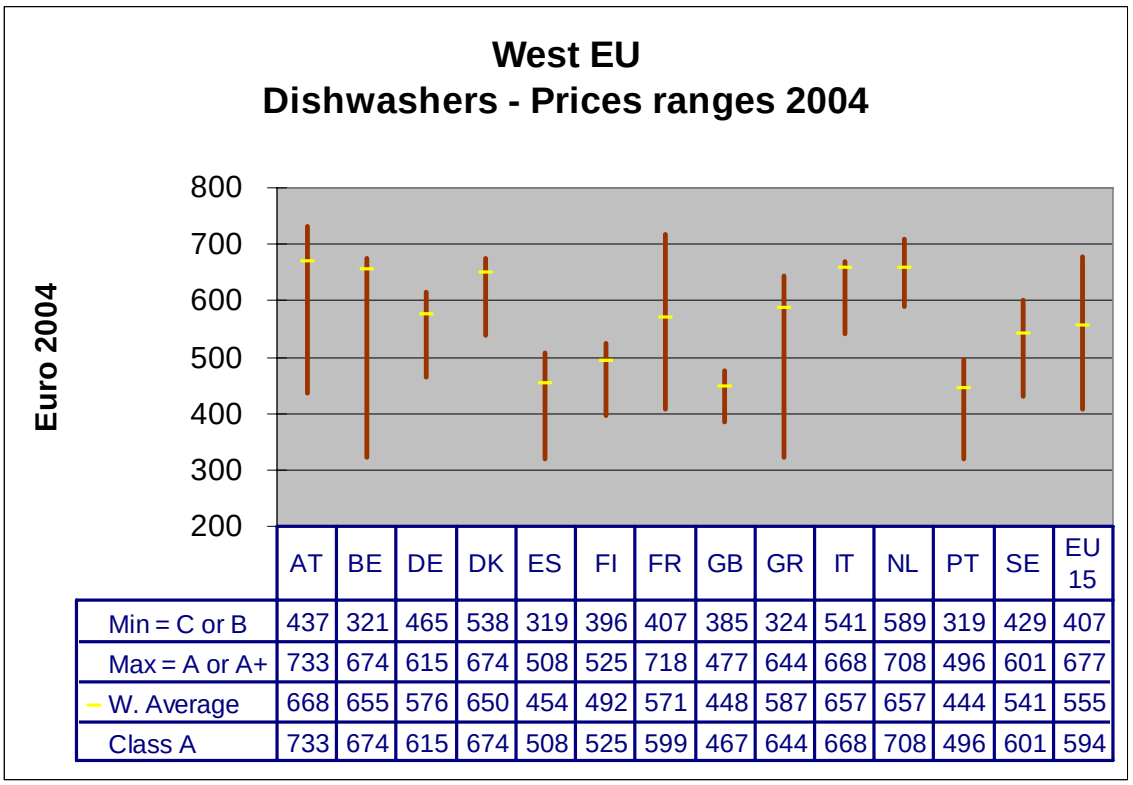
	CZ	HU	PL	SK	EE	LT	LV	SI	E. EU 8
Min = C or B	294	240	251	269	426	319	318	325	275
Max = A or A+	480	382	419	487	426	366	381	603	446
W. Average	365	292	315	346	410	358	367	433	333
Class A	369	298	327	358	426	366	381	449	342

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

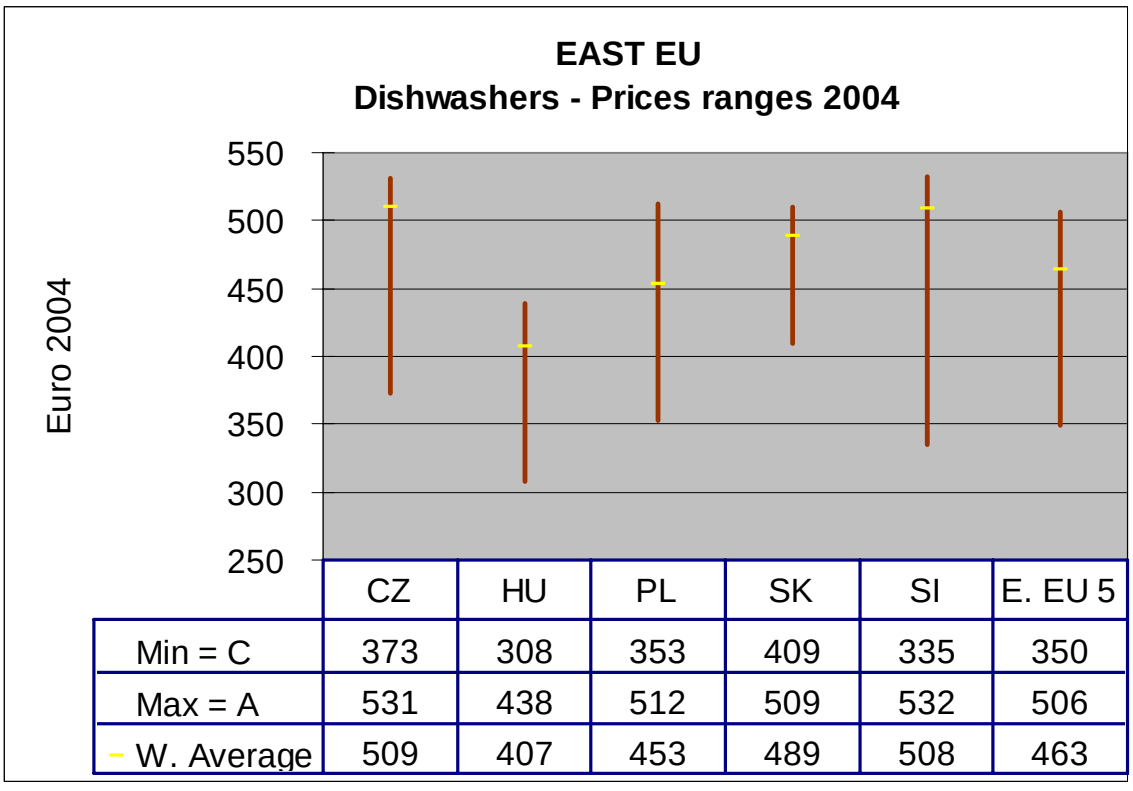
most of the cases (in all cases for the eastern countries) coincides with the top edge of the histograms. Overall the graphs confirm the impression, already provided by the sales analysis of this compartment, of a market that's transforming rather rapidly (actually, the majority of the average prices 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.[9] 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:

[9] 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[10] 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) [11];
- 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:

[10] The average lifetime is the duration when 50% of the devices sold in a given year are no longer in the stock

[11] 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

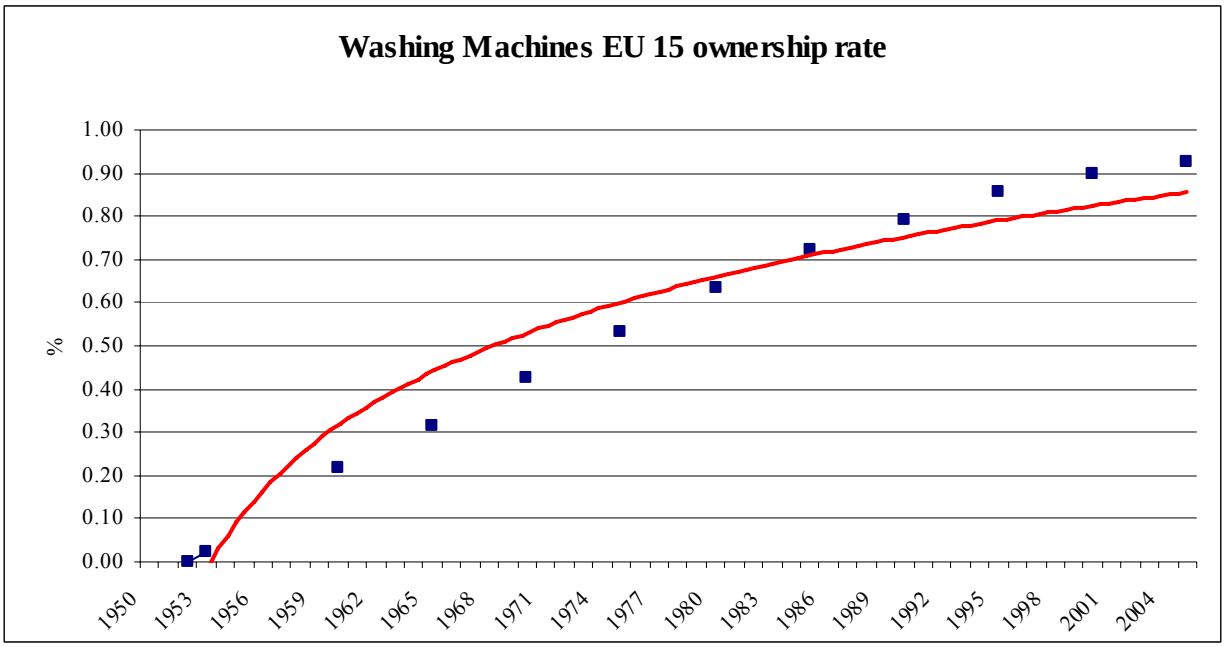
Year	Energy Average Consumption (kWh/cycle)	Number Cycles /Machines/Year
1953-1981	3,250	277
1982-1992	1,830	256
1993-1996	1,350	251
1997	1,177	251
1998-1999	1,177	245
2000	1,081	245
2001-2002	1,081	245
2003-2004	1,081	234
2005	0,997	234

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

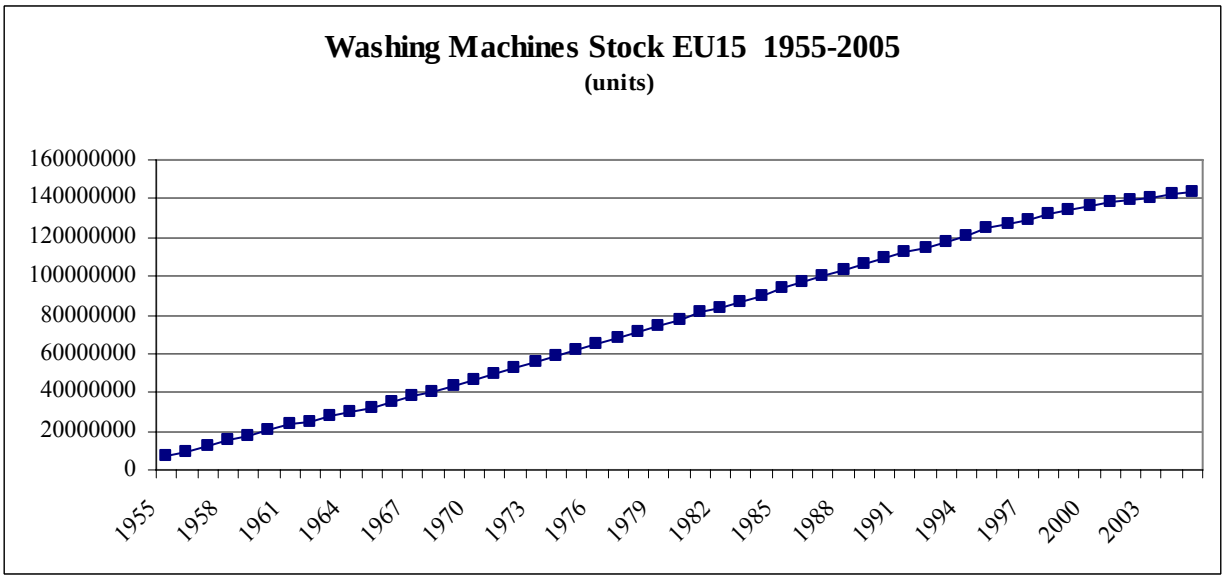
The ownership rate is estimated assuming:

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)

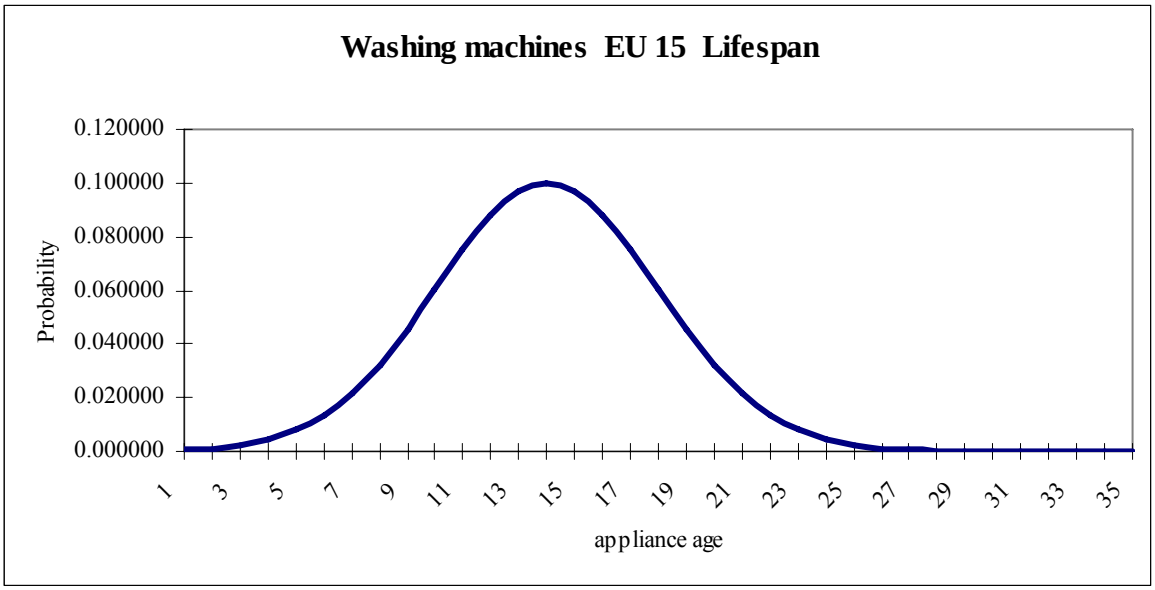


After estimation of the stock, the sales have been thus calculated through the following formula.

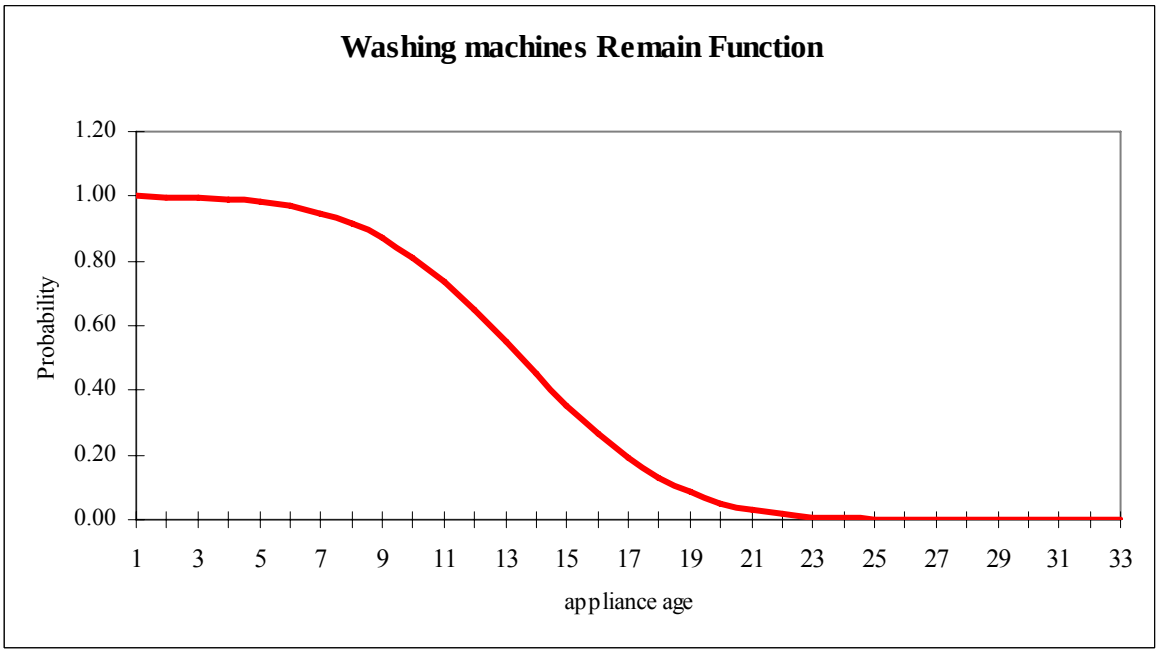
(1)

$$ESTsales(k) = Stock(k) - \sum_{i=i0}^{k-1} ESTsales(i) * \mathrm{Re}\,main(i,k)$$

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)[12].



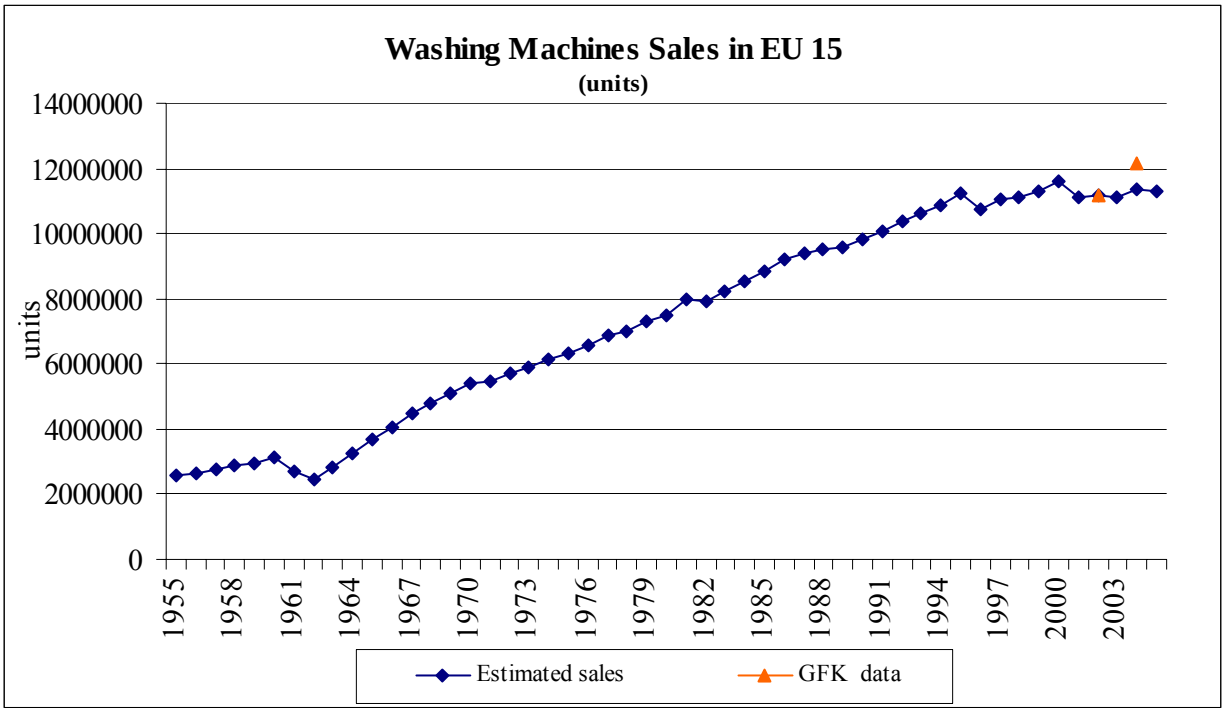
The trend of the function *Remain (j, k)*, that is the probability that the appliances sold in year j and are still remaining in the stock in year k, is shown in the following graph:



The estimated sales are shown in Figure 2.20 where the results have been calibrated (see note 12) by considering the actual sales data of the years 2002 and 2004 (the orange triangles, GfK).

[12] 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)

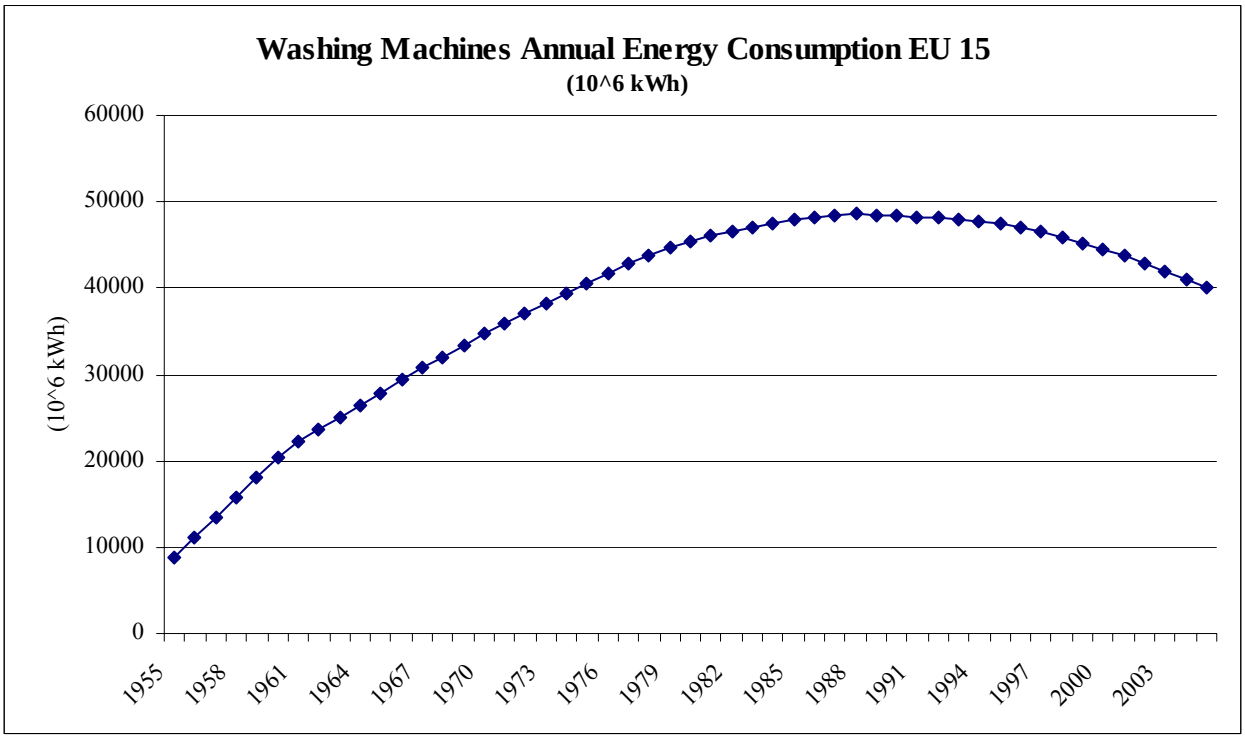


Figure 2.22 shows the unitary energy consumption trend of the refrigerator stock for the same period of time, obtained by dividing the energy consumption data by the corresponding stock data. The EU 15 stock unitary consumption passes from the 969 kWh/app of 1955 to the 304 kWh/app of 2005 with an efficiency gain of the 69 %.

Figure 2.22 Washing machines unitary stock energy consumption trend for EU 15 (1955 – 2005)

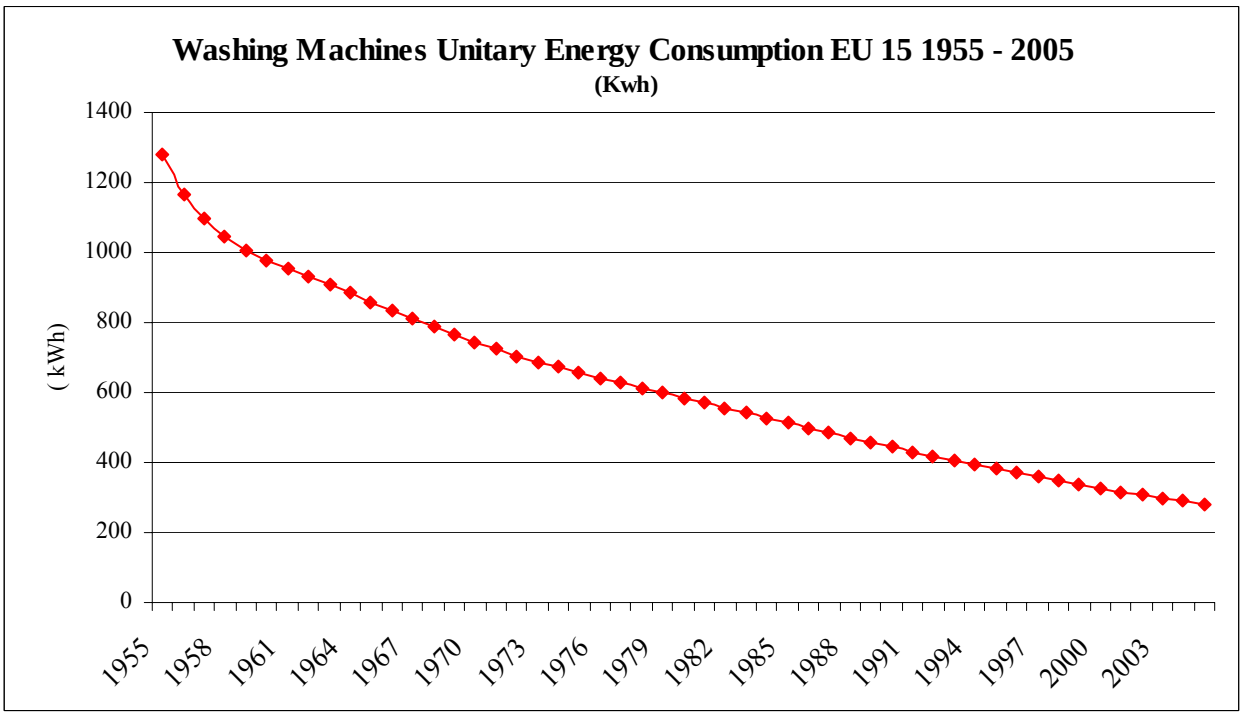


Table 2.13 shows the appliances stock and the corresponding total and unitary energy consumption as provided by the stock model. Table 2.14 shows the corresponding five-year variation rates.

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

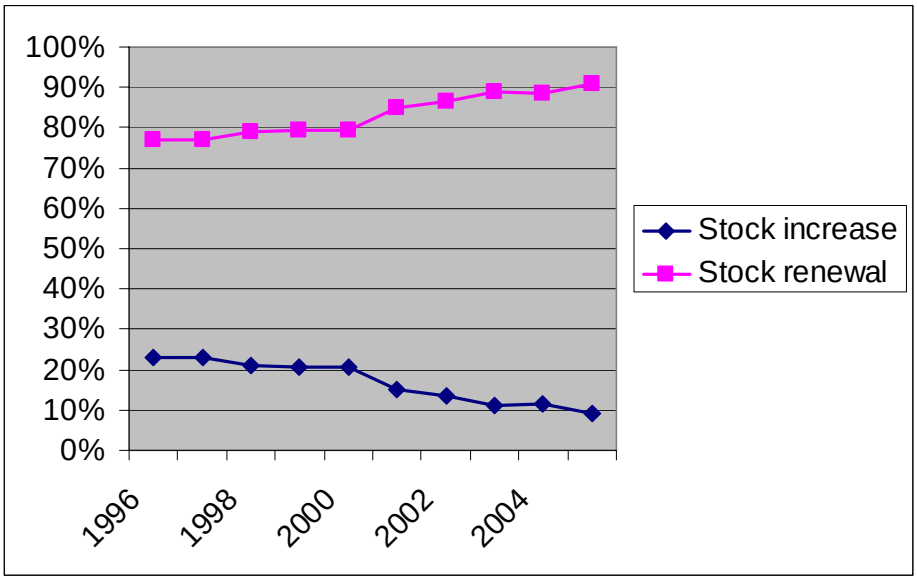
Year	Washing machines Stock	Total stock Energy Consumption	Unitary stock Energy Consumption
	%	%	%
1990-1995	14,11	-12,31	-23,15
1995-2000	9,64	-13,03	-20,68
2000-2005	4,96	-14,12	-18,18

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) [13];
- 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

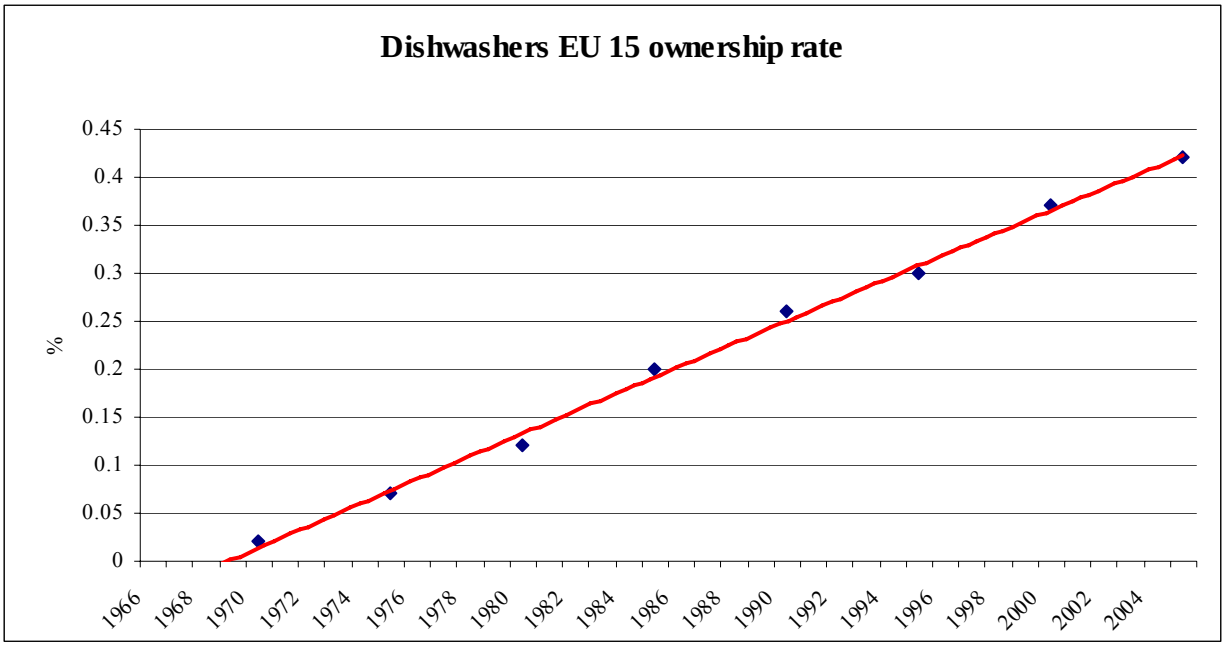
[13] Source: CECED databases and stock model [ref 6]

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

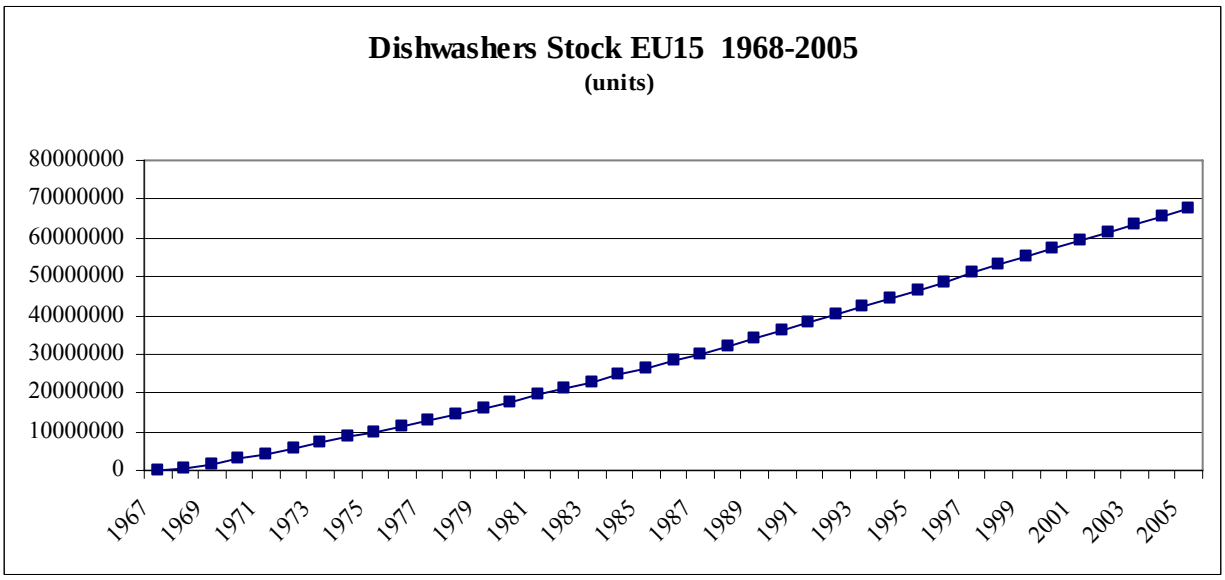
The ownership rate is estimated, assuming that:

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)

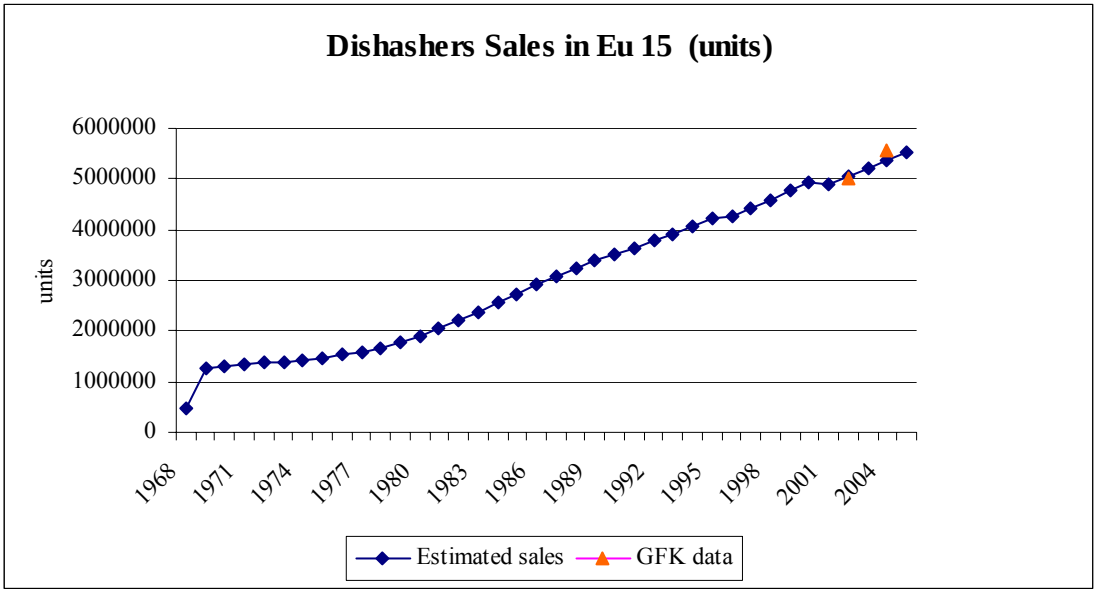
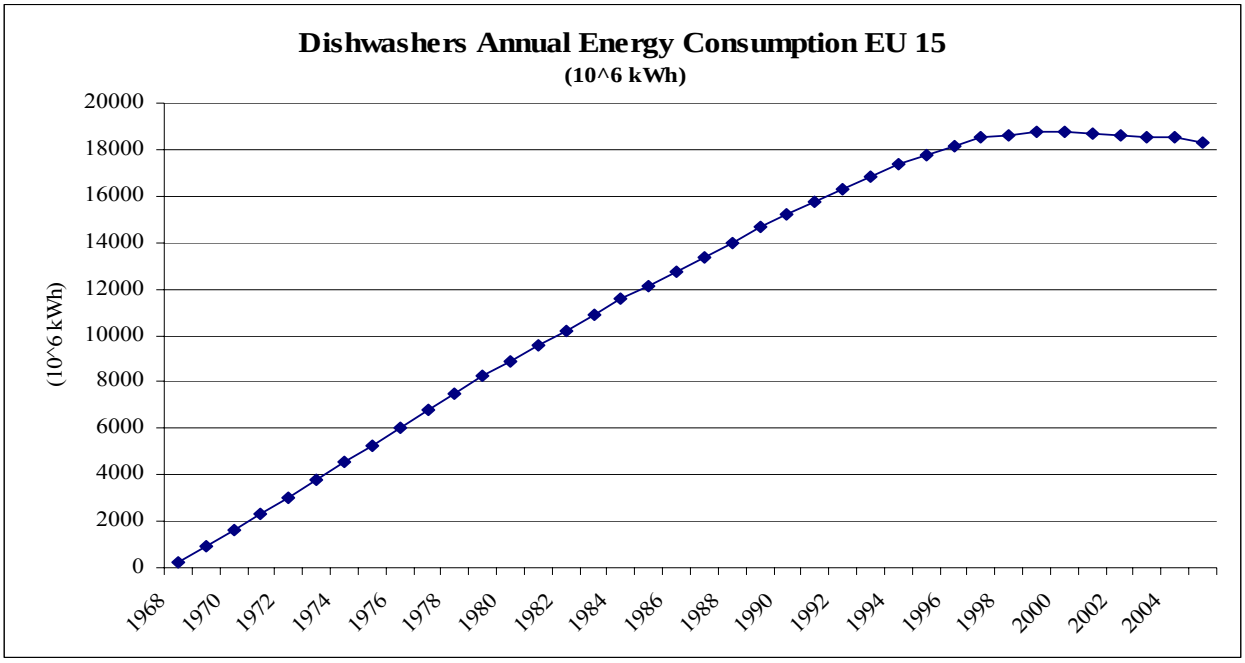


Figure 2.26 Dishwashers total stock energy consumption trend for EU 15 (1968 – 2005)



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)

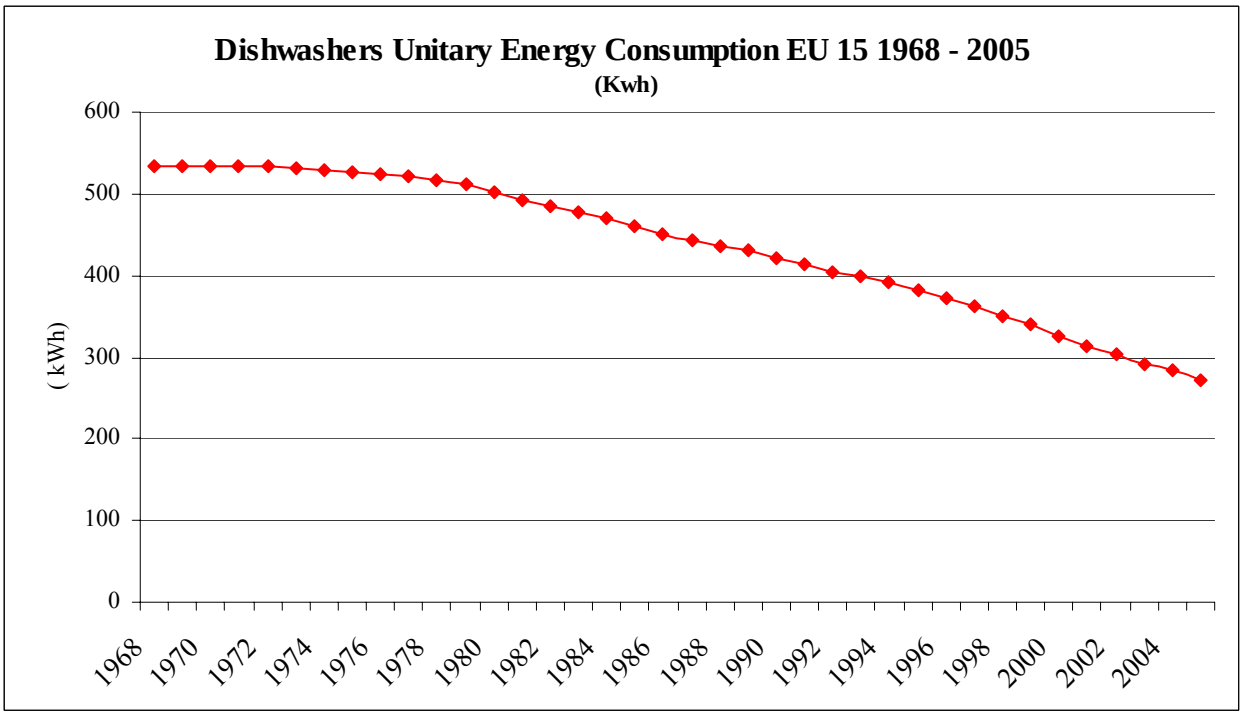


Table 2.16 shows the appliances stock and the corresponding total and unitary energy consumption as provided by the stock model and Table 2.17 shows the corresponding five-year variation rates.

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

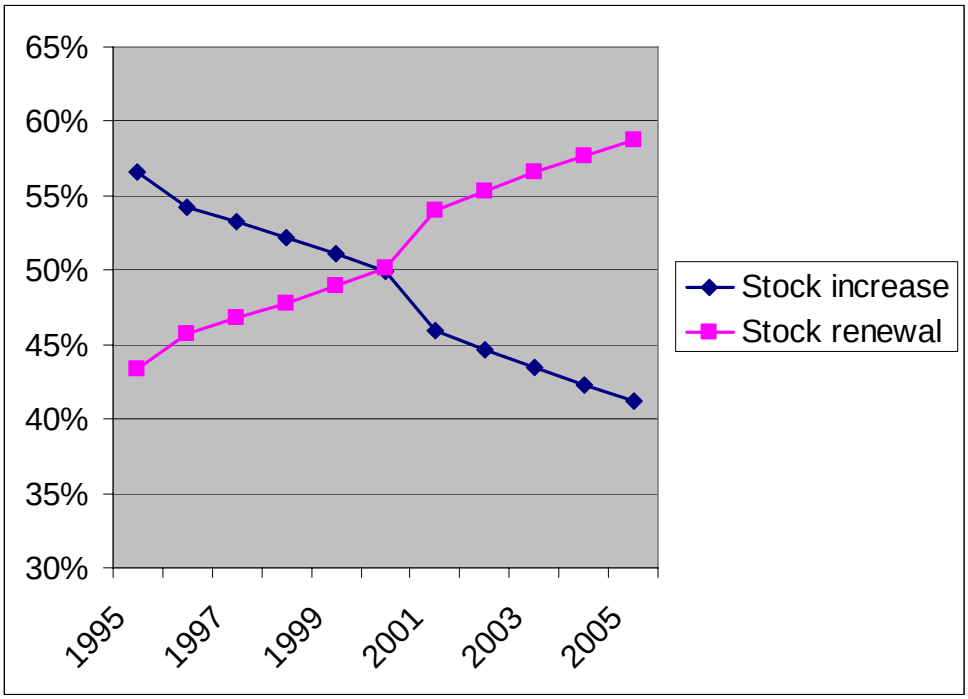
Year	Dishwashers Stock	Total Stock Energy Consumption	Unitary Stock Energy Consumption
	% variation	*% variation*	*% variation*
1990-1995	29,45	17,02	-9,60
1995-2000	23,09	5,38	-14,39
2000-2005	17,69	-2,44	-17.11

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[14], 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 %

[14] 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

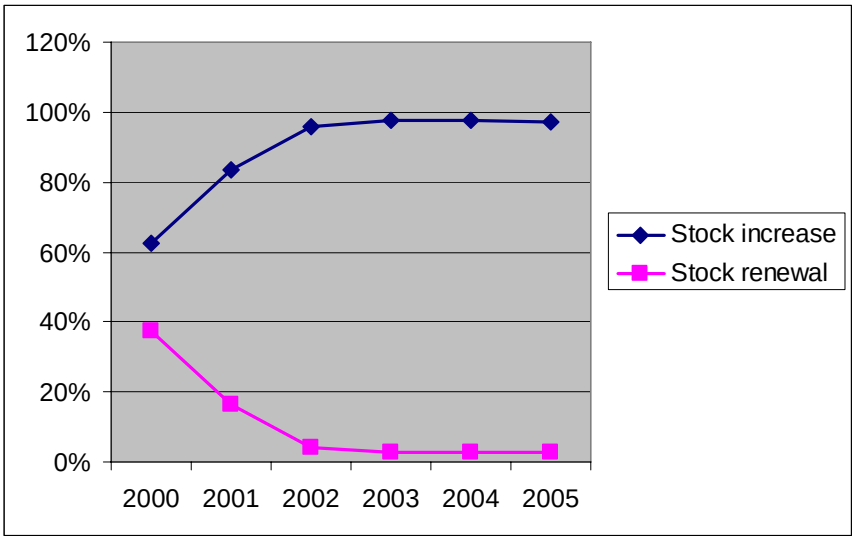
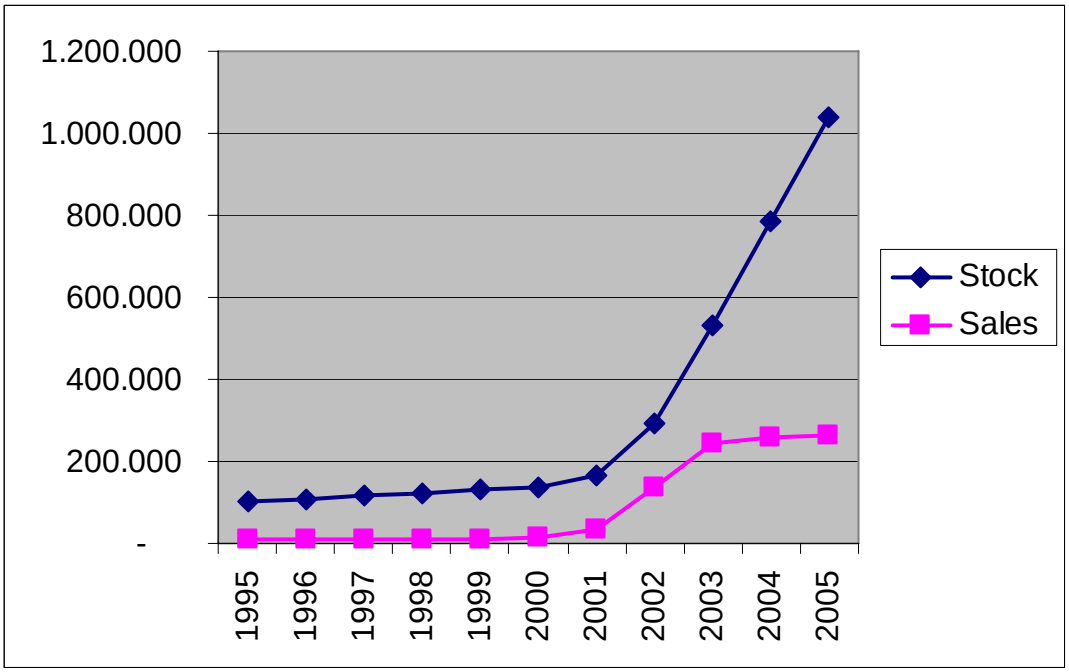


Figure 2.30: Stock and sales trend of the dishwashers in the EU 10 countries



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

REFERENCES:

1. Michael A. McNeil, Virginie E. Letscher. *Forecasting Electricity Demand in Developing Countries: A study on Household Income and Appliance Ownership.* Lawrence Berkeley National Laboratory. Berkeley (CA)
2. Christopher Riedy (2003). *Vintage Stock Modelling of Domestic Appliances: Dealing With Uncertainties* . Institute for Sustainable Futures, University of Technology, Sydney (Australia)
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.

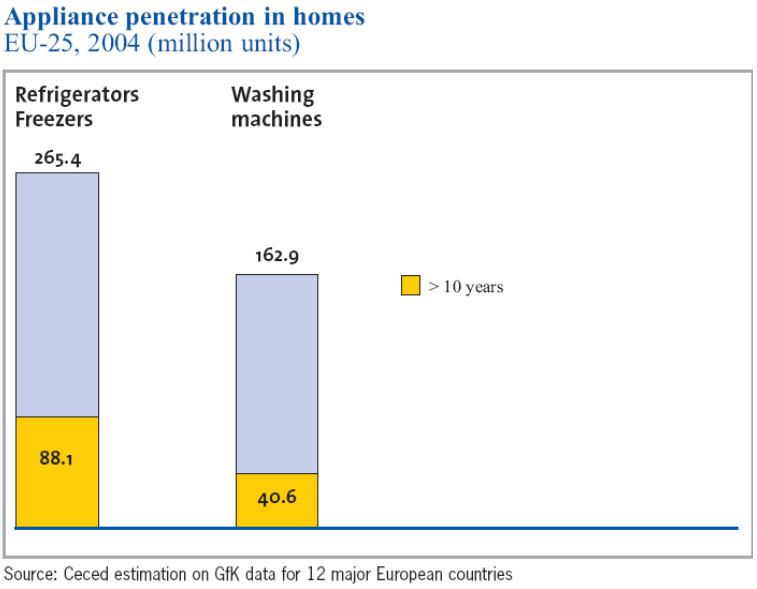


Figure 2.31 Household appliances penetration in homes EU-25, 2004 (source: CECED[15])

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:

[15] 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[16]

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[17]

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 %)[18].

Rate of equipment	in %
washing machine	94,7

Figure 2.34: Household appliances in households, 2007 – FRANCE[19]

[16] http://www.czso.cz/eng/redakce.nsf/i/table_3_public_spending_social_sphere_culture_living_standard_bf/$File/3bf_pub.xls

[17] http://www.stat.fi/index_en.html)

[18] 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)[20])**

[19] http://www.gifam.fr/pages/lemarche/lemarche.html

[20] 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[21] (Figure 2.37). Within five years (2000-2005) the saturation of washing machines showed an increase of 5% (Figure 2.37).

[21] 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[22]

Sweden

In the year 2002 only 72 % of all Swedish households possessed a washing machine[23]. 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.

[22] Fuente: National Statistics Institute www.ine.es

[23] 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[24]

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.

[24] 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[25].

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[26]. 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[27].

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[28]. Some studies, e.g. the Swiss SAMMER/WÜSTENHAGEN[29] or the German INNOFACT AG[30] 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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[25] World energy council (2005): Energy Efficiency Policies and Indicators Online: http://www.worldenergy.org/wec-geis/publications/reports/eepi/policy_evaluation/labelling.asp

[26] see www.CECED.org, text dated 27.6.2006

[27] 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

[28] http://www.greenlabelspurchase.net/Licht_EU_Energie_Label.html

[29] 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

[30] 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

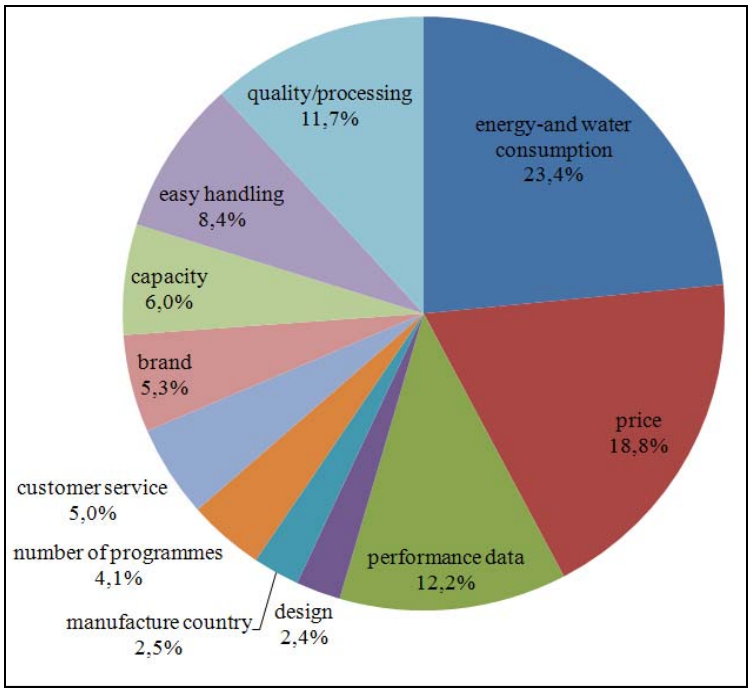


Figure 2.41: Innofact study: buying criteria – washing machine 2005

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).

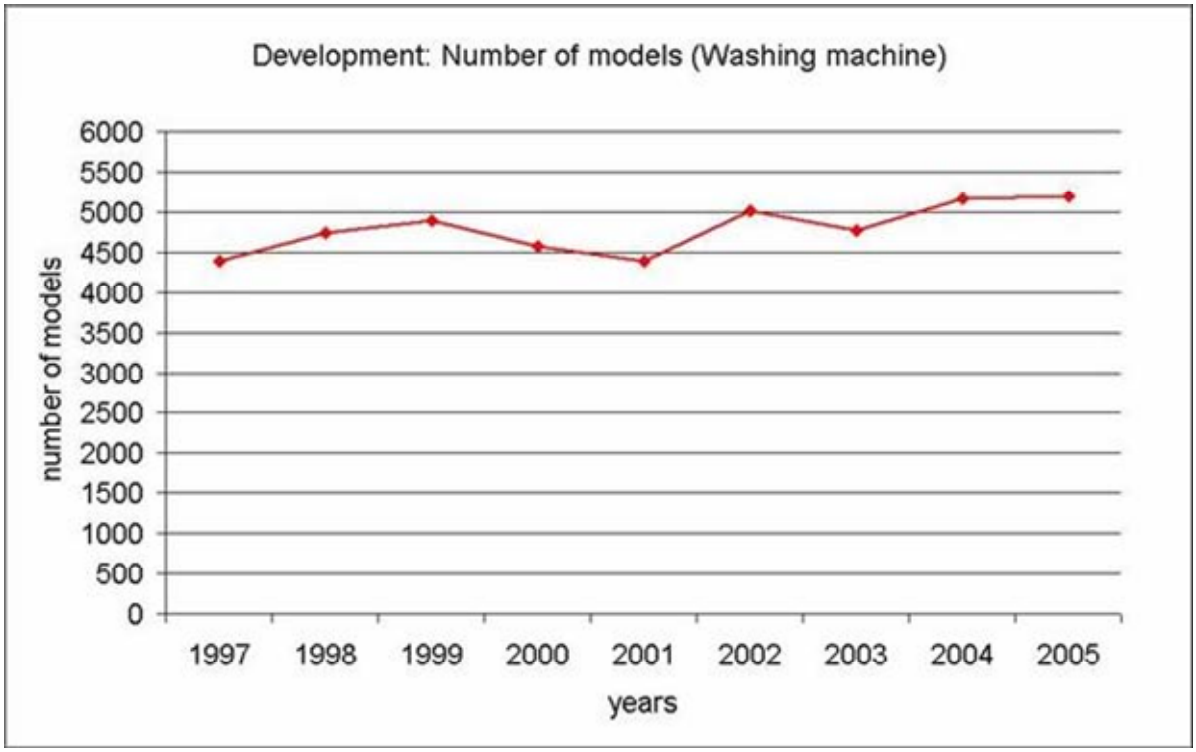


Figure 2.43- 1 development of number of models of washing machines in CECED databases

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).

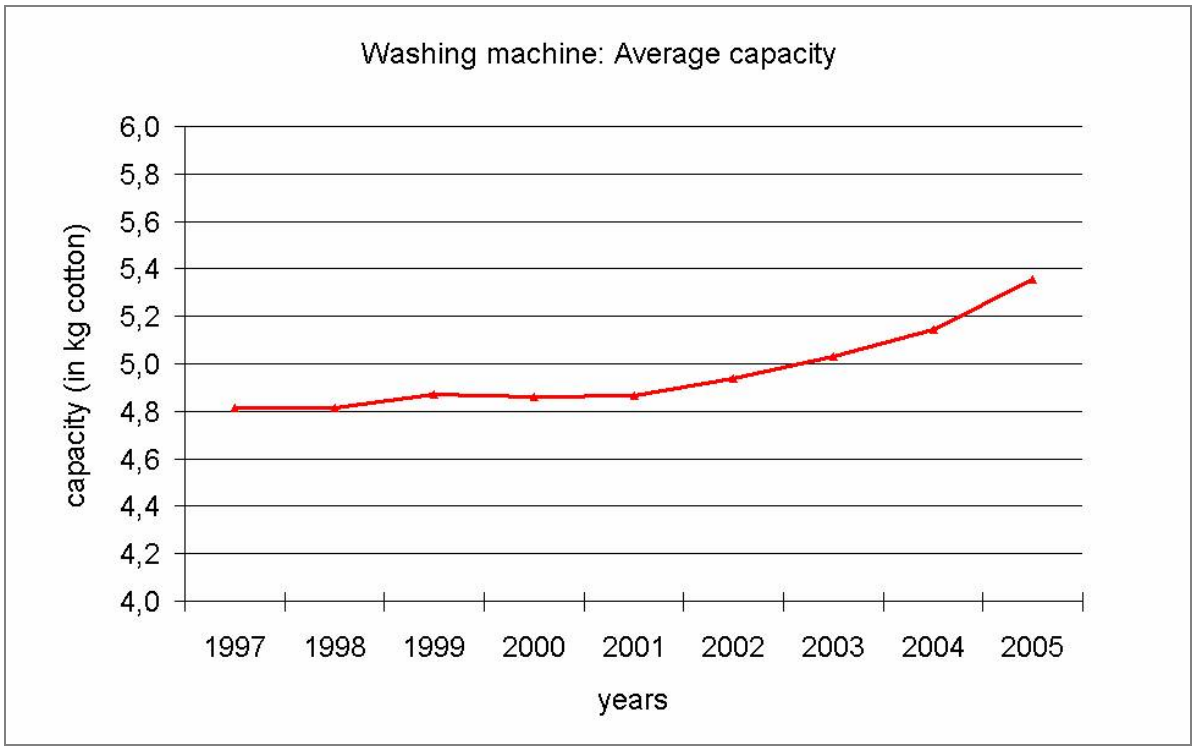


Figure 2.44: average rated capacity of washing machines

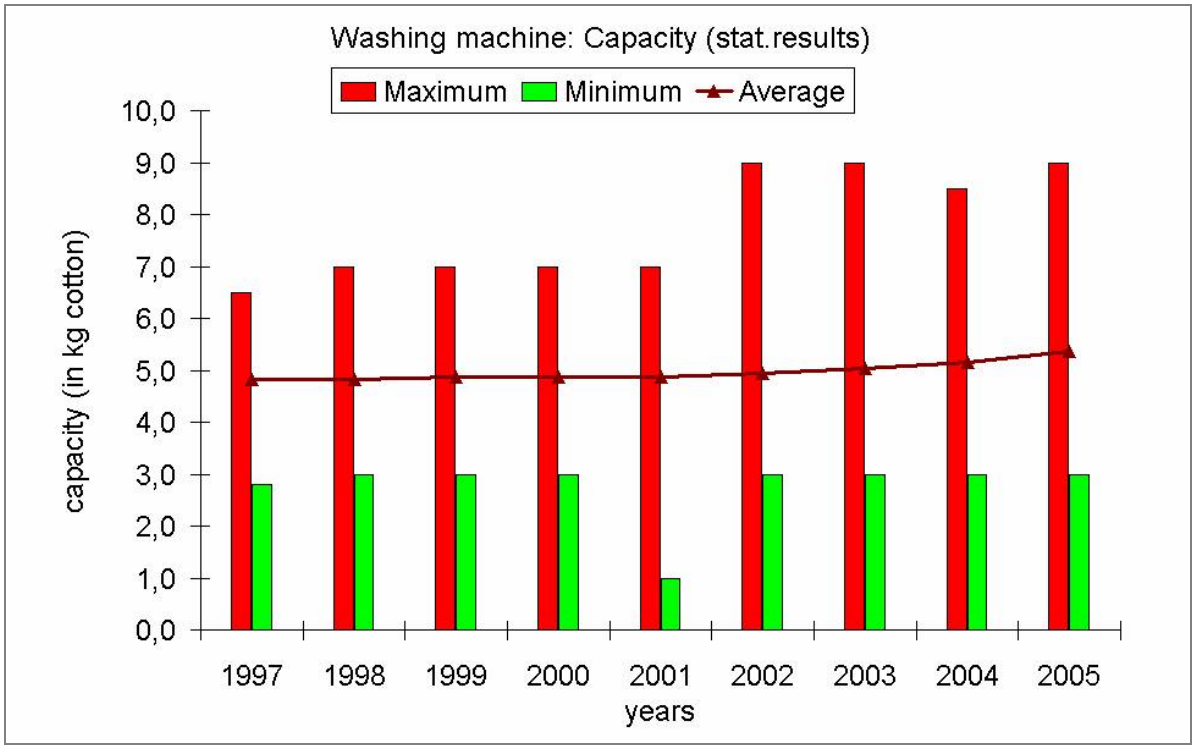


Figure 2.45: minimum, maximum and average rated capacity for washing machines

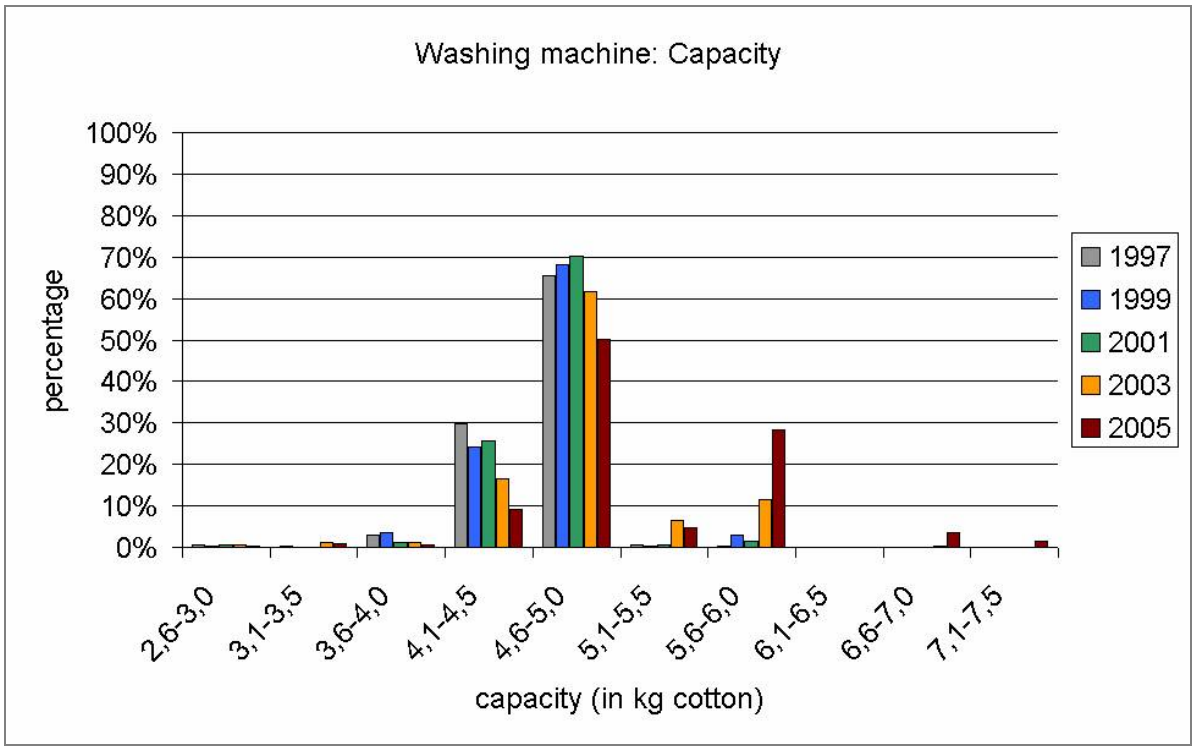


Figure 2.46: distribution of washing machines models at various capacities

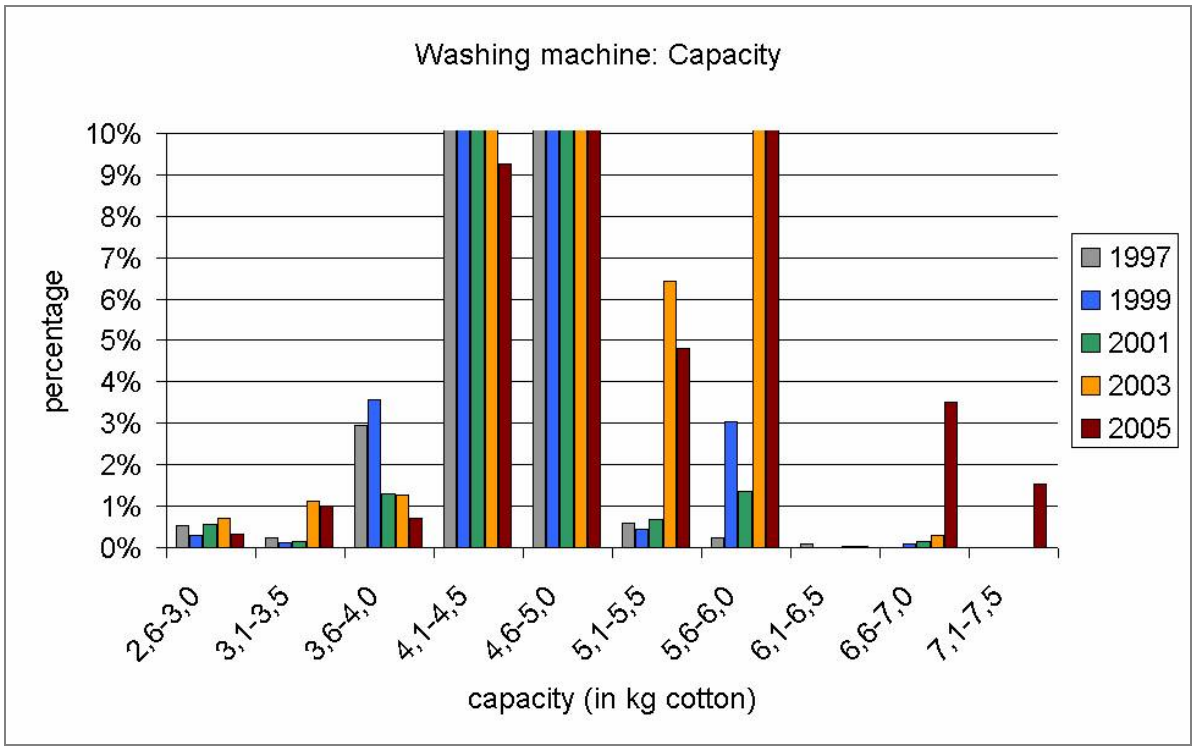


Figure 2.47: distribution of washing machines models at various capacities (enlarged scale)

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.

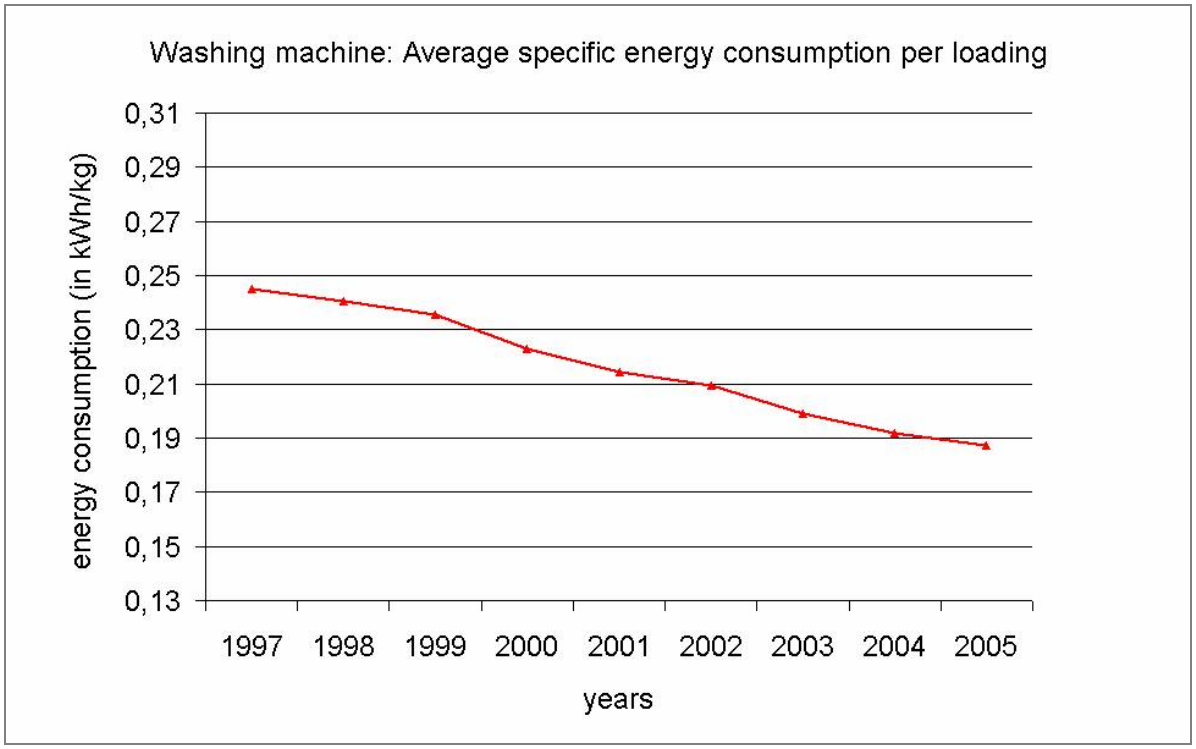


Figure 2.48: average specific energy consumption for washing machines

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.

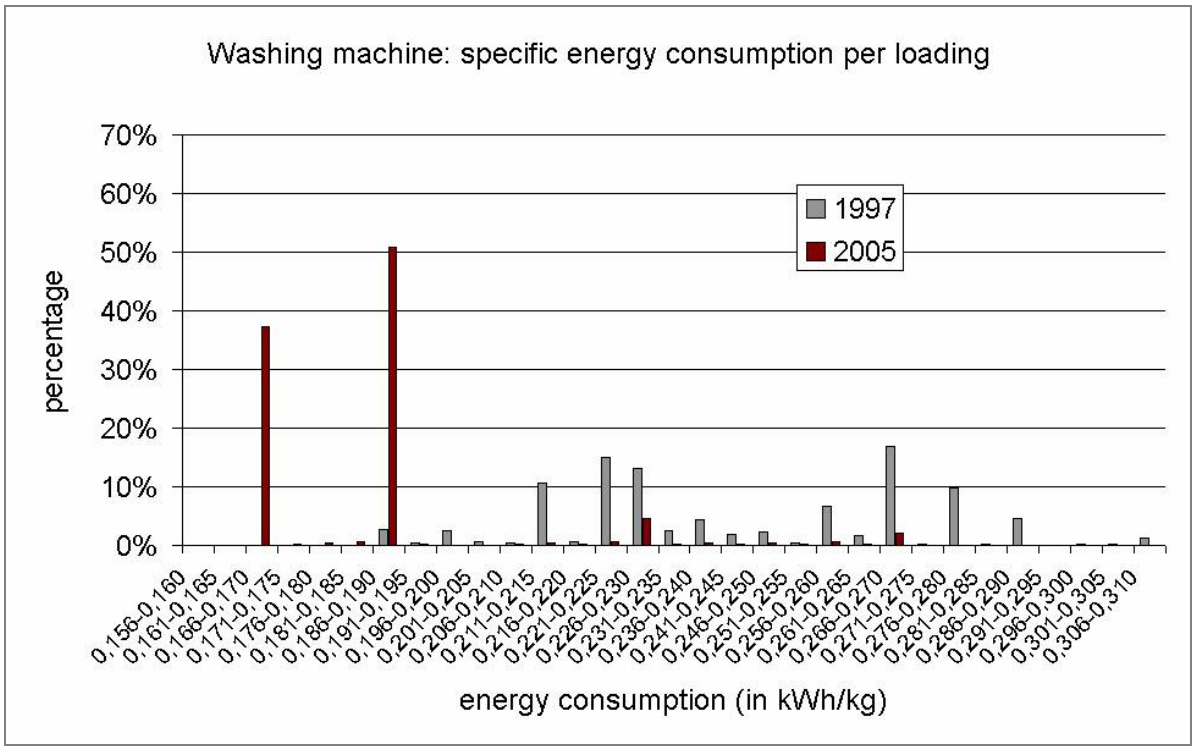


Figure 2.49: distribution of washing machines models at various specific energy consumptions

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.

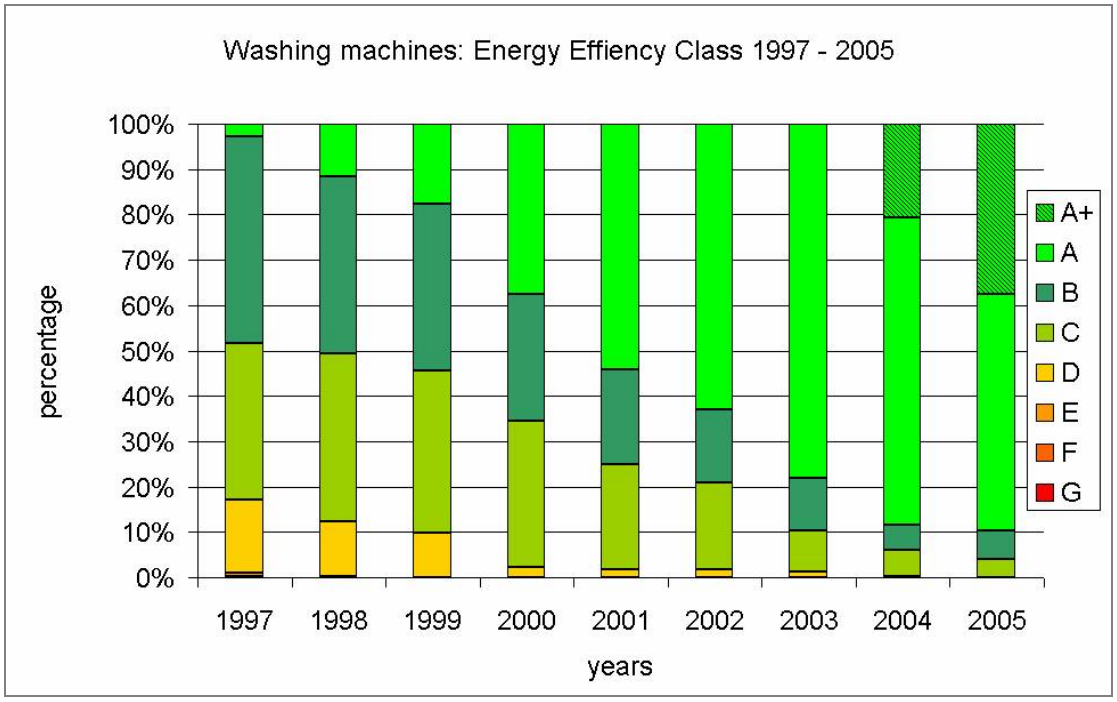


Figure 2.50: distribution of energy efficiency classes for washing machines in 1997-2005

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.

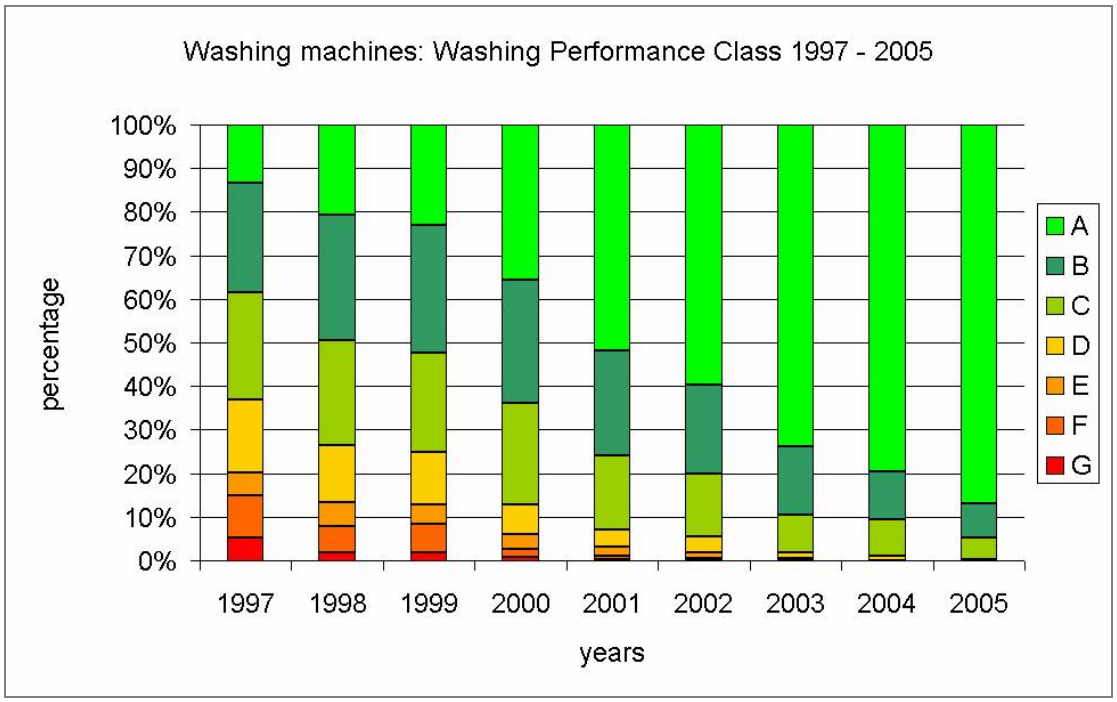


Figure 2.51: distribution of washing performance classes for washing machines in 1997-2005

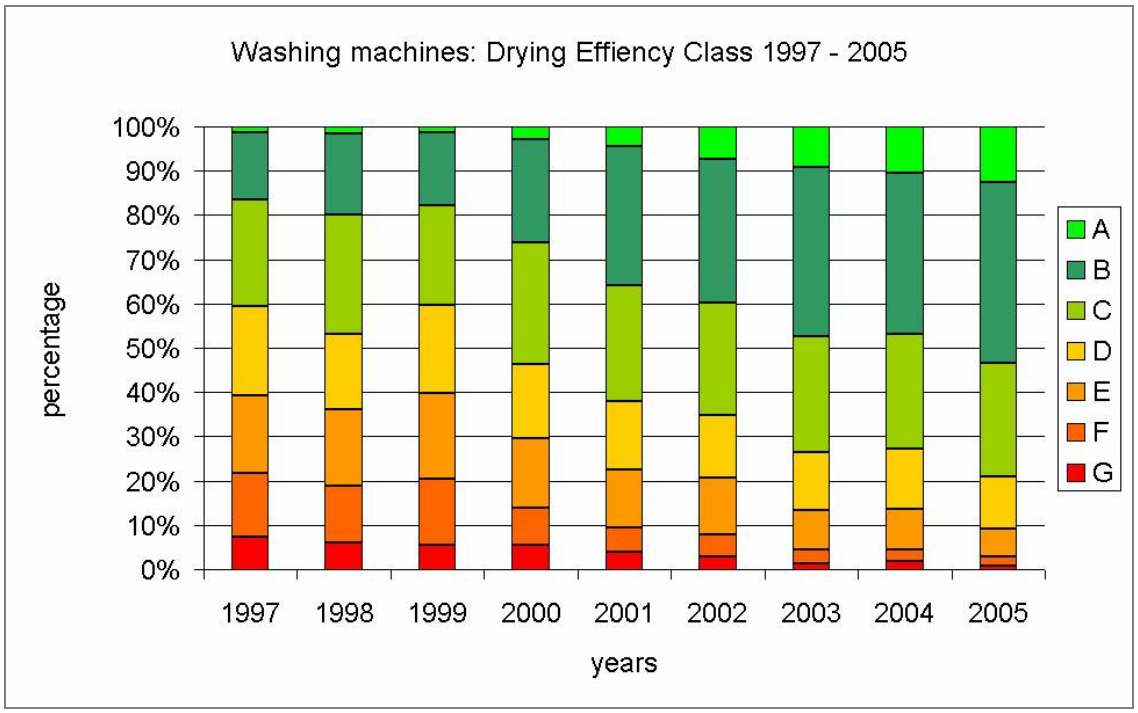


Figure 2.52: distribution of drying performance classes for washing machines in 1997-2005

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.

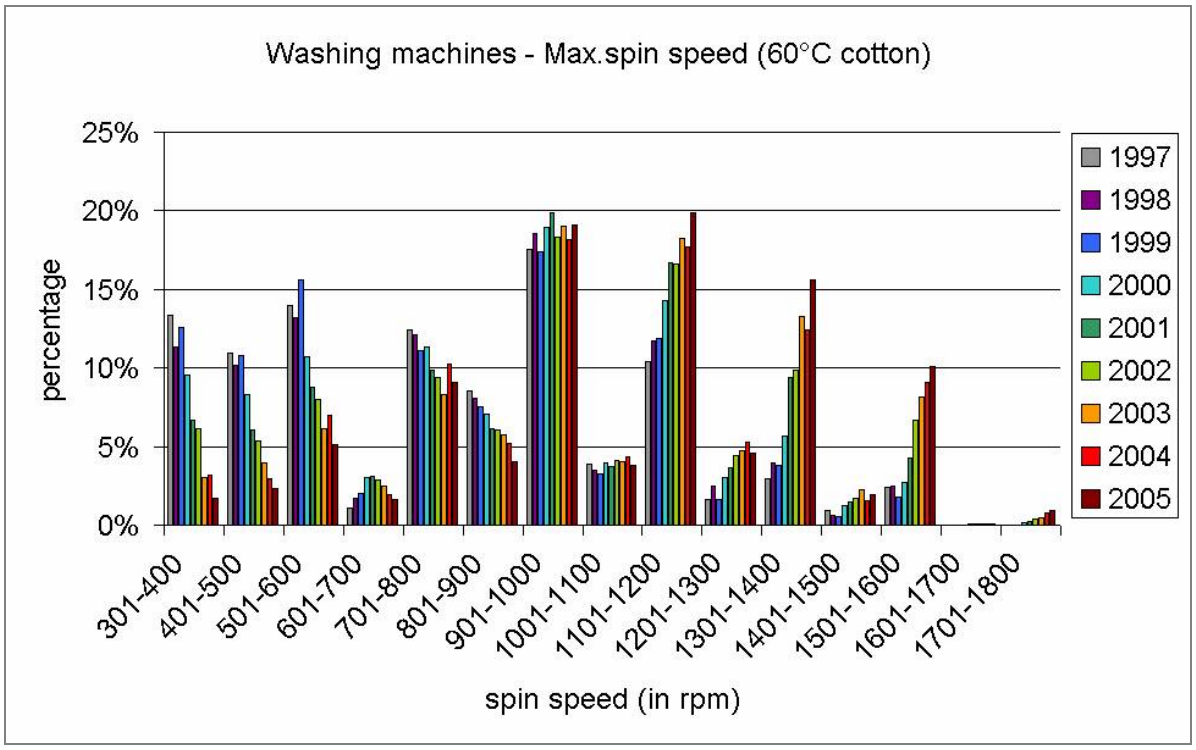


Figure 2.53: distribution of maximum spin speeds

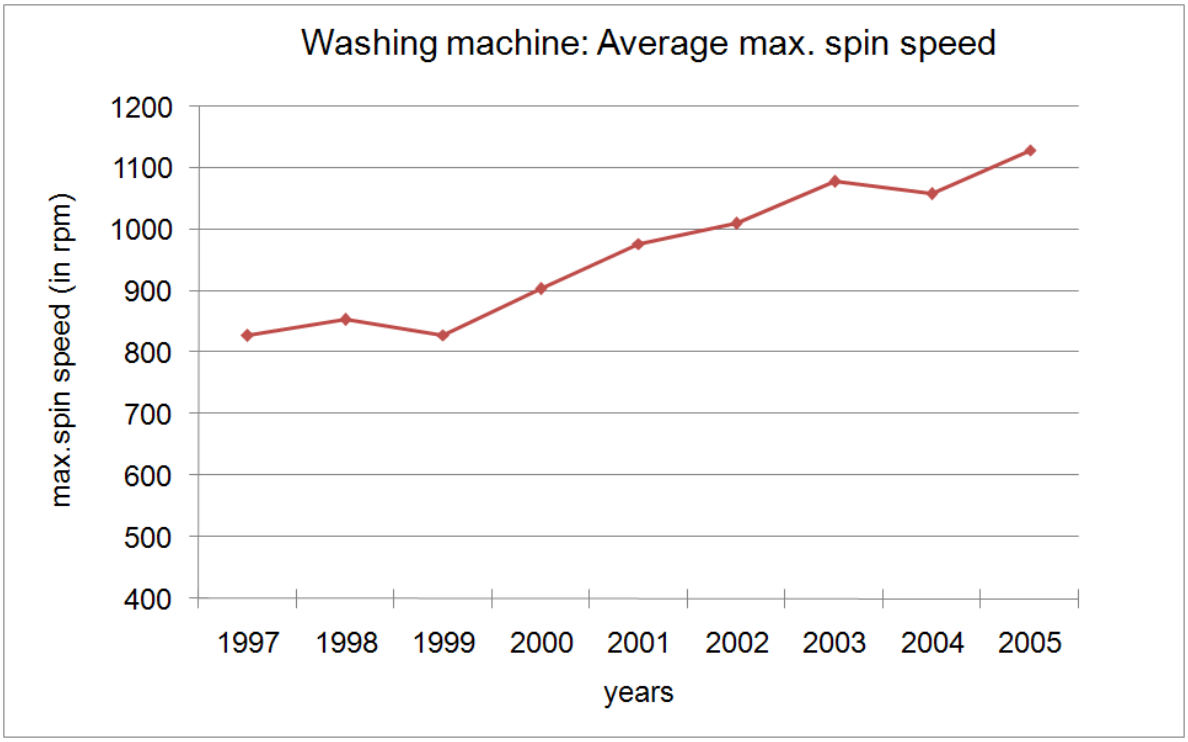


Figure 2.54: development of average spin speed

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.

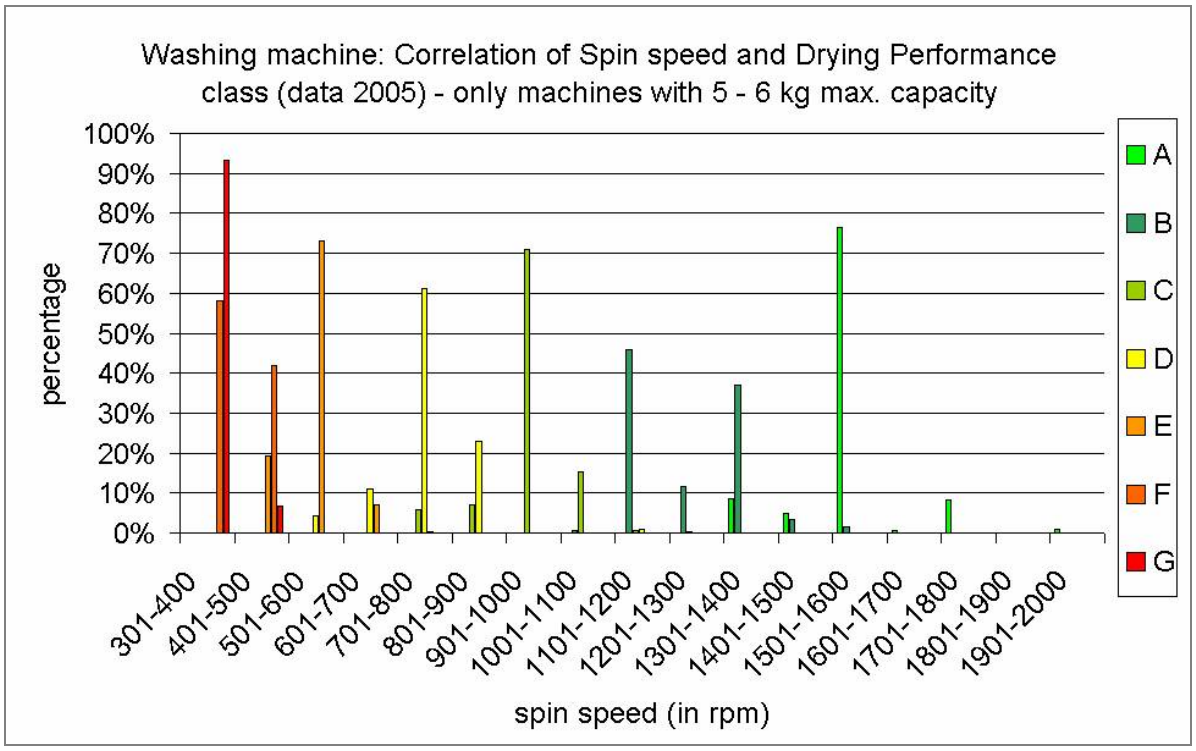


Figure 2.55: correlation of spin speed and drying performance class

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.

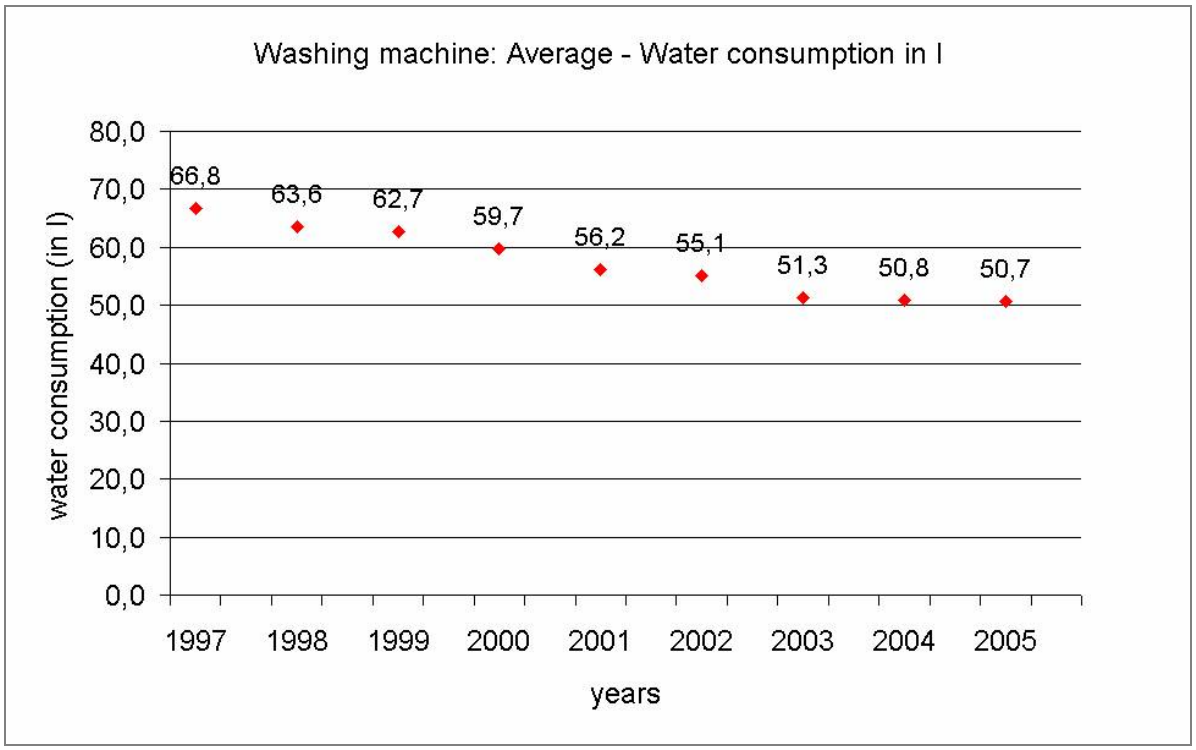


Figure 2.56: development of the average water consumption per cycle in washing machines

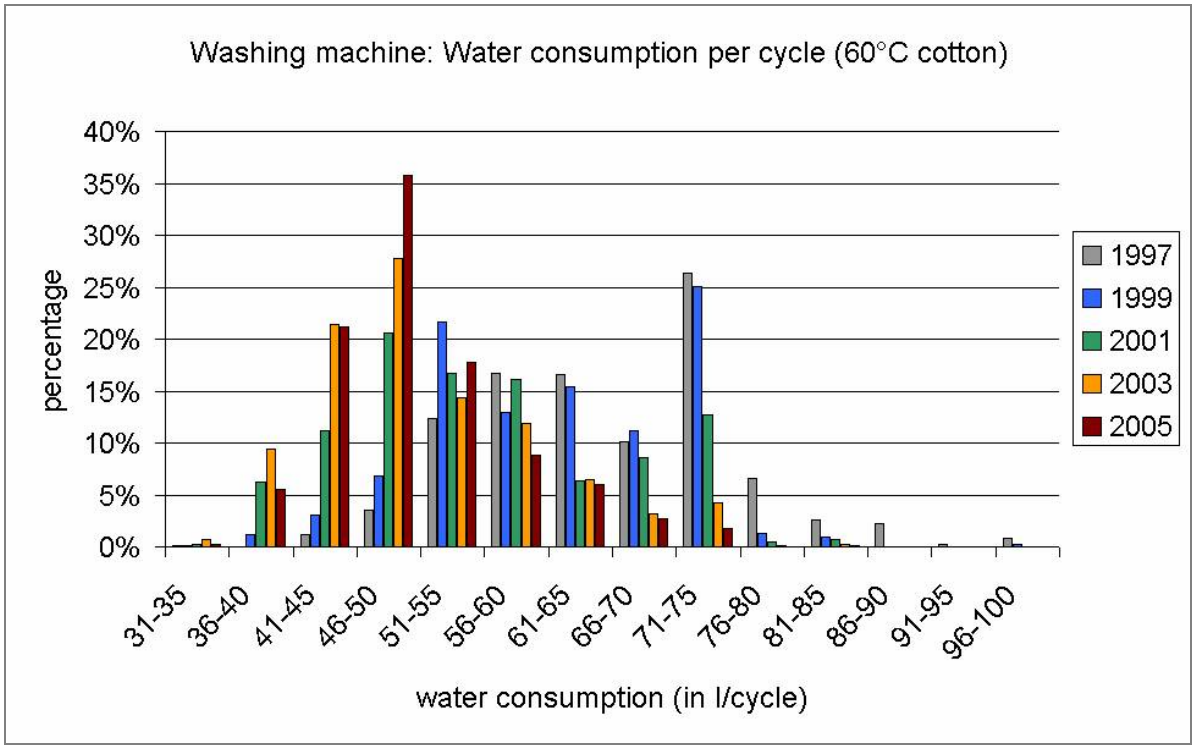


Figure 2.57: distribution of the water consumption values per cycle in washing machines

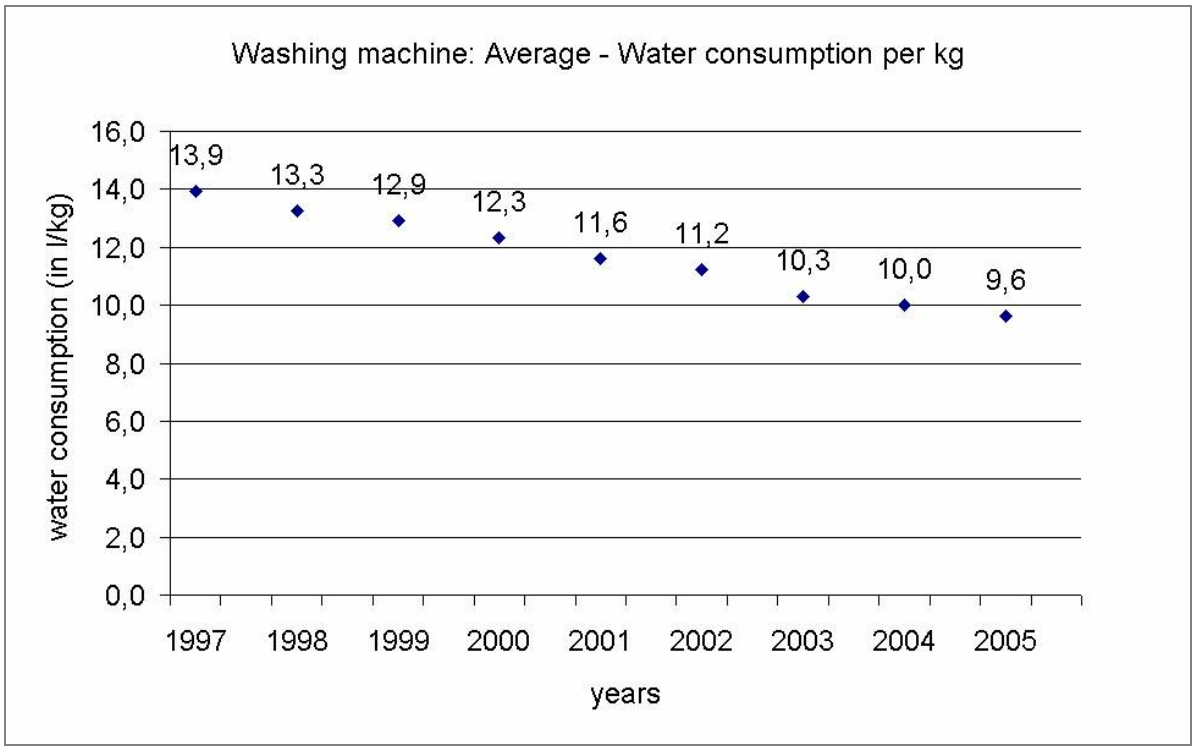


Figure 2.58: development of the average specific water consumption in washing machines

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.

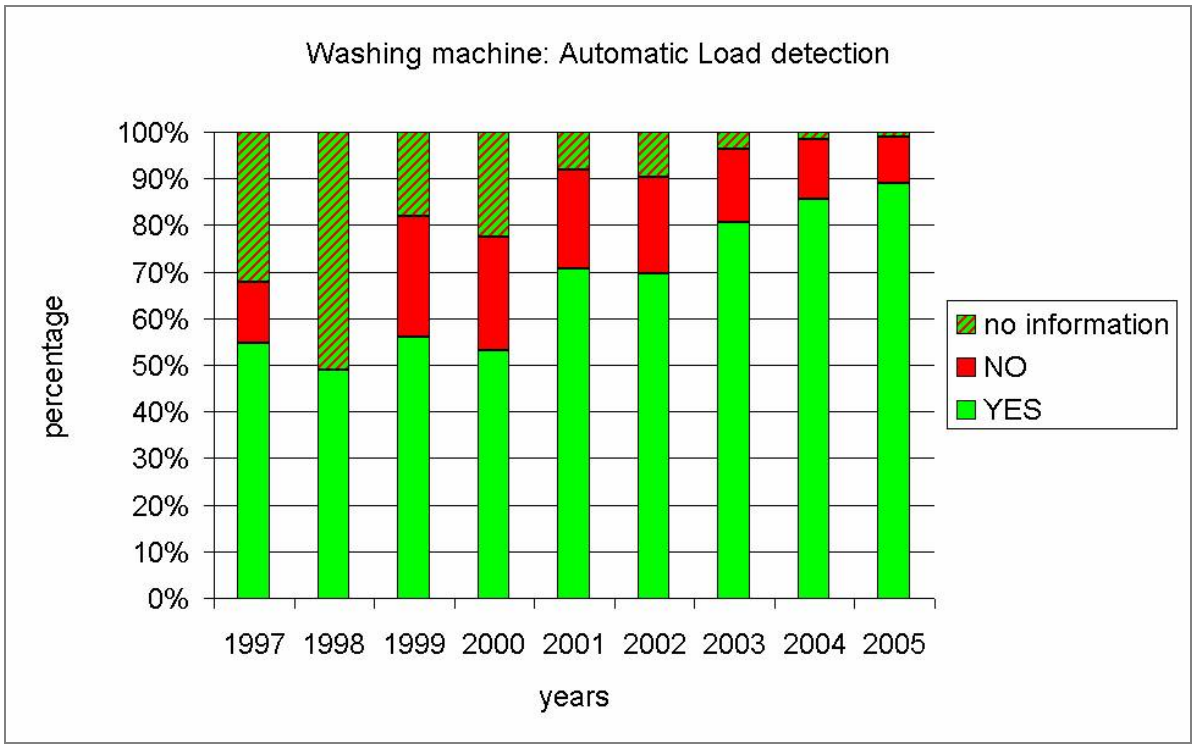


Figure 2.59: development of the automatic load detection in washing machines

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[31] 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.

[31] 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.

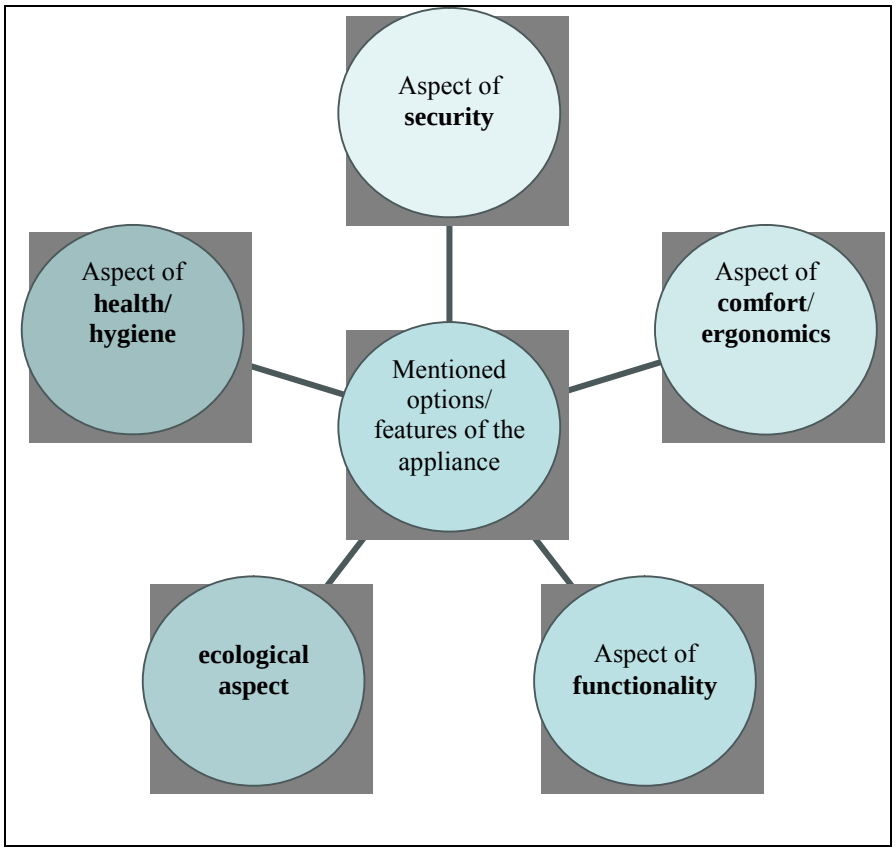


Figure 2.60: grouping criteria of the washing machines options

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.

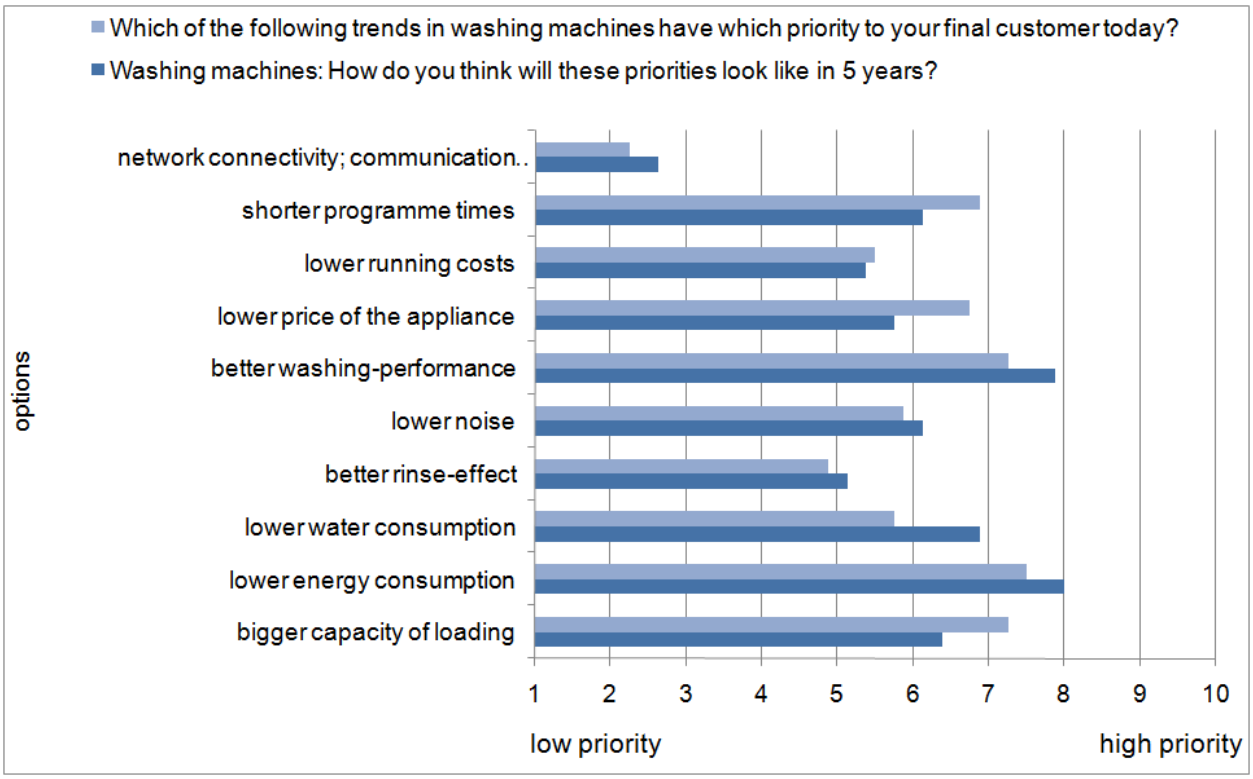


Figure 2.61: washing machines: priority ranking (comparison: today – future) asked to manufacturer

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 %

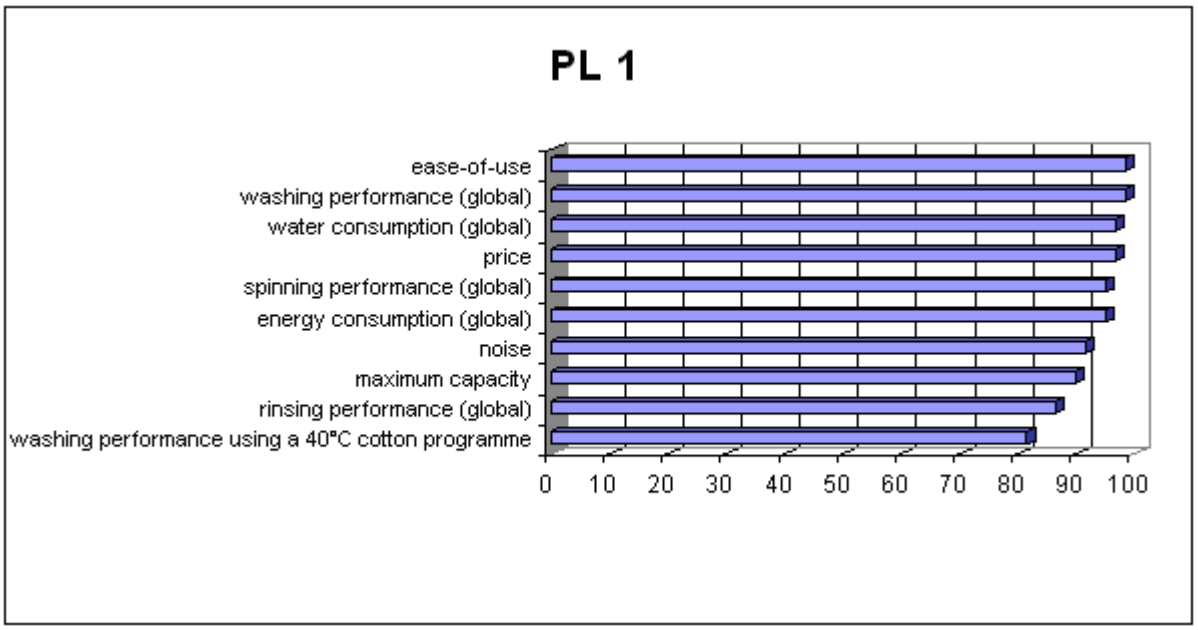


Figure 2.62: washing machines - priority level 1 (PL): frequency of the tested criteria

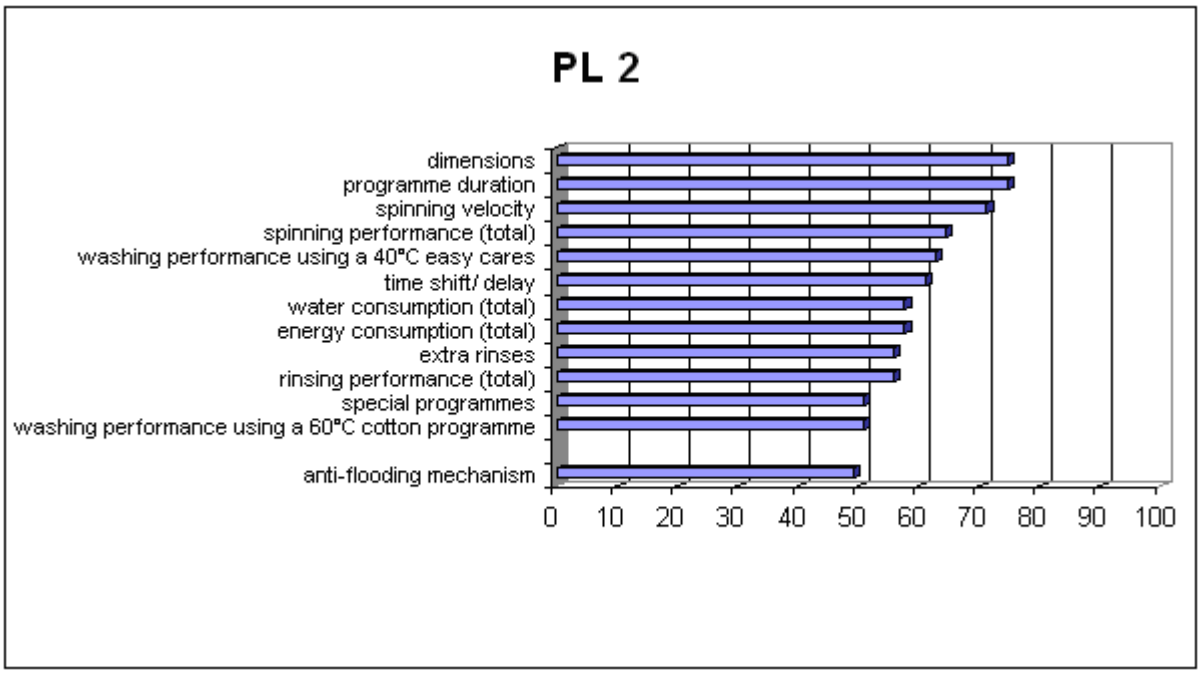


Figure 2.63: washing machines - priority level 2 (PL): frequency of the tested criteria

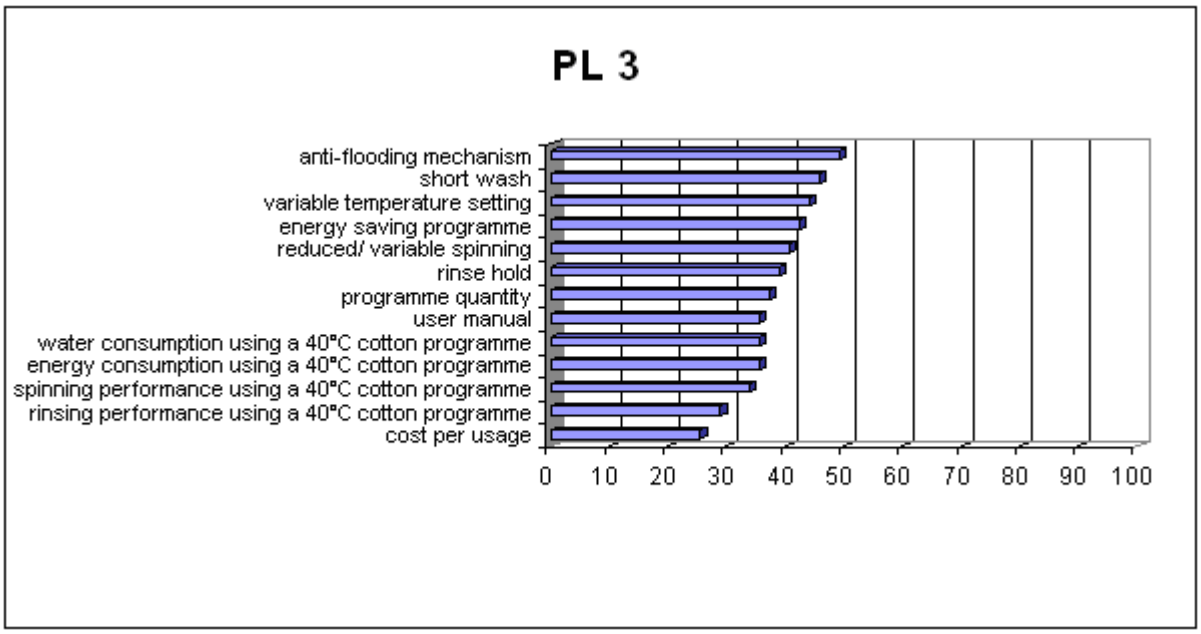


Figure 2.64: washing machines - priority level 3 (PL): frequency of the tested criteria

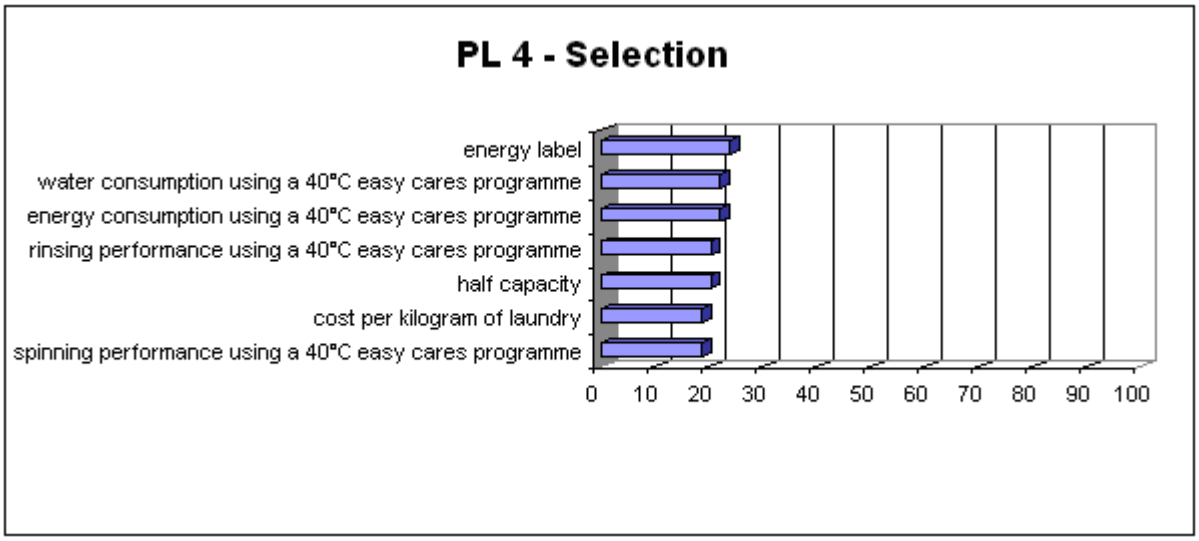


Figure 2.65: washing machines - priority level 4 (PL): frequency of the tested criteria

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*.

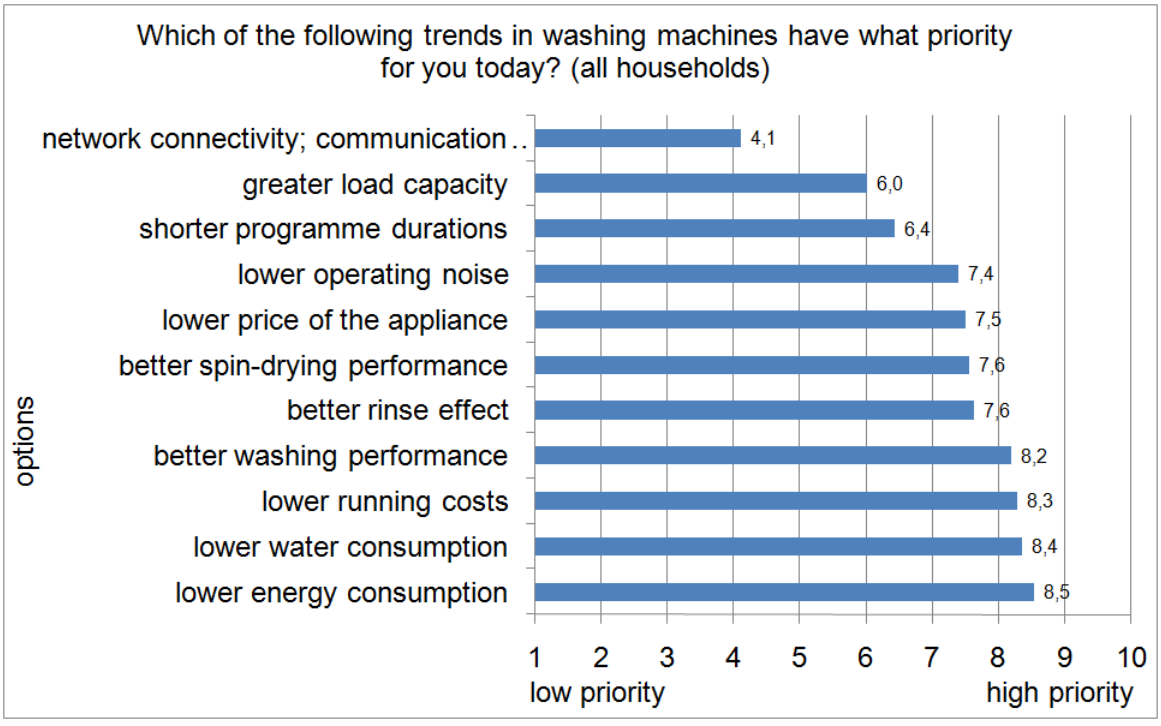


Figure 2.66: washing machines: ranking of appliance options by the consumer

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.

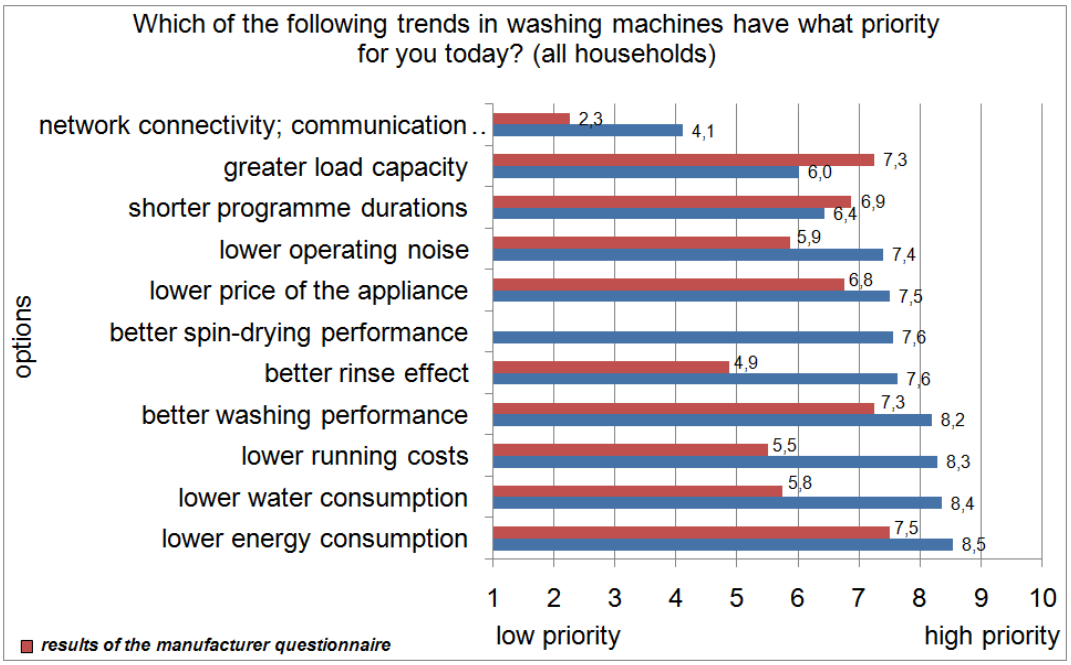


Figure 2.67: washing machines: ranking of appliance options (consumer vs. manufacturers)

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[32])

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:

[32] 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)[33])

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[34]

[33] 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[35]

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 [36] (Figure 2.72).

Poland

Only about 7 % of all Polish households had a dishwasher in the year 2005[37], 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).

[34] http://www.stat.fi/index_en.html)

[35] http://www.gifam.fr/pages/lemarche/lemarche.html

[36] 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

[37] 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[38])

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.

[38] 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[37])

	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[39]

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[40])

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[41], because of social-demographic changes, like more new young households and changes in consumer awareness[42].

[39] Fuente: National Statistics Institute www.ine.es

[40] 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

[41] 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).

[42] Source: http://www.statistics.gov.uk/cci/nugget.asp?id=868

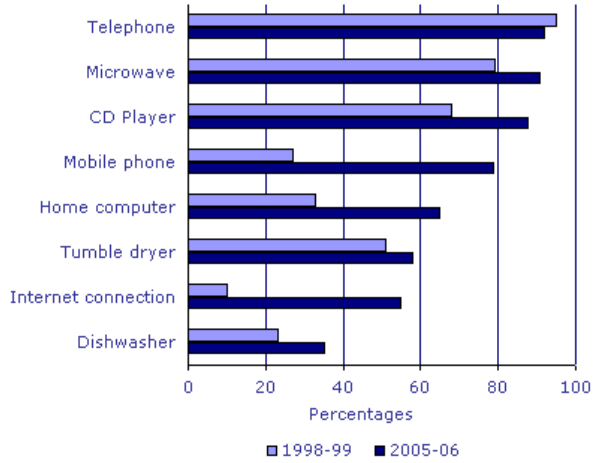


Figure 2.76: equipment of households, 1998-2006 (UK)

	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[43]

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[44]. Some studies, e.g. the Swiss SAMMER/WÜSTENHAGEN or

[43] Source: http://www.statistics.gov.uk/StatBase/ssdataset.asp?vlnk=7611&Pos=4&ColRank=1&Rank=272

[44] 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.

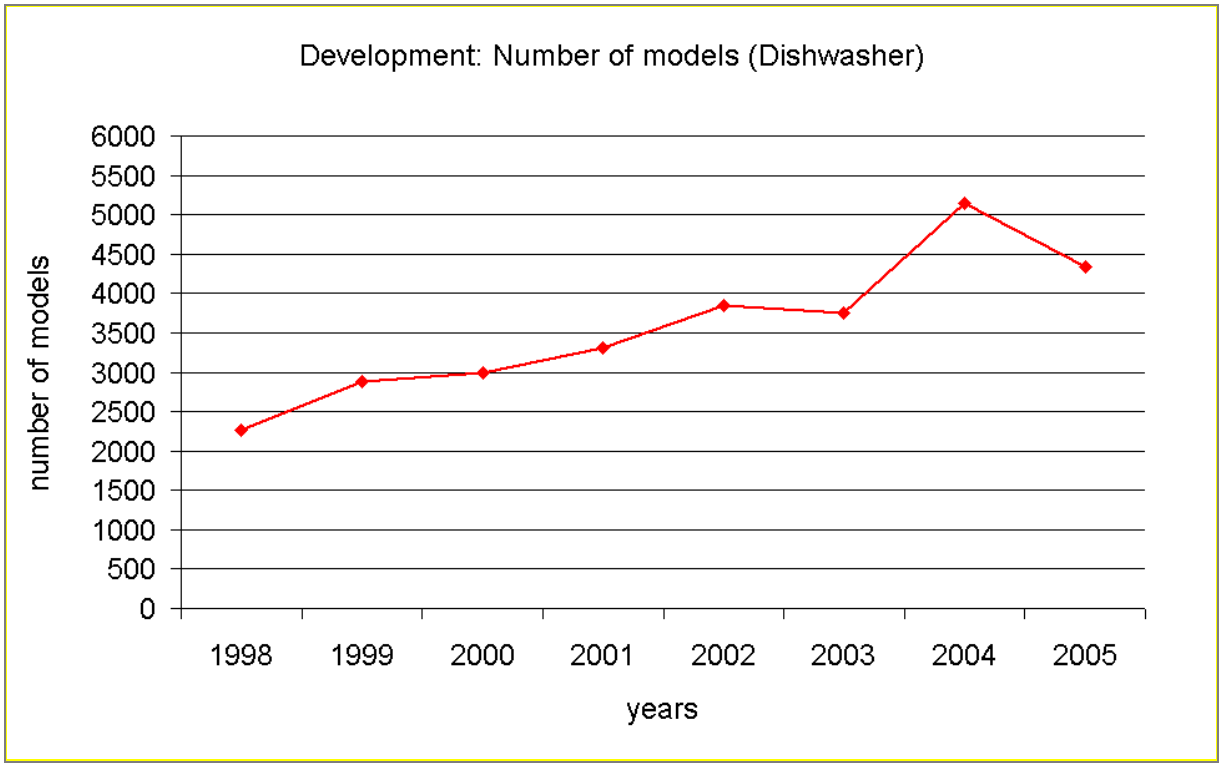


Figure 2.78: number of models in CECED database on dishwashers

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.

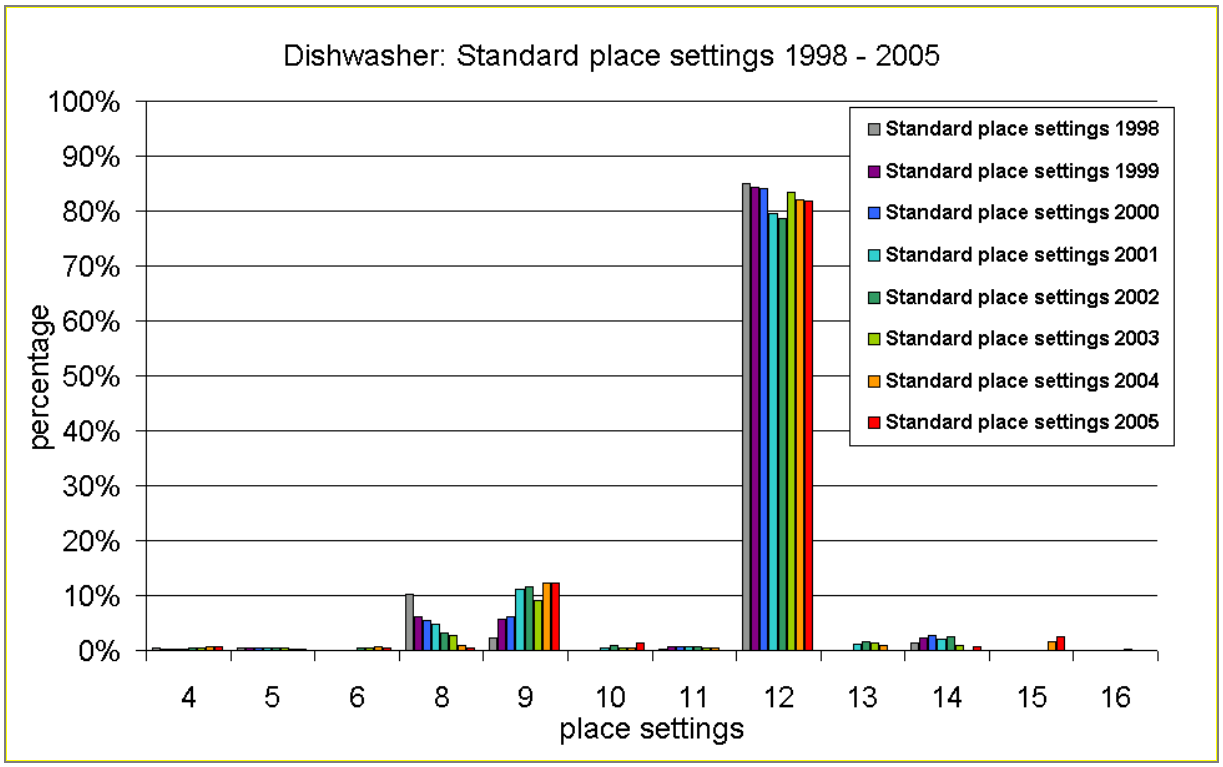


Figure 2.79: distribution of dishwasher models capacity in terms of place settings

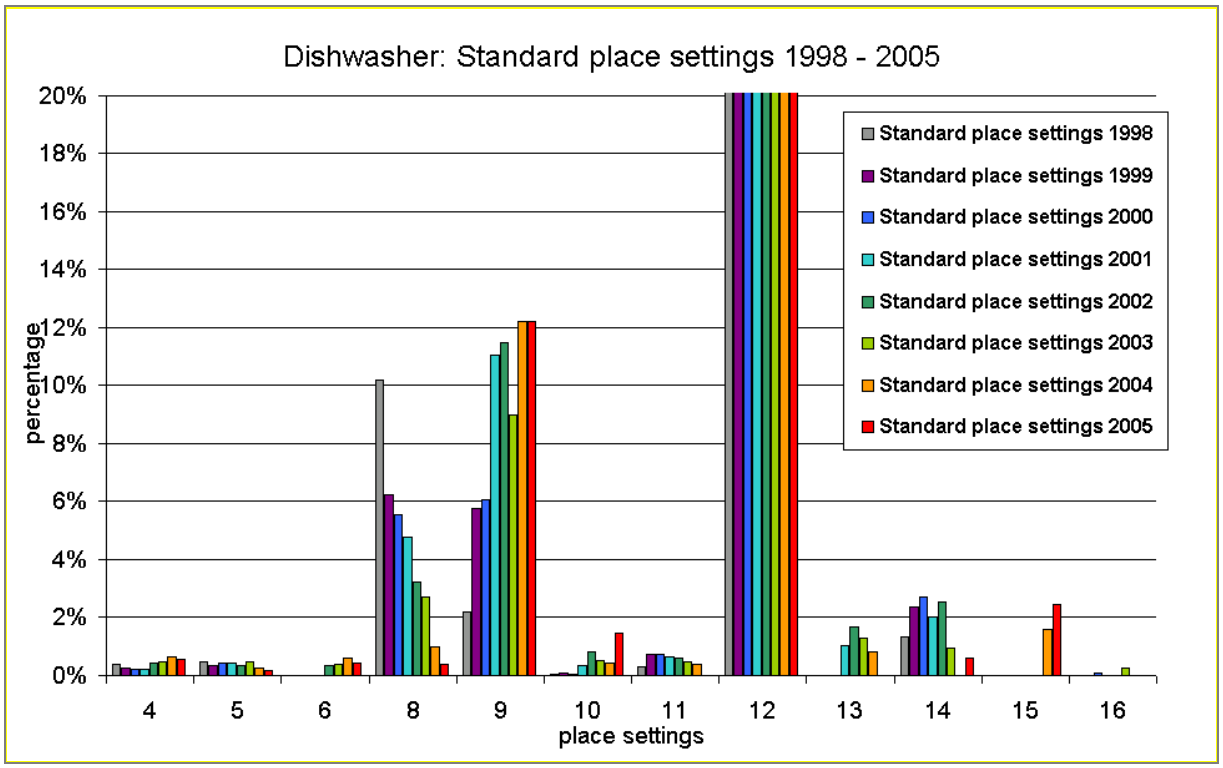


Figure 2.80: distribution of dishwasher models capacity in terms of place settings (ordinate enlarged)

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.

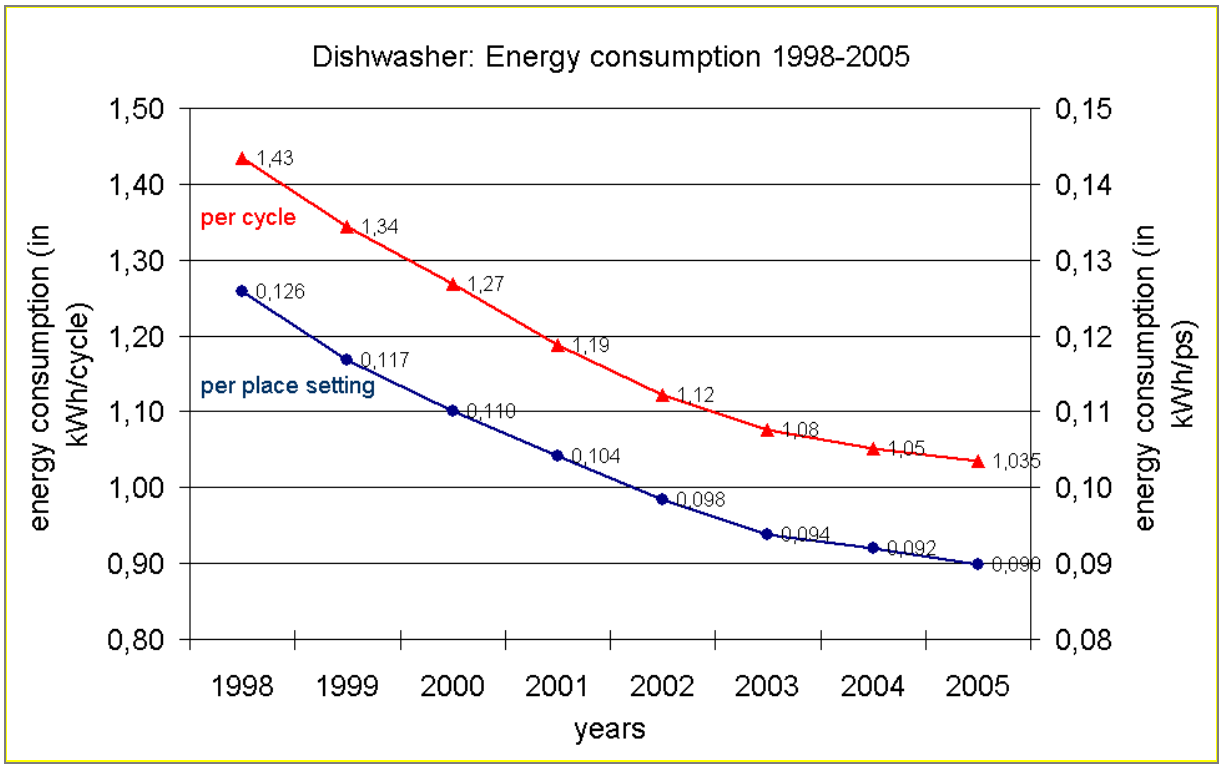


Figure 2.81: development of the average energy consumption per cycle and per place setting

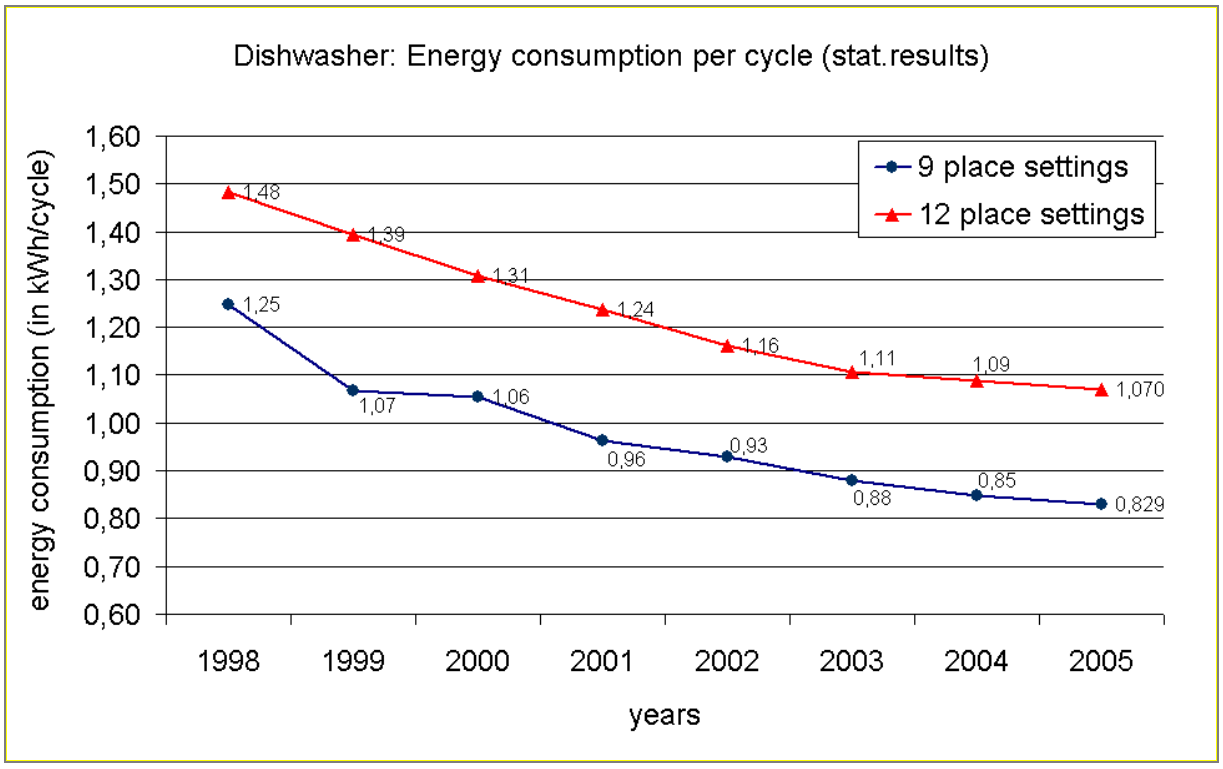


Figure 2.82: development of the average energy consumption for 9 and 12 place setting machines

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[45] (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.

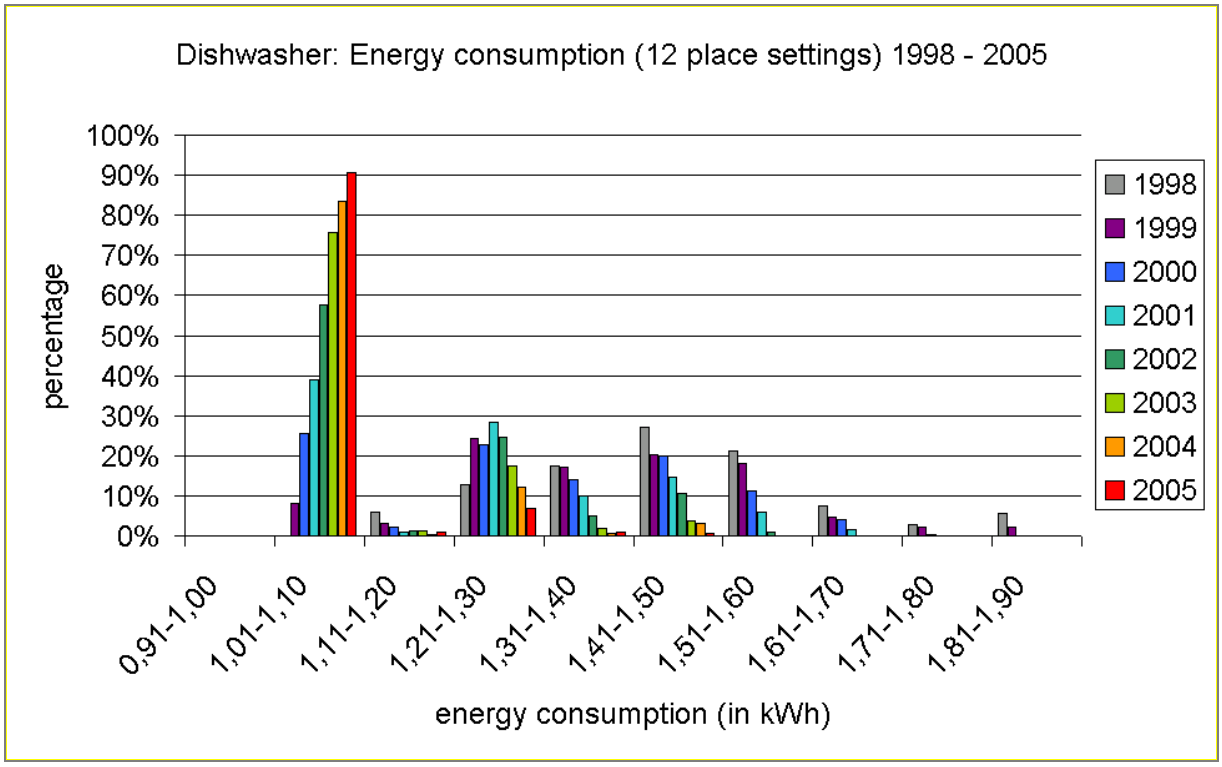


Figure 2.83: distribution of the energy consumption values for 12 place setting machines

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.

[45] "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

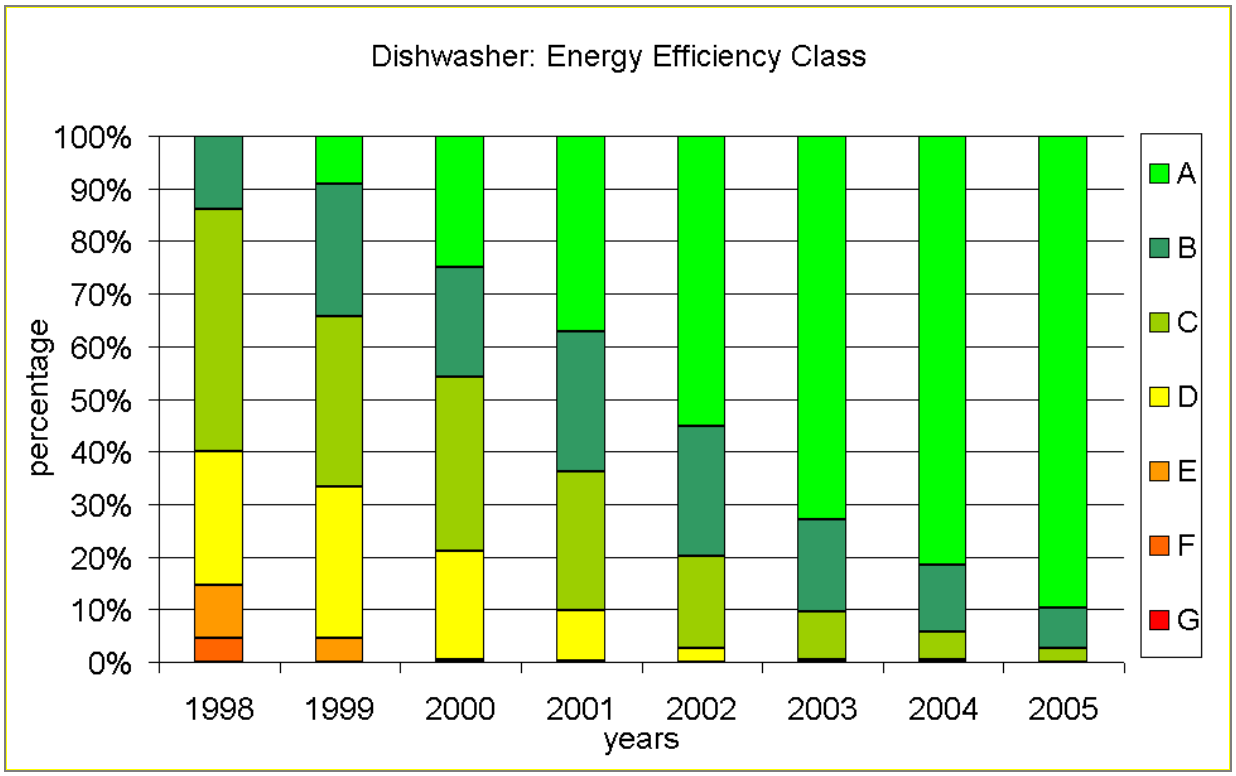


Figure 2.84: distribution of energy efficiency classes for dishwasher

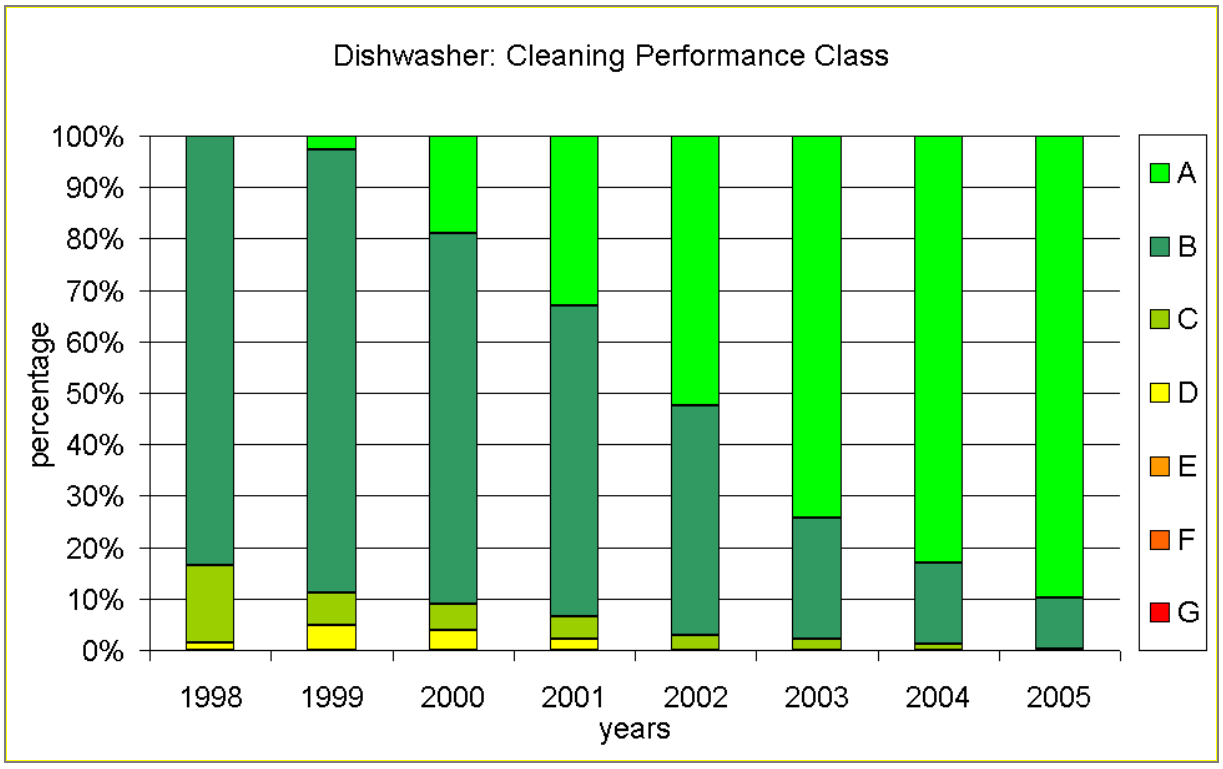


Figure 2.85: distribution of cleaning performance classes for dishwasher

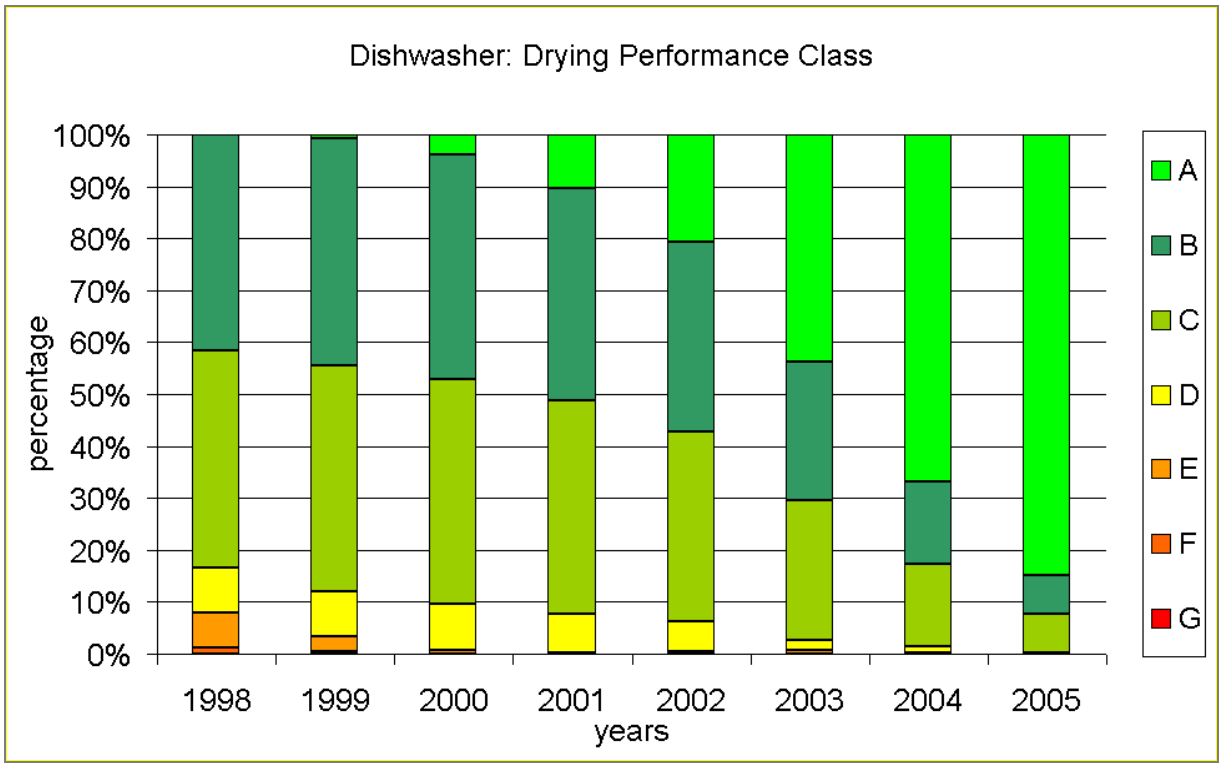


Figure 2.86: distribution of drying performance classes for dishwasher

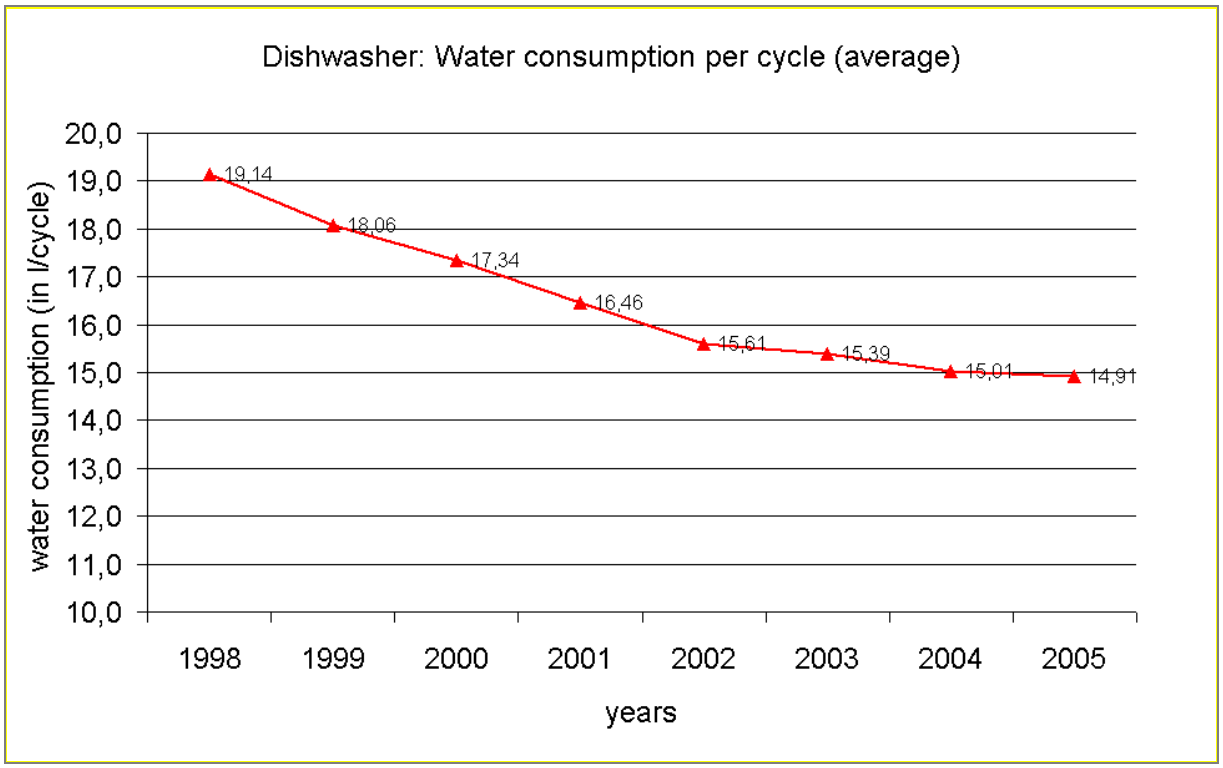


Figure 2.87: development of the average water consumption for dishwashers

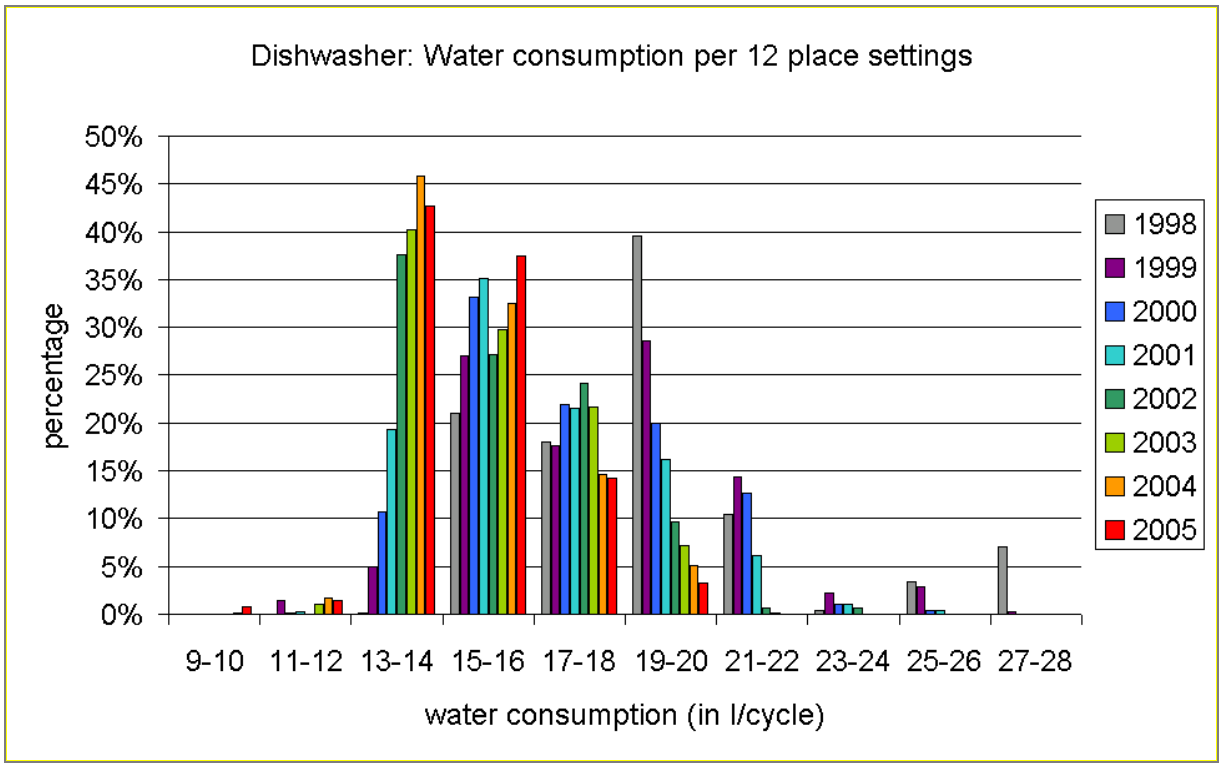


Figure 2.88: distribution of the water consumption for 12ps machines

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[46] 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

[46] 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.

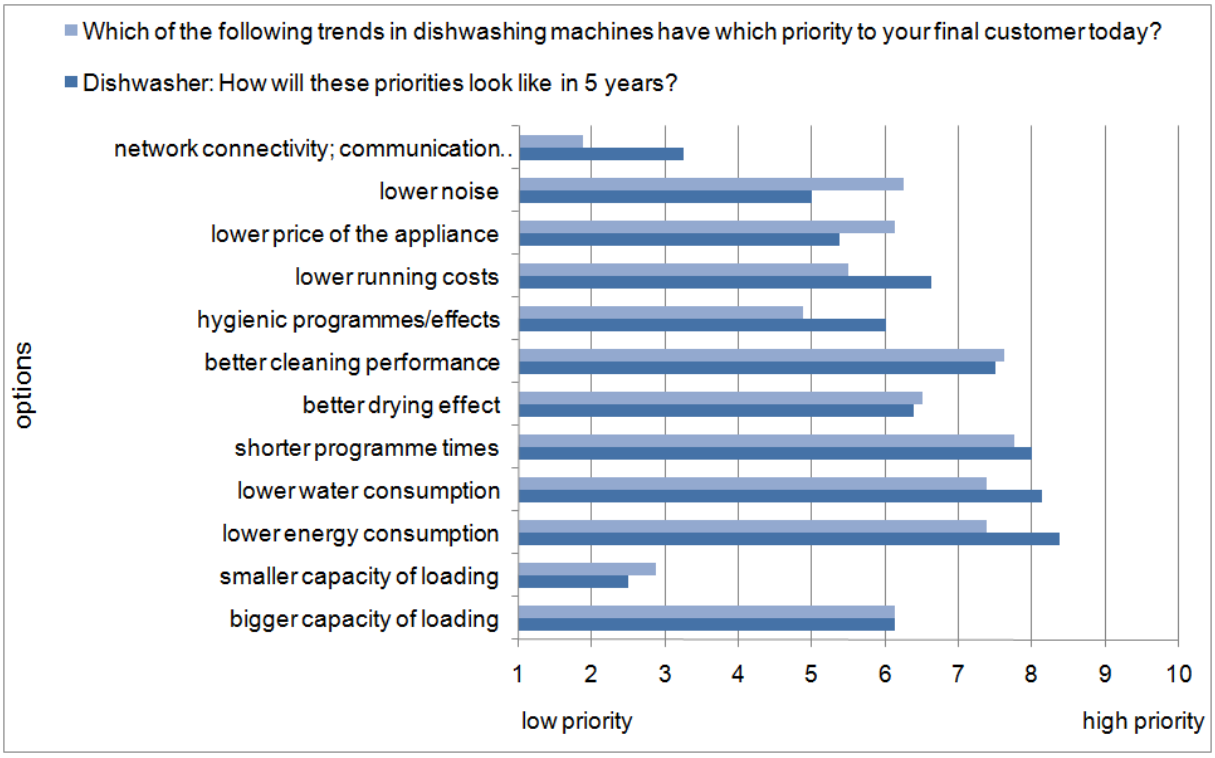


Figure 2.89: dishwasher: priority ranking (comparison: *today – future*) asked to manufacturers

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 %

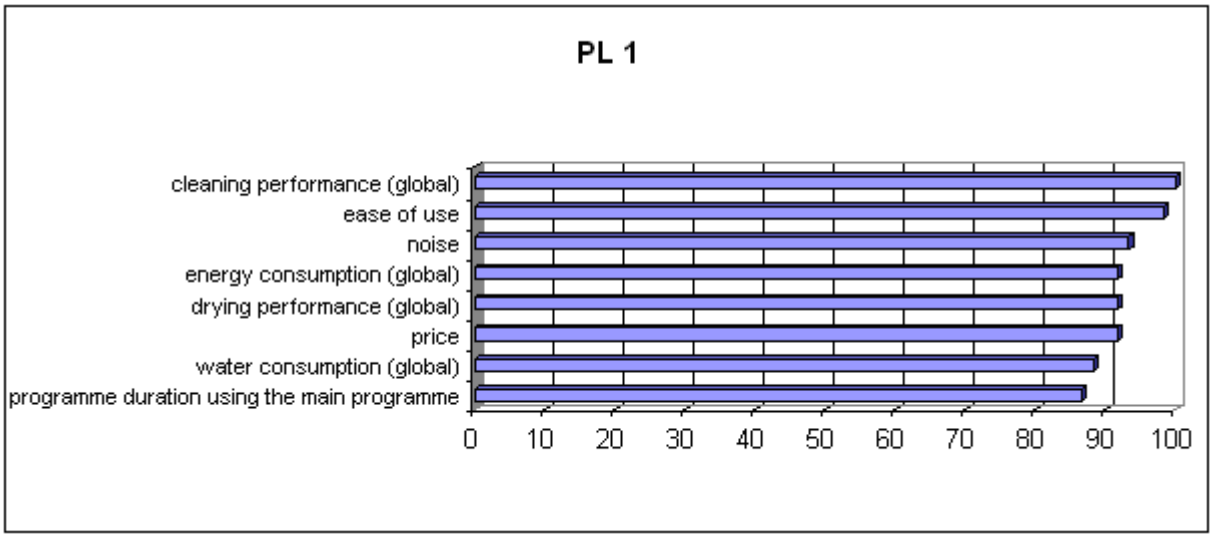


Figure 2.90: dishwasher - priority level 1 (PL): frequency of the tested criteria

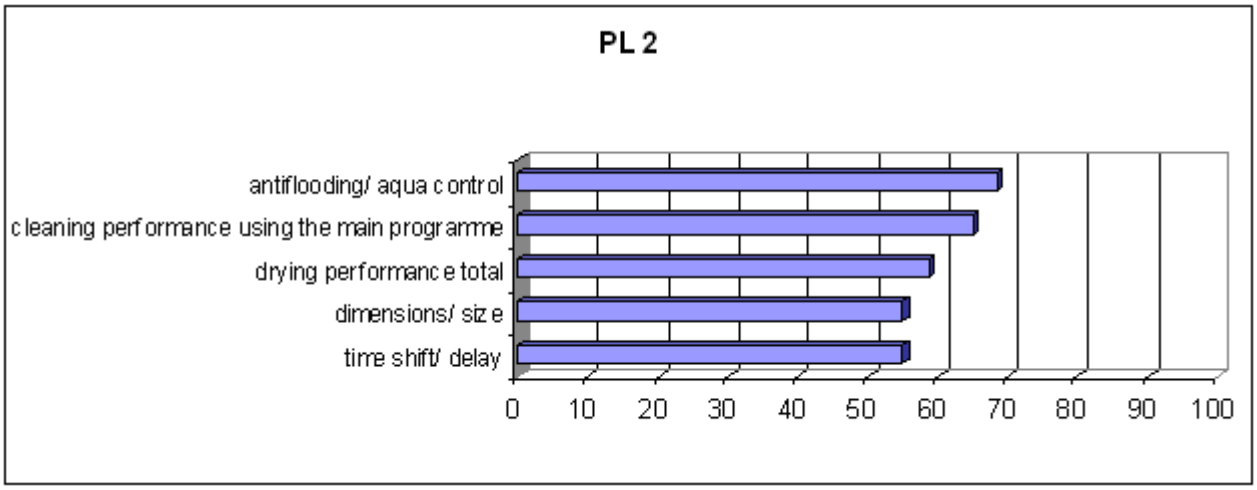


Figure 2.91: dishwasher - priority level 2 (PL): frequency of the tested criteria

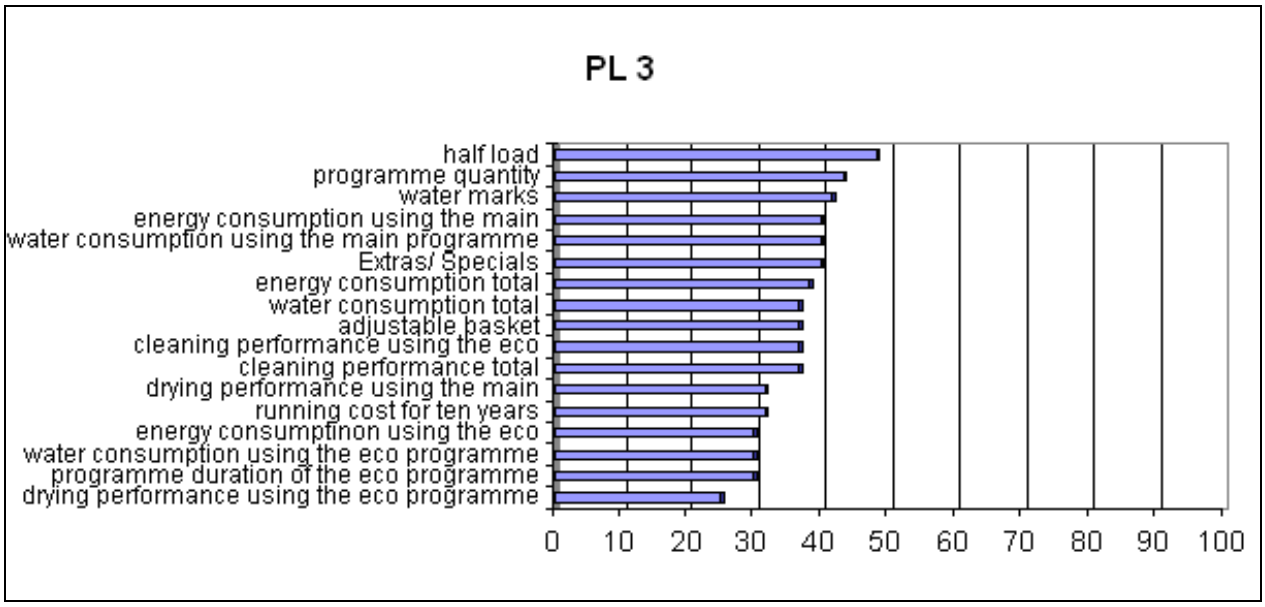


Figure 2.92: dishwasher - priority level 3 (PL): frequency of the tested criteria

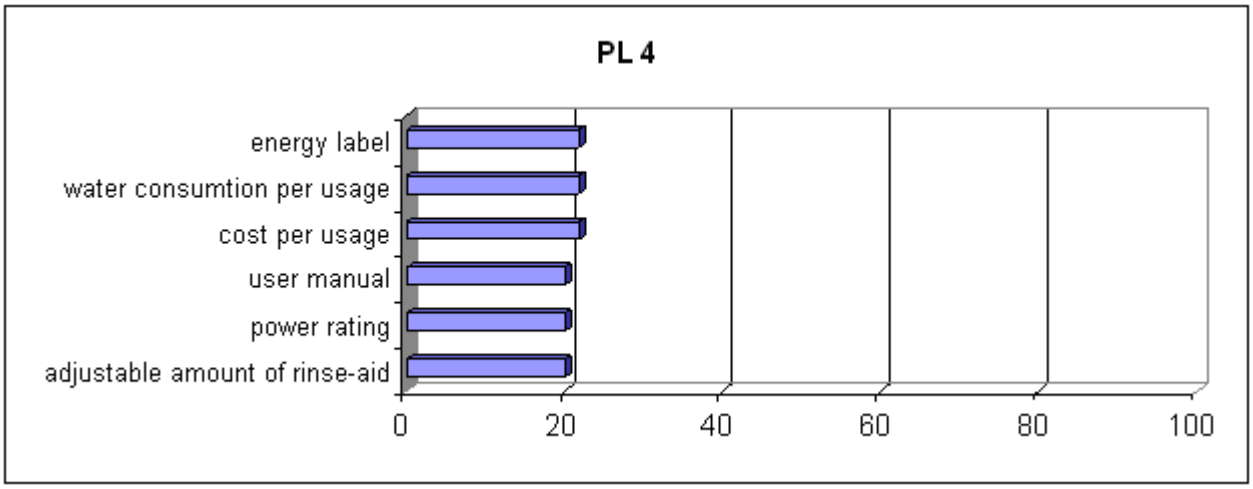


Figure 2.93: dishwasher – priority level 4 (PL): frequency of the tested criteria

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).

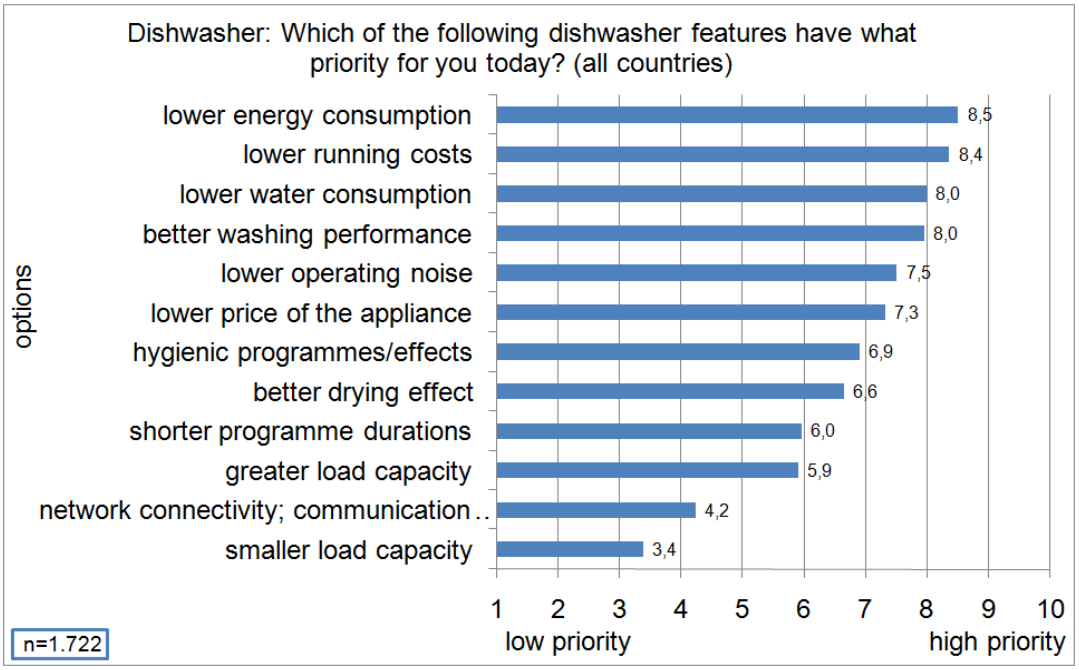


Figure 2.94: dishwasher: ranking of appliance options by the consumer

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.

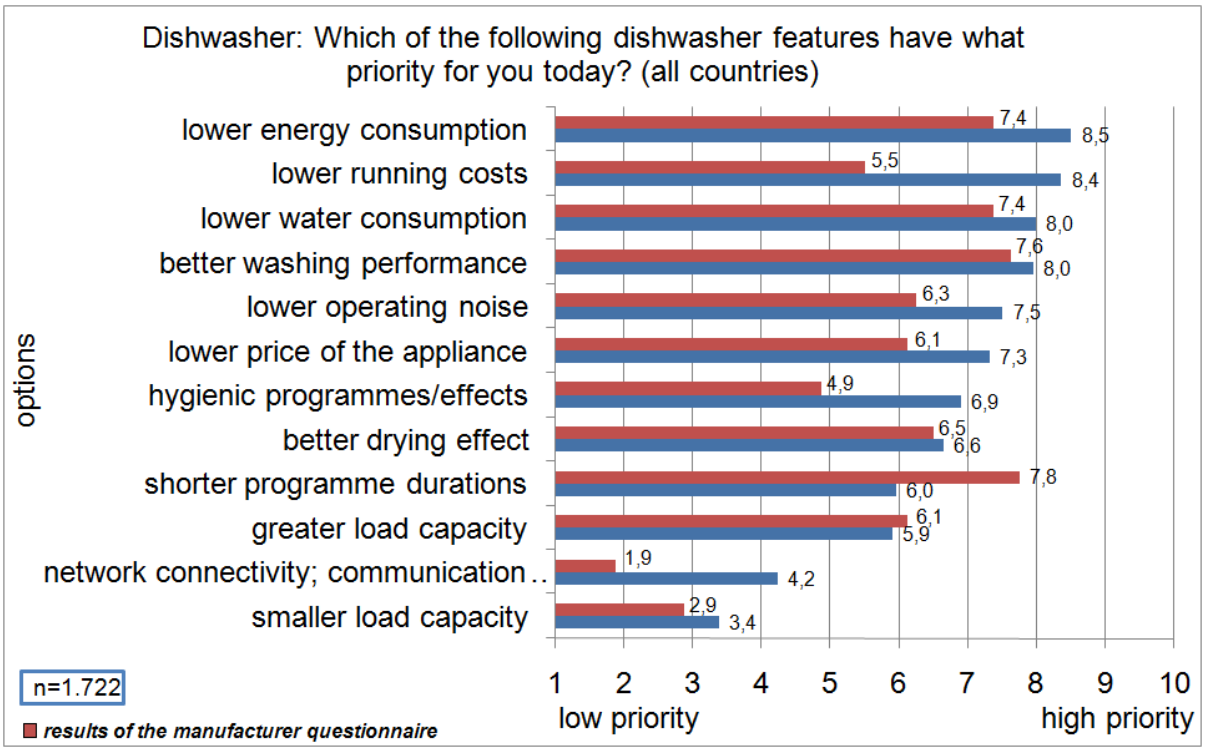


Figure 2.95: dishwasher: ranking of appliance options (consumer vs. manufacturers)

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.

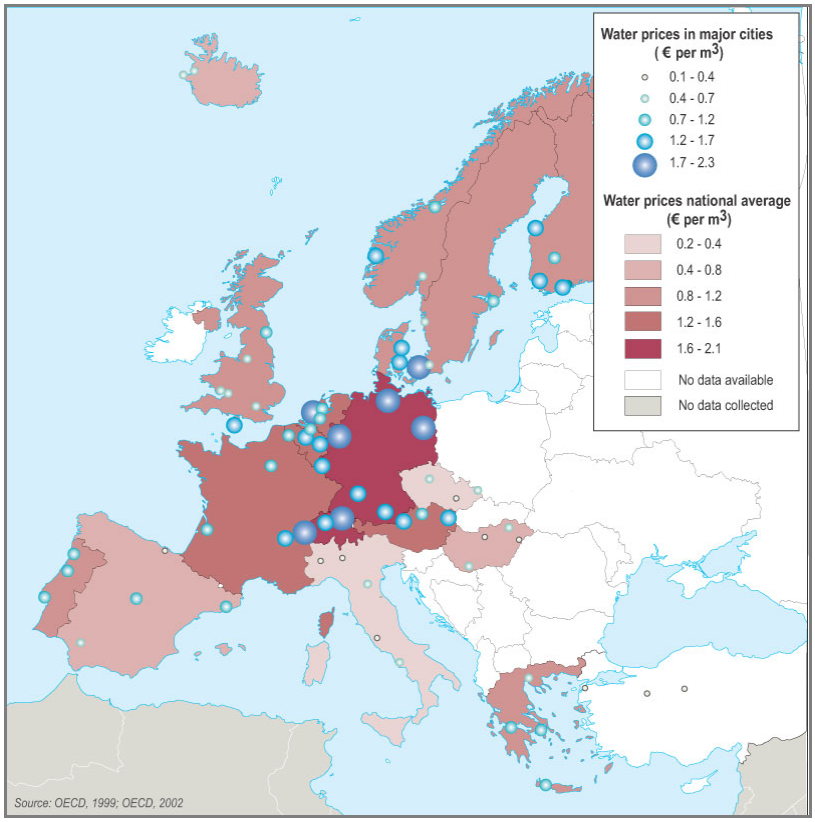
2.4 CONSUMER EXPENDITURE BASE DATA

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[47]

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					

[47] 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[48] 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[49], 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.

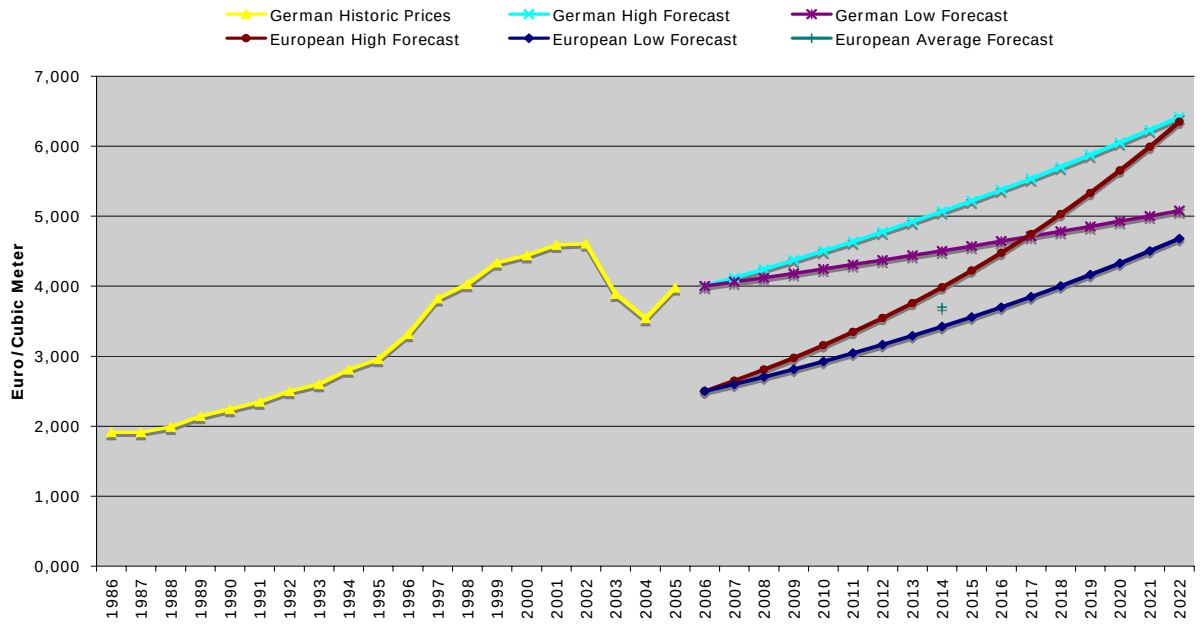
EU25 prices are believed to be much lower than the German average as most countries do not yet follow full cost pricing. It estimated that the European average price is currently about one-half the German value, or 2,5 Euro/m^3. This would be consistent with the cost data in Table 2. It will begin to catch up with the German complete full cost price; we hypothesize 6 % and 3 % annual high and low real growth rates as illustrated in

[48] Source: OECD 2006, Infrastructure to 2030: Telecom, Land Transport, Water and Electricity, ISBN 92-64-02398-4..

[49] Source: Stiftung Warentest and ZVEI Arbeitskreis Maschinelles Geschirrspülen.

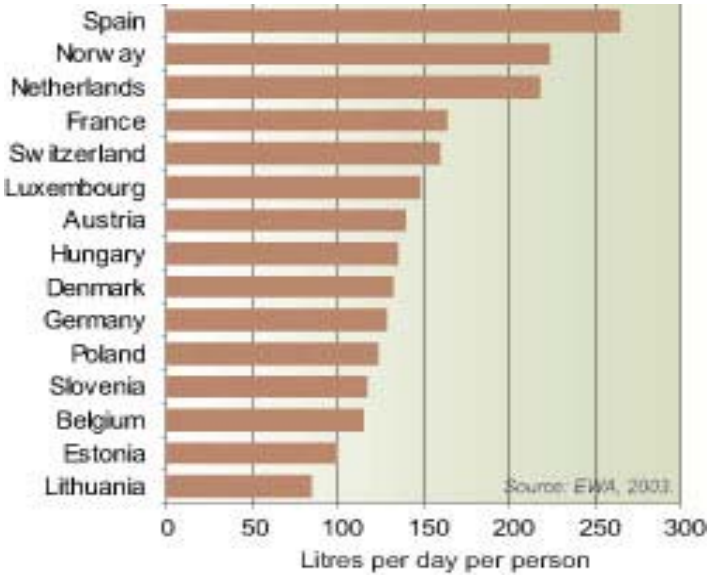
Figure 2.97. An average European household water plus sewage price of 3,7 Euro/m^3 is proposed for the study. Sensitivity analysis will be made around this value.

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



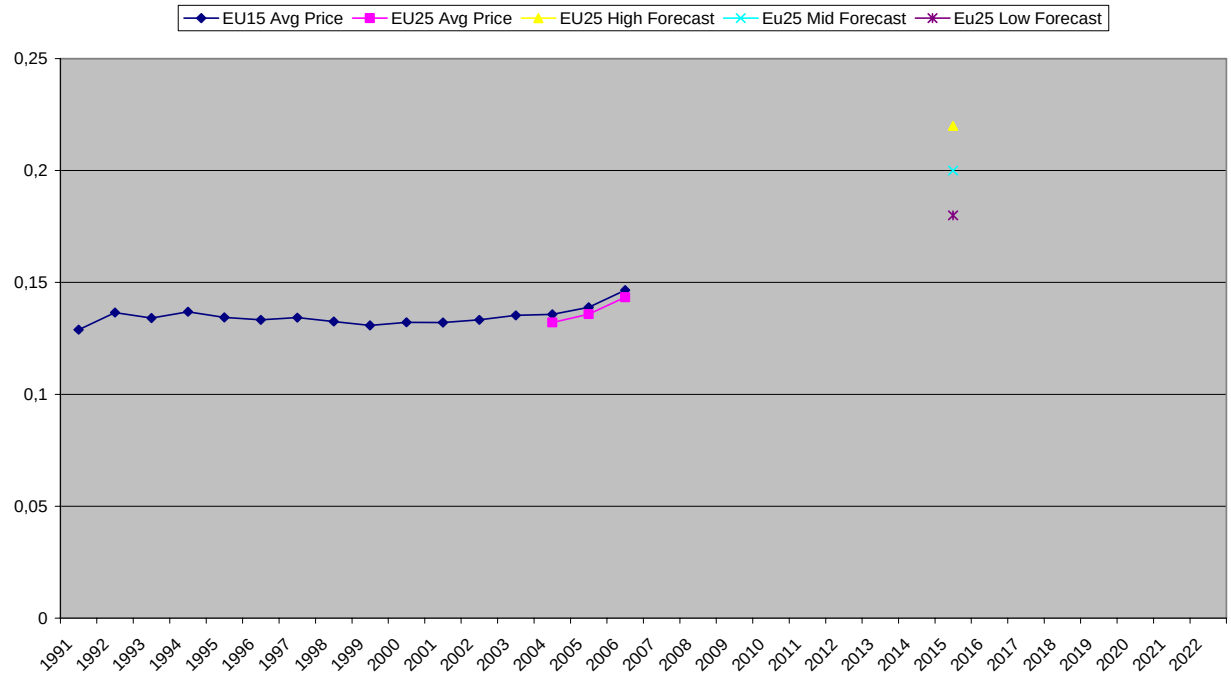
2.4.2 Electricity Prices

The evolution of the electricity prices including all taxes for the group EU15 and EU25 is shown in

Figure 2.99[50]. 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.

[50] Source: Eurostat, January 2007.

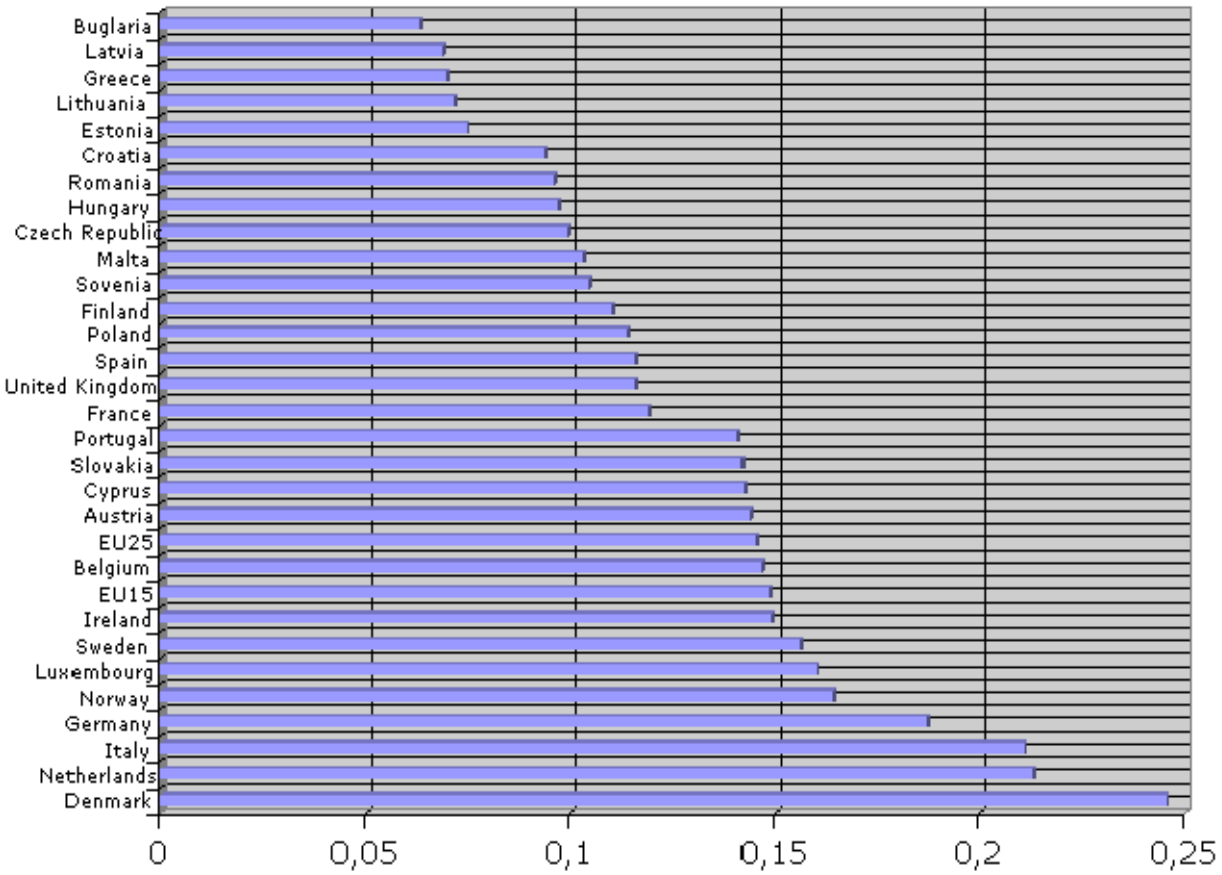
Figure 2.99: The evolution of the weighted average electricity prices including all taxes for EU15 and EU25



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 **Errore. L'origine riferimento non è stata trovata.** (page **Errore. Il segnalibro non è definito.**) of Task 1, 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.

$$\mathbf{P_{i+n} = P_i*(1+rate\ of\ inflation\%)^n *(1+real\ price\ growth\ rate\%)^n}$$

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

$$\mathbf{NPV=investment\ cost - Q\sum_{j=1,2...n} (P_0*(1+rate\ of\ inflation\%)^j *(1+real\ price\ growth\ rate\%)^j)/ ((1+rate\ of\ inflation\%)^j *(1+real\ cost\ of\ capital\%)^j)}$$

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:

$$\mathbf{NPV=investment\ cost - Q\sum_{j=1,2...n} (P_0 *(1+real\ price\ growth\ rate\%)^j)/(1+real\ cost\ of\ capital\%)^j}$$

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.