Preparatory Studies for Eco-design Requirements of EuPs

(Tender TREN/D1/40-2005)

LOT 14: Domestic Washing Machines & Dishwashers

Final Report

Draft Version

Tasks 3 -5

Lead contractor: ISIS

Contribution from

Ms Milena Presutto, ENEA	(Tasks 1 and 5.1)
Mr Rainer Stamminger, University of Bonn	(Tasks 2.3 and 3)
Mr Raffaele Scialdoni, ISIS	(Task 5.2 and 5.3)
Mr Wiliam Mebane, ISIS	(Task 2.4, 4 and 5.4)
Ms Rita Esposito, ISIS	(Task 2.1 and 2.2)

Project Leader: Stefano Faberi, ISIS

December 2007

Table of Contents

0 BRIEF SUMMARY OF THE STUDY TASKS 230

0.3 DESCRIPTION OF TASK 3 230

0.4 DESCRIPTION OF TASK 4 232

0.5 DESCRIPTION OF TASK 5 233

0.5.1 Subtask 5.1: Definition of Base Case for Washing Machines and Dishwashers 233

0.5.2 Subtask 5.2: Product-specific inputs 234

0.5.3 Subtask 5.3: Base Case Environmental Impact Assessment 236

0.5.4 Subtask 5.4: Base Case Life Cycle Cost 237

0.5.5 Subtask 5.5: EU Totals 237

0.5.6 Subtask 5.6: EU25 Total System Impact 238

3 TASK 3: CONSUMER BEHAVIOUR AND LOCAL INFRASTRUCTURE 239

3.1 DESCRIPTION OF TASK 3 239

3.2 THE BASIC CRITERIA AND GOALS OF THE CONSUMER SURVEY 240

3.3 THE GENERAL SURVEY RESULTS 243

3.3.1 Demography 243

3.3.2 Living conditions 244

3.3.3 The installed household appliances 249

3.3.4 The consumer opinion about "household appliances" 251

3.3.5 Identification of Possible Barriers to Eco-design Innovation 256

3.3.6 Consumer attitude towards energy saving options 267

3.3.7 The purchasing of a dishwasher 270

3.4 USER DEFINED PARAMETERS: WASHING MACHINES 273

3.4.1 Consumer behaviour and appliance energy consumption & saving 273

3.4.2 The results of the consumer behaviour questionnaire 284

3.5 USER DEFINED PARAMETERS: DISHWASHERS 295

3.5.1 Consumer behaviour and appliance energy consumption & saving 295

3.5.2 The results of the consumer behaviour questionnaire 301

3.6 ELEMENTS FOR THE COMPARISON OF REAL LIFE AND STANDARD CONDITIONS FOR WASH APPLIANCES 314

3.6.1 The laundry washing process 314

3.6.2 The dishwashing process 320

3.7 SUMMARY 325

3.7.1 Washing machines 325

3.7.2 Dishwashers 326

3.8 ANNEX 1 328

4 TASK 4: PRODUCT SYSTEM ANALYSIS 337

4.1 DESCRIPTION OF TASK 4 337

4.2 SYSTEM BOUNDARY 338

4.3 HOT TUB FILL 340

4.4 REAL CONSUMER USE OF WASHING MACHINES 340

4.4.1 Washing machine consumer behaviour 341

4.4.2 Energy and detergent tradeoffs in the choice of programme temperatures 341

4.4.3 Partial loading 343

4.4.4 Consumer needs and trends 345

4.4.5 Improvement in electricity peak loads 345

4.4.6 Spinning speed tradeoffs 346

4.4.7 Improved user/appliance interface 346

4.5 HAND WASHING OF DISHES 347

4.6 REAL CONSUMER USE OF DISHWASHERS 347

4.6.1 *Dishwasher real-life use* ... *347*
4.6.2 *Improvement in electricity peak loads* ... *348*
4.6.3 *Changing consumer needs and an improved user/appliance interface* ... *348*

4.7 CEDA EU25 PRODUCT AND ENVIRONMENTAL MODEL ... 349

5 TASK 5: DEFINITION OF BASE CASE ... 353

5.1 SUBTASK 5.1: DEFINITION OF BASE CASE ... 353
5.1.1 *The Standard Base Case for Dishwashers* ... *353*
5.1.2 *The Standard Base Case for Washing machines* ... *366*
5.1.3 *The Real Life Base Case for Dishwashers* ... *381*
5.1.4 *The Real Life Base Case for Washing Machines* ... *383*

5.2 SUBTASK 5.2: PRODUCT-SPECIFIC INPUTS ... 386
5.2.1 *The Selection of Real Models for Data Collection* ... *386*
5.2.2 *The BOM and Inventory Data Collection* ... *388*

5.3 SUBTASK 5.3: BASE CASE ENVIRONMENTAL IMPACT ASSESSMENT ... 391
5.3.1 *Considerations and Assumptions to use the inventory data in EuP-Ecoreport* ... *391*
5.3.2 *LCA of wash appliance base cases using EuP-Ecoreport* ... *393*
5.3.3 *Preliminary conclusions and remarks* ... *393*
5.3.4 *SimaPro analysis results and comparison with the EUP Ecoreport outputs* ... *401*

5.4 SUBTASK 5.4: BASE CASE LIFE CYCLE COST ... 409
5.4.1 *Base case LCC for Dishwashers* ... *409*
5.4.2 *Base case LCC for Washing Machines* ... *410*

5.5 SUBTASK 5.5: EU TOTALS ... 411

Appendix A: Life Cycle Inventory data ... 416

Appendix B: EuP-Ecoreport data ... 422

Appendix C: SIMA-PRO output ... 431

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

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

0 Brief summary of the Study Tasks

A summary of the tasks included in this second part of the interim report on the wash appliances study (tasks 3-5) is outlined in the following paragraphs

0.3 DESCRIPTION OF TASK 3

The behaviour of the consumer with household appliances influences the environmental impact because of the usage of resources like water and/or energy and/or chemicals.

An extensive consumer survey (almost 2 500 households interviewed from ten European countries) was developed to identify the “real life” consumer behaviour when using/handling household appliances, especially washing machines and dishwashers, and to evaluate the differences between the standard and the real life conditions affecting the impact of the appliances, including their effect on the energy and water consumption.

The participants are also were asked about their opinion about energy saving issues in general and infrastructural options in particular.

In European households washing machines are available in almost 100% of the households (not necessarily in the own apartment), while dishwashers ownership is lower, going from households without the dishwasher to more than 60%. But since these appliances remain in the household for normally ten years and more, their energy/water consumption and performance is as it was at the time of the production. Eco-design improvements will therefore take more than ten years to get fully implemented in the market. This time is even longer when second-hand appliances are used. As the survey has shown, the second-hand models account for only a minor share of the market.

Consumers asked about the relative influence of **washing machines** on the total energy consumption of a household considered this appliance as the most energy using product. This is associated with a high level of willingness to use energy saving options.

Consumer behaviour has been identified as being the main source of influence on the actual energy consumption and environmental impact on the washing process. In particular:

- the average nominal washing temperature is 45,8 °C and the most frequently used programme is at 40 °C (including all programmes for wool, silk, synthetics, etc),
- nevertheless, the cotton 60°C programme is still the most frequently used programme and consumes more energy than a cotton 40 °C programme
- the average wash frequency is 4,9 cycles per week,
- most consumers normally use the full loading capacity of their washing machine, but it is agreed that this does not mean that the rated capacity is really used,
- delay start options are only used in approximately 8% of the cycles with a shift of the washing starting time by an average of 3 hours (no reason could be identified for this delay)
- at programme end the machine may stay in this mode in about 50% of the cases for an average of 3 hours. Afterwards in about 90% of the cases the machine is switched off.

This information about the consumer behaviour and recent data on the energy consumption allow us to estimate the average energy and water consumption of laundry washing per household per week: for an average household size of 2,9 people using the average 2005 washing machine model under real life conditions the energy consumption is 3,5 kWh and the water consumption 230 litres. This is 28% less energy consumption than the same number of cycles calculated for a machine operated under standard conditions. The difference is mainly due to the lower average temperature of the wash programmes as well as by the effect of under-loading the machine.

Nevertheless it should be highlighted that the use of the washing machine at the rated capacity would increase the washing energy efficiency and would reduce the energy consumption. The difference of the water consumption under real life and standard conditions is 9 %.

Standby and other low power modes have been estimated to contribute on average between 4 and 8 percent of the real life energy consumption. These figures may be higher if consumers do not switch off the washing machine after unloading; showing again that the individual consumer behaviour has a major influence on the amount of energy and water used in the specific household.

Therefore consumer training and education is a very important element for the further decrease of the energy and/or water and/or chemicals consumption in real life. The second element to be taken into consideration is that the definition of measurement methods in the European standards should be made more in line with the consumer real life behaviour.

Consumers asked about the relative influence of **dishwashers** on the total energy consumption of a household considered this appliance as having as moderate to great impact. This is associated with a high level of willingness to use energy saving options.

The manual dishwashing process done in all households that do not own a dishwasher causes – on average – a higher consumption of energy and water. But also households owning a dishwasher do manual dishwashing for some part of their tableware and even some of the items are then loaded into a dishwasher and undergo a pre-cleaning process. This last process of manual dishwashing is closely linked to the automatic dishwashing process but it is not requested by dishwasher manufacturers and could be avoided through correct information provided to the consumers. It was initially considered in the shown calculation as an additional consumption under real life conditions for the dishwashers. All other consumption related with manual dishwashing is not considered, but may be higher than those of the automatic dishwashing machine.

Consumers asked about the relative influence of **dishwashers** on the total energy consumption of a household considered this appliance to have a moderate to great impact: for nearly 15% of the consumers the high energy and water consumption is an element against the purchasing of a dishwasher. This opinion is more important in those countries where the penetration of the dishwasher is lower. Another negative element (for nearly 23,5% of the consumers) is the initial purchasing price. In general there is also a high level of willingness in using energy saving options in automatic dishwashing.

Consumer behaviour has been identified as having a high influence on the energy and water consumption of the automatic dishwashing process under real life conditions. It is shown, that

- the average dishwashing temperature is at a nominal temperature of 59,3 °C and the most frequently used programme, followed by eco- and automatic programmes
- the average automatic dishwashing frequency is at 4,1 cycles per week
- most consumer are using normally the full loading capacity of their dishwasher, but it is not known if this means that the rated capacity is used
- delay start function is only used in approximately 10% of the cycles with an average shift of 3 hours (it was not identified for what reason this shifting is done)
- at programme end the machine may stay in this mode in about 50% of the cases for an average of 3 hours. Afterwards in about 70% of the cases the machine is switched off.

All the information about the consumer behaviour and the recent data on the energy consumption allows estimation of the average energy and water consumption per household per week: for an average household size of 2,9 people using the average 2005 dishwasher model under real life conditions, the amount of electricity used for automatic dishwashing is at 5,63 kWh and the amount of water is at 86 litres, when the manual pre-rinsing is included. It is 4,88 kWh and 63 litres when pre-rinsing is not considered. This is 29,4% higher in electricity than when calculated under standard conditions, which is reduced to +12,2% when the pre-rinsing is not taken into account. Main differences are caused by the high average (nominal) temperature of the programmes used as well as by the additional energy consumption for the manual pre-rinsing of the dishes.

Nevertheless, it should be highlighted that the use of the dishwasher at the rated capacity would increase the automatic dishwashing energy efficiency and would reduce the energy consumption.

The water consumption under real life is 39% higher than under standard conditions when the manual pre-rinsing is considered, and almost the same if the latter is not taken into account.

Standby and other low power modes have been estimated to contribute on average between 3 and 10% of the real life energy consumption. These figures may be higher if consumers do not switch off the dishwasher after unloading; showing again that the individual consumer behaviour has a major influence on the amount of energy and water used in the specific household.

These figures may be higher if consumer do not switch off the machine after unloading, showing again, that the individual consumer behaviour has a major influence on the amount of energy and water used in the individual case.

Therefore consumer training and education is a very important element for the further decrease of the energy and water consumption in real life. The second element to be taken into consideration is that the definition of measurement methods in the European standards should be more in line with the consumer real life behaviour.

0.4 DESCRIPTION OF TASK 4

The Eco-design Directive is clearly on product design and does not regulate systems or installations as a whole. However, Annex VII.4 of the directive looks into the interaction of the EuP with the installation/system in which it operates and implies that the possible effects of the EuP being part of a larger system are to be identified and evaluated. This task includes therefore a functional analysis of the system to which the product belongs, including a rough estimate of the overall impacts, for example from IPP studies like EIPRO and an assessment of how the integration of the product into the system and its design can improve its overall environmental performance.

Hot fill options, with a second input for hot water, will be examined from the technical and economic point of view. To date, except for the possibility of a small niche market, the economics for a general EU27 market appear to be discouraging. This is due to the high cost of installation in most houses and extra costs of the price increase, with no offsetting benefits, for great majority of non-users.

While dishwashers and washing machines do not have a strong impact on the immediate installation system within the house, they can have an important impact on the electricity production and distribution system by utilizing off-peak hours of electricity primarily during the night.

The machines will have to be modified to be more silent and to have a timer or other device to permit use of off-peak electricity. These modifications will be made in the design phase and included as options in Tasks 6.1 and 6.2.

The purpose of this Task is thus to simulate the environmental impact with the CEDA EU25 (product and environmental) input output model, for the normal use of electricity and for the off-peak hour use of electricity of the improved machines. Unfortunately in input output model the dishwasher is not given as a separate product or service and thus cannot be modelled. Instead washing machines are included, also as the service, 'washing with household laundry equipment,' CEDA code 540300 and will be studied.

It is also important to make the comparison with the bottom-up LCC (including environmental impact) method and top-down input output approach. Thus the inputs to the two methods should be same. Namely, the number of base case models and other models sold in year 2005 that is total models sold estimated in the bottom up approach should be the same as that used in the input output model. Of course the input output method will use the monetary value, or the number of models times the average price. Likewise the total amount of electricity required in 2005 for washing should be the same in both the input output and bottom-up approach.

The comparison of these results is should give us a better understanding of the two different methods. The primary difference should be due to the fact that the input output approach includes a more complete accounting for secondary input requirements, such the capital goods required to make the steel used in electricity production and in the production of washing machines etc. Another source of difference will be the use of slightly different environmental impact coefficients no doubt.

One of the most interesting aspects of comparison will include the modelling of the impact of the use of off-peak electricity. A hypothesis of increased off-peak load will be made compatible with the situation of the new sales and existing stock that could have timers and be relatively silent. The first aspect of the new simulation will be to change the electricity product mix part of the input output table in favour of a base load and less off-peak electricity. The second aspect is more complicated, and after an analysis of the literature, lower investments in capital goods will be introduced for electricity generation and distribution. This is due to the higher degree of utilization made possible by the load shifting.

At this point the two simulations of the CEDA EU25 input output model will be performed one with the normal load and one with the load optimizing. The environmental impacts for 'washing with household laundry equipment,' CEDA code 540300, will be compared and discussed. Sensitivity analysis will also be performed. In the simulation with CEDA EU25, a minimum amount of support by the authors or the EC will be required.

0.5 DESCRIPTION OF TASK 5

0.5.1 Subtask 5.1: Definition of Base Case for Washing Machines and Dishwashers

One or two average EU product(s) for the representative product category will be defined as the "Base case" for the whole of the EU25 for the two appliance types.

A "Standard Base Case" and "Real Life Base Case" will be defined. The base case is the average washing machine/dishwasher on the European market, where:

- the "Standard Base Case" (STBC) is defined according to the standard consumer behaviour (in terms of washing temperature, amount of load/place settings, number of cycles/year, etc.) as defined in measurement standards or in EU legislation;
- the "Real Life Base Case" (RLBC) is defined according to the actual average consumer behaviour, which can significantly differ from the standardised definition.

The selection of base case models will be done on the basis of the analysis of the latest technical database developed by CECED. CECED database have been developed since 1997 for washing machines and 1999 for dishwashers, and are regularly presented to the EC and the Regulatory Committee responsible for the management of the EU energy labelling scheme. Technical databases include the parameters declared for the energy labelling directives for the two product types.

The selection of the reference model(s) will be mainly based on the analysis of the energy and water consumption and of functional performance classification. The energy consumption characteristics of the models will be expressed through their actual consumption values in kWh/kg_cycle or kWh/place setting (first choice) or with their energy efficiency class.

The database analysis will result in the identification of a *virtual average* reference model (or more than one) for each appliance group. This model will be then compared with the real models in the database: the models close to the "virtual average" could be considered as participating in the composition of the average itself, both in terms of technical characteristics and relevant brands & manufacturers. The technical characteristics of the selected real models will be averaged to evaluate how close the *real average* reference model is from the "virtual" one. This analysis will allow the validation of the chosen real average reference washing machine and dishwasher, or will suggest the need of selecting a new set of models from the database or to accept more than one set. In addition, outcome of Tasks 2 and 3 will be taken into consideration.

Once the real average reference model(s) is validated, its brand composition will be analysed, in term of number of models per each brand included in the selected real models. The results will be the percentage of each brand (and therefore of each manufacturer) concurring to the real average reference model in each appliance group.

At this point, the identified manufacturers/brands will be asked to select a real appliance model (or more than one model) - possibly[1] among the identified set in the technical database - and to provide the information included in the so called "Environmental Performance Questionnaire" for this reference model. Once the information is collected, all data will be weighted according to the previously mentioned brand/manufacturer composition, to create the ecological profile of the base case average reference washing machine and dishwasher models. As alternative, a more simple average of the data collected by the manufacturers could be used.

The ssme procedure will be applied for the identification of the "best case" model(s) or "top of the range model(s)" in each appliance category. Top of the range models will be used to evaluate the gap already existing between the average and the best available appliances in the reference year.

0.5.2 Subtask 5.2: Product-specific inputs

Product-specific inputs will be, first of all collected and organised according to the "EuP Eco Report" requirements and taking into account the LCA ISO 14040 norms. Similarly, the methodology used for the LCA analysis will be, at first glance, based on the EuP-Ecoreport settings, but it will be, as close as possible, also compared and aligned with the LCA standard methodology by using others LCA software and data (like, i.e. the Simapro tool) and databases).

Primary input data will come from direct communication with producers and/or, if not available, collected on sector specific or commercial data base (secondary data). These data will be considered both for the standard and the real base case for the two appliance types.

[1] Since the analysed technical database includes models produced in 2005 or before, manufacturers could select a reference model, which is not among the identified set.

The product's specific inputs are thus classified according to the following data sets:

- General information on product type (washing machines and dishwashers reference models, efficiency class, capacity, …);
- Production phase (raw materials, components and assembling):
  - Used materials, related working processes (moulding, extrusion, wiring, ..), average distances from production sites, percentage of scrap, …)
  - Energy consumption (electric - kWh, thermal – MJ as Natural Gas, Oil,….or different sources) for assembling
  - Water (and others) consumption for assembling
  - Waste production
  - Waste water quality (BOD, COD, other indicators, …);
- Distribution of products (average distances and types of transport modes);
- Use phase (average life, specific consumption, maintenance and repairs);
- Packaging (type and weight);
- End of Life (disposal, thermal valorisation, incineration, dismantling…).

Production phase: a portion of a possible data-input inventory table for the production phase is:

Material	***from recycling***	***net weight***	***scrap***	***gross weight***	***processing*** *(on gross weight)*	***average distance***	***Mode of transport***
	(%)	(kg)	%	(kg)		(km)	
Ferro metals							
Iron							
Stainless steel							
…..							
Non Ferro Metals							
Aluminium							
Copper							
…..							
Electronic equipments							
Plastics							
ABS							
PP							
PVC							
….							
Glass							
White							
….							
Rubber							
Others							
Total weight							

Any other specification on material type, specific processes, would be useful to complete the picture. All data as is to be product specific (allocation procedure).

Distribution: the following data are required:

- transport to final user: average distance and transport medium (at least more than one transport medium and specific distances covered);
- packaging management: indication on packaging recovery and disposal (as an alternative medium EU situation will be considered).

Use: the following data are required:

- average life
- energy consumption (kWh/cycle) and load in kg for washing machines (to calculate the specific energy consumption (in kWh/kg_cycle) and in place settings for dishwashers (to calculate the specific energy consumption (in kWh/ps_cycle);
- water consumption (in litre/cycle);
- detergent consumption (detergent, rinsing aid, softener, depending on the appliance type as g/cycle);
- waste water quality (BOD, COD, Eutrophication)
- washing performance and spin drying performance for washing machines and washing performance and drying performance for dishwashers
- stand-by power consumption (literature data and measured data if available) in Watt, defined according to the product measurement standard (if existing)
- Ordinary Maintenance (ex: substitution of pumps, ….) as requested by producer for a specified working time;
- Extra-ordinary maintenance (if possible, as suggested by producer or market analysis)
- Noise (dB(A)).

Disposal: the following data are required:

- indication on typical (or average) disposal system (if existing or known) and % and types of recycled materials.

If specific data from producers are not available, average EU data will be used.

0.5.3 Subtask 5.3: Base Case Environmental Impact Assessment

The environmental impact assessment will be performed for both the Standard Base Case and the Real-life Base Case. The methodology used will be based on the "EuP EcoReport", specifying emissions and raw material consumption during the whole life cycle of the appliance.

A life cycle assessment will be in parallel also carried out using a different specialised LCA module (as the "Simapro" one) in order to verify and validate the results obtained by the "EuP EcoReport". The methodology used will comply with the ISO 14040 standards and will take into account the whole life cycle of products and their related impacts.
According to the LCA standards, output will be firstly presented in physical terms (e.g. kg of CO_2), disaggregated by each Life Cycle Phase (assembling, use, distribution, end of life, ..). Then the physical parameters will be aggregated by damage category (e.g.: global warming, as weighted addition of greenhouse gases), as follow:

- global warming,
- acid rain,
- ozone depletion,
- resource consumption
- energy consumption

It is worth noting that EuP-Ecoreport stops at Characterization phase. In order to evaluate the magnitude of damage among the different life cycle phase and compare the eco-profile outputs between different products and/or scenarios, it will be also analysed and discussed the subsequent LCA phases (normalisation, weighting, damage evaluation) by using tools like SimaPro6.

Using SimaPro6 is useful in order to compare and validate the EuP-Ecoreport. The extensive data bases of SimaPro6 improves the possibility that chosen data corresponds as close as possible with the information provided by producers (for geography, technology, period and other relevant characteristics including data quality).

Output, both from EuP-Ecoreport and from SimaPro6 software, will be presented by domestic appliance (e.g. CO_2/machine) and by unit service (CO_2/place setting or CO_2/kg_load). The second type of indicator, per unit service, is more effective for the comparison of different appliances.

0.5.4 Subtask 5.4: Base Case Life Cycle Cost

The life cycle costs, or net present value of the costs, to the consumer are calculated for each technological option beginning with the standard and real-life base case. The formula using the real cost of capital, interest – inflation, as suggested in the invitation to tender[2], will be utilized. This implies that the average real (as opposed to nominal) future price of electricity over the next 15 years should be used in this calculation.

To standardize and make the results of the different lots comparable, it was suggested that the DG-TREN set a reference price for electricity to be used in these studies. The DG may also wish to standardize the real cost of capital to around 5% which also would make all the LCC analysis of the different lots readily comparable. Nevertheless, a value between 0,14-0,15 Euro/kWh will be used for this study, along with a real cost of capital of 5%.

Sensitivity analysis will be applied to the main parameters here including purchase price and electricity price and the level of consumption per year of the representative washing machines and dishwashers.

0.5.5 Subtask 5.5: EU Totals

With regard to the total LCC data, the starting point is the individual LCC data for the real life base case of the representative wash appliances estimated in Subtask 5.3. In general, the sales for the year 2005 and the cumulative sales from 2005 to 2020 will be estimated for EU-25 for the representative models. The product of individual LCC and the 2005 sales gives the total life cycle costs for the base case models in 2005. Instead, the total cumulative sales, 2005 through 2020, cannot be simply multiplied times the LCC for 2005 to give the cumulative total, since LCC refers to the present year (2005) and the LCCs in question occur at each year over the product life. They must be discounted. So the average growth rate in sales for the EU25 is estimated and the total LCC is calculated for each year and discounted accordingly.
An effort will be made to estimate the LCC of representative new models coming to the market after the base case model, depending upon the availability of data. The total calculations will be performed as above.

In addition to the total models sold in 2005, it is necessary to estimate the energy consumption of the existing stock for year 2005. This will allow the environmental impact to be estimated for the existing stock. Adding the impacts for the models of the base case, of the other new models for 2005 and the existing stock(less the new sales) we have the impact environmental impact for 2005

[2] We define, for the Standard and Real-Life Base-Case, the Life Cycle Costs. LCC = PP + PWF * OE, where LCC is Life Cycle Costs, PP is the purchase price, OE is the operating expense and PWF (Present Worth Factor) is PWF= $\{1 - 1/(1+r)^N\}/r$, in which N is the product life and r is the discount (interest-inflation) rate.

which can be compared to the results of the CEDA EU-25 Input Output method, which will require some scaling, as described in Task 4. This comparison can be performed for washing machines, which is an explicit product and product service (household laundry washing) in the CEDA model, but not for dishwashers that are not included as a distinct product.

Essentially repeating for each of the future years the calculation of the base case unit sales, other non-base case unit sales and the number of units in stock (minus new sales) along with their respective environmental impacts, the cumulative environmental impact and LCC for the next fifteen years can be estimated. The impact of production, use and disposal of the product group assumes post-RoHs[3] and post-WEEE[4] conditions. This cumulative result will constitute the "Business as Usual" scenario for the lifetime of the product. Actually it makes sense to discount the annual results. Discounting environmental impacts for the cumulative impact may be new to some environmentalists, however certainly most would agree that there is a value in deferring these negative impacts. Total environmental impact without discounting will also be shown

0.5.6 Subtask 5.6: EU25 Total System Impact

For the year 2005 the results of Task 4, the environmental impact of the I/O model for 'washing with household laundry equipment,' CEDA code 540300, will be compared to the total environmental impacts given in Subtask 5.4 for year 2005, including those for sales of the base case models and for the other new models for year 2005 and for the existing stock in 2005, as previously described.

The steps necessary to make these two results as comparable as possible has been discussed in the description of Task 4. The guiding idea is to have the basic inputs of specific energy consumption and number of unit sales and units in the stock be the same for both methods. With this approach it will be possible to analyze and understand the differences in results, which will be due primarily to the addition of indirect inputs in the input output method and in the possible difference in environmental coefficients. Because we have controlled for inputs this is a good opportunity to better understand the two methods.

The other very important result will be the analysis of the environmental differences in the CEDA outputs between no use of off peak electricity (the normal use) and the use of off-peak electricity through the utilization of more silent machines during the night. While the economic advantages have been studied, the environmental impacts are less well established and constitute an important part of this research. Besides modelling a change in the input energy mix for the production of electricity, an attempt will be made to introduce the changes due to better utilization of the capacity for production and distribution of electricity.

---

[3] RoHs directive: Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, O.J. L37, 13.02.2003.

[4] WEEE directive: Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE), O.J. L37, 13.02.2003.

3 Task 3: Consumer behaviour and local infrastructure[5]

3.1 DESCRIPTION OF TASK 3

The data concerning this part of the study will be collected through a survey having the aim to identify actual consumer behaviour and consumer reactions on EuP design options. The following areas will be investigated:

- Actual use conditions of washing machines and dishwashers
- Program selection (type and temperature)
- Additional features selected (extra water, no spin, etc)
- Amount and type of laundry
- Detergent used (amount, type)
- Importance and acceptance of environmental conscious features
- Use of energy saving program option
- Use of halve load button or trust of fuzzy control
- Information on energy and water consumption
- Remote control (safety warning)
- Remote control (use of green energy – time delay)
- Use of hot water supply.
- The survey will be prepared and carried out according to the following steps:
- Identification of areas where energy savings in real use situations might exist. The energy usage of wet appliances is mainly influenced by following consumer relevant factors:
    - Size (capacity) of the purchased appliance and usage of this size
    - Temperature setting
    - Actual load size (kg of laundry or place settings)
    - Frequency of use (number of washing cycle/year)
- For dishwashers, the washing of dishes by hand has to be investigated in parallel, as this is the alternative way the dishes might be cleaned. Consumer acceptance and preferences for either way have to be explored.
- Preparation and design of a questionnaire to verify the existence of these areas in real household usage
- Carrying out the survey via Internet service on a relevant number of households in 10 EU countries (UK, DE, IT, FR, ES, SE, PL, HU, FI and CZ each with 250 people). To do so, the questionnaire will be transferred into an electronic format, where answers can be easily marked by ticking on predefined fields or added verbally. A link to this questionnaire will then be send to customers of a specialised Internet service provider that then will fill in the questionnaire. Answers are collected centrally. To achieve a good coverage, appropriate criteria will be used for selection of the customers who are invited to participate on this survey.

[5] Note: the paragraph numbering of this report starts with the number three to be consistent with the final report paging.

- Analysis of results in terms of real consumer behaviour and potential for optimisation.
- Analysis of the country specific trends.

The following areas will be investigated in detail via Internet survey for both washing machines and dishwashers:

- Demographic data
- Washing machine and Dishwasher (two separate questionnaires)
- Age of machines (classes of age)
- Capacity and use of capacity
- Program selection
- Usage habits (e.g. degree of filling)
- Satisfaction
- Problems associated with cleaning and drying performance
- Use of energy saving options
- Reaction on energy improvement/eco design (see above) measures
- Market preferences and cultural and social aspects relating to purchase (when and why the appliance will be substituted, product life expectancies, attitude toward the second-hand market)
- Level of information on the energy efficiency categories (labelling) and, in general, on the EU or national initiatives on the environmental protection
- Source of information/advice in case of purchasing of a new appliance (general or specialised magazines, shops, maintenance services…)
- Other questions concerning the electricity tariffs and how the consumer deals with them (i.e. how and if to take advantage of possible night tariffs and related problems like the appliances noise).

3.2 THE BASIC CRITERIA AND GOALS OF THE CONSUMER SURVEY

The behaviour of the consumer with household appliances influences the environmental impact because of the usage of resources like water and/or energy and/or chemicals. Although some studies on the consumer behaviour with washing machines are available in Europe[6], they are neither complete nor updated to allow an actual assessment of the consumer behaviour on the environmental impact.

The aim of the survey was to identify the "real life" consumer behaviour concerning the use/handling of household appliances and to identify differences between the real use pattern and the standard test conditions (potentially) affecting the environmental impact of the appliances. With the support of an external market research institute[7] 2 497 European households in 10 European countries were interviewed via an online questionnaire (Figure 3.1). The participants were asked about their behaviour when using selected household appliances and about their opinion on this topic as well as on the energy saving issues. Demographic data were recorded additionally.

---

[6] E.g. SAVE II: Revision of energy labelling & targets washing machines (clothes), Novem (NL), March 2001

[7] ODC Services GmbH, 80636 **Munich**

The selected countries nearly represent 75 % of the European population. 250 households were interviewed per country, with the exception: Czech Republic with only 247 households.

Households for this survey were selected to be - as much as possible - representative of the population in the country and to fit with the scope and needs of the study.

The following selection criteria and quotas were chosen:

- Indicator of citizenship: total
- Distribution of gender: not less than 50% female persons
- Selected age groups:
    - between 20 – 39 years
    - between 40 – 59 years
    - between 60 – 74 years
- Household size: 1, 2, 3, 4 and ≥4 persons.

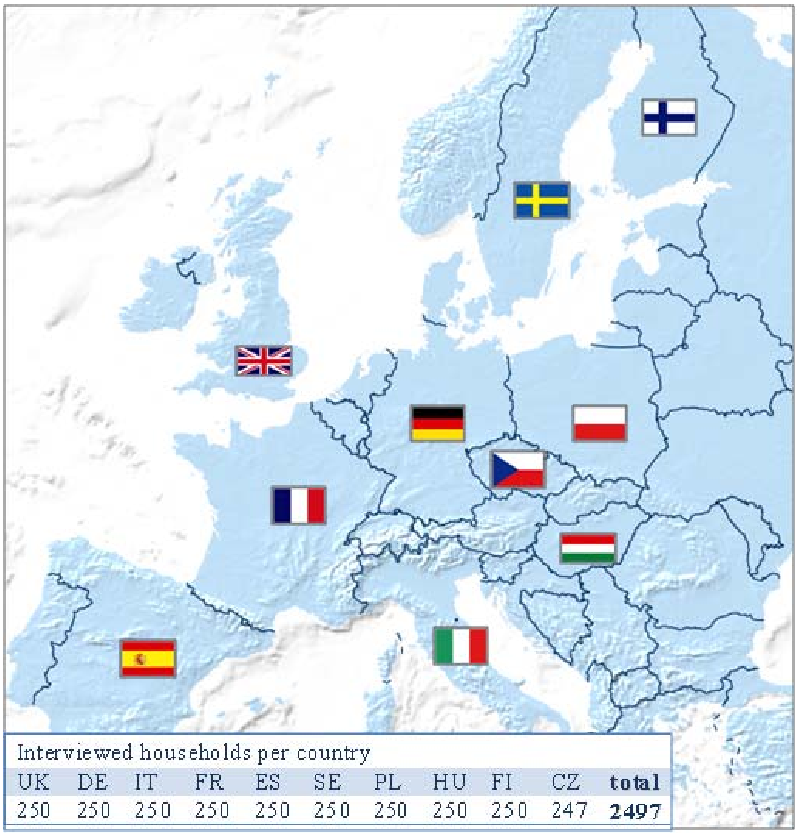


Figure 3.1: geographic coverage and sample size of the survey[8]

Also specific quotas about the presence of selected household appliances were set:

- not less than 50 % of all interviewed persons per country should possess a <u>dishwasher,</u>
- 100 % of all interviewed persons per country should possess a <u>washing machine,</u>

[8] Figure own creation with Map Creator Version.1.0 (free edition)

- 100 % of all interviewed persons per country should possess a refrigerator,
- not less than 70 % of all interviewed persons per country should possess a freezer,

to insure a sufficient coverage of the interested products and a better comparability of the results: The selection of gender and age groups were made to interview the persons who most likely were involved in housekeeping. To guarantee the interviewed sample to be representative of the age group and household size distribution, Eurostat[9] data about the distribution of the population by age group and household size for each country were used to normalise the sample (Table 3.1). Maximum differences of ± 5 % resulted between the Eurostat distribution and the sample in the survey (Annex 1- 1).

Table 3.1: population by household size and age group: comparison of results of own survey vs. Eurostat data[10] e.g. UK

United Kingdom		Age group			total
		20-39 years	40-59 years	60- 74 years	
Eurostat [11]	1 person	4 %	5 %	5 %	*14 %*
	2 persons	10 %	13 %	12 %	*36 %*
	3 persons	10 %	9 %	2 %	*21 %*
	4 persons	10 %	8 %	1 %	*19 %*
	more than 4 persons	6 %	4 %	0 %	*11 %*
	total	*41 %*	*39 %*	*20 %*	*100 %*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
participation in survey	1 person	3,9 %	7,1 %	4,2 %	15,1 %
	2 persons	11,6 %	12,2 %	10,6 %	34,4 %
	3 persons	11,6 %	10,9 %	1,6 %	24,1 %
	4 persons	8,0 %	8,7 %	1,0 %	17,7 %
	more than 4 persons	4,8 %	3,9 %	0,0 %	8,7 %
	total	*39,9 %*	*42,8 %*	*17,4 %*	*100,0 %*
		Age group			
		20-39 years	40-59 years	60- 74 years	
Differences between Eurostat data and participation in survey	1 person	0,1 %	-2,1 %	0,8 %	-1,1 %
	2 persons	-1,6 %	0,8 %	1,4 %	1,6 %
	3 persons	-1,6 %	-1,9 %	0,4 %	-3,1 %
	4 persons	2,0 %	-0,7 %	0,0 %	1,3 %
	more than 4 persons	1,2 %	0,1 %	0,0 %	2,3 %
	total	*1,1 %*	*-3, 8%*	*2,6 %*	*0,0 %*

[9]EUROSTAT:http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/popul/popula/cens/cens_n2001/cens_nhou&language=de&product=EU_population_social_conditions&root=EU_population_social_conditions&scrollto=162

[10]Own calculation: Population by household size and age group based on EUROSTAT data.

[11]Own calculation: via crosstabs of EUROSTAT.data of population by household size and age group.

3.3 The General Survey Results

3.3.1 *Demography*

On average 56 % of all interviewed people were female and 44 % male (Figure 3.1). The highest value of nearly 70 % of females was found in the United Kingdom (Table 3.2). In general, the differences among the actual gender distributions in European countries and the results of this survey are between less than 1 % and 18 % in favour of female participation.

Table 3.2 results consumer survey: share of female persons (percentage per country)

Gender	County	UK	DE	IT	FR	ES	SW	PL	HU	FI	CZ
Female		68,8 %	59,6 %	60,8 %	50,0 %	50,8 %	62,4 %	50,8 %	50,0 %	56,8 %	47,4 %

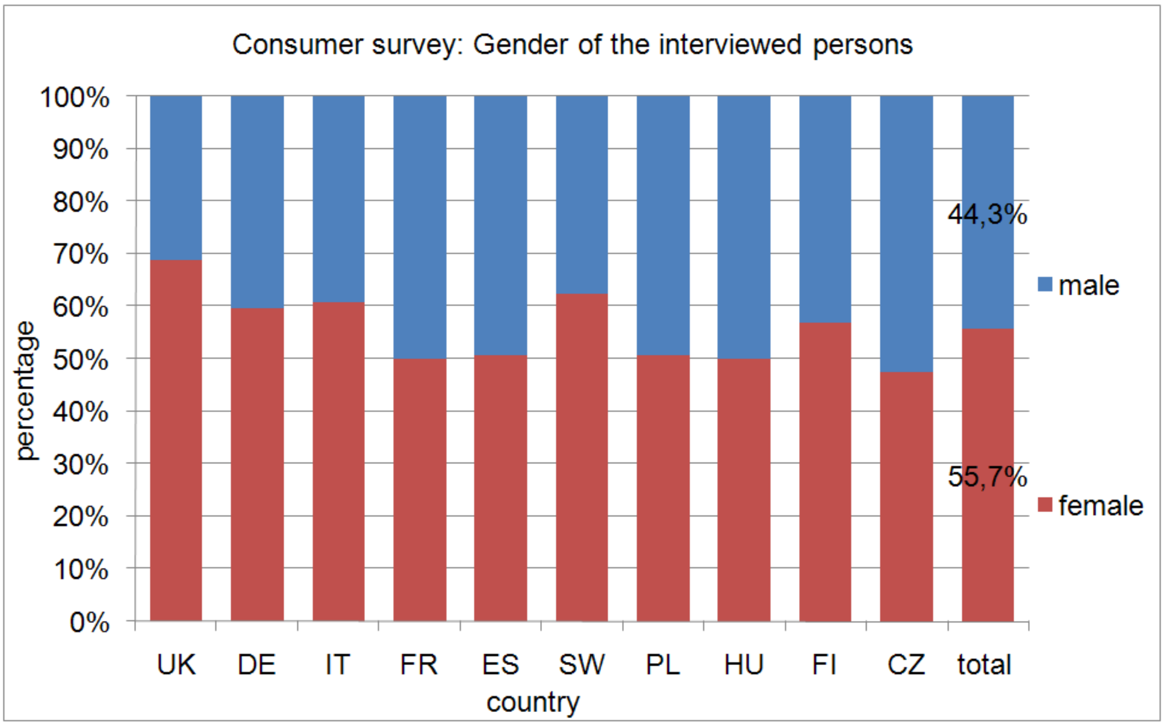


Figure 3.2: distribution: gender of the interviewed persons (per country)

Due to the self-declaration of the age by the survey participants, only persons with an age between 20 and 74 years were interviewed. People with an age between 20 and 39 years as well as 40 and 59 years resulted in nearly 40 % of the entire sample. No significant differences could be found with the European countries statistics, where the percentage of the two mentioned age groups lay between 39 and 42 %. The highest share of young participants could be calculated for Italy (47,6 %), Spain (46 %) and Poland (44,8 %) (Figure 3.3): 19 % of the interviewed persons are between 60 and 74 years old. The highest share of people of this age group can be found in Sweden (22 %), Hungary (20,8 %) and Germany (19,6 %).

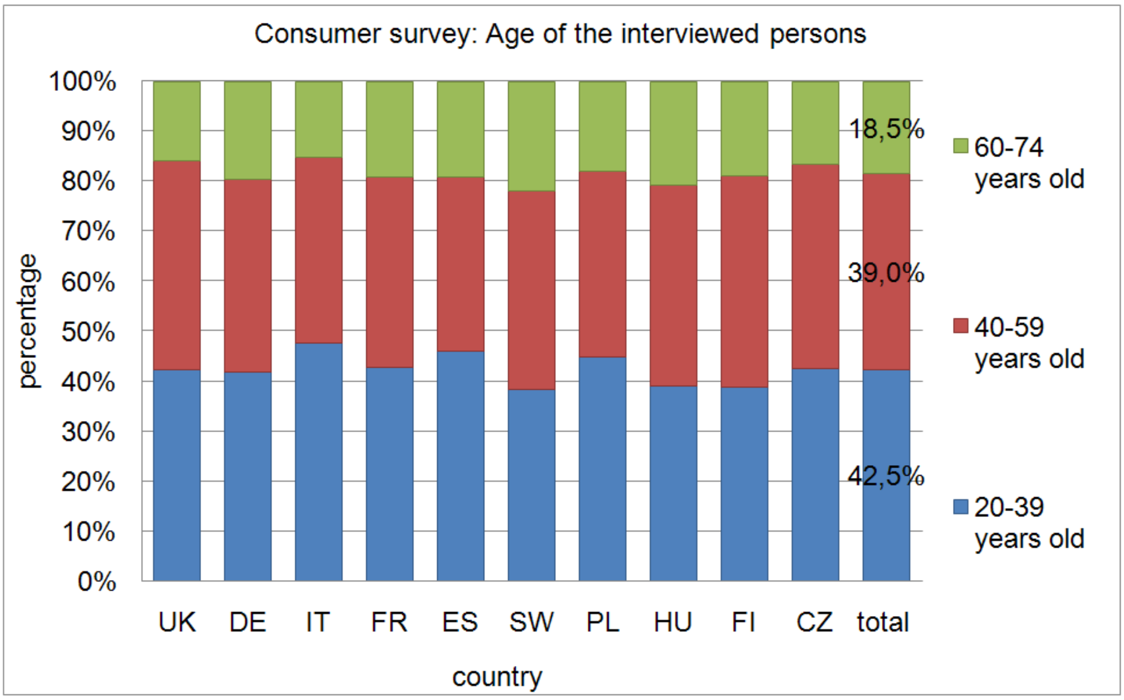


Figure 3.3: distribution: age of the interviewed persons (per country)

3.3.2 Living conditions

People were also asked to describe their dwelling type: 52 % of all interviewed households (or 2 497) said that they live in a city. Nearly 80 % of all Polish interviewed persons live in a city (Figure 3.4), which is the highest share of all European countries.

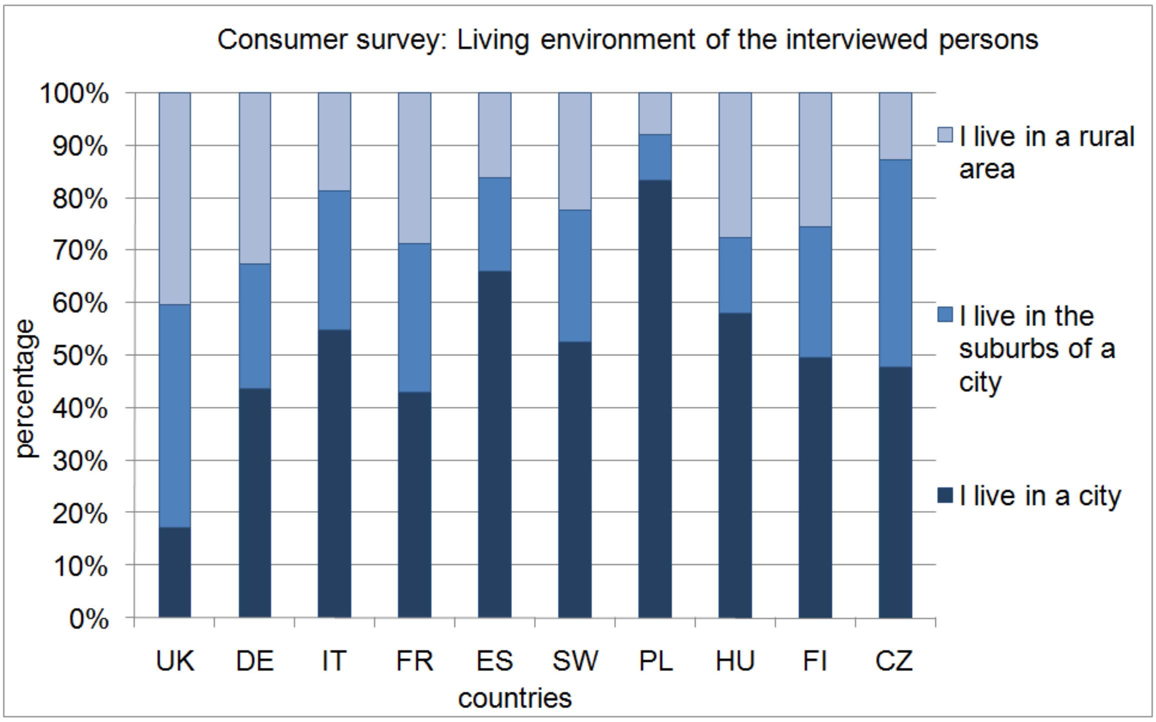


Figure 3.4: living environment of the interviewed persons (per country)

Over 60 % of all Spanish participants are city dwellers. A fourth of all households live in the suburbs of a city (25 %), of which mostly British (42 %) and Czech (39 %) interviewees, while the other countries show percentages between 14 and 28 %. The remaining interviewees (23 %) answered that they live in a rural area, especially in UK (40 %); German (33 %), French (29 %) and Hungarian (28 %) people live in the same conditions.

Nearly 60 % of all interviewed people live in a family household (Figure 3.5). This household type could be found mostly in Italy and Czech Republic with over 70 % and also in Poland and Hungary with over 66 % (Figure 3.6).

Approximately 40 % of all family households consist of 3 or 4 persons and even 10 % over 4 persons (Figure 3.7). Almost a fourth of all interviewed consumers (22 %) live in couple households, which are mostly represented by 2-person households (18 %). Especially in Finland and France this type of household is over 30 % (Figure 3.8). Over 14 % of all participants live in a single-/one-person household: particularly in Sweden 27,6 % and in Finland 18,4 % of all households are single-households. With only 3,5 % the multi-person non-family household was mentioned least frequently (Figure 3.5). With the exception of Italy in all European countries the share in this type of household is marginal, with values between 0,8 % and 5,2 % (Figure 3.6). Because of possible misunderstandings of the declaration of the different household types, it is recommended that a check with the number of the persons in the household be done.

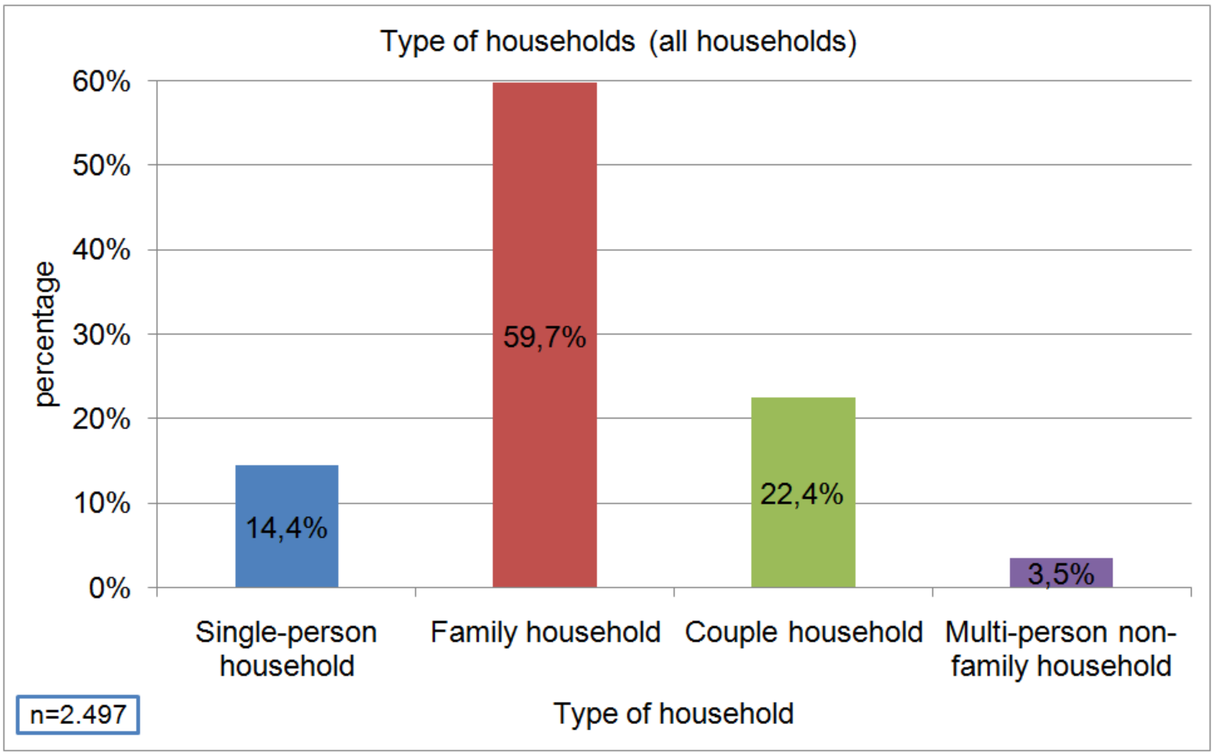
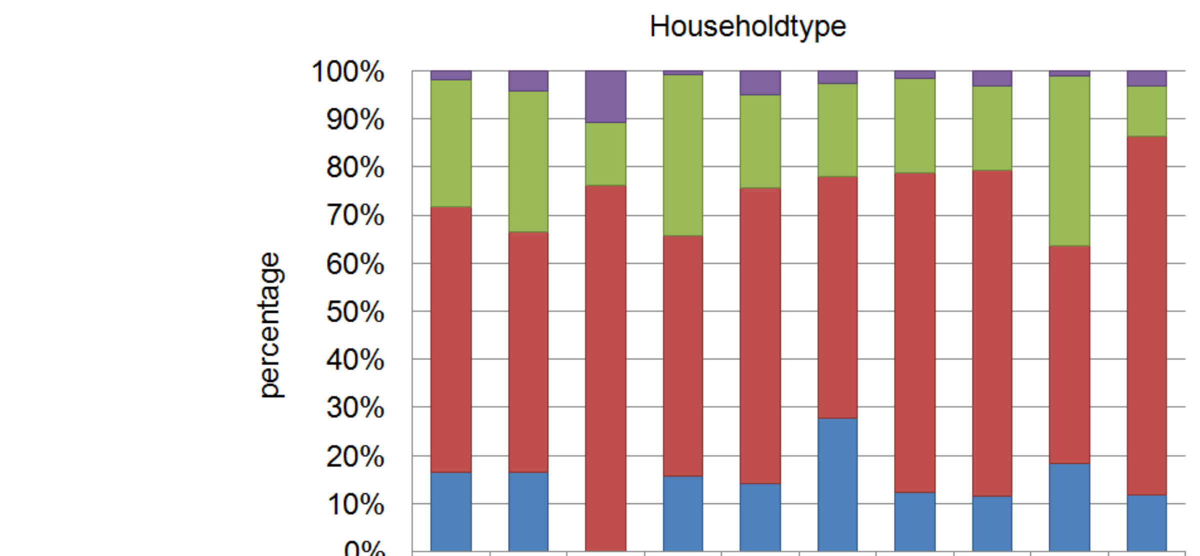
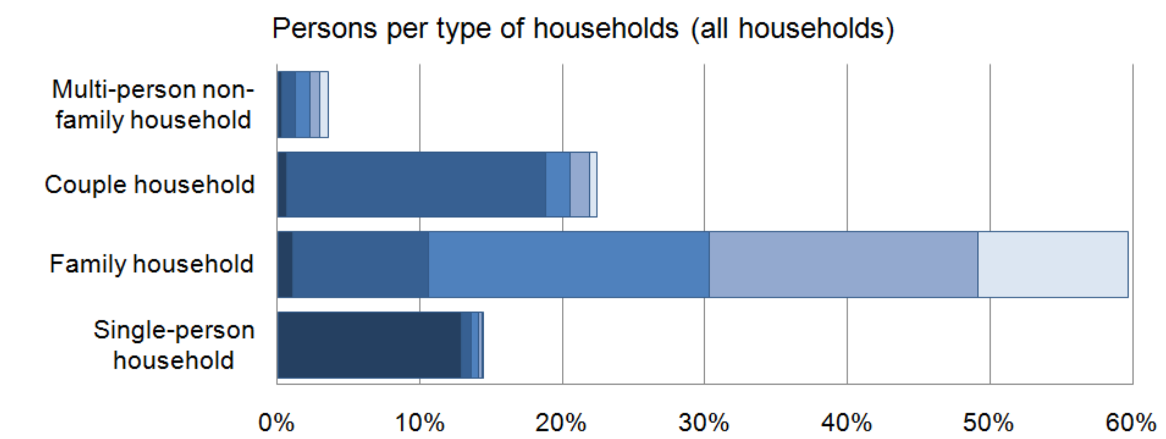


Figure 3.5: distribution: type of household (all households)



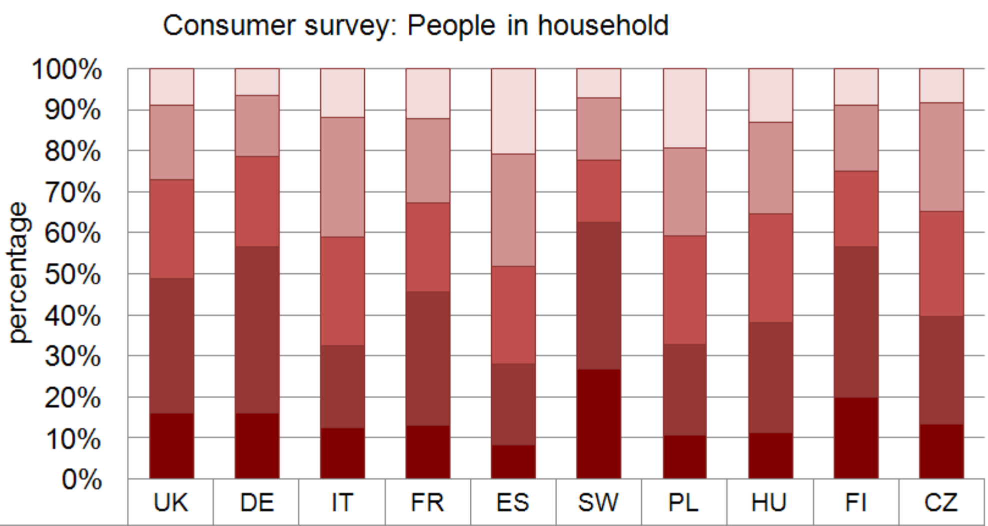
	UK	DE	IT	FR	ES	SW	PL	HU	FI	CZ
Multi-person non-family household	2,0%	4,4%	10,8%	0,8%	5,2%	2,8%	1,6%	3,2%	1,2%	3,2%
Couple household	26,4%	29,2%	13,2%	33,6%	19,2%	19,2%	19,6%	17,6%	35,2%	10,5%
Family household	55,2%	50,0%	76,0%	50,0%	61,6%	50,4%	66,4%	67,6%	45,2%	74,5%
Single-person household	16,4%	16,4%	0,0%	15,6%	14,0%	27,6%	12,4%	11,6%	18,4%	11,7%

Figure 3.6: distribution: type of household (per country)



	Single-person household	Family household	Couple household	Multi-person non-family household
1 person	12,9%	1,1%	0,6%	0,2%
2 persons	0,7%	9,5%	18,1%	1,0%
3 persons	0,5%	19,7%	1,7%	1,0%
4 persons	0,2%	18,8%	1,4%	0,7%
more than 4 persons	0,1%	10,6%	0,6%	0,6%

Figure 3.7: distribution: by type of household and person per household (all households)



	UK	DE	IT	FR	ES	SW	PL	HU	FI	CZ
more than 4 persons	9,2%	6,8%	12,0%	12,4%	20,8%	7,2%	19,6%	13,2%	9,2%	8,5%
4 persons	18,0%	14,8%	29,2%	20,4%	27,6%	15,2%	21,2%	22,4%	16,0%	26,3%
3 persons	24,0%	22,0%	26,4%	21,6%	23,6%	15,2%	26,4%	26,4%	18,4%	25,5%
2 persons	32,8%	40,4%	20,0%	32,4%	19,6%	35,6%	22,0%	26,8%	36,4%	26,3%
1 person	16,0%	16,0%	12,4%	13,2%	8,4%	26,8%	10,8%	11,2%	20,0%	13,4%

Figure 3.8: number of people in households (per country)

The detailed analysis of the answers to the question how many people are living in the household results an average of 2,9 people per household. In comparison with the average household size published by UNECE[12], for those countries investigated here, an average difference of -0,3 people per household could be calculated (Table 3.3).

Table 3.3: average household (countries of this survey) source: UNECE (2004)

Countries	EUROSTAT		Consumer survey		Δ Average household size (EUROSTAT – Consumer survey)
	Average household size	Year	Average household size	Year	
Czech Republic	2,7	1998	2,9	2006	-0,2
Finland	2,1	2001	2,6		-0,5
France	2,4	2001	2,9		-0,5
Germany	2,2	2001	2,6		-0,4
Hungary	2,6	2001	3,0		-0,4
Italy	2,6	2001	3,1		-0,5
Poland	3,1	1995	3,2		-0,1
Spain	2,9	2001	3,3		-0,4
Sweden	2,9	2001	2,4		0,5

---

12 The Statistical Yearbook of the Economic Commission for Europe 2003. Online: http://www.unece.org/stats/trends/ch2/2.1.xls

United Kingdom	2,3	2001	2,7		-0,4

The highest number of persons per household, with more than four, was seen in nearly 20 % of the Spanish and Polish households in our survey (Figure 3.8). Also nearly 30 % of all Italian, Spanish, Czech and Polish interviewees stated that there are four persons in their households. Following the consumer survey analysis the most single member households could be calculated with nearly 30 % for Sweden and with 20 % for Finnish households. For the other analysed European countries, single member households represented between 8 and 16 % (Figure 3.8).

In nearly 38 % of all European households of our survey at least one person is younger than 18 years. Figure 3.9 shows that in 17 % of all households live one and in nearly 14% live two persons under this age, mostly in France (46 %), Hungary (44 %), Poland (42 %) and Italy (41 %). Households with the least share of people under 18 years were found in Czech Republic (29,6 %), Sweden (33,6 %) and Spain (32,4 %).

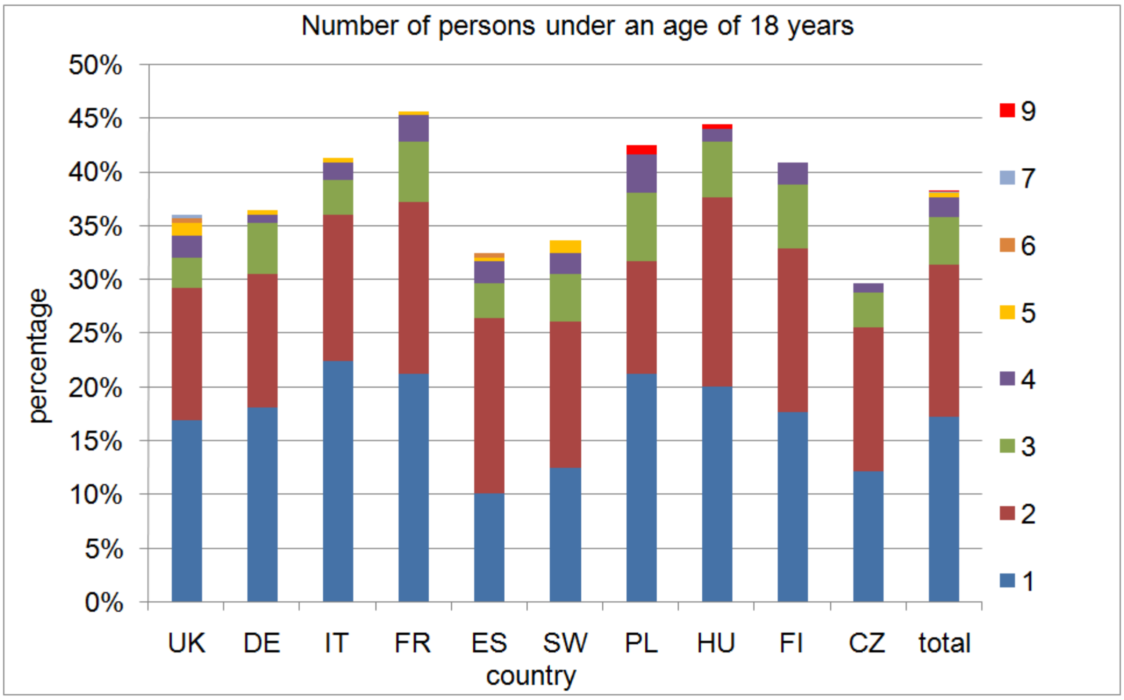


Figure 3.9: number of people under an age of 18 years (per country) living in household

The comparison of the results of our survey and published European data about the proportion of households with children aged between 0 and 17 years[13] shows differences between -4,4 % and + 15,1 % (Annex 1-3).

All these differences between the ‘official’ average country data and data of this survey may be explained by the setting of quotas on the age of the participants, as this eliminated quite some elderly households and properly also some very young (student) households. Following the

[13] http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1073,46870091&_dad=portal&_schema=PORTAL&p_product_code=FBA10512

intention of this survey to cover the average European behaviour of using household appliances this procedure is justified.

3.3.3 The installed household appliances

A total of 10 044 household appliances are installed in the interviewed households (2 497). Refrigerators and washing machines were reported with an ownership of 100 %, because of the predefined questionnaire criteria; 69 % (n = 1 722) of all households possess a dishwasher and over 35 % (n = 893) a tumble dryer (Figure 3.10). As far as the cold appliances (e.g. refrigerators and freezers) are concerned, approximately 75 % (n = 1 871) of households own an upright freezer and nearly a fourth a chest freezer (22,6 %; n = 564); 14.2 % (n = 355) of all interviewees have both.

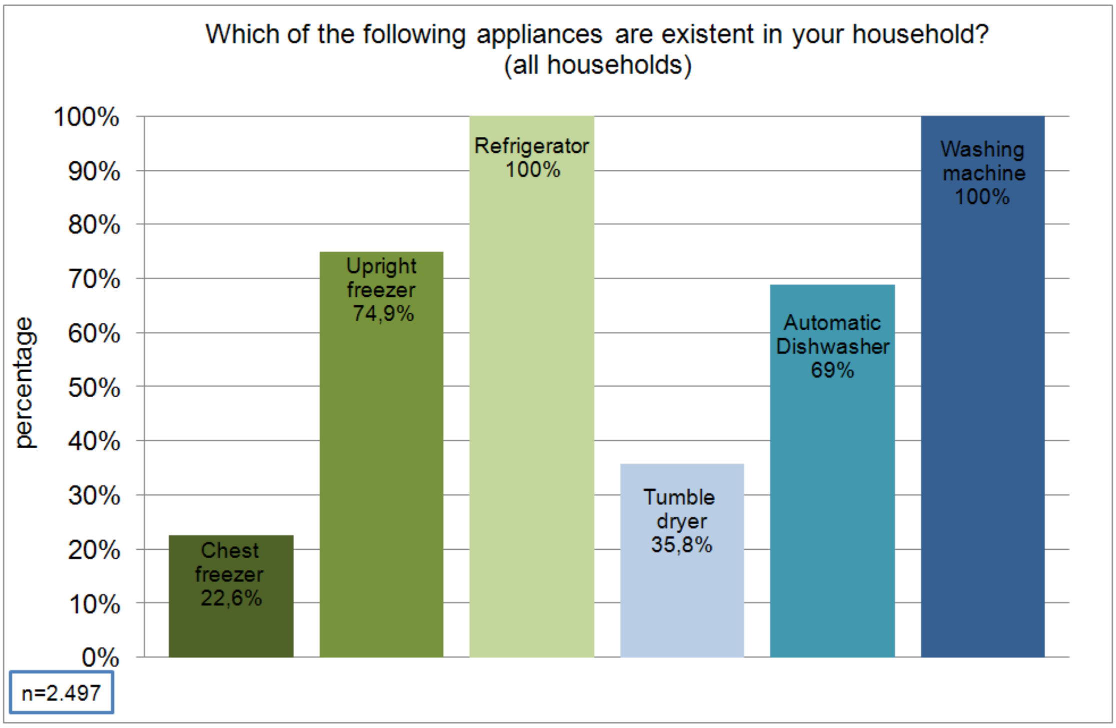


Figure 3.10: equipment of household appliances in % (all households)

The highest share of dishwashers was found in French households with 88 % and in Germany with about 77 % (Figure 3.11); less than 50 % of Polish households possess a dishwasher; 57 % of Czech interviewees mentioned that they have a dishwasher. The highest ownership of tumble dryers could be found in British households, with nearly 70 %, followed by more than 50 % in German, French and Swedish household. On the other side, in only 8 % and 9 % of Czech and Italian households a dryer do exist.

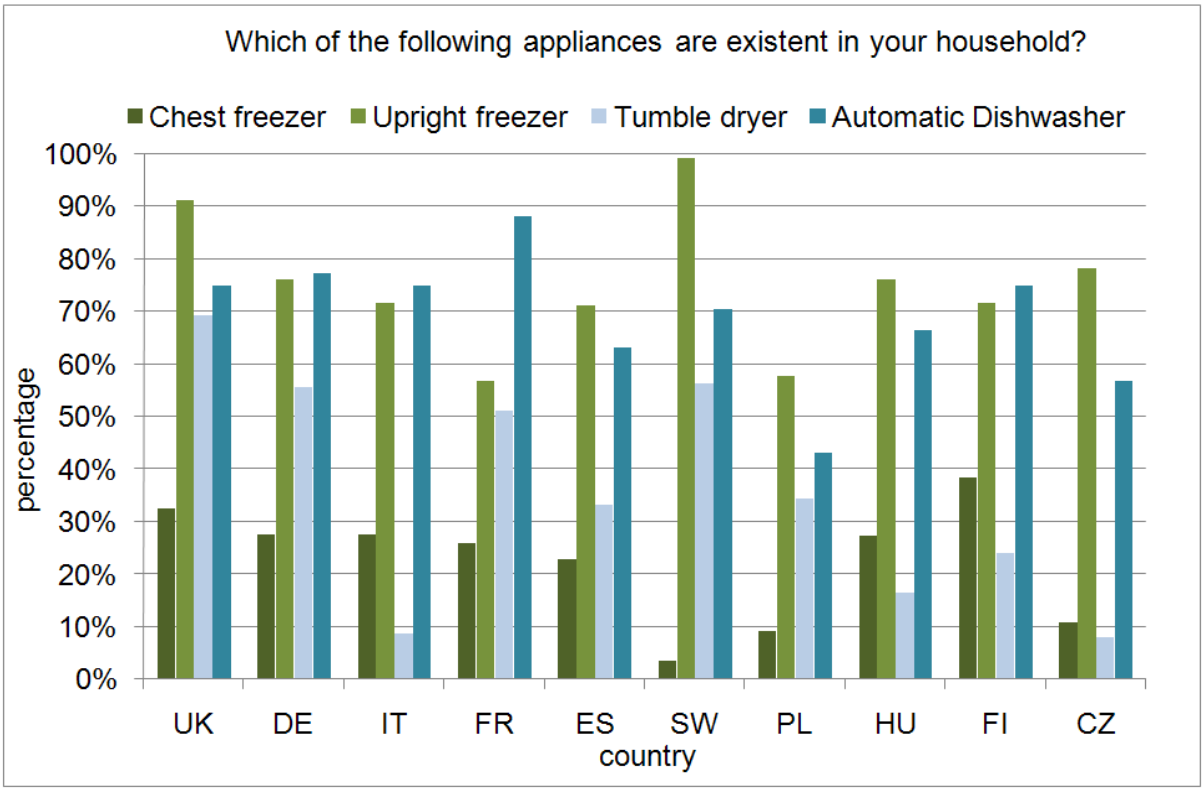


Figure 3.11: equipment of household appliances in % (per country)

Couple- and family-households show the same distribution of household appliances: over 70 % possess a dishwasher and nearly 40 % a tumble dryer (Figure 3.13). Only 49 % of single households possess a dishwasher, while 80 % of more than 4 person households have one (Figure 3.12 and Figure 3.13). The reason could be the space availability or the dwelling type.

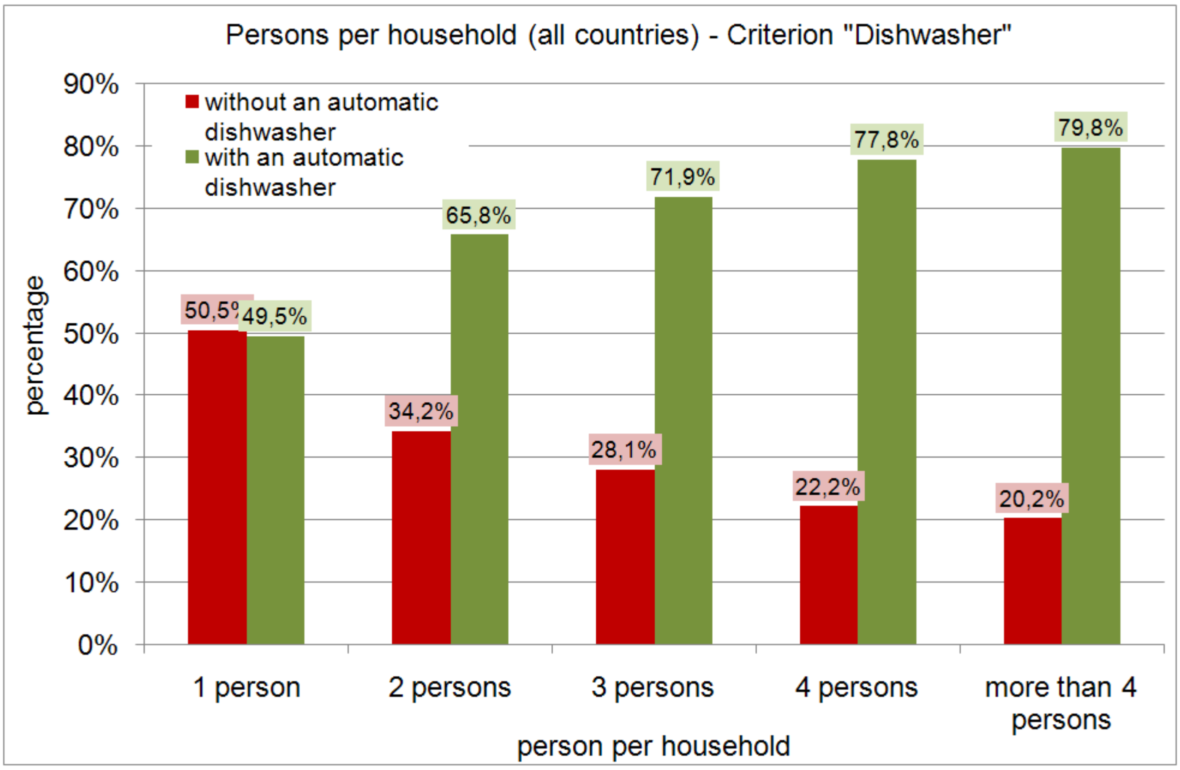


Figure 3.12: persons per household – criterion: „ dishwasher“

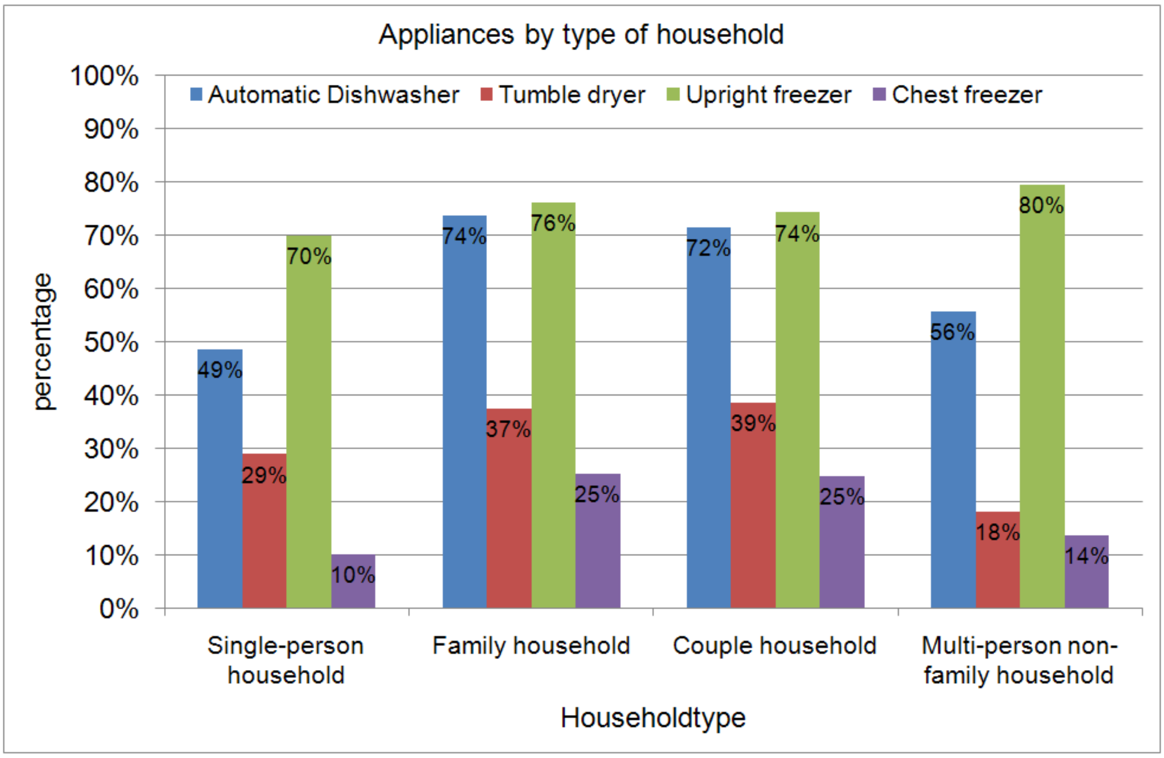


Figure 3.13: equipment of household appliances by type of household

3.3.4 *The consumer opinion about "household appliances"*

Consumers were asked their opinion about a list of general statements concerning their behaviour when using household appliances and the consequent environmental impact.

Nearly all interviewees stated that appliances should *just do a perfect job* (Figure 3.14) so that the consumer does not need to worry about it (53,9 %). Ecological aspects are very important for the consumers too: most of them know that their *behaviour plays a role for the environmental impact*; consequently nearly 90% of the interviewed persons mentioned that it's very important *to be able to protect the environment with their behaviour* and they also agreed with the statement that *a correct use of their machines would save energy* (94,7 %) (Figure 3.15). It is also a high priority for the interviewees that household *appliances show very good economical consumptions* (39,7 %) and *work economically* too (38,3 %).

Aspects like the aesthetics or the price seem to play a minor role for the consumers: approximately 40 % of all consumers disagree, and 7,9 % strongly disagree, with the statement that an *appliance should reflect their lifestyle or match the interior of their home* (Figure 3.14). Also nearly 30 % disagree that they primarily pay attention to an *attractive price of the appliances* (Figure 3.15), which on the other side means that 70 % of the interviewees consider the price as important or very important (more than 20 % of the answers).

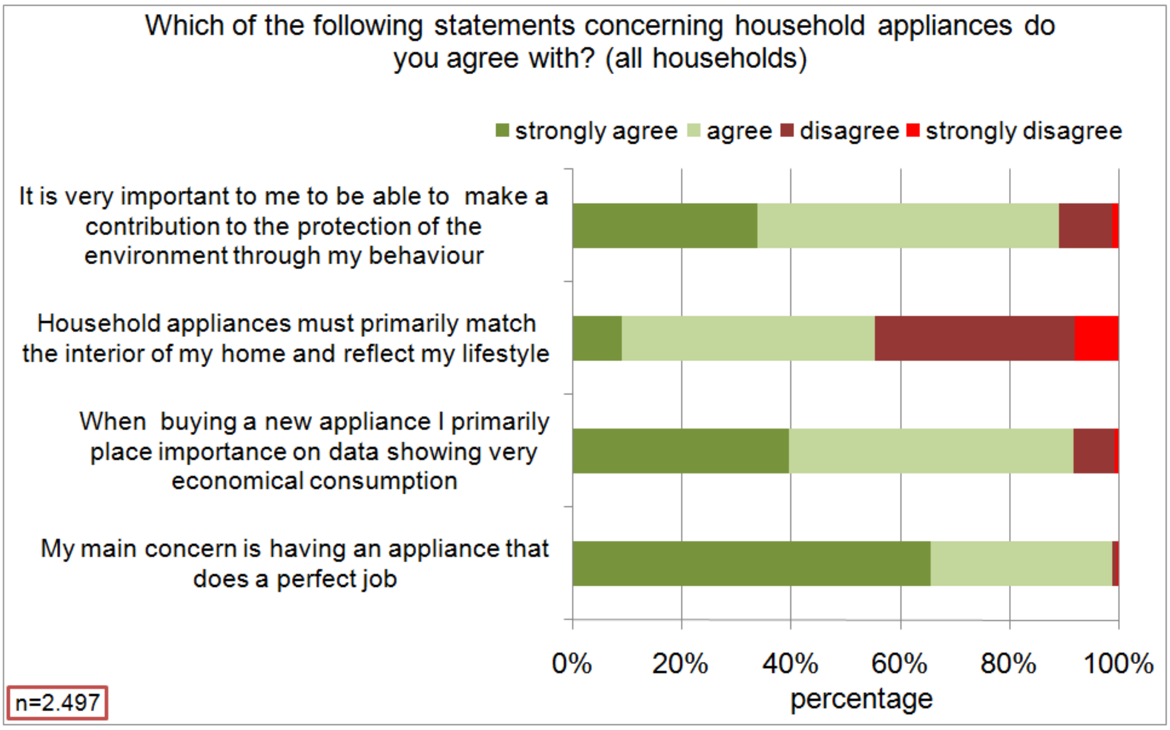


Figure 3.14: consumer statements – part I

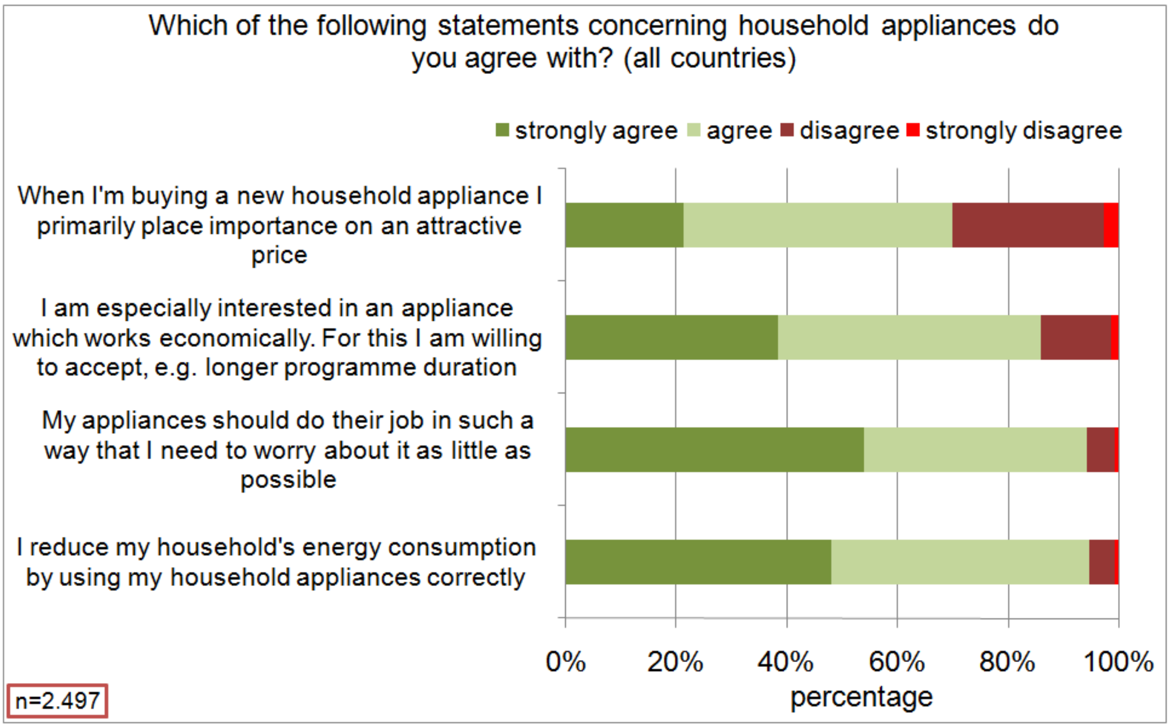


Figure 3.15: consumer statements – part II

The consumers were also asked which sources of information they would consult when they plan to buy a new appliance (multiple answers allowed). The main source of information resulted to be consumer's own *experience* (55,7 %) (Figure 3.16). The second main source of information is *Internet sites of the manufacturers* (52,2 %). *Information on the energy label* is important for nearly 52 % of all interviewed consumers. Approximately equally quoted are *advices and experiences of friends* and *test reports from consumer organizations* (50,5 % and 50,8 %).

When compared with the results of a study of a German magazine (STERN) (Figure 3.17) concerning information when purchasing an electrical domestic appliance, the importance of *information in trade* is considered less important. The *advice from sales representatives in a shop* (46,4 %) are less important for the interviewees (Figure 3.16), and a similar answer is given for "information *by manufacturers' brochures"* with nearly 30 %, which is in good agreement with the STERN[14] survey.

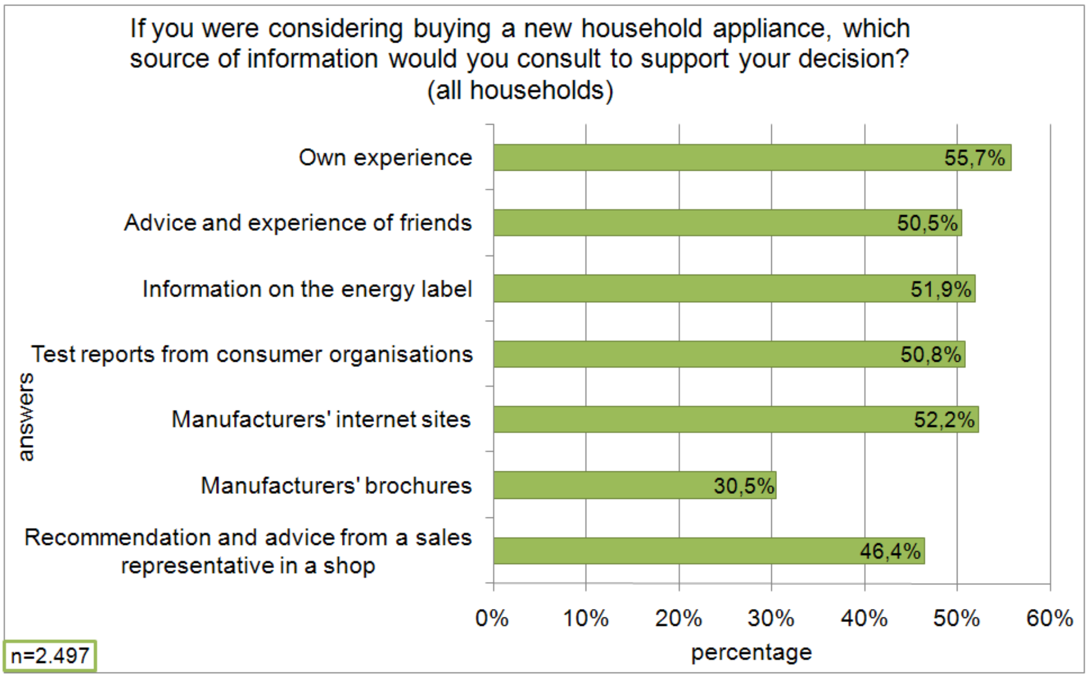


Figure 3.16: sources of information when purchasing a new appliance

[14] STERN (2005): TrendProfil "Elektronische Haushaltsgeräte". Online: http://www.gujmedia.de/_content/20/50/205011/TP_0505_Elektr_HHG.pdf?PHPSESSID=3d884f1d5fee754e7b0e5320766a6ab2

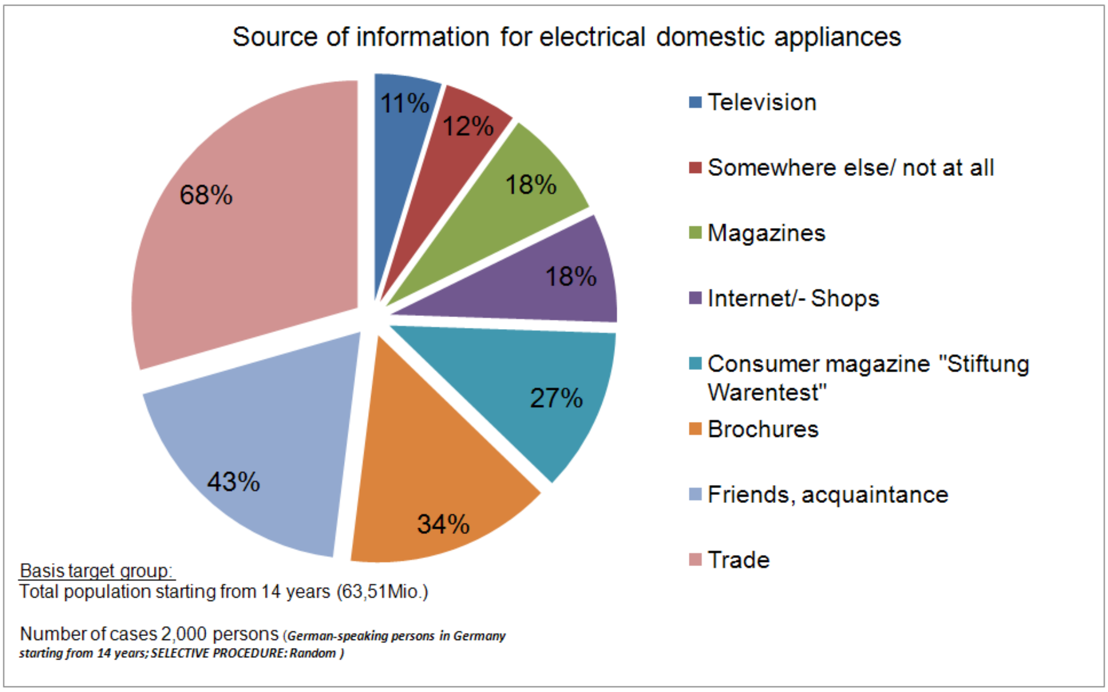


Figure 3.17: results study STERN: sources of information when purchasing an electrical domestic appliance (STERN 2005)

For approximately 52 % of the interviewees the *information on the energy label* is important for their buying decision (Figure 3.16).

The consumers were then asked in detail which information they would expect on the energy label and list of options was provided: for over 80 % the *energy efficiency class* and information about the *water consumption* are considered very important (Figure 3.18); more than about 50 and 60 % of all interviewees mentioned and chose elements which are already included in the energy label, such as for example the *cleaning/washing performance* (58,1 %), the load *capacity* (57,5 %), the *noise emission* (55,4 %) or the *spin/drying performance* (50,5 %); the information on the *programme duration* is are expected only by 45,2 % of the consumers.

As far as the *energy consumption* is concerned, the consumer expects more information on the consumption *per cycle per day* (56,4 %) than on the *annual consumption* (34,1 %); other detailed information on all *programmes or features of the appliance* or on *programme and temperature used for the assessmen*t are only desired by about 28 % of the consumers. Financial aspects like *yearly* or *running cost (per cycle)* are also requested by only about 32 % to 34 %.

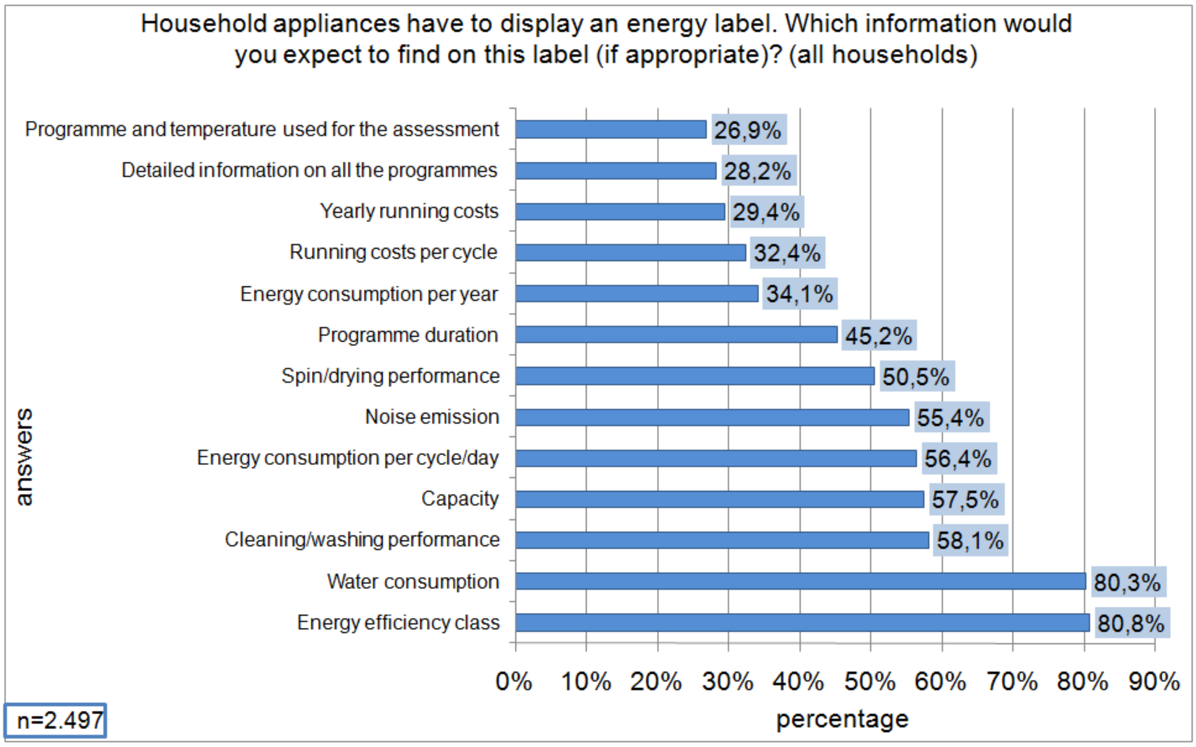


Figure 3.18: energy label – expected information

A very *low consumption of resources like water and/or energy* is the most important aspect for the consumers when they plan on buying a new appliance (83,9 %) (Figure 3.19).

Also for over 70 % of the interviewed persons a *very good cleaning/washing performance* has a high priority and more than half pay attention to a *low operating noise emission* of the appliance. Accordingly, consumers not only look at the *purchase price of the machine* (38,2 %) but also for a very *good result on the energy label* (36 %). More than one fourth of the consumers expect a *good dishes-/textile protection* too. Other criteria like *shorter programme duration*, *low detergent consumption* or a *large number of different programmes* are only mentioned by 15-18,5 % of the consumers. The lowest values are reached by a *higher capacity* (10,2 %) and an *innovative aesthetic design* (7,2 %).

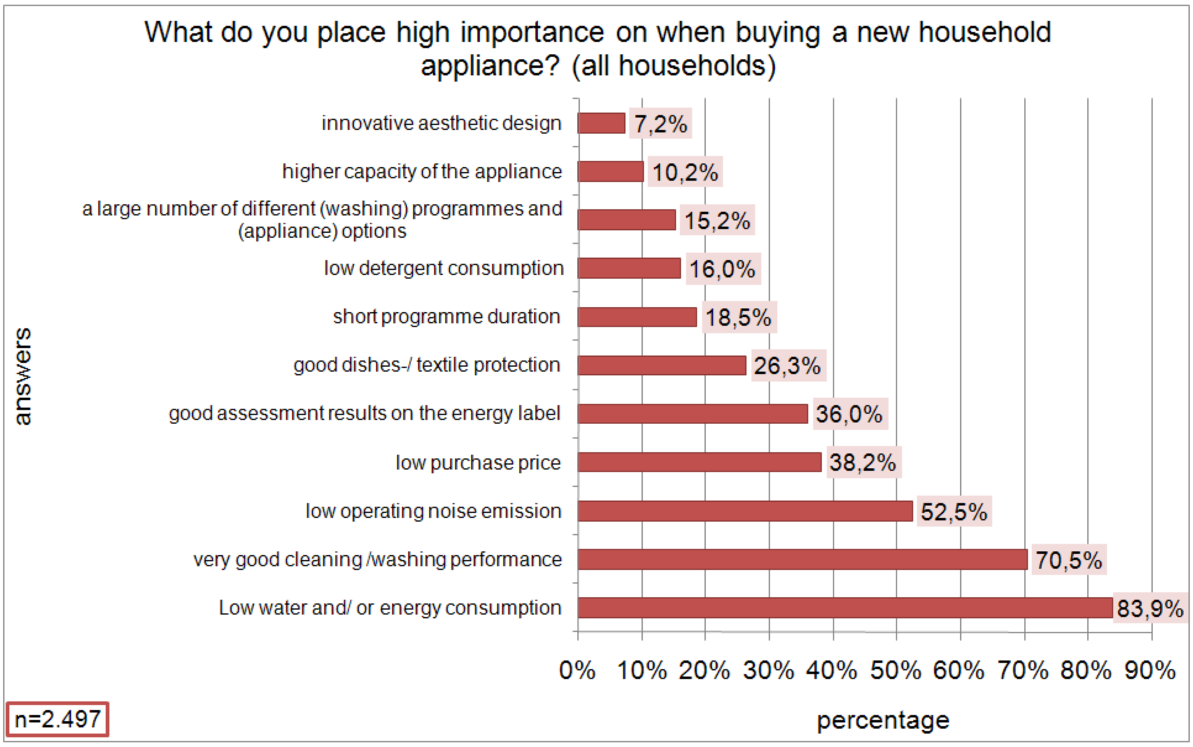


Figure 3.19: criteria when purchasing a new appliance

3.3.5 Identification of Possible Barriers to Eco-design Innovation

3.3.5.1 Appliance lifetime

Unnecessary energy consumption in households is influenced by over-aged appliances among other things.

The energy efficiency of **washing machines** has been improved considerably over the last decade. Running old washing machines is therefore far less efficient than replacing them by new models. The average lifetime of a washing machine is over ten years[15]. According to data from a CECED study nearly 25 % of all washing machines were older than ten years in 2004[16].

The consumer survey results show that nearly 50 % of all washing machines are younger than four years with 90 % younger than ten years (Figure 3.20). The analysis of the households per country shows that nearly 50 % of all washing machines are younger than 3-4 years with 90 % younger than 8-11 years (Figure 3.21). The calculated average age of washing machines in the interviewed households is 5,5 years (Figure 3.22). The lower average age was found the UK and Spanish households with 4,5 and 5,2 years respectively (Figure 3.22), the higher average age was found in Italian and Polish households with 5,7 years and in Sweden with 5,6 years.

---

[15] http://www.freescale.com/webapp/sps/site/overview.jsp?nodeId=02M0zpbnQXGM10G4KwF8; http://mail.mtprog.com/CD_Layout/Day_1_21.06.06/1400-1545/ID76_Stamminger_final.pdf

[16] 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

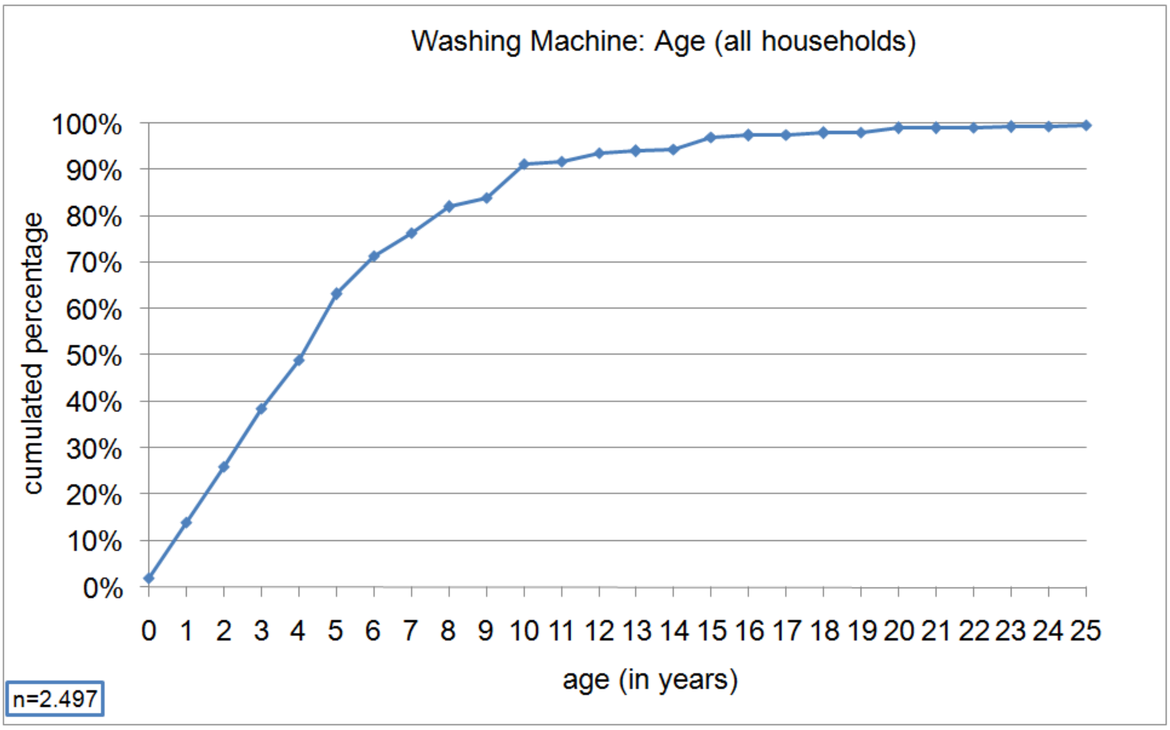


Figure 3.20: age of washing machines (all households)

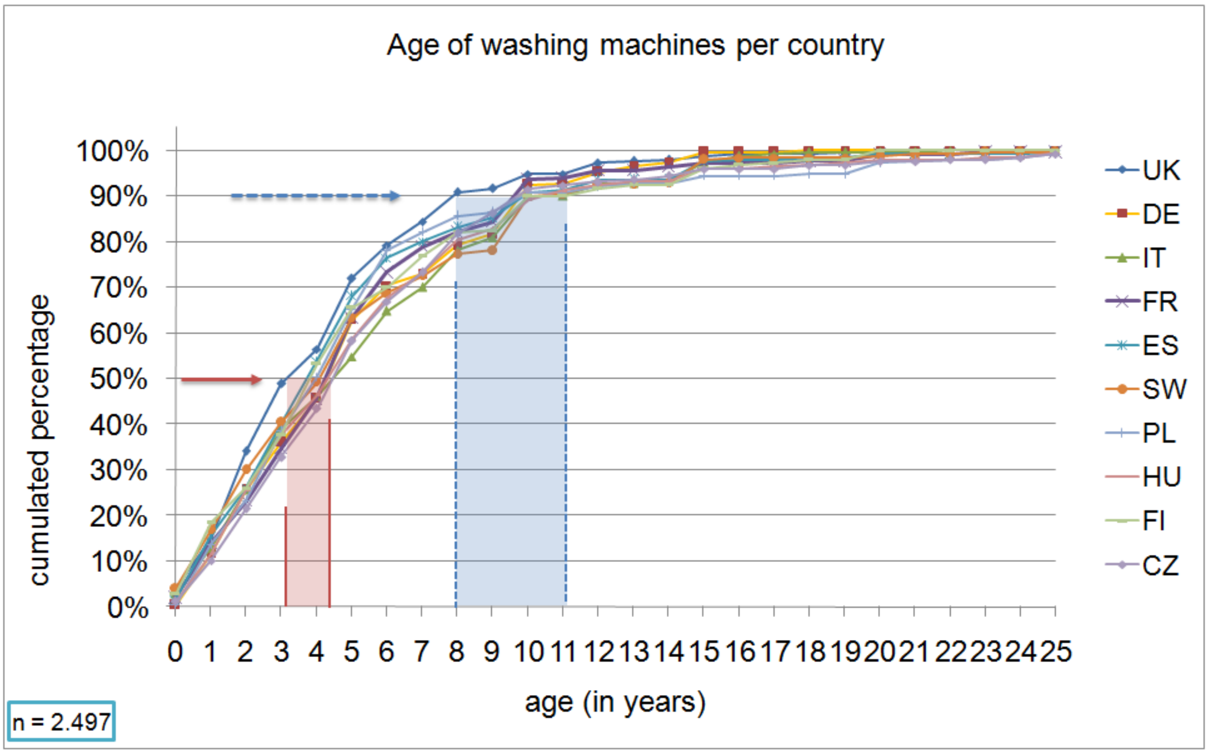


Figure 3.21: age of washing machines per country

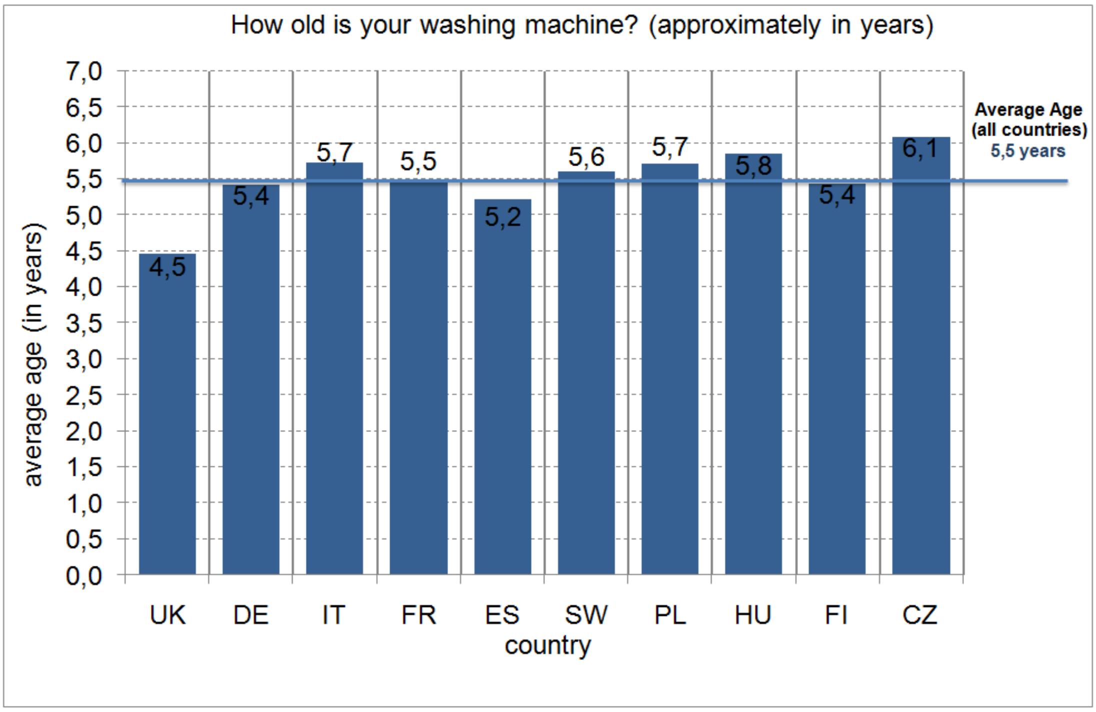


Figure 3.22: average age of washing machines per country

According to published sources the average economic lifetime of **dishwashers** is 10-12 years[17]. The difference between the energy consumption per cycle of an over 10 years old 12 place settings dishwasher and a similar appliance of today is nearly 0,5 kWh[18].The average age of dishwashers (n = 1 722) in all interviewed households is 4,7 years.

[17] Öko-Institut. (2006): http://www.ecotopten.de/download/EcoTopTen_Kriterien_Spuelen.pdf
[18] Stamminger, R. (2006): http://www.haushaltstechnik.uni-bonn.de/waschtag/pdfMulitplikatoren/VortagMultseminar_Stamminger.pdf

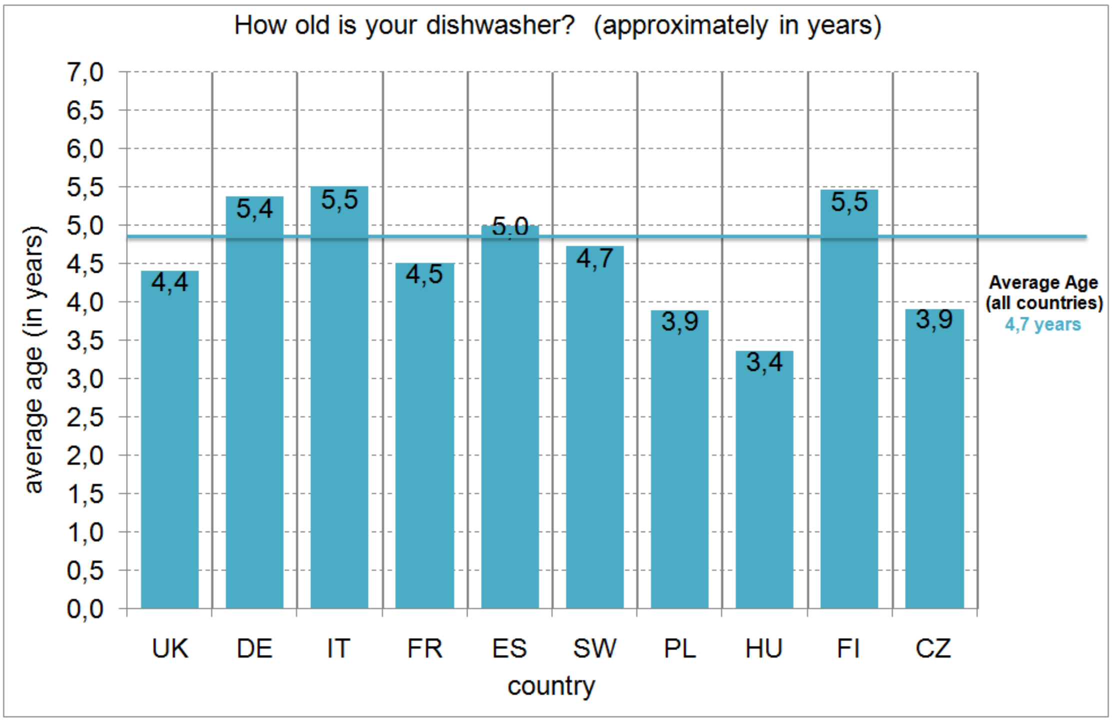


Figure 3.23: average age of dishwashers per country

Half of all dishwashers are younger than three years with 90 % younger than 9,5 years (Figure 3.24). Also the analysis of the age distribution per country (Figure 3.25) shows that 50 % of the dishwashers are between 2,2 and 4,3 years old or younger; 90 % of all appliances have an age younger than between 6 and 11,5 years. Dishwashers with the highest average age can be found in Italy and Finland with 5,5 years, followed by Germany (5,4 years). The youngest machines with an average age < 4 years are found in Polish (3,9 years), Hungarian (3,4 years) and Czech households (3,4 years). Dishwashers in the other countries have and age between 4,4 and 5 years on average.

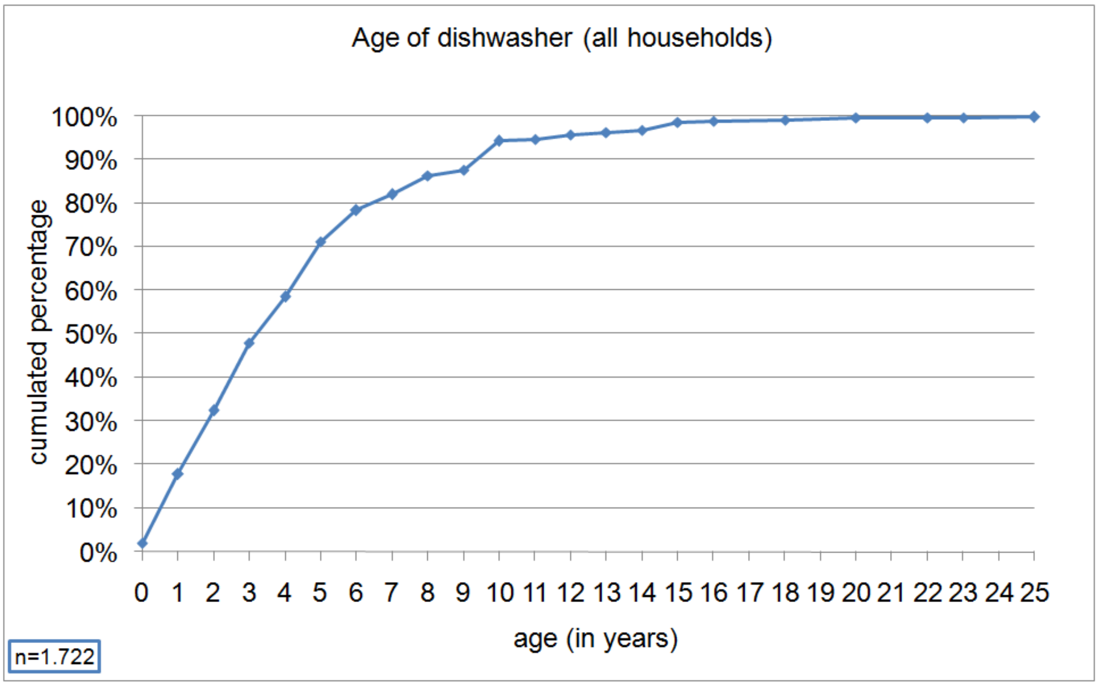


Figure 3.24: age of dishwasher (all households)

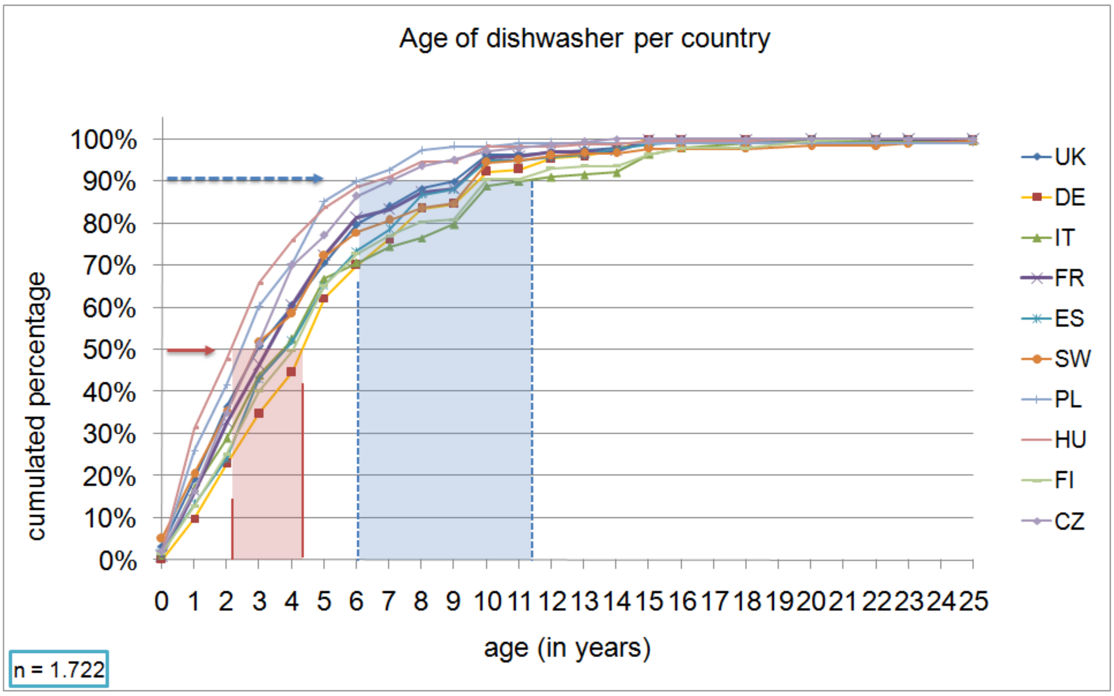


Figure 3.25: age of dishwasher per country

3.3.5.2 Maintenance and repairs

Sixteen percent (n = 1 611) of all household appliances covered by the survey were repaired or serviced (Table 3.4). Washing machines are reported to be the mostly repaired/serviced appliance with a share of 30 % (Figure 3.26), followed by dishwashers with nearly 18 %.

Table 3.4: overview: distribution of repaired/serviced appliances

	total	repaired/ serviced
Dishwasher	1.722	309
Washing machine	**2.497**	**750**
Tumble-dryer	893	133
Refrigerator	2.497	306
Freezer	1.871	78
Chest freezer	564	35
Sum (repaired/serviced)		**1.611**
all appliances		10.044
% of all appliances		**16,0**

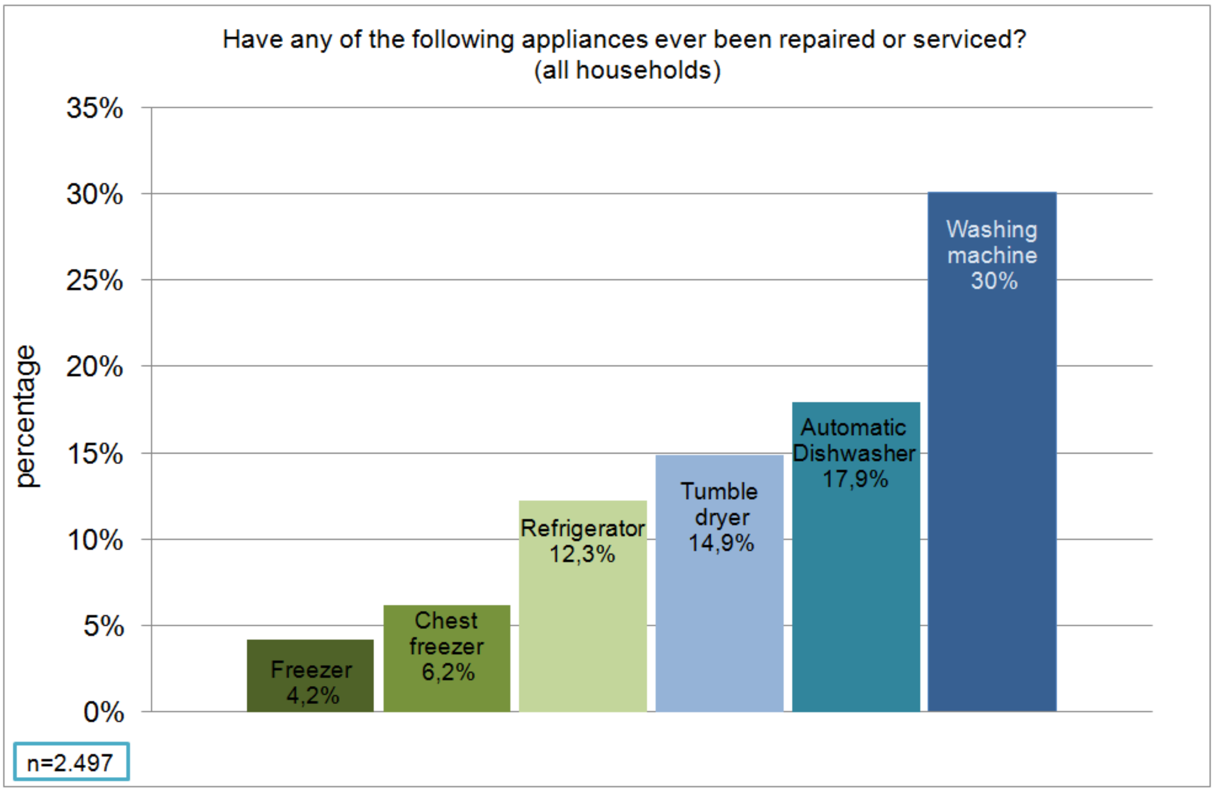


Figure 3.26: appliances – repaired or serviced

The highest share of repaired/serviced **washing machines** (48 %) was found in Spain and the lowest (7 %) in Swedish households, followed by the French ones (16 %) (Figure 3.27). In the other countries values vary between 24 % and 38 %.

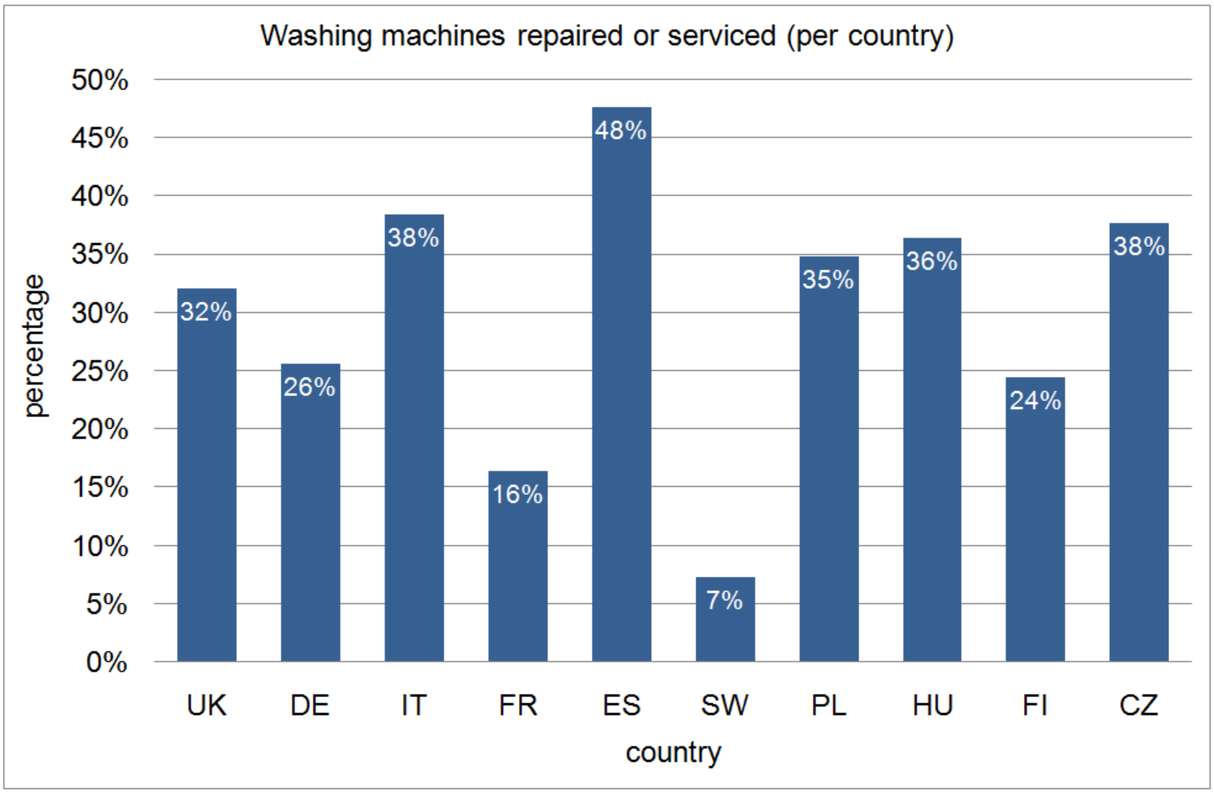


Figure 3.27: washing machines repaired or serviced per country

In comparison with the 5,5 years average age of all washing machines, machines, which have been serviced, were on average 1,3 years older (average 6,8 years) (Figure 3.28), therefore the servicing/repairing resulted in an extension of the lifetime.

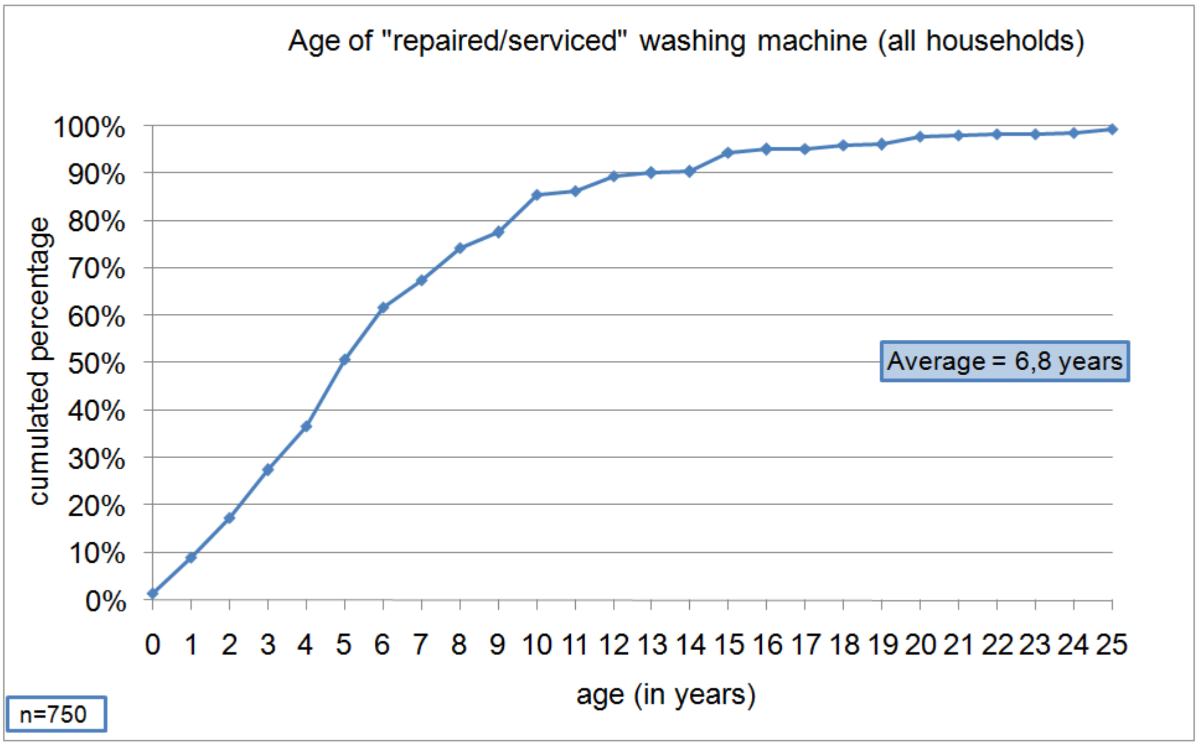


Figure 3.28: age of „repaired/serviced“ washing machines

One third of **dishwashers** (35 %) in Italy have been repaired or serviced. United Kingdom, Spain and Czech Republic followed with a percentage between 19 to 24 % (Figure 3.29). The lowest percentage of repaired/serviced dishwashers can be found in Sweden with only 6 %.

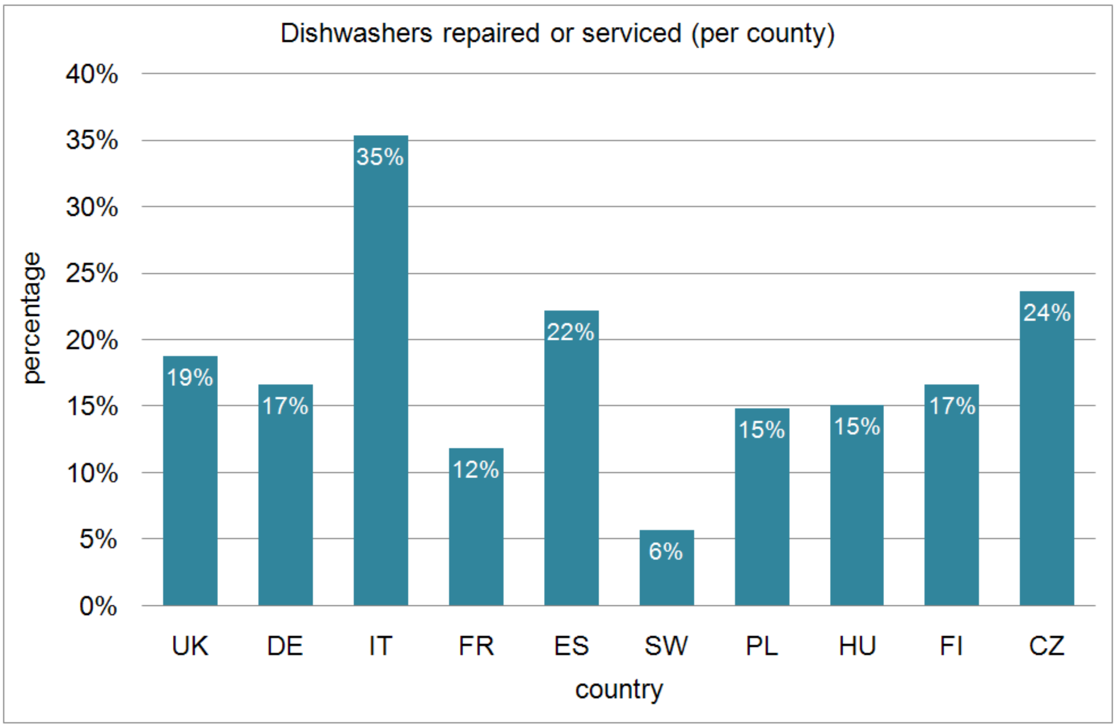


Figure 3.29: dishwashers repaired or serviced per country

The average age of repaired or serviced dishwashers is 6,4 years: 50 % are younger than 4,5 years and 90 % are younger than 13 years. (Figure 3.30). In comparison with non-repaired dishwashers they are between 1,7 and 3,5 years older.

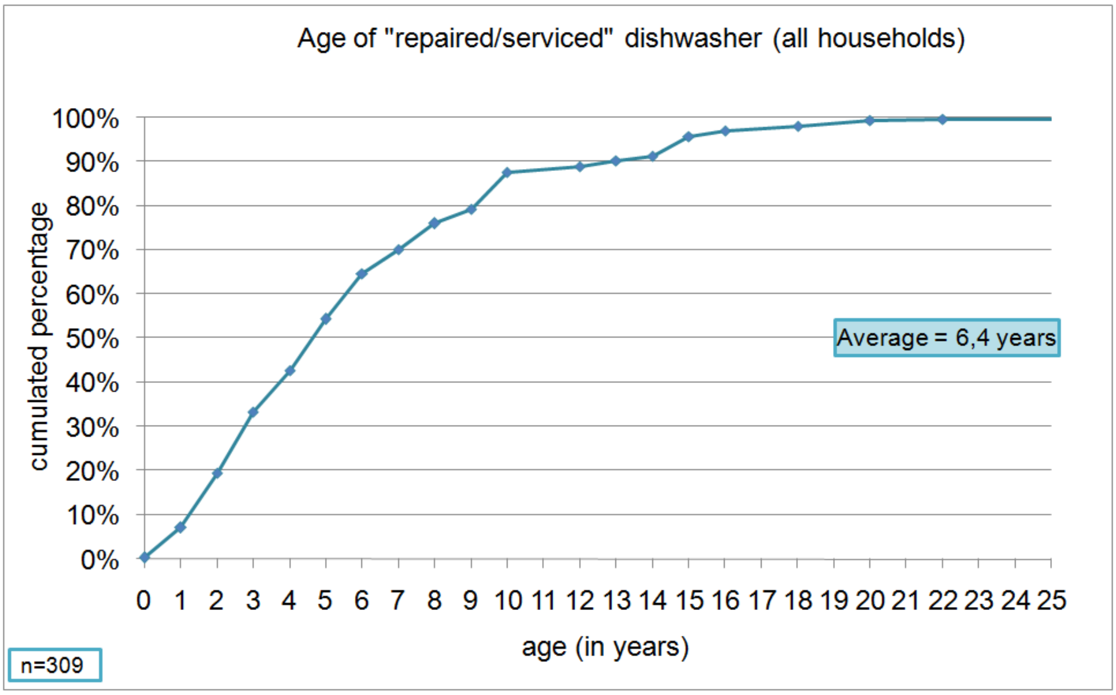


Figure 3.30: age of „repaired/serviced" dishwashers

3.3.5.3 Second hand market

Another possible barrier for the implementation of eco-design innovations is the stock of second-hand purchased appliances in households. Consumers may choose to replace broken or missing appliances by second-hand machines, which have lower performance than the new models on the market.

The consumers were asked which appliances they purchased second-hand. In general, 6,3 % (n = 633) of all appliances were purchased this way (Table 3.5). Washing machines only show a share of 5,6 % of second-hand purchases, dishwashers a 6,6 % share. (Figure 3.31).

Table 3.5: overview: distribution of second hand appliances

	total	second hand
Dishwasher	1.722	114
Washing machine	**2.497**	**140**
Tumble-dryer	893	59
Refrigerator	2.497	122
Freezer	1.871	118
Chest freezer	564	80
Sum (second hand)		**633**
all appliances		10.044
% of all appliances		**6,3**

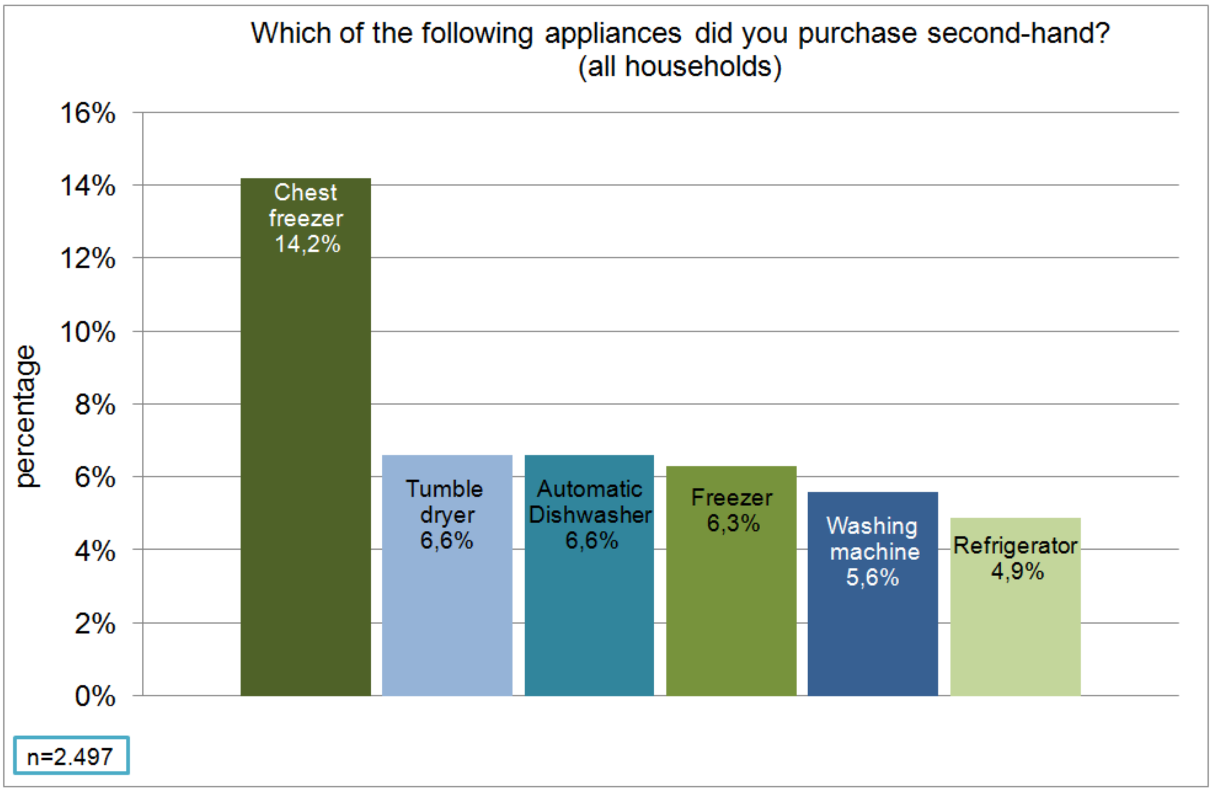


Figure 3.31: appliances – purchased second-hand

Most of second-hand **washing machines** could be found in Finland (10 %), Sweden (8,8 %) and the Czech Republic (8,1 %) (Figure 3.32). The lowest percentage of second-hand washing machines was found for Italian households with only 1,2% and for Spanish households with 2 %. On average second-hand washing machines are 7,3 years old or 1,8 years older in comparison to all washing machines (average age 5,5 years); 10 % are older than 13 years and 50 % are older than 5,5 years. (Figure 3.33).

Comparing these results with the energy efficiency improvements achieved in the last decade, second-hand appliances are in general less efficient: therefore, the re-selling of washing machines older then 10 years through the second-hand market is not an energy saving behaviour.

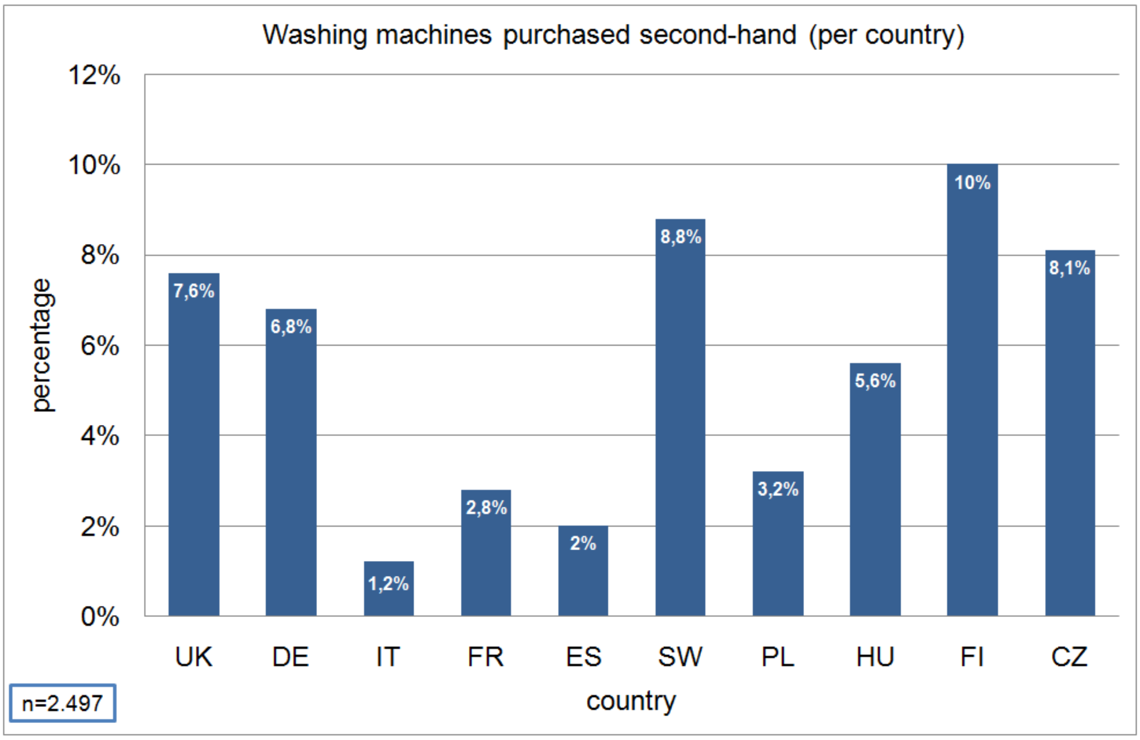


Figure 3.32 washing machines purchased second-hand per country

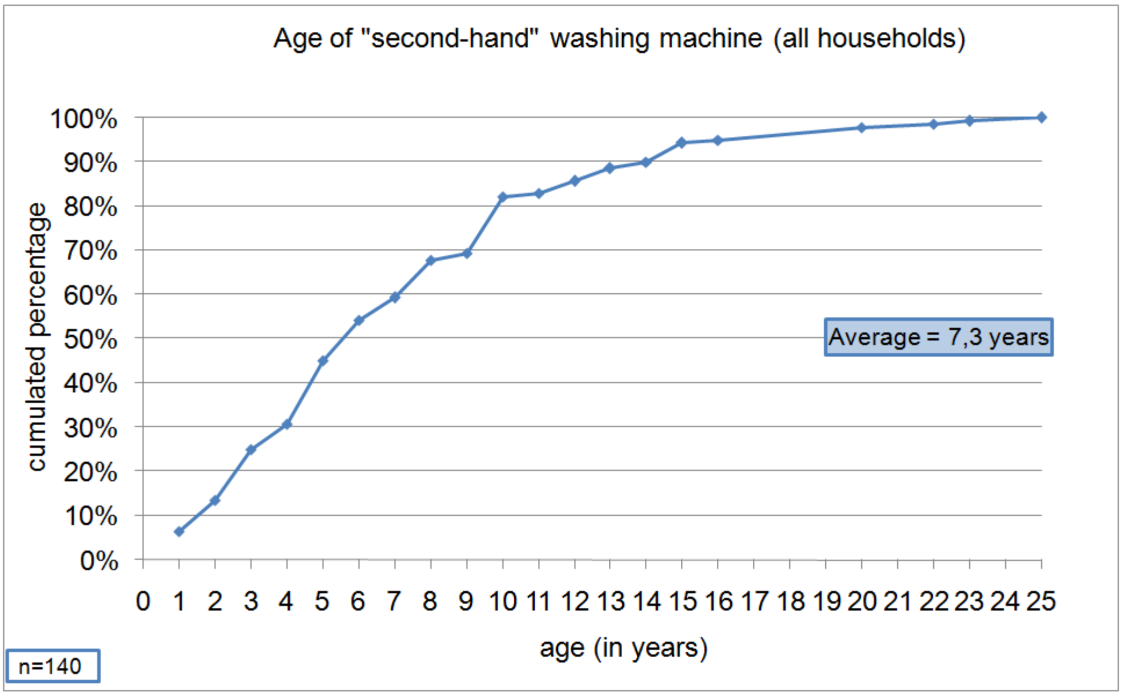


Figure 3.33: age of „second hand“ washing machines

The highest share of second-hand **dishwashers** can be found in Finnish households with 10,7 % and in Sweden and the Czech Republic with 8,5 % and 8,6 %, respectively (Figure 3.34). The results for Italy show the smallest share of second-hand dishwashers with a percentage of only 2,7.

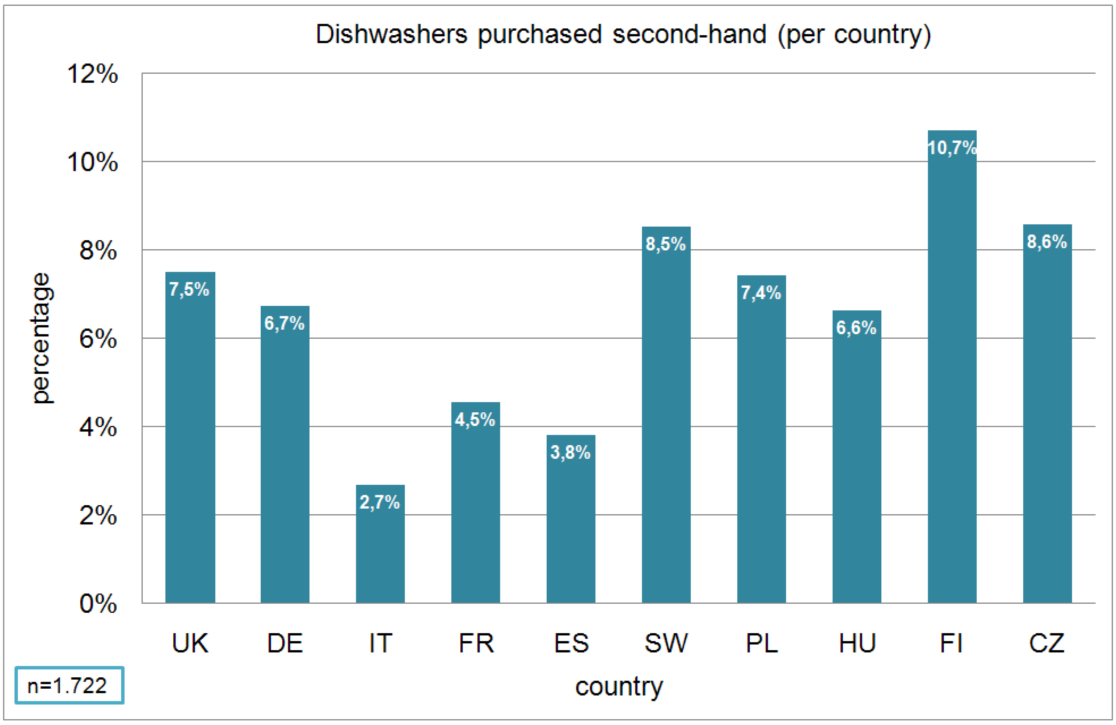


Figure 3.34: dishwashers purchased second-hand per country

The average age of second-hand dishwashers is 6,1 years, with 50 % younger than 4,5 years and nearly 90 % younger than 10 years (Figure 3.35).

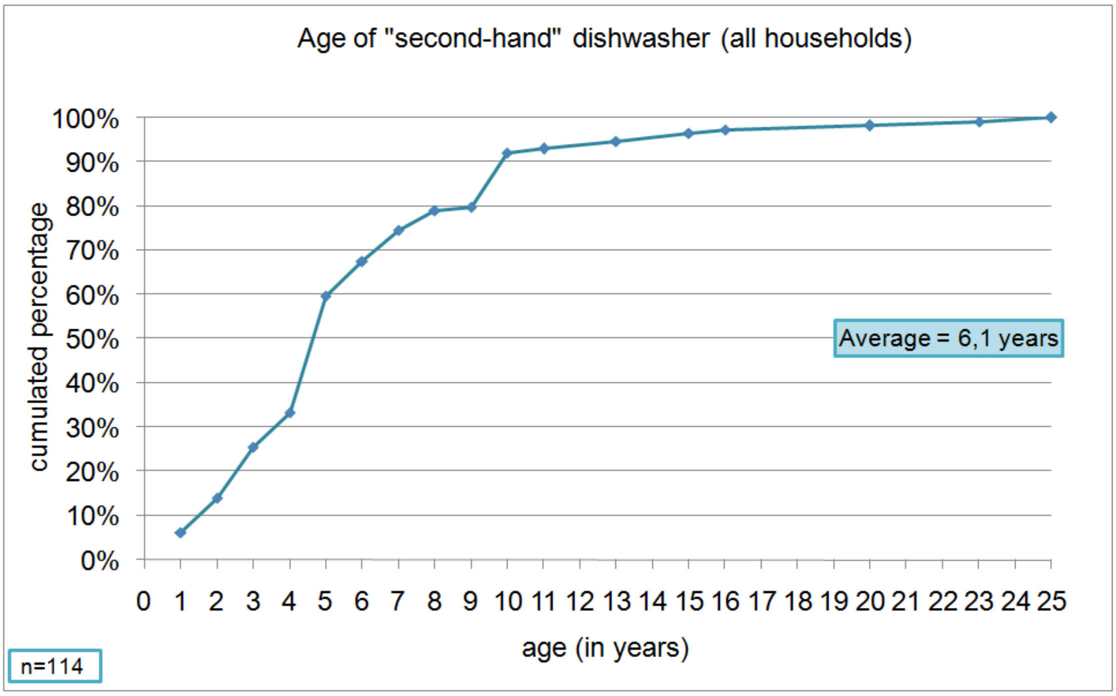


Figure 3.35: age of „second hand“ dishwasher

3.3.6 Consumer attitude towards energy saving options

Over 60 % of the interviewed consumers estimate the influence of a washing machine on the overall energy consumption of a household as “great” or even more, “massive” (Figure 3.36). In addition, the consumers consider the washing machines as the most energy consuming appliance of the listed products. The results for dishwashers show that nearly 70 % of all consumers think that the influence is “moderate” (35,2 %) or “great”(32,6 %).

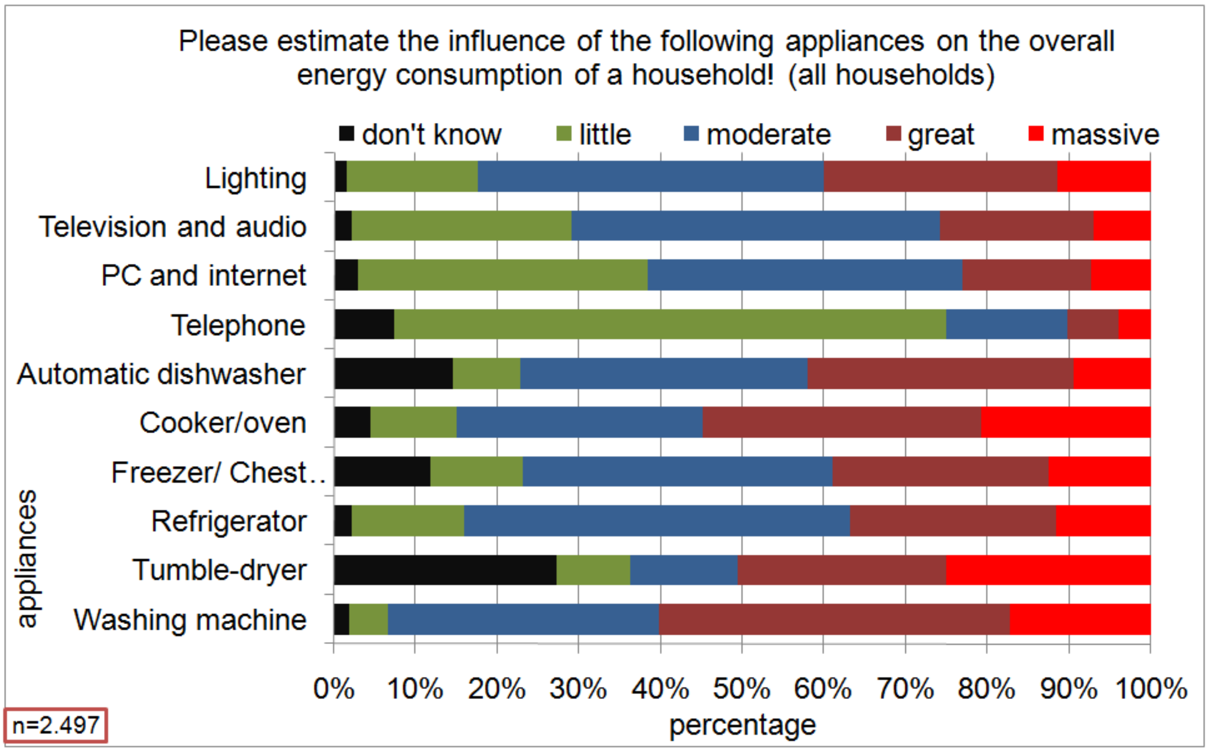


Figure 3.36: estimation: influences of appliances on the energy consumption of a household

To identify possible barriers to eco-design innovation and effective ways for their implementation, the consumer opinion about energy saving options was analysed.

Consumers were asked to select the preferred options to save energy or money.

The analysis of the answers for **washing machines** shows that most of the consumers (73,8 %) would definitely use *economic programmes* or would perhaps choose this option (22,5 %) more frequently than the other listed options (Figure 3.37). The options "*longer programme duration*" and *"delay start"* achieved similar values: in both cases 80 % of the consumers would "use" or "perhaps use" them. The lowest consideration was give to the use of "*hot water supply*" with 28,3 % of consumer not willing to use and only slightly more than 30 % clearly accepting it.

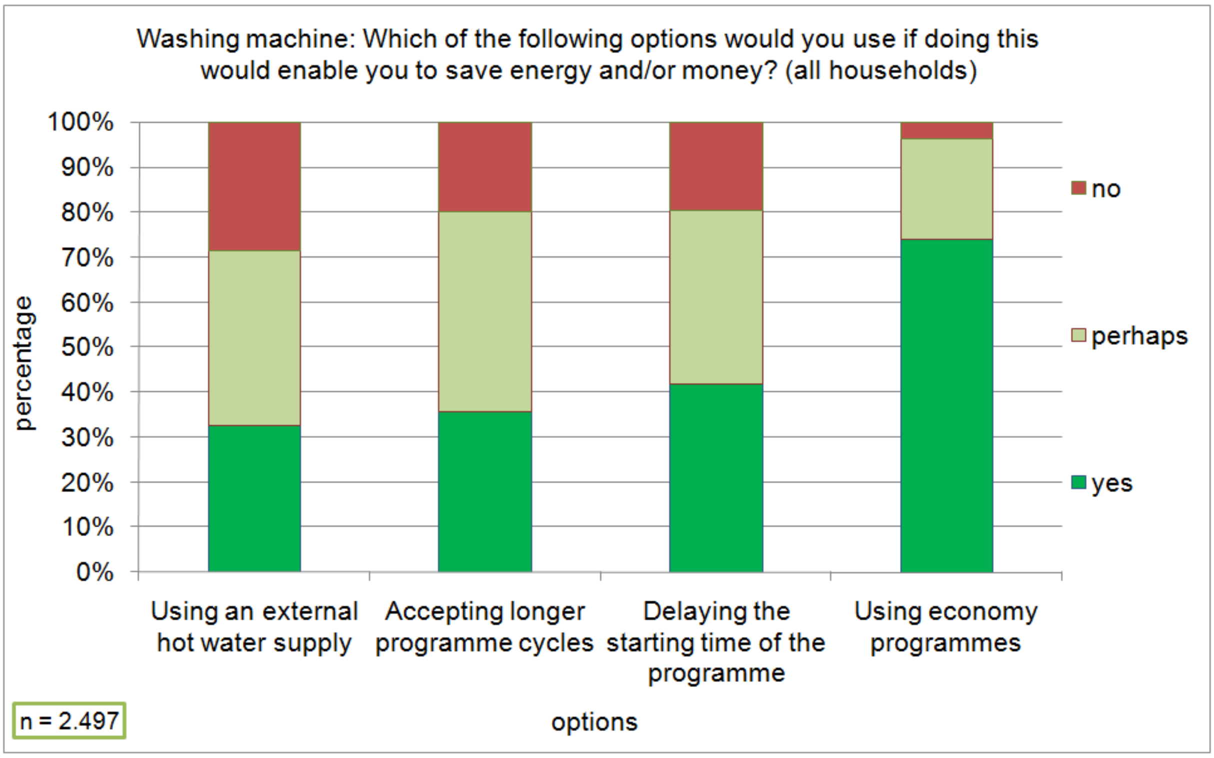


Figure 3.37: washing machines: consumer attitudes – energy saving options

For **dishwashers**, most of the consumers (72,1 %) would choose the *eco-programme* (Figure 3.38). Nearly 80 % of all consumers would use or consider using the *start-delay option* or *longer programme cycles* if this would save energy and/or money. The results concerning the use of an external *hot water supply* are ambiguous: 30,4 % of consumers would choose this option and 28,7 % would refuse it; the remaining consumers will perhaps choose the option.

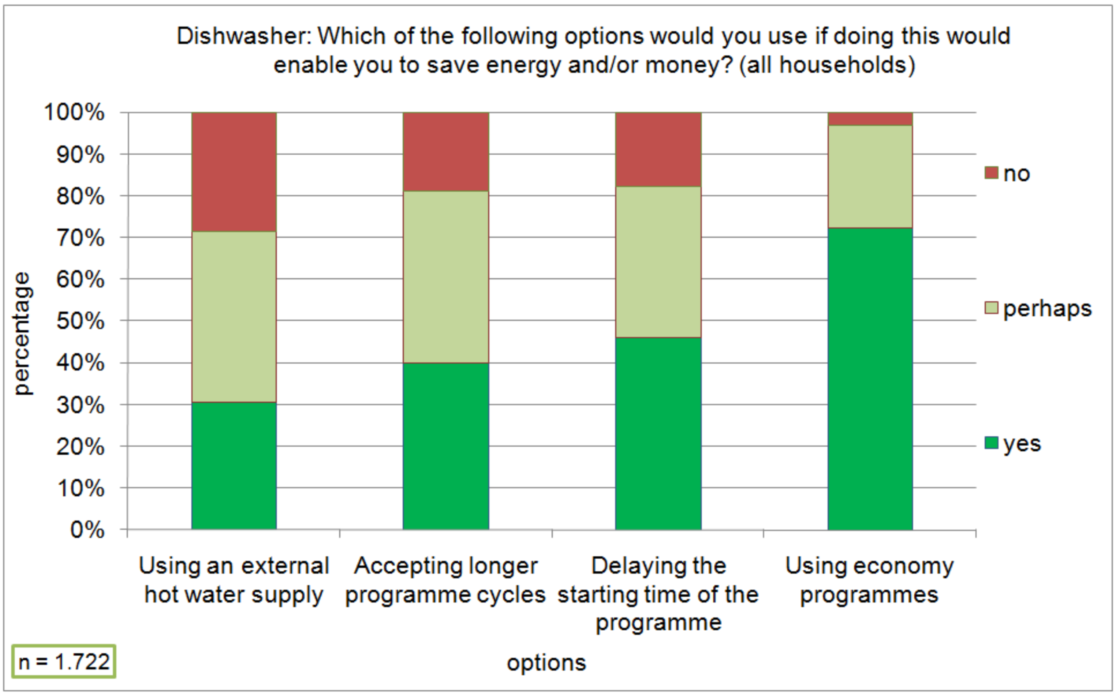


Figure 3.38: dishwasher: consumer attitudes – energy saving options

3.3.7 *The purchasing of a dishwasher*

All interviewed consumers without a dishwasher were asked for the reasons for not having a dishwasher. The most named reason is *shortage of space in the kitchen* (56,8 %) (Figure 3.39), frequently mentioned by consumers in United Kingdom, Germany, Italy, Sweden and Poland (Figure 3.40). Another frequent reason is that there are *not enough dishes* to justify the purchase (49,3 %), which is the main justification for French, Spanish, Hungarian and Czech consumers (with answers between 57 % and 70 %). The reason that consumers are *just happy without a dishwasher* is mentioned with an average percentage of about 39 %, in particular for the Finnish consumers (57,1 %); the initial cost is too high for 23,5 %. For nearly 15 % of the consumers the *high energy and water consumption* is the reason against the purchasing of the dishwasher: for consumers in Poland, Hungary, Czech Republic and United Kingdom this is an important point (17,6-22,2 %).

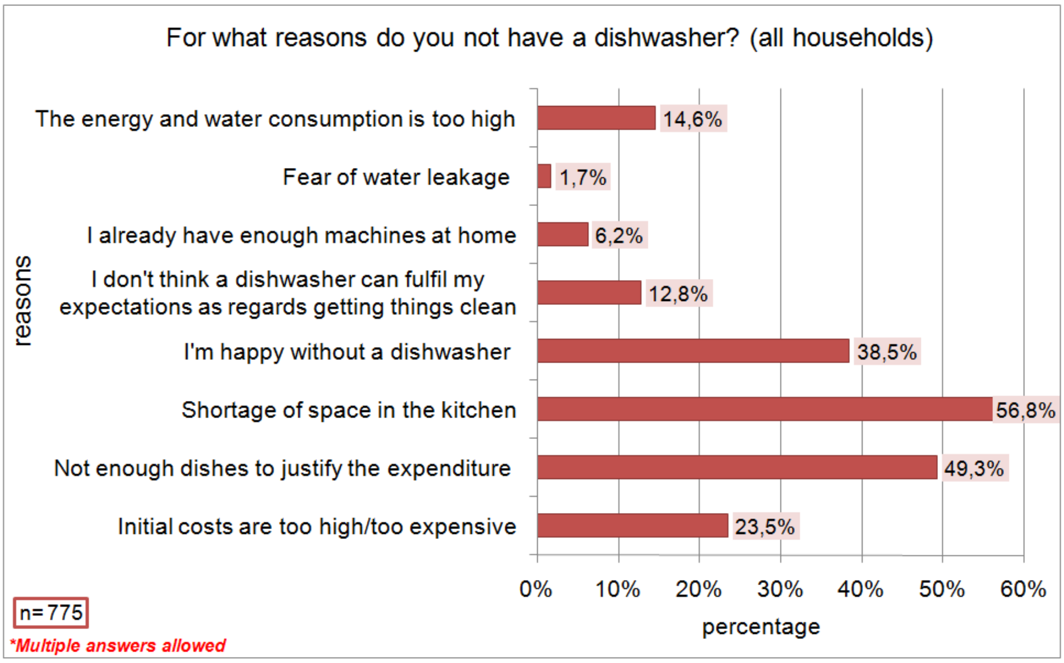
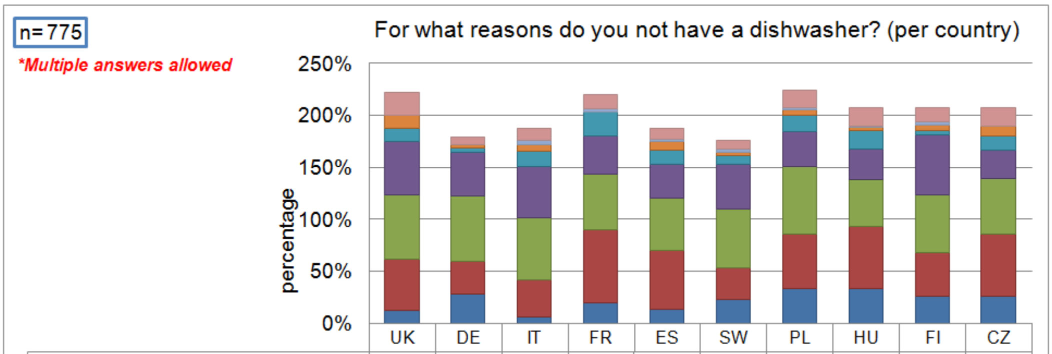


Figure 3.39: reasons for not having a dishwasher



	UK	DE	IT	FR	ES	SW	PL	HU	FI	CZ
The energy and water consumption is too high	22,2%	7,0%	11,1%	13,3%	10,9%	8,1%	17,6%	17,9%	14,3%	17,8%
Fear of water leakage	0,0%	0,0%	4,8%	3,3%	2,2%	2,7%	1,4%	1,2%	3,2%	0,0%
I already have enough machines at home	12,7%	3,5%	6,3%	0,0%	8,7%	4,1%	5,6%	2,4%	4,8%	9,3%
I don't think a dishwasher can fulfil my expectations as regards getting things clean	12,7%	3,5%	14,3%	23,3%	13,0%	8,1%	15,5%	17,9%	4,8%	14,0%
I'm happy without a dishwasher	50,8%	42,1%	49,2%	36,7%	32,6%	43,2%	33,8%	29,8%	57,1%	27,1%
Shortage of space in the kitchen	61,9%	63,2%	60,3%	53,3%	51,1%	56,8%	64,8%	45,2%	55,6%	53,3%
Not enough dishes to justify the expenditure	49,2%	31,6%	34,9%	70,0%	56,5%	29,7%	52,8%	59,5%	42,9%	59,8%
Initial costs are too high/too expensive	12,7%	28,1%	6,3%	20,0%	13,0%	23,0%	33,1%	33,3%	25,4%	26,2%

Figure 3.40: reasons for not having a dishwasher per country

If, as previously mentioned, most of the consumers consider the dishwashers as having a moderate or great influence on the overall household energy consumption, in detail over 40% of all households without dishwashers “don’t know” the energy consumption of a dishwasher, in comparison with households with a dishwasher (2,3 % “don’t know”) (Figure 3.41). Especially Polish, Spanish and Czech consumers can hardly estimate the influence of the dishwasher (57 %; 64,1 %; and 65,4 %) on the household energy consumption (Figure 3.42). A higher number of the Spanish consumers without a dishwasher estimate the influence of a dishwasher as “little” compared with the average results of the other European countries. A “great” or “massive” influence of the dishwasher on the energy consumption is mostly mentioned by French (13,3 %) and Italian (23,8 %) consumers (Figure 3.43). This opinion was given also by French and Italian consumers with a dishwasher (21,4 % and 19,8 %).

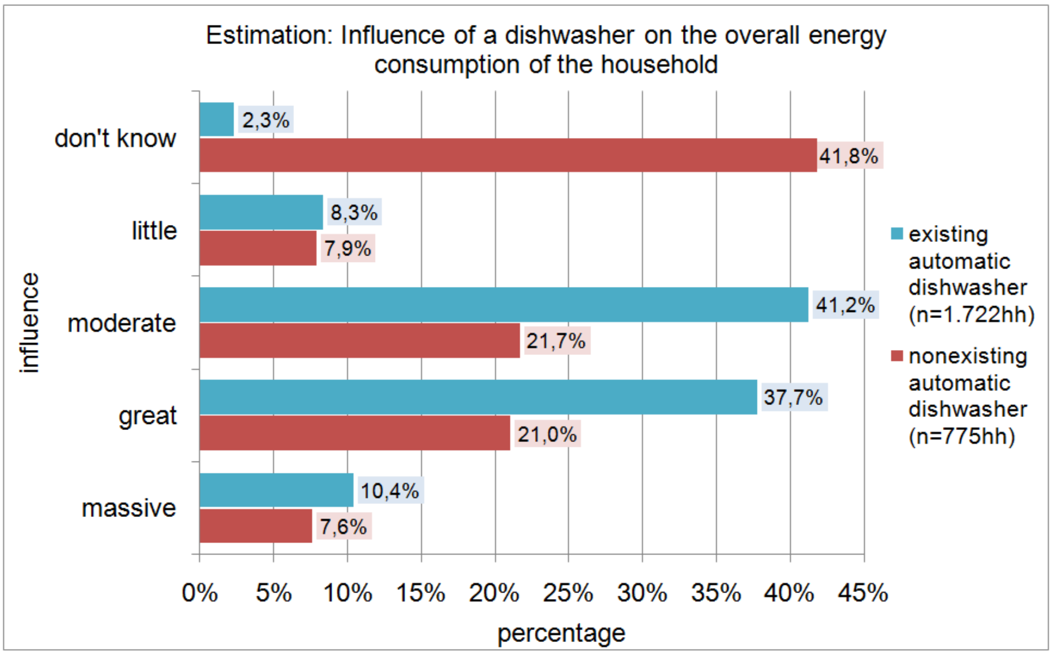


Figure 3.41: estimation – influence dishwasher on the energy consumption (households with vs. without a dishwasher)

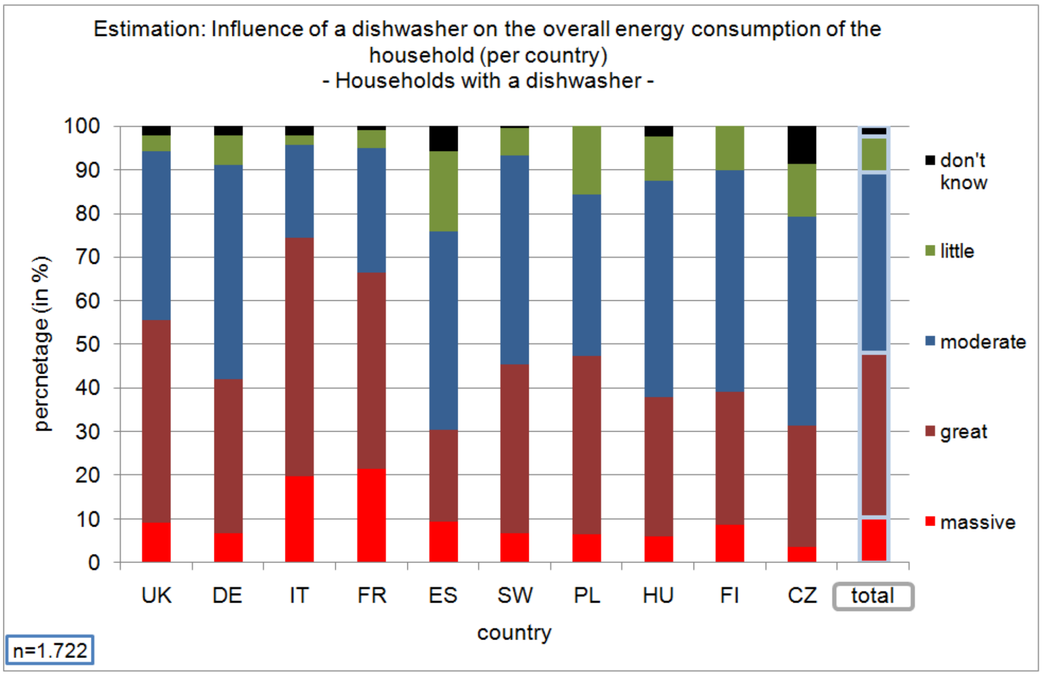


Figure 3.42: estimation: influence of a dishwasher on the energy consumption of a household (households with a dishwasher per country)

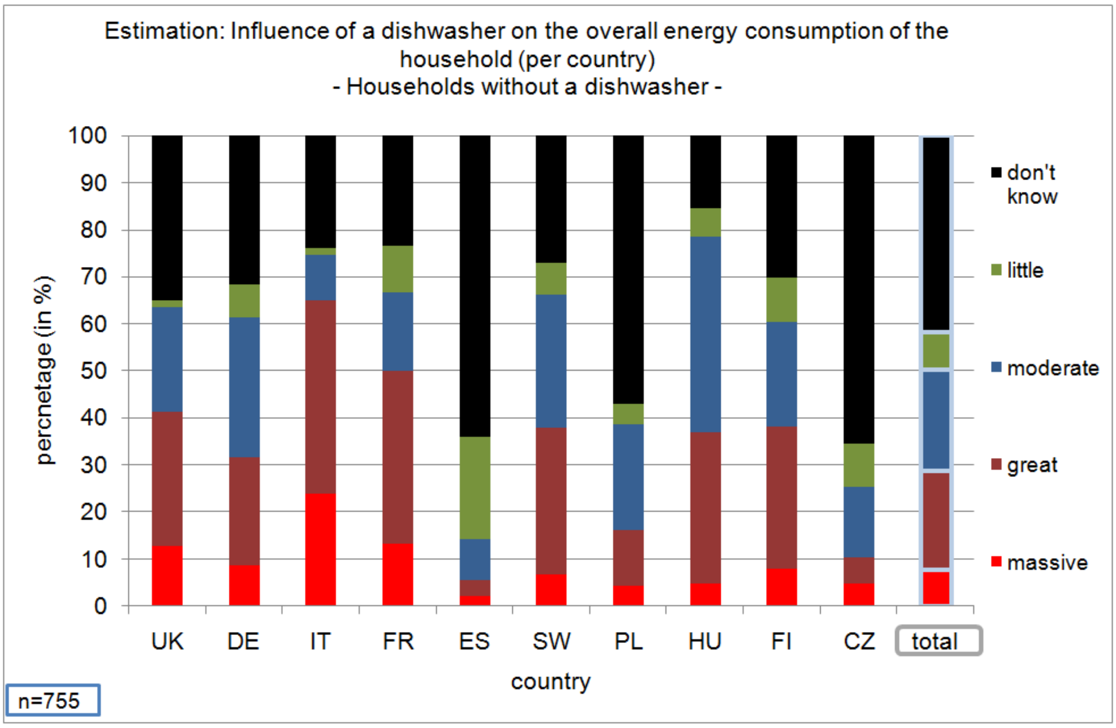


Figure 3.43: estimation: influence of a dishwasher on the energy consumption of a household (Households without a dishwasher (per country))

For 23,5 % of all consumers, the *high initial costs* are deterring, especially for Polish and Hungarian consumers (nearly 33 %); with the exception of German and Finnish consumers the rest of the interviewed European households also indicated that a dishwasher *wouldn't fulfil their expectations in cleaning performance*. On average nearly 13 % mentioned this point as a reason for not having a dishwasher. The less important reasons are *fear of water leakage* (1,7 %) and *high equipment level* (6,2 %).

3.4 User Defined Parameters: Washing Machines

3.4.1 Consumer behaviour and appliance energy consumption & saving

Washing machines are operated on consumer demand only. Therefore their energy consumption in the use phase is due by the listed, mainly consumer driven, factors:

- Ambient conditions
- Frequency of operation
- Selected programme and its consumption
- Programme temperature in combination with amount (and type) of detergent
- Option/feature chosen
- Machine efficiency under real use conditions
- Load size
- Low power mode (delay start, left-on, off, etc.)

The ambient where the washing machine is located and the resources that are used may have some influence on the actual consumption of these resources. While it may be calculated that the influence of the ambient temperature is relatively small, the temperature of the supply water may have some more significant influence, if the temperature of the selected wash programme is higher that the inlet water temperature.

The use of pre-heated water (by other sources than electricity) was used extensively in UK in the past. Due to the tendency to wash at lower temperatures and due to the need for additional installations (double piping for installation and the washing machine) this option is less and less attractive[19] (see Task 4 for a more detailed discussion of this infrastructural option).

A metering study[20] developed in Germany has shown the need to correct the ”theoretical energy consumption” based on 15 °C water inlet temperature by a constant value of 180 Wh, which may be explained by a lower water inlet temperature. No statistical data on the average annual temperature of the cold water supply in European households could be found.

The frequency of operation mainly depends on the household size, as this defines the amount of load to be treated. For washing machines consumer research of the real washing practice in 100 households in Germany for one month has roughly shown a linear increase of the number of washing cycles with the number of persons living in the household (Figure 3.44). The same study has measured the weight of the laundry washed and concluded, that per person per week an almost constant load of 4,0 kg of laundry was washed.

In this study also the programme used was recorded. The analysis (Figure 3.45) shows that the most frequently used programme/temperature combination in Germany is still the cotton 60°C programme, while the most frequently selected temperature is 40 °C, due to the variety of different programmes available at this temperature (e.g. cotton, easy-care, silk, wool). The same study also measured the real wash load of washing machines (Figure 3.46). The weight of the load is different for the various types of garments/programme types and shows a frequent under-loading for the cotton programmes and over-loading for the other types of programmes, compared to what is recommended by the manufacturer as maximum load. For cotton programmes alone (Figure 3.47) the average load used is 3,2 kg, but goes up to more than 5 kg for some loads.

---

[19] http://www.mtprog.com/ApprovedBriefingNotes/PDF/MTP_BNW15_2007April10.pdf

[20] Berkholz P., et al.: Verbraucherverhalten und verhaltensabhängige Einsparpotentiale beim Betrieb von Waschmaschinen, Shaker-Verlag, 2007

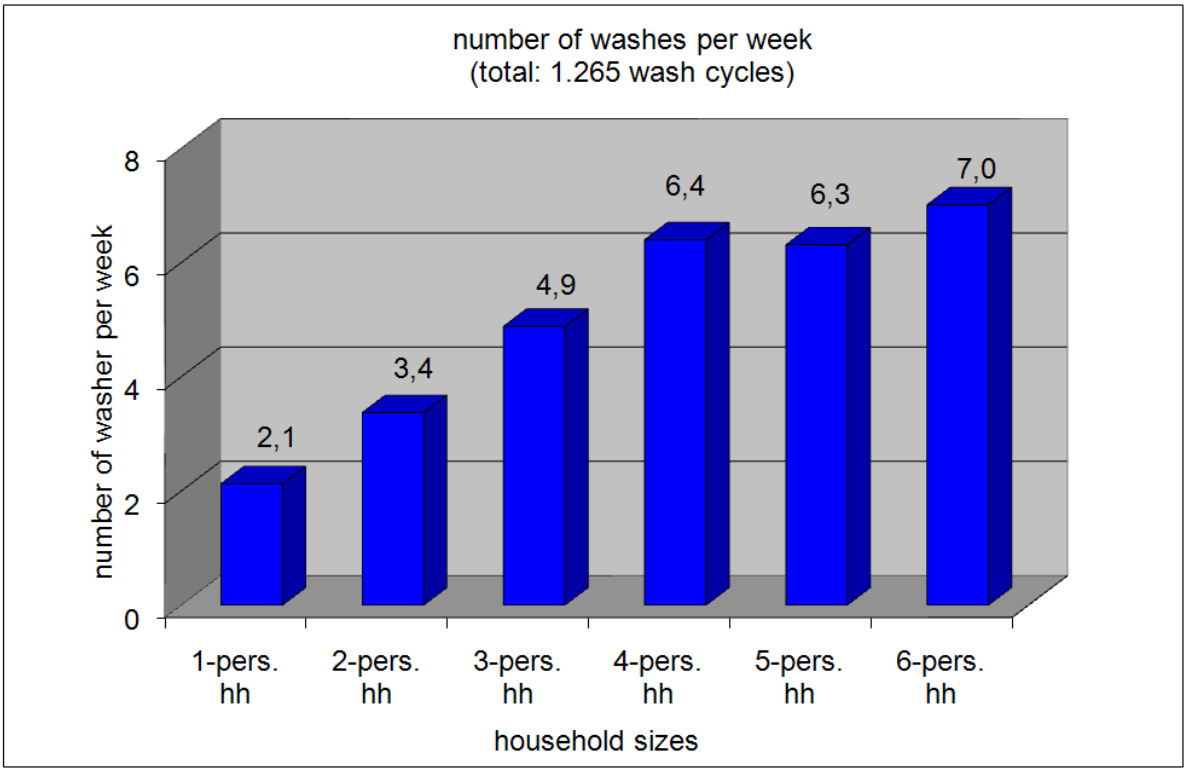


Figure 3.44: number of washes per week in relation to household size (source: Berkholz P., et al. [20])

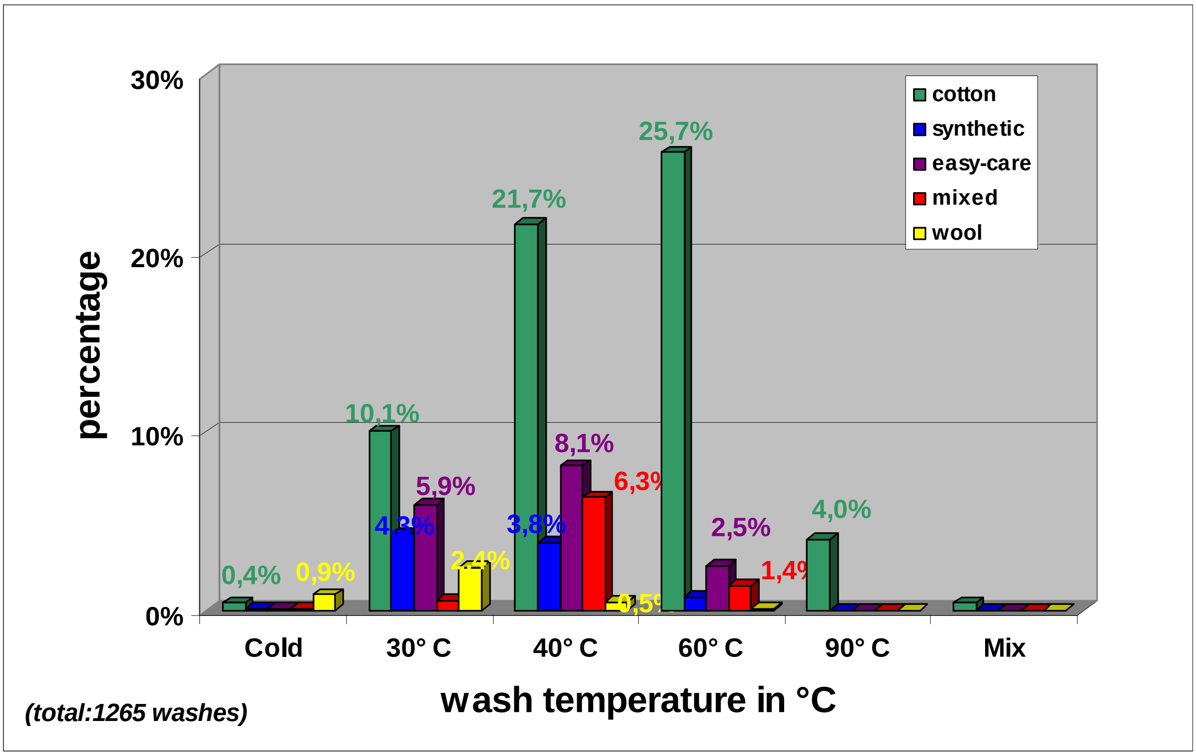


Figure 3.45: distribution of wash programmes and temperature (source: Berkholz P., et al. [20])

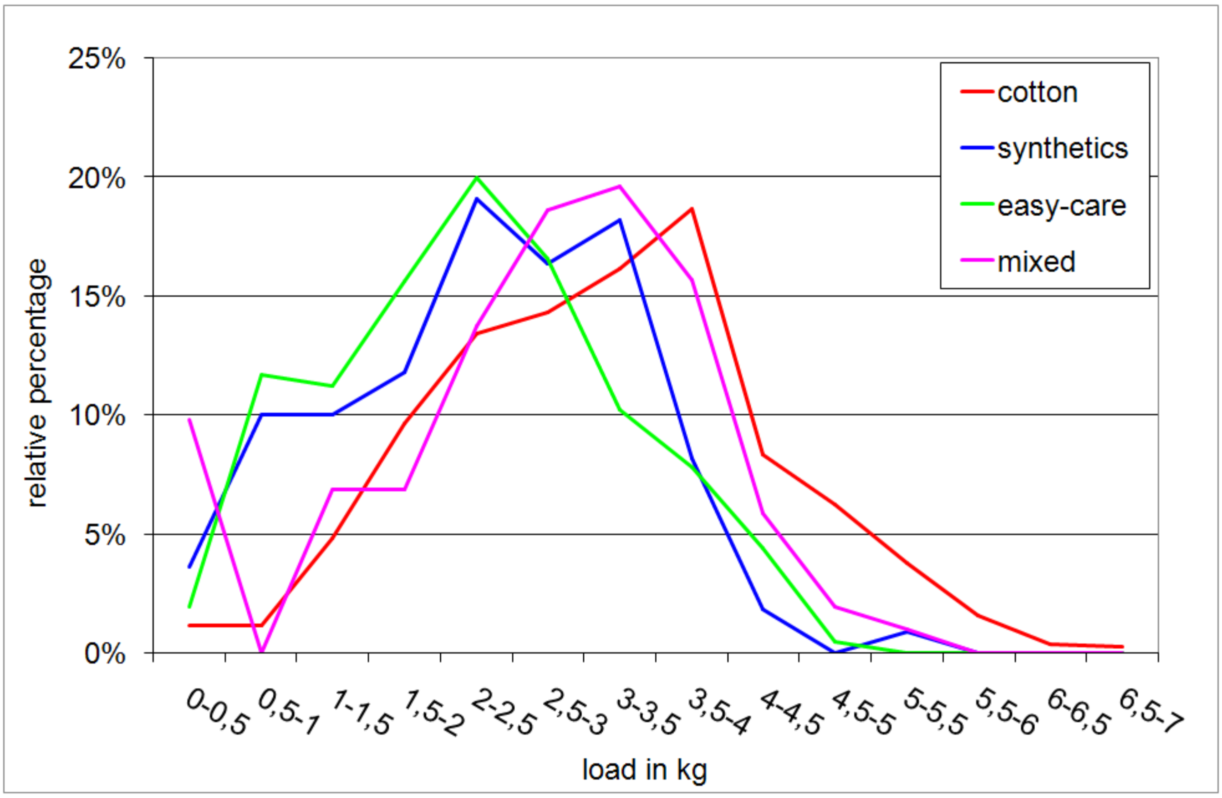


Figure 3.46: distribution of the load size for various programme types (source: Berkholz P., et al. [20])

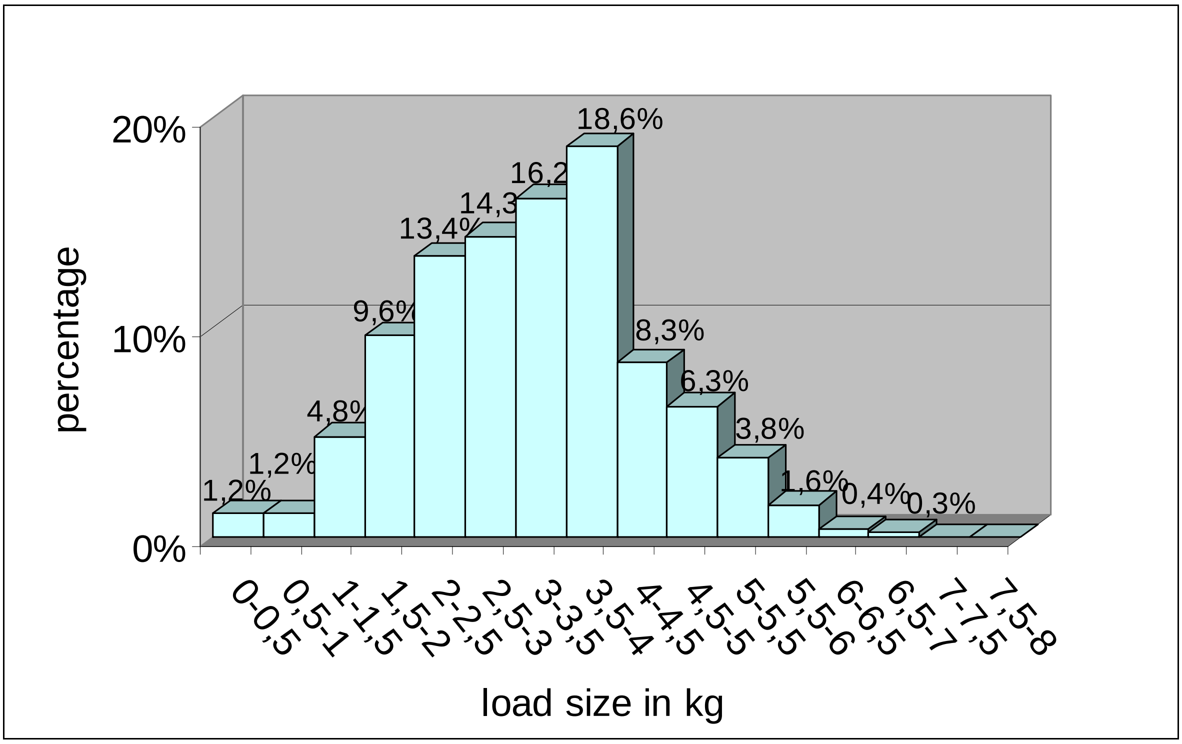


Figure 3.47: relative frequency of load sizes washed in cotton programmes (source: Berkholz P., et al. [20])

The measured real energy consumption in the studied 100 households (Figure 3.48) shows for cotton load an average of 1,02 kWh/cycle, averaging all the different temperatures, load sizes and machines used in the households. For other programmes the average consumption is even lower than for cotton, due to the lower washing temperature for these programmes. The programme temperature has the highest influence on the machine energy consumption (Figure 3.49), although the distribution is broad due to the various load sizes and machine efficiency levels found in the households.

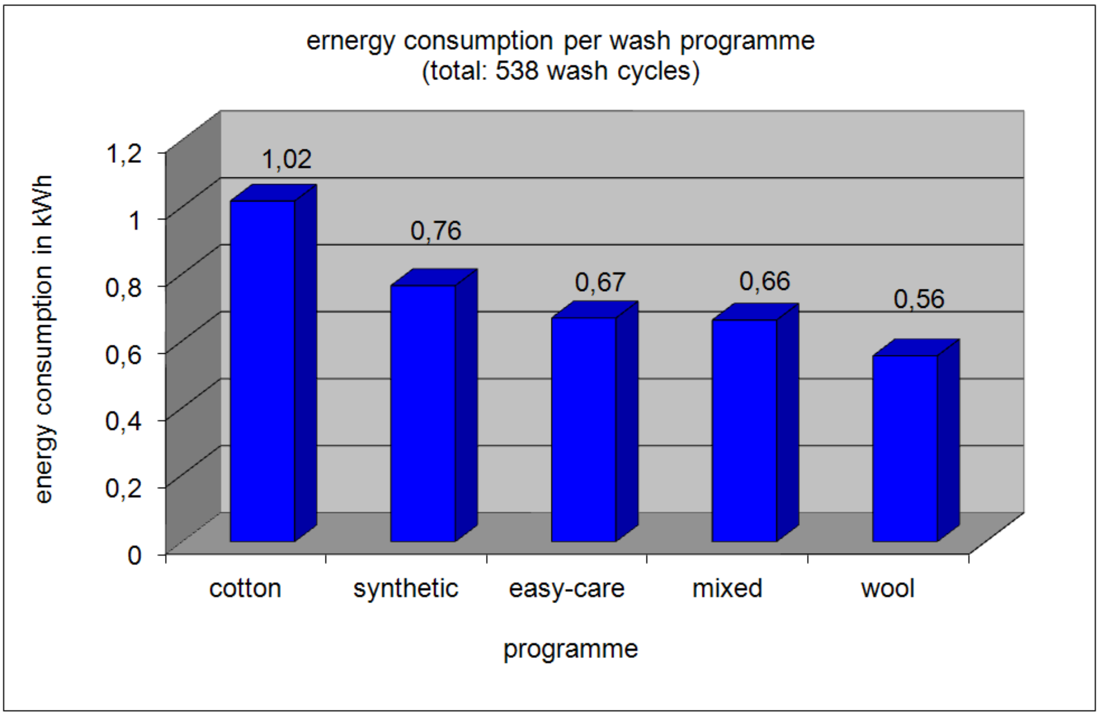


Figure 3.48: average measured energy consumption for various programme types selected (source: Berkholz P., et al. [20])

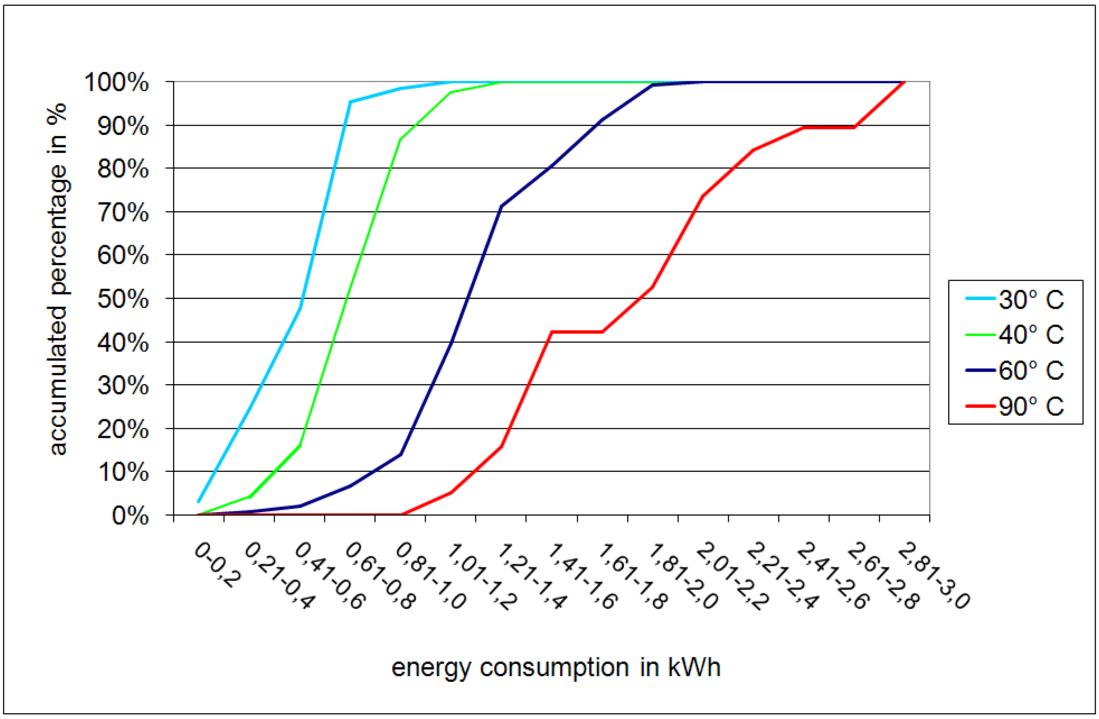


Figure 3.49: cumulated distribution of energies consumed at different temperatures selected (source: Berkholz P., et al. [20])

The average measured energy consumptions found in the German study may be compared to values previously calculated using the AISE stock model[21] for EU15: some significantly lower values for the boil wash programme and somewhat higher values for low temperature programmes at 30 °C are found (Figure 3.50). This increase in the energy consumption at low wash temperatures may be explained with an increased washing performance at lower temperatures, which in turn allows the use of these programmes for everyday washing, while some year ago these programmes where more considered as refreshing programmes only. The calculated energy consumption increase per degree Celsius between 40 and 60 °C nominal wash temperature for both studies is 0,031 kWh/K or 0,027 kWh/K.

These changes in programme efficiency are possible for all programme types and temperatures and are closely linked to the type and amount of detergent used. Temperature and amount of detergent are balanced in such a way, that one may be substituted by the other to a large extend without decreasing the washing performance. This was experimentally shown[22] in tests using the nominal (100 %) amount of detergent for 40, 60 and 90 °C cotton programmes. In addition, the washing machines were operated with reduced (50 %) and increased (150 %) detergent dosage for the 60 °C cotton programme. The tests were developed to take into account the flexibility of the users in adjusting the performance of their washing machines by choosing different temperatures or by varying the amount of detergent.

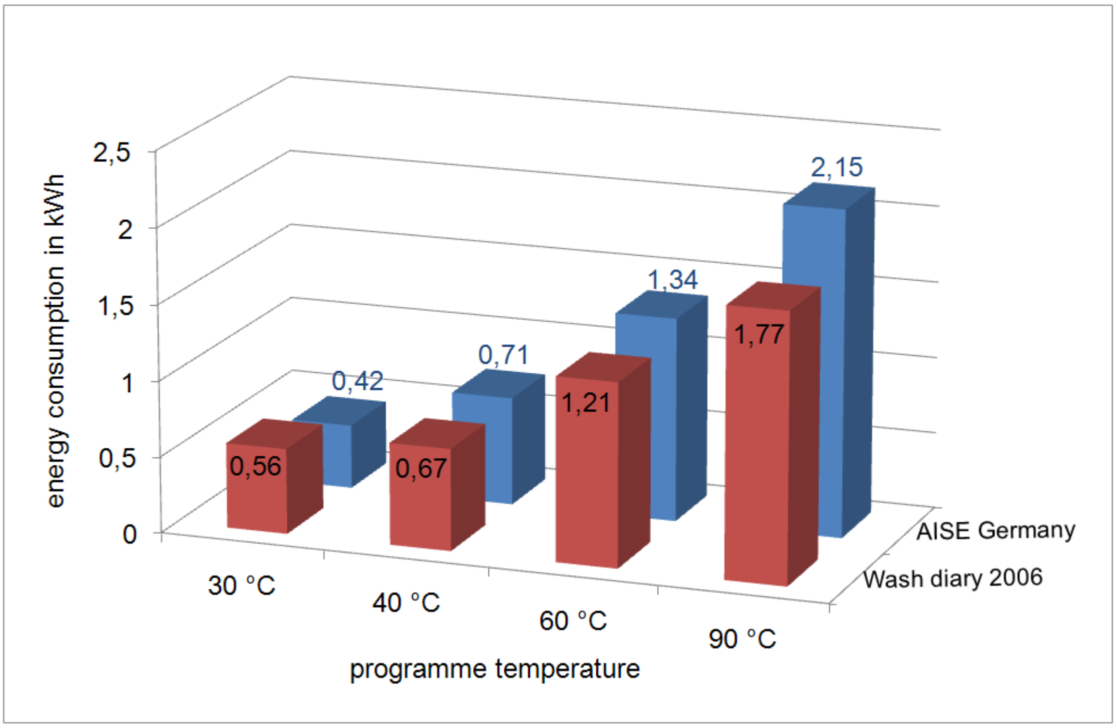


Figure 3.50: average energy consumption at the different wash temperatures observed, compared to a stock model prediction (picture: Univ. Bonn)

---

[21] AISE Code of Good Environmental Practice: Final report to the European Commission 1996-2001, Annex 5 (www.aise.com)

[22] Stamminger, R., Barth, A., Dörr, S.; Old Washing Machines Wash Less Efficiently and Consume More Resources. In: Hauswirtschaft und Wissenschaft 3/2005, p. 124-131

The results are presented in terms of the index and washing efficiency class as defined in the European energy labelling scheme, although the test conditions were not fully complying with the standard measurement method.

A three-dimensional plot of the performance fields[23] which washing machines can achieve depending on the amount of detergent used and on the temperature selected, provides the best overview of the results (Figure 3.51 a). The same level of performance can be achieved in a 90 °C programme with only 50 % of the nominal detergent dose, in a 60 °C programme with the nominal detergent dosage, or in a 40 °C programme with 150 % of the nominal detergent dose. Thus, consumers are basically free to select any combination to achieve a specific level of cleaning performance, the only limitation being the temperature stability of the fabrics to be washed.

[23] Stamminger, R. et al.: Old Washing Machines Wash Less Efficiently and Consume More Resources. In: Hauswirtschaft und Wissenschaft 3/2005, p. 124-131

a: new washing machine

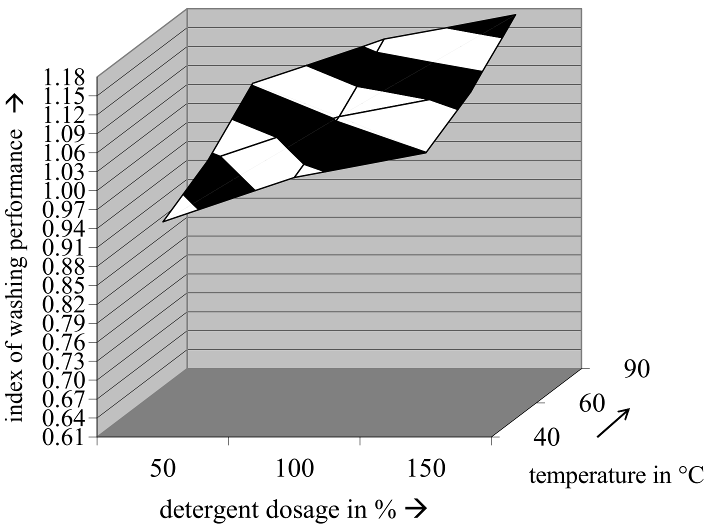


Figure 3.51: washing performance index of a new and an old washing machine respectively under varying conditions. Shaded areas represent classes of washing performance according to the European Energy Label system and are for visualisation only. The machines' performance with reduced and increased doses of detergent at 40 and 90 °C was calculated by linear extrapolation (source: Stamminger, R. et al.[23]).

Figure 3.51

Other washing machines, particularly older ones, have similar performance, but their absolute values are considerably lower, and their slopes show an increased influence of dosage and temperature on washing performance (Figure 3.52 b).

b: washing machine from 1975

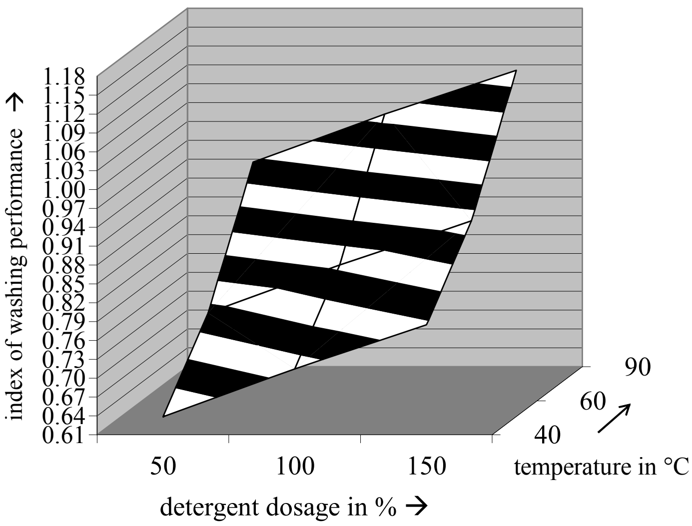


Figure 3.52: index of washing performance of a new and an old washing machine respectively under varying conditions. Shaded areas represent classes of washing performance according to the European Energy Label system and are for visualisation only. The machines' performance with reduced and increased doses of detergent at 40 and 90 °C was calculated by linear extrapolation (source: Stamminger, R. et al.[23]).

Figure 3.52

A synopsis of the 60 °C cotton cycle measurements, for the three detergent dosages (Figure 3.53), shows that performance, in addition to varying greatly between machines, can be adjusted effectively via detergent dosage. This becomes even more evident when the results are ranked according to the European energy label washing performance index, in which machines are graded in classes of 0,03 width ranging from A (best) to G (worst). Older machines rarely achieve class A performance, which are common in new washing machines (at nominal capacity – which was not used in the shown tests), and they usually require increased doses of detergent. In addition, the slopes of older washing machines' performance differ significantly from that of newer machines: the loss in performance going from 100 % to 50 % detergent dosage being significantly greater than going from 150 % to 100 %. This may be due to detergent sump losses in older washing machines with large proportions of the loaded detergent probably being unused.

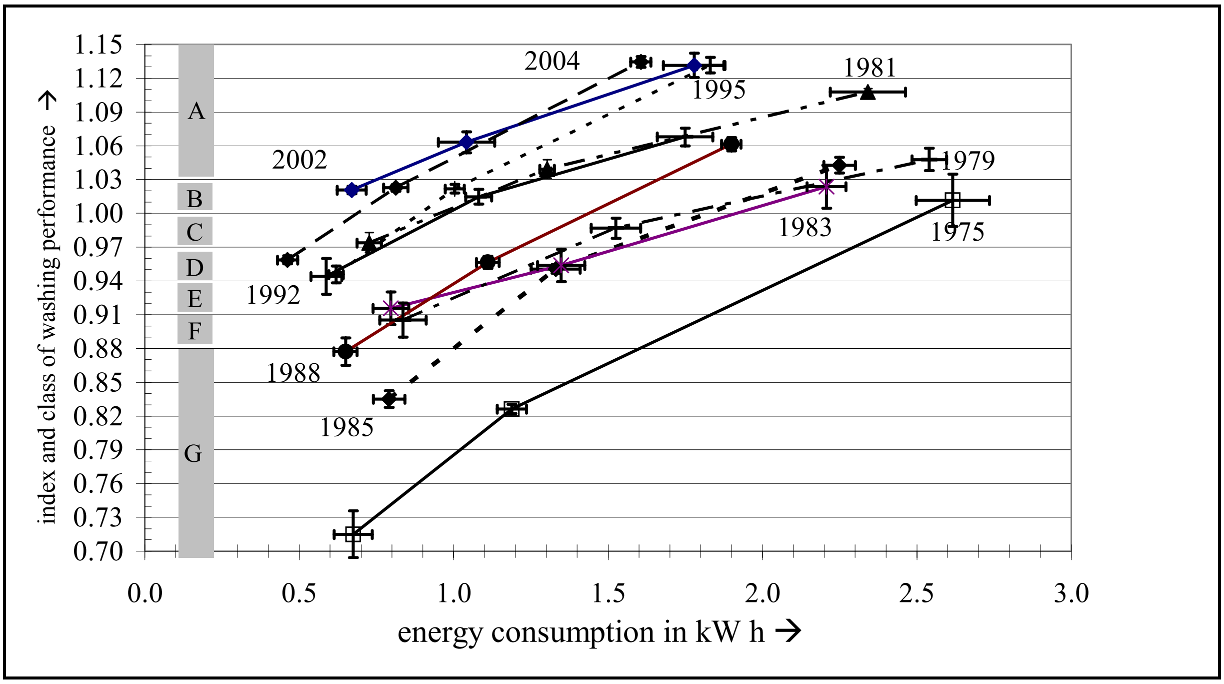


Figure 3.53: washing performance versus energy usage values for all machines under study (coded by year of production). From left to right the energy values indicate the machines' energy use for 40, 60 and 90 °C programmes; washing performance is given as index and corresponding class A to G as used by the European Energy Label. Error bars indicate standard deviation of index of washing performance and energy measured. Lines are for visualisation only. (Source: R.Stamminger et al.)

A comparison of the washing performance levels achieved at 40, 60 and 90 °C programmes with the corresponding energy use gives surprising results: the distribution of the curves is even less uniform, and it becomes clear that older washing machines need much more energy to achieve a good washing performance. Indeed, to achieve the same washing performance as new machines in a 40 °C programme, old machines must be operated at a 90 °C programme Moreover, at 40 °C (the point furthest left in the graphs) the washing performance of old washing machines is much lower than that of new ones.

Another factor influencing consumption values under real life conditions is the actual amount of textiles washed. As it previously shown the load size is variable and is often lower than the rated capacity declared by the manufacturers. Depending on the real load size and the soaking capability of the textiles the washing machine will somehow adjust the amount of water taken in for the main wash and the rinse cycles in an automatic way. Additionally, sensor systems available in some machines (e.g. the so called ‘fuzzy’ logic) may measure the weight or the soaking capacity of the load and additionally adjust both the programme and water intake to ensure a good washing and rinsing performance with a reduced amount of water and energy. How effective the adjustment is and how different is the energy/water consumption between the machines was recently investigated (Figure 3.54). The results show a very different behaviour of the machines, with load adjustment factors between 0,12 kWh/kg and -0,02 kWh/kg for a cotton 60 °C programme. The later value means that this machine actually consumes more energy when only partly loaded, but it is not known if this machine was equipped with the partial load detection, or if it was an old or control machine without this option.

On average the load dependency is 0,08 kWh/kg. A machine consuming 1,0 kWh/cycle at 5kg load will consume 0,6 kWh/cycle when almost no laundry is put in. A similar dependency is seen for water, where the best machine was found to use 6,7 l/kg and the worst -0,04 l/kg (meaning again an increase of water consumption for lower amounts of loads put into the drum, but the same warning about this machine applies). The average found was found at 2,8 litres per kg of reduced load compared to the rated capacity.

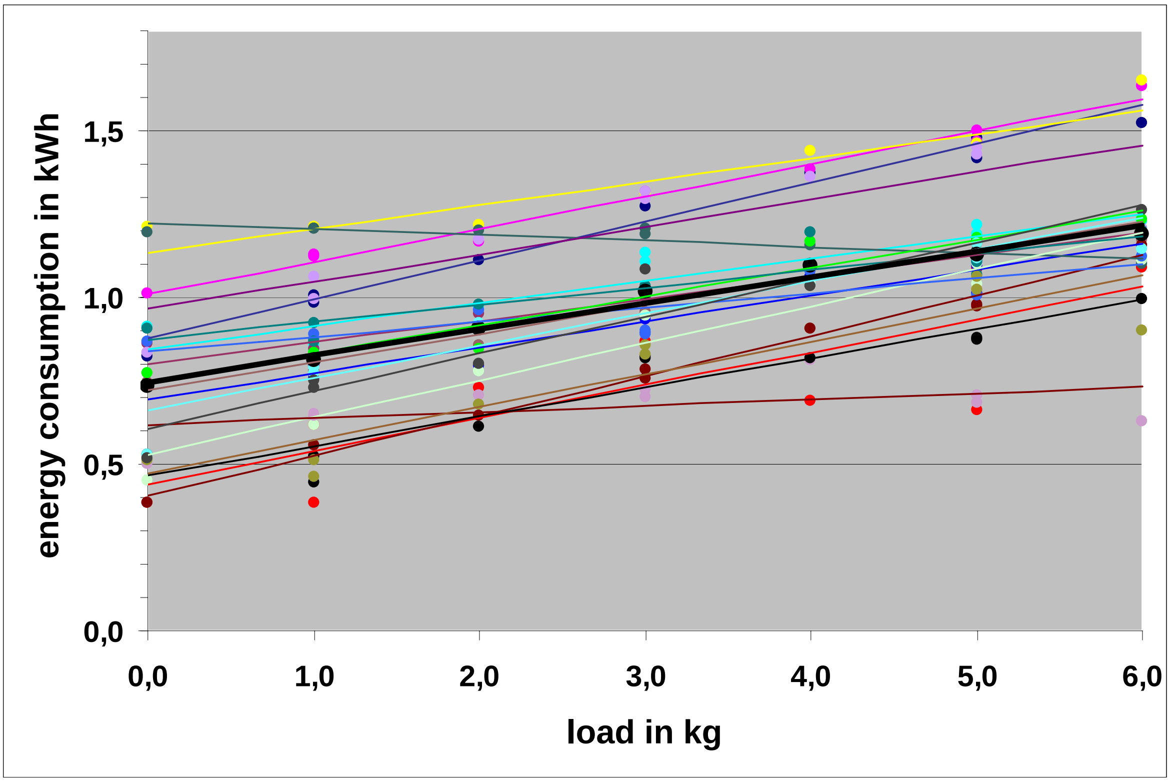


Figure 3.54: energy consumption of 20 washing machines at various load size at 60°C cotton programme. Lines are trends lines for each machine. The black line indicates the average behaviour of the 20 measured machines (source: Berkholz P., et al[20])

As energy may not only be consumed during the operation cycle, other modes like the off- or standby-mode, delay-start, programme-end or left-on-mode may be important as well. Some tests of the energy consumed in these modes have been done by Consumer Organisations and published[24] (Figure 3.55). On average, the energy consumption of the standby-mode for 1 hour was measured at 0,61 Wh, the delay-start-mode at 4,34 Wh and programme-end-mode at 3,29 Wh. As the two latter

[24] Stiftung Warentest, private communication

are only active for some hours, their contribution to the annual energy consumption is rather small. More relevant may be the left-on-mode[25], as this may persist indefinitely between wash cycles.

The European Commission within Lot 6 of the Tender TREN/D1/40-2005 has launched a specific study on standby consumption for EuPs. The European Association of Household Appliance Manufacturers CECED has provided to Lot 6 study group an estimation of the average low power mode consumption of washing machines (Table 3.6).

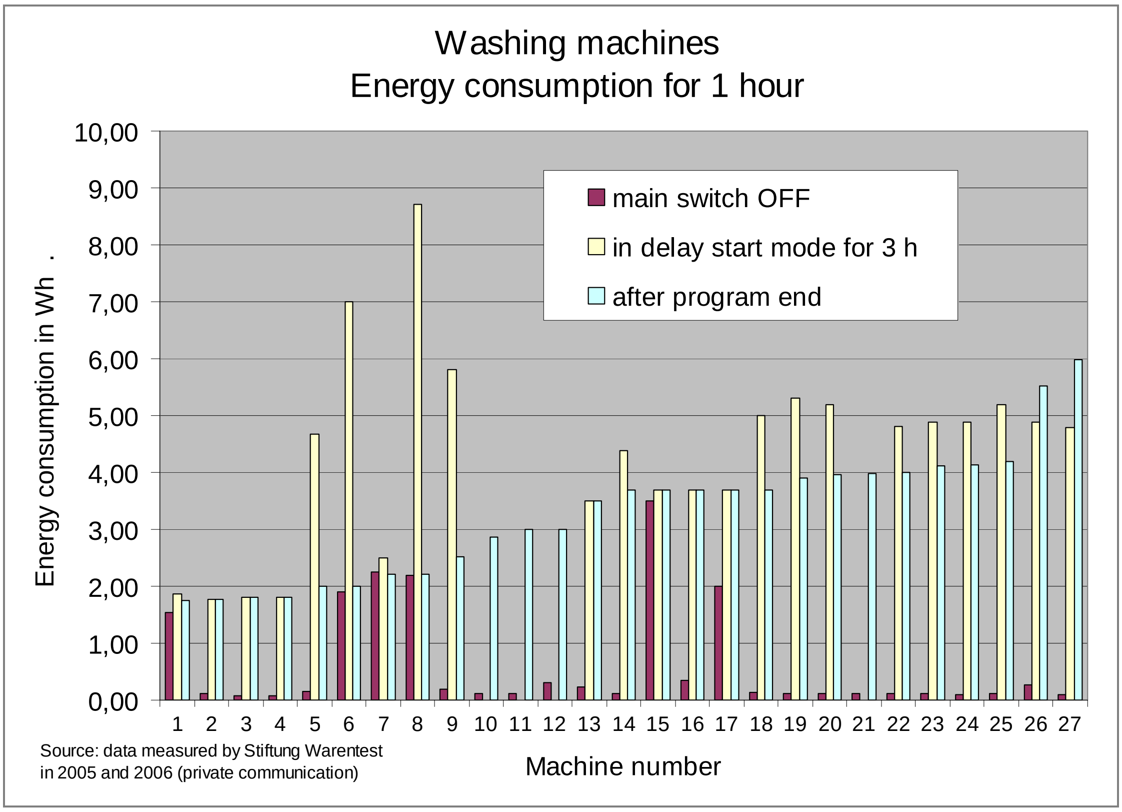


Figure 3.55: energy consumption measured in three different low-power modes of 27 washing machines (graphic: Univ. Bonn)

Table 3.6: stand-by and low-power mode consumptions of washing machines [26]

Steady state condition	Average real life power (W)
Delay-start	2,5
End of cycle	1,6
Off-mode*	0,5

*As defined in EuP Lot 6 study

[25] see Task 1 for the definition as given in IEC 60456 5th edition draft

[26] Document: CECED Contribution on BAT/BNAT about Lot 6 EuP Preparatory Study (GS_07-30_CECED_Contribution_for_Chap._6_of_Lot_6.pdf)

A detailed analysis of the standby and other low power mode for washing machines, and a comparison between the definitions presented in Task 1 and the Lot 6 outcome will be run in Task 6 of this study.

3.4.2 The results of the consumer behaviour questionnaire

The number of washing cycles is the most important element affecting the use of resources for laundry washing. Since the consumer questionnaire is representative of the household size of the covered countries, the resulting values are very likely representative of the average number of washes run per household (Figure 3.56). This figure goes from 4,1 (Czech) up to 6,0 (Italy) wash cycles per household per week, with an average at 4,86 washes per household per week.

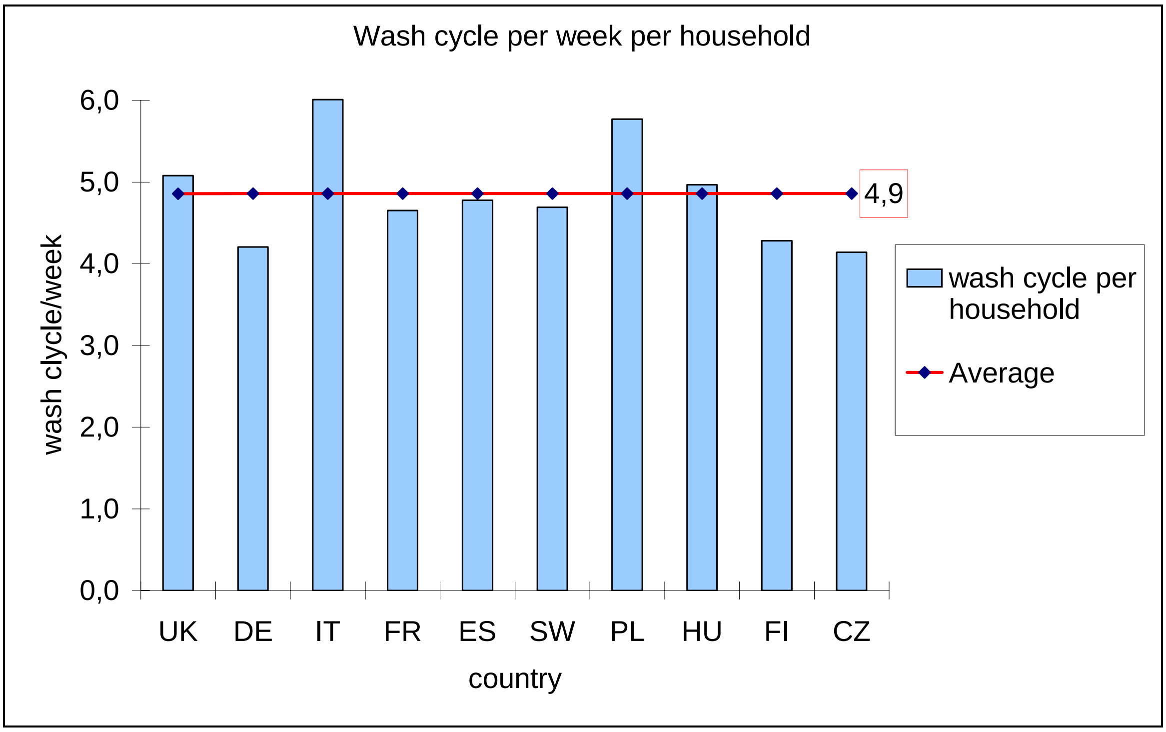


Figure 3.56: average number of wash cycles per household per week

Since the household size may be different from country to country, the number of washing cycles per week per person living in the households may be a more significant parameter for comparison among countries: this number is between 1,4 (Czech and Spain) and 2,0 (Sweden) washing cycles per person and week, with an average of 1,7 washes per person per week (Figure 3.57).

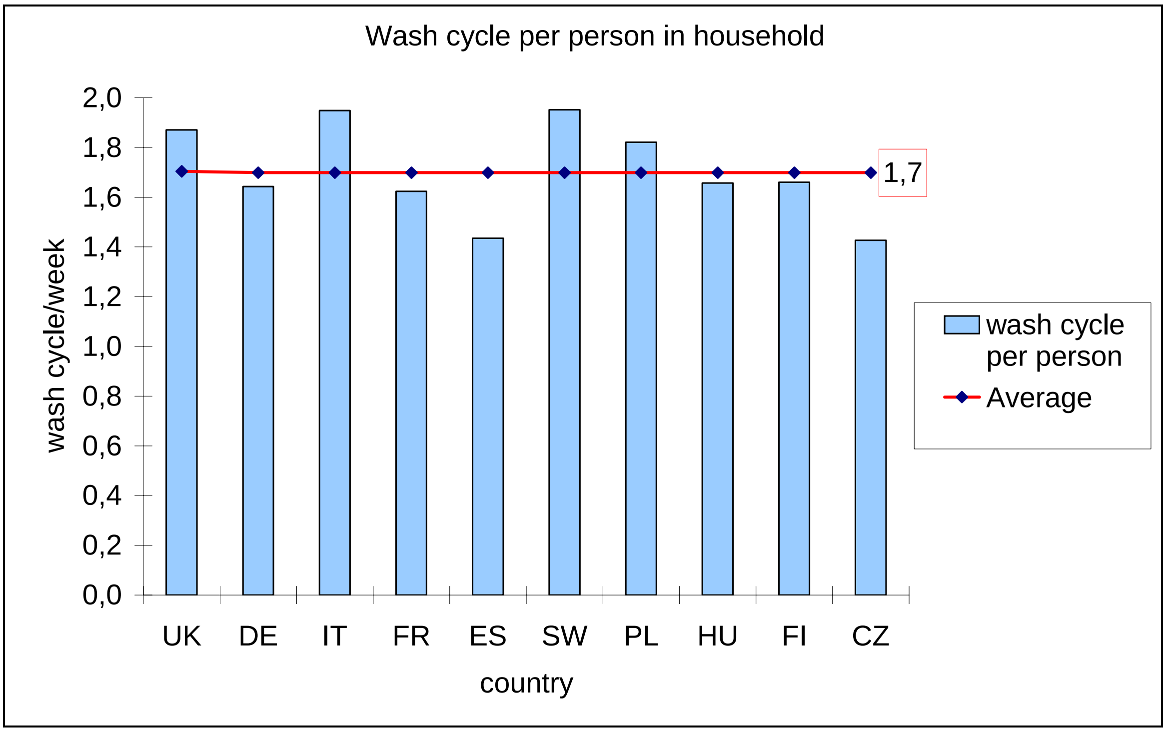


Figure 3.57: average number of wash cycles per week per person

The second most important element affecting the energy consumed in the washing process is the temperature of the selected wash programme. Averaging the answers from almost 2 500 consumers from 10 countries, a 37 % preference for the 40 °C programmes (Figure 3.58) results; the second most used temperature is 60°C with 23 % of all the washes; but also the 90 °C is declared to be used almost 7 % of the times. The calculated average of all the nominal wash temperatures is 45,8 °C.

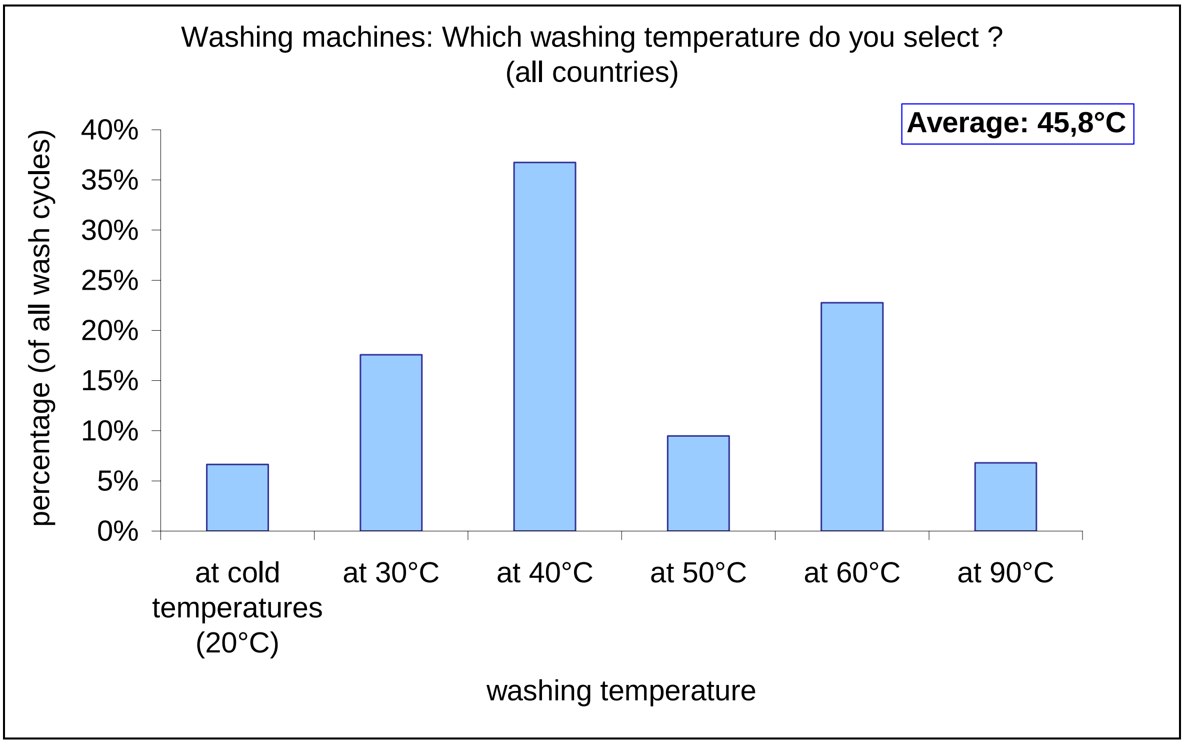


Figure 3.58: relative occurrence of wash temperatures in Europe (average of 10 countries)

The share of the temperatures (Figure 3.59) in the covered countries is quite different:

- in Spain more than 40 % of the washes are done at cold temperatures (tap water) and almost no (3 %) boil wash temperature programmes are used.
- in other countries (especially Sweden and Czech Republic) more than 50 % of the washes are at or above 50 °C and the boil wash programme is used more than 10 % of the times.

These differences are also visible when looking at the average wash temperatures for all the investigated countries (Figure 3.60), which range from 33,3 °C to 50,1 °C.

The chosen wash programme type shows (Figure 3.61) a dominance of the cotton programmes (cotton, linen, mixed) where more than 50 % of the consumers declare that these programmes are used *always or often*. Less frequently used are programmes for easy-care, delicate or synthetic laundry and even less the programmes for silk and wool articles.

Other programmes and options are available in washing machines, which once selected by the consumers, may influence the water and/or the energy consumption of the machine: 'energy saving/eco-washing' is found (Figure 3.62) to be the most frequently used option or programme, followed by 'soft wash' programmes and options, which consume more energy (stain wash or intensive wash) or water (extra rinse, additional water). The later are used only by some 15 % of the consumer *often or always*.

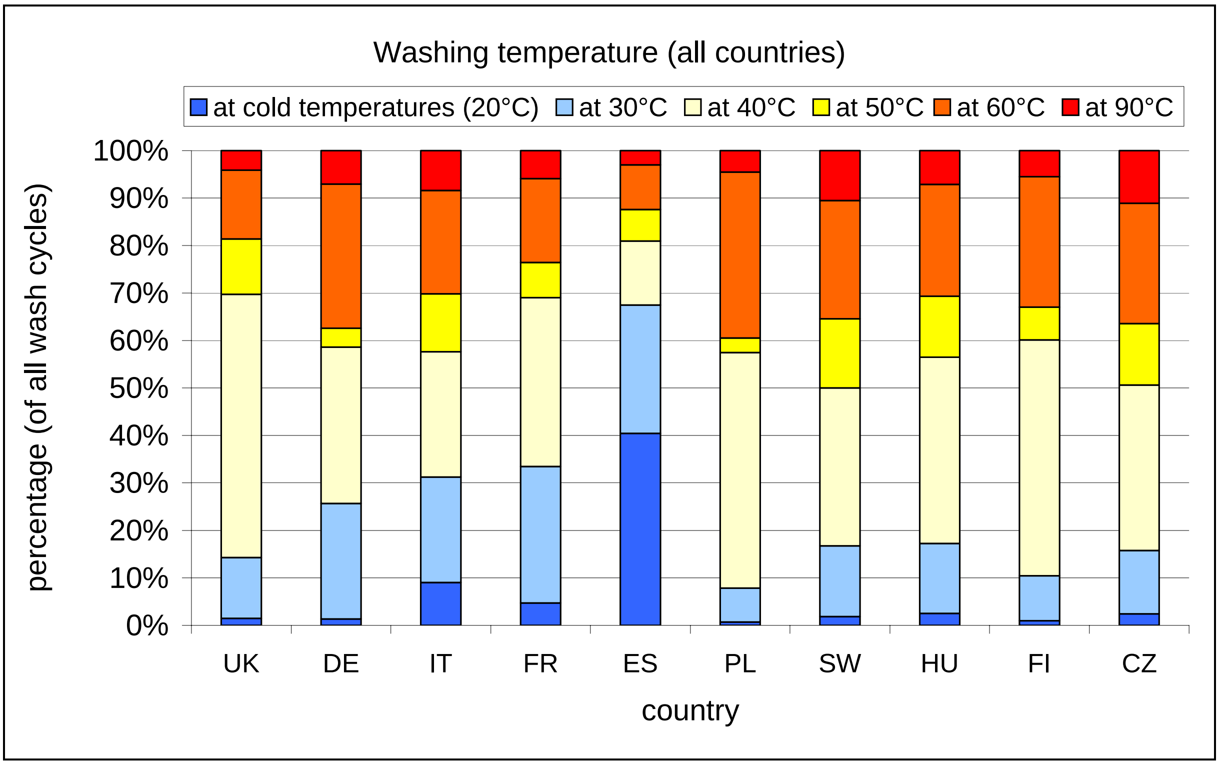


Figure 3.59: temperature distribution of wash programmes for various countries

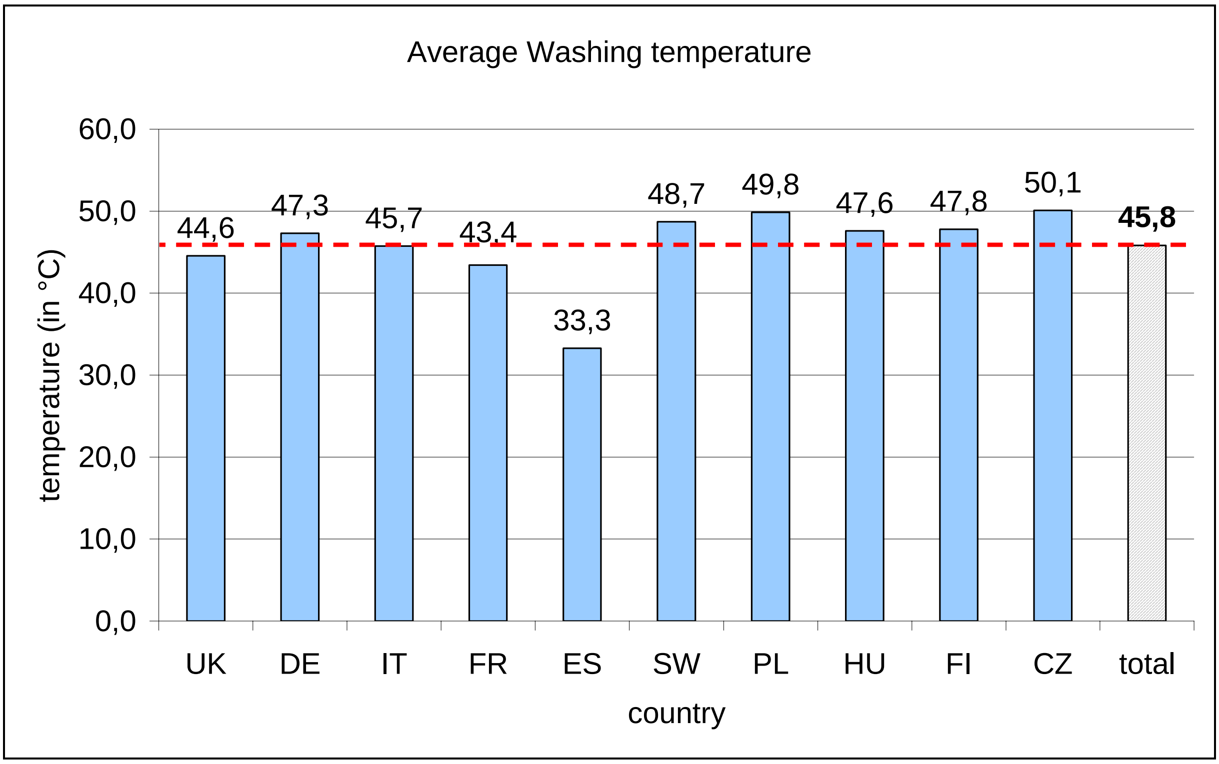


Figure 3.60: average nominal wash temperature

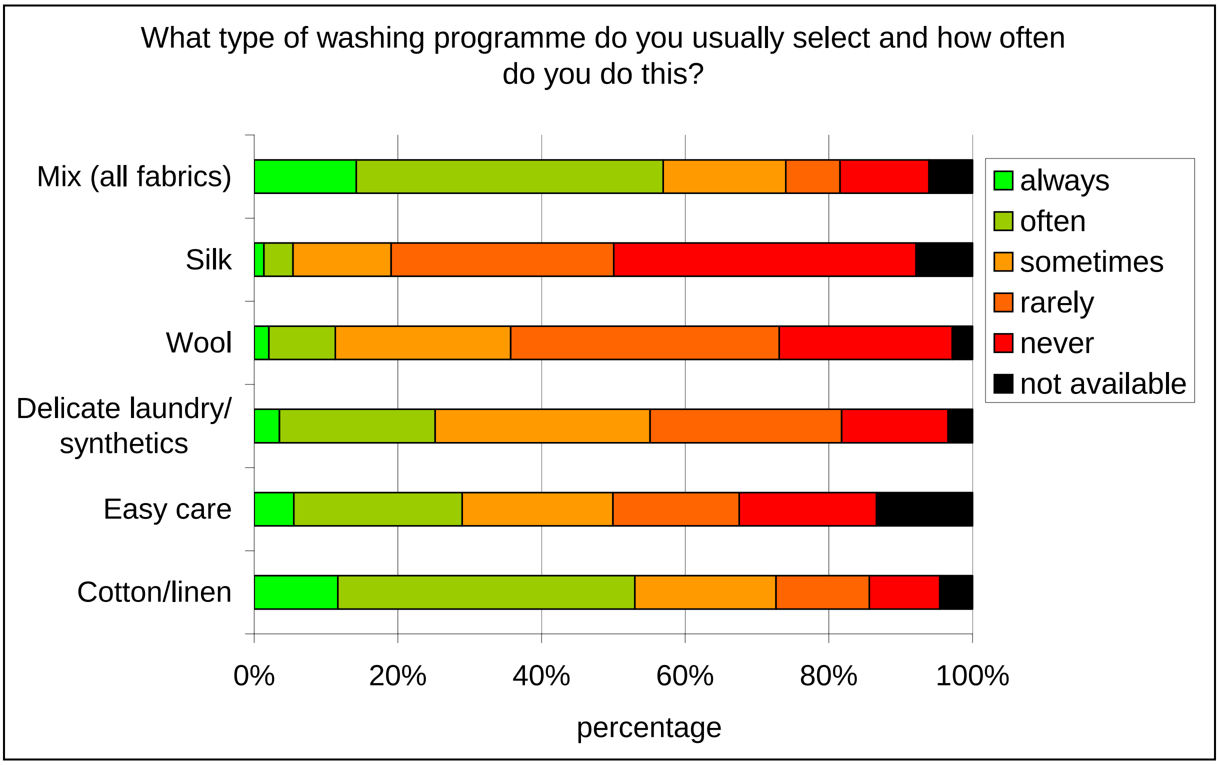


Figure 3.61: frequency of use of various programmes regarding the type of textiles washed

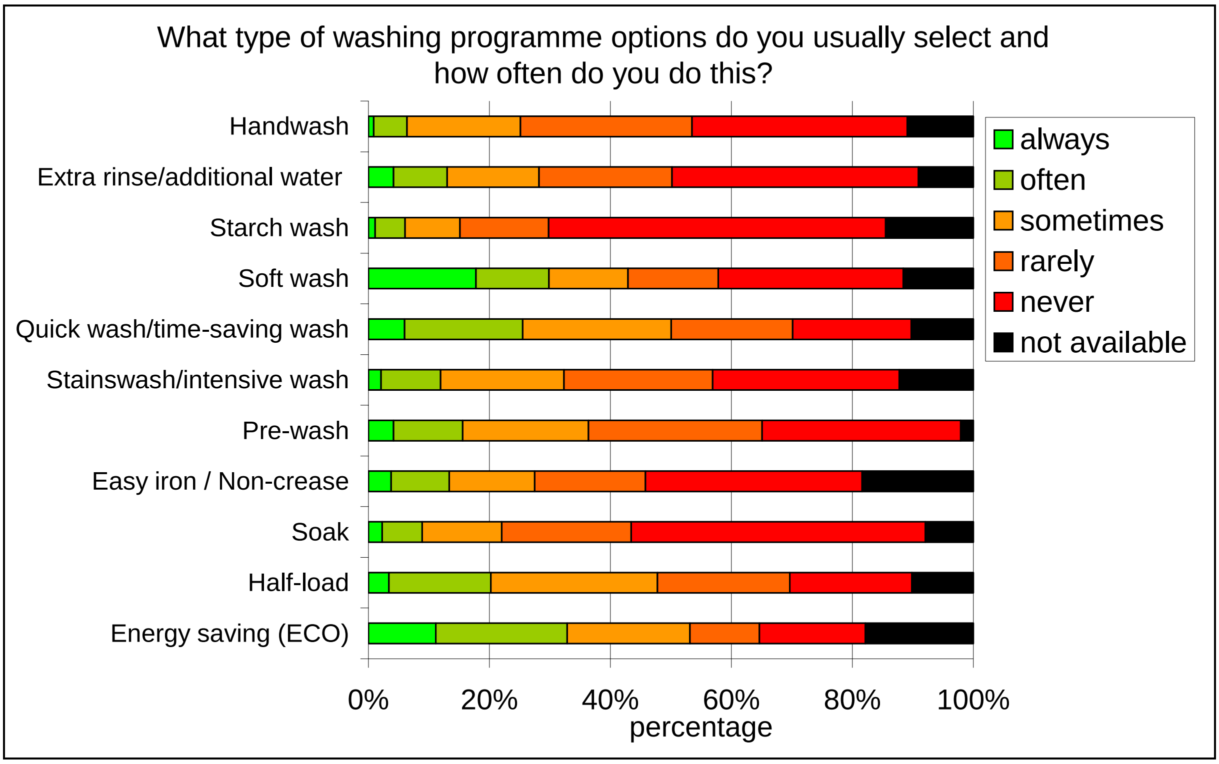


Figure 3.62: frequency of use of various other programmes or options

A higher influence on the actual energy and water consumption may be expected by the use of the machine at full capacity. Almost 3 out of 4 consumers claim (Figure 3.63) to use the full capacity of the machine, although they normally do not check it.

Assuming that those consumer answering an ‘overloading’ of the machine may have loaded 4,5 kg, those using ‘the full capacity without overloading’ may have put in 3,25 kg, those which ‘don’t fill the machine completely’ use 2,0 kg and those which ‘run the machine even with a small quantity’ may have a 1,0 kg load the average load size was calculated and the answers from country were compared (Table 3.7). **Although the result calculated for Germany fits quite well with the values measured in the previously mentioned study, the underlying assumptions may be challenged**.

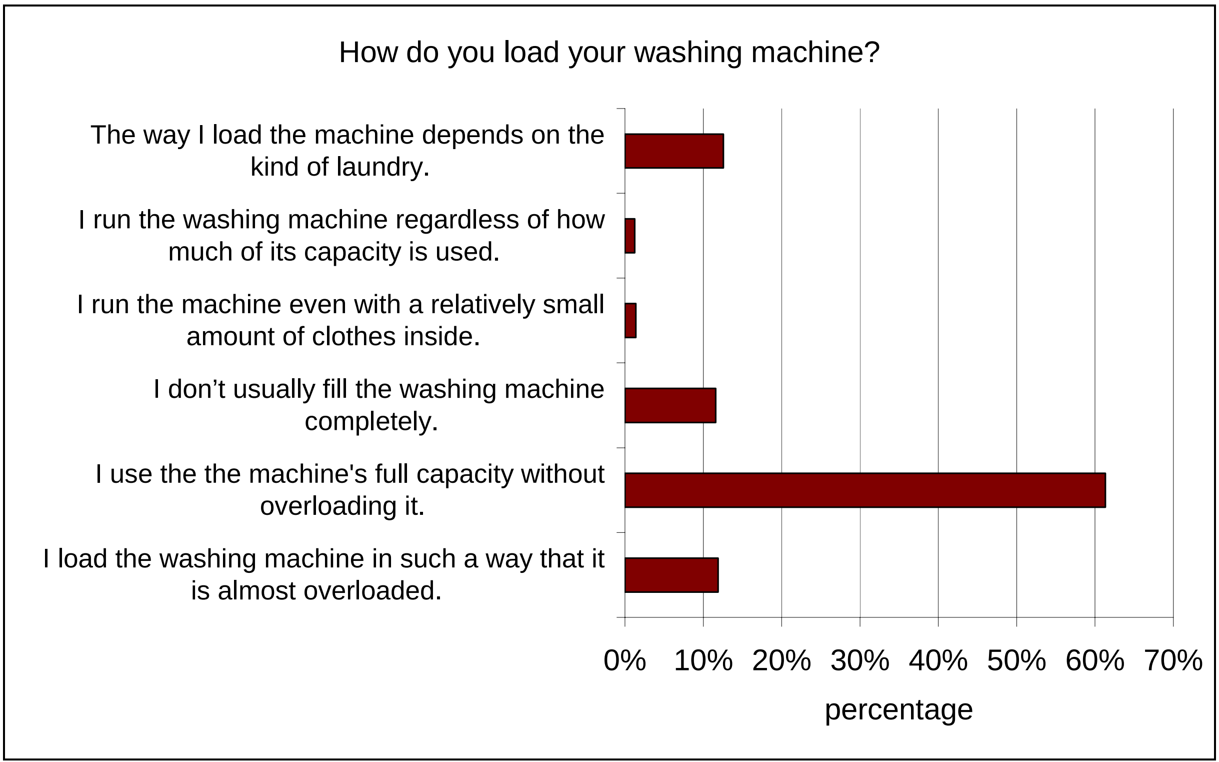


Figure 3.63: consumer answers about the load they are putting into the washing machine

Table 3.7: calculated average load size

Country	**UK**	**DE**	**IT**	**FR**	**ES**	**SW**	**PL**	**HU**	**FI**	**CZ**	All
average load in kg	3,2	3,3	3,5	3,3	3,1	3,2	3,2	3,1	3,2	3,1	3,2

Looking at the final spin speed, the distribution shows large differences (Figure 3.64) among countries: while in Italy, Spain, Poland, Hungary and Czech about 70 % of the spin cycles are at or below 900 rpm, in UK, Germany and Sweden 70 % are above 900 rpm. Taking the average of the individual range of spin speeds given from ≤ 400 up to ≥ 1 300 rpm, the average spin speed per country can be calculated (Figure 3.65) which confirms the same differentiation between the low-spin and high-spin countries. The average of all investigated country is 914 rpm.

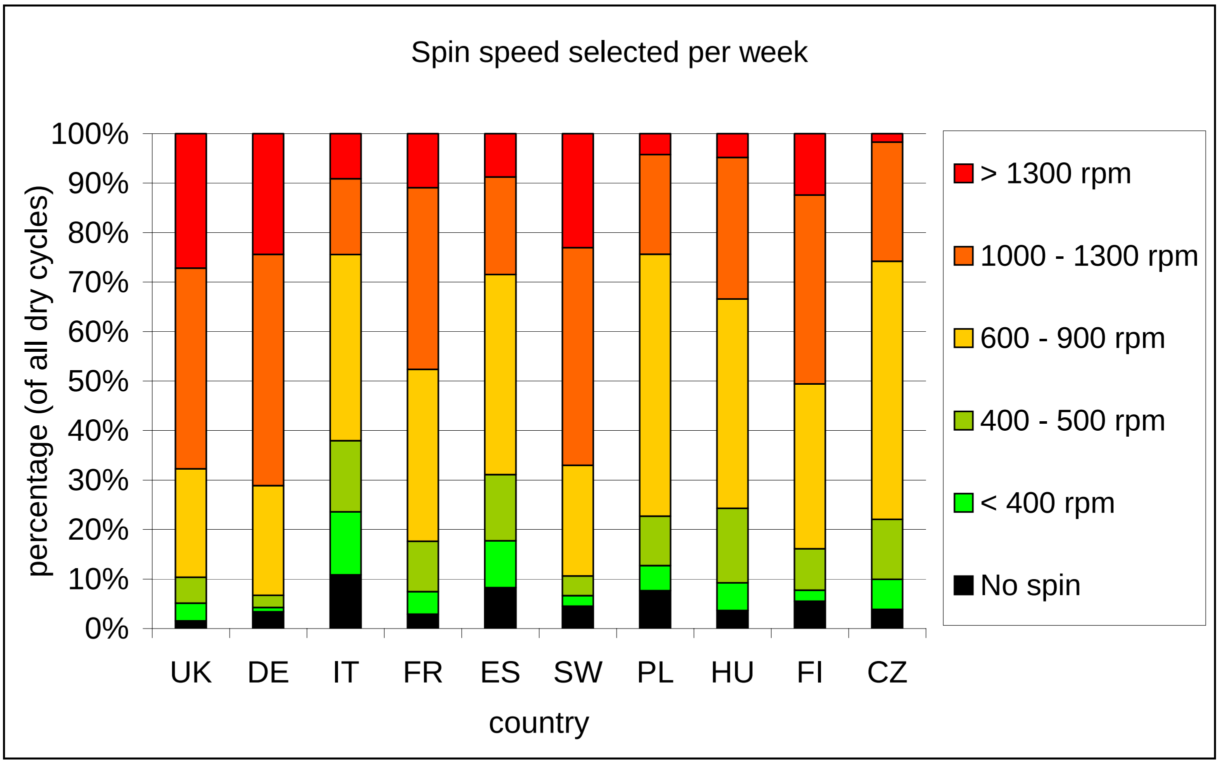


Figure 3.64: distribution of spin speeds

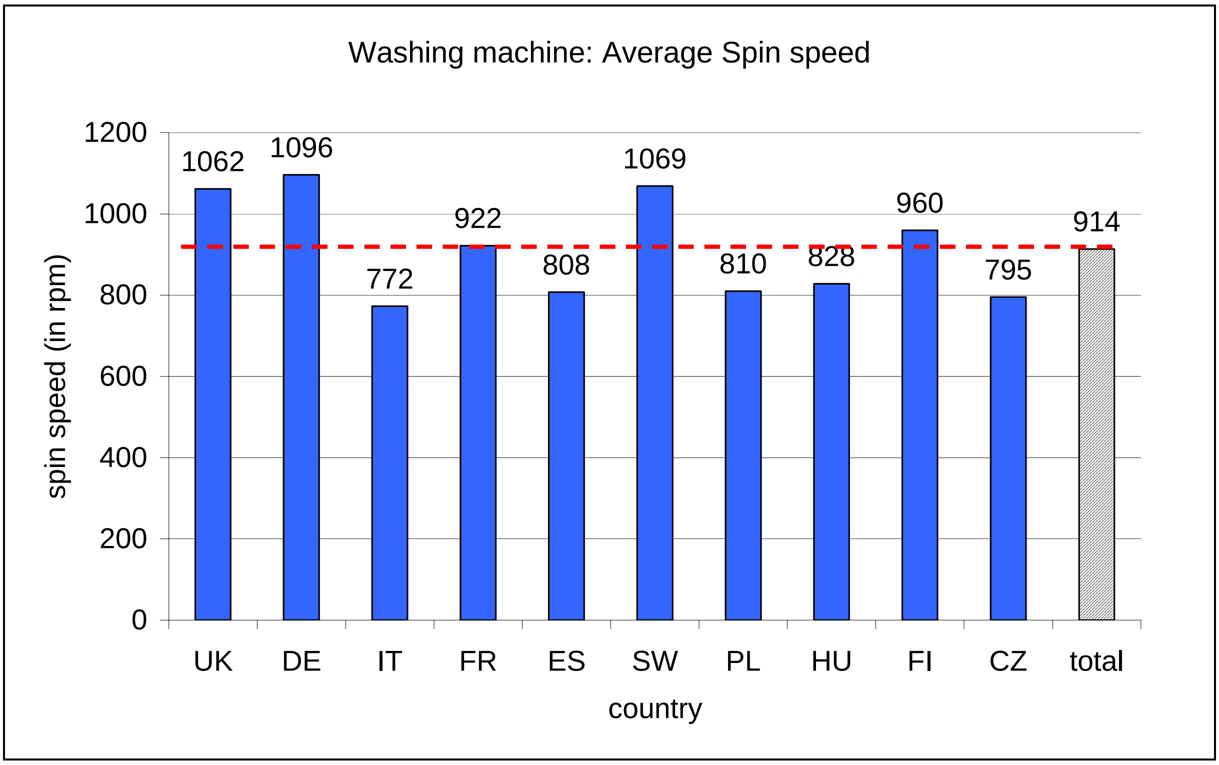


Figure 3.65: calculated average spin speed per country and in total

As a delay of the start of the washing process may be used to postpone the energy (and water) consumption when - during the day or the night - cheaper (off-peak) tariffs may be offered, the selection and the frequency of use of this option have been investigated.

Consumers were asked if their washing machine was equipped with a delay-start time pre-selection function: over 32 % of the washing machines have this option but with some differences among countries (Figure 3.66).

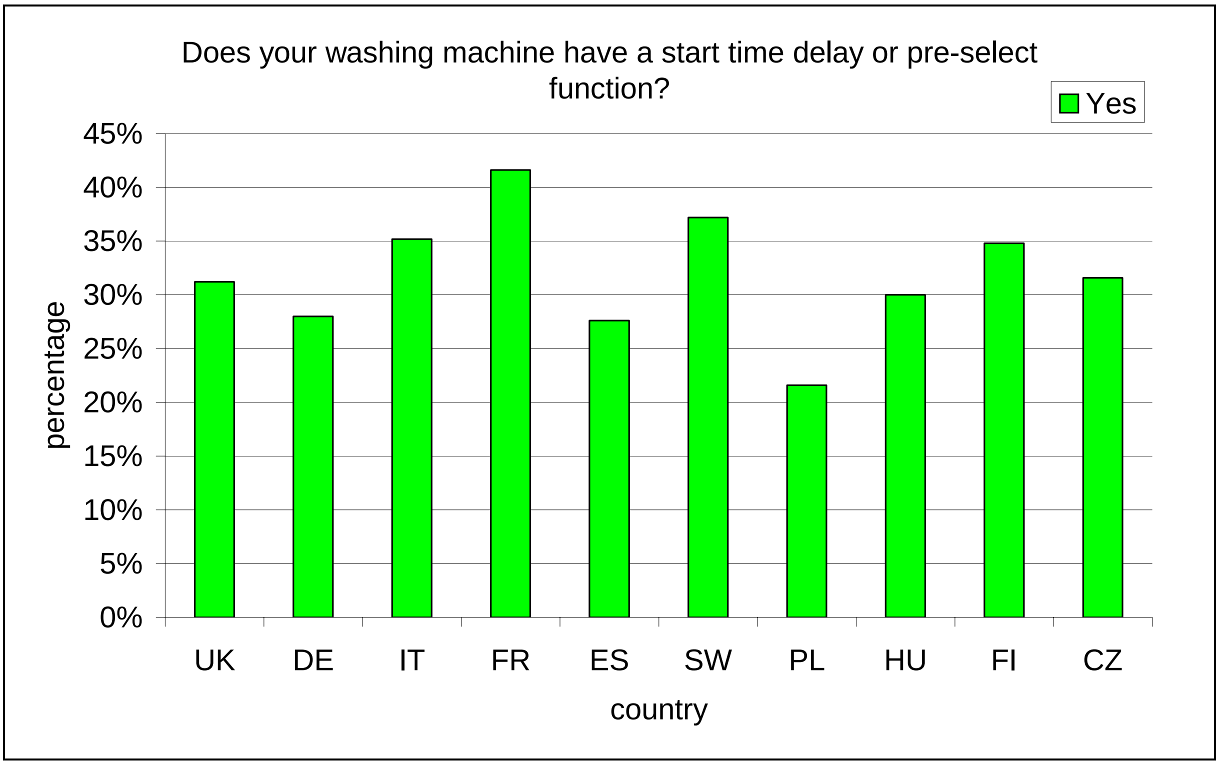


Figure 3.66: availability of start-time pre-select function

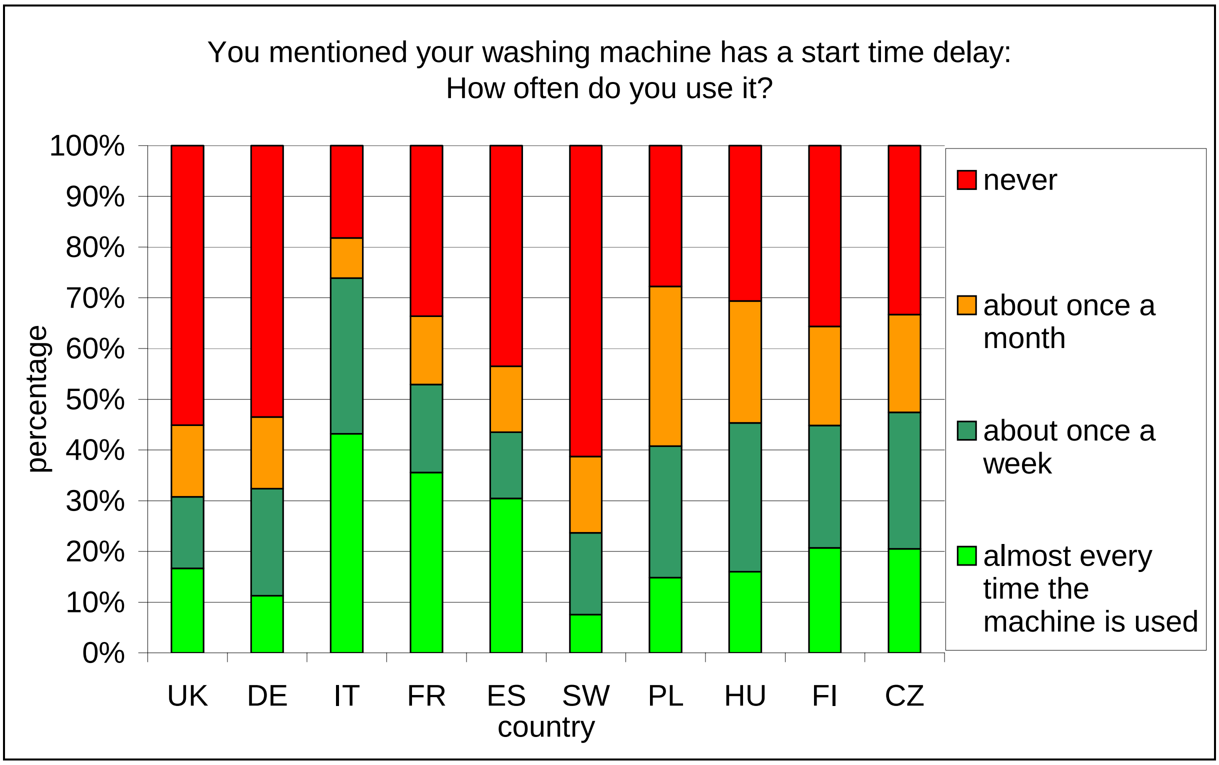


Figure 3.67: usage frequency of the delay start function

When asked about the frequency of use of this delay start option, most consumers confess (Figure 3.67) to 'never' use them (on average 40 %); only 22 % say they always use this function and another 22 % use it about once per week. It would have been interesting to know also the reason why consumer selects this option: if to match off-peak tariffs or for their personal convenience (laundry ready when needed), but this aspect was not included in the questionnaire.

This function also has a possible negative impact on the energy consumption on one side because the consumer convenience may - at least potentially - lead to start the washing cycle during peak hours, and on the other side because the machine consumes some energy when waiting for the start time. Asking those consumers having and using a delay start function in their washing machine, on average 56 % declared to choose a time between 0 and 3 hours (Figure 3.68), while 28 % use it to delay the start time between 4 and 6 hours and 16 % to delay it for more than 7 hours.

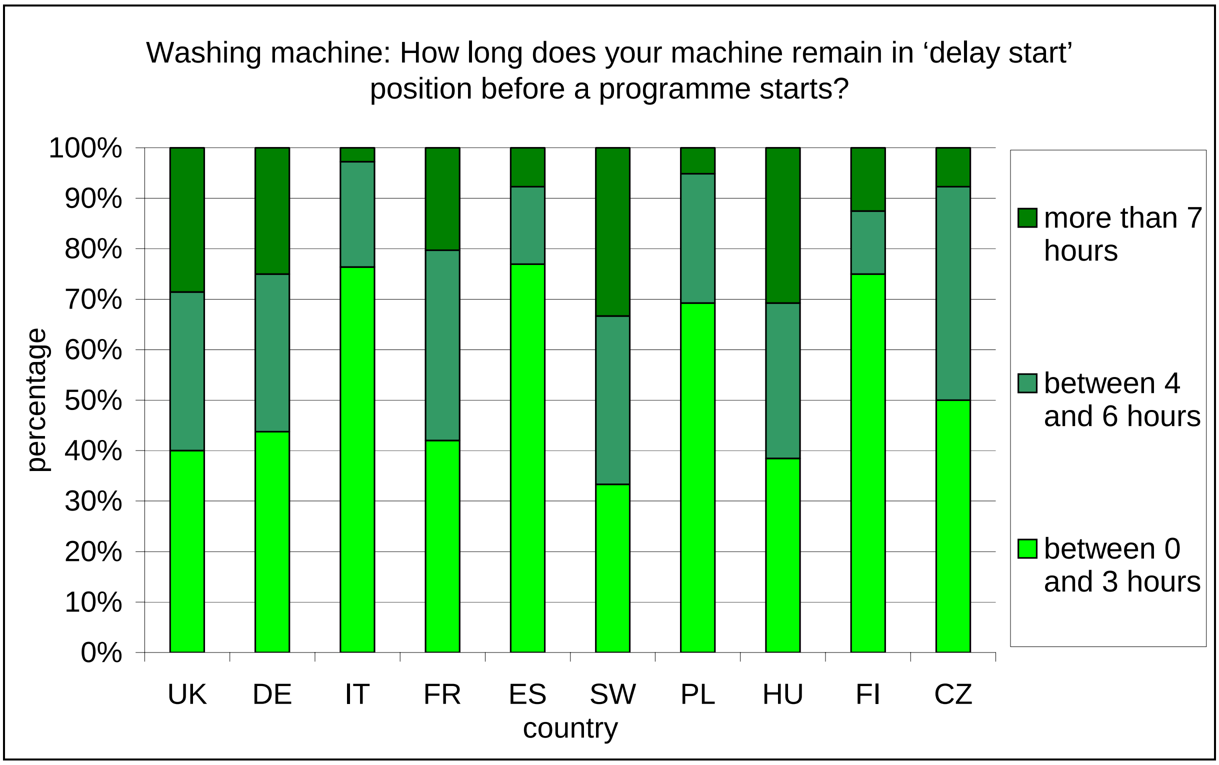


Figure 3.68: frequency of delay start time in hours

Additional energy may be consumed when the machine is entering the programme-end-mode, which may be tentatively defined as the time between finishing the washing programme (including a final spin) and unloading. During this time the machine may run for example some de-wrinkling actions with the drum turning time to time. Asked how long this time normally is, on average 37 % of the consumers (Figure 3.69) open the door immediately after the programme has ended and 57 % do this within a maximum of three hours; only 6 % admit to wait for more than 3 hours.

But also after the washing machine is unloaded, there may be an additional amount of energy being consumed, when the machine is "left on" and not switched off completely. On average 48 % of the consumers declared (Figure 3.70) to switch off the appliance immediately and an additional 22 % to do this after unloading; only 10 % of the consumers claim not to switch off the appliance always or most of the time. Most of the remaining consumers have a machine, which turns automatically to 'off', and a minority do not know.

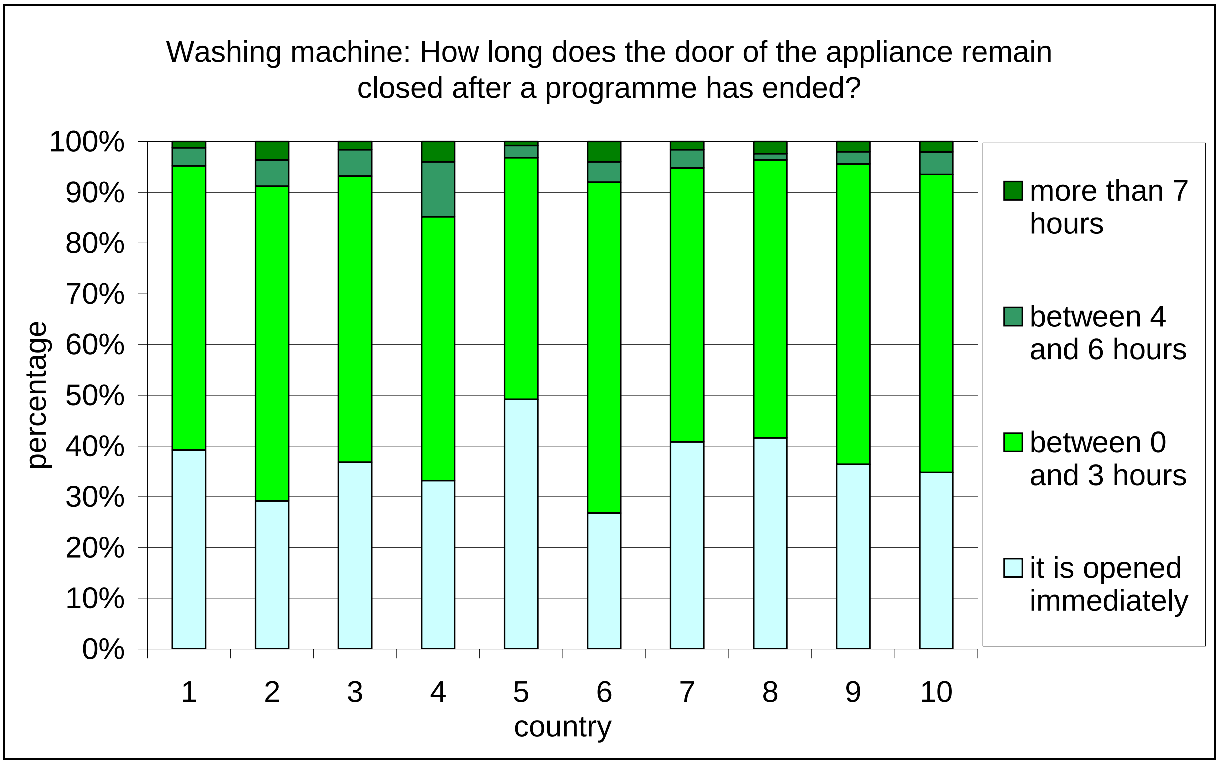


Figure 3.69: time of keeping the door closed after programme end

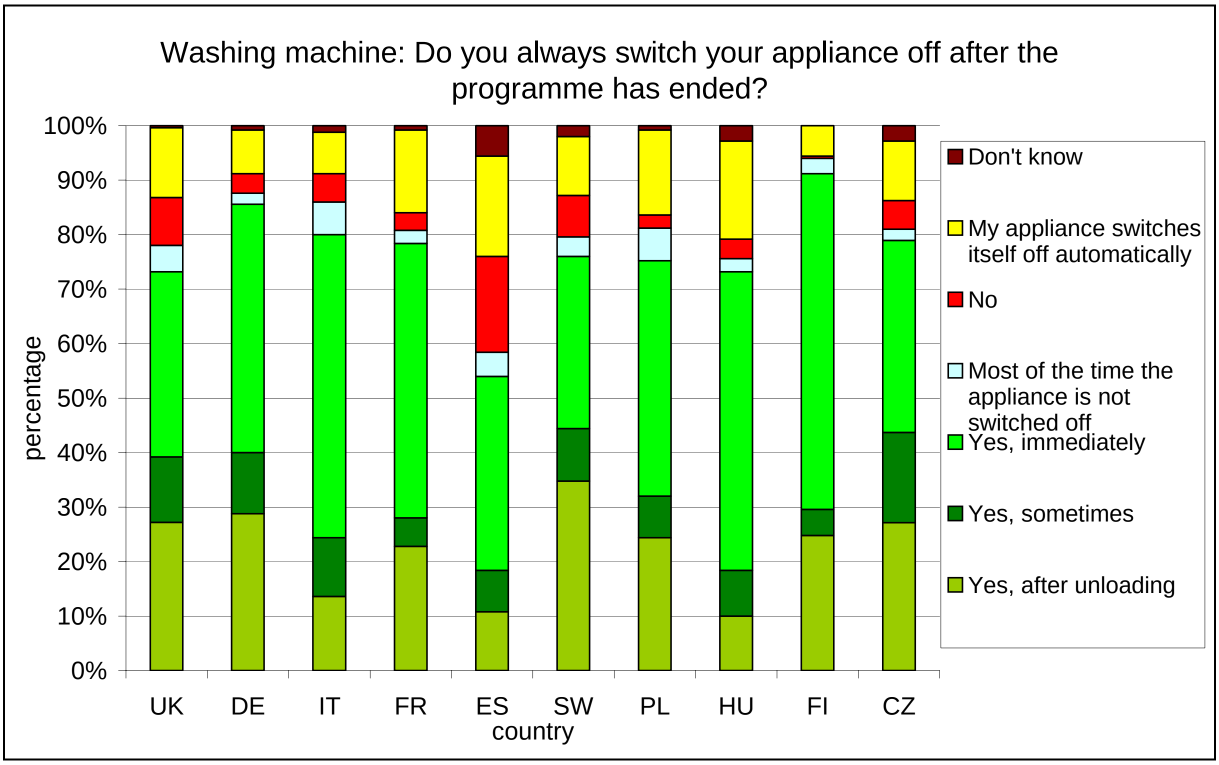


Figure 3.70: action after programme has ended regarding off-switching

Regarding drying of the clothes, large differences can be found between summer and winter time: while in summer time, about 40 % of the consumer always dry the clothes outside on a cloth line and another 28 % do it often (Figure 3.71), these figures reduce in winter time to just 7 and 10 %, respectively (Figure 3.72). The preferred way of drying clothes in winter is to dry them in the house in a heated room: this is always done by 28 % and often by 33 % of the consumers.

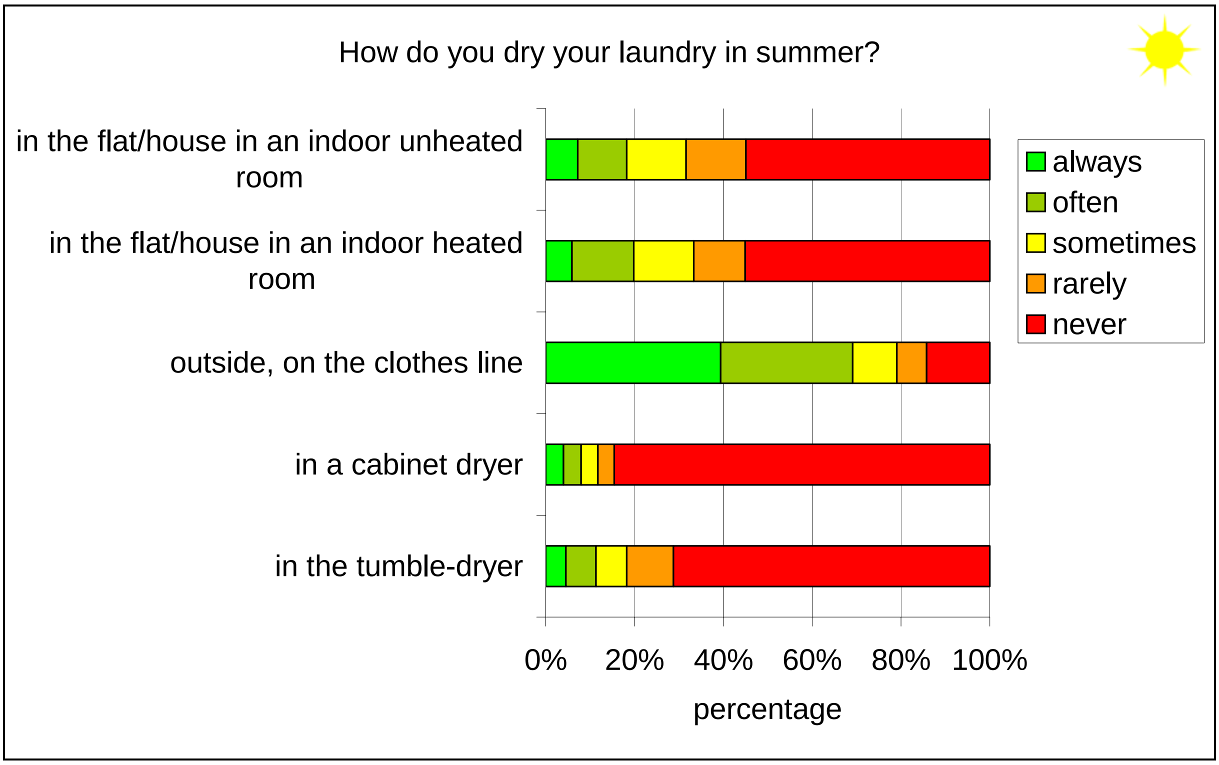


Figure 3.71: ways of drying clothes in summer time

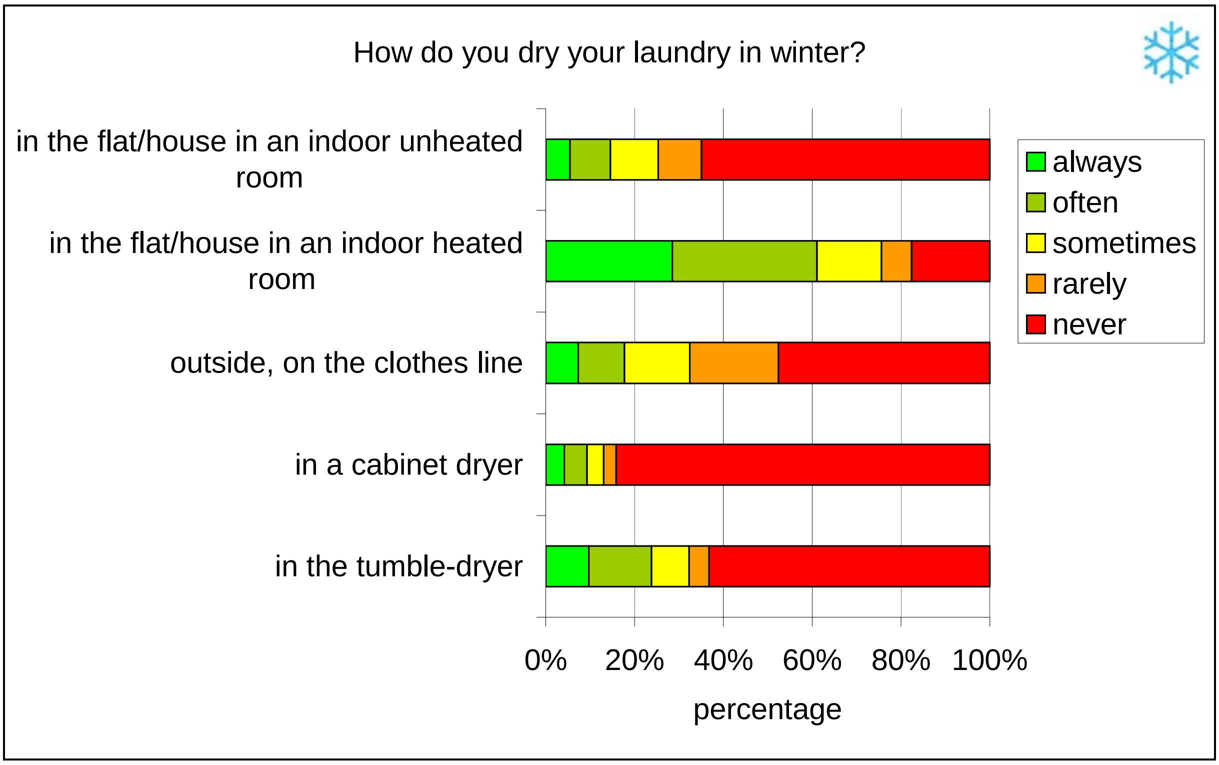


Figure 3.72: ways of drying clothes in winter time

In summary, the consumer behaviour regarding washing their laundry in a washing machine is characterised by:

- 4,9 washing cycles are done per week per household or 1,7 washing cycles per week per person
- the wash programme at 40 °C nominal temperature is the most frequently used for all kind of textiles (37 %) followed by the 60 °C programme (23 %)
- average nominal wash temperature is 45,8 °C (including all possible programme and textiles)
- cotton and mixed (cotton) are the most frequently used programmes
- the energy saving programme (or button) is the most frequently used option
- average spin speed used is 914 rpm, but there are higher and lower spin speed countries
- consumers claim to always use the full capacity of the washing machine
- delay start function is not used very often and only for short time delays
- about 70 % of the consumers switch off the appliance after the machine has ended or was unloaded
- while in summer most clothes are dried outside on a cloth line, in winter these are most commonly dried inside in a heated room

The consumer investigation has shown an average frequency of use of the washing machines of 4,9 cycles per household per week. Using this figure and the energy consumption of the standard base case washing machine, the effect of those factors that are not included in the standard testing procedure may be calculated.

3.5 USER DEFINED PARAMETERS: DISHWASHERS

3.5.1 Consumer behaviour and appliance energy consumption & saving

Also dishwashers are operated on consumer demand only, and their consumption in the use phase is due by the listed, mainly consumer driven, factors:

- Penetration of dishwashers
- Ambient condition
- Frequency of operation
- Selected programme and its consumption
- Programme temperature in combination with amount (and type) of detergent
- Option/feature chosen
- Machine efficiency under real use conditions
- Load size
- Low power mode (e.g. delay start, left-on, …)
- Manual washing of dishes

The ambient where the dishwasher is located and the resources that are used may have some influence on the actual consumption of these resources. While it may be calculated that the influence of the ambient temperature is relatively small, the temperature of the supply water may have some more significant influence, if the temperature of the selected wash programme is higher that the inlet water temperature.

The use of a hot and cold water supply has never been a real option for dishwashers. Since the water needs to be heated up in the main wash phase and in the final rinse of a washing cycle, a cold water intake in between would cool down the loaded tableware and would therefore cause a higher energy consumption in the final rinse. A better option for dishwashers could just to be connected to a hot water source: if the source has low installation costs, if the hot water generation is environmentally sound and losses are small this might be a viable infrastructural option. Most dishwashers are able to use this option. (in Task 4 a more detailed analysis of this infrastructural option is presented).

The frequency of operation depends mainly on the household size, as this defines the amount of tableware to be treated. Very simple considerations may be used to estimate the number of dishes to be cleaned, as for each meal every day of the year dirty dishes, glasses, cutlery and cooking utensils are produced. Assuming three meals per day and the use of one place setting per meal (each place setting consisting of 11 items), 1 095 place settings per person per year will have to be cleaned. Since meals are also taken outside of the house (e.g. at a canteen or a restaurant) the real place settings number will be considerably lower, depending on the working and living situation of the people in the household.

However, not all of the dishes will be washed in a dishwasher. First, not all households own a dishwasher: in Western Europe dishwashers are present in 42 % of the households, in Eastern Europe only in 3 % of the households[27]. In addition, larger families tend to have more frequently a dishwasher, therefore no more than half of the people living in the EU will have the possibility to wash dishes in a dishwasher. Second, also those households owning a dishwasher do not clean all items in it: it is estimated that only 30-40 % of all tableware is actually cleaned in a dishwasher. The rest is treated with a manual washing process, which also consumes resources.

Manual dishwashing was studied intensively and found in average to take more water and energy than washing the same amount of dishes in a fully loaded dishwasher (Figure 3.73)[28]. But since this condition may not always be fulfilled, the correlation between of the resources consumption of a dishwasher at lower load has to be considered. The study also revealed that the practice in washing the dishes by hand is very different from person to person.

[27] Information from: Technischer Arbeitskreis Maschinelles Geschirrspülen, ZVEI, Germany

[28] R. STAMMINGER, R. BADURA, G. BROIL, S. DÖRR, A. ELSCHENBROICH, A European Comparison of Cleaning Dishes by Hand. In: EEDAL 2003 Conference Proceedings, p. 735 - 743

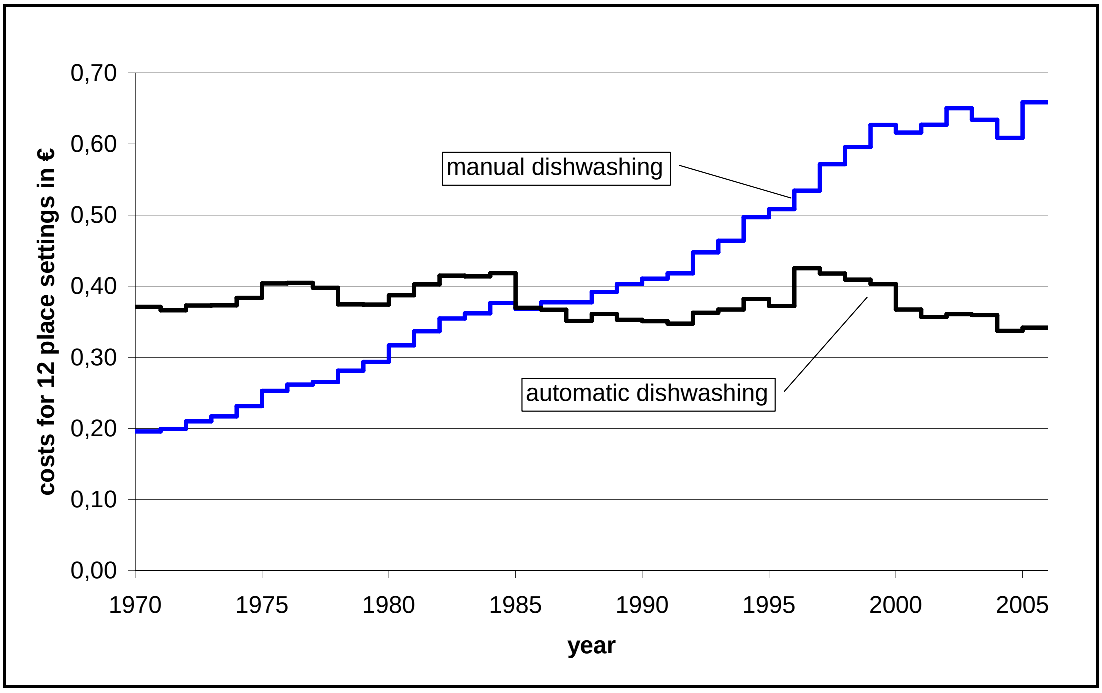


Figure 3.73: historical comparison of costs of washing 12 place settings of dishes by hand or in a dishwasher in Germany (source: R. Stamminger [31])

No general correlation was found[29] between the resources input and performance output of the manual dishwashing process (Table 3.8), therefore the logical conclusion is that there are ways to perform the dish washing consuming less water and energy than the evaluated average, but it is not clear which way is the best (in terms of resources consumption) nor how consumers can be made aware and trained about the optimal manual dish washing procedure.

[29] R. Stamminger, et al.; Washing-up behaviour and techniques in Europe. In: Hauswirtschaft und Wissenschaft 1-2007

, p. 31-40.

R. Stamminger, et al.; Dishwashing under various consumer-relevant conditions. In Hauswirtschaft und Wissenschaft 2-2007

Table 3.8: comparison of consumption for manual and automatic dishwashing (source: R. Stamminger et al[29])

Country/region	**Water** (litre)	**Energy** (kWh)	**Time** (min)	**Cleaning** (0 – 5)
D	46	1,3	76	3,2
Pl /Cz	94	2,1	92	3,3
I	115	2,5	76	3,4
E / P	170	4,7	79	3,4
Tr	126	2,0	106	3,5
F	103	2,5	84	3,4
GB / Irl	63	1,6	65	2,9
Total manual	**103**	**2,5**	79	3,3
Dishwasher **(new, A class)**	**15 - 22**	**1,0 – 2,0**	Loading and unloading: 15 min Programme time: 100-150 min	3,3 - 4,3

A rough calculation[30] resulted in an overall energy consumption for cleaning dishes (only direct energy) in EU25 of about 88 TWh, with a saving potential of 33 TWh by introducing more dishwashers. The use of a dishwasher can also be seen as economically beneficial, as it could halve the costs for washing dishes[31]. This comparison presented in previous Figure 3.73 shows the historical development of the manual dishwashing costs in Germany in the last thirty years, assuming a constant way of washing dishes by hand. Due to the increasing price of water and energy, the costs for washing the dishes manually rise, while using a dishwasher the increase in costs could be balanced by the reduction of the energy and water consumption of new appliances (Figure 3.74 and Figure 3.75).

[30] R.Stamminger, G.Goerdeler: Consumer habits and practises in manual dish-washing in Europe. In: Proceedings of *52. SEPAWA KONGRESS with European Detergent conference, 12.-14. October 2005, Würzburg, German*

[31] R. Stamminger, Daten und Fakten zum Geschirrspülen per Hand und in der Maschine. In: SFÖW - Journal, 3-2006

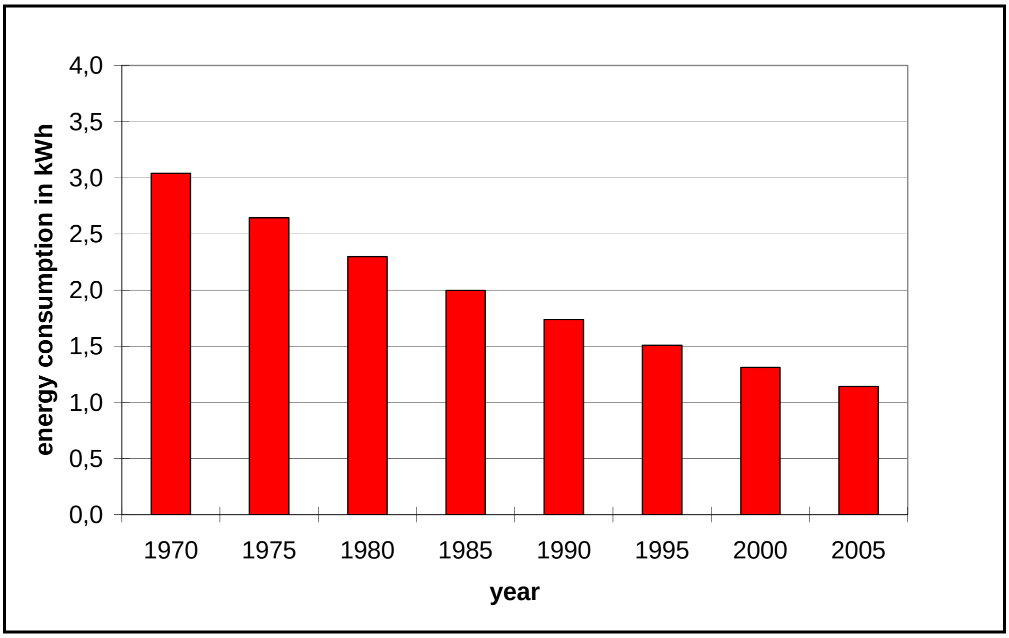


Figure 3.74: energy consumption of dishwashers versus year of testing (source: R. Stamminger [31])

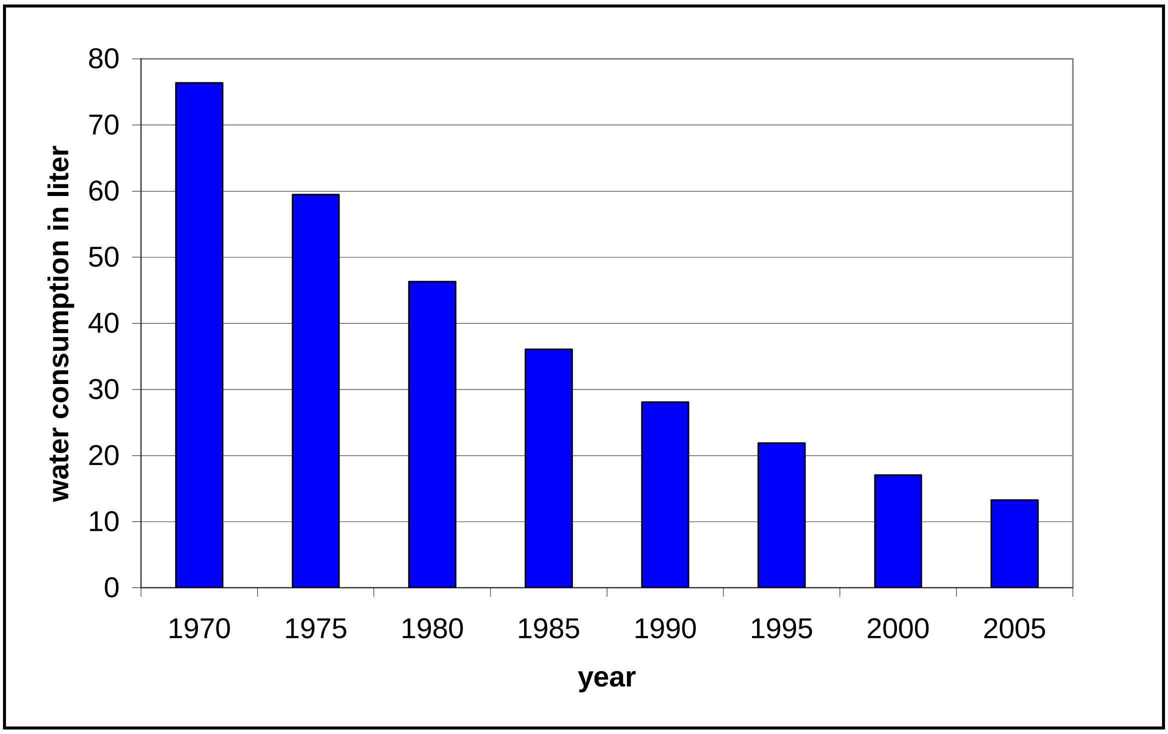


Figure 3.75: water consumption of dishwashers versus year of testing (source: R. Stamminger [31])

Since this comparison is based on the 'normal'-programme or in recent years on the economy-programme it is worth asking about the differences in the washing programmes. The German Stiftung Warentest has measured and recently published[32] (Figure 3.76) a comparison where on average the energy consumption of the "eco-programme" (normally the programme used for the energy label directive declaration) is 1,13 kWh, against 1,42 kWh for the "intensive programme"

[32] ‚test' of Stiftung Warentest, issue 7-2006, p.66-69

(which is recommended for heavily soiled pots and pans). Beyond these two programmes dishwashers usually offer additional programmes or options for other type of loads or soiling.

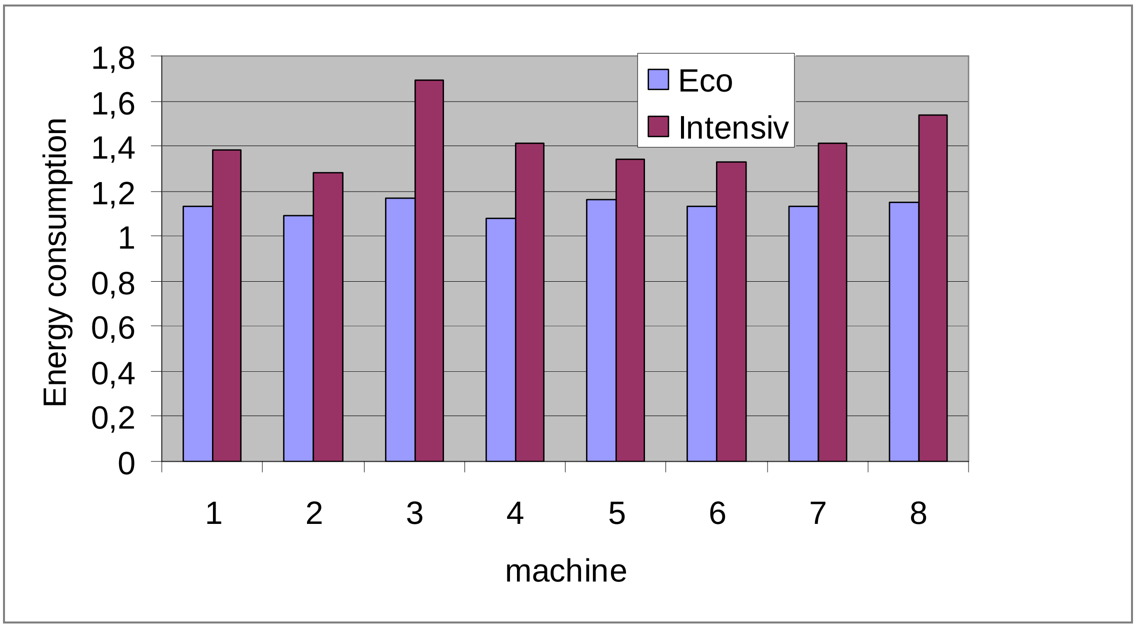


Figure 3.76 : intensive-programme (source: 'test'; graphic: R. Stamminger 32))

No public data is available regarding the amount of dishes loaded under real life conditions in the dishwasher. Some information from Germany[33] show that the average number of dishes loaded in the dishwashers of 20 German households (Figure 3.77) is always below the number of dishes used for the measurements according to the EN 50242 standard used for the EU energy labelling scheme. This investigation has also shown that the splitting of the load in private homes into the different baskets of a dishwasher is somehow different to the standard procedure, with a lower number of items in the lower basket and in the cutlery basket as in the real life.

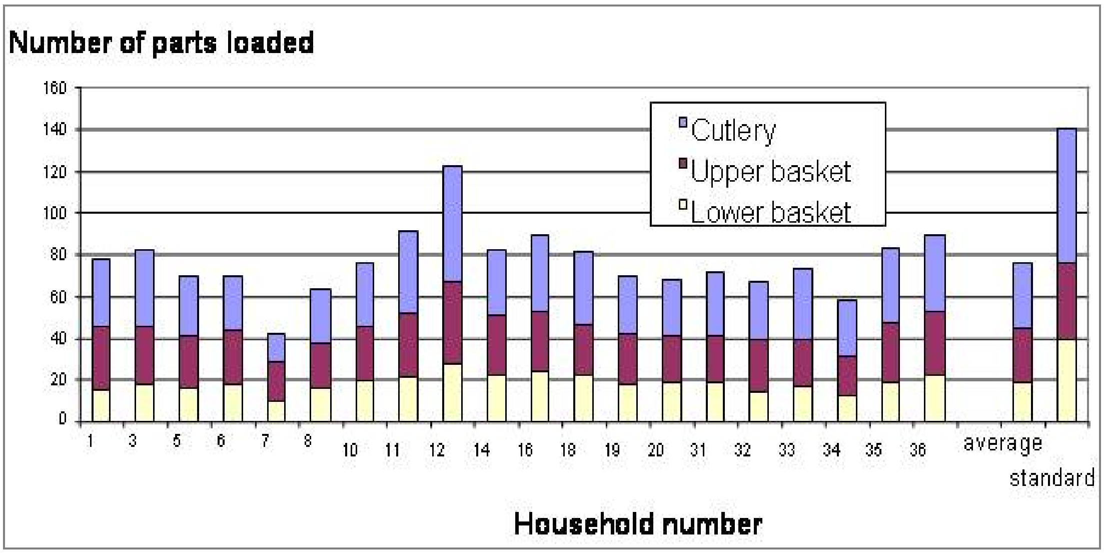


Figure 3.77: average number of parts loaded in dishwashers (12 place settings) in 20 households and comparison with the standard load according to EN 50242.[33]

[33] source: Dr. Ennen, Fa. Miele – private communication

The number of loaded items, or better their weight and heat capacity, may influence the amount of the energy used, since the load has to be heated to the selected washing cycle temperature. A lighter load will therefore lead to a lower energy consumption of the wash cycle (but higher consumption per place setting) without any adjustment needed from the machine side. Although in the past some dishwashers were equipped with a half-load button, this feature has almost disappeared from the market. Contemporarily, ‘automatic’ programmes have entered the market claiming to take into consideration also the amount of dishes loaded and adjusting the water and energy consumption accordingly.

Another aspect of the actual use of a dishwasher is the additional energy, which may be used when it is not performing its main function. These low power modes have been investigated in Germany in the framework of a research work for the international standardisation of dishwasher[34], which collected consumer data about the frequency of use of these modes in 9 households. Assuming an average power level of 1 W in standby and 5 Watt in programme-end and delay-start modes the following annual consumption values were calculated and reported:

- Consumption of washing programmes (213 cycles/year at 1 kWh/cycle): 213 kWh
- Consumption of standby mode (~8 000 h at 1 W): 8 kWh
- Consumption of programme-end mode (~240 h at 5 W): 1,2 kWh
- Consumption of delay-start mode (~40 h at 5 W): 0,2 kWh

A detailed analysis of the standby and other low power mode for washing machines, and a comparison between the definitions presented in Task 1 for washing machines and the Lot 6 outcome will be run in Task 6 of this study.

3.5.2 The results of the consumer behaviour questionnaire

The first classification of the dishwashing process has been done considering the way the dishes are washed: by hand or in a dishwasher. But also in those households owning a dishwasher, manual dishwashing is not completely banned (Figure 3.78). On average 16,6 manual dishwashing ‘cycles’ (meaning washing any number of dishes at a time) are done in households not owning a dishwasher per week, and 9,9 in those owning a dishwasher. But since the size of the household owning and not owning a dishwasher is different, a more correct comparison was run considering the number of manual dishwashing cycles per person per week, which resulted to be (Figure 3.79) on average 6,6 cycles per person per week for those households not owning a dishwasher and 3,3 cycles per person per week for those owning a dishwasher.

[34] DKE UK513.5 and AK513.5.3; Standby and other low power modes on dishwashers; Analysis of a small consumer investigation in Germany. Published also in IEC TC59, WG9

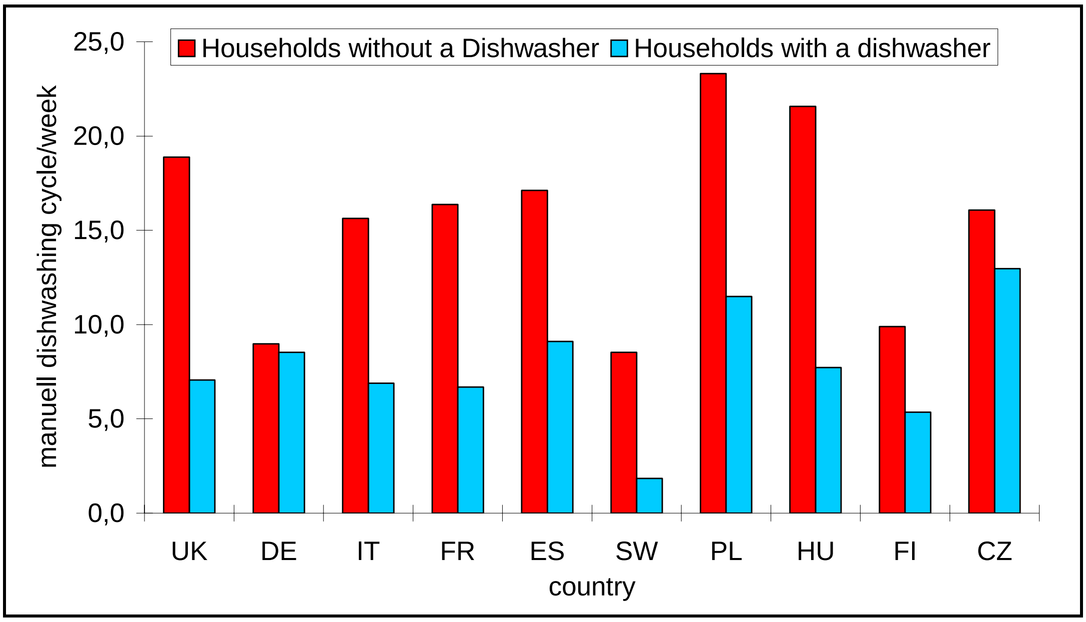


Figure 3.78: frequency of manual dishwashing per week in households with and without a dishwasher

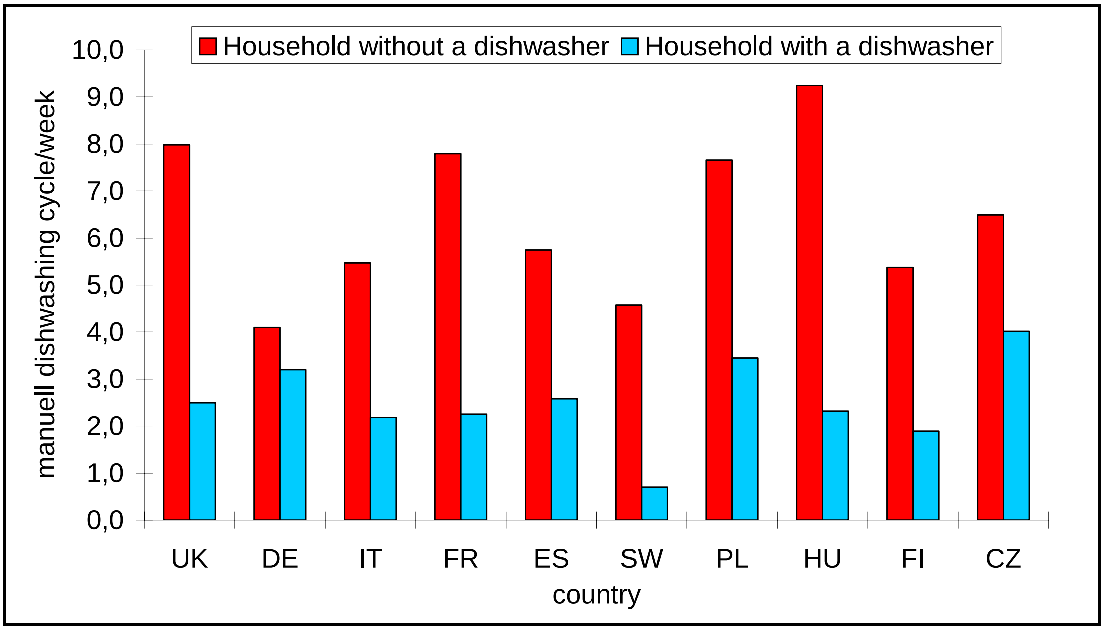


Figure 3.79: frequency of manual dishwashing per week per person in households with/without a dishwasher

Looking at the way the manual dishwashing is done, two main procedures were investigated in the consumer survey: washing the dishes 'in a sink or bowl' or washing 'under running tap water'. The answers show a large variation from country to country (Figure 3.80 and Figure 3.81) and from households with/without a dishwasher: the 'under running tap water' washing was the preferred method for less than 10 % (in UK) to about 50 % (in Spain, Hungary, Poland, Czech Republic) households without a dishwasher.

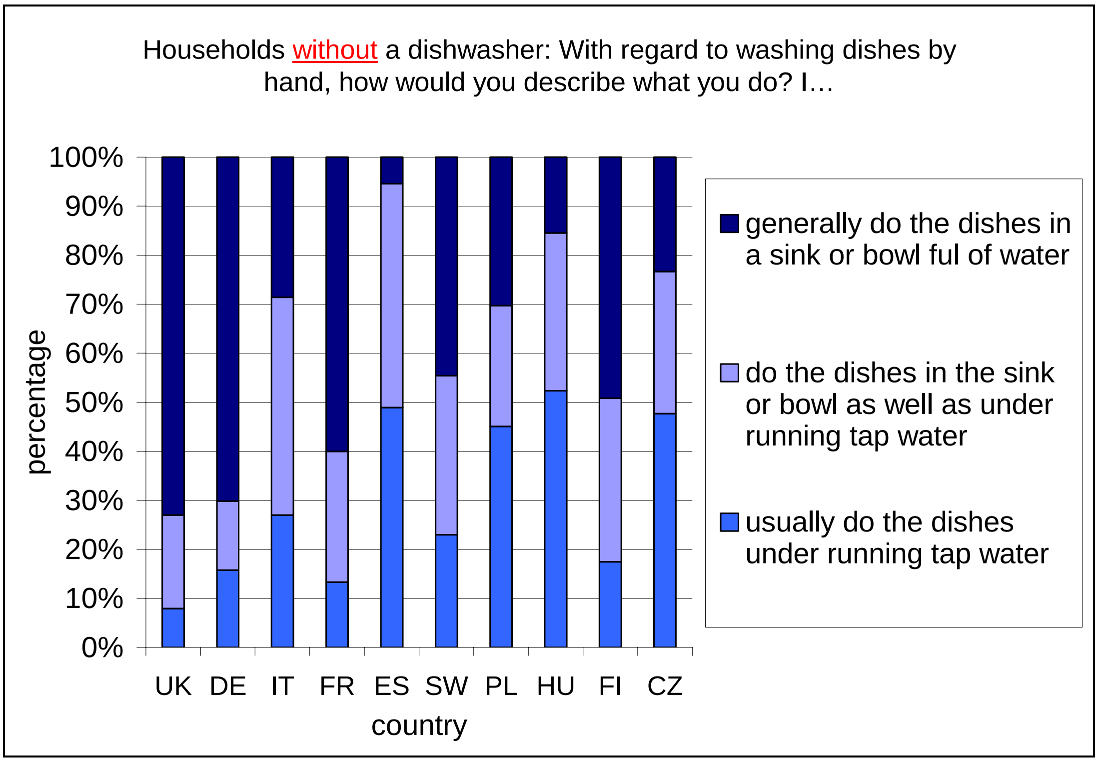


Figure 3.80: way of manually washing the dishes for households without a dishwasher

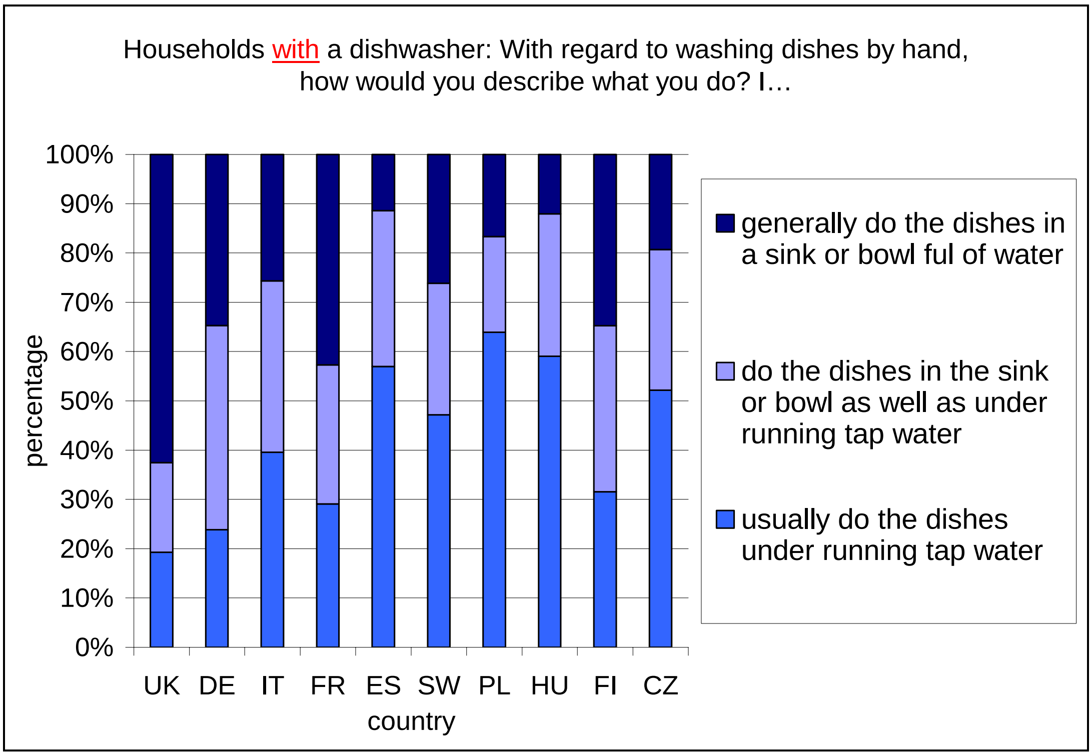


Figure 3.81: way of manually washing the dishes for households with a dishwasher

Differences between consumers owning and not owning a dishwasher were also found: people with the dishwasher prefer manual washing ‘under running tap water’; on average, the manual washing ‘under running tap water’ increases from 34,5 % of the households without a dishwashers to 40,2 % of the households where a dishwasher is installed and contemporarily the ‘in a bowl or sink’

washing reduces on average from 35,1 % to 30,2 %. This may be explained by the fact that owners of dishwashers do not place all tableware items to be washed in the dishwasher but tend to wash some pieces by hand, probably if an item is needed quickly or if it may require a special treatment.
An important aspect affecting the use of resources by the automatic dishwashing is the number of wash cycles. Since the consumer questionnaire is representative of the household size of the investigated countries, the calculated values are very likely representative of the average number of dishwasher cycles per household (Figure 3.82). This figure goes from 3,5 (Germany) up to 4,5 (UK, Sweden) cycles per household per week, with an average of 4,06 cycles per household per week.

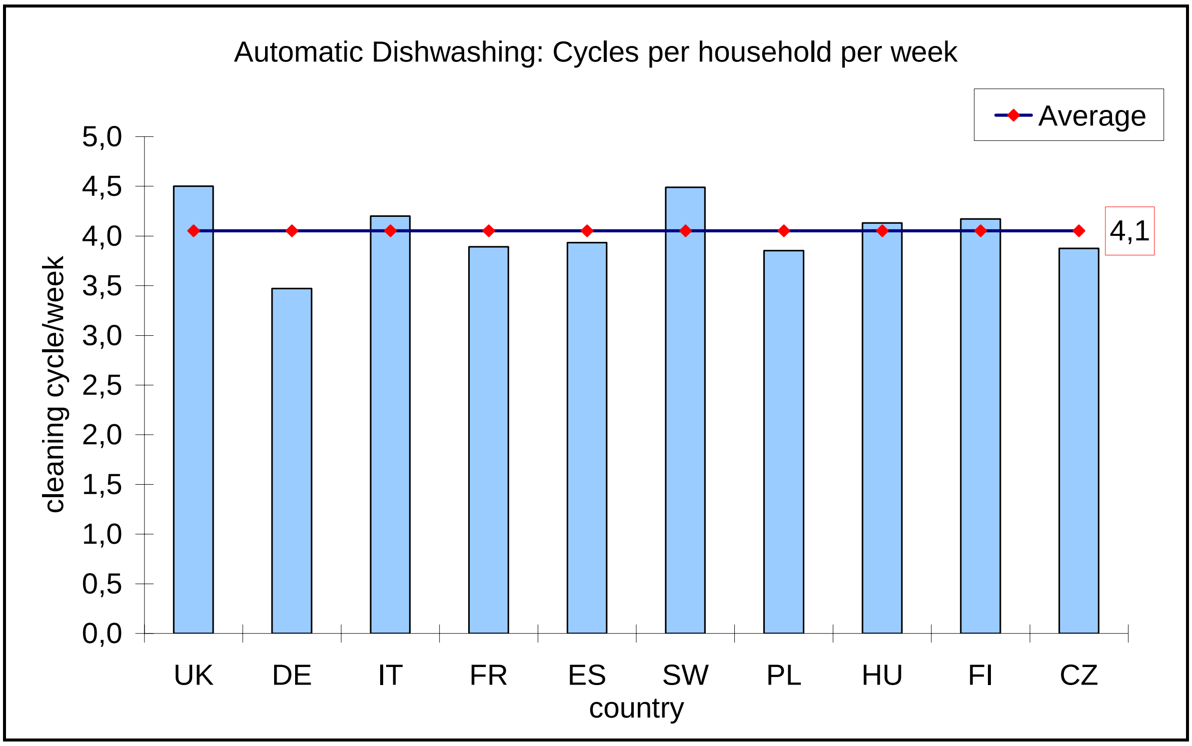


Figure 3.82: average number of dishwasher cycles per household per week

Since the penetration of dishwashers and the household size varies from country to country, it is more correct comparing the countries by the numbers of washing cycles per week per person (Figure 3.83): this number varies from 1,1 (Spain) and 1,7 (Sweden) dishwasher cycles per person and week, with an average of 1,34 cycles per person per week.

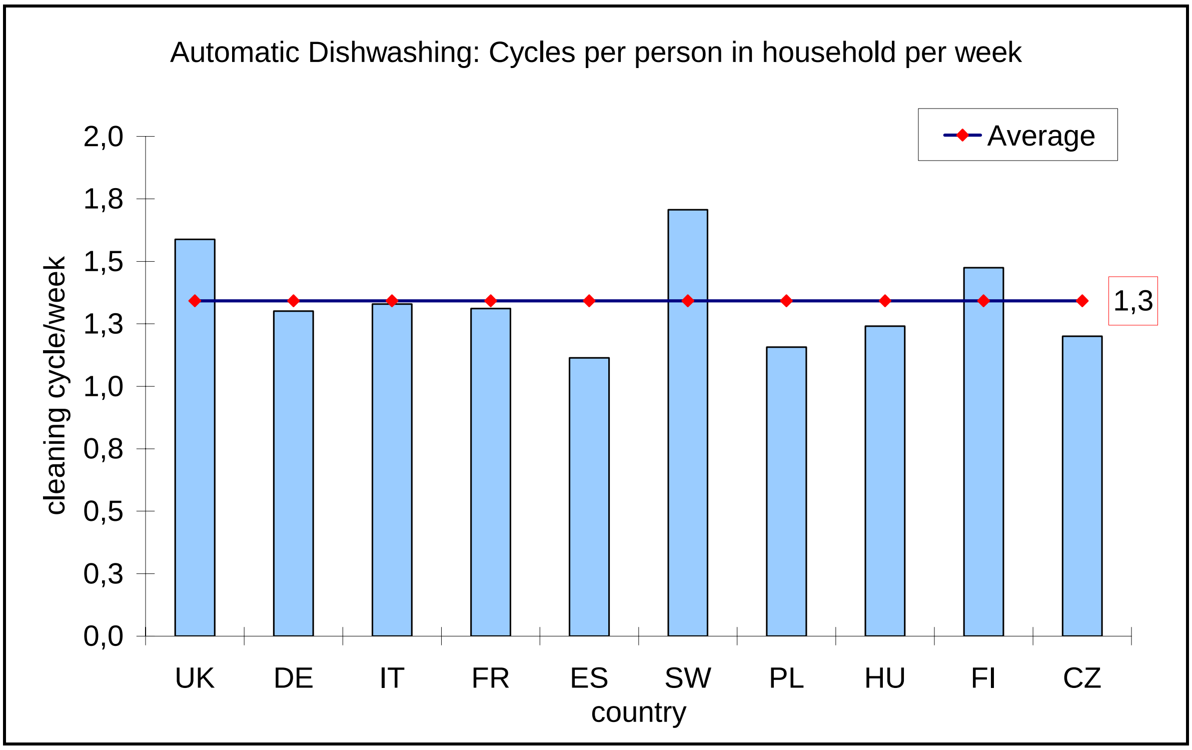


Figure 3.83: number of dishwasher cycles per person per week

The second important aspect affecting the energy consumption of a dishwasher is the temperature of the selected washing programme. The answers of 1 722 consumers from 10 countries did not show a clear preference (Figure 3.84): programmes at 50/55 °C (36,3 %) are as common as programmes at 60/65 °C (35,6 %); the same occurs for the programmes at higher temperature (70°C) which are used on average in 14,2 % of the cases, while lower temperature programmes (40/45 °C) are used in 13,9 % of the cases. The averaging nominal washing temperatures is 59,3 °C. It is worth noting that 22,2 % of the consumers could not report the temperature of the programmes they use, as this may be not indicated on the machine control panel.

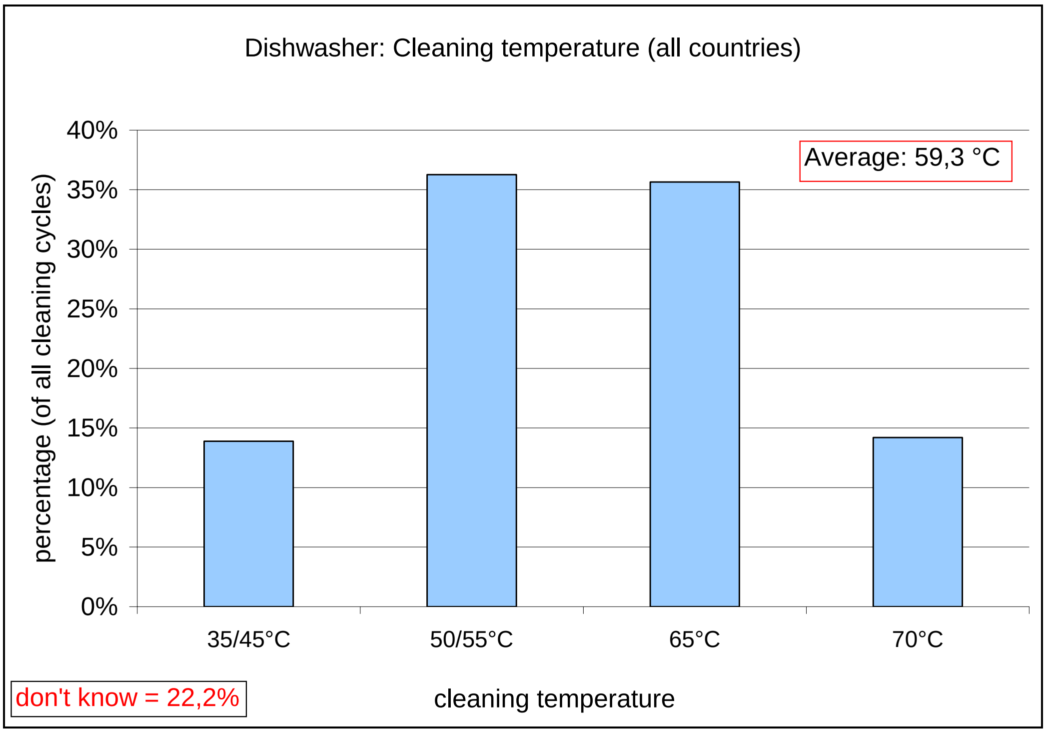


Figure 3.84: relative occurrence of dishwasher temperatures in Europe (average of 10 countries)

Analysing the questionnaire answers more in detail (Figure 3.85) the temperatures range in the investigated countries is quite different:

- in some countries high temperatures are used for less than 10 % of the cycles (France), in other countries they are used for more than 20 % of the cycles (Sweden, Italy);
- low temperature washing cycles are very common in Spain, with more than 30 % of the cycles being at 35 to 45 °C.

These differences are also visible when comparing the average wash temperatures for all of the 10 countries investigated (Figure 3.86), which range from 56,6 °C to 60,8 °C.

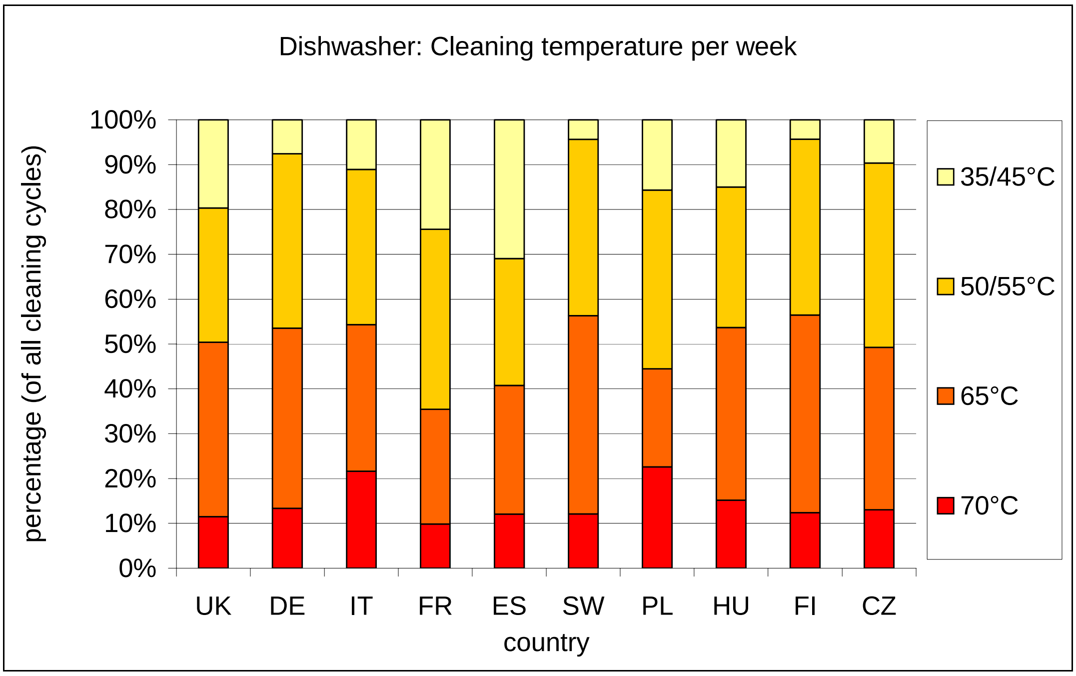


Figure 3.85: temperature distribution of dishwasher programmes in various countries

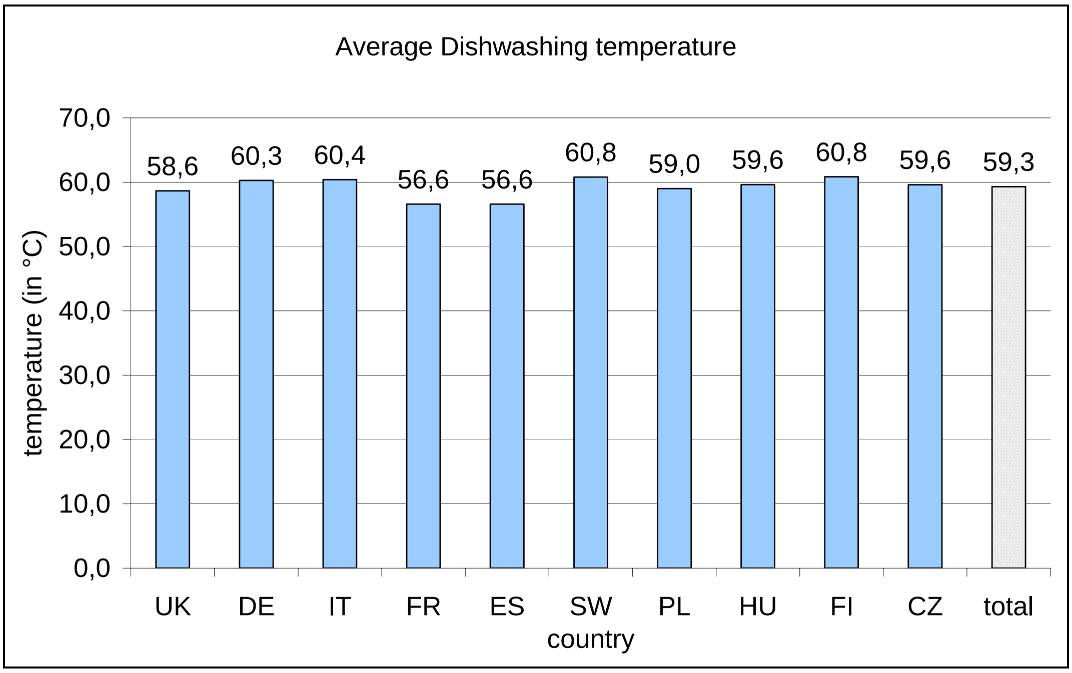


Figure 3.86: average nominal dishwashing temperatures for all countries

The type of the selected dishwasher programme shows (Figure 3.87) a dominance of the 'normal/regular' programme, where about 40 % of the consumers use it *always* and another 25 % *often*; the second most used programme is, when available, the 'automatic' programme (which claims to adjust to the machine consumption to the actual load or soiling level), almost as used as the 'eco'-programme, which is often indicated as the programme used for the EU energy labelling declaration); the less frequently used programme is the 'rinse and hold' cycle. The 'rinse and hold' cycle is intended to be used mainly to rinse off heavy residues from the dishes and to pre-rinse the dishes with some cold water if they are not immediately washed due to the time needed to fill the dishwasher with dirty tableware. However, some of the consumers seem to prefer to do this job manually (Figure 3.88): slightly more than 30 % quickly manually pre-rinse almost all items before putting them into the dishwasher.

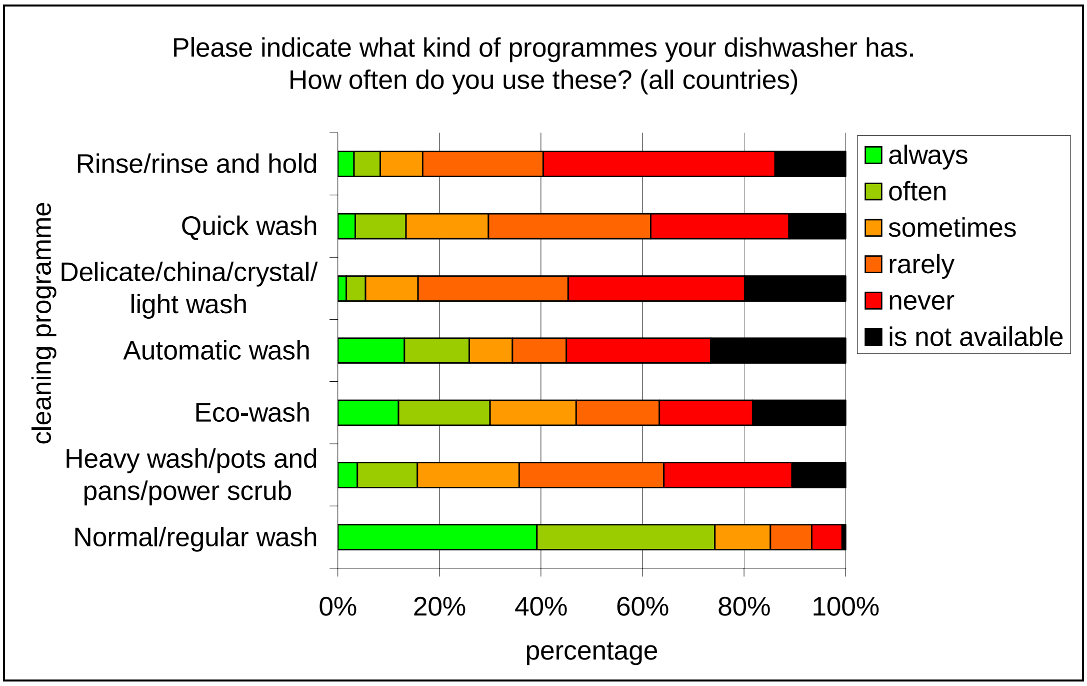


Figure 3.87: frequency of use of various programmes of a dishwasher

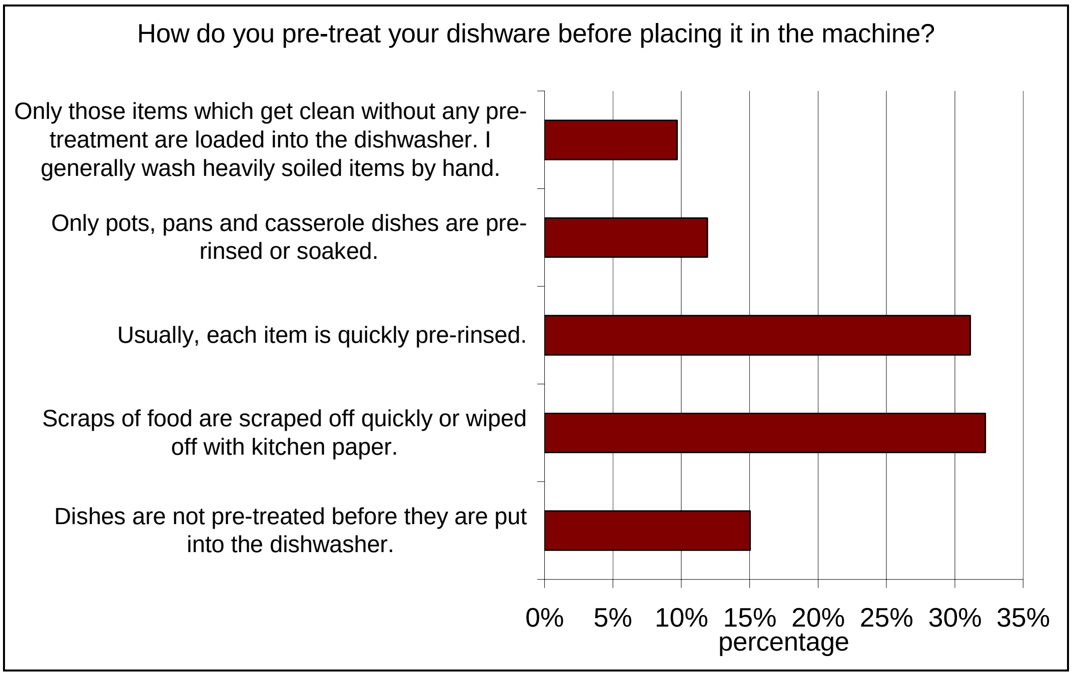


Figure 3.88: frequency and type of pre-treatment of dishes

Regarding the loading of the dishwasher, most of the interviewees declare to fill it completely and even to overload it; only about 10 % admit to run the dishwasher also when not completely filled or do not care about the amount of load in the appliance (Figure 3.89). Due to the structure of the consumer questionnaire it was not possible to verify what consumers mean in terms of load items amount when saying they load the dishwasher completely.

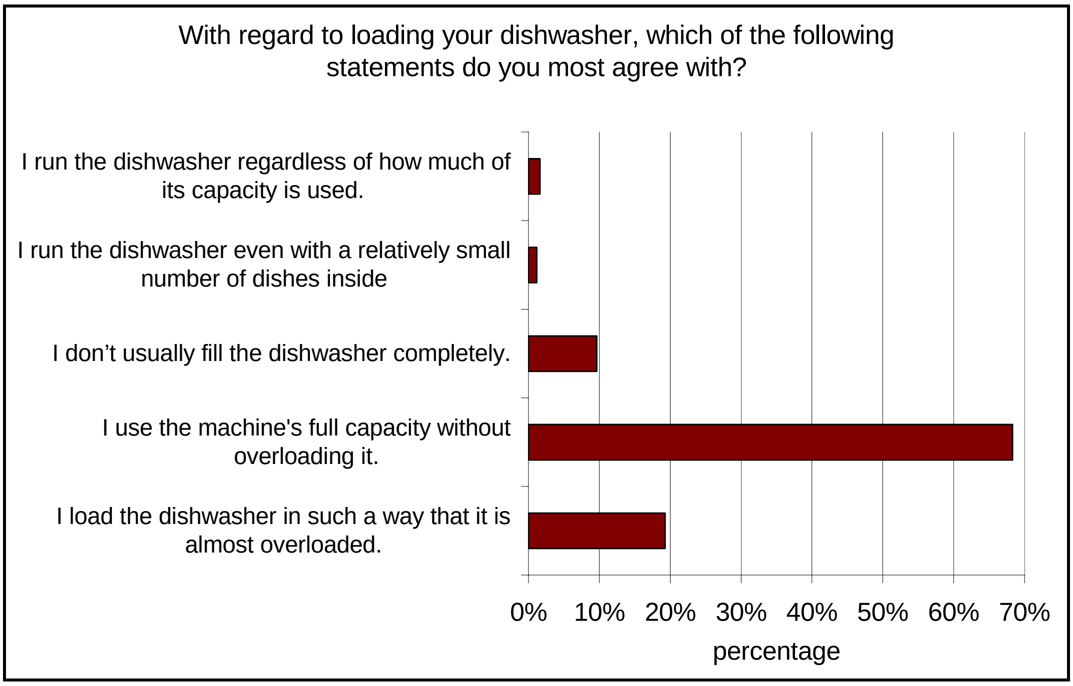


Figure 3.89: consumer answers about the load they are putting into the dishwasher

As a delay of the start of the dishwashing process may be used to postpone the energy (and water) consumption when - during the day or the night - cheaper (off-peak) tariffs may be offered, the selection and the frequency of use of this option have been investigated. Consumers were asked if their washing machine was equipped with a delay-start time pre-selection function: over 39 % of the dishwashers are equipped with such an option, but with some differences among countries (Figure 3.90).

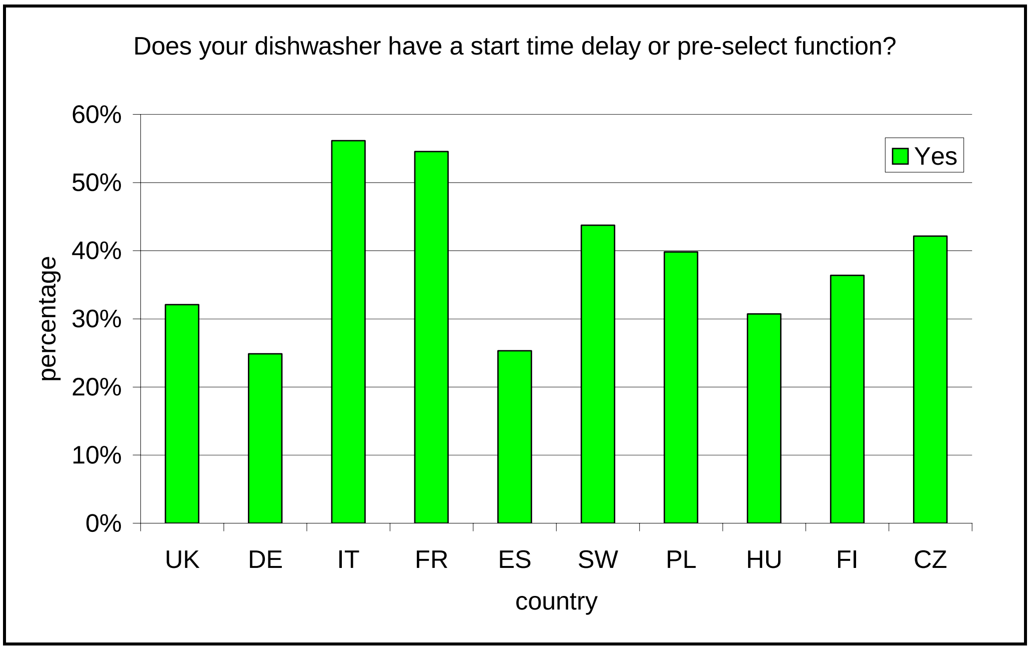


Figure 3.90 availability of a time delay function of the dishwasher

But when asked about the frequency of the usage of this delay-start option, 45 % of the consumers confess (Figure 3.91) to 'never' use it; 27 % say they use this function 'almost always' and another 15 % use it about 'once per week'. It would have been interesting to know also the reason why consumers select this option: if to match off-peak tariffs or for their personal convenience (clean tableware ready when needed), but this aspect was not included in the questionnaire.

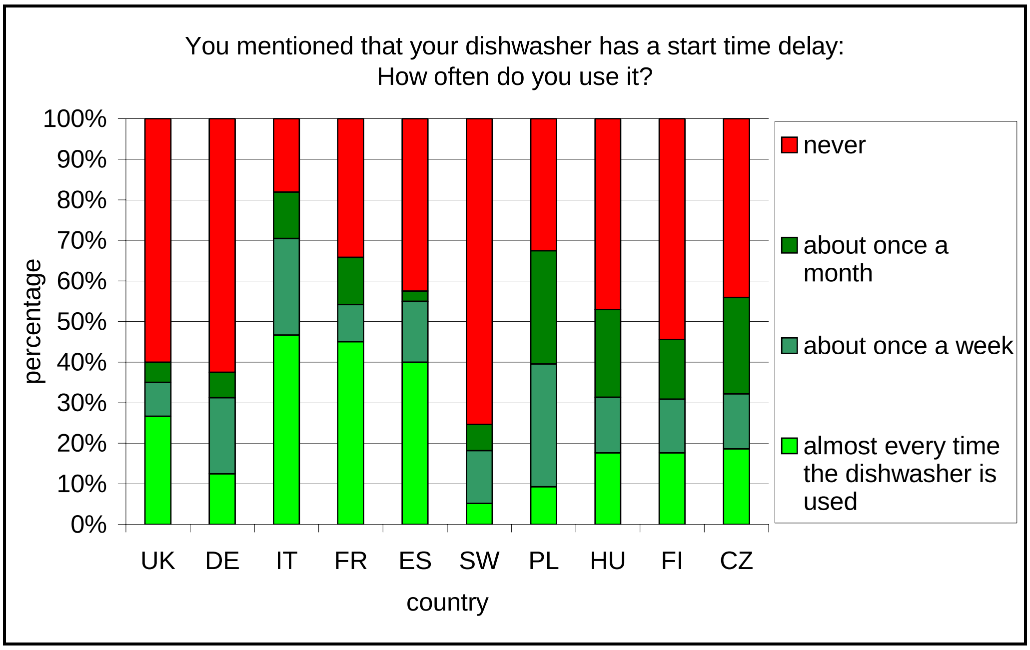


Figure 3.91: frequency of use of the time delay function

This function also has a possible negative impact on the energy consumption on one side because the consumer convenience may - at least potentially - lead to start the dishwashing cycle during peak hours, and on the other side because the machine consumes some energy when waiting for the start time. Asking (to those consumers having a delay start function in their dishwasher and making use of it), about the selected start time delay, on average 66 % chose a time between 0 and 3 hours (Figure 3.92), while 24 % use it to delay the start time between 4 and 6 hours and 10 % to delay it for more than 7 hours.

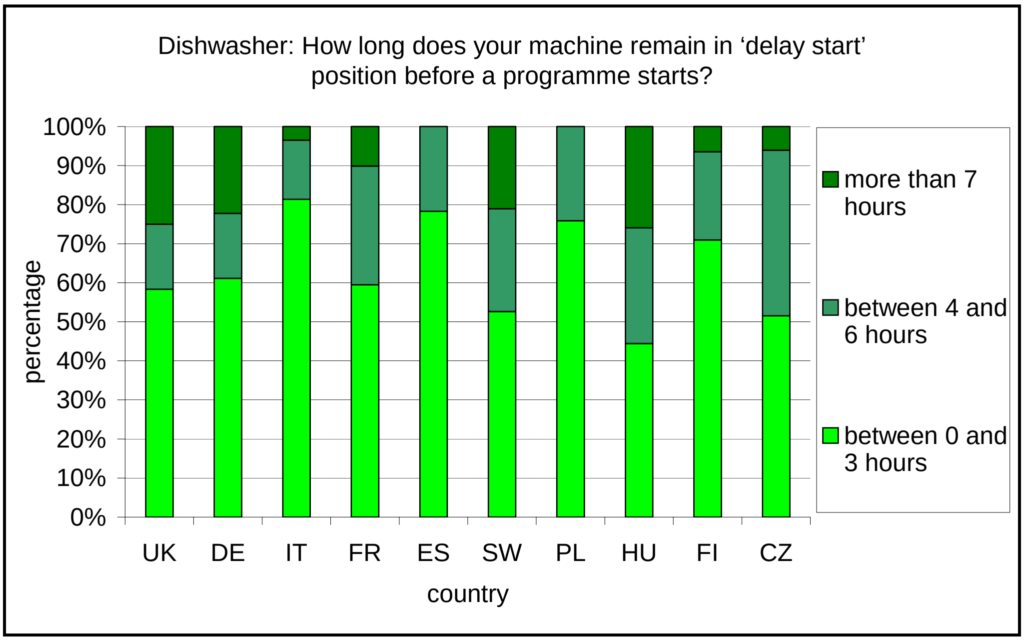


Figure 3.92: frequency of start time delay hours

Additional energy may be consumed when the machine is entering the programme-end-mode, which may be defined as the time between finishing the dishwashing programme (including the final hot rinse) and unloading. During this time the machine may do some additional drying function. Asked about how long this mode normally is, on average 33 % of the consumers (Figure 3.93) open the door immediately after the programme has ended; 54 % do this within a maximum of 3 hours; and only 13 % admit to wait for more than 3 hours.

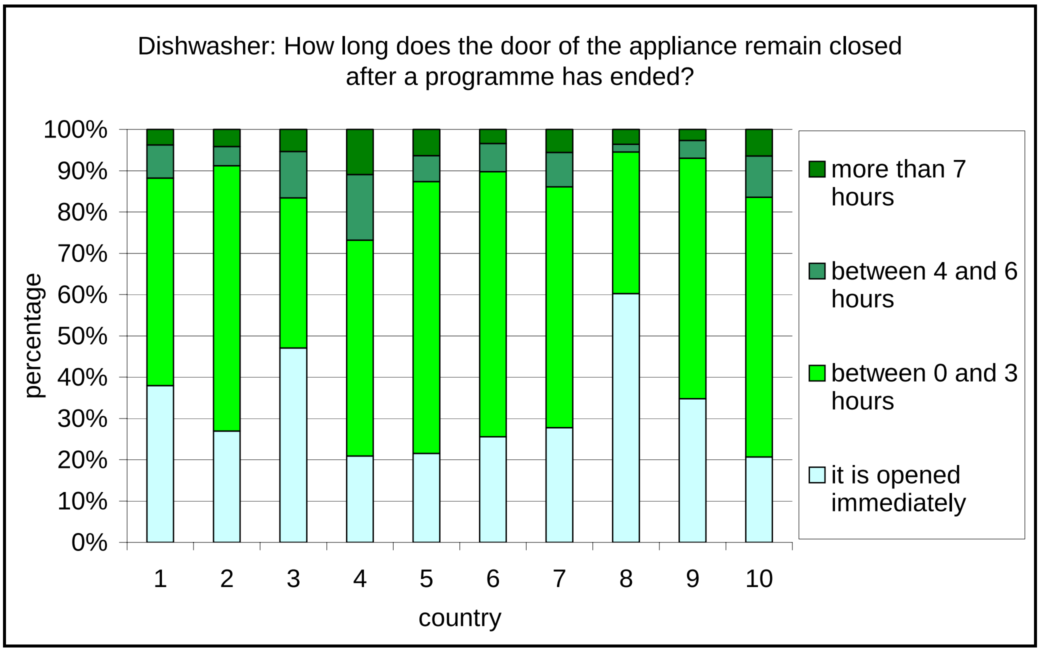


Figure 3.93: time of keeping the door closed after programme end

Also after the dishwasher is unloaded there may be additional energy consumption when the machine is "left on" and not switched off completely. On average 44 % of the consumer declared (Figure 3.94) to switch off the appliance immediately and additional 14 % to do this after unloading; only 12 % of the consumers claim not to switch off the appliance always or most of the time.

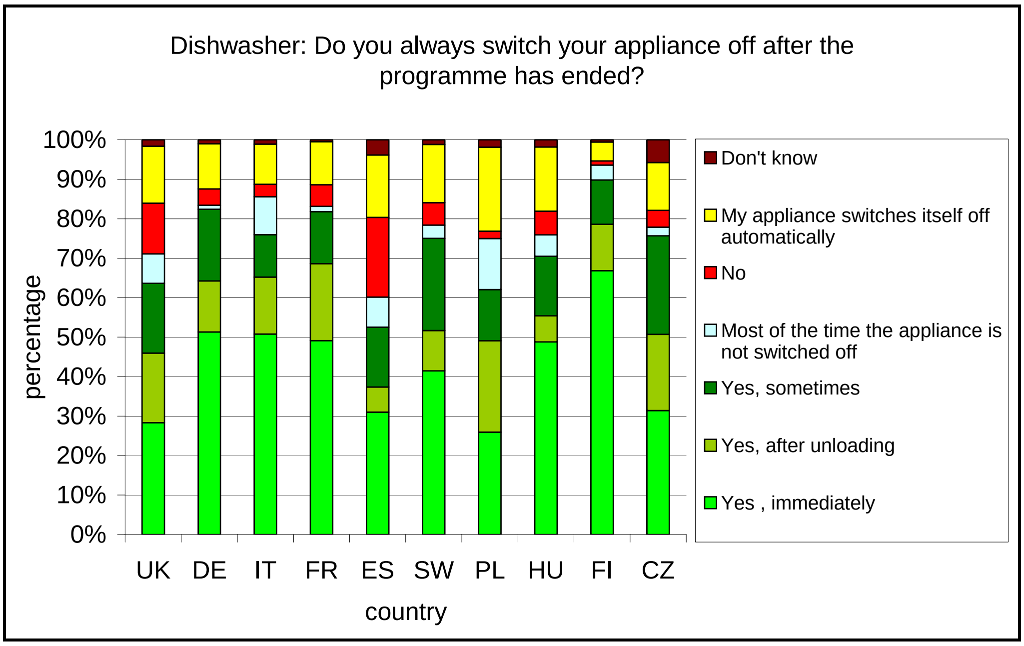


Figure 3.94: action after programme has ended regarding off-switching

In summary, the consumer behaviour regarding washing their tableware in a dishwasher is characterised by:

- on average 4,1 automatic dishwashing cycles are done per week per household or 1,34 dishwashing cycles per week per person
- programmes at 50/55 °C (36,3 %) are as common as programmes at 60/65 °C (35,6 %), with an average programme temperature of 59,3 °C
- normal/regular programme is the most frequently used programme (65 % of the households always or often)
- the automatic programme is the second most frequently used, when available, almost as used as the 'eco'-programme (often the basis for the EU energy labelling scheme declaration)
- consumer claim to load the dishwasher almost always at the full capacity or even more
- delay-start function, present on average in 39 % of the dishwashers, is not used by about half of the households, and when used it is very often only for short time delays (0-3 hours)
- about 58 % of the consumer switch the appliance off after the machine has ended the washing programme or was unloaded
- additional energy and water is consumed by pre-treatment (soaking, pre-rinsing) of dishes which are then loaded into the dishwasher
- manual dishwashing (3,3 cycles per person per week) is also regularly done in households owning a dishwasher
- manual dishwashing 'under running tap water' is a common practise in many households and more frequently used in households owning a dishwasher (40,2 %)
- manual dishwashing procedures show a large variation from country to country, more than automatic dishwashing.

3.6 ELEMENTS FOR THE COMPARISON OF REAL LIFE AND STANDARD CONDITIONS FOR WASH APPLIANCES

Consumers behaviour for laundry washing and dishwashing shows a large variability, and differences may be found also with the standard conditions defined in the European measurement methods, and used within the energy labelling schemes, to evaluate the consumption and the performance of washing machines and dishwashers. These differences are summarised in the following paragraphs as far as they may affect the energy and water consumption of the laundry- or dish-washing process.

The final decision about the elements to be considered in the definition of the real-life base case(s) for washing machines and dishwashers will be taken in Task 5 of this study.

3.6.1 The laundry washing process

The differences between the real-life and the standard conditions for the laundry washing process are summarised here. Not considered here is the energy consumption associated with manual washing of laundry (which was not investigated due to the selection criteria of the consumers questionnaire sample), and with manual processes done in addition to the automatic washing on garments which are then placed into the washing machine, which are considered to be very small.

The factors, which are not considered among the standard conditions, but are relevant for the energy consumption under real life, are:

- the consumer survey has shown an average frequency of use of the washing machines of 4,9 cycles per household per week. Using this figure the energy consumption under standard conditions and the effect of those factors which are not included in the testing procedure may be calculated;
- the real life average nominal washing temperature was found to be 45,8 °C which is considerably lower than the nominal 60 °C used under standard conditions for the energy labelling declarations. The effect of this reduced temperature can be calculated applying the energy consumption increase per degree Celsius between 40 and 60 °C nominal wash temperature found in the German (0,0031 kWh/K) or the AISE studies (0,027 kWh/K) to the energy consumption of the average 2005 washing machine model at 60 °C, or 0,998 kWh/cycle.

An alternative is considering the specific energy consumption of the average 2005 washing machine model, or 0,187 kWh/kg cycle and comparing it with the average specific energy consumption found by Stiftung Warentest[35] of 0,110 kWh/kg cycle for a 40°C cotton programme: a temperature effect of 0,0038 kWh/kg/K results. This latter factor is used in the following calculations;

in Germany the average annual water inlet temperature may be significantly lower than defined in standard conditions (15 °C). As no proven European survey on these temperatures was found, an average water inlet temperature of 10 °C was assumed. Compared to the standard conditions the additional energy to heat up the main wash water volume (assumed to be 15 litres) to 15°C needs to be considered. This assumption – valid for Germany - may be challenged for other countries if their average water inlet temperature is higher than 15 °C; should this the case some less energy to heat up the main wash water volume will be used compared to standard conditions.

Real load sizes are somewhat smaller than the maximum capacity used under standard conditions. Although the underlying calculation assumptions may be challenged, an average load of 3,2 kg was estimated using the consumer answers and correlating it to metering data from Germany. Since the consumers in this questionnaire most likely have one of the machines produced in the last decade, this quantity can be compared to the average capacity of the washing machines as reported in the CECED databases (see Task 2). The most frequent washing machine model from 1997 to 2005 has a rated capacity of 5,0 kg, leading to a loading of 64 % of the rated capacity in the average real life case. The reduced real life load, compared to the nominal capacity of the machine, will also require a reduced amount of energy to be washed. Taking the average found in a study of 20 washing machines measured at 60°C, this can be estimated to be 0,08 kWh per kg reduced load.

Since the average wash temperature is considerably lower, this slope will also be lower: therefore this load dependency factor is scaled down accordingly to now be at 0,057 kWh/kg of reduced load when the previous 0,0038 kWh/kg/K factor is applied. This factor is applied to the 2005 average washing machine model capacity.

Standby and low power modes:

- investigation has shown the delay start function is used in about 8 % of the programme cycles for delaying the start by an average of less than 3 hours. Average power level may be estimated to be at 4,3 W according to Consumer Organisations and 2,5 W as suggested by CECED

[35] Communication to CENELEC TC59X, WG1, SG1.6

- after the programme has ended, the washing machine is not unloaded immediately, but left for an average of 3 hours in 50 % of the cases. Power level may be assumed to be at 3,3 W following Consumer Organisations information or 1,6 W as suggested by CECED
- even after unloading some 10 % of the consumers may not switch off the appliance but leave it in 'ON'-status up to the next programme starts. Power level in this left-on mode is assumed to be the same as at programme end
- the other 90 % of the consumers switch their appliance off and therefore only consume the associated power. On average this mode is assumed to have a power of 0,6 W or 0,5 W depending on the information source.

All these individual items of energy consumption can be summarised (Table 3.9) to obtain the total energy used for laundry washing in an average household in one week and compared it to what a similar calculation would yield just for taking the average washing machine model in 2005 under standard conditions multiplied by the same number of cycles per week.

Table 3.9: comparison of the washing machine energy consumption under real-life versus standard conditions (in kWh)

Activity	Effect	Real life conditions	Standard conditions
Programme selection	Average washing temperature 45,8°C	3,469	4,890
Colder water inlet temperature	15 litre of water heated from 10°C (real life tap water) to 15°C (water inlet under standard conditions)	0,427	--
Real average load size	64 % of the average rated capacity (or 5,36 kg) under standard conditions at -0,0567 kWh/kg	-0,537	--
Low power modes consumption:			
delay start	3 h at 4,3W for 8 %	0,005	
programme end	3 h at 3,3W for 50 %	0,024	--
left-on	the remaining time at 3,3 W for 10 %	0,052	
off-mode (standby)	the remaining time at 0,6 W for 90 %	0,084	
	Total consumption per week	3,525	4,890
	difference	- 1,365 or -27,9 %	

Comparing the figures (Figure 3.95), the total energy used for laundry washing in real life is lower than under standard conditions: this is mainly due to the lower wash temperature, lower inlet water temperature and lower filling of the drum used in real life. Re-calculating the real life energy consumption per washing cycle leads to an energy consumption of 0,72 kWh/cycle.

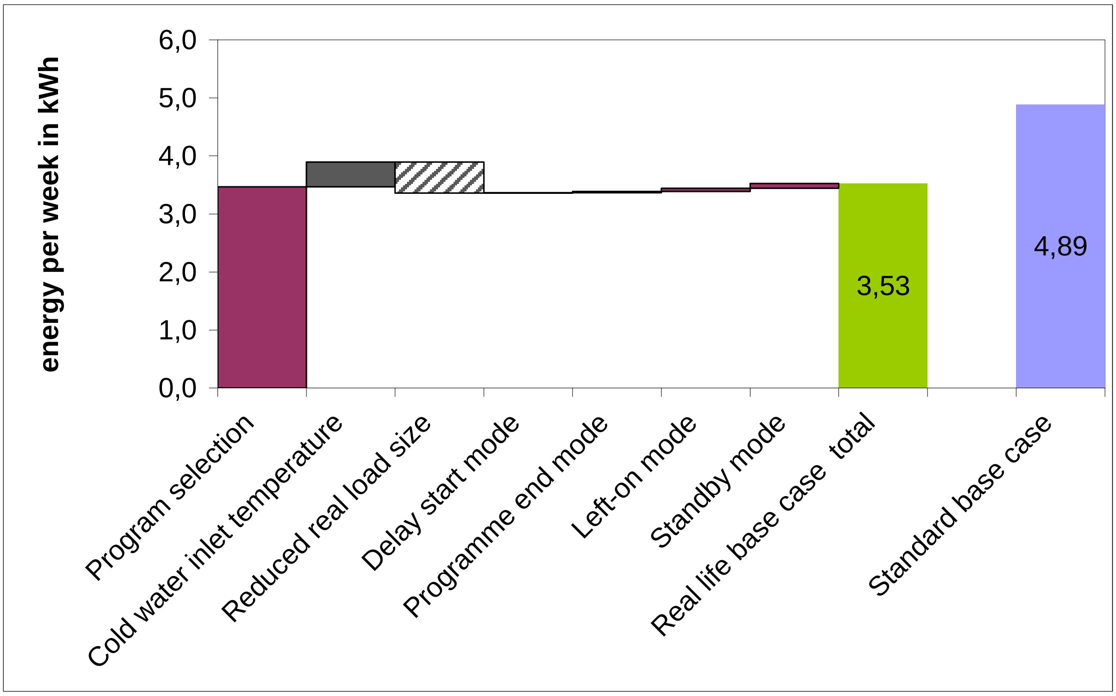


Figure 3.95: graphic representation of factors under real-life and standard conditions for the energy consumption per week of washing machines

Asking the consumer to fill the machines more would theoretically reduce the 'benefit' given in this calculation, but would in real life provide an even higher saving if this better loading is reflected in a reduced number of washing cycles.

Concerning the low-power modes consumptions, only the left-on mode and the off-mode (standby) seem to have a minor influence on the real life energy consumption: when the data from Stiftung Warentest is used this influence is <5 % when data from CECED is used, this influence is reduced to 3 %.

Not considered here is the difference in the amount of detergent used between the standard conditions and real life. The European standard requires the use of the standardised detergent "A*" (see in Task 1 the description of the EN 60456 standard) whereof for a 5 kg load 134 g are used for a water hardness of 2,5 mmol/l. In real life detergent dosage may be lower in absolute values but due to under-loading of the drum the specific amount of detergent used per kg load may be more inline with the standard conditions. Anyhow the real life detergent is somewhat different from the standard detergent.

Regarding water consumption the average 2005 washing machine results in 248 litres[36] per week. This value is reduced by about 27 litres due to the reduced filling of the drum in real life and the automatic adjustment of the washing machine to it. Extra rinse cycles or selecting additional water is not used very commonly but will add an extra amount of water; only 4,2 % of the consumers state to always use extra rinsing water and 8,9 % use it often; assuming 10 % of the wash cycles are done with an extra rinse of 10 litre per cycle, a water consumption of about 5 litres is added to the

[36] due to the rounding in the calculation, a specific water consumption of 9,5 litre/kg results when dividing the average water consumption of 50,7 litre/cycle for the average load capacity of 5,36kg, instead of the 9,6 litre/cycle reported in this Task. When a consumption of 9,6 litre/kg are used, the overall water consumption per week is 252,1 litres.

average consumption per household per week in real life. In total, the consumer will actually consume about 227 litres per week (Table 3.10).

Table 3.10 real life vs. standard water consumption calculation for washing machines (in litre)

Activity	Effect	Real-life conditions	Standard conditions
Basis	50,7 litre per wash in a 5,36 kg machines	248,4	248,4
Real average load size	64 % of rated capacity at 2,817 l/kg	-26,6	--
Extra rinse cycle	10 % at 10 litre	4,9	--
	Total litres per week	226,7	248,4
	difference	-21,7 or -8,7 %	

In summary, the comparison of standard conditions with real life consumer behaviour results in a lower amount of energy used in real life than when calculating that the same number of cycles is run with the average 2005 washing machine model under standard conditions. The energy consumed for washing per week is 1,36 kWh or about 28% lower than when calculated under standard conditions. This difference is roughly confirmed by the lower average energy consumption measured per cycle (0,89 kWh) in a recent metering study in Germany, considering that the German stock of washing machines is less efficient than the average 2005 model. As far as the water consumption is concerned, the difference is about 22 litres or 8,7 % lower in the real life compared to the standard conditions, mainly due to the reduced water taken by the lower average load

It should be nevertheless highlighted that the use of the washing machine at the rated capacity would increase the energy and water efficiency which in turn might allow having less washing cycles with a reduction in the energy/water consumption of both under real life and standard conditions.

In trying to assess the sensitivity of the results to the household size, calculations were done also for the average consumer behaviour of single-person-households and of 4-person-households:

- average washing frequency was found to be 2,6 times per week for single- and 6,2 for 4 person households;
- load size and temperature selection were found not to differ significantly with the household sizes and were therefore kept constant;
- real life energy consumption for a washing machine per cycle in a single household (Figure 3.96) was calculated to 25 % lower and 29 % lower for a 4 person household (Figure 3.97). The contribution of standby and low power modes energy consumption increases 4 % of the total consumption for a 4-person household and 8 % for a single person household.

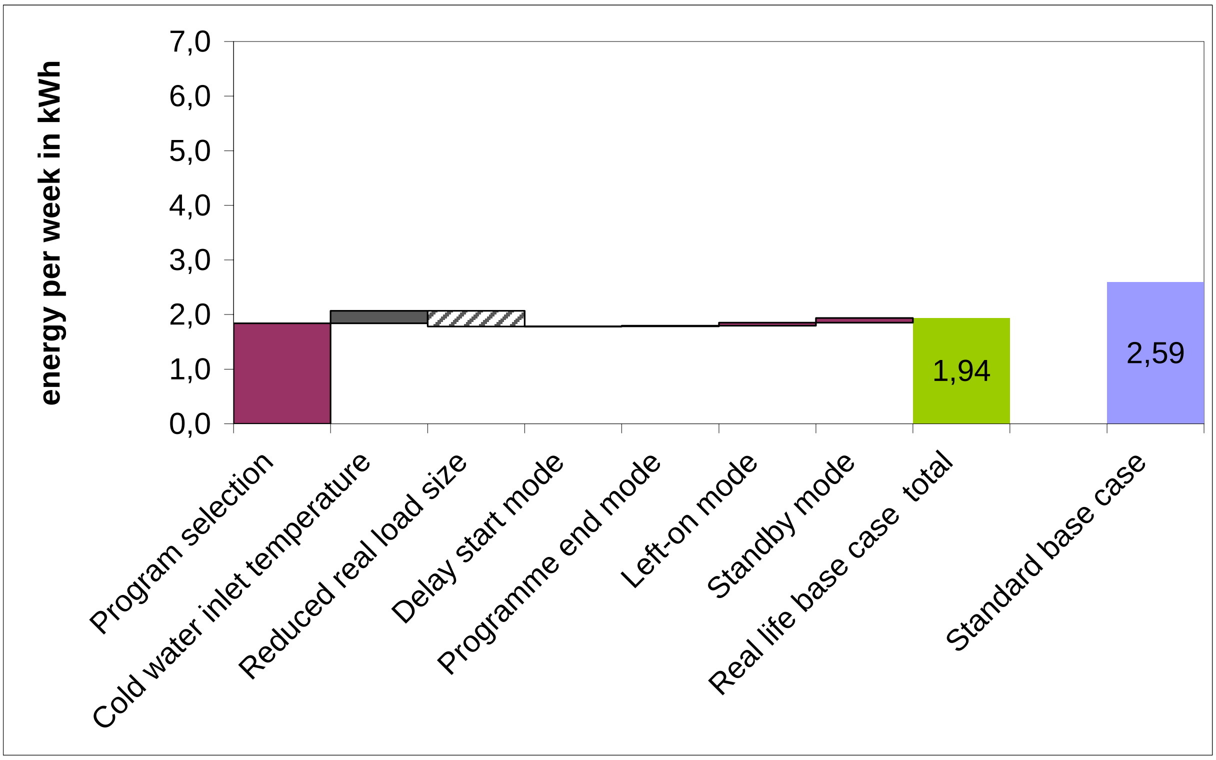


Figure 3.96: real life condition energy consumption per week for an average single-person-household compared to standard conditions for washing machines

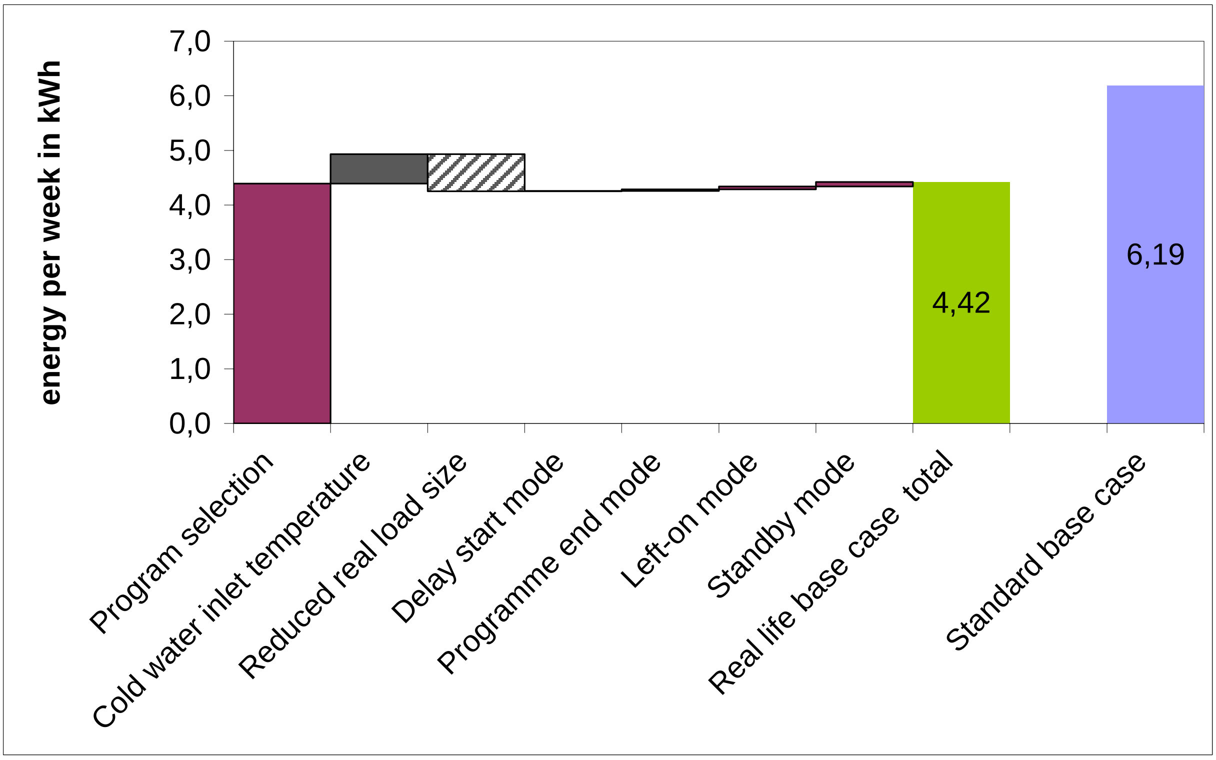


Figure 3.97: real life conditions energy consumption per week for an average 4-person-household compared to standard conditions for washing machines

3.6.2 *The dishwashing process*

The differences between the real-life and the standard conditions for the dishwashing process are summarised here. It is worth noting that the energy consumption associated with manual dishwashing (which is still the only way to have clean tableware for about half of the EU population) and the energy used for those cleaning processes done in addition to the automatic dishwashing (such as for example for the manual washing pots and pans) is not considered. For sake of completeness of the description, the additional pre-rinsing and cleaning processes done on those items which are then placed into the dishwasher are here evaluated: it is assumed that these processes may be avoided by providing the right information to the consumer and by proper functioning of the dishwasher, but it is not known whether pre-rinsing is due to a poor washing performance or to a consolidated bad habit of consumers.

The consumer investigation has shown an average frequency of use of the dishwasher at 4,06 cycles per household per week for those households owning a dishwasher, and which have also a larger size (in terms of the number of persons per household) than the average household. Using this figure and the energy consumption of the average 2005 dishwasher 12 place setting model (see Task 5) the effect of the conditions not explicitly considered in the European test method are evaluated.

The factors that are not considered among standard conditions, but are relevant for the energy consumption under real life conditions are:

31 % of the households are found to pre-rinse their dishes before placing them into the dishwasher. This causes an additional consumption of water and energy. Based on the result of investigating manual dishwashing it is assumed that 0,1 kWh and 3 litres of water are used per place setting (for 6 place settings per cycle).

In real life the most frequently used programme is the normal/regular programme at an average temperature of 59,3°C which will cause higher energy consumption than in the eco-programme. It is assumed this will add 10 % to the energy consumption compared to the standard condition programmes running at 50 or 55 °C.

in Germany the average annual water inlet temperature may be significantly lower than defined in standard conditions (15°C). As no proven European survey on these temperatures was found, an average water inlet temperature of 10 °C was assumed. Compared to the standard conditions the additional energy to heat up the main wash water volume (assumed to be 15 litre) to 15°C needs to be considered. This assumption – valid for Germany - may be challenged for other countries if their average water inlet temperature is higher than 15°C; should this the case then some less energy to heat up the main wash water volume will be used compared to the standard conditions.

Real load sizes are somewhat small than the maximum capacity used for standard measurements. Since about 1/3 of the energy is used to heat up the load and about 1/3 less of the maximum capacity may be loaded on average, an acceptable assumption may be to allocated a 10 % reduction of the energy consumption under the real life condition due to this factor.

Standby and low power modes:

- investigation has show the delay start function is used in about 10% of the programme cycles for delaying the start by an average of 3 hours. Average power level is found to be at 4,3 W (same as for washing machines)
- after the programme has ended, the dishwasher is not unloaded immediately, but left for an average of 3 hours in 50 of the cases. Power level is reported to be at 3,3 W (same as for washing machines)

- even after unloading some 30 % of the people may not switch off the appliance but leave it in 'ON'-status up to the next programme starts. Power level in this mode is assumed to be the same as at programme end
- the other 7 % are switching their appliance off and are therefore only consuming the power that is associated with this mode. On average this mode is assumed to have a power of 0,6 W (same as for washing machines).

All these factors can be summarised (Table 3.11), to evaluate the total energy used for dishwashing in an average household in one week in comparison with the consumption of the average 2005 dishwasher models under standard conditions for the same number of cycles per week.

Comparing the figures, the total energy used for the real dishwashing cycles is almost identical in real life and under standard conditions (real life: 4,779 kWh – 0,406 kWh = 4,313 kWh) because the energy consumption reduction for under-loading the dishwasher is of the same magnitude than the additional energy associated with the higher washing programme temperature. This substantial equivalence will no be longer valid if the programme used in the test method is further optimised without a contemporary action inducing the consumers to decrease the actual washing programme from their habit of using other washing programmes at higher temperatures.

The overall consumption of the dishwashing cycle under real conditions and standard conditions is similar when the pre-rinsing is not considered: 4,87 kWh per week against 4,34 kWh per week, but this will require a change in a (bad) consumers habit.

Table 3.11: comparison of real-life versus standard conditions energy consumption in kWh for dishwashers

Activity	Effect	Real life conditions	Standard conditions
Manual pre-rinsing	31 % using 0,1 kWh and 3 litres of water per place setting (for 6 place settings per cycle)	0,755	--
Programme selection	Normal/regular programme selected at 59,3°C (10 % higher consumption than under standard conditions assumed)	4,779	4,344
Colder water inlet temperature	10 litre of water heated from 10°C (real life tap water) to 15°C (water inlet under standard conditions)	0,236	--
Real average load size	9 place settings	-0,406	--
Low power modes consumption:			
delay start	3 h at 4,3 W for 10 %	0,005	--
programme end	3 h at 3,3 W for 50 %	0,020	
left-on	the remaining time at 3,3 W for 30 %	0,162	
off-mode (standby)	the remaining time at 0,6 W for 70 %	0,069	
	Total consumption per week	5,620	4,344
	difference	+1,28 or +29,4	
	Total consumption per week without pre-rinsing	4,865	4,344

Activity	Effect	Real life conditions	Standard conditions
	difference	+0,54 or +12,2 %	

As far as the standby and other low-power modes consumption is concerned (Figure 3.98) only the left-on and the off (standby) modes seem to have some minor influence on the real life energy consumption (in total less than 5%). When data from CECED is used, this influence is reduced to 3 %.

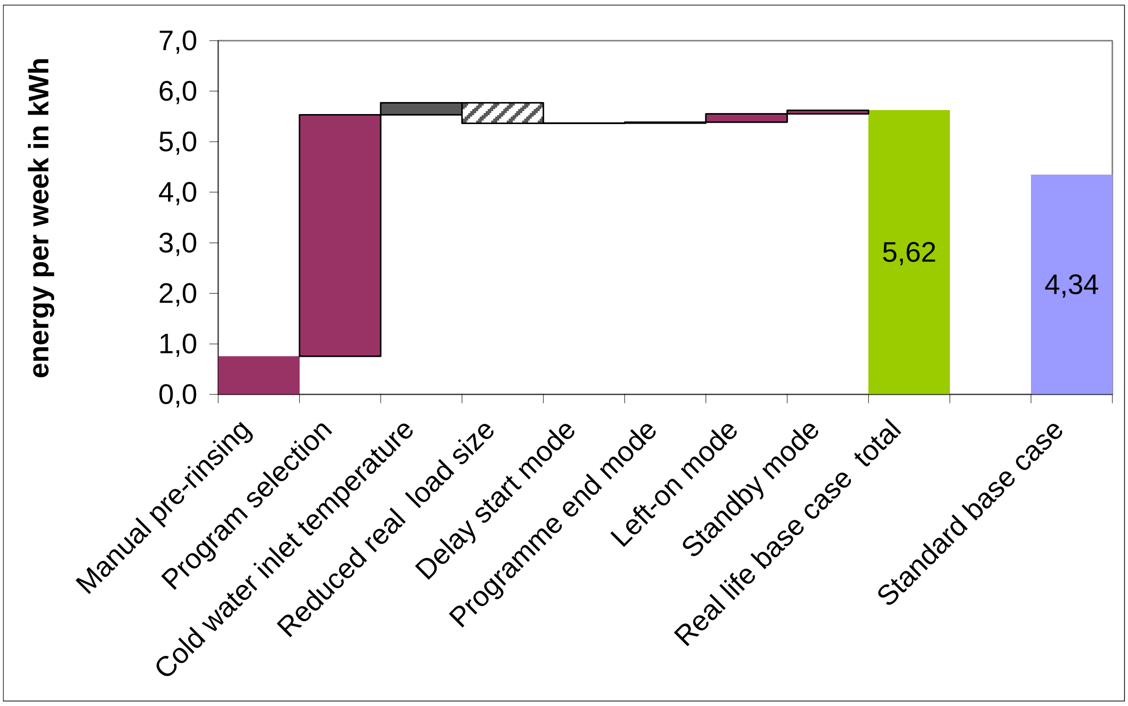


Figure 3.98: graphic representation of factors under real-life and standard conditions for the energy consumption per week of dishwashers

Regarding the water consumption, under standard conditions the total amount is 62 litres per week per household owning an automatic dishwasher. This value is increased by about 23 litres or 37 % when the additional pre-rinsing done by 31 % of the consumers (for the calculation it is assumed this is done on 6 place settings per cycle and it takes 3 litres per place setting). The extra rinse cycles or rinse and hold is used by only 3,2 % of the consumer always and 5,2 % often. Assuming that 5 % of the wash cycles are done with an extra rinse of 5 litres per cycle, this will add a water consumption of 1 litre to the average consumption per household per week. In total under real life conditions water consumption will reach 85 litres per week per household owning a dishwasher (Table 3.12).

Table 3.12: comparison of real-life vs. standard conditions water consumption (in litre) for dishwashers

Activity	Effect	Real-life conditions	Standard conditions
Basis	15,2 litre per wash for 4,06 cycle/week	62	62
Manual pre-rinsing	31 % using 0,1 kWh and 3 litres of water per place setting (for 6 place settings per cycle)	23	--
Extra rinse cycle	5 % at 5 litre	1	--

Total litres per week with pre-rinsing	86	62
difference	+24 or +39 %	
Total litres per week without pre-rinsing	63	62

Another relevant difference between the dishwashing process under standard and real life conditions is the amount of detergent used: the standard calls for 30 g of reference detergent B (see the description of EN 50242 standard in Task 1) for a 12 place setting machine, while in practise some consumers use tablets which have only a weight of about 20 g. Although the chemical ingredients are different, the reduced quantity might have an impact on the total life cycle.

The calculations also exclude water and energy consumption used for additional manual dishwashing, which is done by almost all households.

The comparison of the average consumption under standard and real life conditions results in a higher amount of energy used in real life: per week the energy taken for running an automatic dishwasher is 1,28 kWh or nearly 29 % higher as it is under standard conditions when the manual pre-rinsing is considered, if it is not included in the calculations, the consumption under real life conditions is 12,2 % higher than under standard conditions.

Regarding water consumption the difference is 24 litres or 39 % higher in the real life compared to the standard conditions due to the pre-rinse done before the dishwasher is started. When again this pre-rinse is not considered the water consumption is almost the same.

Additional energy and water are consumed by doing manual dishwashing, but here no difference between standard and real life conditions can be expected.

In trying to assess the sensitivity of the results with the household size, calculations were done also for the average single-person households and for the 4-person households: Since the single household will most likely not have a standard dishwasher (with 60 cm width), the energy and water consumption of the average 2005 9 place setting machine was used. Other input data were adjusted accordingly. Average operation frequency is found to be 2,33 times per week for single-person and 4,86 for 4-person households. Real life energy consumption for running a dishwasher for a single household turns out (Figure 3.99) to be 33 % higher and 29 % higher for a 4 person household (Figure 3.100) when the additional pre-rinse is considered. The contribution of standby and low power modes energy consumption is increasing from 4 % of the total consumption for a 4 person household to 10 % for a single person household.

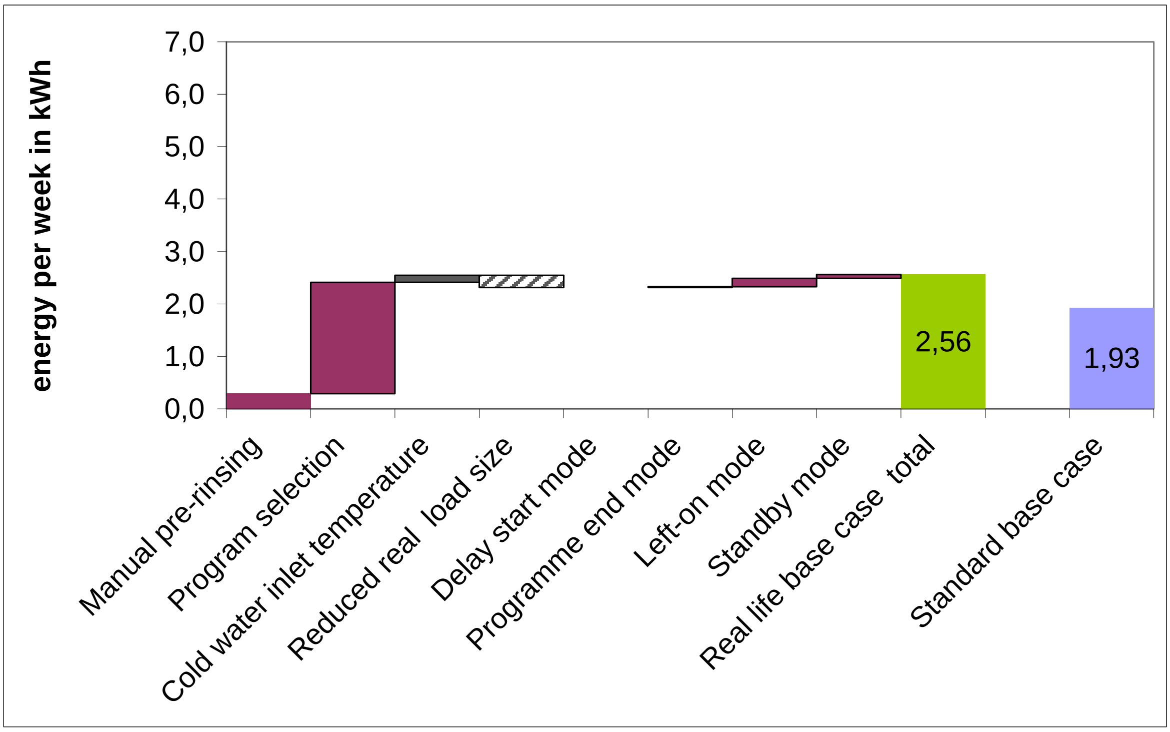


Figure 3.99: real life energy consumption per week for a single person household compared to standard conditions for dishwashers

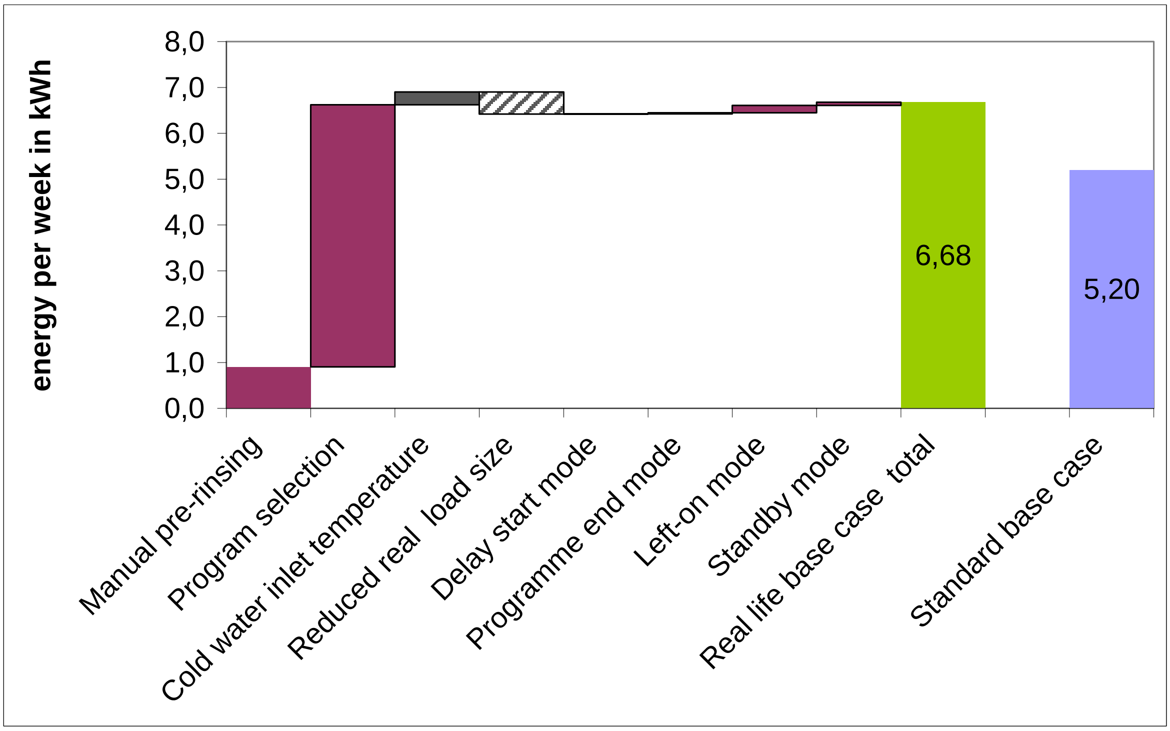


Figure 3.100: real life energy consumption per week for a 4 person household compared to the standard conditions for dishwashers

3.7 SUMMARY

Consumer survey on an almost representative sample of consumers from 10 European countries covering 75 % of the population revealed a very high level of awareness of the consumer towards the environmental aspects of household appliances. This is also reflected when buying decisions are taken and the European energy label is seen as an informational tool almost as important as the own experience and the information available on the Internet.

3.7.1 Washing machines

In European countries washing machines are available in almost 100 % of the households (not necessarily in the own apartment). But since these appliances remain in the household for normally 10 years and more, their energy/water consumption and performance is as it was at the time of the production. Eco-design improvements will therefore take more than 10 years to get fully implemented in the market. This time is even longer when second-hand appliances are used. As the survey has shown, the second-hand models account for only a minor share of the market.

Consumers asked about the relative influence of washing machines on the total energy consumption of a household considered this appliance as the most energy using product. This is associated with a high level of willingness to use energy saving options.

Consumer behaviour has been identified as being the main source of influence on the actual energy consumption and environmental impact on the washing process. In particular:

- the average nominal washing temperature is 45,8 °C and the most frequently used programme is at 40 °C (including all programmes for wool, silk, synthetics, etc),
- nevertheless the cotton 60 °C programme is still the most frequently used programme and consumes more energy than a cotton 40 °C programme,
- the average wash frequency is 4,9 cycles per week,
- most consumers normally use the full loading capacity of their washing machine, but it is agreed that this does not mean that the rated capacity is really used,
- delay start options are only used in approximately 8 % of the cycles with a shift of the washing starting time by an average of 3 hours (no reason could be identified for this delay),
- at programme end the machine may stay in this mode in about 50 % of the cases for an average of 3 hours. Afterwards in about 90 % of the cases the machine is switched off.

This information about the consumer behaviour and recent data on the energy consumption allow to estimate the average energy and water consumption of laundry washing per household per week: for an average household size of 2,9 people using the average 2005 washing machine model under real life conditions the energy consumption is 3,5 kWh and the water consumption 230 litres. This is a 28% lower energy consumption than the same number of cycles calculated for a machine operated under standard conditions. The difference is mainly due to the lower average temperature of the wash programmes as well as by the effect of under-loading the machine.

Nevertheless it should be highlighted that the use of the washing machine at the rated capacity would increase the washing energy efficiency and would reduce the energy consumption under both the real life and the standard conditions if resulting in a lower number of washing cycles per week (or year).

The difference of the water consumption under real life and standard conditions is 9 %.

Standby and other low power modes have been estimated to contribute on average between 4 and 8 % of the real life energy consumption. These figures may be higher if consumers do not switch off the washing machine after unloading; showing again that the individual consumer behaviour has a major influence on the amount of energy and water used in the specific household.

Therefore consumer training and education is a very important element for the further decrease of the energy and water consumption in real life. The second element to be taken into consideration is the definition of measurement methods in the European standards more in line with the consumer real life behaviour.

3.7.2 Dishwashers

Penetration of dishwashers in European households varies with the country. But since these appliances remain in the household for normally 10 years and more, their energy/water consumption and performance is as it was at the time of the production. Eco-design improvements will therefore take more than 10 years to get fully implemented in the market. This time is even longer when second-hand appliances are used. As the survey has shown, the second-hand model accounts for only a minor share of the market.

The manual dishwashing process done in all households, which do not own a dishwasher, causes – on average – a higher consumption of energy and water. But also households owning a dishwasher do manual dishwashing for some part of their tableware and even some of the items then loaded into a dishwasher undergo a pre-cleaning process. This last process of manual dishwashing is closely linked to the automatic dishwashing process but it is not requested by dishwashers manufacturers and could be avoided through a correct information provided to the consumers, It was preliminary considered in the shown calculation as an additional consumption under real life conditions for the dishwashers.

All other consumptions related with manual dishwashing are not considered, but may be higher than those of the automatic dishwashing machine.

Consumers asked about the relative influence of dishwashers on the total energy consumption of a household considered this appliance having a moderate up to great impact.For nearly 15 % of the consumers the high energy and water consumption is an element against the purchasing of a dishwasher. This opinion is more important in those countries where the penetration of the dishwasher is lower. Another negative element (for nearly 23,5 % of the consumers) is the initial purchasing price. In general there is also a high level of willingness in using energy saving options in automatic dishwashing.

Consumer behaviour has been identified as having a high influence on the energy and water consumption of the automatic dishwashing process under real life conditions. It is shown, that

- the average dishwashing temperature is at a nominal temperature of 59,3 °C and the most frequently used programme, followed by eco- and automatic programmes,
- the average automatic dishwashing frequency is at 4,1 cycles per week,
- most consumer are using normally the full loading capacity of their dishwasher, but it is not known if this mean that the rated capacity is used,
- delay start function is only used in approximately 10 % of the cycles with an average shift of 3 hours (it was not identified for what reason this shifting is done),

- at programme end the machine may stay in this mode in about 50 % of the cases for an average of 3 hours. Afterwards in about 70 % of the cases the machine is switched off.

All the information about the consumer behaviour and the recent data on the energy consumption allow estimating the average energy and water consumption per household per week: for an average household size of 2,9 people using the average 2005 dishwasher model under real life conditions, the amount of electricity used for automatic dishwashing is at 5,63 kWh and the amount of water is at 86 litres, when the manual pre-rinsing is included and 4,88 kWh and 63 litres when this non requested but used process is not considered. This is 29,4 % higher in electricity than when calculated under standard conditions, which is reduced to + 12,2 % when the pre-rinsing is not taken into account. Main differences are caused by the high average (nominal) temperature of the programmes used as well as by the additional energy consumption for the manual pre-rinsing of the dishes.

Nevertheless it should be highlighted that the use of the dishwasher at the rated capacity would increase the automatic dishwashing energy efficiency and would reduce the energy consumption under both the real life and the standard conditions if resulting in a lower number of washing cycles per week (or year).

The water consumption under real life is 39 % higher than under standard conditions when the manual pre-rinsing is considered, and almost the same if the latter is not taken into account.

Standby and other low power modes have been estimated to contribute on average between 3 and 10 % of the real life energy consumption. These figures may be higher if consumers do not switch off the dishwasher after unloading; showing again that the individual consumer behaviour has a major influence on the amount of energy and water used in the specific household.

These figures may be higher if consumer do not switch off the gadget after unloading, showing again, that the individual consumer behaviour has a major influence on the amount of energy and water used in the individual case.

Therefore consumer training and education is a very important element for the further decrease of the energy and water consumption in real life. The second element to be taken into consideration is the definition of measurement methods in the European standards more in line with the consumer real life behaviour.

3.8 ANNEX 1

Annex 1- 1: population by household size and age group: comparison results own survey vs. Eurostat data[37]

United Kingdom		Age group			total
		20-39 years	40-59 years	60-74 years	
results own survey	1 person	3,9%	7,1%	4,2%	15,1%
	2 persons	11,6%	12,2%	10,6%	34,4%
	3 persons	11,6%	10,9%	1,6%	24,1%
	4 persons	8,0%	8,7%	1,0%	17,7%
	more than 4 persons	4,8%	3,9%	0,0%	8,7%
	total	*39,9%*	*42,8%*	*17,4%*	*100,0%*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
Eurostat*	1 person	4%	5%	5%	*14%*
	2 persons	10%	13%	12%	*36%*
	3 persons	10%	9%	2%	*21%*
	4 persons	10%	8%	1%	*19%*
	more than 4 persons	6%	4%	0%	*11%*
	total	*41%*	*39%*	*20%*	*100%*
		Age group			
		20-39 years	40-59 years	60- 74 years	
Differences	1 person	0,1%	-2,1%	0,8%	-1,1%
	2 persons	-1,6%	0,8%	1,4%	1,6%
	3 persons	-1,6%	-1,9%	0,4%	-3,1%
	4 persons	2,0%	-0,7%	0,0%	1,3%
	more than 4 persons	1,2%	0,1%	0,0%	2,3%
	total	*1,1%*	*-3,8%*	*2,6%*	*0,0%*

France	Age group			total
	20-39 years	40-59 years	60- 74	

[37]Own calculation: Population by household size and age group based on EUROSTAT data.

* Own calculations: crosstabs with EUROSTAT data of population by age group and household size

				years	
results own survey	1 person	5,9%	3,9%	3,9%	13,8%
	2 persons	9,1%	11,0%	11,8%	31,9%
	3 persons	9,8%	9,8%	2,0%	21,7%
	4 persons	11,0%	7,9%	1,2%	20,1%
	more than 4 persons	7,5%	5,1%	0,0%	12,6%
	total	*43,3%*	*37,8%*	*18,9%*	*100,0%*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
Eurostat*	1 person	6%	4%	4%	*15%*
	2 persons	9%	11%	12%	*32%*
	3 persons	10%	9%	2%	*22%*
	4 persons	11%	8%	1%	*19%*
	more than 4 persons	7%	5%	0%	*12%*
	total	*42%*	*38%*	*20%*	*100%*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
Differences	1 person	0,1%	0,1%	0,1%	1,2%
	2 persons	-0,1%	0,0%	0,2%	0,1%
	3 persons	0,2%	-0,8%	0,0%	0,3%
	4 persons	0,0%	0,1%	-0,2%	-1,1%
	more than 4 persons	-0,5%	-0,1%	0,0%	-0,6%
	total	*-1,3%*	*0,2%*	*1,1%*	*0,0%*

Czech Republic		Age group			total
		20-39 years	40-59 years	60- 74 years	
results own survey	1 person	4,0%	5,3%	4,0%	13,4%
	2 persons	6,1%	10,9%	9,3%	26,3%
	3 persons	12,1%	11,3%	2,0%	25,5%
	4 persons	15,0%	10,1%	1,2%	26,3%
	more than 4 persons	5,3%	3,2%	0,0%	8,5%
	total	*42,5%*	*40,9%*	*16,6%*	*100,0%*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
Eurostat*	1 person	5%	5%	5%	*14%*

		20-39 years	40-59 years	60- 74 years	total
	2 persons	6%	11%	10%	*27%*
	3 persons	12%	11%	2%	*25%*
	4 persons	15%	10%	1%	*25%*
	more than 4 persons	5%	3%	0%	*9%*
	total	*42%*	*40%*	*18%*	*100%*

		Age group			total
		20-39 years	40-59 years	60- 74 years	
Differences	1 person	1,0%	-0,3%	1,0%	0,6%
	2 persons	-0,1%	0,1%	0,7%	0,7%
	3 persons	-0,1%	-0,3%	0,0%	-0,5%
	4 persons	0,0%	-0,1%	-0,2%	-1,3%
	more than 4 persons	-0,3%	-0,2%	0,0%	0,5%
	total	*-0,5%*	*-0,9%*	*1,4%*	*0,0%*

Germany		Age group			total
		20-39 years	40-59 years	60- 74 years	
results own survey	1 person	6,3%	6,0%	4,8%	17,2%
	2 persons	11,8%	14,8%	12,7%	39,3%
	3 persons	10,3%	9,4%	1,8%	21,5%
	4 persons	9,4%	6,0%	0,0%	15,4%
	more than 4 persons	3,9%	2,7%	0,0%	6,6%
	total	*41,7%*	*39,0%*	*19,3%*	*100,0%*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
Eurostat*	1 person	7%	5%	5%	*18%*
	2 persons	8%	14%	16%	*38%*
	3 persons	9%	9%	2%	*21%*
	4 persons	9%	7%	0%	*17%*
	more than 4 persons	4%	3%	0%	*7%*
	total	*38%*	*38%*	*24%*	*100%*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
Differences	1 person	0,7%	-1,0%	0,2%	0,8%
	2 persons	-3,8%	-0,8%	3,3%	-1,3%
	3 persons	-1,3%	-0,4%	0,2%	-0,5%

	4 persons	-0,4%	1,0%	0,0%	1,6%
	more than 4 persons	0,1%	0,3%	0,0%	0,4%
	total	*-3,7%*	*-1,0%*	*4,7%*	*0,0%*

Spain		Age group			total
		20-39 years	40-59 years	60- 74 years	
results own survey	1 person	3,1%	2,0%	3,1%	8,2%
	2 persons	6,3%	5,5%	7,8%	19,5%
	3 persons	10,9%	7,8%	5,1%	23,8%
	4 persons	13,7%	11,7%	2,0%	27,3%
	more than 4 persons	11,7%	7,8%	1,6%	21,1%
	total	*45,7%*	*34,8%*	*19,5%*	*100,0%*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
Eurostat*	1 person	3%	2%	3%	*7%*
	2 persons	7%	5%	8%	*20%*
	3 persons	11%	8%	5%	*24%*
	4 persons	14%	12%	2%	*28%*
	more than 4 persons	11%	8%	2%	*21%*
	total	*45%*	*35%*	*20%*	*100%*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
Differences	1 person	-0,1%	0,0%	-0,1%	-1,2%
	2 persons	0,8%	-0,5%	0,2%	0,5%
	3 persons	0,1%	0,2%	-0,1%	0,2%
	4 persons	0,3%	0,3%	0,0%	0,7%
	more than 4 persons	-0,7%	0,2%	0,4%	-0,1%
	total	*-0,7%*	*0,2%*	*0,5%*	*0,0%*

Finland		Age group			total
		20-39 years	40-59 years	60- 74 years	
results own survey	1 person	7,6%	7,2%	5,2%	19,9%
	2 persons	10,0%	13,9%	12,4%	36,3%
	3 persons	7,6%	9,6%	1,6%	18,7%
	4 persons	8,4%	7,6%	0,0%	15,9%

	more than 4 persons	5,2%	4,0%	0,0%	9,2%
	total	*38,6%*	*42,2%*	*19,1%*	*100,0%*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
Eurostat*	1 person	7%	7%	5%	*20%*
	2 persons	10%	14%	11%	*35%*
	3 persons	8%	9%	2%	*19%*
	4 persons	8%	7%	0%	*16%*
	more than 4 persons	5%	4%	0%	*10%*
	total	*38%*	*43%*	*19%*	*100%*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
Differences	1 person	-0,6%	-0,2%	-0,2%	0,1%
	2 persons	0,0%	0,1%	-1,4%	-1,3%
	3 persons	0,4%	-0,6%	0,4%	0,3%
	4 persons	-0,4%	-0,6%	0,0%	0,1%
	more than 4 persons	-0,2%	0,0%	0,0%	0,8%
	total	*-0,6%*	*0,8%*	*-0,1%*	*0,0%*

Hungary		Age group			total
		20-39 years	40-59 years	60- 74 years	
results own survey	1 person	1,9%	3,9%	5,1%	10,9%
	2 persons	6,2%	10,9%	9,7%	26,8%
	3 persons	11,7%	10,9%	3,1%	25,7%
	4 persons	11,7%	9,3%	1,6%	22,6%
	more than 4 persons	7,8%	5,1%	1,2%	14,0%
	total	*39,3%*	*40,1%*	*20,6%*	*100,0%*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
Eurostat*	1 person	2%	4%	5%	*11%*
	2 persons	6%	11%	10%	*27%*
	3 persons	11%	11%	3%	*25%*
	4 persons	12%	9%	1%	*23%*
	more than 4 persons	8%	5%	1%	*15%*
	total	*40%*	*40%*	*20%*	*100%*

		Age group			total
		20-39 years	40-59 years	60- 74 years	
Differences	1 person	0,1%	0,1%	-0,1%	**0,1%**
	2 persons	-0,2%	0,1%	0,3%	**0,2%**
	3 persons	-0,7%	0,1%	-0,1%	**-0,7%**
	4 persons	0,3%	-0,3%	-0,6%	**0,4%**
	more than 4 persons	0,2%	-0,1%	-0,2%	**1,0%**
	total	***0,7%***	***-0,1%***	***-0,6%***	***0,0%***

Italy		Age group			total
		20-39 years	40-59 years	60- 74 years	
results own survey	1 person	4,2%	4,5%	3,2%	12,0%
	2 persons	8,4%	5,8%	7,5%	21,8%
	3 persons	12,0%	10,4%	4,2%	26,6%
	4 persons	14,9%	11,4%	1,6%	27,9%
	more than 4 persons	6,5%	4,5%	0,6%	11,7%
	total	*46,1%*	*36,7%*	*17,2%*	*100,0%*
Eurostat*	1 person	3%	3%	4%	*9%*
	2 persons	7%	6%	10%	*23%*
	3 persons	12%	10%	5%	*27%*
	4 persons	13%	12%	2%	*27%*
	more than 4 persons	6%	5%	1%	*13%*
	total	*41%*	*36%*	*23%*	*100%*
		Age group			**total**
		20-39 years	40-59 years	60- 74 years	
Differences	1 person	-1,2%	-1,5%	0,8%	**-3,0%**
	2 persons	-1,4%	0,2%	2,5%	**1,2%**
	3 persons	0,0%	-0,4%	0,8%	**0,4%**
	4 persons	-1,9%	0,6%	0,4%	**-0,9%**
	more than 4 persons	-0,5%	0,5%	0,4%	**1,3%**
	total	***-5,1%***	***-0,7%***	***5,8%***	***0,0%***

Poland		Age group			total
		20-39 years	40-59 years	60- 74 years	
results own survey	1 person	3,2%	4,0%	3,6%	10,7%
	2 persons	4,0%	8,3%	7,9%	20,2%
	3 persons	9,9%	10,3%	3,2%	23,4%
	4 persons	11,9%	9,9%	1,2%	23,0%
	more than 4 persons	11,9%	9,1%	1,6%	22,6%
	total	*40,9%*	*41,7%*	*17,5%*	*100,0%*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
Eurostat*	1 person	3%	4%	4%	*10%*
	2 persons	4%	8%	8%	*20%*
	3 persons	10%	10%	3%	*23%*
	4 persons	12%	10%	1%	*23%*
	more than 4 persons	12%	9%	2%	*23%*
	total	*42%*	*41%*	*18%*	*100%*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
Differences	1 person	-0,2%	0,0%	0,4%	**-0,7%**
	2 persons	0,0%	-0,3%	0,1%	**-0,2%**
	3 persons	0,1%	-0,3%	-0,2%	**-0,4%**
	4 persons	0,1%	0,1%	-0,2%	**0,0%**
	more than 4 persons	0,1%	-0,1%	0,4%	**0,4%**
	total	***1,1%***	***-0,7%***	***0,5%***	***0,0%***

Sweden		Age group			total
		20-39 years	40-59 years	60- 74 years	
results own survey	1 person	12,5%	8,6%	5,9%	27,0%
	2 persons	7,8%	12,1%	15,2%	35,2%
	3 persons	7,0%	7,0%	1,2%	15,2%
	4 persons	7,4%	7,8%	0,0%	15,2%
	more than 4 persons	3,5%	3,9%	0,0%	7,4%
	total	*38,3%*	*39,5%*	*22,3%*	*100,0%*
		Age group			total
		20-39 years	40-59 years	60- 74	

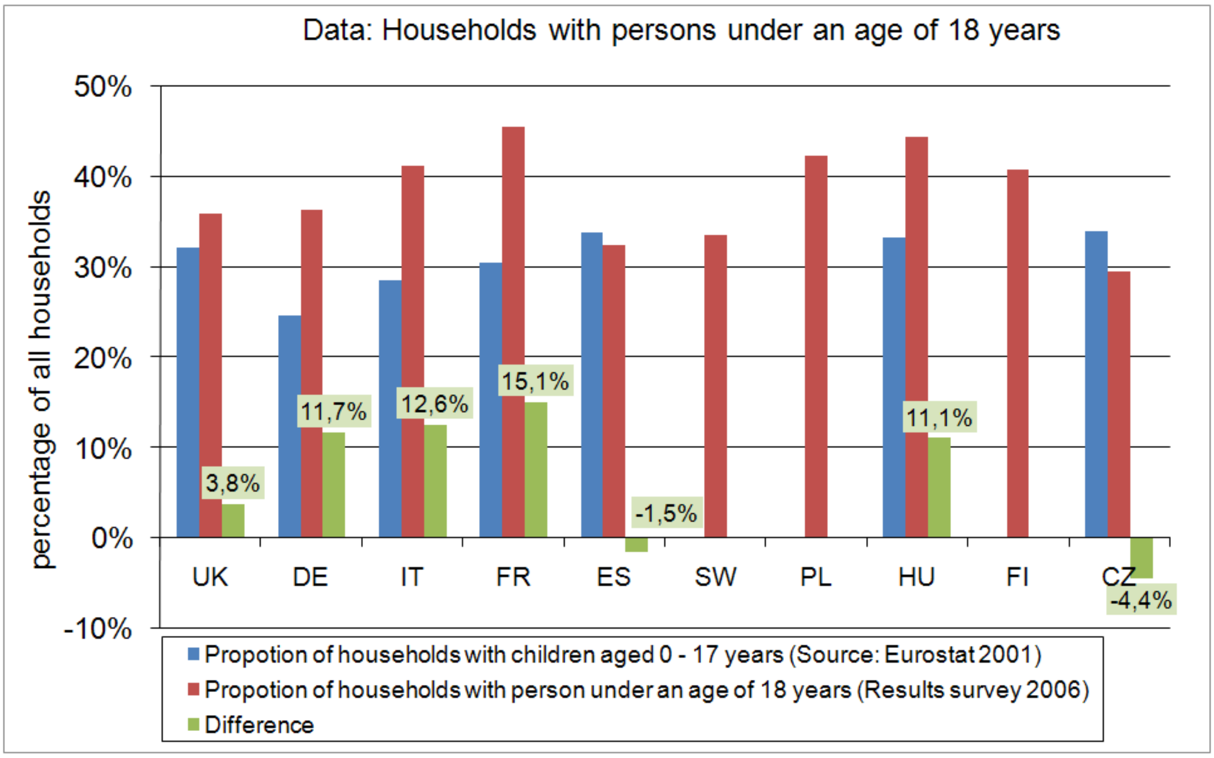
				years	
Eurostat*	1 person	12%	9%	6%	*27%*
	2 persons	8%	12%	15%	*35%*
	3 persons	7%	7%	1%	*15%*
	4 persons	8%	8%	0%	*16%*
	more than 4 persons	3%	4%	0%	*7%*
	total	*38%*	*40%*	*23%*	*100%*
		Age group			total
		20-39 years	40-59 years	60- 74 years	
Differences	1 person	-0,5%	0,4%	0,1%	**0,0%**
	2 persons	0,2%	-0,1%	-0,2%	**-0,2%**
	3 persons	0,0%	0,0%	-0,2%	**-0,2%**
	4 persons	0,6%	0,2%	0,0%	**0,8%**
	more than 4 persons	-0,5%	0,1%	0,0%	**-0,4%**
	total	***-0,3%***	***0,5%***	***0,7%***	***0,0%***

Annex 1- 2: population by household size (results of this survey vs. Eurostat data)

	People per household	**CZ**	**DE**	**ES**	**FR**	**IT**	**HU**	**PL**	**FI**	**UK**	**SW**
Source: EUROSTAT (2005)[38]	1 person	30,3%	35,8%	20,3%	31,0%	24,9%	26,2%	24,8%	37,3%	30,2%	no data
	2 persons	28,2%	33,8%	25,2%	31,1%	27,1%	28,8%	23,2%	31,5%	33,9%	
	3 persons	18,9%	14,5%	21,2%	16,2%	21,6%	19,7%	19,9%	13,6%	15,5%	
	4 persons	17,5%	11,5%	21,5%	13,8%	19,0%	16,5%	18,0%	11,1%	13,4%	
	> 4 persons	5,2%	4,4%	11,8%	7,9%	7,5%	8,7%	14,1%	6,5%	7,0%	
Results survey		**CZ**	**DE**	**ES**	**FR**	**IT**	**HU**	**PL**	**FI**	**UK**	**SW**
	1 person	13,4%	16,0%	8,4%	13,2%	12,4%	11,2%	10,8%	20,0%	16,0%	26,8%
	2 persons	26,3%	40,4%	19,6%	32,4%	20,0%	26,8%	22,0%	36,4%	32,8%	35,6%
	3 persons	25,5%	22,0%	23,6%	21,6%	26,4%	26,4%	26,4%	18,4%	24,0%	15,2%
	4 persons	26,3%	14,8%	27,6%	20,4%	29,2%	22,4%	21,2%	16,0%	18,0%	15,2%
	> 4 persons	8,5%	6,8%	20,8%	12,4%	12,0%	13,2%	19,6%	9,2%	9,2%	7,2%
		CZ	**DE**	**ES**	**FR**	**IT**	**HU**	**PL**	**FI**	**UK**	

[38] http://epp.eurostat.ec.europa.eu/extraction/retrieve/en/theme3/cens/cens_nheco?OutputDir=EJOutputDir_1244&user=unknown&clientsessionid=2D0572A025FB02509B4413EF05D8A0DC.extraction-worker-1&OutputFile=cens_nheco.htm&OutputMode=U&NumberOfCells=72&Language=en&OutputMime=text%2Fhtml&

Differences	1 person	-17%	-20%	-12%	-18%	-12%	-15%	-14%	-17%	-14%
	2 persons	-2%	7%	-6%	1%	-7%	-2%	-1%	5%	-1%
	3 persons	7%	7%	2%	5%	5%	7%	6%	5%	8%
	4 persons	9%	3%	6%	7%	10%	6%	3%	5%	5%
	> 4 persons	3%	2%	9%	4%	5%	4%	6%	3%	2%



Annex 1-3: population: households with persons under an age of 18 years (results of this survey vs. Eurostat data, for Sweden, Finland, Poland no data available)

4 Task 4: Product System Analysis

4.1 DESCRIPTION OF TASK 4

The Eco-design Directive is clearly on product design and does not regulate systems or installations as a whole. However, Annex VII.4 of the directive looks into the interaction of the EuP with the installation/system in which it operates and implies that the possible effects of the EuP being part of a larger system are to be identified and evaluated. This task includes therefore a functional analysis of the system to which the product belongs, including a rough estimate of the overall impacts, for example from IPP studies like EIPRO and an assessment of how the integration of the product into the system and its design can improve its overall environmental performance.

Hot fill options, with a second input for hot water, will be examined from the technical and economic point of view. To date, except for the possibility of a small niche market, the economics for a general EU27 market appear to be discouraging. This is due to the high cost of installation in most houses and extra costs of the price increase, with no offsetting benefits, for great majority of non-users.

While dishwashers and washing machines do not have a strong impact on the immediate installation system within the house, they can have an important impact on the electricity production and distribution system by utilizing off-peak hours of electricity primarily during the night.

The machines will have to be modified to be more silent and to have a timer or other device to permit use of off-peak electricity. These modifications will be made in the design phase and included as options in Tasks 6.1 and 6.2.

The purpose of this Task is thus to simulate the environmental impact with the CEDA EU25 (product and environmental) input output model, for the normal use of electricity and for the off-peak hour use of electricity of the improved machines. Unfortunately in input output model the dishwasher is not given as a separate product or service and thus cannot be modelled. Instead washing machines are included, also as the service, 'washing with household laundry equipment,' CEDA code 540300 and will be studied.

It is also important to make the comparison with the bottom-up LCC (including environmental impact) method and top-down input output approach. Thus the inputs to the two methods should be same. Namely, the number of base case models and other models sold in year 2005 that is total models sold estimated in the bottom up approach should be the same as that used in the input output model. Of course the input output method will use the monetary value, or the number of models times the average price. Likewise the total amount of electricity required in 2005 for washing should be the same in both the input output and bottom-up approach.

The comparison of these results is should give us a better understanding of the two different methods. The primary difference should be due to the fact that the input output approach includes a more complete accounting for secondary input requirements, such the capital goods required to make the steel used in electricity production and in the production of washing machines etc. Another source of difference will be the use of slightly different environmental impact coefficients no doubt.

One of the most interesting aspects of comparison will include the modelling of the impact of the use of off-peak electricity. A hypothesis of increased off-peak load will be made compatible with the situation of the new sales and existing stock that could have timers and be relatively silent. The first aspect of the new simulation will be to change the electricity product mix part of the input output table in favour of a base load and less off-peak electricity. The second aspect is more complicated, and after an analysis of the literature, lower investments in capital goods will be introduced for electricity generation and distribution. This is due to the higher degree of utilization made possible by the load shifting.

At this point the two simulations of the CEDA EU25 input output model will be performed one with the normal load and one with the load optimizing. The environmental impacts for 'washing with household laundry equipment,' CEDA code 540300, will be compared and discussed. Sensitivity analysis will also be performed. In the simulation with CEDA EU25, a minimum amount of support by the authors or the EC will be required.

4.2 SYSTEM BOUNDARY

The Eco-design directive is referred to product design and not to systems or installations as a whole. However, Annex VII.4 considers the interaction of the specific EuP with the installation/system where it operates, implicitly stating that the possible effects of the EuP being part of a larger system are to be identified and evaluated. This task includes therefore a functional analysis of the system to which the product belongs, including an assessment of how the integration of the product into the system can change overall energy and environmental performance.

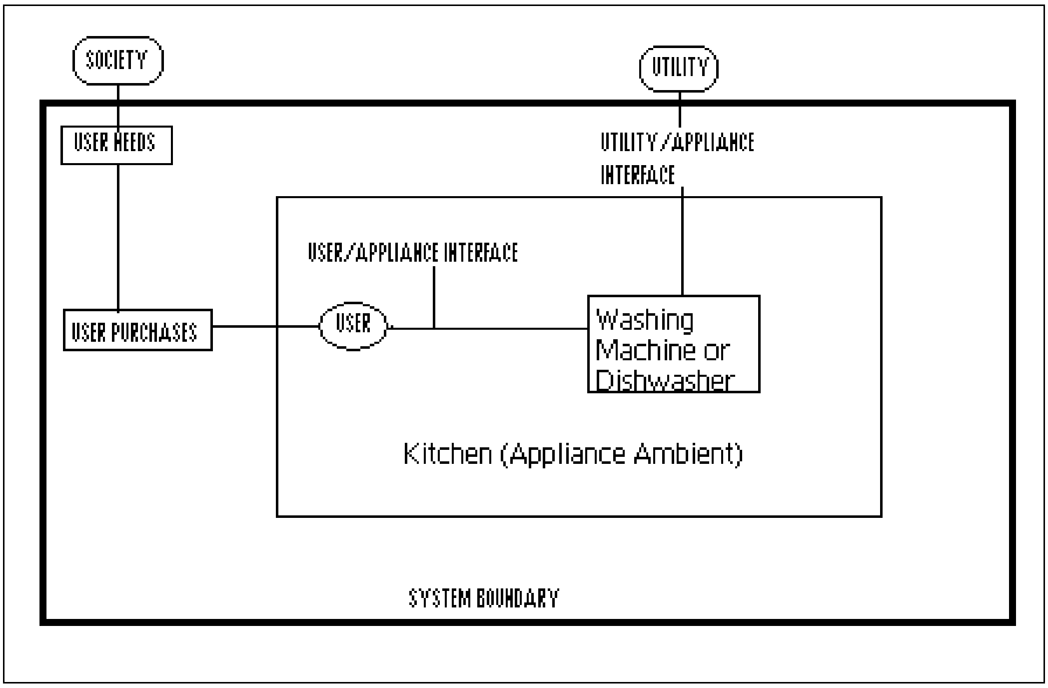
Particular attention is given to the actual ambient conditions in which the washing machine and dishwasher are used and the other aspects of utilization that are not included in the base cases to be defined in Task 5. Probably the most important element in the system is man himself, in the form of user of the appliance and electric utility.

The primary objective of this Task is to explore from a systematic point of view the elements, not considered in the base cases, which influence the present and future energy/environmental impact of the wash appliances. Thus a brief review of the results of the consumer habits, fully presented in Task 3, will be developed, to then proceed to the analysis of changing consumer needs, the enriched user/appliance interface and finally the utility/appliance interface. The part of the task regarding the use of the CEDA EU25 Product and Environmental Model is in a preliminary phase and not yet presented. It was preferred to give priority to specific systems issues that emerged in real use of the appliance and future needs and trends of the consumer. This was necessary for a better understanding of the base cases and long-term scenarios.

After the first energy crises in 1973, appliance producers began looking at possible ways to integrate and save otherwise wasted energy or capacity. This included looking at the kitchen as a system and looking at the home as part of the national energy system. Initial efforts included ideas such as possible heat recovery between appliances such as using the refrigerator cooling coils to preheat water for other appliances such as clothes washers. This required considerable co-ordination and possible common design standards among appliances, or the consumer purchasing appliances in blocks, both of which were considered unrealistic and these complex schemes for heat recovery were dropped. At the thermal level there remained the possibility of the use of hot water from more efficient sources such as gas-fired hot water heaters that was available in any case for other purposes. In fact, in the UK this scheme is in use for washing machines with hot water fill. A more general case can be made for reducing the peak electricity load by more opportune timing of washing machines and dishwashers. As energy efficiencies have been drastically improved, other external system aspects have come into play such as the amount of water and the detergents utilized and their impacts. With the introduction of less and less expensive electronics, home computing, and the possibility of the connection of the appliance to the home computer, internet, and cell phones: the appliance/human interface assumes new dimensions and possibilities.

The considered system boundary is widened to include: i) the kitchen or place of use within the home; ii) the product user, in particular how he/she actually uses the appliance and his/her changing needs for clothes and dish washing; iii) the enriched user/appliance interface made possible by less and less expensive electronic, displays and Internet; iv) the utility/appliance interface regarding demand side management and the successive use washing machines and dishwashers. This is illustrated graphically in Figure 4.1.

Figure 4.1: System elements and boundary



Within the kitchen the use of hot tub fill for washing machine and how householders perform in washing dishes by hand are examined. The consumer is at the centre of attention in understanding the real-life base cases: in particular, the program selection (including manual pre-rinsing for dishwashers), the amount of effective loading, the use of water, and the impact of various modes of low power and standby, including that of delayed start for night tariffs. Attention is drawn to the possible tradeoffs between energy and detergent in the choice of programme temperatures. The possibility of an improved user/appliance interface is discussed and finally the variation of spinning speeds for subsequent machine or natural drying is introduced as a system topic.

4.3 HOT TUB FILL

This practice of using warm water heated by more efficient sources such as gas fired instantaneous water heaters is used in only one Member State, the UK. Here washers with inputs for cold and hot water are offered. However, the use of hot tub fill has been declining. Informal estimates are that less than one-half of the UK market uses the option. Some producers are no long offering it.

The reasons for the decline are multiple. Probably most of the easy installations have been realised, the ones available now are farther from the available hot water source, more costly and bothersome because walls may have to be modified and repainted. At the same time energy savings, water saving and lower washing temperature realized by technological improvements introduced in these appliances has greatly reduced the impact of hot fill. The most popular temperature for washing is now at 40 °C. and the amount of water utilized has gone from 66,8 litre in 1997 to 50,7 litre in 2005, a 24% reduction. With a reduced amount of hot water required at the various stages of washing, there is the risk that the lukewarm water in the pipes and heater will actually supply most of this, before the hot water actually becomes available. System savings by hot water fill undoubtedly has been reduced, which corresponds to its lower use in the UK and lack of growth to other Member States. Most manufacturers no longer produce hot fill washing machines for the UK market because it is considered to be unnecessary[39].

One of the problems typical of linkage to special external systems (supply of more efficient hot water) is that of partial use. From the economic point of view, it would important that the extra cost of hot water fill is a minimum so that it does not unduly penalize those users that do not have non-electric sources of hot water. To reduce such costs, in theory, a single water input for cold or warm water would be possible with the addition of sensors. The idea is that the water coming in, warm or cold, would be heated to the desired temperature, if necessary. The problem of course is the presence of only warm water input for cooler 30-40°C washing or cold rinse. The rinse might be more effective at warm temperatures and perhaps less water could be used; however, in the case of having to allow for cooling of the warm water, the hot fill benefits would be lost. In any case the limited amount of any benefit and the reduced number of opportunities for its use make the matter unfeasible.

4.4 REAL CONSUMER USE OF WASHING MACHINES

The consumer behaviour using washing machines, fully described in Task 3, is only summarized here. Instead greater detail is given to improvements for electricity peak loads, energy and detergent

[39] Market Transformation Programme, Briefing Note W15: Washing machine – efficient use FAQS, 30 March 2007, www.mtprog.com

tradeoffs in the selection of programme temperatures, performance with partial loads, spin speed tradeoffs, and finally changing consumer needs and an improved user/appliance interface.

4.4.1 Washing machine consumer behaviour

The major finding is that the real consumer base case is estimated to consume 35% less than the same machine measured according to the European standard (described in Task 1) for the average household.

This lower electricity consumption is due primarily to the use of lower temperature programs: households on the average wash with 46°C programmes compared to the 60°C standard cotton cycle, and the 46°C programme consumes only 71% of the 60°C one. Loading is also not at the nominal machine capacity: users filled the washing machines at 68% of the rated capacity (the capacity declared in the energy labelling). Most of all models have sensors for the amount of water absorbed or the weight of the wash load and can reduce water and electricity requirements for a lighter load. This saves 9,8% of the energy consumption under standard conditions, on a per load basis. Various forms of low power modes (for delayed start, program end, and ‘left on” mode) add energy relative to the standard washing cycle, but only 1,7%; finally standby mode is expected to contribute another 1,7% arriving to the total for of 65% for the real-life use, or 35% less than the consumption measured according to the European standard, on a load basis.

However, as reported the load factor was 68% of the rated capacity. Thus a ‘standard average’ family stuffing their machine full at 5,4 kg washes[40] in ten washings does 54 kg of laundry, whereas the ‘real-life’ family gets only 68% of that or 37 kg in ten loads. For comparison we must presume that the families have the same amount of wash, so the “real life family” has to wash 1,47 (=1/0,68) times the cycles of the “standard average family”. Thus if the standard average family consumes 4,890 kWh per week (standard average machine consumption per week at 4,9 washes/week), for the same amount of kg of wash per week, the real-life family consumes 4,644 kWh (real life machine consumption per week times 1,47) , only 5,0% less.

The resulting difference in electricity consumption can be presented in two ways: with the same number of cycles, in which the real life washing machine has 35% less consumption than the standard average machine; or with the same amount of clothes washed (in kg), in which the real life machine has a 5% less consumption than the standard average machine.

The lower temperature wash and the low real load size are such significant and compensating deviations from the standard conditions that both should be incorporated in revisions to the measurement method in the washing machine European standard.

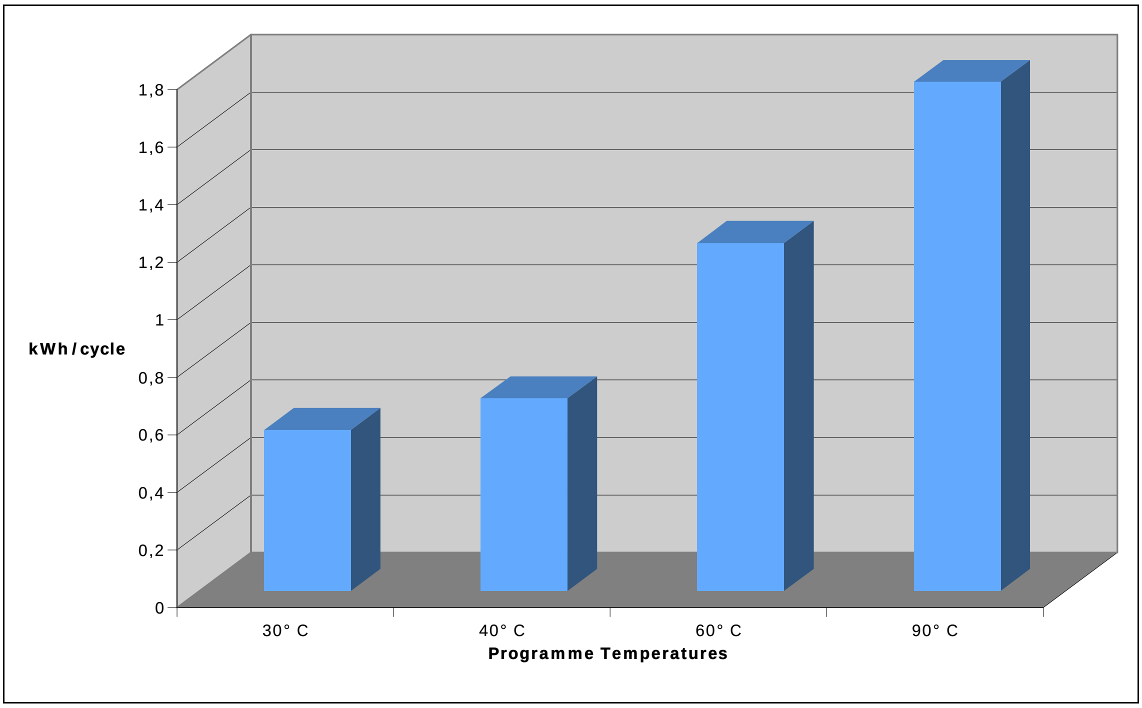
4.4.2 Energy and detergent tradeoffs in the choice of programme temperatures

This most important reduction in the use of energy has been realized by the use of lower temperature water for washing, achieved by using more improved detergents with enzymes, and perhaps in some cases a better washing action from the machine itself.

[40] The average load of the 2005 washing machines models in the CECED database, as found in Task 2.

Energy values measured in a recent Germany study[41] illustrate the strong influence of wash temperatures on electricity consumption (Figure 4.2). Also the amount of detergent used for the same washing efficiency at different temperature was recently simulated[42]: these changes in programme efficiency are possible for all programmes types and temperatures and are closely linked to the type and amount of detergent used; temperature and amount of detergent are balanced in such a way, that one may be substituted by the other to a large extend without sacrificing the washing performance; this was shown by tests using nominal (100%) amounts of detergent at 40, 60 and 90°C cotton programmes. In addition, the machines were operated with reduced (50%) and increased (150%) doses of detergent in the standard 60°C cotton programme, to take account of the flexibility of users in adjusting the performance of their washing machines by choosing different temperatures or by varying the amount of detergent. The results are presented in terms of the index system and class definitions of washing efficiency as known from European energy labelling, although the test conditions were not all according to the definitions for this system. The conclusions of the authors were that it is evident that the same level of performance can be achieved in a 90°C programme with only 50% of the rated detergent dose, in a 60°C programme with rated detergent dosage, or in a 40°C programme with 150% of the rated detergent dose. Thus, consumers are basically free to select any one of these options to achieve a specific level of cleaning performance, the only limitation being the temperature stability of the fabrics to be washed.

Figure 4.2: Average energy consumption observed at the different wash temperatures

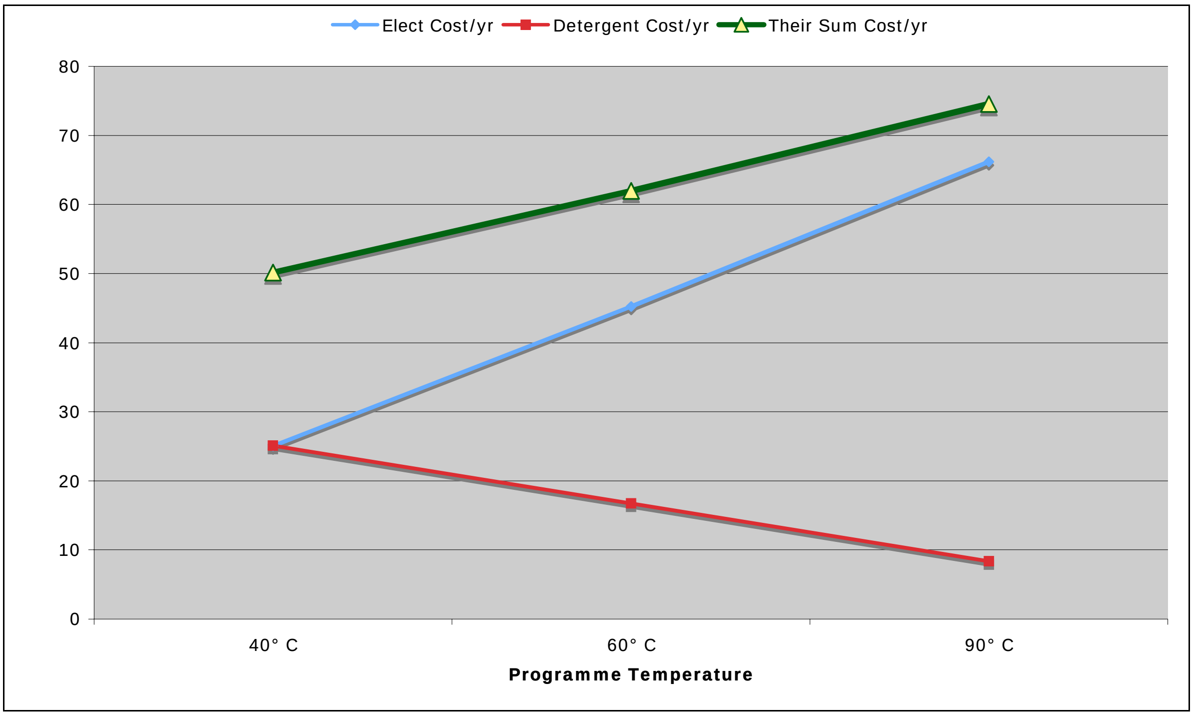


Using the standard prices, 0,17 €/kWh and 0,07 €cents detergent/standard wash, these tradeoffs can be shown (Figure 4.3): the total costs still favour lower temperatures, but the comparative environmental impacts are not shown, and will be subject to further investigation.

[41] Wash Diary 2006.
[42] Stamminger, R., Barth, A., Dörr, S.; Old Washing Machines Wash Less Efficiently and Consume More Resources. In: Hauswirtschaft und Wissenschaft 3/2005, p. 124-131

With this increase in the concentration of detergents, particularly in the more popular low temperature programmes, the quality of the rinse has come into question. The laundry may be clean but does it feel or behave differently due to residuals left by the rinse? The problem is complicated by the fact that we do not yet have a European standard to measure effectiveness of the rinse. This could be a major concern of households and their consumer organizations. An energy and/or water savings that results in high or unacceptable residuals could be jeopardized. The introduction of a European rinsing efficiency evaluation is a recommended action; however, this could have the impact of raising water consumption to reach a good performance level (at constant washing temperature). The total costs still favour lower temperatures, but the comparative environmental impacts are not shown, and will be subject to further investigation.

Figure 4.3: Tradeoffs between energy and detergent costs with variation in programme temperature



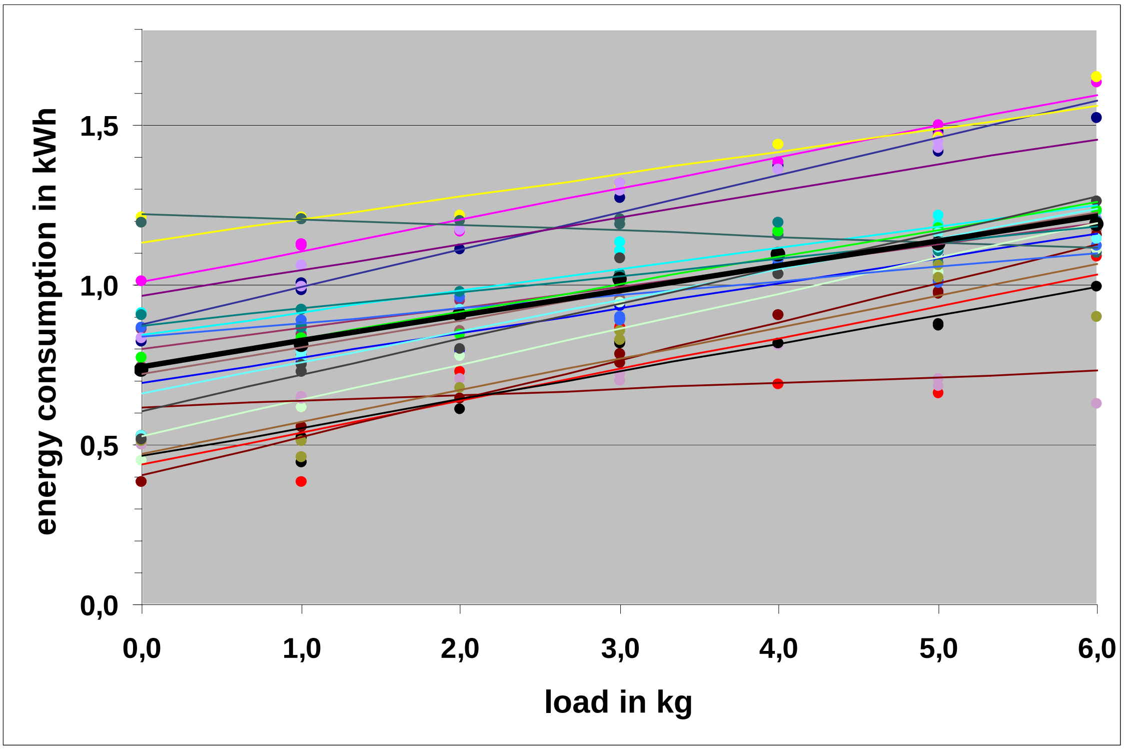
With this increase in the concentration of detergents and enzymes particularly in the more popular low temperature programmes, the quality of the rinse has come into question. The laundry may be clean but does it feel or behave differently due to residuals left by the rinse? The problem is complicated by the fact that a European standard to measure effectiveness of the rinse is at present not available. This could be a major concern of households and their consumer organizations. An energy or water savings that results in high or unacceptable residuals could be jeopardized. The introduction of the rinsing performance evaluation is thus a recommended action; however, this could have the impact of raising energy/water consumption and/or altering the present Energy labelling declarations.

4.4.3 Partial loading

Eighty-nine percent of the washing machines sold in 2005 have load detection. These models do compensate for the under or over-loading (compared to the nominal rated capacity) by modifying the washing program parameters.

How well this adjustment works and how large the differences between the machines are was recently investigated[43]: the results show a very different behaviour of the machines (Figure 4.4) with load adjustment factors between 0,12 kWh/kg and -0,02 kWh/kg for a cotton 60°C programme. The later value means, that this machine consumes actually more energy when only partly loaded. It should be further investigated if this specific machine has a load detection system, to allow a fair comparison of the different machines results. All together the average of this load dependency is at 0,08 kWh/kg and implies, that such a machine taking 1,0 kWh at 5kg load will still take 0,6 kWh of energy when almost no laundry is put in.

Figure 4.4: Energy consumption of 20 washing machines at various load size at 60 °C cotton programme (lines are trend lines for one washing machine; the black line indicates the average behaviour of the 20 machines.)



This figure is significant also because it illustrates the variety of the responses at partial load among the different models and manufacturers. Thus a measurement method within a European standard that took partial load into consideration would presumably offer manufacturers a means of product differentiation.

Unfortunately, presently the machine does not have control over the amount of detergent. The user may have added more detergent for lower temperature washing and less for high temperature, or he/she may have not changed the amount. This makes it difficult for the machine to optimize the rinsing.

Detergent makers should be encouraged to make partial dosing more available, also in forms for automatic dosing.

[43] R.Stamminger, P.Berkholz, A.Brückner, A.Kruschwitz: Definition und Ermittlung verhaltensabhängiger Energieeinsparpotentiale beim Betrieb elektrischer Haushaltswaschmaschinen; Research report Uni Bonn for Bundesministerium f. Wirtschaft und Technologie BMWI - Projektnummer: 86/05 (to be published)

4.4.4 Consumer needs and trends

Also from a systems point of view both of the key variable program temperature and loading should be studied in a dynamic sense. Lower temperatures probably represent a consumer trend for more delicate washing also made possible by new enzymes introduced by detergent manufacturers. It also saves the consumer energy and total costs as previously shown, thus it is not unreasonable to forecast a continuation of lower average temperatures, at least of several degrees.

Instead the *need* to wash at very partial loads of 68% may in part be due unawareness of the actual load level and be due to unwillingness to wait longer to accumulate more of that type of laundry to make a full load. The first can be improved through better communication and is addressed in the section on enriched user/appliance interface. The second can be a valid time preference of the user. If all the loads were made at such a partial level one might conclude that in Europe there is a significant market for a smaller 3,7 kg load machine. Naturally this is probably not the case, if there is an occasional full load, and consumers likely want to have the full capacity in case they need it. Actually the trend in the EU is toward moderately larger capacity machines: 6kg capacity machines are becoming more and more common in Europe and also higher capacities, up to 9kg, have been introduced, but they represent at present a very minor share of the EU market, largely dominated by the 5-6kg machines.

The situation is different in other markets: larger machines are common in Asia where family size is greater and in the US where washing habits are different.

From the manufacturing point of view it would be better to have a standard size worldwide and this makes the position of the EU market quite critical since pressure from at least some manufacturers is for larger machines, as a way for product differentiation and possibly larger profits (new or perceived different appliances are usually sold at a higher price) while the actual load is 3,7kg in a nominal 5-6kg machine.

The trade-off between the amount of washed load and the nominal machine capacity will be further investigated in Task 6.

4.4.5 Improvement in electricity peak loads

The most important measure to be considered is the addition of acoustic insulation and any necessary controls to facilitate the use of night tariffs. Most washing machines already have timers permitting delayed start. Since most families should be able to program a high percentage of washes for the nighttime performance, the potential utilization should be high. However, certain washes may have high priority and cannot wait, some families may not want to bother with night washing, and many countries have not introduced such tariffs, so the penetration is still quite partial, estimated as 10% of total washes.

Consequently the improvement has the drawbacks of partial use previously mentioned. However, one may consider that it is pleasant to be around a quieter machine even during the day, so there is some benefit to customers not using the special tariffs. The technological option of decreasing the machine noise is analyzed in detail in Task 6.

As an example, a 10% decrease in average EU25 tariffs for night tariffs will yield a 42 € savings over the lifetime (15 years) of a standard average machine used 220 cycles per year, always during the night. If this was the maximum tariff decrease available for night tariff, it would set the economic breakeven point for the consumer price increase for the acoustic insulation. A price increase equal to or less than 42 € would be convenient for the consumer, more would not.

4.4.6 Spinning speed tradeoffs

In areas with warm sunny climate, frequently the wet clothes are hung and dried outside (or inside) without machine drying. In these cases the high spins speeds are not used, and in fact in these areas models with lower spin speeds are generally offered. However, there is a general tendency to increase spin speeds, also offering higher pinning speed models in southern Europe an even more high spinning machines in northern Europe.

If the drying takes place inside the house, on top of radiators for example, the space heating system is heating and drying the clothing and heating the home less, thus the drying is not cost free. To the extent that the household is a 'sun-dryer' and does not want or use the higher speeds, this becomes a feature of partial use with all the related issues of extra costs for the user and producer.

The other issue is the trade-off between high spin velocity and the subsequent use of a dryer. At some point it is probably preferable to limit the spin speed and use the tumble dryer because the over-all efficiency is greater. At present this limitation does not appear to be reached. Some of these questions will be addressed in Task 6.

4.4.7 Improved user/appliance interface

One important interface improvement comes to mind: provide *during loading* the percentage of full load utilized. The percentage of full load could appear on a display on the machine. This is possible with the top-of-the-line machines that measure the weight of the load. It would tackle the problem of the low 68% present level of capacity utilization. The other machines measure the amount of water absorbed (after the door is closed) and could tell the user how well they filled tub only afterwards, which still might have some learning impact. Now the user knows nothing about how well the washing machine is filled.

It is hard to imagine all the possible other interfaces. Certainly user friendliness will continue to be a direction of emphasis. Given the demographic trends, user friendliness for the elderly appears to be appropriate. Voice recognition of the basic commands might be helpful. Some washing machines make an analysis of the nature of the fabrics being loaded into the machine and automatically suggest the appropriate washing programs. This kind of 'thinking' by the machine could be extended. Early diagnosis of potential maintenance problems is another area, although probably costly. The washing history could be kept and updated through the PC in the home. Knowing what and when the family washed, the system could even make suggestions of wash schedules, also more in keeping with the capacity of the machine.

4.5 HAND WASHING OF DISHES

An innovative study reports that in a laboratory setting, hand washing uses much more water and secondary energy (and time) than machine dishwashing. It was found that manual dishwashing required on the average 103 litres of water and 2,5 kWh of secondary energy compared to 15-22 litres and 1,0-2,0 kWh for machine dish washing, per setting of twelve. However, the machine dish washing may have been artificially near the maximum utilization of the dishwasher capacity, because the amount of tableware used in the experiment was that required to completely fill the dishwasher and because it was outside the real setting of variable time requirements of the family. In a real setting, the dishwasher is probably used at lower levels of capacity utilization.

This factor may be corrected with the recent findings on utilization from the consumer behaviour analysis. Using an average of 70% utilization for washing tableware, a reduction in the cost of hand washing by 70% is achieved and the cost of machine washing remains essentially the same. Actually there is a savings of 7 to 8% due to the heating of fewer load, which was subtracted.

The results, in Table 4.1, show that there is at least a savings in 50 litres of water and a likely savings of electricity depending on the dishwasher model and consumption, which was between 0,9 and 1,8 kWh7cycle in the laboratory experiment (in 2005, a 12ps A class dishwasher has an energy consumption a value of 1,050 kWh/cycle).

Table 4.1: Comparison of hand and machine dishwashing at 70% load

Washing method	Resources (12ps)	
	Water (litre/cycle)	Electricity (kWh/cycle)
Hand wash	72	1,75
Machine wash	15-22	0,9-1,8

However, hand dish washing utilizes, in part, more efficient heating of hot water and thus less primary energy than 100% electricity. This primary energy calculation is to be made when the intermediate results of EuP - Lot 2 (water heaters) are known. In any case, due to the importance of the general finding, additional field studies are recommended.

4.6 REAL CONSUMER USE OF DISHWASHERS

The consumer behaviour, improvements in electricity peak loads, the changing consumer needs and improved user/appliance interface are examined.

4.6.1 Dishwasher real-life use

Surprisingly the consumer behaviour results in energy consumption of a dishwasher that is 24% higher than the consumption of the same machine under standard conditions (see Task 1 for the description of the European standard for dishwashers).

The largest increase, 15%, comes from hand pre-rinsing obviously not considered under standard conditions, as not necessary. This makes for a more realistic picture of actual consumption, given that only 15% of households reported no pre-treatment of dishes. A 13% increase results in the use of higher temperature programmes that the temperature of the programme used for the energy labelling declaration. The problem of partial load is also significant and estimated to be 70%, which causes a 9% decrease due to heating of a lighter load. Finally the various standby and low power modes are estimated to add 5%, resulting in the grand total of a 24% increase.

If we consider only the user impact on machine performance, ignoring hand pre-rinse, the real life dishwashing is about 9% higher than under standard conditions.

The European measurement method should better define the programme temperature and lower amount of filling the machine, which are the two most significant impact factors concerning the machine performance. The former problem could be also addressed by a mandatory common definition and disclosure of the programme used for energy labelling declaration.

Water consumption is 29% greater in the real life, mainly due to the additional pre-rinsing done by the consumer before loading the tableware into the dishwasher.

4.6.2 Improvement in electricity peak loads

The technical options to be considered are the addition of acoustic insulation and any necessary controls to facilitate the use of night tariffs. Most dishwashers already have timers permitting delayed starts. Since most families should be able to program a high percentage of washes for the night time performance, the potential utilization should be high. However, certain dishwashing may have high priority and cannot wait, some families may not want to bother with night washing, and many countries have not introduced such tariffs, so the penetration is still quite partial, about 25% of households use the delay start option for an estimated 10% of total washes.

The technological and LCC analysis, including noise reduction, will be carried out in Task 6. The cost and price limits of the additional insulation are dictated by the night tariffs, not counting the pleasure of having a more silent machine in general.

4.6.3 Changing consumer needs and an improved user/appliance interface

The issue of pre-rinse has implications beyond the re-setting of consumption starting point in the energy scenarios. It hopefully is dynamic and can be reduced since it amounts to an increase of 16% of the energy consumption of a machine tested under standard conditions. In part, this pre-rinse may be due to ignorance of the cleaning efficacy of the modern dishwashers. Perhaps earlier models were less effective. In part it may be the desire to remove foods on dishes to avoid odours or unsightly dishware, not all of them being placed in the washer immediately. Some very soiled items such as pots and pans may actually require some form of soaking or pre-treatment. The household should be advised to scrape foods off without water and to use cold water for unavoidable soaking, keeping the pre-treatment phase to a minimum.

Some moderate improvement may be made, but it may be difficult to change these types of habit also concerning hygiene. The consumer may prefer to error on what he/she perceives as the conservative side.

The low capacity utilization is somewhat similar to that of washing machines, both appliances having a low level of fill around 70%. However in the case of dishwashers the degree of utilization is much more apparent; in loading the user readily sees the available space available. Also the dishwasher utilization would appear to be *lumpy* and more rigid, regarding the amount of dishware available for washing after one or two meals. In the case where a meal provides more than enough dishware for a full load, the washer would be completely used; in other cases the user may prefer to not wait and proceed with a half-load or fraction of a full load. Waiting to fully load the machine might also involve hand washing those items that are in excess of the full load. The idea of a 'clean kitchen', without a fraction of the dishware to be washed, may contribute to this and lower levels of utilization. These habits do not appear to be very easy to change.

Regarding the user/appliance interface, if the amount of load could be measured, the degree of utilization could be communicated to the user. However, the user sees the free space and such a message might even be counterproductive.

Some of the same general consumer trends will apply: user friendliness will continue to be a direction of emphasis. Given the demographic trends, user friendliness for the elderly appears to be appropriate. Voice recognition of the basic commands might be helpful. This kind of 'thinking' by the machine could be extended. Early diagnosis of potential maintenance problems is another area, although probably costly.

4.7 CEDA EU25 PRODUCT AND ENVIRONMENTAL MODEL

The outputs of CEDA I/O model of EIPRO are given for year 2003. Unfortunately data and outputs do not exist for more recent years and it outside the scope and means of the present study to update and run this model on more recent data. Therefore we have attempted to take the output of our study and convert it to the conditions of CEDA I/O model.

The first step to use the CEDA model is to extract the total environmental impacts for all economic activity. These are given as scores per impact category in Table 5.1.1 Normalisation values for the EU-25 used in the EIPRO study.[44]

The total EU-25 impacts in year 2003 for the three impact categories (in common) are:

Global warming GWP100: 4,71E+12 kg CO_2 eq/yr

Acidification: (incl. fate, average Europe total , A&B)
4,31E+10 kg SO_2 eq/yr

Eutrophication: (fate not incl.) 1,05E+10 kg PO_4 eq/yr

The other impact categories are not in common with that of the methods used in the present study.

These totals are multiplied times their fractional shares of impact for the use of washing with household laundry equipment (code 540300) from the shares table of the same report.[45]

The above vector product is divided by the number of families in EU-25 in year 2003, namely 182,126,800 as indicated in the Table4.2. The result is the EU-25 environmental impacts per family,

[44] Page 97, Annex 5: Annexes to Chapter 5, Environmental Impact of Products (EIPRO), Annex Report, May 2006, Report EUR 22284 EN.

[45] Page 179, Annex 5: Annexes to Chapter 5, Environmental Impact of Products (EIPRO), Annex Report, May 2006, Report EUR 22284 EN.

per year, for the use of washing machines as shown in the sixth column of the table. This is divided by the washing machine ownership level for that year (89,73%) to give the annual impact per washing machine as illustrated in the seventh column of Table 4.2.

From our study, we utilize the environmental impacts reported in Task 3, dividing them by 15 years to obtain the annual impact given in column eight.

This now can be compared with the impacts of the I/O model, shown in the adjacent column.

Table 4.2: Comparison of Environmental Annual Impact Per Family (EU -25) for the Use of Laundry Washing Equipment

			Comparison for Washing Machines:				
			EU25 (2003)	EU25 (2003)	EU25 (2003)	EU25 (2003)	Present Study
	EU25 (2003) Value		Fraction due to:	Total due to	Aver. Family due to	Aver. W.M.	Aver. W.M.
Units	(from I/O Model)	Summarized Themes	Use of W. M.	Use of W. M.	Use of W. M.	(family/0,8973)	(for one year)
kg antimony eq./yr.	**1,33E+10**	Abiotic depletion	1,64E-02	2,18E+08	1,20E+00	**1,33**	
kg CO2 eq./yr.	**4,71E+12**	Global Warming GWP100	2,37E-02	1,12E+11	6,13E+02	**683,06**	**118,53**
kg CFC-11 eq./yr.	**3,69E+07**	Ozone layer depletion	8,91E-03	3,29E+05	1,81E-03	**0,00**	
kg 1,4-dichlorobenzene eq./yr.	**1,91E+12**	Human toxicity htp inf.	1,52E-02	2,90E+10	1,59E+02	**177,65**	
kg 1,4-dichlorobenzene eq./yr.	**1,29E+12**						
kg 1,4-dichlorobenzene eq./yr.	**5,75E+15**						
kg 1,4-dichlorobenzene eq./yr.	**2,64E+11**						
	1,92E+15	Ecotoxicity score(avg.of 3)	1,46E-02	2,80E+13	1,54E+05		
kg ethylene eq./yr.	**3,84E+10**	Photochemical oxidation	1,07E-02	4,11E+08	2,26E+00	**2,51**	
kg SO2 eq./yr.	**4,31E+10**	Acidification	4,00E-02	1,72E+09	9,47E+00	**10,55**	**0,71**
kg PO4---eq./yr.	**1,05E+10**	Eutrophication	5,63E-03	5,91E+07	3,25E-01	**0,36**	**0,0027**

As can be seen the values are considerably different. If we take the ratio of the I/O model values to that of the present study the ratios are: 5, 15 and 130 for global warming, acidification and eutrophication respectively. While in general the I/O values could be expected to be higher, due to the fact that the EU-25 average washing machines are older and less efficient than our average model and due to the fact that with the indirect inputs of the I/O model the requirements should be more inclusive and thus somewhat greater; such large differences in global warming, acidification and eutrophication are not reasonable.

Furthermore, the same methodology of comparison was applied to the cold appliances and the ratio of the I/O model impact to present study impacts resulted in factors of 1,4, 4 and 5 respectively.

We could continue to apply such large difference to the various totals and scenarios; however, it is meaningless without understanding the differences at the more fundamental single family or single appliance level, including the inputs to the I/O model. We do not rule out the possibility that we have misread or misunderstood the I/O model results. It is suggested that these results be posted for comments.

5 Task 5: Definition of base case

5.1 SUBTASK 5.1: DEFINITION OF BASE CASE

A “Standard Base Case” and “Real Life Base Case” will be defined for washing machines and dishwashers.

5.1.1 The Standard Base Case for Dishwashers

During the first stakeholder meeting of the study it was proposed to define two standard base cases for the dishwashers, a 9 place settings machine (representing the so called “compact dishwashers”) and a 12 place settings machine (representing the so called “standard dishwashers”). The subdivision of the dishwashers in the two mentioned families derives from the knowledge of the market of this appliance type in the past decade and has been followed in the policy measures already in place: it is in fact at the basis of the ecolabel criteria for energy and water consumption, the energy efficiency classes of the energy labelling scheme and the industry voluntary commitment described in Task 1.

5.1.1.1 The analysis of the 2005 technical database

The 2005 technical database collected by CECED includes 4 342 models, from 4 to 15 place settings. The analysis started with the validation of the collected data, mainly in terms of the coherence between the declared Energy Efficiency Class of each model and the relevant energy consumption and the energy and water consumption of the models within the same place settings category. In other words, the data declared for the best and the worst models were particularly examined for errors. For 12 (0,28%) of the 4 342 models, a lack of coherence was found: for 9 models the declared place settings was wrong, and was therefore corrected, while for 3 model a lack of coherence existed between the declared energy efficiency class and the calculated one: for 2 models the declared class was better than what should be but for 1 other model the declared class was found worse than the recalculated one. For sake of coherence of the statistical analysis all the “wrong” models were corrected and the statistical analysis of the energy efficiency class was based on the validated results.

About 82% of the models in the database belong to the 12ps category, followed by the 9ps with 12,2% of the models (Table 5.1), these to categories account for 94% of the entire database. The third category in order of importance - the 15 place settings - accounts for only the 2,4% of the models. The energy and water consumption of the models in the database, in kWh and litres per cycle, are presented in Figures 5.1-5.2, while in Figures 5.3-5.4 the specific energy and water consumption, in kWh and litre per place setting and per cycle, are given.

Average, minimum and maximum consumption values are also presented in Table 5.2 for the different place settings. The 9ps and the 12ps machines are highlighted. In the same Table also the break down of the models in the energy efficiency, washing performance and drying performance classes is given. As clearly shown also in Figure 5.5, in 2005 the large majority of the models belonged to A class for the three characteristics: 90% for energy efficiency and washing

Figure 5.1: Energy consumption as function of the place settings for the dishwasher models in the 2005 CECED technical database

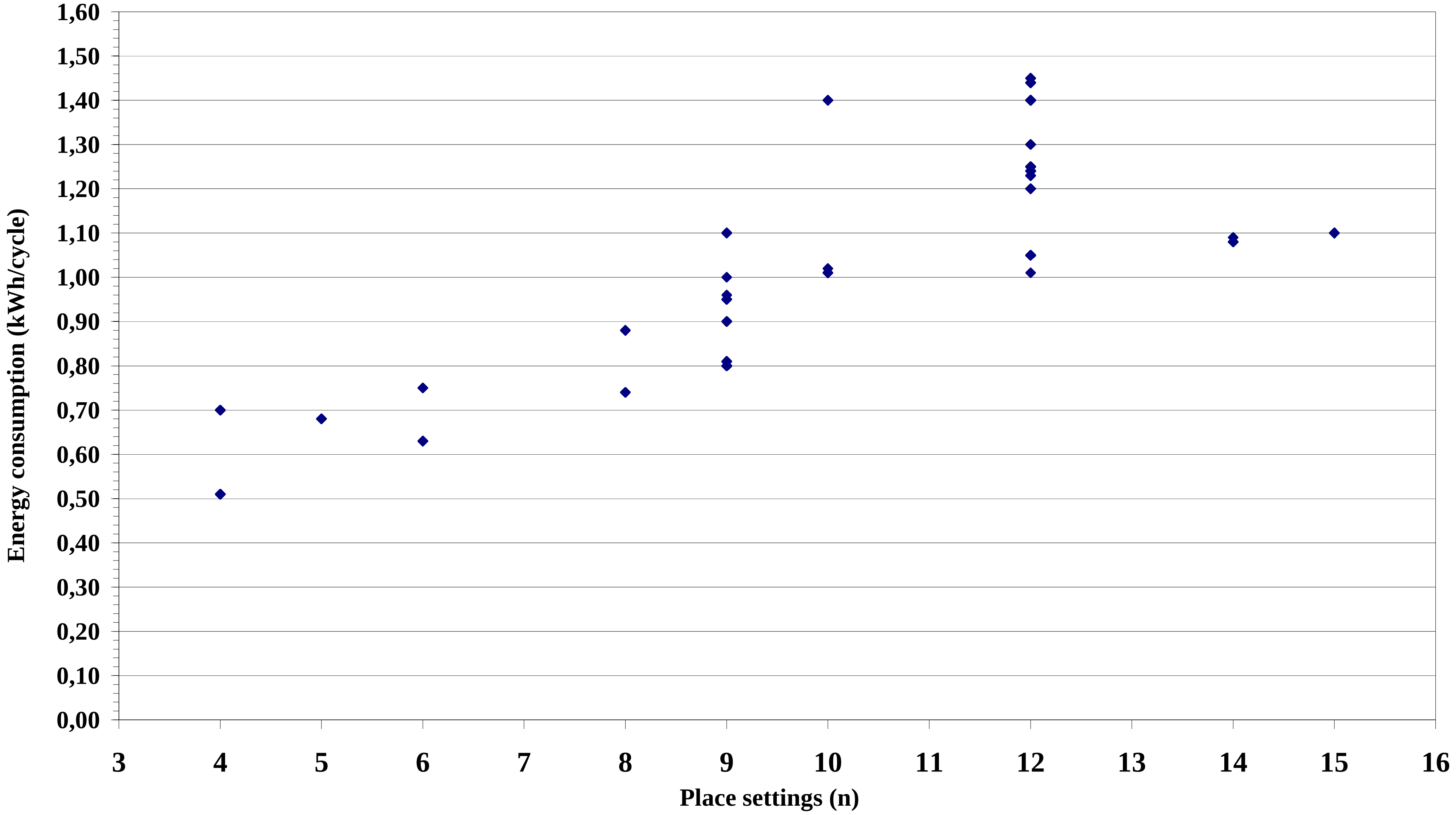


Figure 5.2: Water consumption as function of the place settings for the dishwasher models in the 2005 CECED technical database

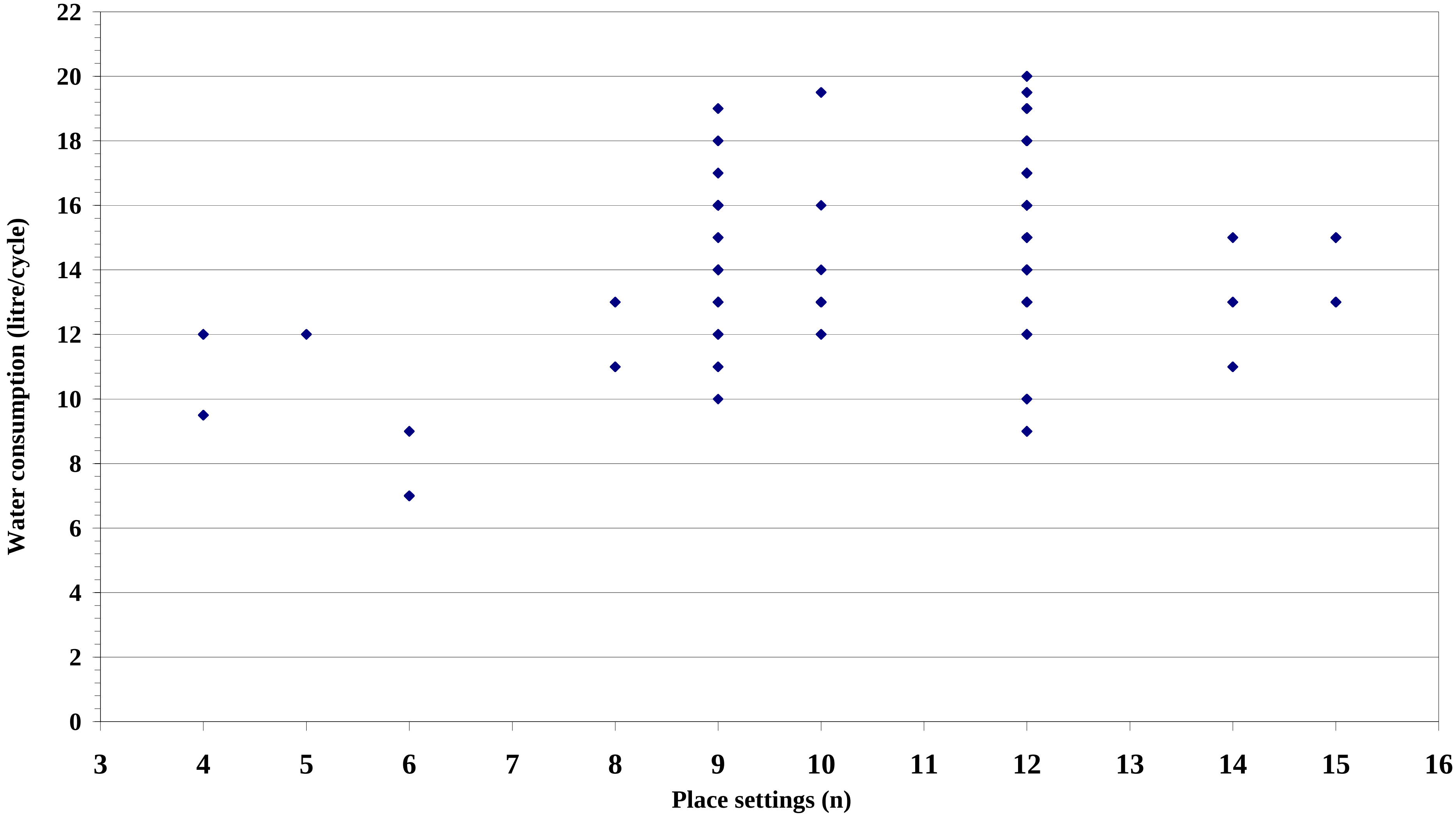


Figure 5.3: Specific energy consumption as function of the place settings for the dishwasher models in the 2005 CECED technical database

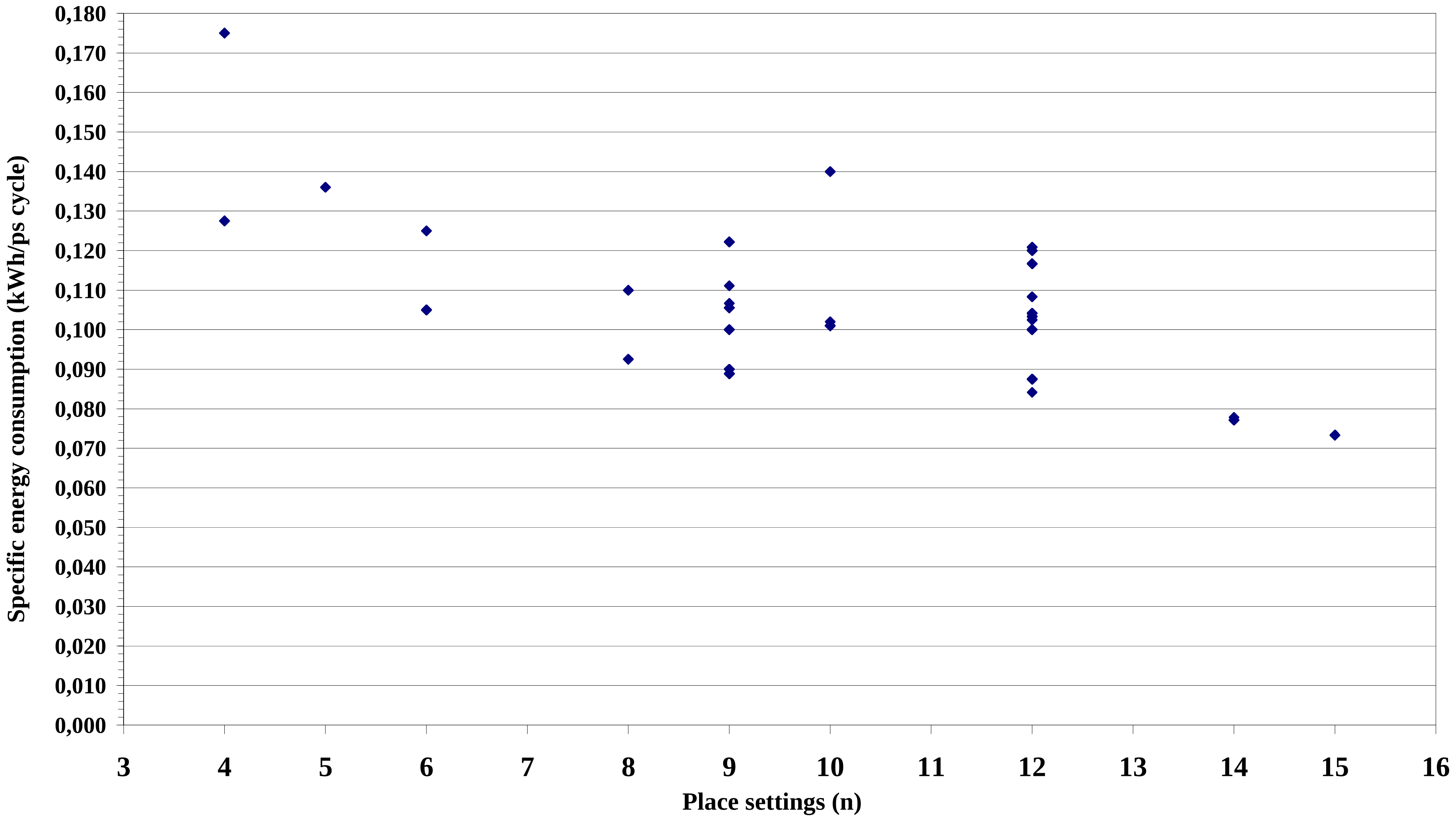


Figure 5.4: Specific water consumption as function of the place settings for the dishwasher models in the 2005 CECED technical database

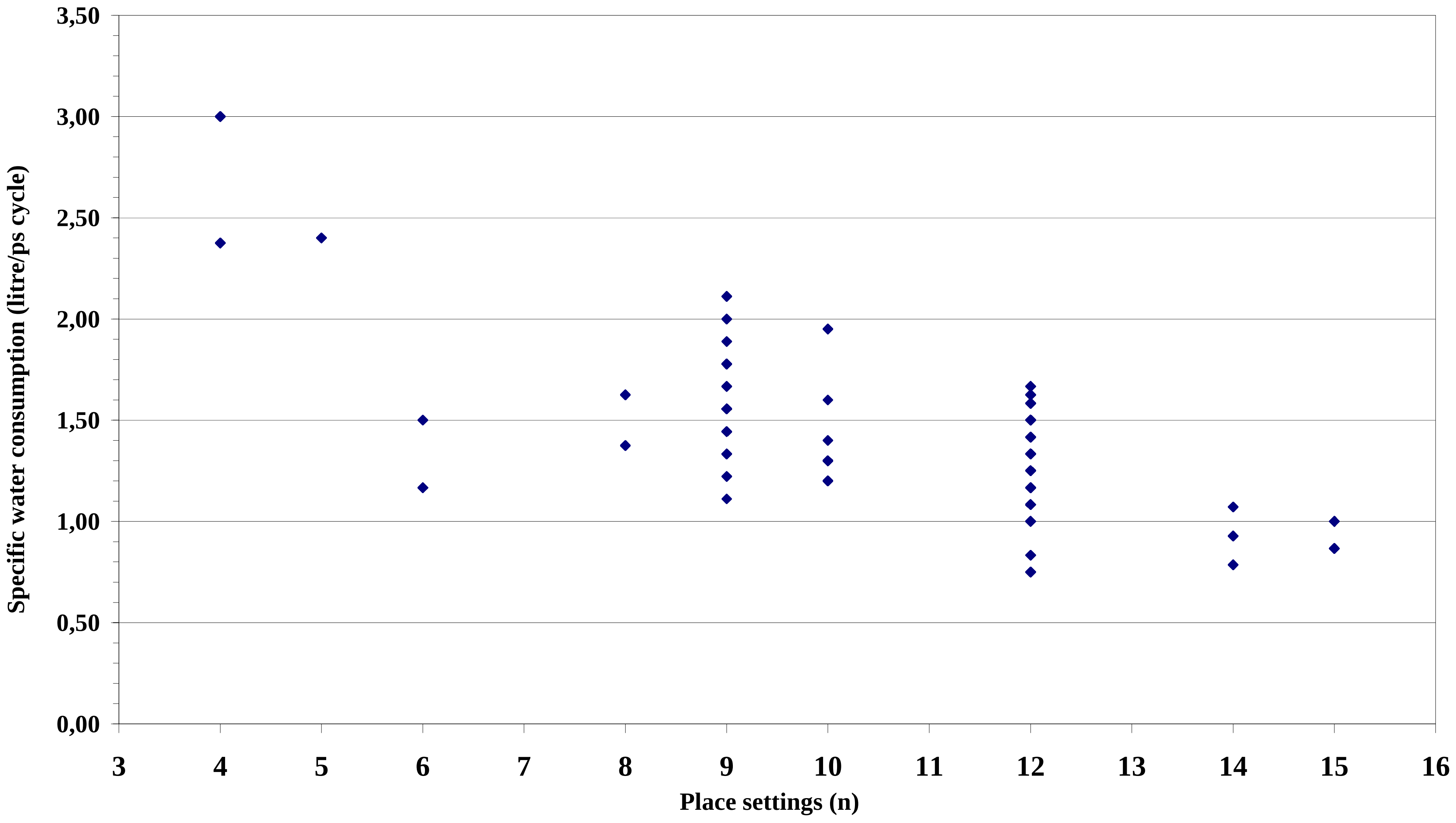


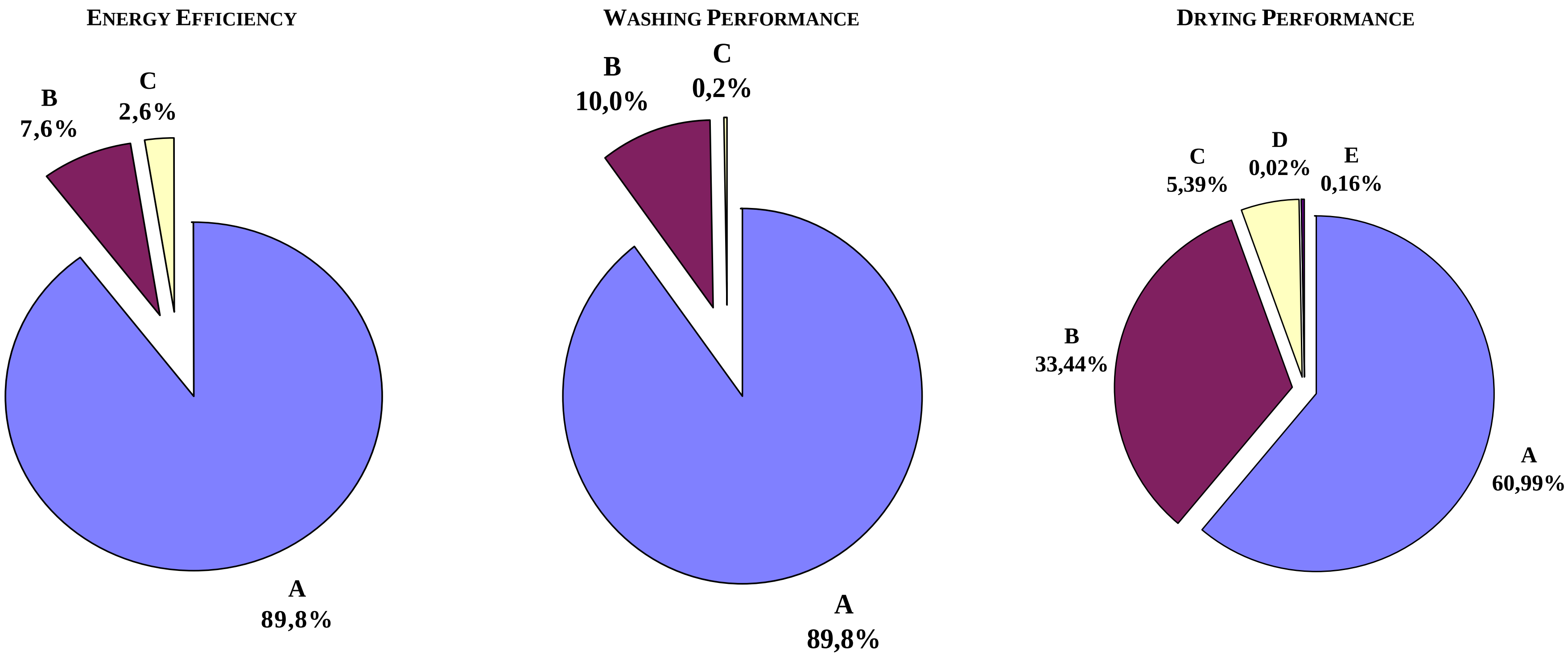
Table 5.1: Distribution of the 2005 dishwasher models by place settings

Standard place settings (number)	Models (number)	Models (%)
4	25	0,58
5	7	0,16
6	19	0,44
8	17	0,39
9	530	12,2
10	59	1,36
12	3 552	81,8
14	27	0,62
15	106	2,44
Tot.	4 342	100

Table 5.2: Energy and water consumption, energy efficiency, washing and drying performance classes for the dishwasher models in the CECED 2005 technical database

Place settings	Energy consumption (kWh/cycle)			Water consumption (litre/cycle)			Specific energy consumption (kWh/ps cycle)			Specific water consumption (litre/ps cycle)			Energy Efficiency classes			Washing Performance classes			Drying performance classes					Models
(n)	average	min	max	average	min	max	average	min	max	average	min	max	A	B	C	A	B	C	A	B	C	D	E	(n)
4	0,609	0,510	0,700	10,8	9,5	12,0	0,1522	0,1275	0,1750	2,70	2,38	3,00	12		13	12	13			12	13			25
5	0,680	0,680	0,680	12,0	12,0	12,0	0,1360	0,1360	0,1360	2,40	2,40	2,40		7				7					7	7
6	0,649	0,630	0,750	7,3	7,0	9,0	0,1082	0,1050	0,1250	1,22	1,17	1,50	16	3		16	3			19				19
8	0,814	0,740	0,880	12,1	11,0	13,0	0,1018	0,0925	0,1100	1,51	1,38	1,63	8	9		11	6		6	9	2			17
9	**0,828**	0,800	1,100	**13,7**	10,0	19,0	**0,0920**	0,0889	0,1222	1,52	1,11	2,11	453	49	28	427	103		259	228	43			**530**
10	1,050	1,010	1,400	13,5	12,0	19,5	0,1050	0,1010	0,1400	1,35	1,20	1,95	53		6	50	9		25	34				59
12	**1,070**	1,010	1,450	**15,2**	9,0	20,0	**0,0892**	0,0842	0,1208	1,27	0,75	1,67	3 223	263	66	3 251	299	2	2 278	1 097	176	1		**3 552**
14	1,081	1,080	1,090	13,1	11,0	15,0	0,0772	0,0771	0,0779	0,93	0,79	1,07	27			26	1		26	1				27
15	1,100	1,100	1,100	14,4	13,0	15,0	0,0733	0,0733	0,0733	0,96	0,87	1,00	106			106			54	52				106
Aver./Tot.	1,035			14,9			0,0899			1,30			3 898	331	113	3 899	434	9	2 648	1 452	234	1	7	4 342

Figure 5.5: Energy efficiency, washing and drying performance of the dishwasher models in the 2005 CECED technical database



performance and 60% for the drying performance. B class models were 10% or less for energy efficiency and water performance, while for drying performance they were one third. The other classes, where existing are residuals.

The energy efficiency and washing and drying performance for the 9ps and the 12ps models are presented in Tables 5.3-5.4. The 12ps appliances appear to be slightly more "performing" than 9ps ones, especially for the drying, where about half of the models are below A.

Table 5.3: Distribution of the energy efficiency, washing and drying performance classes for the 12ps models

Classes	Energy efficiency		Washing performance		Drying performance	
	(n)	(%)	(n)	(%)	(n)	(%)
A	3 222	90,7	3 251	91,5	2.278	64,1
B	266	7,5	299	8,4	1 097	30,9
C	64	1,8	2	0,1	176	5,0
D					1	0,0
E						
F						
G						
Total	3 552	100	3 552	100	3 552	100

Table 5.4: Distribution of the energy efficiency, washing and drying performance classes for the 9ps models

Classes	Energy efficiency		Washing performance		Drying performance	
	(n)	(%)	(n)	(%)	(n)	(%)
A	453	85,5	427	80,6	259	48,9
B	49	9,2	103	19,4	228	43,0
C	28	5,3			43	8,1
D						
E						
F						
G						
Total	530	100	530	100	530	100

The combination of the energy efficiency, washing and drying performance classes for all the models in the technical database is presented in Table 5.5: AAA, AAB and AAC models are 3 703 over the 4 342 total models, or 85%. AAA models are 2 642 or 60,8%.

The same evaluation for the 9ps and the 12ps machines is presented in Tables 5.6-5.7. For the 9ps category, AAA, AAB and AAC models are 417 over the 530 total models, or 78,7%. AAA models are 258 or 48,7%. For the 12ps, AAA, AAB and AAC models are 3.074 over the 3.552 total models, or 86,5%. AAA models are 2.273 or 64%.

5.1.1.2 The Notary Report of the industry voluntary commitment

The industry voluntary commitment defined by CECED in 1999 for dishwashers foresees that an annual Notary Report is delivered to the Commission and Member States. The Notary Report includes the number of units produced/imported for each place setting and the corresponding weighted average energy consumption (in kWh/cycle). Even if the voluntary commitment expired at the end of 2004, CECED prepared the Notary Report also for 2005.

Table 5.5: Energy efficiency, washing and drying performance class combinations for the dishwasher models in the CECED 2005 technical database

Place settings (n)	Energy efficiency, washing and drying performance classes combinations																			Models (n)
	AAA (n)	AAB (n)	AAC (n)	ABA (n)	ABB (n)	ABC (n)	BAA (n)	BAB (n)	BAC (n)	BBB (n)	BBC (n)	BCE (n)	CAA (n)	CAB (n)	CAC (n)	CBB (n)	CBC (n)	CCC (n)	CCD (n)	
4		12															13			25
5												7								7
6		16								3										19
8	6					2		5		4										17
9	258	157	2	1	25	10		10		35	4					1	27			530
10	25	21			7									4		2				59
12	2 273	750	51		123	26	1	115	24	73	50		4	32	1	4	23	1	1	3 552
14	26				1															27
15	54	52																		106
Total	2 642	1 008	53	1	156	38	1	130	24	115	54	7	4	36	1	7	63	1	1	4 342

Table 5.6: Energy efficiency, washing and drying performance classes combinations for the 9ps dishwasher models in the CECED 2005 technical database

Place settings (n)	Energy efficiency, washing and drying performance classes combinations											Models (n)
	AAA (n)	AAB (n)	AAC (n)	ABA (n)	ABB (n)	ABC (n)	BAB (n)	BBB (n)	BBC (n)	CBB (n)	CBC (n)	
9	258	157	2	1	25	10	10	35	4	1	27	530

Table 5.7: Energy efficiency, washing and drying performance classes combinations for the 12ps dishwasher models in the CECED 2005 technical database

Place settings (n)	Energy efficiency, washing and drying performance classes combinations																	Models (n)
	AAA (n)	AAB (n)	AAC (n)	ABB (n)	ABC (n)	BAA (n)	BAB (n)	BAC (n)	BBB (n)	BBC (n)	CAA (n)	CAB (n)	CAC (n)	CBB (n)	CBC (n)	CCC (n)	CCD (n)	
12	2 273	750	51	123	26	1	115	24	73	50	4	32	1	4	23	1	1	3 552

In 2005, about 8,4 million dishwashers were produced/imported for the EU25 market by the signatories of the voluntary commitment, 7 million of which (82,7%) 12ps units and 0,9 million (10,3%) for 9ps units. In general there is a good correspondence between the number of models in the technical database and the production for 2005. In 2004 the production was of about 8,04 million units.

The comparison of the production weighted average energy consumption with the models average energy consumption, shown respectively in the fourth and the last columns of Table 5.8, demonstrate that the two energy consumptions are very close, with the sales weighted value only slightly higher than the other one. Also the percentage of the appliances per place settings is very close for most of the place setting categories.

Table 5.8: Comparison between the outcome of the Notary Report and the technical database for dishwashers for 2005

Standard place settings	Technical database			Notary report		
	models		Energy consumption	models		Energy consumption
(number)	(number)	(%)	(kWh/cycle)	(number)	(%)	(kWh/cycle)
4	25	0,58	0,609	66 000	0,79	0,581
5	7	0,16	0,680	17 990	0,21	0,750
6	19	0,44	0,649	43 766	0,52	0,662
8	17	0,39	0,814	82 187	0,98	0,837
9	530	12,21	0,828	867 222	10,33	0,840
10	59	1,36	1,050	105 012	1,25	1,160
11	n.a	n.a	n.a	33 490	0,40	1,000
12	3 552	81,81	1,070	6 947 102	82,74	1,078
14	27	0,62	1,081	131 359	1,56	1,082
15	106	2,44	1,100	102 683	1,22	1,100
Total/Average	4 342	100	1,035	8 396 811	100	1,045

5.1.1.3 The sales data by energy efficiency for 2004

Sales data were collected by GfK, a market research firm specialised in household appliances, for 2002 and 2004[46]. Dishwasher sales for 13 Western Europe (AT, BE, DE, DK, ES, FI, FR, GB, GR, IT, NL, PT, SE) and 5 Eastern Europe (CZ, HU, PL, SI, SK) countries were collected by energy efficiency class.

The results are presented in Table 5.9, and compared with the analysis of the technical database for the 2005. In the 18 covered countries 5,8 million dishwashers were sold, 73,5% of which in class A and 15,9% in class B. No distinction is made for place settings.

Compared with the analysis of the CECED 2004 technical database a 7% difference is found for the class A appliances and a 16% with the 2005 technical database. The difference with the 2005 production is 2,5 million units, and 2,1 million units with the 2004 production.

[46] data for 2005 were too costly for the study budget.

Table 5.9: Comparison between the GfK sales data for 2004 and the technical database for dishwashers for 2004/2005

Energy efficiency class	Western Europe	Eastern Europe	EU total		Technical database	
					2005	2004
	(n)	(n)	(n)	(%)	(%)	(%)
A	4 097 493	183.414	4 280 907	73,5	89,8	80,7
B	874 658	50 259	924 917	15,9	7,6	13,3
C	446 986	26 428	473 413	8,1	2,6	5,4
D	32 946	2 938	35 884	0,6		0,5
E	2 875	46	2 920	0,1		
F	4	0	4	0,0		
G	165	0	165	0,003		
Unknown	97 333	6 635	103 969	1,8		
Total	5 552 461	269 720	5 822 180	100	100	100

5.1.1.4 The standard base case characteristics for dishwashers

Taking into consideration the analysis developed in the previous paragraph, two standard base cases can be selected for the dishwashers, a 9ps and a 12ps model, with the following characteristics:

- 12 place settings machine:

  - energy consumption: 1,070 kWh/cycle (energy efficiency class A/B, EEI=0,648)
  - water consumption: 15,2 litre/cycle
  - washing performance class: A/B
  - drying performance class: A or B
  - noise: 50 dB(A) [estimated from models available in catalogues]

- 9 place settings machine:

  - energy consumption: 0,828 kWh/cycle (energy efficiency class B, EEI=0,708)
  - water consumption: 13,7 litre/cycle
  - washing performance class: B
  - drying performance class: A or B
  - noise: 50 dB(A) [estimated from models available in catalogues].

In Tables 5.10-5.11 the characteristics of the different average machines are compared for the two place settings categories. The standard base cases of the 1995 GEA study and of the CECED voluntary commitment are also presented. The top of the range machines as found in the CECED technical database and from specialised journals are given in the same Table.

As far as washing cycle time of the standard cycle is concerned, 140-150 minutes are declared by manufacturers for the cycle used for the energy labelling scheme, against a 75 min cycle described in the GEA study.

Table 5.10: Results of the improvements for the 12ps dishwasher in 2003/2005 and comparison with the standard base case in 1995

Model	Place settings	Energy consumption		EE		WP	DP	Water consumption		Noise	Weight
	(n)	(kWh/cycle)	(Wh/ps)	E_I	(class)	(class)	(class)	(litre/cycle)	(litre/ps)	dB(A)	(kg)
Standard base case, 1995[47]	12	1,651	138,3	1,001	E	n.a	n.a	24	2,0	60[a]	50[b]
Base case CECED VA, 1996-97	12	1,692	141,0	1,025	E	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Production wgt. average, 2005	12	1,078	89,83	0,653	B	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Technical db average, 2005	12	1,070	89,21	0,648	A/B	A	A/B	15,2	1,27	50[a]	n.a.
Standard base case, 2005	12	1,070	89,21	0,648	A/B	A	A/B	15,2	1,27	50	n.a.
Top of the range, db 2005:											
energy consumption	12	**1,010**	84,17	0,612	A	A	A	13	1,08	n.a	n.a.
water consumption	12	1,050	87,50	0,617	A	A	A	**9**	0,75	n.a	n.a.
Best available, 2005/2006:											
energy consumption[c]	12	**0,950**	79,17	0,576	A	n.a.	n.a.	14	1,167	45	n.a.
noise[d,e]	12	1,050	87,50	0,636	A	n.a	n.a	14	1,167	**41**	n.a.

[a] estimated
[b] for the free-standing machine
[c] model LG GENIUS LD-2051 SH, Trade Bianco, November 2004, pag. 90.
[d] model AEG FAVORIT 80850, Trade Bianco, November 2004, pag. 88.
[e] AEG dishwashers with a noise in the range 41-45 dB(A) are advertised in Bianco & Bruno, N. 3-2007, pag.20.

[47] Source: GEA, 1995

Table 5.11: Results of the improvements for the 9ps dishwasher in 2003/2005 and comparison with the standard base case in 1995

Model	Place settings	Energy consumption		EE		WP	DP	Water consumption		Noise	Weight
	(n)	(kWh/cycle)	(Wh/ps)	E_I	(class)	(class)	(class)	(litre/cycle)	(litre/ps)	dB(A)	(kg)
Standard base case, 1995	12	1,651	138,3	1,001	E	n.a	n.a	24	2,0	60[a]	50[b]
Base case CECED VA, 1996-97	9	1,485	165,5	1,179	F	n.a	n.a	n.a.	n.a.	n.a.	n.a.
Production wgt. average, 2005	9	0,840	93,33	0,718	B	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Technical db average, 2005	9	0,828	91,98	0,708	B	A	A/B	13,7	1,5	50[a]	n.a.
Standard base case, 2005	9	0,828	91,98	0,708	B	A	A/B	13,7	1,5	50	n.a.
Top of the range, db 2005:	9										
energy	9	**0,800**	88,88	0,635	A	A	A	11	1,2	n.a.	n.a.
water	9	**0,800**	88,88	0,635	A	B	A	**10**	1,1	n.a.	n.a.

[a]estimated
[b]for the free-standing machine

5.1.2 *The Standard Base Case for Washing machines*

During the already mentioned first stakeholder meeting of the study it was proposed to define only one standard base case for the washing machines, to be selected between a 5kg or a 6 kg load machine, and the final choice done after the analysis of the technical database and the other available information. The proposal to use a specific load capacity machine as representative of the entire product group in Europe came from the knowledge of the market of washing machines in the past decades and has been used as the basis for the policy measures already in place: eco-label, the energy labelling scheme and the industry voluntary commitment described in Task 1.

5.1.2.1 The Analysis of the 2005 technical database

The 2005 technical database collected by CECED includes 5 192 models, with a load capacity from 3,0 kg to 9,0 kg. Also for the washing machines the analysis started with the validation of the collected data, checking the coherence of the declared Energy Efficiency Class. For 22 (0,42%) of the 5 192 models, a lack of coherence was found between the declared energy efficiency class and the calculated one: for 8 models the declared class was better than what should be but in other 14 models the declared class was found worse than the recalculated one. The latter models were at the border between two classes and the manufacturer decided to declare them in the lowest. In any case, for sake of coherence of the statistical analysis, all the "non-coherent" models were corrected and the statistical analysis of the energy efficiency class was based on the validated results.

About 50% of the models have a capacity of 5kg, followed by the 6kg with 28,3% of the models (Table 5.12). These two categories account for 78,3% of the entire database. The third category in order of importance is the 4,5kg accounting for only the 9,3% of the models.

Table 5.12: Distribution of the 2005 washing machines models by load capacity

Machine capacity (kg)	Models (number)	Models (%)
3,0	17	0,33
3,5	52	1,0
4,0	37	0,71
4,5	481	9,26
5,0	2 597	50,0
5,5	250	4,82
6,0	1 471	28,3
6,5	2	0,04
7,0	182	3,51
7,5	79	1,52
8,0	14	0,27
9,0	10	0,19
Total	5 192	100

The energy and water consumption of the models in the database, in kWh and litre per cycle, is presented in Figures 5.6-5.7, while in Figures 5.8-5.9 the specific energy and water consumption, in kWh and litre per kg load and per cycle, are given. The distribution of the spinning speed is presented in Figure 5.10 again as function of the machines load capacity.

Figure 5.6: Energy consumption as function of the load for the washing machine models in the 2005 CECED technical database

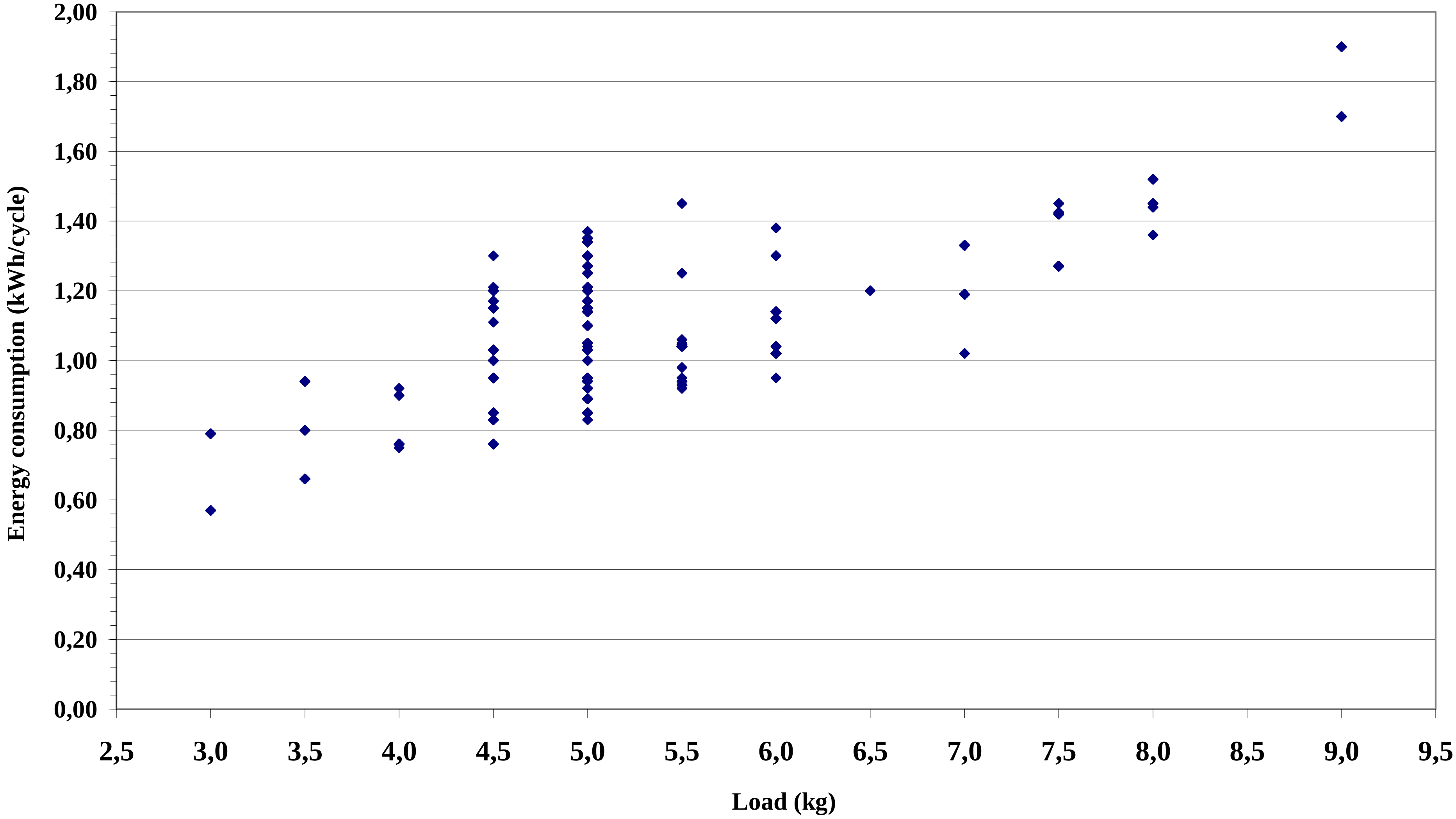


Figure 5.7: Water consumption as function of the load for the washing machine models in the 2005 CECED technical database

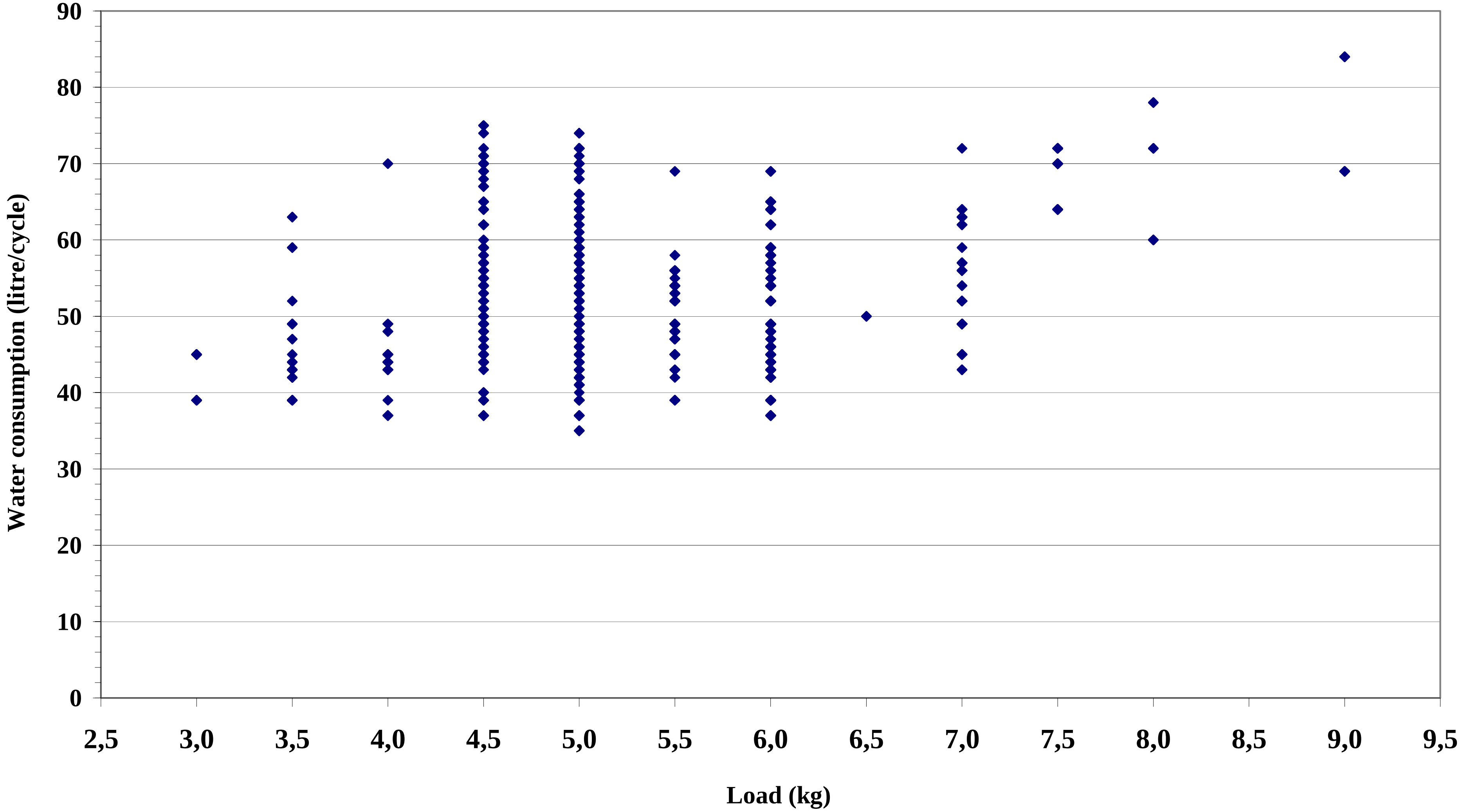


Figure 5.8: Specific energy consumption as function of the load for the washing machine models in the 2005 CECED technical database

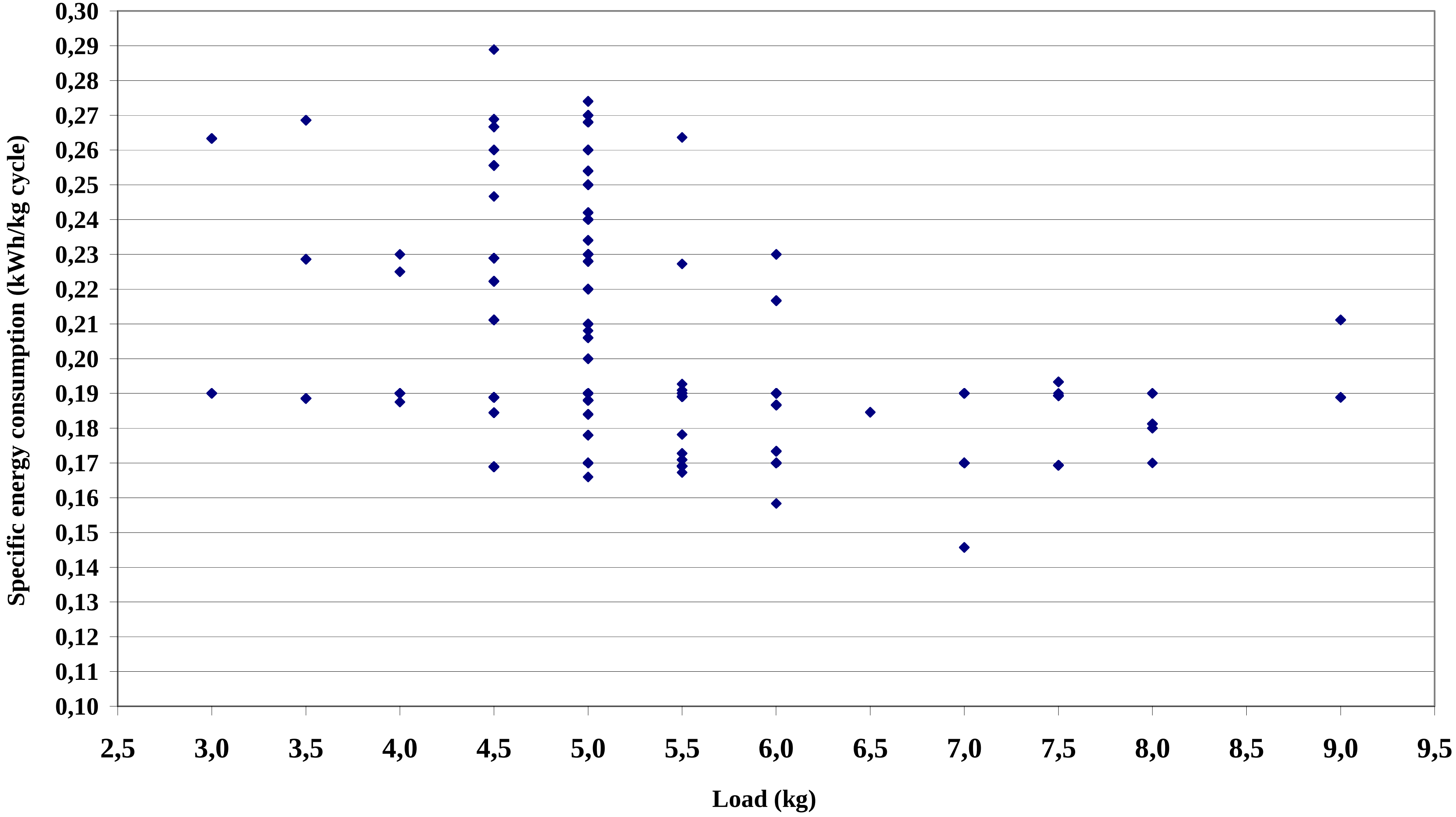


Figure 5.9: Specific water consumption as function of the load for the washing machine models in the 2005 CECED technical database

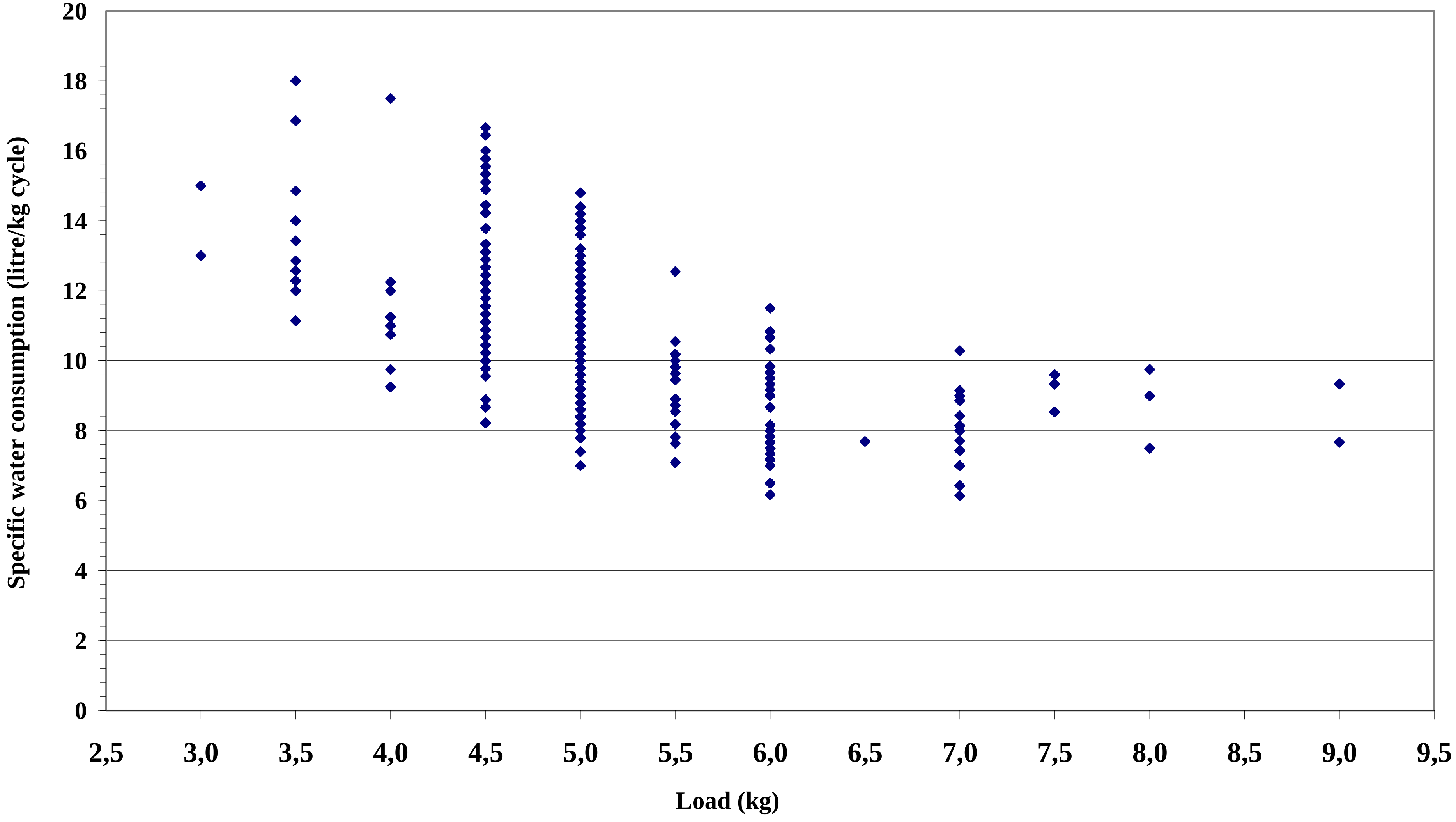
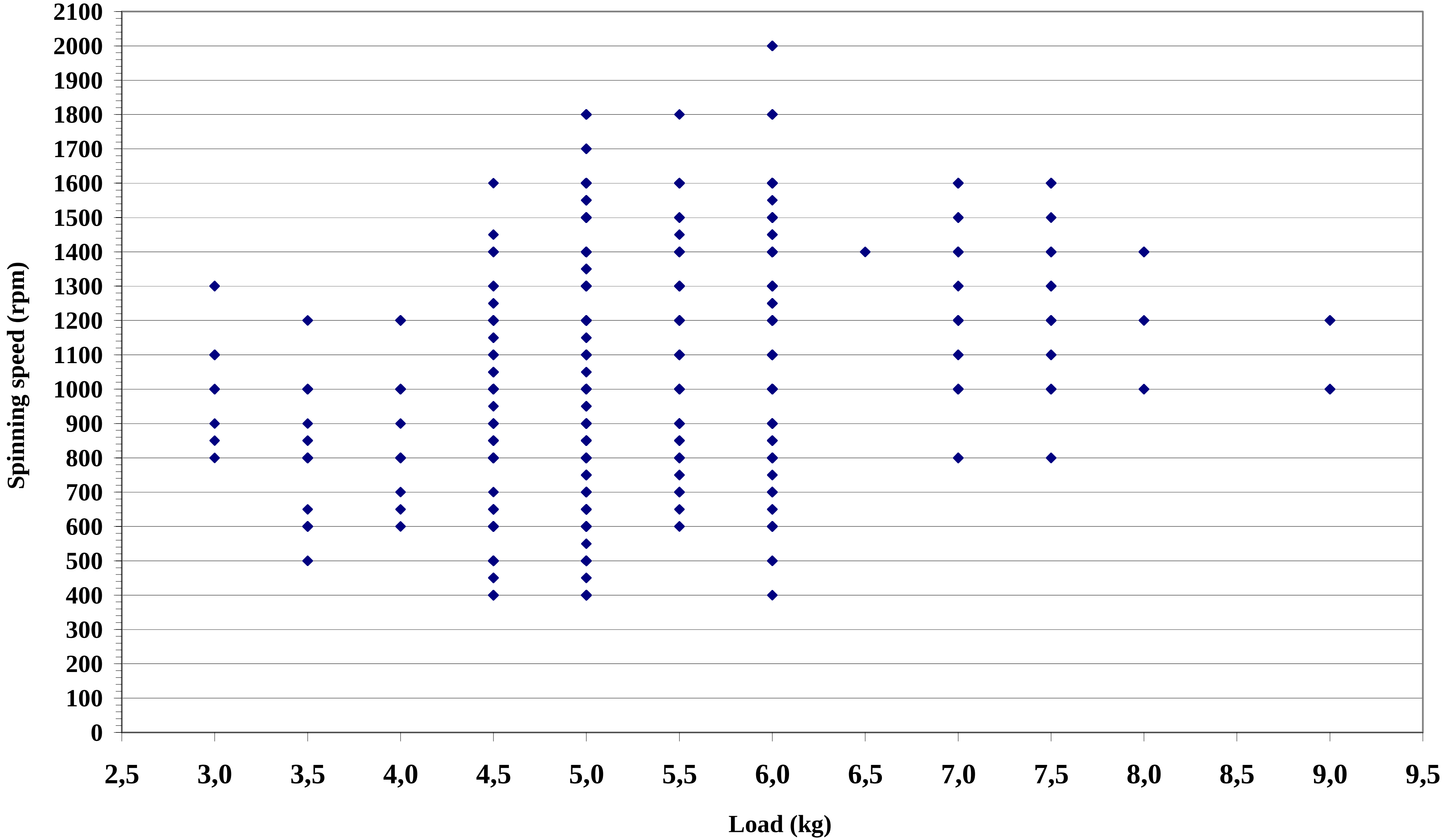


Figure 5.10: Spinning speed as function of the load for the washing machine models in the 2005 CECED technical database



Average, minimum and maximum values for energy and water consumption and spinning speed are presented in Table 5.13 for the different load capacities. The 5kg and the 6kg load capacity machines are highlighted.

In Table 5.14 the break down of the models in the energy efficiency, washing performance and spin drying performance classes is given. As clearly shown also in Figure 5.11, in 2005 the large majority of the models belong to class A+/A for the energy efficiency (89,7%) and for the washing performance (86,8%) while for the spin drying efficiency class A accounts only for 12,6%, class B for 40,8% and class C for one quarter of the models. The other classes, from D to G, are still present even if much less important. Although the "A+" energy efficiency class is not defined in the energy labelling scheme for washing machines, but is based on a commercial agreement among manufacturers, it is anyway indicated in the Tables for a better description of the present situation.

The EU energy labelling scheme does not rate spin speed, but residual moisture content and converts it in spin drying efficiency classes. The spin speed of a machine is a major factor determining the residual moisture content, but not the only factor: drum diameter and geometry of drum-details also are of influence. This influence is highlighted in Table 5.15: class A is reached by machines with at least 1 400 rpm, class B by machines with at least 1 000 rpm, class C from 700 rpm, class D from 600 rpm. The two more frequent spinning speeds are 1 000 rpm and 1 200 rpm, each accounting for about 20% of the models in the database, followed by 1 400 rpm (15% of the models), 1 600 rpm (10% of the models) and 800 rpm (about 9% of the models). The average spinning speed is 1 129 rpm, with a median of 1 200 rpm.

In the same Table also the washing performance and the energy efficiency of the models with the different spinning speeds is presented. A part from the very low spinning (below 600 rpm) A+/A class appliances (for washing performance and energy efficiency) are available for the different speeds.

The energy efficiency, washing performance and spin drying efficiency for the 5kg and the 6kg load capacity models are presented in Tables 5.16- 5.17. The 6kg appliances appear to be slightly more "performing" than 5kg ones, especially from the energy efficiency point of view, since the A+ models are 70,1% against 23,3%.

In Table 5.18 the spinning speed and spin drying efficiency classes for the 5kg load capacity and the 6kg load capacity washing machines is presented: for the 6kg models not all the spinning speeds are available compared to the 5kg load capacity machines.

Most of the machines in the database - 4 626 models out of the 5 192 total ones - present the "automatic load detection option". Only 505 models - or 9,7% - have not and for 61 models it is not specified. This feature allows the machine to evaluate the weight of the load and to adjust consequently the amount of water[48] needed for the washing cycle once the textile type (or the programme to be used) has been selected by the user.

The presence of this option is only partly related to the spinning speed (a higher percentage of low spinning machines has not it compared to the high spinning speed appliances), the energy efficiency and washing performance (almost all machines in energy efficiency classes A/A+ and washing performance classes A/B have it) and the load capacity (again, a higher percentage of low capacity machines has not this option). On the contrary, in practically all load capacity, energy efficiency, washing performance and spinning speed clusters models with this option can be found.

[48] but not the detergent, to be adjusted according to the load following the instruction on the packaging.

Table 5.13: Energy and water consumption, and spinning speed for the washing machine models in the CECED 2005 technical database

Machine load (kg)	Energy consumption (kWh/cycle) average	min	max	Water consumption (litre/cycle) average	min	max	Spinning speed (rpm) average	min	max	Specific energy consumption (kWh/kg cycle) average	min	max	Specific water consumption (litre/kg cycle) average	min	max	Models (n)	
3,0	0,686	0,570	0,790	42,2	39,0	45,0	1 068	800	1 300	0,229	0,190	0,263	14,1	13,0	15,0	17	
3,5	0,722	0,660	0,940	45,3	39,0	63,0	836	500	1 200	0,206	0,189	0,269	12,9	11,1	18,0	52	
4,0	0,772	0,750	0,920	44,6	37,0	70,0	985	600	1 200	0,193	0,188	0,230	11,2	9,3	17,5	37	
4,5	0,917	0,760	1,300	53,2	37,0	75,0	926	400	1 600	0,204	0,169	0,289	11,8	8,2	16,7	481	
5,0	0,956	0,830	1,370	50,4	35,0	74,0	1 073	400	1 800	0,191	0,166	0,274	10,1	7,0	14,8	2 597	
5,5	1,012	0,920	1,450	50,9	39,0	69,0	1 180	600	1 800	0,184	0,167	0,264	9,3	7,1	12,5	250	
6,0	1,057	0,950	1,380	49,2	37,0	69,0	1 262	400	2 000	0,176	0,158	0,230	8,2	6,2	11,5	1 471	
6,5	1,200	1,200	1,200	50,0	50,0	50,0	1 400	1 400	1 400	0,185	0,185	0,185	7,7	7,7	7,7	2	
7,0	1,208	1,020	1,330	52,6	43,0	72,0	1 315	800	1 600	0,173	0,146	0,190	7,5	6,1	10,3	182	
7,5	1,381	1,270	1,450	70,3	64,0	72,0	1 330	800	1 600	0,184	0,169	0,193	9,4	8,5	9,6	79	
8,0	1,466	1,360	1,520	68,1	60,0	78,0	1 300	1 000	1 400	0,183	0,170	0,190	8,5	7,5	9,8	14	
9,0	1,780	1,700	1,900	75,0	69,0	84,0	1 120	1 000	1 200	0,198	0,189	0,211	8,3	7,7	9,3	10	
5,36	**0,998**			**50,7**			**1 129**			**0,187**			**9,6**			5 192	Average/Total

Table 5.14: Energy efficiency, washing and drying performance classes for the washing machine models in the CECED 2005 technical database

Machine load	Energy efficiency classes					Washing performance classes				Spin drying performance classes							Models
(kg)	A+	A	B	C	D	A	B	C	D	A	B	C	D	E	F	G	(n)
3,0		8		9			17				3	7	6	1			17
3,5		37	7	8		20	25	7			2	17	22	11			52
4,0		34	3			34	2	1			11	17	6	3			37
4,5	70	247	96	67	1	356	72	48	5	1	111	195	87	55	27	5	481
5,0	604	1 665	202	126		2 137	256	193	11	224	986	695	342	243	77	30	2 597
5,5	69	179	1	1		231	17	2		20	142	58	28	2			250
6,0	1 031	430	10			1 443	21	7		320	720	296	111	20	4		1 471
6,5		2				2				2							2
7,0	156	26				182				48	97	33	4				182
7,5	22	57				79				30	34	13	2				79
8,0	1	13				14				8	4	2					14
9,0		6	4			10					6	4					10
Total	1 953	2 704	323	211	1	4 508	410	258	16	653	2 116	1.337	608	335	108	35	5 192

Figure 5.11: Energy efficiency, washing and spin-drying performance for the washing machine models in the 2005 CECED technical database

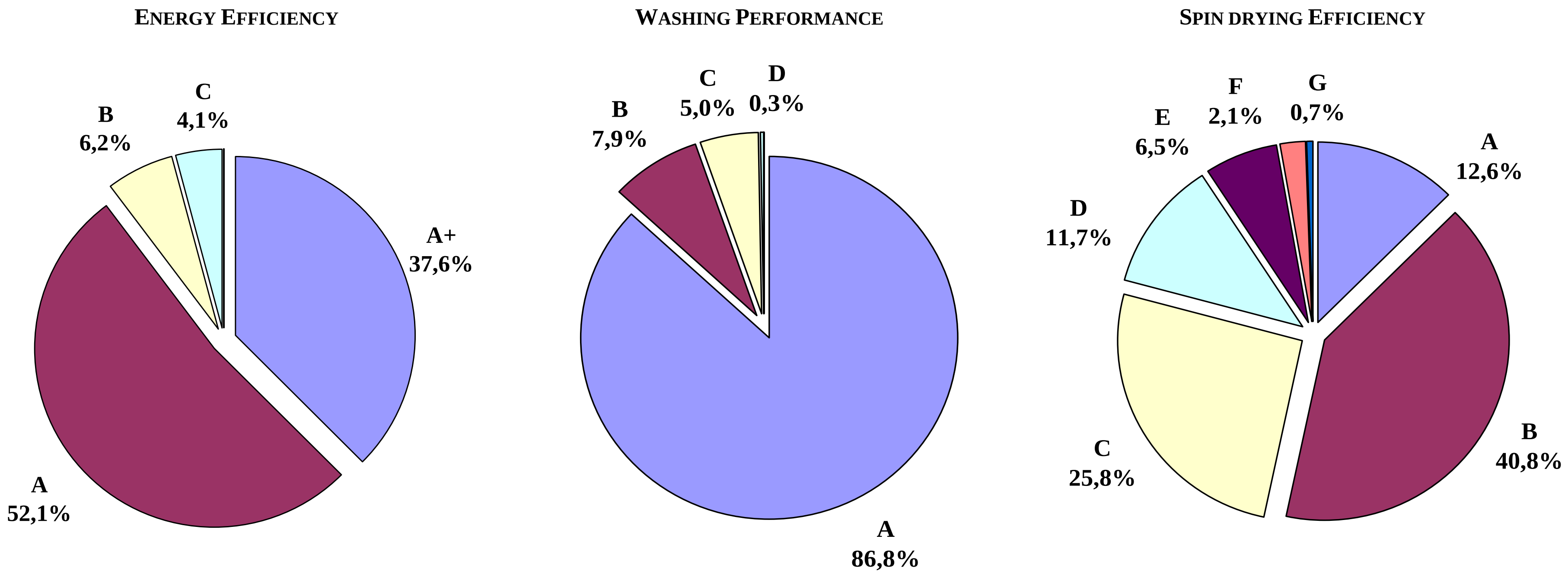


Table 5.15: Relation between spinning speed and spin drying efficiency, washing performance and energy performance for the washing machine models in the CECED 2005 technical database

Spinning speed	Spin drying efficiency							Washing performance				Energy efficiency					Models	
(rpm)	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**A**	**B**	**C**	**D**	**A+**	**A**	**B**	**C**	**D**	(number)	(%)
400						54	33		13	62	12		1	37	49		87	1,7
450						4	2		2	4				2	4		6	0,1
500					65	50		4	37	71	3		18	58	38	1	115	2,2
550					1						1				1		1	0,0
600				20	245			101	78	86		25	120	60	60		265	**5,1**
650				28	5			30	3			6	26	1			33	0,6
700			1	32	17			39	11			11	36	2	1		50	1,0
750			2	10	1			12		1		4	8		1		13	0,3
800			74	383	1			384	59	15		107	309	31	11		458	**8,8**
850			22	50				58	12	2		11	44	10	7		72	1,4
900			59	77				124	12			42	85	8	1		136	2,6
950			4					4					2	2			4	0,1
1 000		4	978	4				857	115	14		294	603	65	24		986	**19,0**
1 050			8					5	3			1	3	1	3		8	0,2
1 100		14	177					179	12			77	98	10	6		191	3,7
1 150		4						4				1	3				4	0,1
1 200		1 016	9	4				995	31	3		413	587	24	5		1 029	**19,8**
1 250		6	2					8				4	4				8	0,2
1 300		230	1					226	5			91	138	2			231	4,4
1 350		4						4				1	3				4	0,1
1 400	67	740						795	12			441	360	6			807	**15,5**
1 450		6						6				2	4				6	0,1
1 500	33	63						91	5			42	53	1			96	1,8
1 550		6						6					5	1			6	0,1
1 600	497	23						520				340	178	2			520	**10,0**
1 700	3							3					3				3	0,1
1 800	47							47				39	8				47	0,9
2 000	6							6				1	5				6	0,1
Total	653	2 116	1 337	608	335	108	35	4 508	410	258	16	204	1 953	323	211	1	5 192	100

Table 5.16: Distribution of the energy efficiency, washing and spin drying efficiency classes for the 5kg models

Classes	Energy efficiency		Washing performance		Spin drying efficiency	
	(n)	(%)	(n)	(%)	(n)	(%)
A+	604	23,3				
A	1.665	64,1	2.137	82,3	224	8,6
B	202	7,8	256	9,9	986	38,0
C	126	4,9	193	7,4	695	26,8
D			11	0,4	342	13,2
E					243	9,4
F					77	3,0
G					30	1,2
Total	2.597	100	2.597	100	2.597	100

Table 5.17: Distribution of the energy efficiency, washing and spin drying efficiency classes for the 6kg models

Classes	Energy efficiency		Washing performance		Spin drying efficiency	
	(n)	(%)	(n)	(%)	(n)	(%)
A+	1 031	70,1				
A	430	29,2	1 443	98,1	320	21,8
B	10	0,7	21	1,4	720	48,9
C			7	0,5	296	20,1
D					111	7,5
E					20	1,4
F					4	0,3
G						
Total	1 471	100	1 471	100	1 471	100

For the 5kg load capacity machines, 2 241 models (86,3%) present the "automatic load detection" option and 304 models (11,7%) do not have this option, while 99,6% - or 1 465 models - of the 6kg load capacity machines present this option.

The combination of the energy efficiency, washing performance and spin drying efficiency classes for the models in the technical database is presented in Table 5.19: combinations from A+AA to AAF account for 4.405 over the 5.192 total models, or 84,8%; A+AA and AAA models are 652 or 12,6%. The two most frequent combinations in 2005 were A+AB and AAB, accounting respectively for 954 (18,4%) and 1.080 (20,8%) models.

The same evaluation for the 5kg machines results in combinations from A+AA to AAF accounting for 2 089 over the 2 597 total models, or 80,4% and for the 6kg machines in 1 442 models over the 1 471 total models, or 98%.

5.1.2.2 The Notary Report of the industry voluntary commitment

The industry voluntary commitment defined by CECED in 2002 for washing machines foresee that an annual Notary Report is delivered to the Commission and Member States.

The Notary Report includes the number of units produced/importer for each energy efficiency class and the corresponding weighted average energy consumption (in kWh/cycle).

Table 5.18: Spinning speed and spin drying efficiency classes for the 5kg and the 6kg washing machines models in CECED 2005 technical database

Spinning speed	Spin drying efficiency class							Models 5kg		Spin drying efficiency class							Models 6kg	
(rpm)	A	B	C	D	E	F	G	(n)	(%)	A	B	C	D	E	F	G	(n)	(%)
400						46	28	74	2,85						1		1	0,07
450							2	2	0,08									0
500					51	31		82	3,16						3		3	0,20
550					1			1	0,04									0
600				19	178			197	7,59				1	13			14	0,95
650				19	2			21	0,81				1	2			3	0,20
700				22	11			33	1,27			1	4	4			9	0,61
750			2	7				9	0,35				1	1			2	0,14
800			45	207				252	9,70			14	67				81	5,51
850			17	31				48	1,85			2	5				7	0,48
900			37	34				71	2,73			6	31				37	2,52
950			3					3	0,12									0
1 000		2	500					502	19,3			208					208	14,1
1 050			2					2	0,08									0
1 100		9	87					96	3,70			58					58	3,94
1 150		2						2	0,08									0
1 200		458	1	3				462	17,8		318	5	1				324	22,0
1 300		126	1					127	4,89		4	2					6	0,41
1 350		4						4	0,15		61						61	4,15
1 400	14	328						342	13,2	30	307						337	22,9
1 500	10	37						47	1,81		4						4	0,27
1 550		5						5	0,19	15	19						34	2,31
1.600	165	15						180	6,93		1						1	0,07
1 700	3							3	0,12	255	6						261	17,7
1 800	32							32	1,23	14							14	0,95
2 000									0	6							6	0,41
Total	224	986	695	342	243	77	30	2 597	100	320	720	296	111	20	4		1 471	100

Table 5.19: Energy efficiency, washing and spin drying efficiency classes combinations for the washing machine models in the CECED 2005 technical database

Load	Energy efficiency, washing and drying performance classes combinations																				
	A+AA	A+AB	A+AC	A+AD	A+AE	AAA	AAB	AAC	AAD	AAE	AAF	ABB	ABC	ABD	ABE	ABF	ACB	ACC	ACD	ACE	BAA
(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)
3,0												3	1	4							
3,5								9	11			2	6	5	4						
4,0							11	14	5	2			1							1	
4,5		10	30	19	11	1	86	101	42	8			1		6		1	1			
5,0	109	293	122	64	16	114	639	443	230	59		27	72	29	25	1		2	7	17	1
5,5	7	36	18	8		13	101	35	12	1		5	5	7							
6,0	261	519	182	62	7	59	198	100	46	7	1		12	1			2	2	2		
6,5						2															
7,0	38	83	31	4		10	14	2													
7,5	4	13	5			26	21	8	2												
8,0	1					7	4	2													
9,0							6														
Total	420	954	388	157	34	232	1 080	714	348	77	1	37	98	46	35	1	3	5	9	18	1

Load	Energy efficiency, washing and drying performance classes combinations																			Models
	BAB	BAC	BAD	BAE	BBB	BBC	BBD	BBE	BBF	BBG	BCC	BCD	BCE	BCF	BCG	BDE	CAB	CAC	CAD	Other	
(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)	(n)
3,0																				9	17
3,5						2	3	2												8	52
4,0		2					1													0	37
4,5	7	22	12	1	5	11	2	11	6		5	4	2	8			1	3	1	63	481
5,0	17	23	4	3	7	22	6	33	10	2	3		25	34	11	1				126	2 597
5,5												1								1	249
6,0	1							5	3				1							0	1 471
6,5																				0	2
7,0																				0	182
7,5																				0	79
8,0																				0	14
9,0		4																		0	10
Total	25	51	16	4	12	35	12	51	19	2	8	5	28	42	11	1	1	3	1	207	5 192

In 2004, about 15,4 million washing machines were produced/imported for the EU25 market by the signatories of the voluntary commitment. The average weighted specific energy consumption was 0,195 kWh/kg cycle. The average specific energy consumption of the models in the 2005 technical database is 0,187 kWh/kg cycle, and is 0,192 kWh/kg cycle in the 2004 technical database, which is very close to the production value.

In general there is a good correspondence between the efficiency/performance distribution of models in the technical database and the 2004 production. The A+/A percentage is higher in the 2005 technical database (Table 5.20).

Table 5.20: Comparison of the energy efficiency distribution of the 2004/2005 technical database and the 2004/2005 production for washing machines

Classes	2005 technical database		Notary report 2005		2004 technical database		Notary report 2004	
	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
A+	1 953	37,6	15 193 708	90,6	1 338	25,9	12 738 810	82,4
A	2 704	52,1			3 067	59,4		
B	323	6,22	635 368	3,79	361	6,99	1 365 151	8,83
C	211	4,06	933 113	5,57	377	7,30	1 344 966	8,70
D	1	0,02			20	0,39	9 473	0,06
E								
F								
G								
Total	5 192	100	16 762 189	100	5 163	100	15 452 400	100

5.1.2.3 The sales data by energy efficiency for 2004

Sales data for washing machines were collected by GfK for 2002 and 2004[49] for 13 Western Europe (AT, BE, DE, DK, ES, FI, FR, GB, GR, IT, NL, PT, SE) and 8 Eastern Europe (CZ, EE, HU, LT, LV, PL, SI, SK) countries by energy efficiency class.

The results are presented in Table 5.21, and compared with the analysis of the technical database for the 2005. In the 21 covered countries 14,0 million dishwashers were sold, 78% of which in class A+/A and 11,9% in class B. No distinction is made for load capacity or front load/top load feature.

A market picture for these characteristics in Italy[50] considers that 70% of the 1,56 million units sold in 2005 was front load and 5kg load capacity, while the 6kg machine should reach 300.000 units at the end of 2006. It is also known that only in France (and partially in Finland) the top loading machines are the majority, compared to the other EU countries where this type of washing machines represents about 10-15% [to be confirmed by further market analysis].

Compared with the analysis of the CECED 2004 technical database, a 7% difference is found for the class A appliances (A+ and A classes together) and a 11% with the 2005 technical database. The difference with the 2004 production and import in the Notary Report is 1,4 million units.

---

[49] data for 2005 were too costly for the study budget.

[50] Source: "Lavaggio, nuove proposte per il 2006", Trade Bianco, March 2006, pp.73-78.

Table 5.21: Comparison between the GfK sales data for 2004 and the technical database for washing machines for 2004/2005

Energy efficiency class	Western Europe	Eastern Europe	EU total		Technical database	
					2005	2004
	(n)	(n)	(n)	(%)	(%)	(%)
A+	929 227	25 588	954 815	6,80	37,6	25,9
A	8 549 715	1 464 054	10 013 769	71,3	52,1	59,4
B	1 441 018	233 094	1 674 112	11,9	6,22	6,99
C	909 048	64 537	973 585	6,93	4,06	7,30
D	88 656	12 042	100 699	0,72	0,02	0,39
E	15.649	365	16 014	0,11		
F	56.923	13	56 936	0,41		
G	1 438	0	1 438	0,01		
Unknown	174 759	74 610	249 369	1,78		
Total	12 166 433	1 874 304	14 040 737	100	100	100

5.1.2.4 The standard base case characteristics for washing machines

Taking into consideration the analysis developed in the previous paragraph, the average washing machine for 2005 presents the following characteristics:

- Standard base case:
  - load capacity: 5,36 kg
  - energy consumption: 0,998 kWh/cycle (“C” = 0,187)
  - water consumption: 50,7 litre (9,6 litre/kg cycle)
  - detergent consumption: 139,76g (54g + 16g/kg load in EN 60456)
  - spinning speed: 1.129 rpm
  - automatic load detection
  - energy efficiency class: A (0,17 <”C” ≤ 0,19)
  - washing performance class: A
  - drying performance class: B or C
  - noise: 53 dB(A) for washing; 70 dB(A) for spinning

In Table 5.22 the characteristics of the different average machines are compared for the proposed standard base case. The standard base cases of the 1995 GEA study and the WASH-2 study are also presented. The top of the range machines, as found in the 2005 CECED technical database, and from specialised journals are given in the same Table. As far as washing cycle time of the standard cycle is concerned, 90-100 minutes are declared by manufacturers for the cycle used for the energy labelling scheme (cotton, 60°C, full load), against a 100-110 min cycle mentioned in the GEA/WASH-2 studies.

5.1.3 The Real Life Base Case for Dishwashers

The GEA study mentioned two EU base cases for dishwashers:

- a standard 12ps base case, referring to the energy use according to the standard EN 60436, or 1,651 kWh/cycle, a water consumption of 24 litre/cycle and a washing time of 75 min;
- a real-life base case, with a load of 7ps, and energy consumption of 1,517 kWh/cycle (8,1% lower than the standard base case), water consumption of 24 litre/cycle and a washing time of 72,5 min.

Table 5.22: Results of the improvements for the washing machines in 1995-2005 and comparison with the standard base case in 1995 (wash programme 60°C, cotton)

Model	Capacity	Energy consumption		EE		WP	DP	Water consumption		Spin speed	Noise
	(kg)	(kWh/cycle)	(Wh/kg)	C	(class)	(class)	(class)	(litre/cycle)	(litre/kg)	(rpm)	dB(A)
Standard base case, 1995[51]	4,7	1,39	0,309	0,31	D	n.a	n.a	85	18,1	900	n.a.
Standard base case, 1998[52]	4,8	1,15	0,240	0,24	C	n.a	n.a	60	12,5	n.a.	n.a.
Production wgt. average, 2004	n.a.	n.a.	0,195	0,20	B	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Technical db average, 2005	5,36	0,998	0,187	0,19	A	A	B/C	50,7	9,6	1 129	n.a.
Standard base case, 2005	5,36	0,998	0,187	0,19	A	A	B/C	50,7	9,6	1 129	53/70
Average 5kg load capacity	5	0,956	0,191	0,19	A	A	B/C	50,4	10,1	1 073	n.a.
Average 6kg load capacity	6	1,057	0,176	0,18	A	A	B/A	49,2	8,2	1 262	n.a.
Top of the range, db 2005:											
energy consumption	5	**0,830**	0,166	0,17	A+	A	B	45	9,0	1 150	n.a.
water consumption	5	0,850	0,170	0,17	A+	A	A	**35**	7,0	1 800	n.a.
Top of the range, db 2005:											
energy consumption	6	**0,950**	0,158	0,16	A+	A	C	49	8,2	1 100	n.a.
energy consumption	7	**1,020**	0,146	0,15	A+	A	B	52	8,1	1 200	n.a.
water consumption	6	1,020	0,170	0,17	A+	A	A	**37**	6,2	1 800	n.a.
spinning speed	6	1,020	0,170	0,17	A+	A	A	39	6,5	**2 000**	n.a.
Top of the range, market 2006:											
energy consumption[53]	8	1,2	**0,15**	0,15	A+	A	A	52	6,5	1 400	53/72

[51] Source: GEA2 study, 1995.
[52] Source: WASH-II study, NOVEM, 2001.
[53] LG machine LG-Imperial Flower, sold in UK see: http://uk.lge.com/prodmodeldetail.do?actType=search&page=1&modelCategoryId=06040902&categoryId=06040902&parentId=060409&modelCodeDisplay=LG-Imperial+Flower&model=1

Taking into consideration the consumer behaviour analysis developed in Task 3, the average real life dishwashers for 2005 presents the following characteristics:

- 12 place settings machine in real life:
  - Load capacity: assumed one third lower than the nominal one or 9ps
  - washing temperature: higher than for the standard base case or 59,3°C
  - energy consumption: 9,1% more than the standard base case or 1,167 kWh/cycle
  - water consumption: one litre more per week corresponding to 15,4 litre/cycle
  - washing performance class: A/B
  - drying performance class: A or B
  - noise: 50 dB(A)

- 9 place settings machine in real life:
  - load capacity: one third lower than the nominal one or 6ps
  - washing temperature: higher than for the standard base case or 59,3°C
  - energy consumption: 9,1% more than the standard base case or 0,903 kWh/cycle
  - water consumption: one litre more per week, corresponding to 13,9 litre/cycle
  - washing performance class: B
  - drying performance class: A or B
  - noise: 50 dB(A).

In particular for the 12ps machine:

- energy consumption: an increase of 0,435 kWh per week (10%) for 4,06 cycle/week results from the use of higher temperature programmes than the temperature of the programme used for the energy labelling declaration; a decrease of 0,406 kWh per week (-9,3%) is due to heating of a lighter load (partial load is estimated to be one third of the nominal load); an increase of 0,236 kWh per week (+5,4%) due to an estimated 10°C water inlet, colder than the 15°C water inlet under standard conditions; finally a 3% increase due to the various standby and low power modes is considered (3-5% were evaluated in Task 3 depending on the considered power levels). In total an increase of (+10-9,3+5,4+3 = 9,1)% occurs for the real life base case energy consumption;
- water: a 1 litre per week increase is considered, due to a possible extra rinse
- chemicals and washing time: detergent, softener, rinsing agent consumption is considered the same as for the standard base case as well as the washing cycle time (140-150 minutes);
- noise, energy efficiency, washing and drying performance: are considered the same as for the standard base case;
- hand pre-rinse: the largest energy consumption increase, +17,4%, which comes from hand pre-rinsing **is not considered for the real-life base case** since it is caused by a specific consumer behaviour outside the machine and not requested in the manufacturers instructions. The pre-rinse will be taken into consideration in the stock model.

The same percentages are applied to the 9ps machine.

5.1.4 The Real Life Base Case for Washing Machines

The GEA study mentioned two EU base cases:

- a standard base case, referring to the energy use according to the standard EN 60456: 1994, based on a 1,3 kWh/cycle calculated energy use in 1995 (since at that time there were insufficient data to issue a statistical average consumption based on measurements) or 0,3 kWh/kg and a water consumption of 85 litres/cycle;

- a real-life base case, referring to the best estimate of energy use when using the programme temperature and the load in practice. The real-life base case was based on a programme setting at almost 60 ºC, but now with a load of 3 kg, instead of the load at rated capacity of 4,7 kg. The AISE data 1996, which covers all EU countries, find an average load of around 2,85 kg.

No real-life base case was addressed in the WASH-II study.

Taking into consideration the consumer behaviour analysis developed in Task 3, the average real life washing machine for 2005 presents the following characteristics:

- Real-life base case washing machine:
  - load capacity: 64% of the standard base case 5,36 kg or 3,4 kg
  - washing temperature: 45,8 °C
  - energy consumption: -27,9% of the standard base case or 0,719 kWh/cycle
  - water consumption: -8,7% of the standard base case or 46,3 litre/cycle
  - detergent consumption 139,76g/cycle
  - spinning speed: 1 129 rpm
  - automatic load detection
  - energy efficiency class: A
  - washing performance class: A
  - drying performance class: B or C
  - noise: 53 dB(A) for washing; 70 dB(A) for spinning.

In particular:

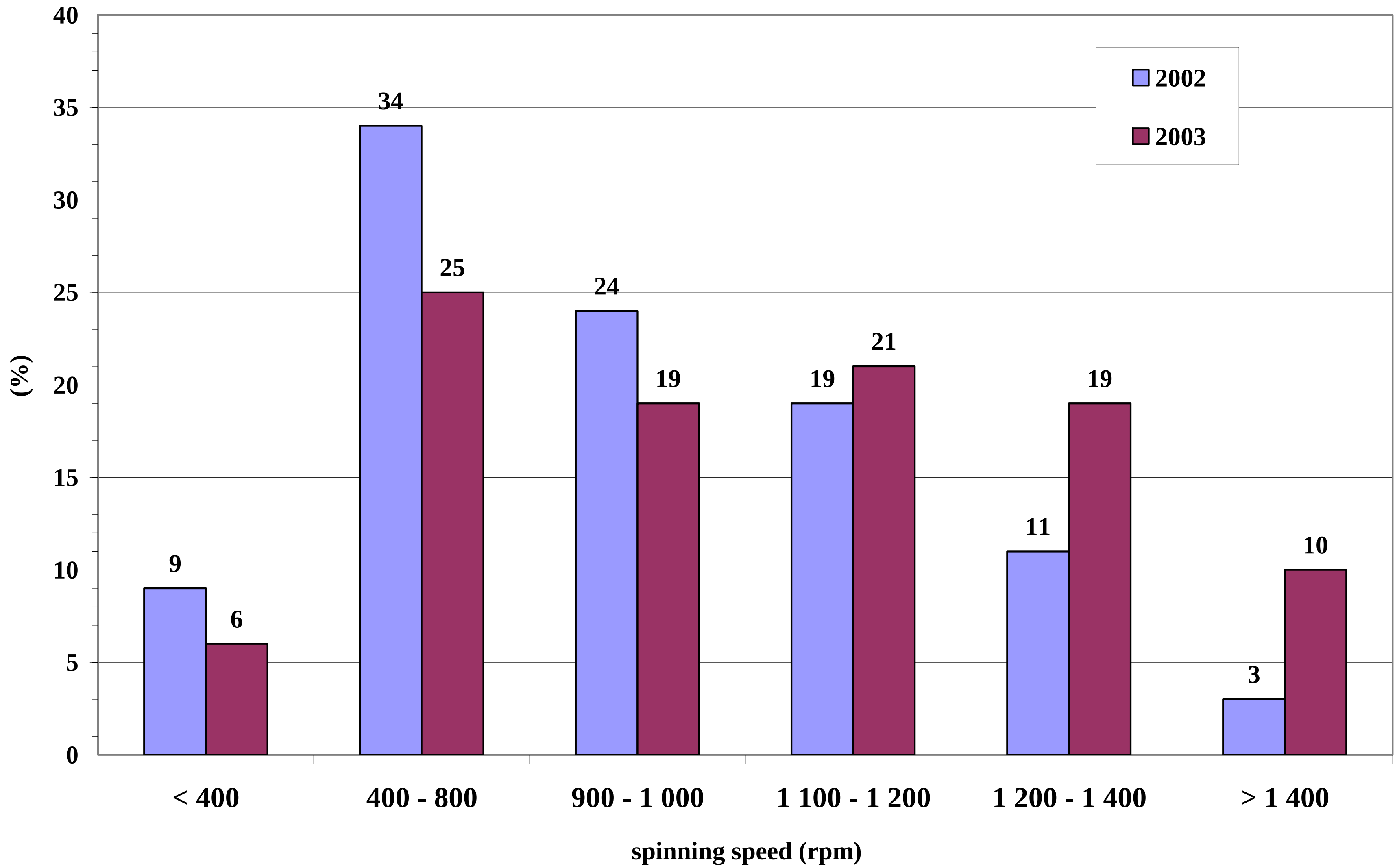
- load capacity has been evaluated in 3,2kg, which is the 64% of the most frequent sold washing machine capacity or 5kg; since the standard base case has a load capacity of 5,36 kg, the corresponding real life base case results in a capacity of 3,4kg;
- energy consumption: a decrease of 1,42 kWh per week (-29%) considering 4,9 cycle/week, results form the use of a lower washing temperature (45,8°C) than the temperature under standard conditions (60°C); a decrease of 0,537 kWh per week (-11%) is due to heating of a lighter load; an increase of 0,427 kWh per week (+8,7%) due to an estimated 10°C water inlet, colder than the 15°C water inlet under standard conditions; finally an increase of 0,165 kWh per week (or 3,4% of the standard base case consumption) due to the various standby and low power modes is considered. In total a decrease of (-29-11+8,7+3,4 = -27,9)% occurs for the real life base case energy consumption. Therefore the energy consumption of the real life base case has been considered 72,1% of the standard base case;
- water consumption: a reduction of 26,6 litres per week (-10,7%) occurs due to the reduction in the load and an increase of 4,9 litre (+2%) due to the possible extra rinse, to give a total water consumption of (-10,7+2=-8,7%) or 46,3 litre/cycle;
- detergent consumption: the detergent consumption is considered the same as in the standard base case in absolute value or 139,76g/cyle, because consumers declare to use the machine almost at full load
- washing time (90-100 minutes), spinning speed, noise, energy efficiency, washing and drying performance: are considered the same as for the standard base case.

In Figure 5.12 the spinning speed of front load washing machines in 10 Member States of West Europe (AT, BE, DE, FR, ES, IT, NL, PT, SE, UK) in 2002 and 2003[54] is presented The models on the market are equally split in two groups ≤1 000 rpm and ≥1 100 rpm including 50% of the sales.

---

[54] Source: "Presente e futuro dell'Europa da vandere", Trade Bianco, December 2003, pp. 39-42.

Figure 5.12: Spinning speed of front load washing machines in West Europe in 2002 and 2003



5.2 SUBTASK 5.2: PRODUCT-SPECIFIC INPUTS

Product-specific inputs are necessary for the development of the LCA and are collected for the following life phases:

- Production (raw materials, components and assembling)
- Distribution of products (average distances and types of transport modes)
- Use phase (average life, specific consumption, maintenance and repairs)
- Packaging (type and weight)
- End of Life (disposal, thermal valorisation, incineration, dismantling…).

These data have been collected and organised according to the "EuP Eco Report" requirements and taking into account the LCA ISO 14040 standards. Similarly, the methodology used for the LCA analysis has been be, at first glance, based on the EuP-Ecoreport settings, but, as far as possible, it has also been compared and aligned with the LCA standard methodology by using others LCA software and data (like, i.e. the SimaPro tool) and databases.

Primary input data have been collected through direct communication with producers and, when not available, from sector specific or commercial data bases for both the standard and the real base cases. Product-specific inputs have been gathered through a specific "BOM and Inventory Data Template" collection form prepared by the study Team to simplify and standardise the elementary information collection. Manufacturers have been requested to provide the information listed in the BOM and Inventory Data Templates basing them on real appliances, whose characteristics are the closest possible to the identified standard (and real life) base cases. A previous analysis has been carried out to make the manufacturers selection simpler by evaluating the type and number of those models in the technical data base.

5.2.1 The Selection of Real Models for Data Collection

5.2.1.1 Availability of real dishwasher models

As already outlined, to facilitate manufacturers data collection task, a specific research has been developed in the CECED 2005 technical database to evaluate (i) how many real models do exist close to the standard base cases and (ii) how close the characteristics of these models are with respect those of the standard base cases. The analysis lead to the identification of a set of 373 9ps and 720 12ps real models with the following characteristics:

<u>12 place settings machine, free standing:</u>

- energy consumption: 1.050 kWh/cycle (energy efficiency class A, EEI ≤ 64)
- water consumption: 15 or 16 litre
- washing performance class: A
- drying performance class: A or B;

<u>9 place settings machine, free standing:</u>

- energy consumption: 0,800 kWh/cycle (energy efficiency class A, EEI ≤ 0,64)
- water consumption: 13 or 14 litre/cycle
- washing performance class: A
- drying performance class: A or B.

These models, a part of the noise not reported in the technical database, are in good agreement with the base cases specifications. Therefore manufacturers should not have encountered major difficulties in selecting a model with the described average characteristics among their own products.

5.2.1.2 Availability of real washing machine models

Taking into consideration the characteristics of the standard base case (especially the capacity of 5,36 kg) two sets of washing machine models have been be selected from the technical database, the 5kg load models and the 6 kg load models with the following average characteristics:

<u>5kg load machine, front loading:</u>

- energy consumption: 0,956 kWh/cycle
- water consumption: 50,4 litre
- spinning speed: 1 073 rpm
- automatic load detection
- energy efficiency class: A
- washing performance class: A
- drying performance class: B or C
- noise: 53 dB(A) in washing /70 dB(A) in spinning;

<u>6kg load machine, front loading:</u>

- energy consumption: 1,057 kWh/cycle
- water consumption: 49,2 litre
- spinning speed: 1.262 rpm
- automatic load detection
- energy efficiency class: A+/A
- washing performance class: A
- drying performance class: B or A
- noise: 53 dB(A) in washing /70 dB(A) in spinning.

Since the greatest number of models in the technical database is that for 5 kg of clothes, and taking in consideration the other relevant data, this machine type has been considered a better “proxy” of the standard base case on the European market than the 6kg machine.

At this point the same procedure discussed and used for the dishwashers was applied to facilitate the manufacturers data collection task. The analysis of the technical database led to the identification of a set of 221 real models with the following characteristics:

- 5kg load machine, front loading:
- energy consumption: 0,950 kWh/cycle (“C” = 0,19)
- water consumption: (50 ± 1) litre
- spinning speed: (1.100 ± 100) rpm
- automatic load detection
- energy efficiency class: A
- washing performance class: A
- drying performance class: B or C
- noise: 53 dB(A) in washing /70 dB(A) in spinning.

These models are very close to the average 5kg machine previously defined, which in turn is the best “proxy” of the standard base case. The selected machines can easily be found in the 2005 technical database, therefore the manufacturers should not have encountered particular difficulties in selecting their own model for BOM and inventory data collection.

5.2.2 The BOM and Inventory Data Collection

Primary input data come from direct communication with manufacturers and/or, if not available, collected on sector specific or commercial data base (secondary data) for both for the standard and (if necessary) the real base cases; information to be collected are related to real appliances whose characteristics are as close as possible to those of the identified standard (and real life) base cases described in Subtask 5.1.

5.2.2.1 The Collected Data for dishwashers and washing machines

Data provided from manufacturers for each appliance base case are:

Appliances	Code	No of models
12 place settings dishwasher standard base case	DW 12ps	6
12 place settings dishwasher standard base case	DW 9ps	4
Washing machine standard base case	WM 5kg	5

In order to define the average model for each standard base case the data collected through the mentioned template have been analysed and the results are briefly summarised. The majority of the collected templates are quite complete.

a) Data from manufacturers of dishwashers

Data collected for dishwashers present the following characteristics (only some manufacturers have provided specific data, like, e.g., information on spare parts, end of life of final product);

- **Production:**
  - Material: data are sufficiently complete; some manufacturers produced data only in terms of “sub-assembled components” (objects) without indications of their material composition.
  - Scrap: generally the data (percentage and EoL) don’t represent all materials used;
  - Processing: given information, also if sometimes exhaustive, are often generic and incomplete and without percentage;
  - Transport: data (average kms and medium) are complete only in some cases;
- **Assembling**: the provided data are generally complete, also if sometimes units of measure are not those required by the inventory data sheets;
- **Use phase**: the provided data are sometimes incomplete and units of measure are not those required by the inventory data sheets (generally no indications on cycle/year);
- **End of Life**: although some producers gave congruent indications, data are difficult to understand and to use.

According to the data quality, questions and remarks were sent to the manufacturers. For each phase the following type of remarks and questions were made:

- <u>Production</u>: generally only total weight for “objects” is available; if it is possible also the

composition could be useful. If no data are available from some manufacturers the data of the others have been used.
- Scrap and EoL: information available only for some materials; for the other materials a zero percent has been considered. EoL sometimes is only qualitative and not usable, or indicated also when scrap is not indicated.
- Processing: sometimes only generic data are available; in this case alternative data from other manufacturers have been be used. When no percentage of processing is indicated, 100% has been considered for the psecific process.
- Transport : clarification on "specific" indicators used is required;
- End of life: when no or incomplete indications are found, the use of EU average for each material, or data form others manufacturers has been taken into consideration.

As a general remark, it was reported that when no data or incomplete data from a manufacturer were available, the main solution was to use data from other manufacturers (when complete data are available) or average EU data (when available). A general agreement was reached:
- to use data from other manufacturers when data are not complete or not available;
- to refer to the EU average, mainly for transport and End of Life;
- to use 100% for processing when no specification is provided.

Some manufactures didn't provide materials specification for some sub-components ("objects" in the inventory data sheet).

b) Data from washing machines manufacturers

Data collected for dishwashers presented the following characteristics:

- **Production**
- *Material Composition*: for some models full indication for each material used have been provided; for other models "objects" are included and data on material composition are available only for some models;
- *Scrap and EoL*: for some models no figures have been provided; for other models only generic and incomplete data have been provided;
- *Processing*: is always indicated but generally without any indication on %;
- *Data on transport*: are complete for most of the models;
- **Assembling:** data are generally complete also if sometimes units of measure are not that required in the inventory data sheets;
- **Use phase:** data are sometimes incomplete and units of measure are not that required in inventory data sheets (generally no indications on cycle/year);
- **End of Life:** specific end of life data per material category have been provided only by few producers.

According to the data quality some questions and remarks were sent to manufacturers. For each phase the following remarks were made:

Production: some producers have provided only total weight for some "objects"; if it is possible, it could be useful to have also the single composition in terms of materials. Without specific data, if available, data from other producers will be used;
Scrap and EoL: information was available only for some materials; for the other materials a zero percent has been considered. EoL sometimes is only qualitative and not usable or indicated. Also scrap is not always indicated.

Processing: sometimes only generic data are available; if possible specify in a detailed way. As an alternative data from other producers will be used. When no percentage is indicated a 100% was considered for the specific process. Sometimes there is no data for compressors and ferrous materials;
Transport: clarification of the "specific " indicators used is required;
End of life: when no or incomplete indications are provided, the use of EU average for each material, or data form others maufacturers are taken into consideration.

A general agreement was reached also in this case:

- to use data from other manufacturers when data are not complete or not available;
- to refer to the EU average, mainly for transport and End of life;
- to use 100% for processing when no percentage specification is provided.

Also for washing machines, some producers didn't provide materials specification for some sub-components ("objects" in the inventory data sheet).

c) Final assumptions for the collected data

Taking into account the "homogeneity" of questions and answers about dishwashers and washing machines, the following assumptions and simplifications were made for the definition of the "average models" for both product groups:

- in general, data have been checked and, if necessary, normalised in order to have a same unit of measure;
- for production phase: in the Bill of Materials scheme, data have been organised into the following material categories:
  - Ferrous metals;
  - Non ferrous metals;
  - Plastics;
  - Various materials;
  - Packaging.
- for manufacturers data, similar or analogous data have been re-organised and re-assembled in the previous material categories;
- some manufacturers provided data in terms of sub-assembled parts. In these cases, the sub-assembled have been disaggregated (when possible) into the single material components and, once again, organised in the previous material categories; when no further material composition break down was possible sub-assemblies were not included in the average data;
- average data for bill of materials have been calculated as the mean of the available values;
- for scrap, the end of life and processing data from the most complete inventory tables have been considered; data used for the average model are not, in general, the mean of the available values but are derived from general considerations regarding the provided values;
- for transport of materials, average kilometres have been calculated, weighted by the weight of singles components, for each model. The average km value for the average model is a second-level averages, weighted on weights of each model;
- for Assembling and Use phases: data provided from manufacturers have been checked and normalised, when necessary for the same unit of measure. Data for the average model for the assembling and use phases, has been calculated as the mean of the available values;
- for End of Life: data from manufacturers are often inhomogeneous: only homogeneous and congruent data have been considered to derive the average model.

In Appendix A, Tables with average composition data for DW 9ps, DW 12ps and WM 5kg base cases are shown (Tables from 5.39 to 5.41).

5.3 Subtask 5.3: Base Case Environmental Impact Assessment

Product specific inputs, developed in previous Sub-task 5.3 for wash appliances, are used to define environmental profile and impact analysis. The system used is the EuP-EcoReport, version 5[55], with this system it is possible to evaluate the environmental impact analysis for:

- Production (Materials, Manufacturing, transport);
- Distribution;
- Use;
- End-of-Life.

EuP-Ecoreport outputs are expressed as:

- Material consumption;
- Other resources and Waste as:
    - Total energy (including electricity);
    - Water (process and cooling);
    - Waste (hazardous and non-hazardous).
- Emission (air) as:
    - GWP;
    - ODP;
    - Acidification;
    - VOC;
    - POP;
    - Heavy metals;
    - PAHs;
    - Particulate matter (PM, dust).
- Emission (water) as:
    - Heavy metals;
    - Eutrophication;
    - POP.

5.3.1 Considerations and Assumptions to use the inventory data in EuP-Ecoreport

In order to use the inventory data from Subtask 5.2 in the EuP Ecoreport software, some considerations and assumptions are required.

Not all materials requested in the inventory tables are useful to compile the EuP Ecoreport: some additional data have been requested for the development of the parallel LCA through a different LCA software (e.g. SimaPro). This parallel LCA study is scheduled for the second part of the study aimed at complement the results coming from EuP-Ecoreport and somehow make a validation through the comparison with the outcome of an internationally recognised LCA procedure. In particular, following data are not requested as input in the EuP-Ecoreport:

- Production phase: data on scrap (percentage and EoL), data on processing and transport of

[55] See http://www.eupproject.org .

single materials, since those data are defined as assumptions in the Eup-Ecoreport; only the setting of the percentage of sheet metal scrap is allowed;
- Assembling phase: data on consumption during the assembling phase, which are assumptions in the Eup-Ecoreport;
- detailed data on EoL: only the setting of the percentage of land-filled materials, and the percentage of plastics recycled, in terms of materials or thermal utilisation is possible.

In addition, it is worth noting that the in the Data Base available in the EuP Ecoreport many materials are missing. For this reason, only the material composition of the identified average models has been used as input in the Bill of Materials of the EuP Ecoreport. For dishwashers, information about consumables is missing in the EuP Ecoreport, the same occurs also for the detergent and softener for the washing machines.

The materials not mentioned in the Data Base have been re-allocated in the existing material categories. Accordingly, the following assumptions were made:

a) for some materials a direct correspondence with the categories in EuP Ecoreport, data base is possible;
b) for some materials an allocation is possible provided specific assumptions and simplifications are done. The following correspondence table was used.
   - Steel strip as Steel Sheet galv.;
   - Prepainted steel as Stainless 18/8;
   - Steel + PA as Stainless 18/8;
   - Bras (Cu + Zn alloy) as Cu Zn 38;
   - Wiring as Cu wire;
   - Zinc die-casting as Cu Zn 38;
   - PP – K40 as PP;
   - PA 66 – GF as PA 6;
   - PC – G as PC;
   - EPDM – rubber as LDPE
   - POM as HDPE;
   - Wood as cardboard;
   - Gravel as Concrete;
   - Thermostat as Controller board;
   - PPO as PP.
c) for some materials no correspondence is possible; in this case the missing materials' weight is re-allocated in other material categories, according to their percentage. Materials without correspondence are:
   - Plastics, others;
   - Adhesive;
   - Others;
   - Cr;
   - Ni;
   - PBT;
   - Bitumen;
   - Cotton;
   - Cotton + Resins;
   - PPS-GF;
   - Filter;
   - Oil-feet.

5.3.2 LCA of wash appliance base cases using EuP-Ecoreport

Taking into account all the previous assumptions, the EuP environmental profiles for DW 9ps, DW 12ps and WM 5kg models have been evaluated. In Appendix B input and output of EuP Ecoreport software are shown. For each model it is reported:

- input tables: Production phase, Assembling, Use, End of life;
- output tables: Materials, Other Resources & Waste, Emissions (Air), Emissions (Water)

As mentioned before, for some materials it was not possible to have correspondence between inventory data from manufacturers data collection and EuP Ecoreport data base: the amount of these materials have been added to the weight of the other materials, according to their percentage. In the following tables the original materials weight is reported in bracket. The final material weight used in EuP Ecoreport is in the central column of input sheet.

5.3.3 Preliminary conclusions and remarks

Some materials have no correspondence in the categories included in the EuP Ecoreport data base. This occurred for the following weight percentage:

- 14,4 % for DW 9ps;
- 15,5 % for DW 12ps;
- 4,4 % for WM 5kg.

Assumptions were made for other materials to find a correspondence with existing categories:

- 14,2 % for DW 9s;
- 12,4 % for DW 12ps;
- 4,8 % for WM 5kg.

This means that between 9% and 29% of the weight of materials in the wash appliances does not have a direct correspondence in the EuP-Ecoreport data base. This has to be taken into consideration for the analysis of the appliances environmental impacts in the EuP-Ecoreport output. Moreover it is also important to remind that in the EuP database:

- the environmental impact for transport is included in materials environmental impacts; this means that the production phase outputs account also for the impact and consumption due to transport;
- in the “distribution” phase the impact due the packaging includes the transport to retailer;
- the data about detergents or other chemicals (e.g. bleaching) for wash appliances are not taken into account;

the extent at which these simplifications affect the final LCA results have also been investigate and are shown later.

On the basis of the described assumptions on the materials substitution and the EuP database, the LCA resulted in:

- the Production and Use phases are responsible for the majority of environmental impacts;
- for the Use phase, energy consumption and water use are the most relevant elements (for both process and cooling), while for the production phase the wastes are more relevant;

- as far as emissions in air are concerned, the Use phase is most relevant for greenhouse gases, acidification and VOC; while the Production phase yields a higher impact of POP, heavy metals and PAHs; and the Distribution phase is relevant for particulate matter (three times the total of production and use phases);
- as far as emissions to water are concerned, the Production phase is the most relevant for heavy metals but not for eutrophication.

5.3.3.1 Impact and consumptions for DW 9

Figures 5.13 to 5.17 show the energy and water consumption as well the air, water and wastes impacts of the DW 9ps model. The Figures indicate that a higher energy and water consumption level are accounted in the Use phase (Figure 5.13) while the Production phase is responsible for the higher quota of the waste production (Figure 5.14).

The emissions to air (Figure 5.15) are shared between the Production and Use phases but in a different way: GWP, acid rain and VOCs are higher in the use phase while POP, Heavy metals and PAH are mainly emitted from the Production one. Particulate matter emissions are finally mainly produced during the Distribution phase (the typical PM10 emitted by diesel motors).

Also the water emissions (Figure 5.16) are mainly due to Production and Use phases. In particular eutrophication pollutants mainly come from the Use phase while heavy metals are produced during the Production phase.

Finally Figure 5.17 provides the overall synthesis of all the environmental impact of this product category.

Figure 5.13: DW 9 ps – Energy and water consumptions

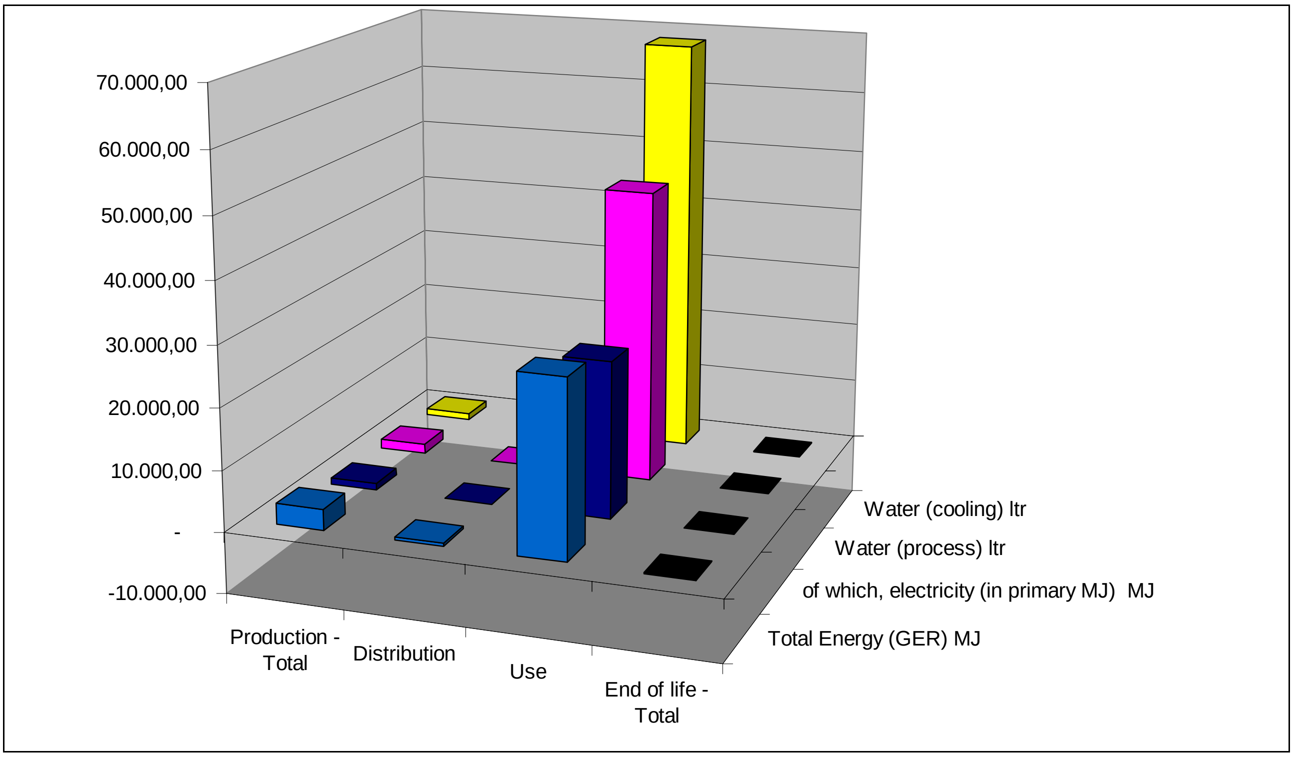


Figure 5.14: DW 9 ps – Waste production

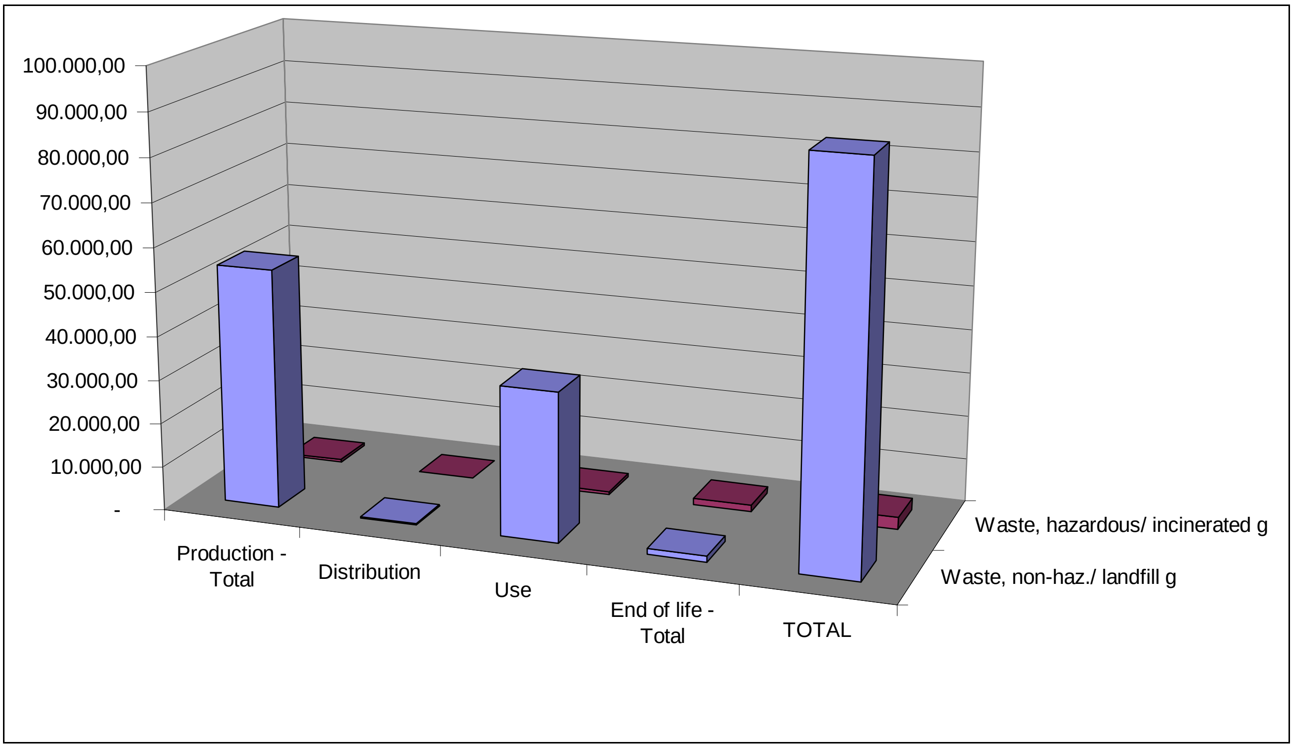


Figure 5.15: DW 9 ps – Emissions (air)

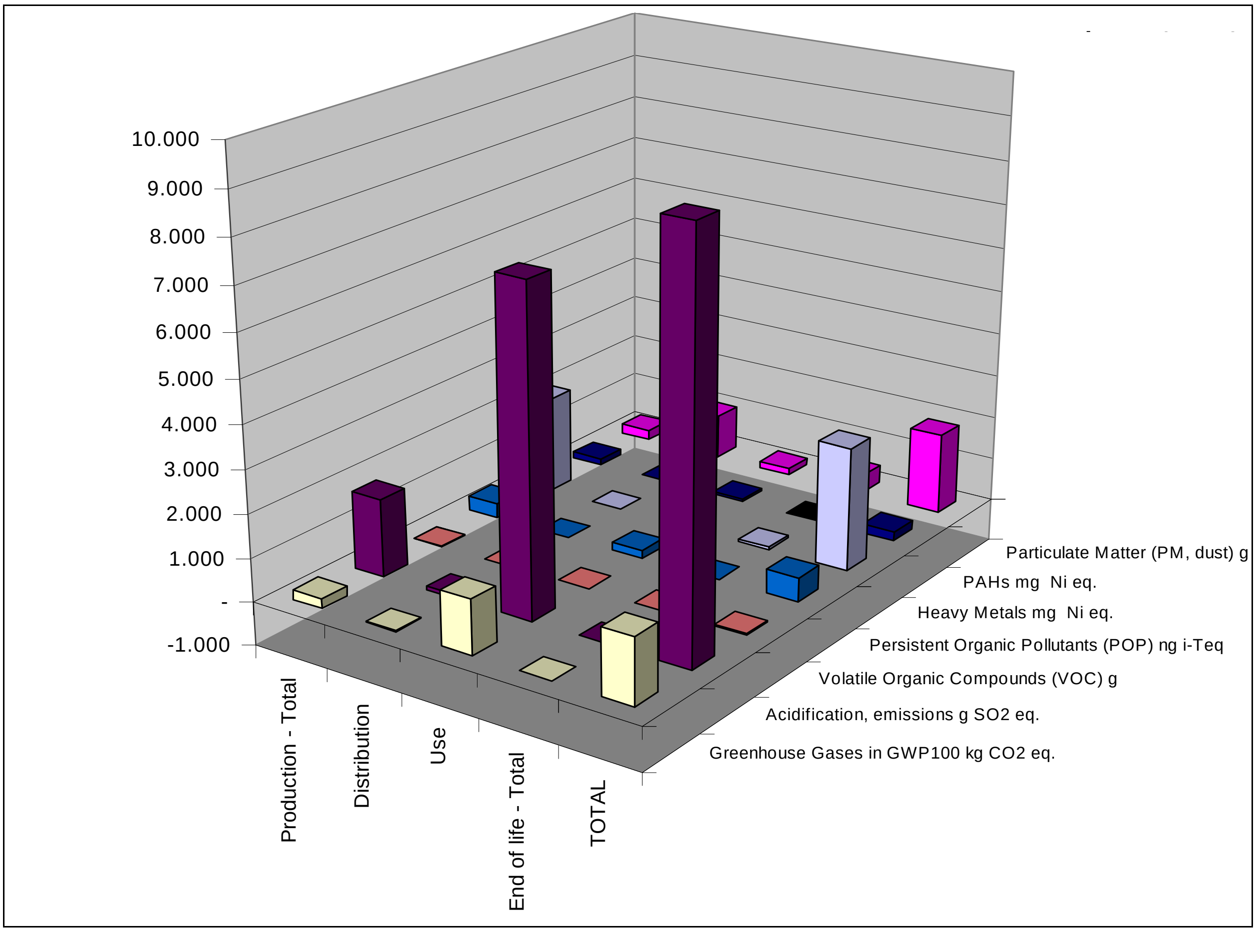


Figure 5.16: DW 9 ps – Emission (water)

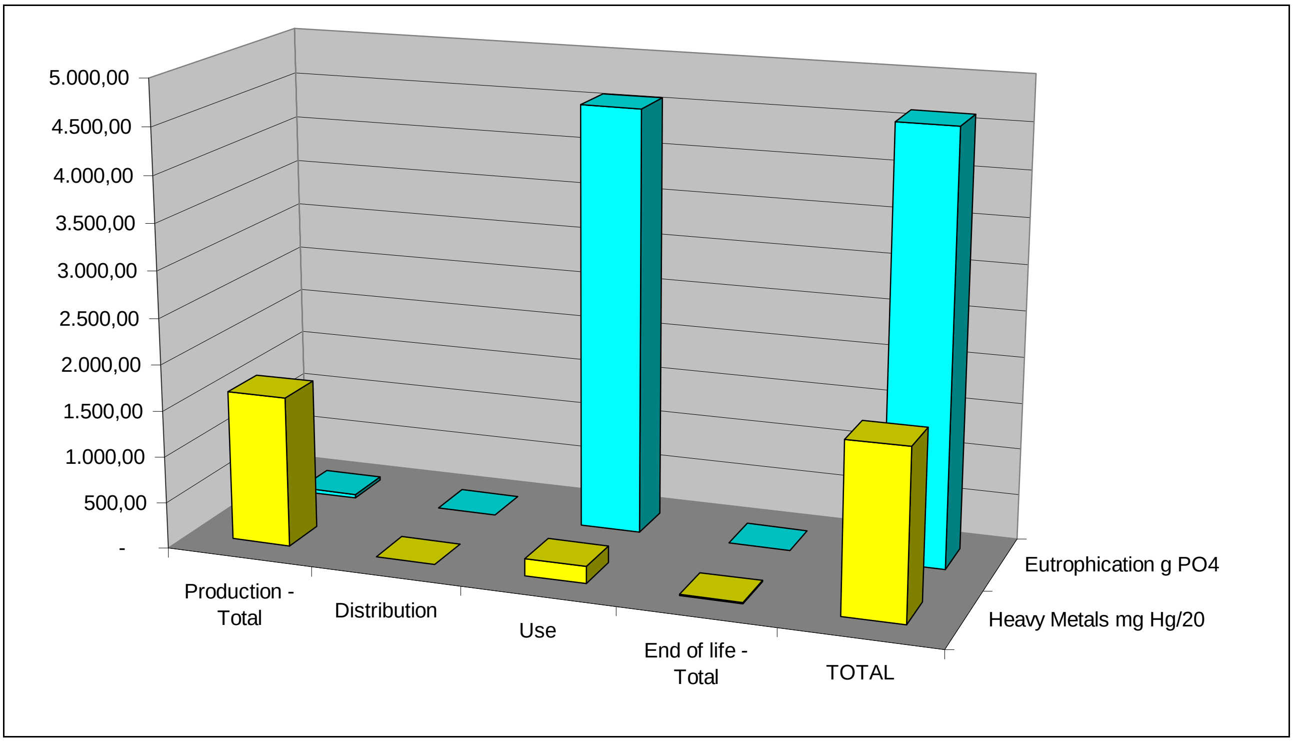
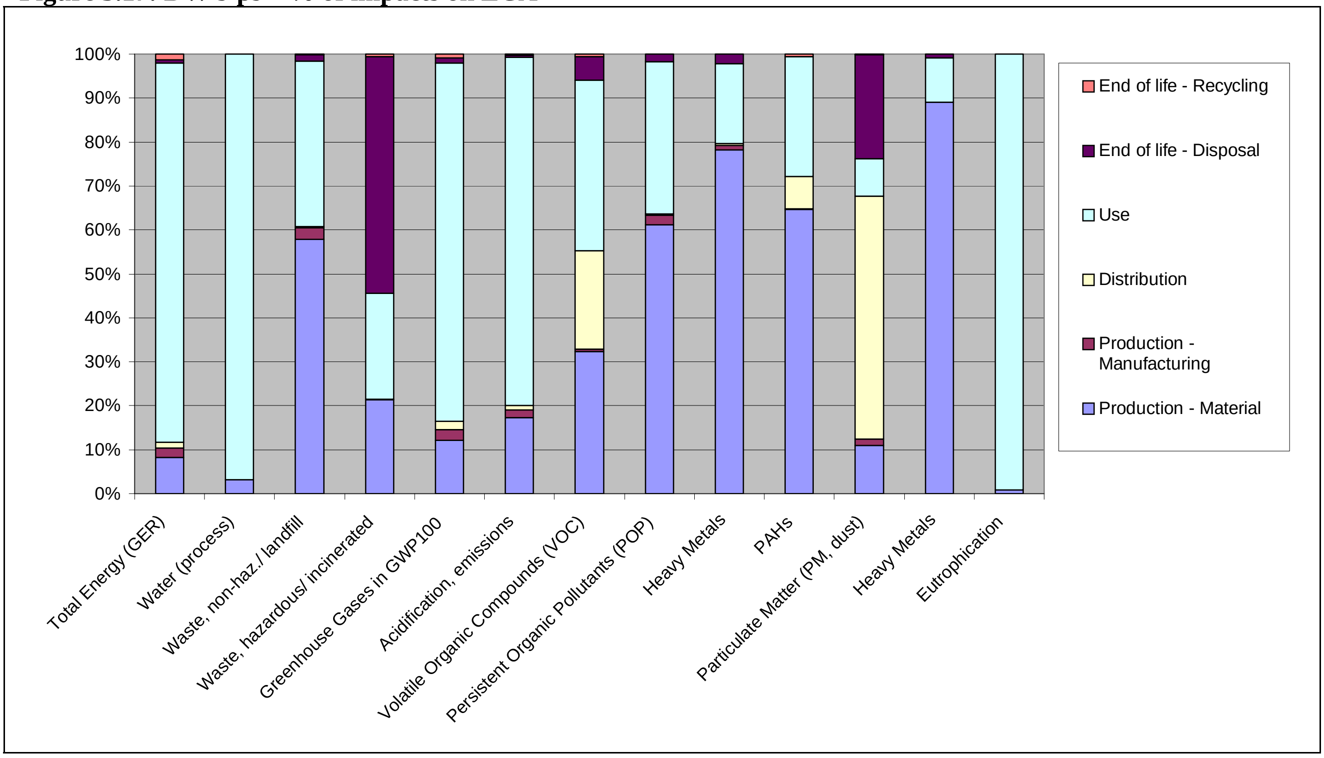


Figure 5.17: DW 9 ps – % of impacts on LCA



5.3.3.2 Impact and consumptions for DW 12

For this appliance type the environmental impact analysis, shown in Figures 5.18-5.21, is practically the same of the DW 9ps model. A difference can only be appreciated for the particulate matter emissions to air (Figure 5.20). For 12ps dishwashers the Use phase has impact values higher than the Distribution phase, the absolute values are not significantly different. Also for this model the overall impacts are summarised in Figure 5.21.

Figure 5.18: DW 12 ps – Energy and water consumptions

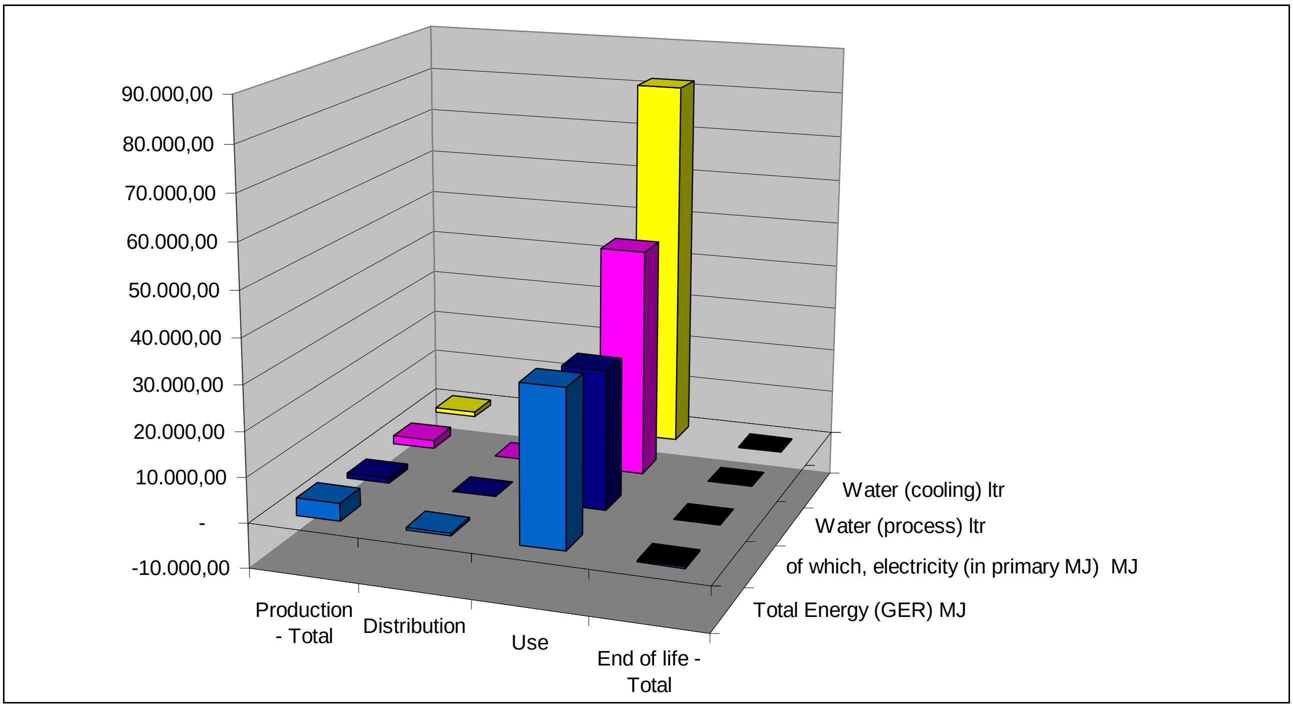


Figure 5.19: DW 12 ps – Waste production

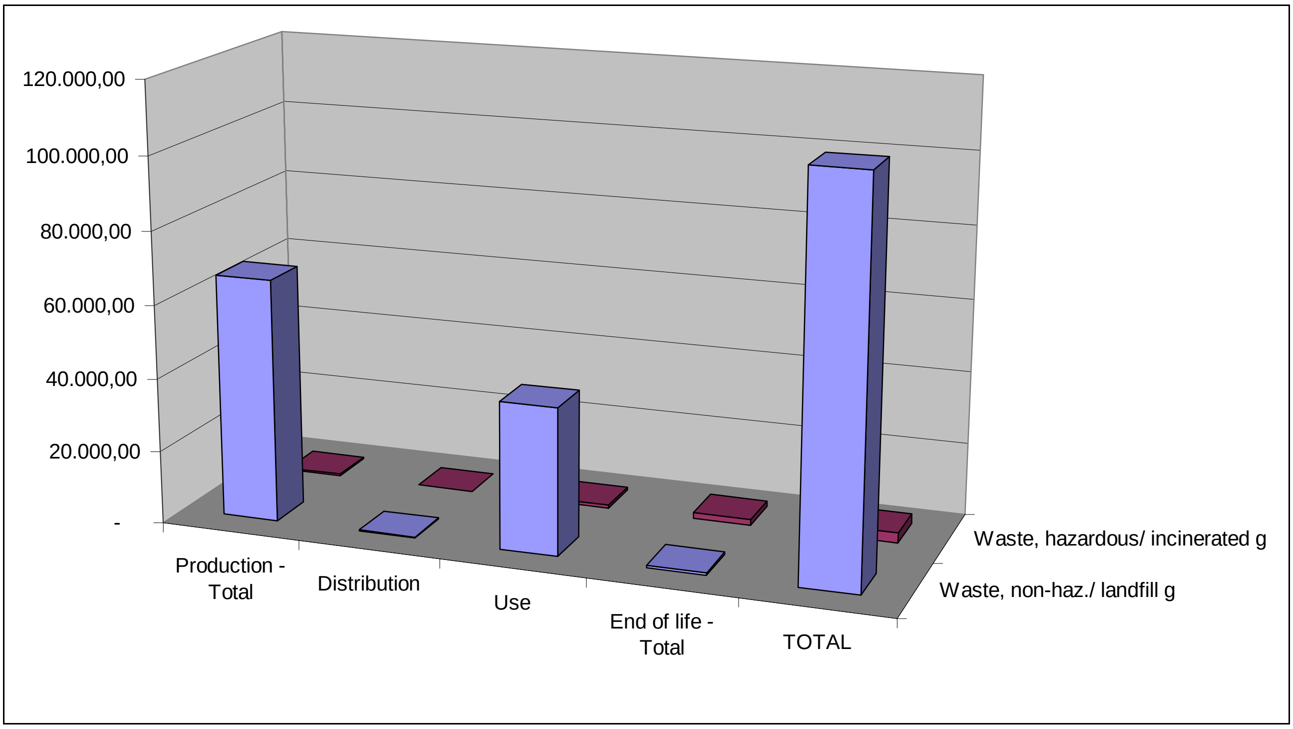


Figure 5.20: DW 12 ps – Emission (air)

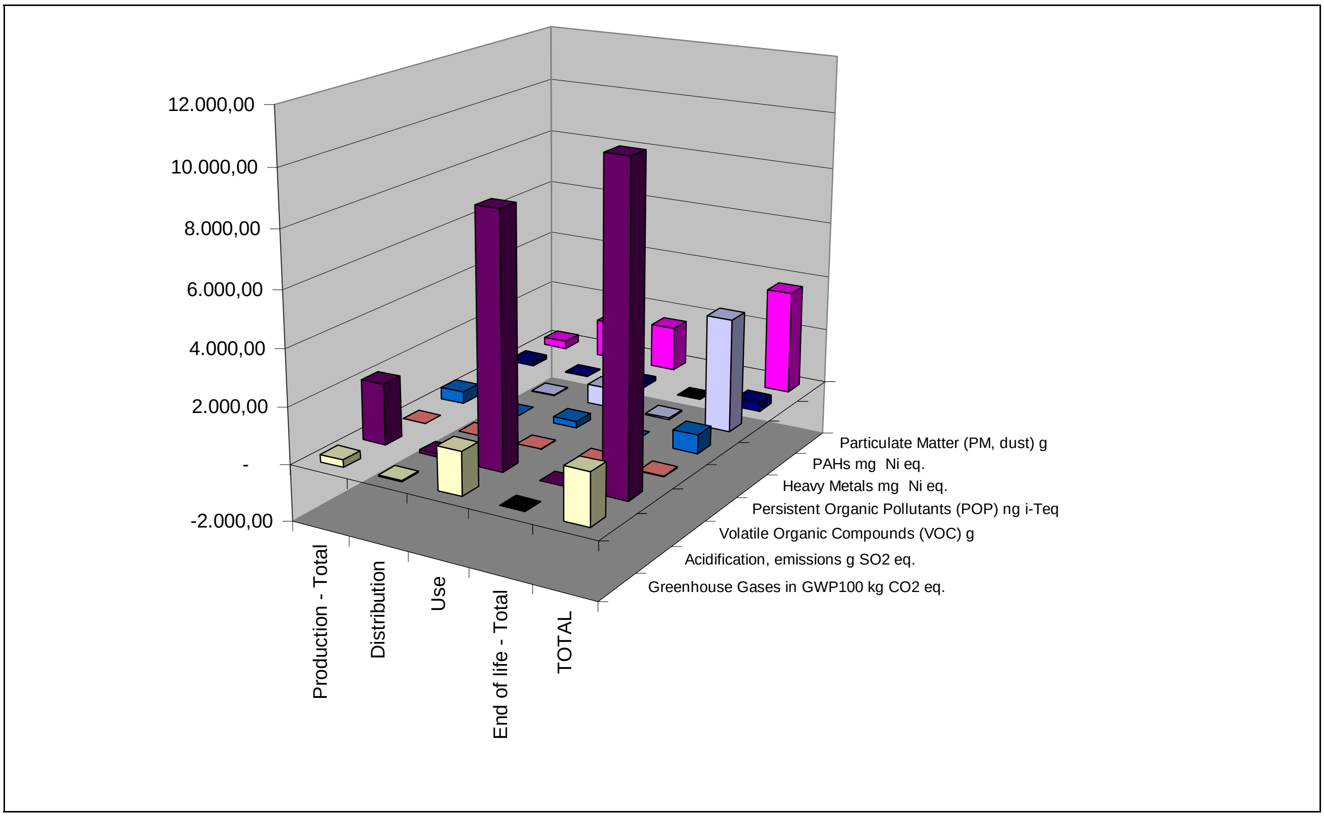


Figure 5.21: DW 12 ps – Emissions (water)

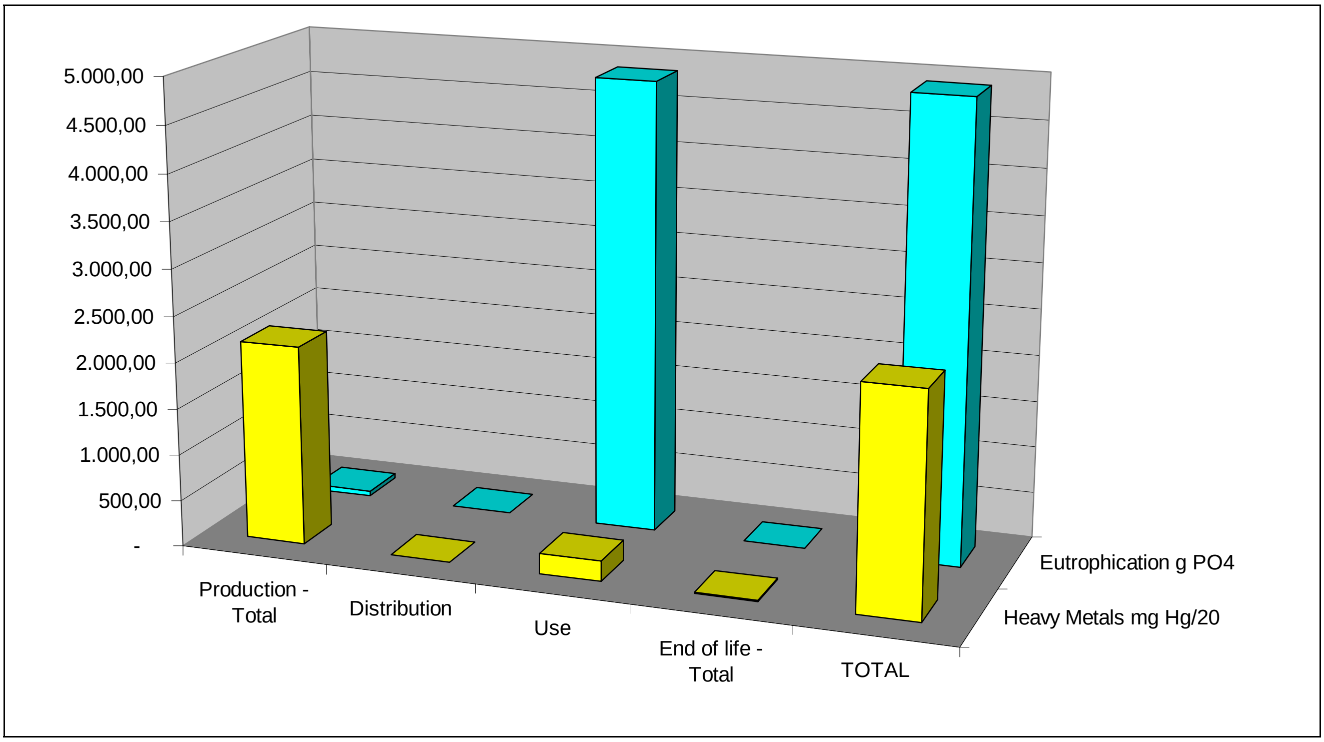
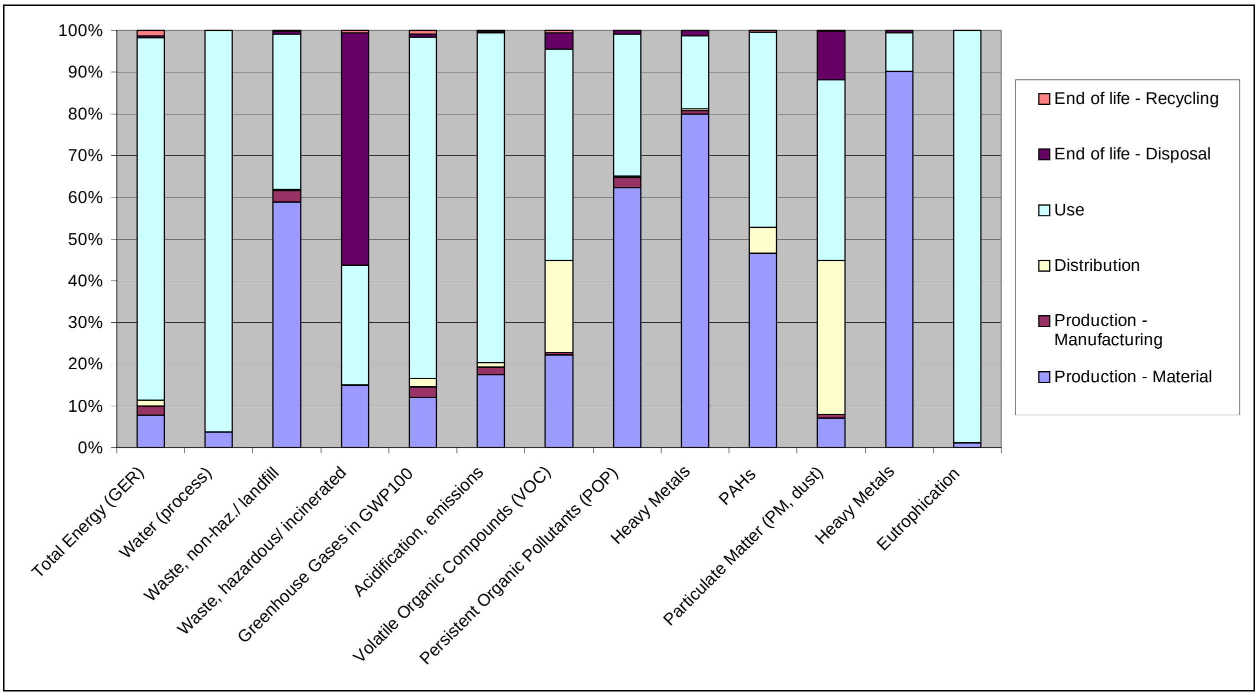


Figure 5.22: DW 12 ps – % of impacts on LCA



5.3.3.3 Impact and consumptions for WM

Also for the washing machines, the impact results, shown in Figures 5.23-5.26, are similar to that of the dishwasher models, with the important exception for the eutrophication effect a very low impact occurs in the Use phase, and apparently some eutrophication only results in the Production phase. Very likely this is more due to the lacking in the EuP database of the washing machines detergents, but a further investigation is needed.

Figure 5.23: WM – Energy and water consumptions

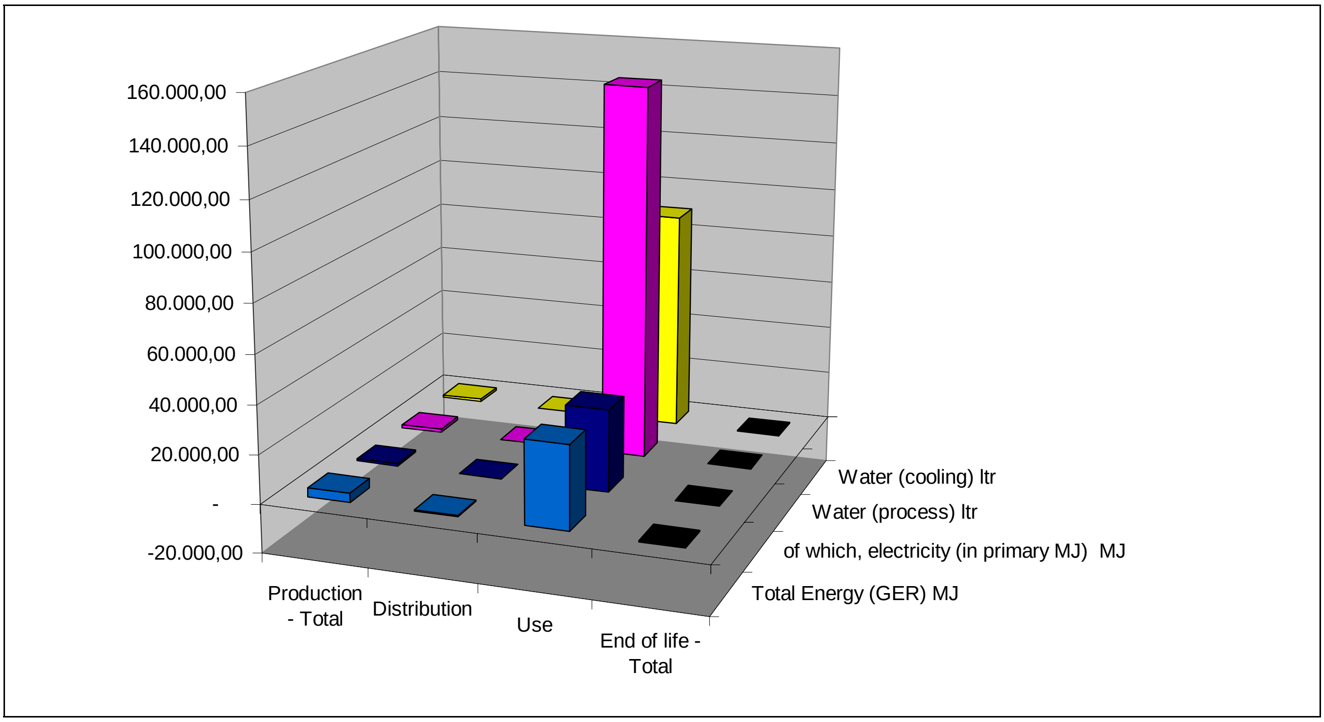


Figure 5.24: WM – Waste production

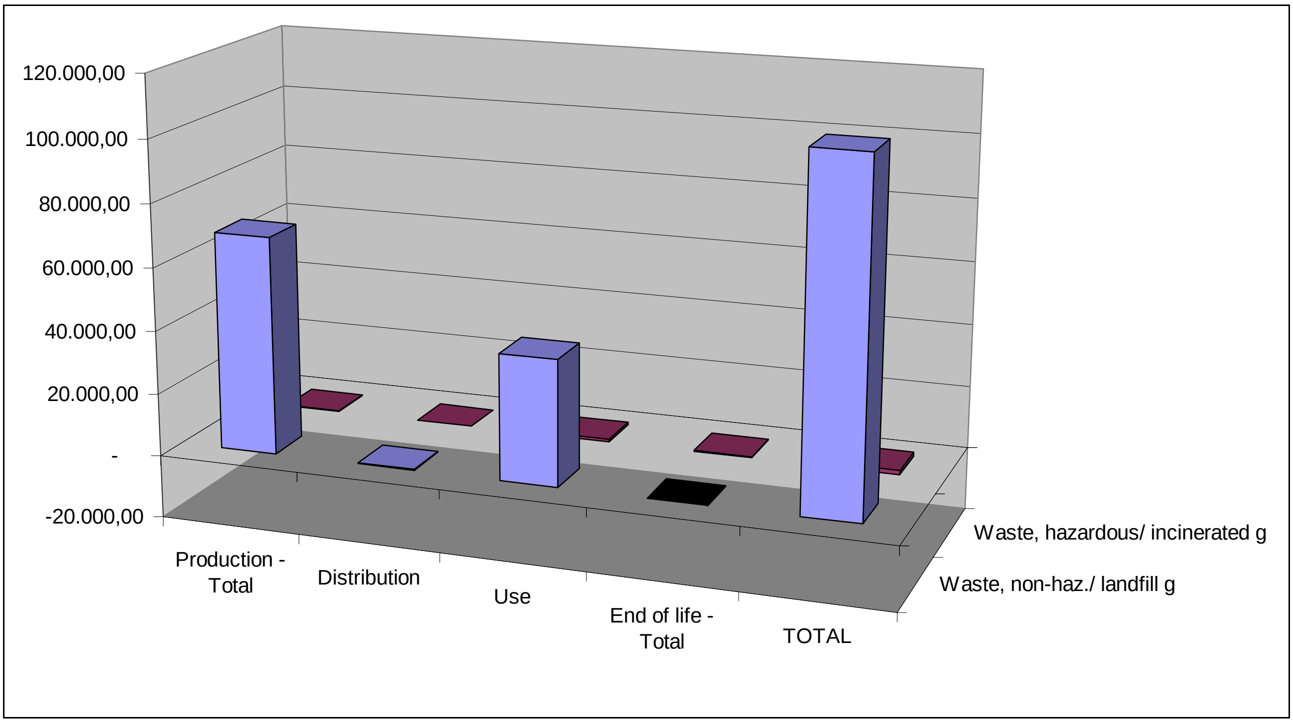


Figure 5.25: WM – Emissions (air)

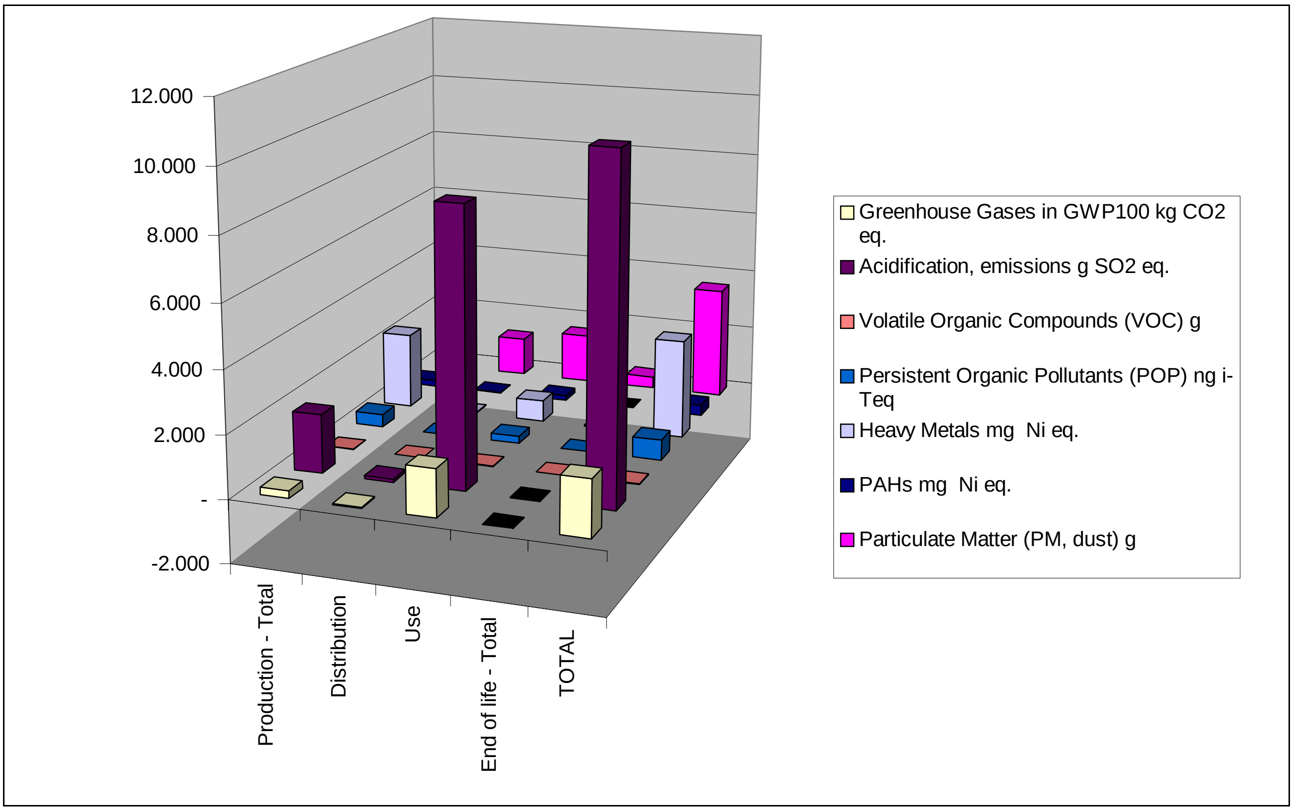


Figure 5.26: WM – Emissions (water)

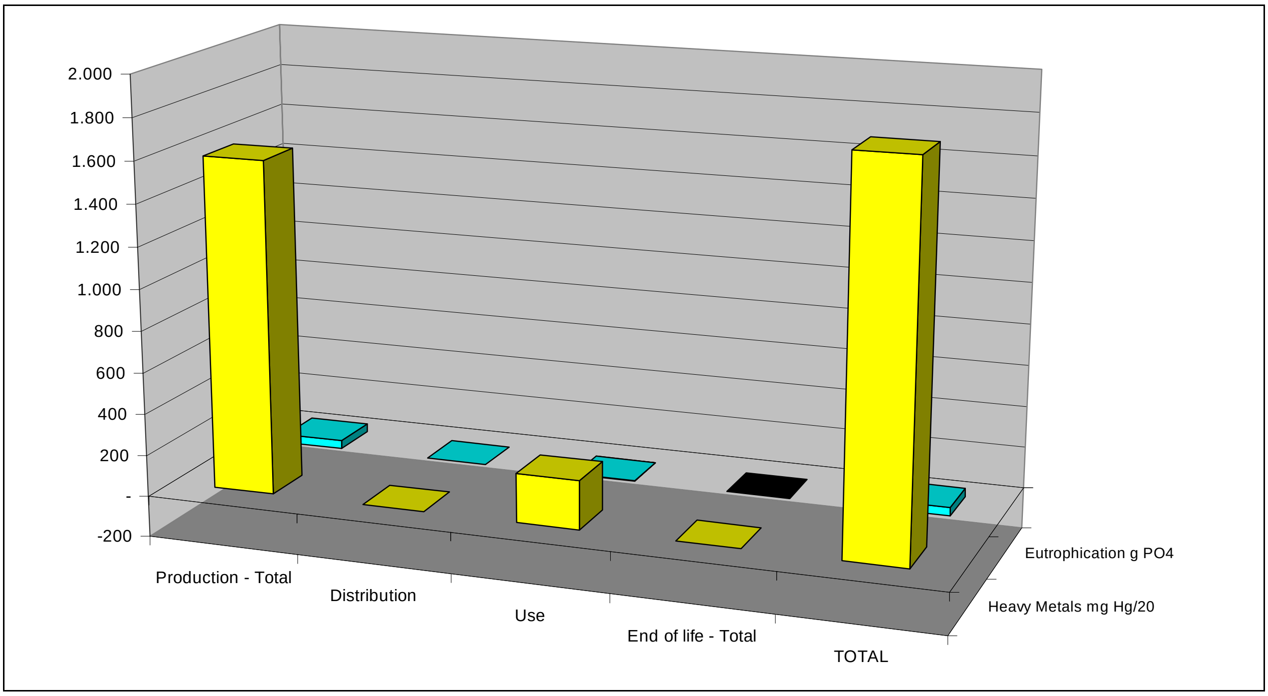
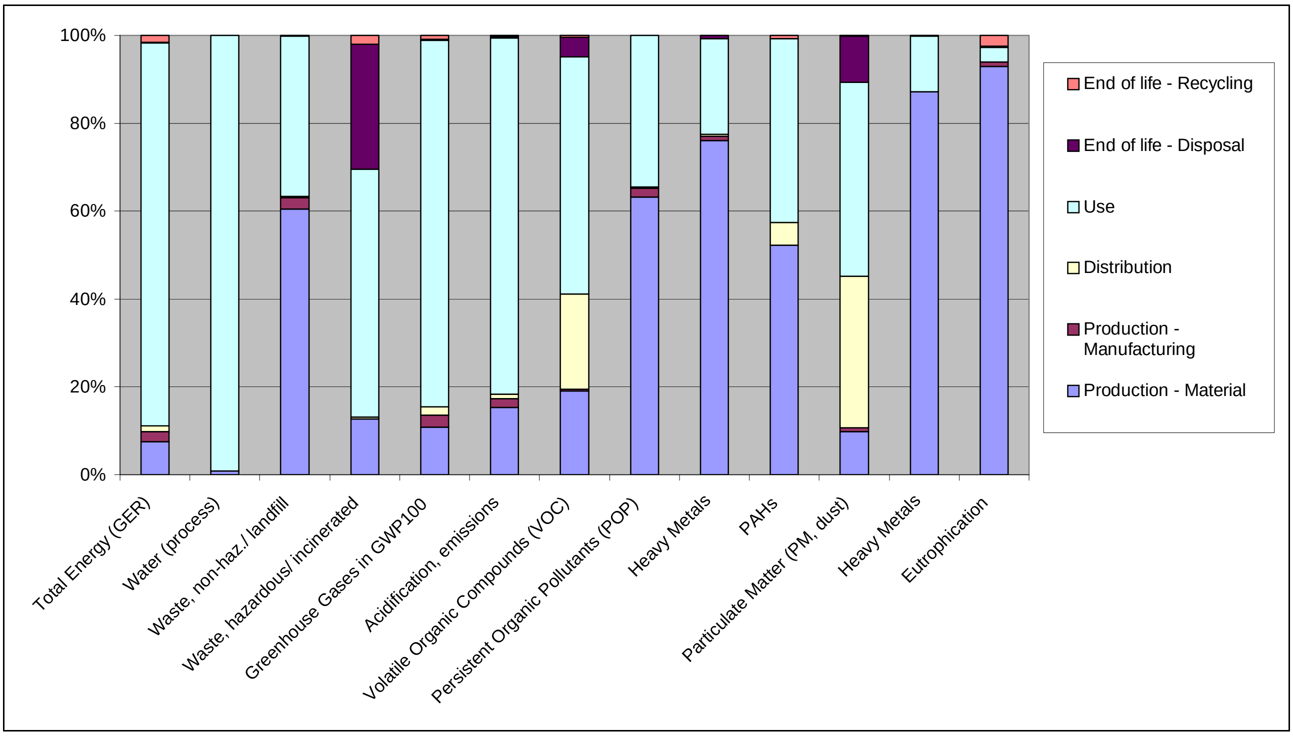


Figure 5.27: WM – % of impacts on LCA



5.3.4 SimaPro analysis results and comparison with the EUP Ecoreport outputs

As explained before, EuP Ecoreport has some limits regarding material data base (lack of data, including detergent for Washing machines), transport (included as a fixed amount in material characteristics) and end of life (only partially considered).

In order to assess the correspondence of EuP-Ecoreport results with appliances real environmental impact, a comparison with the output of a different and well known LCA software (and its database) has been performed. This alternative software is the SimaPro v.7.1, described in Appendix C.

The comparison was performed only for DW 12ps and WM 5kg models. In Appendix C all SimaPro outputs are reported as characterisation chart: assembling, use and end of life.

5.3.4.1 Steps of the comparison

a) Correspondence of materials used in wash appliance manufacturing with SimaPro database

As already mentioned, several databases are available in SimaPro and it is also possible for the user to create specific records. In this way it was possible to significantly reduce the number of data in the inventory data sheet without any loss of correspondence in the SimaPro implementation. Also the number of materials for which assumptions were made to find a correspondence with existing categories has been reduced.

In Appendix C the input Tables in SimaPro are shown for the DW 12ps and for WM 5kg base case models. Comparing these Tables with the original data of the base case models (see Appendix A) one can see how through SimaPro it was possible to find a proper correspondence for almost all materials or processes. Only for the following materials a good correspondence could not be found:

- for DW 12 ps - polishing solution and protective layer-cataphoresys;
- for WM 5 kg - Ni, phosphate and bleach.

In these Tables, a note has been included explaining the proper correspondence of the material or processes selected by the SimaPro database with the original data of the base case models.

b) Main assumption in SimaPro application

In order to implement in the SimaPro SW the inventory data of the DW 12ps and for WM 5kg base case models the following assumptions were made:

- for Assembling phase:
  - <u>scraps</u>: through the evaluation of the data provided by manufacturers, it was possible to consider the scrap percentage equal to 5% for metals and to 1% for other materials (mainly plastics). Therefore the simulation of assembly has been made on the material gross weight;
  - <u>processing</u>: manufacturers data gave an average indication for the type of processing needed for each material during the assembly phase (simplified approach); in this way it was possible to find a list of typical processes for different class of materials (steels, iron, plastics, PVCs, expanded plastics). To avoid an over-estimation of the impact deriving from materials processing, as general rule metals have been assumed to be processed as 50% of total weight and plastics as 70%;
  - <u>transport</u>: for each model an average number of km for transport of materials for the assembly phase has been calculated from the collected information. Because of the need in SimaPro to set both the average km (in terms of t km) and the transport system, the average km has been divided in 70% truck and 30% ship;
- for Use phase: all data collected from manufacturers were used; it was also possible to simulate ad hoc detergents and others washing agents or additives (detergent and softener for the washing machine and detergent and rinsing agent for the dishwasher) as reported in Appendix C;

- for End of life phase: the percentage of the different treatments at the end of life have been calculated from the data provided by manufacturers and reported in SimaPro data input (Appendix C). It has to be highlighted that in the EuP-Ecoreport, end of life was an "internal preassembled calculation methodology" as percentage and final destinations of some materials. For this life phase, EuP-Ecoreport can be considered as a "partially close system", while in SimaPro it is possible to use other data externally collected. For this reason it was decided to show outputs from SimaPro and EuP-Ecoreport "with and without End of life" outputs and to make comparison on outputs "without end of life phase" to reduce the outcome differences.

c) Adapting Ecoindicator95 environmental impact assessment method to EuP-Ecoreport

Environmental indicators (environmental assessment methods) available in SimaPro SW refer to various databases and are different from those used in EuP-Ecoreport. In order to make the environmental indicators more "comparable" a "modified Ecoindicator95 method" has been developed and applied to SimaPro outputs.

In Table 5.23 environmental indicators and related units used as outputs in EuP-Ecoreport have been reported, while in Table 5.24 same data, referred to SimaPro outputs have been reported (as in Ecoindicator 95 method).

Table 5.23: Output indicators in EuP-Ecoreport method

Other Resources & Waste	Unit
Total Energy (GER)	PJ
of which, electricity (in primary PJ)	PJ
Water (process)	mln. m^3
Water (cooling)	mln. m^3
Waste, non-haz./ landfill	kt
Waste, hazardous/ incinerated	kt
Emissions (Air)	
Greenhouse Gases in GWP100	mt CO_2 eq.
Ozone Depletion, emissions	t R-11 eq.
Acidification, emissions	kt SO2 eq.
Volatile Organic Compounds (VOC)	kt
Persistent Organic Pollutants (POP)	g i-Teq
Heavy Metals	ton Ni eq.
PAHs	ton Ni eq.
Particulate Matter (PM, dust)	kt
Emissions (Water)	
Heavy Metals	ton Hg/20
Eutrophication	kt PO4
Persistent Organic Pollutants (POP)	g i-Teq

Table 5.24: Output indicators in Ecoindicator95 method

Environmental impact	Unit
greenhouse	kg CO2
ozone layer	kg CFC11
acidification	kg SO2

eutrophication	kg PO4
heavy metals	kg Pb
carcinogens	kg B(a)P
winter smog	kg SPM
summer smog	kg C2H4
pesticides	kg act. subst.
energy resources	MJ LHV
solid waste	kg

In Appendix C the methodology used to compare SimaPro and EuP-Ecoreport outputs is reported and explained. In any case, it was not possible to completely adapt the "Ecoindicator 95 method" to the EuP-Ecoreport method because of lack a complete list of components for many indicators and related weight in EuP methodology.

In Table 5.25 the comparison between EuP-Ecoreport indicators and "modified SimaPro indicators" is shown.

Table 5.25: Comparison between SimaPro (Eco-indicator 95 rev EuP) and EuP-Ecoreport list of output

Eup / Simapro	8 - Total Energy (GER)	12 (+13) - waste	14 - Greenhouse Gases in GWP100	15 - Ozone Depletion, emissions	16 - Acidification, emissions	17 - Volatile Organic Compounds (VOC)	18 - Persistent Organic Pollutants (POP)	19 - Heavy Metals	19,1 - PAHs	20 - Particulate Matter (PM, dust)	21 - Heavy Metals	22 - Eutrophication	23 - Persistent Organic Pollutants (POP)
8 - energy resources	**ok**												
12 (+13) - solid waste		**p**											
14 - Greenhouse			**ok**										
15 - ozone layer				**ok**									
16 - Acidification					**ok**								
17 - summer smog – VOCs						**p**							
18 - POP (air)							**p**						
19 - Heavy metals (air)								**p**					
19,1 - PAHs (air)									**no**				
20 - winter smog - P.M.										**p**			
21 - Heavy metals (water)											**p**		
22 - Eutrophication												**p**	
23 - POP (water)													**p**
- heavy metals													
- Carcinogens													
- Pesticides													

The comparison of the two methods resulted in:

- for SimaPro indicator:
  - **in blue:** the indicator has been modified (in terms of weight factor of some single components) to be in compliance with EuP;
  - **in orange**: a new indicator for SimaPro, "elaborated" so as replicate the EuP one.
- for compliance index:
  - "OK": good compliance between SimaPro and EuP indicators;
  - "P": partial compliance between SimaPro and EuP indicators due to relevant differences in the number of components taken into account and, sometimes, of the type of components;
  - "No": low compliance between SimaPro and EuP indicators. This is true only for PAHs, in fact in EuP methodology a "weight coefficient" equal to 20 for all PAHs has been used, without a list of the considered type of PAH.

5.3.4.2 SimaPro vs. Eup-ecoreport output

a) 12ps dishwashers

In Tables 5.26 the LCA outputs from SimaPro with Ecoindicator95 (revised according to EuP Method) have been reported for a DW 12ps, while Table 5.27 reports the LCA output from EuP-Ecoreport.

Table 5.26: DW12 ps – LCA output from SimaPro with Ecoindicator 95-rev EuP Method, organised so as EuP outputs

Row in EuP-Ecoreport	Impact category	Unit	DW12ps assembling - Production total	USE	DW12 EoL	Total	Total - EoL
8	energy resources	MJ LHV	4,50E+03	4,73E+04	-5,62E+02	5,12E+04	5,18E+04
12 (+13)	solid waste	kg	9,62E+01	50,00E+00	-4,01E+01	10,61E+01	14,62E+01
14	Greenhouse	kg CO2	2,03E+02	2,16E+03	-3,99E+01	2,32E+03	2,36E+03
15	ozone layer	kg CFC11	7,30E-05	1,17E-03	-1,22E-05	1,23E-03	1,24E-03
16	Acidification	kg SO2	3,11E+00	1,69E+01	-1,36E-01	1,98E+01	2,00E+01
17	summer smog – VOCs	kg C2H4	1,70E-01	4,87E-01	-3,27E-02	6,24E-01	6,57E-01
18	POP (air)	kg TE eq	2,23E-09	5,01E-10	9,69E-11	2,83E-09	2,73E-09
19	Heavy metals (air)	kg Ni eq	9,82E-04	4,64E-03	-1,99E-05	5,61E-03	5,63E-03
19,1	PAHs (air)	kg PAH/20 eq	1,72E-06	1,28E-06	-5,94E-07	2,41E-06	3,01E-06
20	winter smog - P.M.	kg SPM	2,74E+00	1,44E+01	-8,31E-02	1,70E+01	1,71E+01
21	Heavy metals (water)	kg Hg/20 eq	3,59E-03	5,43E-02	-8,55E-04	5,71E-02	5,79E-02
22	Eutrophication	kg PO4	2,37E-01	2,46E+00	-1,25E-02	2,68E+00	2,70E+00
23	POP (water)	kg TE eq	1,05E-13	0,00E+00	0,00E+00	1,05E-13	1,05E-13
	heavy metals	kg Pb	3,71E-03	2,78E-02	-2,88E-04	3,12E-02	3,15E-02
	Carcinogens	kg B(a)P	2,69E-05	7,39E-05	-6,89E-06	9,39E-05	1,01E-04
	Pesticides	kg act.subst	4,41E-02	0,00E+00	0,00E+00	4,41E-02	4,41E-02

According to Simapro outputs, the Use and Production phases are the most important from the environmental impact point of view. The same result comes from the EuP Ecoreport outputs. The main difference between the two software is in the evaluation of the environmental impact importance in Use and Production phases. For Simapro, the Use phase has to be considered the most relevant regarding environmental impact.

Analyzing SimaPro outputs, energy consumption, greenhouse gas, acidification and VOC are more relevant in the Use phase while POP and PAH are mainly emitted from production phase. This is in agreement with EuP-Ecoreport outputs: the main difference being heavy metals, mainly emitted in the Use phase, instead of the Production phase.

Also particulate matter emission is higher in the Use phase, but it should be considered that in Simapro "distribution phase" is not considered in the same wasy that in EuP-Ecoreport (in which PM10 are higher in distribution phase, due to emissions by diesel motors). The only possible comparison with EuP-Ecoreport outputs for water emission is eutrophication: also in this case, according to SimaPro outputs, it has been indicated as more relevant in the Use phase.

The comparison of Simapro and EuP-Ecoreport outputs is reported in Table 5.28.

Table 5.27: DW12 ps – LCA output from EuP-Ecoreport, with a partial Total without Distribution and End of Life contributions

			Production	Distribution	Use	End of Life	TOTAL	Total - distribution - EoL
8	Total Energy (GER)	MJ	3,95E+03	5,95E+02	3,45E+04	-2,91E+02	3,87E+04	3,84E+04
12 (+13)	waste	kg	6,69E+01	3,19E-01	4,09E+01	2,30E+00	1,10E+02	1,08E+02
14	Greenhouse Gases in GWP100	kg CO2 eq.	2,70E+02	3,70E+01	1,52E+03	0,00E+00	1,83E+03	1,79E+03
15	Ozone Depletion, emissions	mg R-11 eq.	negligible					
16	Acidification, emissions	kg SO2 eq.	2,16E+00	1,11E-01	8,83E+00	7,00E-03	1,11E+01	1,10E+01
17	Volatile Organic Compounds (VOC)	kg	9,00E-03	8,00E-03	1,90E-02	1,00E-03	3,70E-02	2,80E-02
18	Persistent Organic Pollutants (POP)	kg i-Teq	4,33E-10	2,00E-12	2,28E-10	6,00E-12	6,69E-10	6,61E-10
19	Heavy Metals	kg Ni eq.	3,25E-03	1,60E-05	7,00E-04	5,30E-05	4,02E-03	3,95E-03
19,1	PAHs	kg Ni eq.	1,52E-04	2,00E-05	1,52E-04	-2,00E-06	3,22E-04	3,04E-04
20	Particulate Matter (PM, dust)	kg	2,95E-01	1,37E+00	1,60E+00	4,31E-01	3,70E+00	1,90E+00
21	Heavy Metals	kg Hg/20	2,15E-03	0,00E+00	2,22E-04	1,30E-05	2,39E-03	2,37E-03
22	Eutrophication	kg PO4	5,70E-02	0,00E+00	4,86E+00	0,00E+00	4,92E+00	4,92E+00
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible					

Table 5.28: DW12 ps – Comparison for LCA output of EuP-Ecoreport vs. SimaPro

Row in EuP-Ecoreport	Impact category	Unit	Production	Use	Total - distribution - EoL
8	energy resources	MJ LHV	14%	37%	35%
12 (+13)	Solid waste	kg	44%	22%	36%
14	greenhouse	kg CO2	-25%	42%	32%
15	ozone layer	kg CFC11			
16	acidification	kg SO2	44%	91%	82%
17	summer smog - VOCs	kg C2H4	1792%	2463%	2247%
18	POP (air)	kg TE eq	415%	120%	313%
19	Heavy metals (air)	kg Ni eq	-70%	563%	42%
19,1	PAHs (air)	kg PAH/20 eq	-99%	-99%	-99%
20	winter smog - P.M.	kg SPM	827%	797%	801%
21	Heavy metals (water)	kg Hg/20 eq	67%	24375%	2342%
22	eutrophication	kg PO4	316%	-49%	-45%
23	POP (water)	kg TE eq			

Main considerations and remarks on Simapro vs. EuP-Ecoreport outputs for dishwashers are:

- main “classic“ indicators (such as energy resources, green house gas and acidification): the total values reported can be considered in compliance with EuP ones; Simapro outputs are higher in absolute value mainly due to better input data accuracy (mainly on materials and assembling) and better definition of the environmental impact of the energy sources. It is worth noting that these indicators are in compliance with EuP-Ecoreport outputs and it is also confirmed that the Use phase is more relevant than the Production phase, with the same ratio in the two software.
- VOC’s and Heavy Metals (water): the difference could be mainly due to the higher number of compounds contributing to the environmental impact considered in Simapro database as compared with a lower number in the EuP-Ecoreport database;
- PAHs: the value in EuP-Ecoreport is higher than in SimaPro output; this could be due to the different calculation methodology used in EuP-Ecoreport (MEEuP report) and SimaPpro (Ecoindicator95 modified);
- Eutrophication: the EuP-Ecoreport total value is higher than in SimaPro; the main reason is apparently the type of detergent used. The eutrophication is higher in the Production phase in SimaPro than in EuP-Ecoreport, but it should be reminded that in SimaPro the detergent production is taken into consideration;
- for all the other indicators: in general higher values in SimaPro output have been reported; this is probably due to a higher number of data considered in SimaPro, but also to the non complete harmonisation between Simapro and EuP indicators.

b) 5kg washing machines

In Table 5.29 the LCA outputs from SimaPro with Ecoindicator95 (revised according to EuP Method) have been reported for a WM 5kg, while Table 5.30 presents the LCA output from EuP-Ecoreport.

Table 5.29: WM 5 kg – LCA output from SimaPro with Ecoindicator 95-rev EuP Method, organised as EuP outputs

Row in EuP-Ecoreport	Impact category	Unit	WM 5kg assembling	Use	WM 5kg EoL	Total	Total - EoL
8	energy resources	MJ LHV	1,23E+04	6,65E+04	-8,43E+02	7,80E+04	7,88E+04
12 (+13)	solid waste	kg	2,09E+02	5,40E+01	-4,01E+01	2,23E+02	2,63E+02
14	greenhouse	kg CO2	6,44E+02	2,83E+03	-5,66E+01	3,42E+03	3,48E+03
15	ozone layer	kg CFC11	1,29E-04	1,34E-03	-2,13E-05	1,44E-03	1,47E-03
16	acidification	kg SO2	6,13E+00	1,87E+01	-2,49E-01	2,46E+01	2,48E+01
17	summer smog -VOCs	kg C2H4	2,91E-01	7,76E-01	-4,62E-02	1,02E+00	1,07E+00
18	POP (air)	kg TE eq	2,15E-09	6,59E-10	2,59E-11	2,84E-09	2,81E-09
19	Heavy metals (air)	kg Ni eq	8,36E-04	7,22E-03	-3,35E-05	8,02E-03	8,06E-03
19,1	PAHs (air)	kg PAH/20eq	2,26E-06	1,47E-06	-7,77E-07	2,96E-06	3,73E-06
20	winter smog - P.M.	kg SPM	5,02E+00	1,56E+01	-1,74E-01	2,04E+01	2,06E+01
21	Heavy metals (water)	kg Hg/20 eq	5,19E-03	6,62E-02	-8,89E-04	7,05E-02	7,13E-02
22	eutrophication	kg PO4	2,50E-01	1,52E+00	-1,66E-02	1,75E+00	1,77E+00
23	POP (water)	kg TE eq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	heavy metals	kg Pb	3,83E-03	3,35E-02	-3,75E-04	3,70E-02	3,73E-02
	carcinogens	kg B(a)P	2,88E-05	1,35E-04	-3,67E-05	1,27E-04	1,64E-04
	pesticides	kg act.subst	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

As in the case of for DW 12ps model, according to Simapro outputs, the Use and Production phases are more important than the other phases for the environmental impacts; this is valid also for EuP-Ecoreport outputs, but the main difference lies in the relative importance of the environmental impact between the Use and the Production phases. For SimaPro the use phase is considered the most relevant for the environmental impact.

Analyzing SimaPro outputs, the energy consumption, greenhouse gas, acidification and VOC are more relevant in the Use phase, while POP and PAH are mainly emitted in the Production phase. This is in agreement with EuP-Ecoreport outputs. The main difference lies in heavy metals, mainly emitted in the Use phase, instead of Production phase. Also particulate matter is higher in the Use phase, but in SimaPro the "distribution phase" is not considered in the same way as in EuP-Ecoreport (in which PM10 are higher in the Distribution phase, due to emissions by diesel motors).

The only comparison possible with EuP-Ecoreprot outputs for water emission is eutrophication, where the Use phase is more important according to SimaPro outputs.

Table 5.30: WM 5 kg – LCA output from EuP-Ecoreport, with a partial Total without Distribution and End of Life contributions

	Resources Use and Emissions		Production	Distribution	Use	End of Life	Total	Total - Distribution - EoL
8	Total Energy (GER)	MJ	3,83E+03	5,47E+02	3,42E+04	-5,07E+02	3,81E+04	3,81E+04
12 (+13)	Waste	kg	6,93E+01	2,96E-01	4,07E+01	2,16E-01	1,10E+02	1,10E+02
14	Greenhouse Gases in GWP100	kg CO2 eq.	2,45E+02	3,40E+01	1,51E+03	-8,00E+00	1,78E+03	1,75E+03
15	Ozone Depletion, emissions	mg R-11 eq.						
16	Acidification, emissions	kg SO2 eq.	1,87E+00	1,02E-01	8,75E+00	-1,20E-02	1,07E+01	1,06E+01
17	Volatile Organic Compounds (VOC)	kg	7,00E-03	8,00E-03	1,90E-02	1,00E-03	3,50E-02	2,60E-02
18	Persistent Organic Pollutants (POP)	kg i-Teq	4,27E-10	2,00E-12	2,26E-10	0,00E+00	6,54E-10	6,52E-10
19	Heavy Metals	kg Ni eq.	2,43E-03	1,50E-05	6,87E-04	2,40E-05	3,15E-03	3,12E-03
	PAHs	kg Ni eq.	1,90E-04	1,90E-05	1,53E-04	-2,00E-06	3,60E-04	3,43E-04
20	Particulate Matter (PM, dust)	kg	3,88E-01	1,25E+00	1,60E+00	3,75E-01	3,61E+00	1,99E+00
21	Heavy Metals	kg Hg/20	1,60E-03	0,00E+00	2,34E-04	2,00E-06	1,83E-03	1,83E-03
22	Eutrophication	kg PO4	4,10E-02	0,00E+00	1,00E-03	-1,00E-03	4,10E-02	4,20E-02
23	Persistent Organic Pollutants (POP)	ng i-Teq						

Details comparing SimaPro and EuP-Ecoreport outputs are presented in Table 5.31.

Table 5.31: WM 5 kg – Comparison for LCA output with EuP-Ecoreport vs SimaPro.

Row in EuP-Ecoreport	Impact category	Unit	WM 5kg assembling	Use	Total - EoL
8	energy resources	MJ LHV	221%	94%	107%
12 (+13)	solid waste	kg	201%	33%	139%
14	greenhouse	kg CO2	163%	88%	98%
15	ozone layer	kg CFC11			
16	acidification	kg SO2	228%	113%	133%
17	summer smog - VOCs	kg C2H4	4056%	3986%	4005%
18	POP (air)	kg TE eq	404%	192%	331%
19	Heavy metals (air)	kg Ni eq	-66%	951%	159%
19,1	PAHs (air)	kg PAH/20 eq	-99%	-99%	-99%
20	winter smog - P.M.	kg SPM	1193%	875%	937%
21	Heavy metals (water)	kg Hg/20 eq	225%	28172%	3797%
22	eutrophication	kg PO4	510%	151750%	4110%
23	POP (water)	kg TE eq			

Main considerations and remarks on Simapro vs. EuP-Ecoreport outputs for washing machines are the same already described for dishwashers, with the exception of 'eutrophication'. The EuP-Ecoreport total value for eutrophication is higher than in SimaPro: the main reason is that in EuP-Ecoreport no data are available for washing machines detergent.

5.4 SUBTASK 5.4: BASE CASE LIFE CYCLE COST

The Life Cycle Costs (LCC) for the various base cases are estimated given the economic assumptions, including the consumer prices for various models. The LLC of the base case is the starting point for the optimisation of the technology options in Task 6 and will be re-presented in that context.

Sensitivity analysis will be applied to the main parameters here including purchase price and electricity price and the level of consumption per year of the representative appliances.

5.4.1 Base case LCC for Dishwashers

5.4.1.1 The key technical and financial assumptions

The key technical and financial assumptions for dishwashers are:

– Product life	15 years (also with 10, 12 and 17 years)
– Cycles per year	280 (also 208 and 220 are considered)
– Discount rate	5%/year (PWF = 10,38 for 15years)
– Electricity price	0,17 Euro/kWh
– Water price	3,7 Euro/m^3
– Detergent, softener, rinsing agent:	2,34[56] Euro/kg, 0,6 Euro/kg and 2,4 Euro/kg
– Maintenance & repairs	5,5 Euro/year = 82,5 €/15y
– Disposal & recycling	61 Euro/life (at the end of life)
– Average 12ps machine price	548,4 Euro, with 552 Euro in West EU countries and 464 Euro in East EU countries
– Average 9ps machine price	520 Euro for 9ps machine.

In particular:

- number of washing cycles per year: the value of 208 cycle/year has been kept for sake of comparison with previous results, 220 cycle/year is used is the labelling directive, 280 cycle/year was found in a German study made by STIWA in 2003;
- chemicals: the use of detergent is 30g/cycle, for softener (salt) 20g/cycle and for rinsing agent 4g/cycle;
- the sales weighted average price of the dishwashers sold in 2004 according GfK was 552 Euro in West EU countries and 464 Euro in East EU countries, with an average of 548,4 Euro for the 13 EU member stated where GfK collected the market data. The 9ps machine price is estimated in 520 Euro;
- as far as the disposal and recycling are concerned, no actual reliable data are available for the EU Member States about the effects of the WEEE directive on the costs of household appliances and on the transfer of these costs to the consumers through an improvement of the products purchase price. In Task 2, the recycling and system costs occurred in 1999-2001 were given for six European countries that have experience in recycling of electric and electronic equipment before the WEEE directive came into force[57]. The range is from 1,90 to 0,92 Euro/kg

[56] Low alkaline compact powder with enzymes.

[57] Sources: M. Dempsey , *The WEEE Directive: The UK Experience*, APSWG, 2006 and M. Savage -AEA Technology, *Implementation of the Waste Electric and Electronic Equipment Directive in the EU*, JRC-IPTS, EUR 22231 EN, 2006.

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 (on average 15 years after the purchase). Discussion with the stakeholders revealed that, at least for some appliances such as washing machines and dishwashers and in some countries the value of the recovered metals covers almost completely the disposal and recycling system costs. Since on one side no reliable data are available at EU and Member States level and on the other side the "disposal and recycling costs" are a constant added to the LCC, the following LCC analysis will use the value of 61€, while a lower estimated values will be analysed through the sensitivity analysis.

Using these parameters and the standard and real life base cases characteristics the LCC is calculated in the following paragraph for the basic parameter combination. A sensitivity analysis is here presented only for the appliance lifetime and number of cycles per year, which have an immediate impact on the operating costs, while the sensitivity for the other parameters will be presented in Task 6.

5.4.1.2 The analysis results for dishwashers

The Life Cycle Cost for the consumer is the sum of the purchase price plus the discounted annual costs and the discounted end of life cost of recycling and disposal as shown in Tables 5.32 and 5.33 for the standard and the real life base case respectively.

The life cycle costs for the standard base cases are more than double the purchase price in most cases, a part from when the higher number of cycles is considered, indicating the importance of the annual operating costs in particular the electricity and water, which will be subject to reduction in Task 6. With the present reduced levels of water consumption, the chemical costs are superior to the water costs on a cycle or annual basis. For the real life base cases the life cycle costs are only very slightly higher, since the lighter load well compensate the higher washing temperature and the low power mode(s) additional consumption, when the hand pre-rinse is not taken into consideration. Again the annual operating costs are dominated by the energy costs.

5.4.2 Base case LCC for Washing Machines

5.4.2.1 The key technical and financial assumptions

The key technical and financial assumptions for washing machines are:

– Product life:	15 years (also with 10, 12 and 17 years)
– Cycles per year:	220 (also with 200 and 245 cycles)
– Discount rate:	5%/year (PWF = 10,38 for 15years)
– Electricity price:	0,17 Euro/kWh
– Water price:	3,7 Euro/m^3
– detergent costs:	0,22 Euro/wash for 139,76 g/wash or 1,90 €/kg
– Maintenance & repairs:	5,5 Euro/year = 82,5 €/15y
– Disposal & recycling	61 Euro/life (at end of life)
– Machine price:	443,5 Euro, with 562 Euro in West EU countries and 326 Euro in East EU countries.

In particular:

- number of cycles per year: 200 is the number of washing cycles considered in the energy labelling directive for a four-person household and forecast for 2010 in the WASH-II study; 222 is the number of cycles in the WASH-II study; 245 is the number of cycles used in GEA study;
- the sales weighted average price of the washing machines sold in 2004 according GfK was 562 Euro in West EU countries and 326 Euro in East EU countries, with an average of 443,5 Euro for the 13 EU member stated where GfK collected the market data;
- for disposal and recycling the same note about lack of actual reliable data already discussed for dishwashers applies. In the following LCC analysis the indicated value of 61€ will be used while different estimated values will be analysed through the sensitivity analysis in Task 6.

Using these parameters and the standard and real life base cases characteristics the LCC is calculated in the following paragraph for the basic parameter combination. A sensitivity analysis is here presented only for the appliance lifetime and number of cycles per year, which have an immediate impact on the operating costs, while the sensitivity for the other parameters will be presented in Task 6.

5.4.2.2 The analysis results for washing machines

The results are given in Tables 5.34 and 5.35 for the standard and the real-life base cases.

The LCC for the standard base case varies from a minimum of 1.415 € (lifetime 10y and 200 cycle/year) to a maximum of 2.127 € (lifetime 17y and 245 cycle/year). Not too surprisingly the annual water costs exceed those of electricity, and the chemicals costs exceed those of water and electricity. This is testimony to the achievement in reducing energy costs using the various policy instruments over the last decade. For the real life base case the detergent costs are even more dominating the LCC, with water and energy costs again almost at the same level. The RLBC life cycle cost is -7/7,5% lower than SBC depending on the number of cycles and lifetime considered. Purchase prices are roughly one-third of the total when 200 cycle/year are considered in real life.

5.5 SUBTASK 5.5: EU TOTALS

For the wash appliances the lifetime energy and water consumption, life cycle cost, and life cycle environmental impacts are aggregated for the total units sold in 2005 in EU25.

This is calculated for the standard Base Case and BAT models, using the characteristics of the models developed in the Tasks 5 and 6, together with the stock and market data from Task 2. In addition to the total environmental impacts, the partial impacts are shown, including disposal assuming post-RoHS and post-WEEE conditions.

The 2005 total for the base case represents today's situation of the average models sold. A total for year 2005 was also calculated for the BAT model and these values are subtracted from those of the Base Case, this difference representing the potential maximum of technological savings from the substitution of all the base case models by the BAT model. This is a theoretical maximum savings potential as certainly BAT penetration will not reach 100%, however the number of models sold will increase slowly from the level in year 2005.

The lifetime energy and water consumption together with life cycle costs are shown for the single models and for the total of year 2005 in Table 5.36.

Table 5.32: Life Cycle Cost of standard base cases for dishwashers

Standard Base Case (description)	Consumer price (€)	Energy consumption (kWh/year)	Energy costs (€/year)	Water consumption (litre/cycle)	Water costs (€/year)	Chemicals costs (€/year)	Maintenance costs (€/year)	Recycling & disposal costs at end of life (€)	LCC at 10 years (€)	LCC at 12 years (€)	LCC at 15 years (€)	LCC at 17 years (€)
12ps (208 cycle/y)	548	1,070	37,84	15,20	11,70	19,09	5,50	61,00	1.158	1.239	1.347	1.411
12ps(220 cycle/y)	548	1,070	40,02	15,20	12,37	20,20	5,50	61,00	1.189	1.274	1.388	1.455
12ps (280 cycle/y)	548	1,070	50,93	15,20	15,75	25,70	5,50	61,00	1.342	1.450	1.594	1.679
9ps (208 cycle/y)	520	0,828	29,28	13,70	10,54	17,63	5,50	61,00	1.044	1.112	1.203	1.256
9ps (220 cycle/y	520	0,828	30,97	13,70	11,15	18,65	5,50	61,00	1.069	1.141	1.237	1.294
9ps (280 cycle/y	520	0,828	39,41	13,70	14,19	23,74	5,50	61,00	1.197	1.288	1.409	1.481

Table 5.33: Life Cycle Cost of real-life base cases for dishwashers

Real life Base Case (description)	Consumer price (€)	Energy consumption (kWh/year)	Energy costs (€/year)	Water consumption (litre/cycle)	Water costs (€/year)	Chemicals costs (€/year)	Maintenance costs (€/year)	Recycling & disposal costs at end of life (€)	LCC at 10 years (€)	LCC at 12 years (€)	LCC at 15 years (€)	LCC at 17 years (€)
9ps (208 cycle/y)	548	1,167	41,27	15,40	11,85	15,72	5,50	61,00	1.160	1.241	1.349	1.413
9ps (220 cycle/y)	548	1,167	43,65	15,40	12,54	16,63	5,50	61,00	1.191	1.276	1.391	1.458
9ps (280 cycle/y)	548	1,167	55,55	15,40	15,95	21,17	5,50	61,00	1.344	1.452	1.597	1.682
6ps (208 cycle/y)	520	0,903	31,93	13,90	10,70	14,60	5,50	61,00	1.042	1.110	1.200	1.254
6ps (220 cycle/y	520	0,903	33,77	13,90	11,31	15,44	5,50	61,00	1.067	1.139	1.235	1.291
6ps (280 cycle/y	520	0,903	42,98	13,90	14,40	19,66	5,50	61,00	1.195	1.286	1.406	1.477

Table 5.34: Life Cycle Cost of standard base case washing machine

Standard Base Case (description)	Consumer price (€)	Energy consumption (kWh/year)	Energy costs (€/year)	Water consumption (litre/cycle)	Water costs (€/year)	Chemicals costs (€/year)	Maintenance costs (€/year)	Recycling & disposal costs at end of life (€)	LCC at 10 years (€)	LCC at 12 years (€)	LCC at 15 years (€)	LCC at 17 years (€)
5,36kg (200 cycle/y)	443,5	0,998	33,93	50,70	37,52	44,00	5,50	61,00	1.415	1.549	1.728	1.834
5,36kg (220 cycle/y)	443,5	0,998	37,33	50,70	41,27	48,40	5,50	61,00	1.504	1.652	1.848	1.964
5,36kg (245 cycle/y)	443,5	0,998	41,57	50,70	45,96	53,90	5,50	61,00	1.615	1.780	1.998	2.127

Table 5.35: Life Cycle Cost of real-life base case washing machine

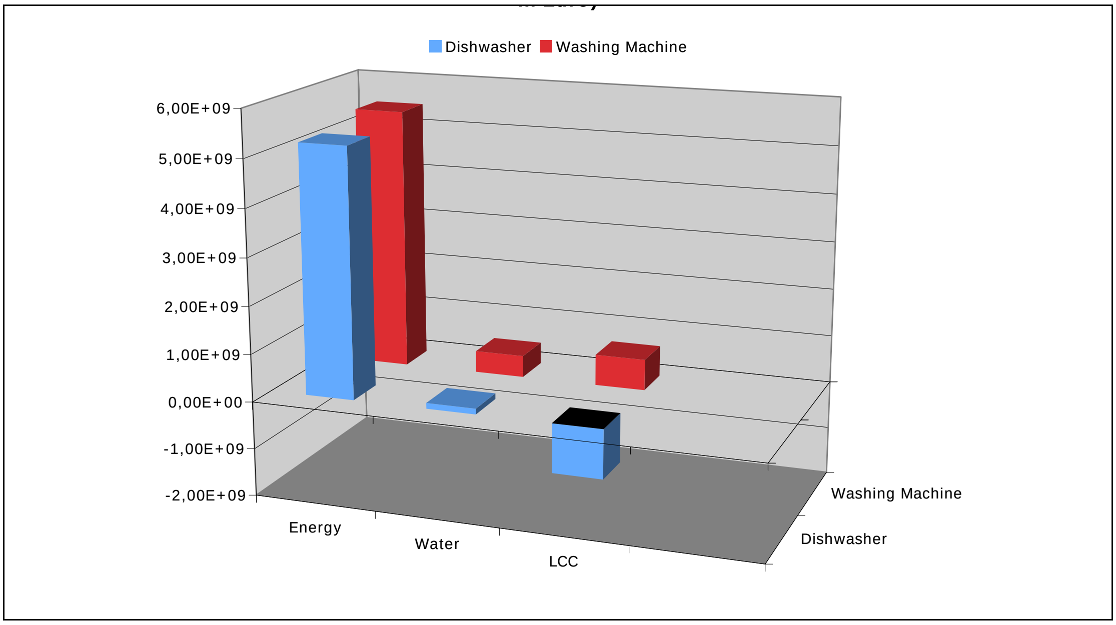
Real life Base Case (description)	Consumer price (€)	Energy consumption (kWh/year)	Energy costs (€/year)	Water consumption (litre/cycle)	Water costs (€/year)	Chemicals costs (€/year)	Maintenance costs (€/year)	Recycling & disposal costs at end of life (€)	LCC at 10 years (€)	LCC at 12 years (€)	LCC at 15 years (€)	LCC at 17 years (€)
3,4kg (200 cycle/y)	443,5	0,719	24,34	46,30	34,26	44,00	5,50	61,00	1.316	1.437	1.596	1.690
3,4kg (220 cycle/y)	443,5	0,719	26,78	46,30	37,69	48,40	5,50	61,00	1.396	1.528	1.703	1.806
3,4kg (245 cycle/y)	443,5	0,719	29,82	46,30	41,97	53,90	5,50	61,00	1.495	1.641	1.836	1.951

Table 5.36: Washing Machine and Dishwasher: lifetime energy and water consumption and Life Cycle Costs for single models and for total models sold in year 2005 in EU-25

WASHING MACHINES						
	Single Model:			Year 2005 (EU-25 Sales = 11.600.000 units)		
Characteristics	Base	BAT	Potential Savings	100% Base	100% BAT	Potential Savings
Lifetime Energy Consumption (kWh)	3293,4	2821,5	471,9	3,82E+10	3,27E+10	5,47E+09
Lifetime Water Consumption (Cubic Meters)	167,31	127,71	39,6	1,94E+09	1,48E+09	4,59E+08
Life Cycle Costs (Euro)	1952	1896	56	2,26E+10	2,20E+10	6,50E+08
DISHWASHERS (12ps)						
	Single Model:			Year 2005 (EU-25 Sales = 5.800.000 units)		
Characteristics	Base	BAT	Potential Savings	100% Base	100% BAT	Potential Savings (or Cost)
Lifetime Energy Consumption (kWh)	4494	3591	903	2,61E+10	2,08E+10	5,24E+09
Lifetime Water Consumption (Cubic Meters)	63,84	43,05	20,79	3,70E+08	2,50E+08	1,21E+08
Life Cycle Costs (Euro)	1594	1772	-178	9,25E+09	1,03E+10	-1,03E+09

On a unit basis, the potential energy savings is almost double with the dishwasher, due to a higher consumption base model and 280 cycles per year versus 220 for washing machines. Instead the water savings potential is greater for the washing machine with the greater amount of water used in clothes washing. A curious fact is that the LCC is actually lower for the BAT model washing machine. When these unit values are multiplied times the sales in year 2005 in EU25, we have the aggregate totals as shown. The maximum savings potential for the aggregate amount in year 2005 is illustrated in Figure 5.28.

Figure 5.28: Maximum Potential Lifetime Savings for Models Sold in Year 2005 EU25



The relative impact of the washing machine is obviously greater due to the fact that washing machine sales are double that of dishwashers, although maximum energy savings are nearly equal. Water savings are six times greater in the case of washing machines.

Appendix A Life Cycle Inventory Data

Table A.1: Average data for the DW 9ps model life cycle phases

PRODUCTION		
Materials type	**Material**	**DW 9ps (g)**
Ferrous metals	galvanized steel	504
	Iron	2.136
	Prepainted Steel	1.941
	stainless steel	6.866
	Steel	1.828
	Steel strip	6.298
	Steel+PA	1.208
Ferrous metals		***20.781***
Non ferrous metals	Al	172
	Cu	398
	Zn	7
Non ferrous metals		***77***
Packaging	Cardboard	123
	EPS	648
	paper	5
	PE - foil	132
	Wood	47
Packaging		***955***
Plastics	ABS	708
	EPDM - rubber	433
	EPS	88
	PA	172
	PBT polybutylene terephthalate	58
	PE	178
	Plastics, others	121
	PMMA	10
	POM	191
	PP	5.026
	PS	367
	PU Foam - Insulation	3
	PVC (excl. wire insul.)	210
Plastics		***7.564***
Various	adhesive	15
	Bitumen	5.043
	Concrete	2.153
	Cotton+Resins noise absorbers	565
	Electronic, boards, switches, lamp, etc	694
	others	36
	paper	130
	Resins	200
	Thermostat	17
	Wiring	503
	Wood	1.928
Various		***11.284***
TOTAL		**41.160**

TRANSPORT: average km = 706

ASSEMBLING	
Energy (kWh)	
Electricity	11,60
Heat	10,02
Mechanical	0,0005
Water (m3)	0,08
Other materials (g)	
polishing solution	106
protective layer-cataphoresys	143
white painting powder	49
Volume of packaged final product (m^3)	0,303

USE		
Product Life	**12,50**	years
Electricity		
On-mode: Consumption per hour, cycle, setting, etc.	**0,8825**	kWh/cycle
On-mode: n. of hours, cycles, settings, etc. / year	220	
Standby-mode: Consumption per hour	**0,0013**	kWh
Standby-mode: n. of hours / year	200	
Off-mode: Consumption per hour	**0,00010**	kWh
Off-mode: n. of hours / year	8000	
TOTAL over Product Life		
Heat		
Avg. Heat Power Output		
No. of hours / year		
Type and efficiency		
TOTAL over Product Life		
Consumables (excl. spare parts)		
Water	**3,69**	m3/year
Detergent dishwasher.	**6,85**	kg/ year
Rinsing agent dishwasher.	**1,16**	kg/ year
Salt dishwasher.	**8,33**	kg/ year
Maintenance, Repairs, Service		
n. of km over Product-Life		
Spare parts		
or Spare parts (object x)		
Spare parts (object y)		

END OF LIFE (%)	
recycling	80,42
energy recovery	16,80
land filling	2,78
Total	100

Table A.2: Average data for the DW 12ps model life cycle phases

PRODUCTION		
Materials type	**Material**	**DW12ps (g)**
Ferrous metals	galvanized steel	403,2
	Iron	2302,6
	Prepainted Steel	1269,2
	Stainless Steel	8690,92
	Steel	6535,616
	Steel strip	7097,4
	Steel+PA	966,6
Ferrous metals		***27265,536***
Non ferrous metals	Al	268,624
	Brass (Cu+Zn alloy)	23,4
	Cr	71,3
	Cu	656,14
	Zn	4,2
Non ferrous metals		***1023,664***
Packaging	Cardboard	632,2
	EPS	724,4
	Paper	3
	PE - foil	171,72
	Wood	1011
Packaging		*2542,32*
Plastics	ABS	751,26
	EPDM - rubber	523,96
	EPS	39,7
	PA	398,6
	PBT - polybutylene terephthalate	35
	PE	187,32
	Plastics, other	267,94
	PMMA	5,8
	POM	229,88
	PP	4948,42
	PP Volute	32,2
	PS	511,54
	PU Foam - Insulation	2,4
	PVC	184,2
	PVC (excl. wire insul.)	219
Plastics		***8337,22***
Various	adhesive	10
	Bitumen	6089
	Cement - Gravel	1262,8
	Cotton	452,18
	Cotton+Resins noise absorbers	489
	Electronic, boards, switches, lamp etc	447,5
	Others	59,36
	Paper	205,52
	Resins	120
	Thermostat	10
	Wiring	350
	Wood	2034,4
Various		***11529,76***
TOTAL		**50698,5**

TRANSPORT: average km = 652

ASSEMBLING	
Energy (kWh)	
Electricity	17,31
Heat	9,20
Mechanical	
Water (m3)	0,09
Other materials (g)	
polishing solution	106
protective layer-cataphoresys	156
white painting powder	53
Volume of packaged final product (m3)	0,40

USE		
Product Life	12,5	year
Electricity		
On-mode: Consumption per hour, cycle, setting, etc.	1,058	kWh/cycle
On-mode: n. of hours, cycles, settings, etc. / year	220	
Standby-mode: Consumption per hour	0,00133	kWh
Standby-mode: n. of hours / year	200	
Off-mode: Consumption per hour	0,00016	kWh
Off-mode: n. of hours / year	8000	
TOTAL over Product Life		
Heat		
Avg. Heat Power Output	1,97500	kW
No. of hours / year	0,50	hrs/cycle
Type and efficiency		
TOTAL over Product Life		

USE		
Consumables (excl. spare parts)		
Water	3,85	m3/year
Detergent dishwasher	7,25	kg/year
Rinse agent dishwasher	1,02	kg/year
Salt dishwasher.	7,835	kg/year
Maintenance, Repairs, Service		
n. of km over Product-Life	160,00	km/product life
Spare parts		
or Spare parts (object x)		
Spare parts (object y)		

END OF LIFE (%)	
recycling	82,66
energy recovery	15,86
land filling	1,47
Total	100

Table A.3: Average data for the WM 5kg model life cycle phases

PRODUCTION		
Materials type	**Material**	**WM5kg (g)**
Ferrous metals	cast iron	6.214
	Iron	4.978
	Stainless Steel	1.939
	Stainless steel sheet	564
	Steel	12.521
	Steel strip	6.145
Ferrous metals		***32.361***
Non ferrous metals	Al	1.503
	Aluminium sheet	1
	Aluminium casting (recycled 80%)	729
	Brass	14
	Copper sheet	0
	Copper wire	348
	Cr	1.761
	Cu	869
	Ni	1
	zinc die-casting	85
Non ferrous metals		***5.311***
Packaging	Cardboard	107
	EPS	678
	Paper (booklets etc)	10
	PE - foil	175
	Plastics, others	56
	PP	8
	Wood	879
Packaging		***1.912***
Plastics	ABS	1.145
	EPDM - rubber	1.675
	PA	6
	PA 66-GF(Glass Fibre Reinforced)	0
	PA66	88
	PC	188
	PC-G (Glass Reinforced)	2
	PE	10
	Plastics, others	1.037
	POM	41
	PP	5.402
	PP-K40	2.533
	PPO (=PPE)	2
	PPS-GF	76
	PVC	221
	PBT	8
Plastics		***12.434***
Various	Bitumen	38
	Concrete	18.180
	Electronic, boards, switches, lamp, etc	165
	Filter	28
	Glass	1.773
	Gravel	25
	Oil - Feet	28
	Others	204
	Paper (booklets etc)	106
	Wiring	88
	Wood	1.573
Various		***22.206***
TOTAL		**74.225**

TRANSPORT: average km = 648

ASSEMBLING	
Energy (kWh)	
Electricity	28,98
Heat	14,79
Water (m3)	0,59
Other materials (g)	
Lubricating oil : ave factory	45
Phosphating : ave factory	47
Volume of packaged final product (m3)	0,36

USE		
Product Life	15,00	years
Electricity		
On-mode: Consumption per cycle	0,93	kWh/cycle
On-mode: n. of hours, /cycle	225,00	cycle/year
Standby-mode: Consumption per hour	0,00320	kW
Standby-mode: n. of hours / year	200	
Off-mode: Consumption per hour	0,00065	kW
Off-mode: n. of hours / year	8.000	
TOTAL over Product Life		
Heat		
Avg. Heat Power Output	1,95	kW
No. of hours / year	0,40	hrs./cycle
Type and efficiency		
TOTAL over Product Life		
Consumables (excl. spare parts)		
Water	10,01	m3/year
Detergent (compact)	24,93	kg/ year
Softening washing machine	20,00	kg/ year
Bleach	1	l/year
Maintenance, Repairs, Service		
n. of km over Product-Life	160,00	km/product life
Spare parts		
or Spare parts (object x)		
Spare parts (object y)		

END OF LIFE (%)	
Dismantling	26,70
recycling	70,00
energy recovery	3,30
Total	100

Appendix B EUP-Ecoreport Data

Table B.1: DW 9ps INPUT - EuP-Ecoreport

Version 5 VHK for European Commission 28 Nov. 2005
ECO-DESIGN OF ENERGY-USING PRODUCTS

Document subject to a legal notice (see below)
EuP EcoReport: INPUTS
Assessment of Environmental Impact

Nr	Product name	Date	Author
	DW 9 ps MEDIA	**21/05/2007**	

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !
1	ABS (707,83 g)	828,1	1-BlkPlastics	**10-ABS**
2	adhesive (14,58 g)			
3	Al (171,66 g)	200,8	4-Non-ferro	**26-Al sheet/extrusion**
4	Bitumen (5043,33 g)			
5	Concrete (2153 g)	2518,7	7-Misc.	**58-Concrete**
6	Cotton+Resins noise absorbers (565,41 g)			
7	Cu (397,66 g)	465,2	4-Non-ferro	**29-Cu wire**
8	Electronic, boards, switches, lamp etc (694,16 g)	812,1	6-Electronics	**98-controller board**
9	EPDM - rubber (432,66 g)	506,2	1-BlkPlastics	**1-LDPE**
10	EPS (87,5 g)	102,4	1-BlkPlastics	**6-EPS**
11	galvanized steel (504 g)	589,6	3-Ferro	**21-St sheet galv.**
12	Iron (2136,33 g)	2499,2	3-Ferro	**23-Cast iron**
13	others (35,66 g)			
14	PA (171,66 g)	200,8	2-TecPlastics	**11-PA 6**
15	paper (130 g)	152,1	7-Misc.	**57-Office paper**
16	PBT polybutylene terephthalate (58,33 g)			
17	PE (178,33 g)	208,6	1-BlkPlastics	**2-HDPE**
18	Plastics, others (120,66 g)			
19	PMMA (9,66 g)	11,3	2-TecPlastics	**13-PMMA**
20	POM (191,33 g)	223,8	1-BlkPlastics	**2-HDPE**
21	PP (5026,46 g)	5880,3	1-BlkPlastics	**4-PP**
22	Prepainted Steel (1940,66 g)	2270,3	3-Ferro	**25-Stainless 18/8 coil**
23	PS (367 g)	429,3	1-BlkPlastics	**5-PS**
24	PU Foam - Insulation (3 g)	3,5	2-TecPlastics	**16-Flex PUR**
25	PVC (excl. wire insul.) (209,66 g)	245,3	1-BlkPlastics	**8-PVC**
26	Resins (200 g)	234,0	2-TecPlastics	**14-Epoxy**
27	stainless steel (6866 g)	8032,3	3-Ferro	**25-Stainless 18/8 coil**
28	Steel (1828,16 g)	2138,7	3-Ferro	**25-Stainless 18/8 coil**
29	Steel strip (6297,66 g)	7367,5	3-Ferro	**21-St sheet galv.**
30	Steel+PA (1208,25 g)	1413,5	3-Ferro	**25-Stainless 18/8 coil**
31	Thermostat (16,66 g)	19,5	6-Electronics	**98-controller board**
32	Wiring (503,33 g)	588,8	4-Non-ferro	**29-Cu wire**
33	Wood (1927,66 g)	2255,1	7-Misc.	**56-Cardboard**
34	Zn (6,66 g)	7,8	4-Non-ferro	**31-CuZn38 cast**
	TOTAL	**40205**		

Pos nr	MANUFACTURING Description	Weight in g	Percentage Adjust	Category index (fixed)
201	**OEM Plastics Manufacturing** (fixed)	8874		20
202	**Foundries Fe/Cu/Zn** (fixed)	2507		34
203	**Foundries Al/Mg** (fixed)	0		35
204	**Sheetmetal Manufacturing** (fixed)	22013		36
205	**PWB Manufacturing** (fixed)	0		53
206	**Other materials** (Manufacturing already included)	6812		
207	**Sheetmetal Scrap** (Please adjust percentage only)	1101	**5%**	37

Pos nr	DISTRIBUTION (incl. Final Assembly) Description		Answer	Category index (fixed)
208	**Is it an ICT or Consumer Electronics product <15 kg ?**		NO	59
209	**Is it an installed appliance (e.g. boiler)?**		NO	60
				62
210	**Volume of packaged final product in m^3**	in m3	0,302523432	63

Pos	USE PHASE		unit	Subtotals

nr	Description			
211	Product Life in years	12,5	years	
	Electricity			
212	On-mode: Consumption per hour, cycle, setting, etc.	0,8825	kWh	194,15
213	On-mode: No. Of hours, cycles, settings, etc. / year	220,00	#	
214	Standby-mode: Consumption per hour	0,00125	kWh	0,25
215	Standby-mode: No. Of hours / year	200,00	#	
216	Off-mode: Consumption per hour	9,6333E-05	kWh	0,770666667
217	Off-mode: No. Of hours / year	8000,00	#	
	TOTAL over Product Life	2,44	MWh (=000 kWh)	65
	Heat			
218	Avg. Heat Power Output	0	kW	
219	No. Of hours / year	0	hrs.	
220	Type and efficiency (Click & select)			85-not applicable
	TOTAL over Product Life	0,00	GJ	
	Consumables (excl. spare parts)			material
221	Water	3,69	m^3/year	83-Water per m3
222	Auxilliary material 1 (Click & select)	6,85	kg/ year	80-Detergent dishw.
223	Auxilliary material 2 (Click & select)	1,16	kg/ year	81-Rinsing agent dish
224	Auxilliary material 3 (Click & select)	8,33	kg/ year	82-Regen. Salt dishw
	Maintenance, Repairs, Service			
225	No. of km over Product-Life	0	km / Product Life	86
226	Spare parts (fixed, 1% of product materials & manuf.)	402	g	

Pos nr	DISPOSAL & RECYCLING Description		unit	Subtotals
	Substances released during Product Life and Landfill			
227	Refrigerant in the product (Click & select)	0	g	1-none
228	Percentage of fugitive & dumped refrigerant	0%		
229	Mercury (Hg) in the product	0	g Hg	
230	Percentage of fugitive & dumped mercury	0%		
	Disposal: Environmental Costs perkg final product			
231	Landfill (fraction products not recovered) in g en %	1118	3%	88-fixed
232	Incineration (plastics & PWB not re-used/recycled)	1491	g	91-fixed
233	Plastics: Re-use & Recycling ("cost"-side)	7136	g	92-fixed
	Re-use, Recycling Benefit	in g	% of plastics fraction	
234	Plastics: Re-use, Closed Loop Recycling (please edit%)	0		4
235	Plastics: Materials Recycling (please edit% only)	7136	80%	4
236	Plastics: Thermal Recycling (please edit% only)	1491	17%	72
237	Electronics: PWB Easy to Disassemble ? (Click&select)	0	YES	98
238	Metals & TV Glass & Misc. (95% Recycling)	29765		fixed

Table B.2: DW 9ps OUTPUT – EuP-Ecoreport

Version 5 VHK for European Commission 28 Nov. 2005

Document subject to a legal notice (see below))

EuP EcoReport: RESULTS
Assessment of Environmental Impact

ECO-DESIGN OF ENERGY-USING PRODUCTS

Table . Life Cycle Impact (per unit) of DW 9 ps MEDIA

Nr	Life cycle Impact per product:	Date	Author
0	DW 9 ps	21/05/07	

Nr	Life Cycle phases --> Resources Use and Emissions	unit	PRODUCTION Material	PRODUCTION Manuf.	PRODUCTION Total	DISTRIBUTION	USE	END-OF-LIFE* Disposal	END-OF-LIFE* Recycl.	END-OF-LIFE* Total	TOTAL
	Materials	**unit**									
1	Bulk Plastics	g			**8424**			1415	7009	**8424**	**0**
2	TecPlastics	g			**450**			76	374	**450**	**0**
3	Ferro	g			**24311**			676	23635	**24311**	**0**
4	Non-ferro	g			**1263**			35	1228	**1263**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**832**			832	0	**832**	**0**
7	Misc.	g			**4926**			137	4789	**4926**	**0**
	Total weight	g			**40205**			3170	37035	**40205**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	2735	714	**3450**	**462**	**28839**	223	447	**-224**	**32526**
9	of which, electricity (in primary MJ)	MJ	713	427	**1141**	**1**	**25628**	0	26	**-26**	**26743**
10	Water (process)	ltr	1568	6	**1574**	**0**	**47916**	0	17	**-17**	**49473**
11	Water (cooling)	ltr	866	199	**1065**	**0**	**68320**	0	143	**-143**	**69243**
12	Waste, non-haz./ landfill	g	52215	2395	**54610**	**249**	**33943**	1393	100	**1293**	**90095**
13	Waste, hazardous/ incinerated	g	592	0	**592**	**5**	**670**	1491	16	**1475**	**2742**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	186	40	**226**	**29**	**1259**	16	14	**2**	**1516**
15	Ozone Depletion, emissions	mg R-11 eq.				negligible					
16	Acidification, emissions	g SO2 eq.	1621	172	**1792**	**87**	**7440**	40	29	**12**	**9331**
17	Volatile Organic Compounds (VOC)	g	9	0	**9**	**6**	**11**	1	0	**1**	**28**
18	Persistent Organic Pollutants (POP)	ng i-Teq	339	12	**351**	**1**	**192**	10	0	**10**	**554**
19	Heavy Metals	mg Ni eq.	2209	28	**2237**	**13**	**517**	60	0	**60**	**2826**
	PAHs	mg Ni eq.	139	0	**139**	**16**	**58**	0	1	**-1**	**211**
20	Particulate Matter (PM, dust)	g	205	26	**232**	**1035**	**161**	442	3	**439**	**1867**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	1623	0	**1623**	**0**	**184**	15	0	**15**	**1822**
22	Eutrophication	g PO4	42	0	**43**	**0**	**4593**	1	1	**0**	**4636**
23	Persistent Organic Pollutants (POP)	ng i-Teq				negligible					

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

Legal notice
This document does not necessarily reflect the view of the European Commission. It was drafted to the best of ability within budget restrictions. VHK and the European Commission do not assume any liability for any material or immaterial damage from using this document or information contained therein.
Copyright ©Van Holsteijn en Kemna BV 2005. Distribution rights European Commission 2005. Duplication allowed if source, draft version and legal notice are mentioned.

Table B.3: DW 12 ps INPUT – EuP-Ecoreport

Version 5 VHK for European Commission 28 Nov. 2005 — Document subject to a legal notice (see below)

ECO-DESIGN OF ENERGY-USING PRODUCTS — EuP EcoReport: INPUTS

Assessment of Environmental Impact

Nr	Product name	Date	Author
	DW 12ps MEDIA	21/05/2007	

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !
1	galvanized steel (403,2 g)	477,3	3-Ferro	21-St sheet galv.
2	Iron (2302,6 g)	2725,6	3-Ferro	23-Cast iron
3	Prepainted Steel (1269,2 g)	1502,4	3-Ferro	25-Stainless 18/8 coil
4	Stainless Steel (8690,92 g)	10287,5	3-Ferro	25-Stainless 18/8 coil
5	Steel (6535,61 g)	7736,3	3-Ferro	25-Stainless 18/8 coil
6	Steel strip (7097,4 g)	8401,3	3-Ferro	21-St sheet galv.
7	Steel+PA (966,6 g)	1144,2	3-Ferro	25-Stainless 18/8 coil
8	Al (268,62 g)	318,0	4-Non-ferro	26-Al sheet/extrusion
9	Brass (Cu+Zn alloy) (23,4 g)	27,7	4-Non-ferro	31-CuZn38 cast
10	Cr (71,3 g)		4-Non-ferro	
11	Cu (656,14 g)	776,7	4-Non-ferro	29-Cu wire
12	Zn (4,2 g)	5,0	4-Non-ferro	31-CuZn38 cast
13	ABS (751,26 g)	889,3	1-BlkPlastics	10-ABS
14	EPDM - rubber (523,96 g)	620,2	1-BlkPlastics	1-LDPE
15	EPS (39,7 g)	47,0	1-BlkPlastics	6-EPS
16	PA (398,6 g)	471,8	2-TecPlastics	11-PA 6
17	PBT - polybutylene terephthalate (35 g)			
18	PE (187,32 g)	221,7	1-BlkPlastics	2-HDPE
19	Plastics, other (267,94 g)			
20	PMMA (5,8 g)	6,9	2-TecPlastics	13-PMMA
21	POM (229,88 g)	272,1	1-BlkPlastics	2-HDPE
22	PP (4948,42 g)	5857,5	1-BlkPlastics	4-PP
23	PP Volute (32,2 g)	38,1	1-BlkPlastics	4-PP
24	PS (511,54 g)	605,5	1-BlkPlastics	5-PS
25	PU Foam - Insulation (2,4 g)	2,8	2-TecPlastics	16-Flex PUR
26	PVC (184,2 g)	218,0	1-BlkPlastics	8-PVC
27	PVC (excl. wire insul.) (219 g)	259,2	1-BlkPlastics	8-PVC
28	adhesive (10 g)			
29	Bitumen (6089 g)			
30	Cement - Gravel (1262,8 g)	1494,8	7-Misc.	58-Concrete
31	Cotton (452,18 g)			
32	Cotton+Resins noise absorbers (489 g)			
33	Electronic, boards, switches, lamp etc (447,5 g)	529,7	6-Electronics	98-controller board
34	Others (59,36 g)			
35	Paper (205,52 g)	243,3	7-Misc.	57-Office paper
36	Resins (120 g)	142,0	2-TecPlastics	14-Epoxy
37	Thermostat (10 g)	11,8	6-Electronics	98-controller board
38	Wiring (350 g)	414,3	4-Non-ferro	29-Cu wire
39	Wood (2034,4 g)	2408,1	7-Misc.	56-Cardboard
	TOTAL	**48156**		

Pos nr	MANUFACTURING Description	Weight in g	Percentage Adjust	Category index (fixed)
201	**OEM Plastics Manufacturing** (fixed)	9652		20
202	**Foundries Fe/Cu/Zn** (fixed)	2758		34
203	**Foundries Al/Mg** (fixed)	0		35
204	**Sheetmetal Manufacturing** (fixed)	29867		36
205	**PWB Manufacturing** (fixed)	0		53
206	**Other materials** (Manufacturing already included)	5879		
207	**Sheetmetal Scrap** (Please adjust percentage only)	1493	5%	37

Pos nr	DISTRIBUTION (incl. Final Assembly) Description		Answer	Category index (fixed)
208	**Is it an ICT or Consumer Electronics product <15 kg ?**		NO	59
209	**Is it an installed appliance (e.g. boiler)?**		NO	60
				62
210	**Volume of packaged final product in m^3**	in m3	0,400625106	63

Pos nr	USE PHASE Description		unit	Subtotals
211	**Product Life in years**	12,5	years	
212	**Electricity** **On-mode: Consumption per hour, cycle, setting, etc.**	1,05833333	kWh	232,8333333

213	On-mode: No. Of hours, cycles, settings, etc. / year	220,00	#	
214	Standby-mode: Consumption per hour	0,00133333	kWh	0,266666667
215	Standby-mode: No. Of hours / year	200,00	#	
216	Off-mode: Consumption per hour	0,0001578	kWh	1,2624
217	Off-mode: No. Of hours / year	8000,00	#	
	TOTAL over Product Life	2,93	MWh (=000 kWh)	65
	Heat			
218	Avg. Heat Power Output	1,975	kW	
219	No. Of hours / year	110	hrs.	
220	Type and efficiency (Click & select)			85-not applicable
	TOTAL over Product Life	9,78	GJ	
	Consumables (excl, spare parts)			material
221	Water	3,85	m^3/year	83-Water per m3
222	Auxilliary material 1 (Click & select)	7,25	kg/ year	80-Detergent dishw.
223	Auxilliary material 2 (Click & select)	1,02	kg/ year	81-Rinsing agent dish
224	Auxilliary material 3 (Click & select)	7,84	kg/ year	82-Regen. Salt dishw
	Maintenance, Repairs, Service			
225	No. of km over Product-Life	160,00	km / Product Life	86
226	Spare parts (fixed, 1% of product materials & manuf.)	482	g	

Pos nr	DISPOSAL & RECYCLING Description		unit	Subtotals
	Substances released during Product Life and Landfill			
227	Refrigerant in the product (Click & select)	0	g	1-none
228	Percentage of fugitive & dumped refrigerant	0%		
229	Mercury (Hg) in the product	0	g Hg	
230	Percentage of fugitive & dumped mercury	0%		
	Disposal: Environmental Costs perkg final product			
231	Landfill (fraction products not recovered) in g en %	708	1%	88-fixed
232	Incineration (plastics & PWB not re-used/recycled)	1531	g	91-fixed
233	Plastics: Re-use & Recycling ("cost"-side)	7979	g	92-fixed
	Re-use, Recycling Benefit	in g	% of plastics fraction	
234	Plastics: Re-use, Closed Loop Recycling (please edit%)	0		4
235	Plastics: Materials Recycling (please edit% only)	7979	83%	4
236	Plastics: Thermal Recycling (please edit% only)	1531	16%	72
237	Electronics: PWB Easy to Disassemble ? (Click&select)	0	YES	98
238	Metals & TV Glass & Misc. (95% Recycling)	36579		fixed

Table B.4: DW 12 ps OUTPUT – EuP-Ecoreport

Version 5 VHK for European Commission 28 Nov. 2005 — Document subject to a legal notice (see below))

EuP EcoReport: RESULTS

ECO-DESIGN OF ENERGY-USING PRODUCTS — **Assessment of Environmental Impact**

Table . Life Cycle Impact (per unit) of DW 12ps MEDIA

Nr	Life cycle Impact per product:	Date	Author
0	**DW 12ps**	**21/05/07**	**0**

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Materials	**unit**									
1	Bulk Plastics	g			**9029**			1432	7596	**9029**	**0**
2	TecPlastics	g			**624**			99	525	**624**	**0**
3	Ferro	g			**32274**			474	31800	**32274**	**0**
4	Non-ferro	g			**1542**			23	1519	**1542**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**542**			542	0	**542**	**0**
7	Misc.	g			**4146**			61	4085	**4146**	**0**
	Total weight	g			**48156**			2631	45525	**48156**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	3075	870	**3945**	**595**	**34487**	203	494	**-291**	**38736**
9	of which, electricity (in primary MJ)	MJ	622	520	**1142**	**1**	**30771**	0	29	**-29**	**31886**
10	Water (process)	ltr	1947	8	**1955**	**0**	**50274**	0	19	**-19**	**52209**
11	Water (cooling)	ltr	971	242	**1213**	**0**	**82039**	0	160	**-160**	**83093**
12	Waste, non-haz./ landfill	g	63531	2939	**66470**	**313**	**40158**	894	112	**781**	**107723**
13	Waste, hazardous/ incinerated	g	409	0	**409**	**6**	**789**	1532	18	**1514**	**2718**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	222	48	**270**	**37**	**1519**	15	15	**0**	**1825**
15	Ozone Depletion, emissions	mg R-11 eq.	negligible								
16	Acidification, emissions	g SO2 eq.	1946	209	**2155**	**111**	**8828**	38	31	**7**	**11101**
17	Volatile Organic Compounds (VOC)	g	8	0	**9**	**8**	**19**	1	0	**1**	**37**
18	Persistent Organic Pollutants (POP)	ng i-Teq	417	16	**433**	**2**	**228**	6	0	**6**	**669**
19	Heavy Metals	mg Ni eq.	3211	38	**3249**	**16**	**700**	53	0	**53**	**4018**
	PAHs	mg Ni eq.	152	0	**152**	**20**	**152**	0	2	**-2**	**322**
20	Particulate Matter (PM, dust)	g	262	32	**295**	**1370**	**1601**	435	3	**431**	**3698**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	2150	0	**2150**	**0**	**222**	13	0	**13**	**2385**
22	Eutrophication	g PO4	57	0	**57**	**0**	**4859**	1	1	**0**	**4917**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

Legal notice

This document does not necessarily reflect the view of the European Commission. It was drafted to the best of ability within budget restrictions. VHK and the European Commission do not assume any liability for any material or immaterial damage from using this document or information contained therein.

Copyright ©Van Holsteijn en Kemna BV 2005. Distribution rights European Commission 2005. Duplication allowed if source, draft version and legal notice are mentioned.

Table B.5: WM 5 kg INPUT – EuP-Ecoreport

Version 5 VHK for European Commission 28 Nov. 2005
ECO-DESIGN OF ENERGY-USING PRODUCTS

Document subject to a legal notice (see below)
EuP EcoReport: INPUTS
Assessment of Environmental Impact

Nr	Product name	Date	Author
	WM 5 kg	**21/05/2007**	

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !
1	cast iron (6214 g)	6499,9	3-Ferro	23-Cast iron
2	Iron (4977,9 g)	5206,9	3-Ferro	23-Cast iron
3	Stainless Steel (1939,2 g)	2028,4	3-Ferro	25-Stainless 18/8 coil
4	Stainless steel sheet (564 g)	589,9	3-Ferro	21-St sheet galv.
5	Steel (12521,34 g)	13097,4	3-Ferro	25-Stainless 18/8 coil
6	Steel strip (6145 g)	6427,7	3-Ferro	21-St sheet galv.
7	Al (1502,8 g)	1571,9	4-Non-ferro	26-Al sheet/extrusion
8	Alluminium sheet (1,34 g)	1,4	4-Non-ferro	26-Al sheet/extrusion
9	Aluminium casting (recycled 80%) (728,8 g)	762,3	4-Non-ferro	27-Al diecast
10	Brass (14,24 g)	14,9	4-Non-ferro	31-CuZn38 cast
11	Copper sheet (0,46 g)	0,5	4-Non-ferro	30-Cu tube/sheet
12	Copper wire (347,76 g)	363,8	4-Non-ferro	29-Cu wire
13	Cr (1761,2 g)		4-Non-ferro	
14	Cu (869,2 g)	909,2	4-Non-ferro	29-Cu wire
15	Ni (0,8 g)		4-Non-ferro	
16	zinc diecasting (84,8 g)	88,7	4-Non-ferro	31-CuZn38 cast
17	ABS (1144,7 g)	1197,4	1-BlkPlastics	10-ABS
18	EPDM - rubber (1675,18 g)	1752,3	1-BlkPlastics	1-LDPE
19	PA (6 g)	6,3	2-TecPlastics	11-PA 6
20	PA 66-GF(Glass Fibre Reinforced) (0,42 g)	0,4	2-TecPlastics	11-PA 6
21	PA66 (87,8 g)	91,8	2-TecPlastics	11-PA 6
22	PC (187,76 g)	196,4	2-TecPlastics	12-PC
23	PC-G (Glass Reinforced) (2,48 g)	2,6	2-TecPlastics	12-PC
24	PE (10,2 g)	10,7	1-BlkPlastics	2-HDPE
25	Plastics, others (1037,04 g)			
26	POM (40,74 g)	42,6	1-BlkPlastics	2-HDPE
27	PP (5401,7 g)	5650,2	1-BlkPlastics	4-PP
28	PP-K40 (2532,5 g)	2649,0	1-BlkPlastics	4-PP
29	PPO (=PPE) (1,9 g)	2,0	1-BlkPlastics	4-PP
30	PPS-GF (76 g)			
31	PVC (221,38 g)	231,6	1-BlkPlastics	8-PVC
32	PBT (8 g)			
42	Bitumen (37,8 g)			
43	Concrete (18179,6 g)	19016,0	7-Misc.	58-Concrete
44	Electronic, boards, switches, lamp etc (164,88 g)	172,5	6-Electronics	98-controller board
45	Filter (28 g)			
46	Glass (1772,6 g)	1854,2	7-Misc.	54-Glass for lamps
47	Gravel (25 g)	26,2	7-Misc.	58-Concrete
48	Oil - Feet (28 g)			
49	Others (203,8 g)			
50	Paper (booklets etc) (106 g)	110,9	7-Misc.	57-Office paper
51	Wiring (87,6 g)	91,6	4-Non-ferro	29-Cu wire
52	Wood (1573 g)	1645,4	7-Misc.	56-Cardboard
	TOTAL	**72313**		

Pos nr	MANUFACTURING Description	Weight in g	Percentage Adjust	Category index (fixed)
201	**OEM Plastics Manufacturing** (fixed)	11833		20
202	**Foundries Fe/Cu/Zn** (fixed)	11810		34
203	**Foundries Al/Mg** (fixed)	762		35
204	**Sheetmetal Manufacturing** (fixed)	23717		36
205	**PWB Manufacturing** (fixed)	0		53
206	**Other materials** (Manufacturing already included)	24190		

207	Sheetmetal Scrap (Please adjust percentage only)	1186	5%	37

Pos nr	DISTRIBUTION (incl. Final Assembly) Description		Answer	Category index (fixed)
208	Is it an ICT or Consumer Electronics product <15 kg ?		NO	59
209	Is it an installed appliance (e.g. boiler)?		NO	60
				62
210	Volume of packaged final product in m^3	in m3	0,3648	63

Pos nr	USE PHASE Description		unit	Subtotals
211	Product Life in years	15	years	
	Electricity			
212	On-mode: Consumption per hour, cycle, setting, etc.	0,928	kWh	208,8
213	On-mode: No. Of hours, cycles, settings, etc. / year	225	#	
214	Standby-mode: Consumption per hour	0,0032	kWh	0,64
215	Standby-mode: No. Of hours / year	200	#	
216	Off-mode: Consumption per hour	0,00065	kWh	5,2
217	Off-mode: No. Of hours / year	8000	#	
	TOTAL over Product Life	3,22	MWh (=000 kWh)	65
	Heat			
218	Avg. Heat Power Output	1,95	kW	
219	No. Of hours / year	90	hrs.	
220	Type and efficiency (Click & select)			85-not applicable
	TOTAL over Product Life	9,48	GJ	
	Consumables (excl. spare parts)			material
221	Water	10,0125	m^3/year	83-Water per m3
222	Auxilliary material 1 (Click & select)	24,9333333	kg/ year	85-None
223	Auxilliary material 2 (Click & select)	20	kg/ year	85-None
224	Auxilliary material 3 (Click & select)	0	kg/ year	85-None
	Maintenance, Repairs, Service			
225	No. of km over Product-Life	160,00	km / Product Life	86
226	Spare parts (fixed, 1% of product materials & manuf.)	723	g	

Pos nr	DISPOSAL & RECYCLING Description		unit	Subtotals
	Substances released during Product Life and Landfill			
227	Refrigerant in the product (Click & select)	0	g	1-none
228	Percentage of fugitive & dumped refrigerant	0%		
229	Mercury (Hg) in the product	0	g Hg	
230	Percentage of fugitive & dumped mercury	0%		
	Disposal: Environmental Costs perkg final product			
231	Landfill (fraction products not recovered) in g en %	0		88-fixed
232	Incineration (plastics & PWB not re-used/recycled)	390	g	91-fixed
233	Plastics: Re-use & Recycling ("cost"-side)	11443	g	92-fixed
	Re-use, Recycling Benefit	in g	% of plastics fraction	
234	Plastics: Re-use, Closed Loop Recycling (please edit%)	3159	27%	4
235	Plastics: Materials Recycling (please edit% only)	8283	70%	4
236	Plastics: Thermal Recycling (please edit% only)	390	3%	72
237	Electronics: PWB Easy to Disassemble ? (Click&select)	0	YES	98
238	Metals & TV Glass & Misc. (95% Recycling)	57456		fixed

Table B.6: WM 5 kg OUTPUT – EuP-Ecoreport

Version 5 VHK for European Commission 28 Nov. 2005 | Document subject to a legal notice (see below))

EuP EcoReport: RESULTS

ECO-DESIGN OF ENERGY-USING PRODUCTS | **Assessment of Environmental Impact**

Table . Life Cycle Impact (per unit) of WM 5 kg MEDIA

Nr	Life cycle Impact per product:	Date	Author
0	WM 5 kg	21/05/07	0

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	g			**11536**			381	11155	**11536**	**0**
2	TecPlastics	g			**298**			10	288	**298**	**0**
3	Ferro	g			**33850**			0	33850	**33850**	**0**
4	Non-ferro	g			**3804**			0	3804	**3804**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**172**			172	0	**172**	**0**
7	Misc.	g			**22653**			0	22653	**22653**	**0**
	Total weight	g			**72313**			563	71750	**72313**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	2943	887	**3830**	**547**	**34230**	101	608	**-507**	**38100**
9	of which, electricity (in primary MJ)	MJ	391	531	**923**	**1**	**33815**	0	47	**-47**	**34692**
10	Water (process)	ltr	1350	8	**1358**	**0**	**152455**	0	31	**-31**	**153782**
11	Water (cooling)	ltr	857	248	**1105**	**0**	**90160**	0	260	**-260**	**91005**
12	Waste, non-haz./ landfill	g	66171	2949	**69120**	**290**	**39889**	37	183	**-146**	**109153**
13	Waste, hazardous/ incinerated	g	175	0	**176**	**6**	**781**	391	29	**362**	**1324**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	195	49	**245**	**34**	**1508**	7	15	**-8**	**1778**
15	Ozone Depletion, emissions	mg R-11 eq.				negligible					
16	Acidification, emissions	g SO2 eq.	1656	213	**1870**	**102**	**8754**	27	39	**-12**	**10714**
17	Volatile Organic Compounds (VOC)	g	7	0	**7**	**8**	**19**	2	0	**1**	**35**
18	Persistent Organic Pollutants (POP)	ng i-Teq	414	13	**427**	**2**	**226**	0	0	**0**	**654**
19	Heavy Metals	mg Ni eq.	2399	30	**2429**	**15**	**687**	24	0	**24**	**3154**
	PAHs	mg Ni eq.	190	0	**190**	**19**	**153**	0	2	**-2**	**360**
20	Particulate Matter (PM, dust)	g	355	33	**388**	**1248**	**1601**	380	5	**375**	**3612**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	1597	0	**1597**	**0**	**234**	2	0	**2**	**1833**
22	Eutrophication	g PO4	40	0	**41**	**0**	**1**	0	1	**-1**	**41**
23	Persistent Organic Pollutants (POP)	ng i-Teq				negligible					

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

Legal notice
This document does not necessarily reflect the view of the European Commission. It was drafted to the best of ability within budget restrictions. VHK and the European Commission do not assume any liability for any material or immaterial damage from using this document or information contained therein.
Copyright ©Van Holsteijn en Kemna BV 2005. Distribution rights European Commission 2005. Duplication allowed if source, draft version and legal notice are mentioned.

B.1 ANNEX C: SIMAPRO DATA

B.1.1 The SimaPro v.7.1 software

Even if it is not in the scope of this study to perform a LCA in full accordance with ISO 14040, the methodology was applied as close as possible. To this end a specialized LCA software tool was used, the SimaPro 7.1, the last version of the software[1].

This software allows one to perform an ecological balance of a product along all its life, taking into account for each material used, raw material extraction, energy and water consumption (with distinction between renewable and non renewable resources) , and related impacts in air, water, soil. Again it is possible to use specific models for energy production, waste treatment, transport and ancillary materials production. It is also possible to use and compare different environmental impact assessment methodologies (Ecoindicator, CML, EPS, Ecopoint…) performing sensitivity analysis. Again in this software many databases are included in a form to be used for a same ecobalance (avoiding double sum of an impact or loss of data).

Using SimaPro it is possible to simulate the LCA of products or services according to the ISO14040 standards.

B.1.2 Input data in SimaPro

B.1.2.1 Dishwashers

Table B.1: DW12ps assembling

Name			
DW12ps assembling	as average on data from producers		
Materials/assembling			Notes
Steel I	424	g	galvanized steel
Crude iron I	2421	g	Iron
Steel I	1334	g	Prepainted Steel
X5CrNi18 (304) I	9136	g	Stainless Steel
Steel I	6870	g	Steel
Steel I	7461	g	Steel strip
Steel I	1016	g	Steel+PA
Aluminium rec. I	272	g	
Brass, at plant/CH U	24	g	Brass
Chromium I	72	g	
Copper I	663	g	
Zinc I	4	g	
Cardboard duplex/tripl	639	g	for packaging
PS (EPS) B250 (1998)	733	g	for packaging
Kraft paper, bleached, at plant/RER U	3	g	for packaging
PE (LDPE) I	174	g	for packaging (PE foil) + laminating
Poplar I	1022	g	wood
ABS I	785	g	
EPDM rubber ETH U	547	g	
PS (EPS) B250 (1998)	41	g	

– [1] Wdit by Prè, NL, see http://www.pre.nl/simapro/default.htm .

PA 6 I	416	g	
PB B250 (1998)	37	g	as PBT
PE (HDPE) I	196	g	as PE
PMMA I	6	g	
HDPE B250	240	g	
PP I	5170	g	
PP I	34	g	as PP volute
PS (EPS) B250 (1998)	534	g	
PUR semi rigid foam I	3	g	PU foam - insulation
PVC B250	192	g	
PVC B250	229	g	
adhesive - glue	10	g	as adhesive
Bitumen refinery Europe U	6157	g	
Concrete I	1277	g	
Cotton fabric I	457	g	
Liquid epoxy resins E	247	g	cotton+resins noise adsorbers
Cotton fibres I	247	g	cotton+resins noise adsorbers
Electronics for control units/RER U	453	g	electronics
Kraft paper, bleached, at plant/RER U	208	g	
Liquid epoxy resins E	121	g	
Electronics for control units/RER U	10	g	AS THERMOSTAT (10 g)
Copper, at regional storage/RER U	354	g	AS WIRING
Poplar I	2057	g	wood
Water demineralized ETH U	88	kg	PROCESS WATER
Paint ETH S	53	g	white painting powder (53 g)
Processi			
Electricity MV use in UCPTE U	17,31	kWh	during assembling
Heat gas B250	9,2	kWh	
Truck 28t B250	23	tkm	transport for assembling
Sea ship B250	10	tkm	transport for assemnling
Hot rolling, steel/RER U	8511	g	
Sheet rolling, steel/RER U	4398	g	
Extruding alum I	136	g	
Wire drawing, copper/RER U	509	g	
Foaming, expanding/RER U	918	g	
Injection moulding/RER U	5201	g	
Extrusion PVC I	295	g	

Table B.2: DW12ps consumables (per year)

Name DW12ps use materials (per year)			
Materials/assembling			Notes
Tap water, at user/CH U	3,85	ton	
Detergent C - EN 50242 or IEC 60436 DW	7,25	kg	
Rinsing agent DW	1,02	kg	
Sodium chloride, powder, at plant/RER U	7,835	kg	Salt dishw.

Table B.3: DW12ps Life cycle

Lyfe Cycle: Name DW12			
Assembling			Note
DW12ps assembling	1	p	

Processes			
Electricity LV use UCPTE U	2930	kWh	consumption of electricity over the life cycle (on-mode, stand-by,
Delivery van (<3.5t) B250	8,11	tkm	transport over product life for maintenance, repairs, service

Table B.4: DW12ps End of Life Scenario

Name		
DW12 EoL		
Assembling		
DW12ps assembling	1	p
Processes		
Disposal		
Recycling only B250 avoided	82	
Incineration B250 (98) avoided	15	
Landfill B250 (98)	3	

B.1.2.2 Washing machines

Table B.5: WM5kg assembling

Assembly:				
Name WM 5kg assembling	as average on data from producers			
Materials/assembling			Notes	
Cast iron ETH U	6524,7	g		
Crude iron I	5226,8	g	Iron	
X5CrNi18 (304) I	2036,16	g	Stainless Steel	
X5CrNi18 (304) I	592	g	Stainless Steel sheet + laminating	
Steel I	13147,4 1	g	steel	
Steel I	6452,25	g	steel strip + laminating	
Aluminium rec. I	1519	g		
Aluminium rec. I	736	g	aluminium casting	
Brass, at plant/CH U	14,38	g	Brass	
Copper I	352	g	copper + wiring	
Chromium I	1779	g		
Copper I	878	g		
Nickel I	0,8	g		
Zinc I	85,65	g		
Cardboard duplex/tripl	111	g	for packaging	
PS (EPS) B250 (1998)	705	g	for packaging	
Kraft paper, bleached, at plant/RER U	10,5	g	for packaging	
PE (LDPE) I	182	g	for packaging (PE foil) + laminating	
PP I	8	g		
Poplar I	915	g	wood	
ABS I	1261	g		
EPDM rubber ETH U	1846	g		
PA 6 I	6,6	g		
PA 66 GF30 I	0,5	g		

PA 66 I	96,75	g		
PC I	207	g		
PC 30% glass fibre I	2,73	g		
PE (HDPE) I	11,24	g	as PE	
HDPE B250	45	g	as POM	
PP granulate average B250	5952	g	as PP	
PP granulate average B250	2790,6	g	as PP-k40	
PP granulate average B250	2,1	g	as PPO	
PP GF30 I	83,74	g	as PPS-GF	
PVC B250	244	g		
PB B250 (1998)	8,8	g	as PBT	
Bitumen refinery Europe U	38,53	g		
	18531,4			
Concrete I	7	g		
Electronics for control units/RER U	168,07	g	electronics	
PP granulate average B250	28,54	g	as filter	
Glass (white) B250	1807	g		
Gravel I	25	g		
Lubricating oil, at plant/RER U	28,54	g		
Kraft paper, bleached, at plant/RER U	108	g		
Copper I	89	g	+ wire	
Poplar I	2057	g	wood	
Water demineralized ETH U	590	kg		
Lubricating oil, at plant/RER U	45	g		
Processi				
Electricity MV use in UCPTE U	28,98	kWh	during assembling	
Heat gas B250	14,79	kWh		
Truck 28t B250	34	tkm	transport for assembling	
Sea ship B250	14	tkm	transport for assemnling	
Hot rolling, steel/RER U	10205	g		
Sheet rolling, steel/RER U	3522	g		
Extruding alum I	759	g		
Wire drawing, copper/RER U	220	g		
Foaming, expanding/RER U	552	g		
Injection moulding/RER U	8567	g		
Extrusion PVC I	171	g		

Table B.6: WM5kg consumables (per year)

Assembling:		
Name		
WM 5kg use materials (per year)		
Materials/assembling		
Tap water, at user/CH U	10,01	ton
Detergent powder WM	24,93	kg
Softening WM	20	kg

Table B.7: WM5kg Life cycle

Life Cycle:			
Name			
WM 5kg			

Assembling			
WM 5kg assembling	1	p	
Processes			
Electricity LV use UCPTE U	3220	kWh	consumption of electricity over the life cycle (on-mode, stand-by,
Delivery van (<3.5t) B250	11,88	tkm	transport over product life for maintenance, repairs, service
Disposal			
WM 5kg EoL			
Cicli di vita supplementari			
WM 5kg use materials (per LC)	1		

Table B.8: WM5kg End of Life Scenario

Name		
WM 5kg EoL		
Assembling		
WM 5kg assembling	1	p
Processes		
Disposal		
Recycling only B250 avoided	82	
Incineration B250 (98) avoided	3	
Landfill B250 (98)	15	

B.1.3 Detergents and other Washing chemicals simulation

Table B.9: Average composition of detergent for washing machine

Detergent for washing mashine	
COMPOSITION %	100
tensioattivi anionici 7-13	12
tensioattivi non ionici 1-5	4
sapone sodico 0-10	7
zeolite A 15-25	22
silicato sodico 1-5	4
carbonato sodico 0-10	7
solfato sodico 0-30	24
perborato sodico 10-25	20
attivatore del perborato 0-4	
componenti minori 0,2-0,5	

Table B.10: Average composition of softening agent for washing machine

Softening for washing mashine	
COMPOSIZIONE %	100,00
Tensioattivi cationici 5-15	15,00
Alcool isopropilico 2-5	5,00
Acidi grassi 0-4	4,00
Citrato sodico 0-2	2,00
Componenti minori: profumo, acidificanti 0,2-0,5	
water up to 100	74,00

Table B.11: Average composition of detergent for dish washer

Detergent for Dish Washer		
Composition		100
sodium tripoliphosphate	23	55
tri-sodium citrate diydrate	22,3	6
sodium perborate monoydrate	6	2
tetraacetyl etilen diammina	2	5
sodium disilicate	5	2
linear fatty alcoholo etoxillate	2	30
maleic acid	4	
protease	1	
amilase	0,7	
sodium carbonate		

Table B.12: Average composition of rinsing agent for dish washer

Rinsing agent for Dish Washer	
Components	100
linear fatty alcohol ethoxilate	15
cumene sulfonate	11,5
cytric acid	3
H2O	70,5

Table B.13: Input data on SimaPro for Detergent for washing machine

Products			
Detergent powder WM	100	kg	Chemicals\Washing agents
Resources			
Materials/fuels			
Fatty alcohol sulfonate, mix, at plant/RER U	16	kg	
Soap, at plant/RER U	7	kg	
Zeolite, powder, at plant/RER U	22	kg	
Sodium silicate, spray powder 80%, at plant/RER U	4	kg	
Sodium percarbonate, powder, at plant/RER U	7	kg	
Sodium sulphate, powder, production mix, at plant/RER U	24	kg	
Sodium perborate, tetrahydrate, powder, at plant/RER U	20	kg	

Table B.14: Input data on SimaPro for Softening for washing machine

Products			
Softening WM	100	kg	Chemicals\Washing agents
Avoided products			
Materials/fuels			
Fatty alcohol sulfonate, mix, at plant/RER U	15	kg	as cationic tensides
Fatty alcohol sulfonate, mix, at plant/RER U	5	kg	as isopropilic acid
Fatty acids, from vegetarian oil, at plant/RER U	4	kg	
Sodium perborate, monohydrate, powder, at plant/RER U	2	kg	as sodium citrate
Water demineralized ETH U	74	kg	

Table B.15: Input data on SimaPro for Detergent for Dish washer

Products			

Detergent C - EN 50242 or IEC 60436 DW	100	kg	Chemicals\Washing agents
Resources			
Materials/fuels			
Sodium tripolyphosphate, at plant/RER U	55	kg	
Sodium perborate, monohydrate, powder, at plant/RER U	6	kg	sodium perborate monohydrate
EDTA, ethylenediaminetetraacetic acid, at plant/RER U	2	kg	Tetraacetyl ethylendiamine
Sodium silicate, spray powder 80%, at plant/RER U	5	kg	sodium disilicate
Ethoxylated alcohols, unspecified, at plant/RER U	2	kg	linear fatty alcohol ethoxylate (non ionic surfactant, low foaming)
Sodium percarbonate, powder, at plant/RER U	30	kg	sodium carbonate

Table B.16: Input data on SimaPro for Rinsing agent for Dish washer

Products			
Rinsing agent DW	100	kg	Chemicals\Washing agents
Avoided products			
Resources			
Materials/fuels			
Ethoxylated alcohols, unspecified, at plant/RER U	15	kg	
Cumene, at plant/RER U	11,5	kg	
Acetic acid, 98% in H2O, at plant/RER U	3	kg	as citric acid (anhydrous)
Water, deionised, at plant/CH U	70,5	kg	H2O

B.1.4 Eco-indocator95 – rev. EuP v.2.03

The Eco-indicator 95 method was developed under the Dutch NOH programme by PRé consultants in a joint project with Philips Consumer Electronics, NedCar, Océ Copiers, Schuurink, CML Leiden, TU-Delft, IVAM-ER (Amsterdam) and CE Delft.

This V2 version is adapted for SimaPro 6.0. All characterisation factors in this method are entered for the 'unspecified' sub-compartment of each compartment (raw materials, air, water, soil) and thus applicable on all sub-compartments.

Other adaptations (V2.1):
- Solid waste expanded with all mass waste flows in SimaPro 6 database
- Energy expanded with energy resources in SimaPro 6 database
- Pesticides to water expanded with pesticides to water in SimaPro 6 database
- Carbon dioxide, biogenic and uptake from carbon dioxide from air (carbon dioxide, in air) are added to the methodology. Similar for 'Carbon monoxide, fossil' and 'carbon monoxide, biogenic'.

Other adaptations (August 2004):

– Energy expanded with energy resources in SimaPro not adapted in V2.1 (values taken from Cumulative energy demand V1.2 method)
– Greenhouse, Summer smog: Methane, biogenic and Methane, fossil added
– Euthrophication: phosphorus compounds completed.
– Acidification, Euthrophication: nitrogen compounds completed.
– Acidification: sulphur compounds completed.
– "Particulates, > 2,5 um, and < 10um" added with the assumption that the characterization factor is the same as for "Particulates, < 10 um"

Other adaptations (March 2005):
– Eutrophication: dinitrogen monoxide removed; nitrogen, to water added (equal to nitrogen, total, to water)
– Solid waste: waste, from drilling, unspecified added.

Other adaptations (August 2005, v.2.03):
– In impact category energy resources the characterisation value for "Gas, natural in ground" has been changed from 40,3 to 38,3 MJ LHV/m^3 following the ecoinvent 1.2 update.

This method is not fully adapted for inventory data from the ecoinvent library and the USA Input Output Database 98, and therefore omits emissions that could have been included in impact assessment.
The characterisation conforms to the CML guide used in the SimaPro2 method; however the toxicity scores are specified into heavy metals, carcinogenic substances, pesticides and winter smog.
Normalisation is based on 1990 levels for Europe excl. former USSR. In Europe ‘g’ missing data was extrapolated using GNP's (gross national product); ‘e’ missing data was extrapolated using energy use. The Europe ‘e’ normalisation is used in the Eco-indicator method.

Weighting is based on distance to target. Criteria for target levels are:
- One excess death per million per year
- 5% ecosystem degradation
- Avoidance of smog periods.

Due to continual adjustments of the method and/or inventory data sets the Eco-indicator 95 in SimaPro will not give the same result as the original printed version. See database manual for further information[2].

SimaPro 7.1	Method	Date:	08/08/2007	Period:	16.11.31
Project	EupProject				
Name	Eco-indicator 95 - rev EuP V2.03				
Comment	Revised by Laura Cutaia (29.07.07) to convert output in form of the software EuP Ecoreport				
Use Damage Assessment	No				
Use Normalization	Yes				
Use Weighting	Yes				
Use Addition	Yes				
Weighting	Pt				

– [2] More information and the "Manual for Designers" can also be downloaded from http://www.pre.nl

unit					
Impact category	greenhouse	kg CO2			
Air	(unspecified)	Carbon dioxide	000124-38-9	1	kg CO2 / kg
Air	(unspecified)	Carbon dioxide, biogenic	000124-38-9	1	kg CO2 / kg
Air	(unspecified)	Carbon dioxide, fossil	000124-38-9	1	kg CO2 / kg
Air	(unspecified)	Carbon dioxide, in air	000124-38-9	-1	kg CO2 / kg
Air	(unspecified)	Carbon monoxide	000630-08-0	1,57	kg CO2 / kg
Air	(unspecified)	Carbon monoxide, biogenic	000630-08-0	1,57	kg CO2 / kg
Air	(unspecified)	Carbon monoxide, fossil	000630-08-0	1,57	kg CO2 / kg
Air	(unspecified)	Chlorinated fluorocarbons, hard		7100	kg CO2 / kg
Air	(unspecified)	Chlorinated fluorocarbons, soft		1600	kg CO2 / kg
Air	(unspecified)	Chloroform	000067-66-3	25	kg CO2 / kg
Air	(unspecified)	Dinitrogen monoxide	010024-97-2	296	kg CO2 / kg
Air	(unspecified)	Ethane, 1-chloro-1,1-difluoro-, HCFC-142	000075-68-3	1800	kg CO2 / kg
Air	(unspecified)	Ethane, 1,1-dichloro-1-fluoro-, HCFC-141b	001717-00-6	580	kg CO2 / kg
Air	(unspecified)	Ethane, 1,1-difluoro-, HFC-152a	000075-37-6	150	kg CO2 / kg
Air	(unspecified)	Ethane, 1,1,1-trichloro-, HCFC-140	000071-55-6	100	kg CO2 / kg
Air	(unspecified)	Ethane, 1,1,1-trifluoro-, HCFC-143a	000420-46-2	3800	kg CO2 / kg
Air	(unspecified)	Ethane, 1,1,1,2-tetrafluoro-, HFC-134a	000811-97-2	1300	kg CO2 / kg
Air	(unspecified)	Ethane, 1,1,2-trichloro-1,2,2-trifluoro-, CFC-113	000076-13-1	4500	kg CO2 / kg
Air	(unspecified)	Ethane, 1,2-dichloro-1,1,2,2-tetrafluoro-, CFC-114	000076-14-2	7000	kg CO2 / kg
Air	(unspecified)	Ethane, 2-chloro-1,1,1,2-tetrafluoro-, HCFC-124	002837-89-0	440	kg CO2 / kg
Air	(unspecified)	Ethane, 2,2-dichloro-1,1,1-trifluoro-, HCFC-123	000306-83-2	90	kg CO2 / kg
Air	(unspecified)	Ethane, chloropentafluoro-, CFC-115	000076-15-3	7000	kg CO2 / kg
Air	(unspecified)	Ethane, hexafluoro-, HFC-116	000076-16-4	9200	kg CO2 / kg
Air	(unspecified)	Ethane, pentafluoro-, HFC-125	000354-33-6	3400	kg CO2 / kg
Air	(unspecified)	Methane	000074-82-8	21	kg CO2 / kg
Air	(unspecified)	Methane, biogenic	000074-82-8	21	kg CO2 / kg
Air	(unspecified)	Methane, bromochlorodifluoro-, Halon 1211	000353-59-3	4900	kg CO2 / kg
Air	(unspecified)	Methane, bromotrifluoro-, Halon 1301	000075-63-8	4900	kg CO2 / kg
Air	(unspecified)	Methane, chlorodifluoro-, HCFC-22	000075-45-6	1600	kg CO2 / kg
Air	(unspecified)	Methane, chlorotrifluoro-, CFC-13	000075-72-9	13000	kg CO2 / kg
Air	(unspecified)	Methane, dichloro-, HCC-30	000075-09-2	15	kg CO2 / kg
Air	(unspecified)	Methane, dichlorodifluoro-, CFC-12	000075-71-8	7100	kg CO2 / kg
Air	(unspecified)	Methane, fossil	000074-82-8	11	kg CO2 / kg
Air	(unspecified)	Methane, tetrachloro-, CFC-10	000056-23-5	1300	kg CO2 / kg
Air	(unspecified)	Methane, tetrafluoro-, FC-14	000075-73-0	6500	kg CO2 / kg
Air	(unspecified)	Methane, trichlorofluoro-, CFC-11	000075-69-4	3400	kg CO2 / kg
Air					
Air	ozone layer	kg CFC11			
Air	(unspecified)	Chlorinated fluorocarbons, hard		1	kg CFC11 / kg
Air	(unspecified)	Chlorinated fluorocarbons, soft		0,055	kg CFC11 / kg
Air	(unspecified)	Ethane, 1-chloro-1,1-difluoro-, HCFC-142	000075-68-3	0,065	kg CFC11 / kg
Air	(unspecified)	Ethane, 1,1-dichloro-1-fluoro-, HCFC-141b	001717-00-6	0,11	kg CFC11 / kg
Air	(unspecified)	Ethane, 1,1,1-trichloro-, HCFC-140	000071-55-6	0,12	kg CFC11 / kg
Air	(unspecified)	Ethane, 1,1,1-trifluoro-2,2-chlorobromo-, Halon 2311	000151-67-7	0,14	kg CFC11 / kg
Air	(unspecified)	Ethane, 1,1,1,2-tetrafluoro-2-bromo-, Halon 2401	000124-72-1	0,25	kg CFC11 / kg
Air	(unspecified)	Ethane, 1,1,2-trichloro-1,2,2-trifluoro-, CFC-113	000076-13-1	1,07	kg CFC11 / kg
Air	(unspecified)	Ethane, 1,2-dibromotetrafluoro-, Halon 2402	000124-73-2	7	kg CFC11 / kg
Air	(unspecified)	Ethane, 1,2-dichloro-1,1,2,2-tetrafluoro-, CFC-114	000076-14-2	0,8	kg CFC11 / kg
Air	(unspecified)	Ethane, 2-chloro-1,1,1,2-tetrafluoro-, HCFC-124	002837-89-0	0,022	kg CFC11 / kg
Air	(unspecified)	Ethane, 2,2-dichloro-1,1,1-trifluoro-, HCFC-123	000306-83-2	0,02	kg CFC11 / kg
Air	(unspecified)	Ethane, chloropentafluoro-, CFC-115	000076-15-3	0,5	kg CFC11 / kg
Air	(unspecified)	Methane, bromo-, Halon 1001	000074-83-9	0,6	kg CFC11 / kg
Air	(unspecified)	Methane, bromochlorodifluoro-, Halon 1211	000353-59-3	4	kg CFC11 / kg
Air	(unspecified)	Methane, bromodifluoro-, Halon 1201	001511-62-2	1,4	kg CFC11 / kg
Air	(unspecified)	Methane, bromotrifluoro-, Halon 1301	000075-63-8	16	kg CFC11 / kg
Air	(unspecified)	Methane, chlorodifluoro-, HCFC-22	000075-45-6	0,055	kg CFC11 / kg
Air	(unspecified)	Methane, chlorotrifluoro-, CFC-13	000075-72-9	1	kg CFC11 / kg
Air	(unspecified)	Methane, dibromodifluoro-, Halon 1202	000075-61-6	1,25	kg CFC11 / kg
Air	(unspecified)	Methane, dichlorodifluoro-, CFC-12	000075-71-8	1	kg CFC11 / kg
Air	(unspecified)	Methane, tetrachloro-, CFC-10	000056-23-5	1,08	kg CFC11 / kg
Air	(unspecified)	Methane, trichlorofluoro-, CFC-11	000075-69-4	1	kg CFC11 / kg
Air	(unspecified)	Propane, 1,3-dichloro-1,1,2,2,3-pentafluoro-, HCFC-225cb	000507-55-1	0,033	kg CFC11 / kg
Air	(unspecified)	Propane, 3,3-dichloro-1,1,1,2,2-pentafluoro-, HCFC-	000422-56-0	0,025	kg CFC11 / kg

		225ca			
Impact category	acidification	kg SO2			
Air	(unspecified)	Ammonia	007664-41-7	1,88	kg SO2 / kg
Air	(unspecified)	Ammonium carbonate	000506-87-6	0,67	kg SO2 / kg
Air	(unspecified)	Ammonium nitrate	006484-52-2	0,4	kg SO2 / kg
Air	(unspecified)	Ammonium, ion	014798-03-9	1,78	kg SO2 / kg
Air	(unspecified)	Dinitrogen monoxide	010024-97-2	1,78	kg SO2 / kg
Air	(unspecified)	Hydrogen chloride	007647-01-0	0,88	kg SO2 / kg
Air	(unspecified)	Hydrogen fluoride	007664-39-3	1,6	kg SO2 / kg
Air	(unspecified)	Hydrogen sulfide	007783-06-4	1,88	kg SO2 / kg
Air	(unspecified)	Nitric acid	007697-37-2	0,51	kg SO2 / kg
Air	(unspecified)	Nitric oxide	010102-43-9	1,07	kg SO2 / kg
Air	(unspecified)	Nitrogen dioxide	010102-44-0	0,7	kg SO2 / kg
Air	(unspecified)	Nitrogen oxides	011104-93-1	0,7	kg SO2 / kg
Air	(unspecified)	Sulfur dioxide	007446-09-5	1	kg SO2 / kg
Air	(unspecified)	Sulfur oxides		1	kg SO2 / kg
Air	(unspecified)	Sulfur trioxide	007446-11-9	0,8	kg SO2 / kg
Air	(unspecified)	Sulfuric acid	007664-93-9	0,65	kg SO2 / kg
Impact category	eutrophication	kg PO4			
Ground	(unspecified)	Ammonia	007664-41-7	0,33	kg PO4 / kg
Water	(unspecified)	Ammonia	007664-41-7	0,33	kg PO4 / kg
Air	(unspecified)	Ammonia	007664-41-7	0,33	kg PO4 / kg
Air	(unspecified)	Ammonium carbonate	000506-87-6	0,12	kg PO4 / kg
Ground	(unspecified)	Ammonium nitrate	006484-52-2	0,074	kg PO4 / kg
Air	(unspecified)	Ammonium nitrate	006484-52-2	0,074	kg PO4 / kg
Water	(unspecified)	Ammonium, ion	014798-03-9	0,33	kg PO4 / kg
Ground	(unspecified)	Ammonium, ion	014798-03-9	0,33	kg PO4 / kg
Air	(unspecified)	Ammonium, ion	014798-03-9	0,33	kg PO4 / kg
Water	(unspecified)	BOD5, Biological Oxygen Demand		0,11	kg PO4 / kg
Water	(unspecified)	COD, Chemical Oxygen Demand		0,05	kg PO4 / kg
Water	(unspecified)	DOC, Dissolved Organic Carbon		0,066	kg PO4 / kg
Water	(unspecified)	Kjeldahl-N		0,42	kg PO4 / kg
Air	(unspecified)	Nitrate	014797-55-8	0,1	kg PO4 / kg
Ground	(unspecified)	Nitrate	014797-55-8	0,1	kg PO4 / kg
Water	(unspecified)	Nitrate	014797-55-8	0,1	kg PO4 / kg
Ground	(unspecified)	Nitric acid	007697-37-2	0,093	kg PO4 / kg
Water	(unspecified)	Nitric acid	007697-37-2	0,093	kg PO4 / kg
Air	(unspecified)	Nitric acid	007697-37-2	0,093	kg PO4 / kg
Air	(unspecified)	Nitric oxide	010102-43-9	0,2	kg PO4 / kg
Water	(unspecified)	Nitrite	014797-65-0	0,13	kg PO4 / kg
Air	(unspecified)	Nitrite	014797-65-0	0,13	kg PO4 / kg
Water	(unspecified)	Nitrogen	007727-37-9	0,42	kg PO4 / kg
Air	(unspecified)	Nitrogen dioxide	010102-44-0	0,13	kg PO4 / kg
Air	(unspecified)	Nitrogen oxides	011104-93-1	0,13	kg PO4 / kg
Ground	(unspecified)	Nitrogen oxides	011104-93-1	0,13	kg PO4 / kg
Water	(unspecified)	Nitrogen oxides	011104-93-1	0,13	kg PO4 / kg
Ground	(unspecified)	Nitrogen, total		0,42	kg PO4 / kg
Water	(unspecified)	Nitrogen, total		0,42	kg PO4 / kg
Air	(unspecified)	Nitrogen, total		0,42	kg PO4 / kg
Ground	(unspecified)	Phosphate	014265-44-2	1	kg PO4 / kg
Air	(unspecified)	Phosphate	014265-44-2	1	kg PO4 / kg
Water	(unspecified)	Phosphate	014265-44-2	1	kg PO4 / kg
Ground	(unspecified)	Phosphoric acid	007664-38-2	0,97	kg PO4 / kg
Air	(unspecified)	Phosphoric acid	007664-38-2	0,97	kg PO4 / kg
Water	(unspecified)	Phosphoric acid	007664-38-2	0,97	kg PO4 / kg
Water	(unspecified)	Phosphorus	007723-14-0	3,06	kg PO4 / kg
Ground	(unspecified)	Phosphorus	007723-14-0	3,06	kg PO4 / kg
Air	(unspecified)	Phosphorus	007723-14-0	3,06	kg PO4 / kg
Ground	(unspecified)	Phosphorus pentoxide	001314-56-3	1,34	kg PO4 / kg
Water	(unspecified)	Phosphorus pentoxide	001314-56-3	1,34	kg PO4 / kg
Air	(unspecified)	Phosphorus pentoxide	001314-56-3	1,34	kg PO4 / kg
Ground	(unspecified)	Phosphorus, total		3,06	kg PO4 / kg
Water	(unspecified)	Phosphorus, total		3,06	kg PO4 / kg
Air	(unspecified)	Phosphorus, total		3,06	kg PO4 / kg

Water	(unspecified)	Suspended solids, inorganic		0,08	kg PO4 / kg
Water	(unspecified)	Suspended solids, unspecified		0,08	kg PO4 / kg
Water	(unspecified)	TOC, Total Organic Carbon		0,066	kg PO4 / kg
Impact category	heavy metals	kg Pb			
Water	(unspecified)	Antimony	007440-36-0	2	kg Pb / kg
Water	(unspecified)	Arsenic, ion	017428-41-0	1	kg Pb / kg
Water	(unspecified)	Barium	007440-39-3	0,014	kg Pb / kg
Water	(unspecified)	Boron	007440-42-8	0,03	kg Pb / kg
Air	(unspecified)	Cadmium	007440-43-9	50	kg Pb / kg
Air	(unspecified)	Cadmium oxide	001306-19-0	50	kg Pb / kg
Water	(unspecified)	Cadmium, ion	022537-48-0	3	kg Pb / kg
Water	(unspecified)	Chromium	007440-47-3	0,2	kg Pb / kg
Water	(unspecified)	Copper, ion	017493-86-6	0,005	kg Pb / kg
Air	(unspecified)	Heavy metals, unspecified		1	kg Pb / kg
Water	(unspecified)	Lead	007439-92-1	1	kg Pb / kg
Air	(unspecified)	Lead	007439-92-1	1	kg Pb / kg
Water	(unspecified)	Manganese	007439-96-5	0,02	kg Pb / kg
Air	(unspecified)	Manganese	007439-96-5	1	kg Pb / kg
Water	(unspecified)	Mercury	007439-97-6	10	kg Pb / kg
Air	(unspecified)	Mercury	007439-97-6	1	kg Pb / kg
Water	(unspecified)	Metallic ions, unspecified		0,002223	kg Pb / kg
Air	(unspecified)	Metals, unspecified		0,03867	kg Pb / kg
Water	(unspecified)	Molybdenum	007439-98-7	0,14	kg Pb / kg
Water	(unspecified)	Nickel, ion	014701-22-5	0,5	kg Pb / kg
Impact category	carcinogens	kg B(a)P			
Air	(unspecified)	Acrylonitrile	000107-13-1	0,00022	kg B(a)P / kg
Air	(unspecified)	Arsenic	007440-38-2	0,044	kg B(a)P / kg
Air	(unspecified)	Benzene	000071-43-2	0,000044	kg B(a)P / kg
Air	(unspecified)	Benzene, ethyl-	000100-41-4	0,000044	kg B(a)P / kg
Air	(unspecified)	Benzo(a)pyrene	000050-32-8	1	kg B(a)P / kg
Air	(unspecified)	Chromium VI	018540-29-9	0,44	kg B(a)P / kg
Air	(unspecified)	Ethene, chloro-	000075-01-4	0,000011	kg B(a)P / kg
Air	(unspecified)	Fluoranthene	000206-44-0	1	kg B(a)P / kg
Air	(unspecified)	Hydrocarbons, aromatic		0,000044	kg B(a)P / kg
Air	(unspecified)	Metals, unspecified		0,000179	kg B(a)P / kg
Air	(unspecified)	Nickel	007440-02-0	0,0044	kg B(a)P / kg
Air	(unspecified)	PAH, polycyclic aromatic hydrocarbons	130498-29-2	0,4792	kg B(a)P / kg
Air	(unspecified)	Tar	008007-45-2	0,000044	kg B(a)P / kg
Impact category	winter smog - P.M.	kg SPM			
Air	(unspecified)	Carbon black	001333-86-4	1	kg SPM / kg
Air	(unspecified)	Iron dust		1	kg SPM / kg
Air	(unspecified)	Particulates, < 10 um		1	kg SPM / kg
Air	(unspecified)	Particulates, < 10 um (mobile)		1	kg SPM / kg
Air	(unspecified)	Particulates, < 10 um (stationary)		1	kg SPM / kg
Air	(unspecified)	Particulates, < 2.5 um		1	kg SPM / kg
Air	(unspecified)	Particulates, > 2.5 um, and < 10um		1	kg SPM / kg
Air	(unspecified)	Particulates, diesel soot		1	kg SPM / kg
Air	(unspecified)	Particulates, SPM		1	kg SPM / kg
Air	(unspecified)	Soot		1	kg SPM / kg
Air	(unspecified)	Sulfur dioxide	007446-09-5	1	kg SPM / kg
Air	(unspecified)	Sulfur oxides		1	kg SPM / kg
Impact	summer smog	kg C2H4			

category	- VOCs				
Air	(unspecified)	2-Propanol	000067-63-0	0,196	kg C2H4 / kg
Air	(unspecified)	Acetaldehyde	000075-07-0	0,527	kg C2H4 / kg
Air	(unspecified)	Acetone	000067-64-1	0,178	kg C2H4 / kg
Air	(unspecified)	Acetonitrile	000075-05-8	0,416	kg C2H4 / kg
Air	(unspecified)	Acrolein	000107-02-8	0,603	kg C2H4 / kg
Air	(unspecified)	Acrylonitrile	000107-13-1	0,416	kg C2H4 / kg
Air	(unspecified)	Alcohols, unspecified		0,196	kg C2H4 / kg
Air	(unspecified)	Aldehydes, unspecified		0,443	kg C2H4 / kg
Air	(unspecified)	Benzaldehyde	000100-52-7	0,334	kg C2H4 / kg
Air	(unspecified)	Benzene	000071-43-2	0,189	kg C2H4 / kg
Air	(unspecified)	Benzene, ethyl-	000100-41-4	0,593	kg C2H4 / kg
Air	(unspecified)	Benzo(a)pyrene	000050-32-8	0,761	kg C2H4 / kg
Air	(unspecified)	Biphenyl	000092-52-4	0,761	kg C2H4 / kg
Air	(unspecified)	Biphenyl, hexachloro-	026601-64-9	0,761	kg C2H4 / kg
Air	(unspecified)	Butane	000106-97-8	0,41	kg C2H4 / kg
Air	(unspecified)	Butene	025167-67-3	0,992	kg C2H4 / kg
Air	(unspecified)	Caprolactam	000105-60-2	0,761	kg C2H4 / kg
Air	(unspecified)	Chloroform	000067-66-3	0,021	kg C2H4 / kg
Air	(unspecified)	Crude oil		0,398	kg C2H4 / kg
Air	(unspecified)	Diethyl ether	000060-29-7	0,398	kg C2H4 / kg
Air	(unspecified)	Ethane	000074-84-0	0,082	kg C2H4 / kg
Air	(unspecified)	Ethane, 1,1,1-trichloro-, HCFC-140	000071-55-6	0,021	kg C2H4 / kg
Air	(unspecified)	Ethane, 1,2-dichloro-	000107-06-2	0,021	kg C2H4 / kg
Air	(unspecified)	Ethanol	000064-17-5	0,268	kg C2H4 / kg
Air	(unspecified)	Ethene	000074-85-1	1	kg C2H4 / kg
Air	(unspecified)	Ethene, chloro-	000075-01-4	0,021	kg C2H4 / kg
Air	(unspecified)	Ethene, tetrachloro-	000127-18-4	0,005	kg C2H4 / kg
Air	(unspecified)	Ethene, trichloro-	000079-01-6	0,021	kg C2H4 / kg
Air	(unspecified)	Ethylene glycol	000107-21-1	0,196	kg C2H4 / kg
Air	(unspecified)	Ethylene oxide	000075-21-8	0,377	kg C2H4 / kg
Air	(unspecified)	Ethyne	000074-86-2	0,168	kg C2H4 / kg
Air	(unspecified)	Formaldehyde	000050-00-0	0,421	kg C2H4 / kg
Air	(unspecified)	Heptane	000142-82-5	0,529	kg C2H4 / kg
Air	(unspecified)	Hexane	000110-54-3	0,421	kg C2H4 / kg
Air	(unspecified)	Hydrocarbons, aliphatic, alkanes, cyclic		0,398	kg C2H4 / kg
Air	(unspecified)	Hydrocarbons, aliphatic, alkanes, unspecified		0,398	kg C2H4 / kg
Air	(unspecified)	Hydrocarbons, aliphatic, alkenes, unspecified		0,906	kg C2H4 / kg
Air	(unspecified)	Hydrocarbons, aliphatic, unsaturated		0,398	kg C2H4 / kg
Air	(unspecified)	Hydrocarbons, aromatic		0,761	kg C2H4 / kg
Air	(unspecified)	Hydrocarbons, chlorinated		0,021	kg C2H4 / kg
Air	(unspecified)	Hydrocarbons, halogenated		0,021	kg C2H4 / kg
Air	(unspecified)	Hydrocarbons, unspecified		0,398	kg C2H4 / kg
Air	(unspecified)	Hydroxy compounds, unspecified		0,377	kg C2H4 / kg
Air	(unspecified)	Kerosene	064742-81-0	0,398	kg C2H4 / kg
Air	(unspecified)	Ketones, unspecified		0,326	kg C2H4 / kg
Air	(unspecified)	Methane	000074-82-8	0,007	kg C2H4 / kg
Air	(unspecified)	Methane, biogenic	000074-82-8	0,007	kg C2H4 / kg
Air	(unspecified)	Methane, dichloro-, HCC-30	000075-09-2	0,021	kg C2H4 / kg
Air	(unspecified)	Methane, fossil	000074-82-8	0,007	kg C2H4 / kg
Air	(unspecified)	Methane, tetrachloro-, CFC-10	000056-23-5	0,021	kg C2H4 / kg
Air	(unspecified)	Methanol	000067-56-1	0,123	kg C2H4 / kg
Air	(unspecified)	Methyl ethyl ketone	000078-93-3	0,473	kg C2H4 / kg
Air	(unspecified)	Methyl mercaptan	000074-93-1	0,377	kg C2H4 / kg
Air	(unspecified)	Naphthalene	000091-20-3	0,761	kg C2H4 / kg
Air	(unspecified)	NMVOC, non-methane volatile organic compounds, unspecified origin		0,416	kg C2H4 / kg
Air	(unspecified)	PAH, polycyclic aromatic hydrocarbons	130498-29-2	0,04932	kg C2H4 / kg
Air	(unspecified)	Pentane	000109-66-0	0,408	kg C2H4 / kg
Air	(unspecified)	Petrol	008006-61-9	0,398	kg C2H4 / kg
Air	(unspecified)	Phenol	000108-95-2	0,761	kg C2H4 / kg
Air	(unspecified)	Phenol, chloro-	025167-80-0	0,021	kg C2H4 / kg
Air	(unspecified)	Phenol, pentachloro-	000087-86-5	0,021	kg C2H4 / kg
Air	(unspecified)	Phthalic anhydride	000085-44-9	0,761	kg C2H4 / kg
Air	(unspecified)	Propane	000074-98-6	0,42	kg C2H4 / kg
Air	(unspecified)	Propene	000115-07-1	1,03	kg C2H4 / kg
Air	(unspecified)	Propionic acid	000079-09-4	0,377	kg C2H4 / kg

Air	(unspecified)	Styrene	000100-42-5	0,761	kg C2H4 / kg
Air	(unspecified)	Tar	008007-45-2	0,416	kg C2H4 / kg
Air	(unspecified)	Terpentine		0,377	kg C2H4 / kg
Air	(unspecified)	Toluene	000108-88-3	0,563	kg C2H4 / kg
Air	(unspecified)	Vinyl acetate	000108-05-4	0,223	kg C2H4 / kg
Air	(unspecified)	VOC, volatile organic compounds		0,398	kg C2H4 / kg
Impact category	pesticides	kg act.subst			
Water	(unspecified)	2,4-D	000094-75-7	1	kg act.subst/kg
Water	(unspecified)	2,4,5-T	000093-76-5	1	kg act.subst / kg
Water	(unspecified)	Acephate	030560-19-1	1	kg act.subst / kg
Water	(unspecified)	Aldicarb	000116-06-3	1	kg act.subst / kg
Water	(unspecified)	Aldrin	000309-00-2	1	kg act.subst / kg
Water	(unspecified)	Anilazine	000101-05-3	1	kg act.subst / kg
Water	(unspecified)	Atrazine	001912-24-9	1	kg act.subst / kg
Water	(unspecified)	Azinphos-ethyl	002642-71-9	1	kg act.subst / kg
Water	(unspecified)	Azinphos-methyl	000086-50-0	1	kg act.subst / kg
Water	(unspecified)	Benomyl	017804-35-2	1	kg act.subst / kg
Water	(unspecified)	Bentazone	025057-89-0	1	kg act.subst / kg
Water	(unspecified)	Bifenthrin	082657-04-3	1	kg act.subst / kg
Water	(unspecified)	Bis(2-chloroethyl)ether	000111-44-4	1	kg act.subst / kg
Water	(unspecified)	Bis(chloromethyl)ether	000542-88-1	1	kg act.subst / kg
Water	(unspecified)	Captafol	002939-80-2	1	kg act.subst / kg
Water	(unspecified)	Captan	000133-06-2	1	kg act.subst / kg
Water	(unspecified)	Carbaryl	000063-25-2	1	kg act.subst / kg
Water	(unspecified)	Carbendazim	010605-21-7	1	kg act.subst / kg
Water	(unspecified)	Carbofuran	001563-66-2	1	kg act.subst / kg
Water	(unspecified)	Chlordane	012789-03-6	1	kg act.subst / kg
Water	(unspecified)	Chlorfenvinphos	000470-90-6	1	kg act.subst / kg
Water	(unspecified)	Chloridazon	001698-60-8	1	kg act.subst / kg
Water	(unspecified)	Chlorothalonil	001897-45-6	1	kg act.subst / kg
Water	(unspecified)	Chlorpropham	000101-21-3	1	kg act.subst / kg
Water	(unspecified)	Chlorpyrifos	002921-88-2	1	kg act.subst / kg
Water	(unspecified)	Coumafos	000056-72-4	1	kg act.subst / kg
Water	(unspecified)	Cyanazine	021725-46-2	1	kg act.subst / kg
Water	(unspecified)	Cypermethrin	052315-07-8	1	kg act.subst / kg
Water	(unspecified)	Cyromazine	066215-27-8	1	kg act.subst / kg
Water	(unspecified)	DDT	000050-29-3	1	kg act.subst / kg
Water	(unspecified)	Deltamethrin	052918-63-5	1	kg act.subst / kg
Water	(unspecified)	Demeton	008065-48-3	1	kg act.subst / kg
Water	(unspecified)	Desmetryn	001014-69-3	1	kg act.subst / kg
Water	(unspecified)	Diazinon	000333-41-5	1	kg act.subst / kg
Water	(unspecified)	Dichlorprop	000120-36-5	1	kg act.subst / kg
Water	(unspecified)	Dichlorvos	000062-73-7	1	kg act.subst / kg
Water	(unspecified)	Dieldrin	000060-57-1	1	kg act.subst / kg
Water	(unspecified)	Dimethoate	000060-51-5	1	kg act.subst / kg
Water	(unspecified)	Dinoseb	000088-85-7	1	kg act.subst / kg
Water	(unspecified)	Dinoterb	001420-07-1	1	kg act.subst / kg
Water	(unspecified)	Diquat dibromide	000085-00-7	1	kg act.subst / kg
Water	(unspecified)	Disinfectants, unspecified		1	kg act.subst / kg
Water	(unspecified)	Disulfothon	000298-04-4	1	kg act.subst / kg
Water	(unspecified)	Diuron	000330-54-1	1	kg act.subst / kg
Water	(unspecified)	DNOC	000534-52-1	1	kg act.subst / kg
Water	(unspecified)	Endosulfan	000115-29-7	1	kg act.subst / kg
Water	(unspecified)	Endrin	000072-20-8	1	kg act.subst / kg
Water	(unspecified)	Ethoprop	013194-48-4	1	kg act.subst / kg
Water	(unspecified)	Fenitrothion	000122-14-5	1	kg act.subst / kg
Water	(unspecified)	Fenthion	000055-38-9	1	kg act.subst / kg
Water	(unspecified)	Fentin acetate	000900-95-8	1	kg act.subst / kg
Water	(unspecified)	Fentin chloride	000639-58-7	1	kg act.subst / kg
Water	(unspecified)	Fentin hydroxide	000076-87-9	1	kg act.subst / kg
Water	(unspecified)	Folpet	000133-07-3	1	kg act.subst / kg
Water	(unspecified)	Fungicides, unspecified		1	kg act.subst / kg
Water	(unspecified)	Glyphosate	001071-83-6	1	kg act.subst / kg
Water	(unspecified)	Heptachlor	000076-44-8	1	kg act.subst / kg
Water	(unspecified)	Heptenophos	023560-59-0	1	kg act.subst / kg
Water	(unspecified)	Herbicides, unspecified		1	kg act.subst / kg

Water	(unspecified)	Insecticides, unspecified		1	kg act.subst / kg
Water	(unspecified)	Iprodione	036734-19-7	1	kg act.subst / kg
Water	(unspecified)	Isoproturon	034123-59-6	1	kg act.subst / kg
Water	(unspecified)	Lindane	000058-89-9	1	kg act.subst / kg
Water	(unspecified)	Lindane, alpha-	000319-84-6	1	kg act.subst / kg
Water	(unspecified)	Lindane, beta-	000319-85-7	1	kg act.subst / kg
Water	(unspecified)	Linuron	000330-55-2	1	kg act.subst / kg
Water	(unspecified)	Malathion	000121-75-5	1	kg act.subst / kg
Water	(unspecified)	Maneb	012427-38-2	1	kg act.subst / kg
Water	(unspecified)	MCPA	000094-74-6	1	kg act.subst / kg
Water	(unspecified)	Mecoprop	000093-65-2	1	kg act.subst / kg
Water	(unspecified)	Metamitron	041394-05-2	1	kg act.subst / kg
Water	(unspecified)	Metazachlor	067129-08-2	1	kg act.subst / kg
Water	(unspecified)	Methabenzthiazuron	018691-97-9	1	kg act.subst / kg
Water	(unspecified)	Methomyl	016752-77-5	1	kg act.subst / kg
Water	(unspecified)	Metobromuron	003060-89-7	1	kg act.subst / kg
Water	(unspecified)	Metolachlor	051218-45-2	1	kg act.subst / kg
Water	(unspecified)	Metribuzin	021087-64-9	1	kg act.subst / kg
Water	(unspecified)	Mevinfos	007786-34-7	1	kg act.subst / kg
Water	(unspecified)	Monolinuron	001746-81-2	1	kg act.subst / kg
Water	(unspecified)	Oxamyl	023135-22-0	1	kg act.subst / kg
Water	(unspecified)	Oxydemethon methyl	000301-12-2	1	kg act.subst / kg
Water	(unspecified)	Parathion	000056-38-2	1	kg act.subst / kg
Water	(unspecified)	Parathion, methyl	000298-00-0	1	kg act.subst / kg
Water	(unspecified)	Permethrin	052645-53-1	1	kg act.subst / kg
Water	(unspecified)	Pesticides, unspecified		1	kg act.subst / kg
Water	(unspecified)	Phoxim	014816-18-3	1	kg act.subst / kg
Water	(unspecified)	Pirimicarb	023103-98-2	1	kg act.subst / kg
Water	(unspecified)	Propachlor	001918-16-7	1	kg act.subst / kg
Water	(unspecified)	Propoxur	000114-26-1	1	kg act.subst / kg
Water	(unspecified)	Pyrazophos	013457-18-6	1	kg act.subst / kg
Water	(unspecified)	Simazine	000122-34-9	1	kg act.subst / kg
Water	(unspecified)	Thiram	000137-26-8	1	kg act.subst / kg
Water	(unspecified)	Tolclophos-methyl	057018-04-9	1	kg act.subst / kg
Water	(unspecified)	Triallate	002303-17-5	1	kg act.subst / kg
Water	(unspecified)	Triazofos	024017-47-8	1	kg act.subst / kg
Water	(unspecified)	Trichlorfon	000052-68-6	1	kg act.subst / kg
Water	(unspecified)	Trifluralin	001582-09-8	1	kg act.subst / kg
Water	(unspecified)	Zineb	012122-67-7	1	kg act.subst / kg
Impact category	energy resources	MJ LHV			
Prima	(unspecified)	Biomass, feedstock		1	MJ LHV / MJ
Prima	(unspecified)	Coal, 18 MJ per kg, in ground		18	MJ LHV / kg
Prima	(unspecified)	Coal, 26.4 MJ per kg, in ground		26,4	MJ LHV / kg
Prima	(unspecified)	Coal, 29.3 MJ per kg, in ground		29,3	MJ LHV / kg
Prima	(unspecified)	Coal, brown, 10 MJ per kg, in ground		10	MJ LHV / kg
Prima	(unspecified)	Coal, brown, 8 MJ per kg, in ground		8	MJ LHV / kg
Prima	(unspecified)	Coal, brown, in ground		10	MJ LHV / kg
Prima	(unspecified)	Coal, feedstock, 26.4 MJ per kg, in ground		26,4	MJ LHV / kg
Prima	(unspecified)	Coal, hard, unspecified, in ground		19,1	MJ LHV / kg
Prima	(unspecified)	Energy, from biomass		1	MJ LHV / MJ
Prima	(unspecified)	Energy, from coal		1	MJ LHV / MJ
Prima	(unspecified)	Energy, from coal, brown		1	MJ LHV / MJ
Prima	(unspecified)	Energy, from gas, natural		1	MJ LHV / MJ
Prima	(unspecified)	Energy, from hydro power		1	MJ LHV / MJ
Prima	(unspecified)	Energy, from hydrogen		1	MJ LHV / MJ
Prima	(unspecified)	Energy, from oil		1	MJ LHV / MJ
Prima	(unspecified)	Energy, from peat		1	MJ LHV / MJ
Prima	(unspecified)	Energy, from sulfur		1	MJ LHV / MJ
Prima	(unspecified)	Energy, from uranium		1	MJ LHV / MJ
Prima	(unspecified)	Energy, from wood		1	MJ LHV / MJ
Prima	(unspecified)	Energy, geothermal		1	MJ LHV / MJ
Prima	(unspecified)	Energy, gross calorific value, in biomass		1	MJ LHV / MJ
Prima	(unspecified)	Energy, kinetic, flow, in wind		1	MJ LHV / MJ
Prima	(unspecified)	Energy, potential, stock, in barrage water		1	MJ LHV / MJ
Prima	(unspecified)	Energy, recovered		1	MJ LHV / MJ
Prima	(unspecified)	Energy, solar		1	MJ LHV / MJ

Prima	(unspecified)	Energy, unspecified		1	MJ LHV / MJ
Prima	(unspecified)	Gas, mine, off-gas, process, coal mining/kg	008006-14-2	49,8	MJ LHV / kg
Prima	(unspecified)	Gas, mine, off-gas, process, coal mining/m3	008006-14-2	39,8	MJ LHV / m3
Prima	(unspecified)	Gas, natural, 30.3 MJ per kg, in ground	008006-14-2	30,3	MJ LHV / kg
Prima	(unspecified)	Gas, natural, 35 MJ per m3, in ground	008006-14-2	35	MJ LHV / m3
Prima	(unspecified)	Gas, natural, 36.6 MJ per m3, in ground	008006-14-2	36,6	MJ LHV / m3
Prima	(unspecified)	Gas, natural, 46.8 MJ per kg, in ground	008006-14-2	46,8	MJ LHV / kg
Prima	(unspecified)	Gas, natural, feedstock, 35 MJ per m3, in ground	008006-14-2	35	MJ LHV / m3
Prima	(unspecified)	Gas, natural, feedstock, 46.8 MJ per kg, in ground	008006-14-2	46,8	MJ LHV / kg
Prima	(unspecified)	Gas, natural, in ground	008006-14-2	38,3	MJ LHV / m3
Prima	(unspecified)	Gas, off-gas, oil production, in ground	008006-14-2	40,9	MJ LHV / m3
Prima	(unspecified)	Gas, petroleum, 35 MJ per m3, in ground		35	MJ LHV / m3
Prima	(unspecified)	Methane	000074-82-8	35,9	MJ LHV / kg
Prima	(unspecified)	Oil, crude, 38400 MJ per m3, in ground		38400	MJ LHV / m3
Prima	(unspecified)	Oil, crude, 41 MJ per kg, in ground		41	MJ LHV / kg
Prima	(unspecified)	Oil, crude, 42 MJ per kg, in ground		42	MJ LHV / kg
Prima	(unspecified)	Oil, crude, 42.6 MJ per kg, in ground		42,6	MJ LHV / kg
Prima	(unspecified)	Oil, crude, 42.7 MJ per kg, in ground		42,7	MJ LHV / kg
Prima	(unspecified)	Oil, crude, feedstock, 41 MJ per kg, in ground		41	MJ LHV / kg
Prima	(unspecified)	Oil, crude, feedstock, 42 MJ per kg, in ground		42	MJ LHV / kg
Prima	(unspecified)	Oil, crude, in ground		45,8	MJ LHV / kg
Prima	(unspecified)	Peat, in ground		13	MJ LHV / kg
Prima	(unspecified)	Steam from waste incineration		1	MJ LHV / MJ
Prima	(unspecified)	Uranium ore, 1.11 GJ per kg, in ground		1110	MJ LHV / kg
Prima	(unspecified)	Uranium, 2291 GJ per kg, in ground	007440-61-1	229100 0	MJ LHV / kg
Prima	(unspecified)	Uranium, 451 GJ per kg, in ground	007440-61-1	451000	MJ LHV / kg
Prima	(unspecified)	Uranium, 560 GJ per kg, in ground	007440-61-1	560000	MJ LHV / kg
Prima	(unspecified)	Uranium, in ground	007440-61-1	560000	MJ LHV / kg
Prima	(unspecified)	Water, barrage		0,01	MJ LHV / kg
Prima	(unspecified)	Wood and wood waste, 9.5 MJ per kg		9,5	MJ LHV / kg
Prima	(unspecified)	Wood, feedstock		15,3	MJ LHV / kg
Prima	(unspecified)	Wood, unspecified, standing/kg		15,3	MJ LHV / kg
Impact category	solid waste	kg			
Waste	(unspecified)	Aluminium waste		1	kg / kg
Waste	(unspecified)	Asbestos		1	kg / kg
Waste	(unspecified)	Asphalt waste		1	kg / kg
Waste	(unspecified)	Bilge oil		1	kg / kg
Waste	(unspecified)	Bitumen waste		1	kg / kg
Waste	(unspecified)	Bulk waste, unspecified		1	kg / kg
Waste	(unspecified)	Calcium fluoride waste		1	kg / kg
Waste	(unspecified)	Cardboard waste		1	kg / kg
Waste	(unspecified)	Carton waste		1	kg / kg
Waste	(unspecified)	Catalyst waste		1	kg / kg
Waste	(unspecified)	Cathode iron ingots waste		1	kg / kg
Waste	(unspecified)	Cathode loss		1	kg / kg
Waste	(unspecified)	Chemical waste, inert		1	kg / kg
Waste	(unspecified)	Chemical waste, regulated		1	kg / kg
Waste	(unspecified)	Chemical waste, unspecified		1	kg / kg
Waste	(unspecified)	Chromium waste		1	kg / kg
Waste	(unspecified)	Coal ash		1	kg / kg
Waste	(unspecified)	Coal tailings		1	kg / kg
Waste	(unspecified)	Construction waste		1	kg / kg
Waste	(unspecified)	Copper absorbent waste		1	kg / kg
Waste	(unspecified)	Copper waste		1	kg / kg
Waste	(unspecified)	Dross		1	kg / kg
Waste	(unspecified)	Dross for recycling		1	kg / kg
Waste	(unspecified)	Dust, break-out		1	kg / kg
Waste	(unspecified)	Dust, unspecified		1	kg / kg
Waste	(unspecified)	E-saving bulb plastic waste		1	kg / kg
Waste	(unspecified)	E-saving bulb waste		1	kg / kg
Waste	(unspecified)	Electronic waste		1	kg / kg
Waste	(unspecified)	Electrostatic filter dust		1	kg / kg
Waste	(unspecified)	Fluoride waste		1	kg / kg
Waste	(unspecified)	Fly ash		1	kg / kg
Waste	(unspecified)	Gas pipe waste		1	kg / kg

Waste	(unspecified)	Glass waste		1	kg / kg
Waste	(unspecified)	Ion exchanger sludge		1	kg / kg
Waste	(unspecified)	Iron waste		1	kg / kg
Waste	(unspecified)	Light bulb waste		1	kg / kg
Waste	(unspecified)	Limestone waste		1	kg / kg
Waste	(unspecified)	Metal waste		1	kg / kg
Waste	(unspecified)	Mineral waste		1	kg / kg
Waste	(unspecified)	Mineral waste, from mining		1	kg / kg
Waste	(unspecified)	Mineral wool waste		1	kg / kg
Waste	(unspecified)	Oil separator sludge		1	kg / kg
Waste	(unspecified)	Oil waste		1	kg / kg
Waste	(unspecified)	Packaging waste, paper and board		1	kg / kg
Waste	(unspecified)	Packaging waste, plastic		1	kg / kg
Waste	(unspecified)	Packaging waste, steel		1	kg / kg
Waste	(unspecified)	Packaging waste, unspecified		1	kg / kg
Waste	(unspecified)	Packaging waste, wood		1	kg / kg
Waste	(unspecified)	Paint waste		1	kg / kg
Waste	(unspecified)	Photovoltaic cell waste		1	kg / kg
Waste	(unspecified)	Photovoltaic panel waste		1	kg / kg
Waste	(unspecified)	Photovoltaic production waste		1	kg / kg
Waste	(unspecified)	Photovoltaic/EVA cell waste		1	kg / kg
Waste	(unspecified)	Plastic waste		1	kg / kg
Waste	(unspecified)	Polyethylene waste		1	kg / kg
Waste	(unspecified)	Polystyrene waste		1	kg / kg
Waste	(unspecified)	Polyvinyl chloride waste		1	kg / kg
Waste	(unspecified)	Printed circuitboards waste		1	kg / kg
Waste	(unspecified)	Process waste		1	kg / kg
Waste	(unspecified)	Production waste		1	kg / kg
Waste	(unspecified)	Production waste, not inert		1	kg / kg
Waste	(unspecified)	Propylene glycol waste		1	kg / kg
Waste	(unspecified)	Refinery sludge		1	kg / kg
Waste	(unspecified)	Rejects		1	kg / kg
Waste	(unspecified)	Rejects, corrugated cardboard		1	kg / kg
Waste	(unspecified)	Residues		1	kg / kg
Waste	(unspecified)	Slags		1	kg / kg
Waste	(unspecified)	Slags and ashes		1	kg / kg
Waste	(unspecified)	Sludge		1	kg / kg
Waste	(unspecified)	Soot		1	kg / kg
Waste	(unspecified)	Steel waste		1	kg / kg
Waste	(unspecified)	Stones and rubble		1	kg / kg
Waste	(unspecified)	Tin waste		1	kg / kg
Waste	(unspecified)	Tinder from rolling drum		1	kg / kg
Waste	(unspecified)	Waste in bioactive landfill		1	kg / kg
Waste	(unspecified)	Waste in incineration		1	kg / kg
Waste	(unspecified)	Waste in inert landfill		1	kg / kg
Waste	(unspecified)	Waste to recycling		1	kg / kg
Waste	(unspecified)	Waste, final, inert		1	kg / kg
Waste	(unspecified)	Waste, from drilling, unspecified		1	kg / kg
Waste	(unspecified)	Waste, from incinerator		1	kg / kg
Waste	(unspecified)	Waste, industrial		1	kg / kg
Waste	(unspecified)	Waste, inorganic		1	kg / kg
Waste	(unspecified)	Waste, nuclear, unspecified/kg		1	kg / kg
Waste	(unspecified)	Waste, solid		1	kg / kg
Waste	(unspecified)	Waste, toxic		1	kg / kg
Waste	(unspecified)	Waste, unspecified		1	kg / kg
Waste	(unspecified)	Welding dust		1	kg / kg
Waste	(unspecified)	Wood ashes		1	kg / kg
Waste	(unspecified)	Wood waste		1	kg / kg
Waste	(unspecified)	Wood, sawdust		1	kg / kg
Waste	(unspecified)	Zeolite waste		1	kg / kg
Waste	(unspecified)	Zinc waste		1	kg / kg
Impact category	Heavy metals (air)	kg Ni eq			
Air	(unspecified)	Arsenic	007440-38-2	3,33	kg Ni eq / kg
Air	(unspecified)	Cadmium	007440-43-9	5	kg Ni eq / kg
Air	(unspecified)	Chromium	007440-47-3	0,5	kg Ni eq / kg
Air	(unspecified)	Chromium-51	014392-02-0	0,5	kg Ni eq / kBq

Air	(unspecified)	Chromium VI	018540-29-9	0,5	kg Ni eq / kg
Air	(unspecified)	Copper	007440-50-8	0,5	kg Ni eq / kg
Air	(unspecified)	Lead	007439-92-1	0,04	kg Ni eq / kg
Air	(unspecified)	Mercury	007439-97-6	5	kg Ni eq / kg
Air	(unspecified)	Nickel	007440-02-0	1	kg Ni eq / kg
Air	(unspecified)	Zinc	007440-66-6	0,04	kg Ni eq / kg
Impact category	PAHs (air)	kg PAH/20 eq			
Air	(unspecified)	Carbon monoxide	000630-08-0	0,000002	kg PAH/20eq/ kg
Air	(unspecified)	Hydrocarbons, aromatic, naphthalenes, C13, trisubstituted		20	kg PAH/20eq/ kg
Air	(unspecified)	Hydrocarbons, aromatic, styrenes, C10		20	kg PAH/20eq/ kg
Air	(unspecified)	Hydrocarbons, aromatic, styrenes, C9		20	kg PAH/20eq/ kg
Air	(unspecified)	Polycyclic organic matter, as 15-PAH		20	kg PAH/20eq/ kg
Air	(unspecified)	Polycyclic organic matter, as 7-PAH		20	kg PAH/20eq/ kg
Air	(unspecified)	Polycyclic organic matter, unspecified		20	kg PAH/20eq/ kg
Impact category	Heavy metals (water)	kg Hg/20 eq			
Water	(unspecified)	Arsenic, ion	017428-41-0	3	kg Hg/20 eq / kg
Water	(unspecified)	Cadmium, ion	022537-48-0	7	kg Hg/20 eq / kg
Water	(unspecified)	Chromium	007440-47-3	0,4	kg Hg/20 eq / kg
Water	(unspecified)	Copper, ion	017493-86-6	2,8	kg Hg/20 eq / kg
Water	(unspecified)	Lead	007439-92-1	0,5	kg Hg/20 eq / kg
Water	(unspecified)	Mercury	007439-97-6	20	kg Hg/20 eq / kg
Water	(unspecified)	Nickel	007440-02-0	7	kg Hg/20 eq / kg
Water	(unspecified)	Zinc	007440-66-6	0,2	kg Hg/20 eq / kg
Water	(unspecified)	Zinc, ion	023713-49-7	0,2	kg Hg/20 eq / kg
Impact category	POP (air)	kg TE eq			
Air	(unspecified)	Dioxin, 1,2,3,7,8,9-hexachlorodibenzo-	019408-74-3	0,1	kg TE eq / kg
Air	(unspecified)	Dioxins, measured as 2,3,7,8-tetrachlorodibenzo-p-dioxin		1	kg TE eq / kg
Air	(unspecified)	Furan	000110-00-9	0,1	kg TE eq / kg
Impact category	POP (water)	kg TE eq			
Water	(unspecified)	Dioxin, 1,2,3,7,8,9-hexachlorodibenzo-	019408-74-3	0,1	kg TE eq / kg
Water	(unspecified)	Dioxins, measured as 2,3,7,8-tetrachlorodibenzo-p-dioxin		1	kg TE eq / kg
Water	(unspecified)	Furan	000110-00-9	0,1	kg TE eq / kg
Normalisation-Weighting set	Europe g				
Normalisation					
greenhouse	7,42E-05				
ozone layer	1,24				
acidification	0,00888				
eutrophication	0,0262				
heavy metals	17,8				
carcinogens	106				
winter smog - P.M.	0,0106				
summer smog - VOCs	0,0507				
pesticides	1,21				
energy resources	6,29E-06				
solid waste	0				
Heavy metals (air)	0				
PAHs (air)	0				
Heavy metals (water)	0				

POP (air)	0				
POP (water)	0				
Pesa					
greenhouse	2,5				
ozone layer	100				
acidification	10				
eutrophicatio n	5				
heavy metals	5				
carcinogens	10				
winter smog - P.M.	5				
summer smog - VOCs	2,5				
pesticides	25				
energy resources	0				
solid waste	0				
Heavy metals (air)	0				
PAHs (air)	0				
Heavy metals (water)	0				
POP (air)	0				
POP (water)	0				
Normalisatio n-Weighting set	Europe e				
Normalisatio n					
greenhouse	7,65E-05				
ozone layer	1,08				
acidification	0,00888				
eutrophicatio n	0,0262				
heavy metals	18,4				
carcinogens	92				
winter smog - P.M.	0,0106				
summer smog - VOCs	0,0558				
pesticides	1,04				
energy resources	6,29E-06				
solid waste	0				
Heavy metals (air)	18,4				
PAHs (air)	92				
Heavy metals (water)	18,4				
POP (air)	0				
POP (water)	0				
Pesa					
greenhouse	2,5				
ozone layer	100				
acidification	10				
eutrophicatio n	5				
heavy metals	5				
carcinogens	10				
winter smog - P.M.	5				
summer smog - VOCs	2,5				

pesticides	25				
energy resources	0				
solid waste	0				
Heavy metals (air)	5				
PAHs (air)	10				
Heavy metals (water)	5				
POP (air)	0				
POP (water)	0				

B.1.5 SimaPro vs. EuP-Ecoreport output

According to “MEUUP Report” by R. Kemna on methodology used in sw EuP-Ecoreport set up, it was possible to have SimaPro outputs in compliance with EuP ones (MEEuP Methodology Report, Final, table 25 and Eco-indicator 95 - rev EuP V2.03).

In 8.4 Eco-indicator 95 - rev EuP V2.03 methodology was fully reported, while in the following table the main indicators used for Simapro outputs, in compliance with EuP- Ecoreport outputs, were reported.

Table B.17: Output indicators in Ecoindicator95-rev EuP method

Eco-indicator 95 - rev EuP V2.03 (Revised by Laura Cutaia)

Environmental impact	Unit
greenhouse	kg CO2
ozone layer	kg CFC11
acidification	kg SO2
eutrophication	kg PO4
heavy metals	kg Pb
carcinogens	kg B(a)P
winter smog - P.M.	kg SPM
summer smog - VOCs	kg C2H4
pesticides	kg act.subst
energy resources	MJ LHV
solid waste	kg
Heavy metals (air)	kg Ni eq
PAHs (air)	kg PAH/20 eq
Heavy metals (water)	kg Hg/20 eq
POP (air)	kg TE eq
POP (water)	kg TE eq

Hereinafter outputs from LCA of DW12 ps and WM 5 kgs have been reported, using SimaPro sw and revised Ecoindicator 95 methodology explained before.

In summary using SimaPro it was possible:
- to use quite all inventory data from producers (BOM) ;
- to use data input in the software in compliance with that available by producers (SimaPro data base contains many more data than EuP and makes possible the “simulation” of new record with new “components” or “materials” – as for detergents and washing agents according to data from producers) ;

- to have compliance between outputs from characterization phase of Eco-Indicator 95 (one of the most used methodology in impact assessment) and EuP-Ecoreport outputs, according to the “chracterisation factors” used in this method (MEEuP by R. Kemna). See the following figure.

Figure B.1: MEEuP Report – Summary of MEEUP weighting factors used to adapting Ecoindicator 95 to EuP-Ecoreport evaluating method

Table 25. Summary MEEUP weighting factors

GHG emissions (air)	CO_2	CO	N_2O	CH_4	CF_4	C_2F_6	SF_6	R134a	other
weighting → CO_2 eq. GWP-100	**1**	**1.57**	**296**	**21**	**6500**	**9200**	**22200**	**1300**	**IPCC**

Acidification emissions (air)	SO_X	NO_X	N_2O	NH_3	HF	HCl	H_2S	H_2SO_4
AP weighting → SO_2 equivalent	**1**	**0.7**	**1.78**	**1.88**	**1.6**	**0.88**	**1.88**	**0.65**

Heavy Metals (air)	Cd	Hg	As	HMU	Ni	Cr	Cu	Pb	Zn	MU
HM weighting -> Ni eq.	**5**	**5**	**3.33**	**2**	**1**	**0.5**	**0.5**	**0.04**	**0.04**	**0.01**

PAHs (air)	PAHs	C6H6	CO
HM weighting -> Ni eq.	**20**	**0.004**	**0.000002**

MU= Metals Unspecified
HMU= Heavy Metals Unspecified. *=preliminary factors

Heavy Metals (water)	Hg	Cd	Ni*	As	HMU	Cu*	Pb*	Cr	Zn
HM Weighting factor → Hg/20 eq.	**20**	**7**	**7**	**3**	**3**	**2.8**	**0.5**	**0.4**	**0.2**

Eutrophication (water)	P	P_2O_5	PO_4	N	NH_4+	NO_3-	BOD	Suspended Solids	DOC	TOC	COD
EP weighting → PO_4 equivalent	**3.07**	**1.34**	**1**	**0.42**	**0.33**	**0.1**	**0.11**	**0.08**	**0.066**	**0.066**	**0.05**

EC Directives and official EU references with threshold and conversion values from which the weighting factors are derived: *IPCC* (GWP), *EC 850/2004* (POP), *2001/81/EC* (SO_x, NO_x, NH_3, VOC), *1999/30/EC* (SO_2, NO_x, PM and Pb), *2000/69/EC* (aromatics, CO), *COM(2003)423* (As, Cd, Hg, Ni, PAHs), *1999/13/EC* & 2002/3/EC (VOC), *EC 2037/2000* (ODP), *91/271/EC & 98/15/EEC* (BOD, COD, P, N, susp. Solids to water), *76/464/EEC* (Metals etc. to water).

In any case in SimaPro it was not possibile to “simulate” distribution phase for final products, for lack of data from producers or from other sources; on the countrary in EuP-Ecoreport simulation of impacts due to distribution is considered by an “internal system”.

B.1.5.1 12 place settings dishwasher

In the following table outputs for DW12 ps have been reported. In ored to compare it with that from EuP-Ecoreport outputs it has to be underlined:

- “DW12ps assembling” in Simapro corresponds to “Production total” in EuP; “assembling” for Simapro includes materials production, transport, forming and assembling also if these items have been calculated separately as in the outputs in 8.6;
- “Electricity LV use UCPTE U”+ “Delivery van (<3.5t) B250” + “DW12 ps Use consumables (per LC)” corresponds to “Use” in EuP;
- “DW12 EoL” corresponds to “End of Life”.

According to the methodology explained and on the correspondence of the outputs (as in the first row - Row in EuP-Ecoreport) it has been possibile to make comparable SimaPro and EuP-Ecoreport outputs.
Main results are in the following table (LCA output by SimaPro according to Ecoindicator 95).

Table B.18: DW12 ps – LCA output (Ecoindicator95-rev EuP method)

Row in	Impact category	Unit	Total	DW12ps	Electricity	Delivery	DW12	DW12 ps

EuP-Ecoreport				assembling	LV use UCPTE U	van (<3.5t) B250	EoL	Use consumables (per LC)
14	greenhouse	kg CO2	2.318,08	202,89	1.756,35	4,68	-39,90	394,06
15	ozone layer	kg CFC11	0,00	0,00	0,00	0,00	-0,00	0,00
16	acidification	kg SO2	19,83	3,11	12,80	0,02	-0,14	4,04
22	eutrophication	kg PO4	2,68	0,24	0,43	0,00	-0,01	2,02
	heavy metals	kg Pb	0,03	0,00	0,01	0,00	-0,00	0,01
	carcinogens	kg B(a)P	0,00	0,00	0,00	0,00	-0,00	0,00
20	winter smog - P.M.	kg SPM	17,01	2,74	10,73	0,01	-0,08	3,62
17	summer smog - VOCs	kg C2H4	0,62	0,17	0,39	0,01	-0,03	0,08
	pesticides	kg act.subst	0,04	0,04	0,00	0,00	0,00	0,00
8	energy resources	MJ LHV	51.242,25	4.502,73	41.615,08	59,86	-562,20	5.626,78
12 (+13)	solid waste	kg	106,10	96,18	50,00	0,00	-40,08	0,00
19	Heavy metals (air)	kg Ni eq	0,01	0,00	0,00	0,00	-0,00	0,00
19,1	PAHs (air)	kg PAH/20 eq	0,00	0,00	0,00	0,00	-0,00	0,00
21	Heavy metals (water)	kg Hg/20 eq	0,06	0,00	0,02	0,00	-0,00	0,04
18	POP (air)	kg TE eq	0,00	0,00	0,00	0,00	0,00	0,00
23	POP (water)	kg TE eq	0,00	0,00	0,00	0,00	0,00	0,00

In the following table the same LCA output by SimaPro according to Ecoindicator 95 revised accordingly to EuP-Ecoreports outputs has been reported.

Table B.19: DW12 ps – LCA output (Ecoindicator95-rev EuP method) adapted to them of EuP-Ecoreport

Row in EuP-Ecoreport	Impact category	Unit	DW12ps assembling - Production total	USE	DW12 EoL	Total
8	energy resources	MJ LHV	4.502,73	47.301,72	-562,20	51.242,25
12 (+13)	solid waste	kg	96,18	50,00	-40,08	106,10
14	greenhouse	kg CO2	202,89	2.155,09	-39,90	2.318,08
15	ozone layer	kg CFC11	0,00	0,00	-0,00	0,00
16	acidification	kg SO2	3,11	16,85	-0,14	19,83
17	summer smog - VOCs	kg C2H4	0,17	0,49	-0,03	0,62
18	POP (air)	kg TE eq	0,00	0,00	0,00	0,00
19	Heavy metals (air)	kg Ni eq	0,00	0,00	-0,00	0,01
19,1	PAHs (air)	kg PAH/20 eq	0,00	0,00	-0,00	0,00
20	winter smog - P.M.	kg SPM	2,74	14,36	-0,08	17,01
21	Heavy metals (water)	kg Hg/20 eq	0,00	0,05	-0,00	0,06
22	eutrophication	kg PO4	0,24	2,46	-0,01	2,68
23	POP (water)	kg TE eq	0,00	0,00	0,00	0,00
	heavy metals	kg Pb	0,00	0,03	-0,00	0,03
	carcinogens	kg B(a)P	0,00	0,00	-0,00	0,00
	pesticides	kg act.subst	0,04	0,00	0,00	0,04

In the following table outputs by SW EuP-Ecoreport has been reported, in a way to be compared with that in tables below .

Table B.20: DW12 ps – LCA output from EuP-Ecoreport

			PRODUCTION Total	DISTRIBUTION	USE	END-OF-LIFE	Total
8	Total Energy (GER)	MJ	**3945**	**595**	**34487**	**-291**	**38736**
9	of which, electricity (in primary MJ)	MJ	**1142**	**1**	**30771**	**-29**	**31886**
10	Water (process)	ltr	**1955**	**0**	**50274**	**-19**	**52209**
11	Water (cooling)	ltr	**1213**	**0**	**82039**	**-160**	**83093**
12	Waste, non-haz./ landfill	g	**66470**	**313**	**40158**	**781**	**107723**
13	Waste, hazardous/ incinerated	g	**409**	**6**	**789**	**1514**	**2718**

14	Greenhouse Gases in GWP100	kg CO2 eq.	**270**	**37**	**1519**	**0**	**1825**
15	Ozone Depletion, emissions	mg R-11 eq.					
16	Acidification, emissions	g SO2 eq.	**2155**	**111**	**8828**	**7**	**11101**
17	Volatile Organic Compounds (VOC)	g	**9**	**8**	**19**	**1**	**37**
18	Persistent Organic Pollutants (POP)	ng i-Teq	**433**	**2**	**228**	**6**	**669**
19	Heavy Metals	mg Ni eq.	**3249**	**16**	**700**	**53**	**4018**
	PAHs	mg Ni eq.	**152**	**20**	**152**	**-2**	**322**
20	Particulate Matter (PM, dust)	g	**295**	**1370**	**1601**	**431**	**3698**
21	Heavy Metals	mg Hg/20	**2150**	**0**	**222**	**13**	**2385**
22	Eutrophication	g PO4	**57**	**0**	**4859**	**0**	**4917**
23	Persistent Organic Pollutants (POP)	ng i-Teq					

B.1.5.2 5kg washing machine

In the following Tables Simapro and EuP-Ecoreport outputs have been reported; methodology, remarks and considerations are the same than DW12 ps described before

Table B.21: WM 5 kg – LCA output (Ecoindicator95-rev EuP method)

Row in EuP-Ecoreport	Categoria d'impatto	Unità	Totale	WM 5kg assembling	Electricity LV use UCPTE U	Delivery van (<3.5t) B250	WM 5kg EoL	WM 5kg use materials (per LC)
14	greenhouse	kg CO2	3,42E+03	6,44E+02	1,93E+03	6,86E+00	-5,66E+01	8,95E+02
15	ozone layer	kg CFC11	1,44E-03	1,29E-04	1,25E-03	7,29E-06	-2,13E-05	7,73E-05
16	acidification	kg SO2	2,46E+01	6,13E+00	1,41E+01	2,55E-02	-2,49E-01	4,59E+00
22	eutrophication	kg PO4	1,75E+00	2,50E-01	4,74E-01	2,93E-03	-1,66E-02	1,04E+00
	heavy metals	kg Pb	3,70E-02	3,83E-03	1,52E-02	2,11E-05	-3,75E-04	1,83E-02
	carcinogens	kg B(a)P	1,27E-04	2,88E-05	4,64E-05	8,63E-08	-3,67E-05	8,81E-05
20	winter smog - P.M.	kg SPM	2,04E+01	5,02E+00	1,18E+01	1,03E-02	-1,74E-01	3,81E+00
17	summer smog - VOCs	kg C2H4	1,02E+00	2,91E-01	4,34E-01	1,91E-02	-4,62E-02	3,23E-01
	pesticides	kg act.subst	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
8	energy resources	MJ LHV	7,80E+04	1,23E+04	4,57E+04	8,77E+01	-8,43E+02	2,07E+04
12 (+13)	solid waste	kg	2,32E+02	2,09E+02	54,00E+00	0,00E+00	-4,01E+01	0,00E+00
19	Heavy metals (air)	kg Ni eq	8,02E-03	8,36E-04	3,67E-03	6,30E-06	-3,35E-05	3,55E-03
19,1	PAHs (air)	kg PAH/20 eq	2,96E-06	2,26E-06	1,23E-06	2,41E-07	-7,77E-07	1,00E-10
21	Heavy metals (water)	kg Hg/20 eq	7,05E-02	5,19E-03	1,95E-02	3,31E-06	-8,89E-04	4,66E-02
18	POP (air)	kg TE eq	2,84E-09	2,15E-09	4,08E-10	0,00E+00	2,59E-11	2,52E-10
23	POP (water)	kg TE eq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Table B.22: WM 5 kg – LCA output (Ecoindicator95-rev EuP method) adapted to them of EuP-Ecoreport

Row in EuP-Ecoreport	Categoria d'impatto	Unità	Totale	WM 5kg assembling	Electricity LV use UCPTE U	Delivery van (<3.5t) B250	WM 5kg EoL	WM 5kg use materials (per LC)
8	energy resources	MJ LHV	7,80E+04	1,23E+04	4,57E+04	8,77E+01	-8,43E+02	2,07E+04
12 (+13)	solid waste	kg	2,32E+02	2,09E+02	54,00E+00	0,00E+00	-4,01E+01	0,00E+00
14	greenhouse	kg CO2	3,42E+03	6,44E+02	1,93E+03	6,86E+00	-5,66E+01	8,95E+02
15	ozone layer	kg CFC11	1,44E-03	1,29E-04	1,25E-03	7,29E-06	-2,13E-05	7,73E-05
16	acidification	kg SO2	2,46E+01	6,13E+00	1,41E+01	2,55E-02	-2,49E-01	4,59E+00
17	summer smog - VOCs	kg C2H4	1,02E+00	2,91E-01	4,34E-01	1,91E-02	-4,62E-02	3,23E-01
18	POP (air)	kg TE eq	2,84E-09	2,15E-09	4,08E-10	0,00E+00	2,59E-11	2,52E-10
19	Heavy metals (air)	kg Ni eq	8,02E-03	8,36E-04	3,67E-03	6,30E-06	-3,35E-05	3,55E-03
19,1	PAHs (air)	kg PAH/20 eq	2,96E-06	2,26E-06	1,23E-06	2,41E-07	-7,77E-07	1,00E-10
20	winter smog - P.M.	kg SPM	2,04E+01	5,02E+00	1,18E+01	1,03E-02	-1,74E-01	3,81E+00

21	Heavy metals (water)	kg Hg/20 eq	7,05E-02	5,19E-03	1,95E-02	3,31E-06	-8,89E-04	4,66E-02
22	eutrophication	kg PO4	1,75E+00	2,50E-01	4,74E-01	2,93E-03	-1,66E-02	1,04E+00
23	POP (water)	kg TE eq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	heavy metals	kg Pb	3,70E-02	3,83E-03	1,52E-02	2,11E-05	-3,75E-04	1,83E-02
	carcinogens	kg B(a)P	1,27E-04	2,88E-05	4,64E-05	8,63E-08	-3,67E-05	8,81E-05
	pesticides	kg act.subst	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Table B.23: DW12 ps – LCA output from EuP-Ecoreport

	Resources Use and Emissions		Production	Distribution	Use	End of Life	Total
8	Total Energy (GER)	MJ	3830	547	34230	-507	38100
9	of which, electricity (in primary MJ)	MJ	923	1	33815	-47	34692
10	Water (process)	ltr	1358	0	152455	-31	153782
11	Water (cooling)	ltr	1105	0	90160	-260	91005
12	Waste, non-haz./ landfill	g	69120	290	39889	-146	109153
13	Waste, hazardous/ incinerated	g	176	6	781	362	1324
14	Greenhouse Gases in GWP100	kg CO2 eq.	245	34	1508	-8	1778
15	Ozone Depletion, emissions	mg R-11 eq.					
16	Acidification, emissions	g SO2 eq.	1870	102	8754	-12	10714
17	Volatile Organic Compounds (VOC)	g	7	8	19	1	35
18	Persistent Organic Pollutants (POP)	ng i-Teq	427	2	226	0	654
19	Heavy Metals	mg Ni eq.	2429	15	687	24	3154
	PAHs	mg Ni eq.	190	19	153	-2	360
20	Particulate Matter (PM, dust)	g	388	1248	1601	375	3612
21	Heavy Metals	mg Hg/20	1597	0	234	2	1833
22	Eutrophication	g PO4	41	0	1	-1	41
23	Persistent Organic Pollutants (POP)	ng i-Teq					

Appendix C SimaPro output

C.1.1.1 12 place settings dishwasher

Table C.1: DW 12 ps – Assembling phase – Output of SimaPro with “Ecoindicator 95 rev EuP method”

Impact category	greenhouse	ozone layer	acidification	eutrophication	heavy metals	carcinogens	winter smog - P.M.	summer smog - VOCs	pesticides	energy resources	solid waste	Heavy metals (air)	PAHs (air)	Heavy metals (water)	POP (air)	POP (water)
Unit	kg CO2	kg CFC11	kg SO2	kg PO4	kg Pb	kg B(a)P	kg SPM	kg C2H4	kg act.subst	MJ LHV	kg	kg Ni eq	kg PAH/20 eq	kg Hg/20 eq	kg TE eq	kg TE eq
Total	2,03E+02	7,30E-05	3,11E+00	2,37E-01	3,71E-03	2,69E-05	2,74E+00	1,70E-01	4,41E-02	4,50E+03	9,62E+01	9,82E-04	1,72E-06	3,59E-03	2,23E-09	1,05E-13
Steel I	4,54E-01	2,11E-09	4,33E-03	3,86E-04	9,46E-06	3,08E-07	2,84E-03	2,05E-04	0,00E+00	8,97E+00	4,85E-03	1,38E-06	2,86E-08	7,48E-07	4,24E-11	0,00E+00
Crude iron I	2,67E+00	1,24E-08	2,78E-02	2,49E-03	2,93E-05	1,76E-06	1,71E-02	1,28E-03	0,00E+00	6,06E+01	6,04E-01	4,99E-06	1,09E-07	3,87E-06	3,15E-15	0,00E+00
Steel I	1,43E+00	6,63E-09	1,36E-02	1,21E-03	2,98E-05	9,68E-07	8,93E-03	6,45E-04	0,00E+00	2,82E+01	1,52E-02	4,34E-06	9,01E-08	2,35E-06	1,33E-10	0,00E+00
X5CrNi18 (304) I	3,36E+01	6,41E-08	1,30E+00	1,18E-02	1,16E-04	3,65E-06	1,29E+00	4,28E-03	0,00E+00	4,87E+02	1,12E-01	1,68E-05	3,46E-07	1,50E-05	5,01E-10	0,00E+00
Steel I	7,36E+00	3,41E-08	7,02E-02	6,25E-03	1,53E-04	4,99E-06	4,60E-02	3,32E-03	0,00E+00	1,45E+02	7,85E-02	2,24E-05	4,64E-07	1,21E-05	6,87E-10	0,00E+00
Steel I	7,99E+00	3,71E-08	7,62E-02	6,79E-03	1,66E-04	5,42E-06	4,99E-02	3,61E-03	0,00E+00	1,58E+02	8,53E-02	2,43E-05	5,04E-07	1,32E-05	7,46E-10	0,00E+00
Steel I	1,09E+00	5,05E-09	1,04E-02	9,24E-04	2,27E-05	7,38E-07	6,80E-03	4,92E-04	0,00E+00	2,15E+01	1,16E-02	3,31E-06	6,86E-08	1,79E-06	1,02E-10	0,00E+00
Aluminium rec. I	3,63E-01	0,00E+00	6,07E-03	7,90E-05	8,31E-10	2,99E-11	5,96E-03	4,60E-04	0,00E+00	4,81E+00	5,36E-02	3,79E-08	6,71E-10	0,00E+00	0,00E+00	0,00E+00
Brass, at plant/CH U	4,81E-02	3,73E-09	2,36E-03	1,08E-04	6,82E-05	1,71E-07	2,30E-03	3,35E-05	0,00E+00	9,77E-01	0,00E+00	2,79E-05	0,00E+00	2,36E-06	2,94E-13	0,00E+00
Chromium I	8,90E-01	1,17E-09	4,03E-03	2,26E-04	1,42E-07	6,89E-10	4,14E-03	6,38E-05	0,00E+00	1,37E+01	1,68E-03	2,18E-08	2,21E-10	1,85E-07	2,97E-16	0,00E+00
Copper I	4,98E+00	3,09E-10	4,58E-01	2,12E-03	7,53E-08	3,45E-10	4,46E-01	1,84E-04	0,00E+00	6,29E+01	8,88E+01	2,25E-08	4,29E-09	4,90E-08	7,88E-17	0,00E+00
Zinc I	1,87E-02	1,18E-09	2,61E-04	9,06E-06	1,94E-07	5,21E-10	2,19E-04	3,57E-06	0,00E+00	2,51E-01	4,02E-03	4,12E-08	1,74E-11	1,94E-07	3,01E-16	0,00E+00
Cardboard duplex/tripl	4,13E-01	1,05E-07	2,03E-03	2,05E-04	1,99E-06	2,61E-08	1,48E-03	1,57E-04	0,00E+00	7,89E+00	7,81E-02	7,85E-07	4,20E-10	5,93E-07	0,00E+00	0,00E+00

Impact category	greenhouse	ozone layer	acidification	eutrophication	heavy metals	carcinogens	winter smog - P.M.	summer smog - VOCs	pesticides	energy resources	solid waste	Heavy metals (air)	PAHs (air)	Heavy metals (water)	POP (air)	POP (water)
PS (EPS) B250 (1998)	1,93E+00	1,06E-06	1,42E-02	1,20E-03	4,19E-06	5,34E-08	8,06E-03	1,61E-03	0,00E+00	5,65E+01	3,07E-02	6,94E-07	1,41E-09	1,56E-06	0,00E+00	0,00E+00
Kraft paper, bleached, at plant/RER U	-1,41E-03	5,06E-10	2,92E-05	1,46E-05	6,81E-08	5,04E-10	1,73E-05	1,73E-06	0,00E+00	2,43E-01	0,00E+00	9,38E-09	0,00E+00	2,23E-07	1,55E-14	0,00E+00
PE (LDPE) I	1,96E-01	0,00E+00	3,04E-03	2,90E-04	1,30E-07	1,55E-10	2,09E-03	1,45E-03	0,00E+00	1,45E+01	6,86E-03	0,00E+00	3,13E-10	0,00E+00	0,00E+00	0,00E+00
Poplar I	1,25E-01	2,55E-09	1,61E-03	2,61E-04	2,19E-07	1,45E-09	3,58E-04	1,88E-04	0,00E+00	2,57E+01	1,06E-01	4,43E-07	8,22E-10	4,04E-07	6,51E-16	0,00E+00
ABS I	2,64E+00	7,85E-07	1,39E-02	1,49E-03	8,37E-07	1,61E-08	7,85E-03	1,65E-03	0,00E+00	6,81E+01	9,54E-02	0,00E+00	5,97E-09	0,00E+00	0,00E+00	0,00E+00
EPDM rubber ETH U	1,75E+00	5,74E-06	1,47E-02	1,10E-03	4,73E-05	1,85E-07	1,21E-02	8,45E-03	0,00E+00	5,67E+01	0,00E+00	8,87E-06	1,50E-09	3,52E-05	7,03E-13	0,00E+00
PS (EPS) B250 (1998)	1,08E-01	5,90E-08	7,97E-04	6,70E-05	2,34E-07	2,99E-09	4,51E-04	9,02E-05	0,00E+00	3,16E+00	1,71E-03	3,88E-08	7,87E-11	8,71E-08	0,00E+00	0,00E+00
PA 6 I	3,30E+00	0,00E+00	7,03E-03	1,04E-03	4,52E-06	1,62E-08	2,09E-03	2,63E-03	0,00E+00	6,59E+01	5,32E-03	2,86E-06	7,59E-10	0,00E+00	0,00E+00	0,00E+00
PB B250 (1998)	1,33E-01	4,80E-08	1,05E-03	7,94E-05	1,14E-07	4,59E-10	6,29E-04	2,20E-04	0,00E+00	3,19E+00	3,51E-03	3,74E-08	8,88E-11	8,86E-08	0,00E+00	0,00E+00
PE (HDPE) I	1,84E-01	0,00E+00	2,56E-03	2,61E-04	1,38E-07	3,50E-11	1,57E-03	1,64E-03	0,00E+00	1,48E+01	6,28E-03	0,00E+00	2,35E-10	0,00E+00	0,00E+00	0,00E+00
PMMA I	3,67E-02	6,00E-09	2,67E-04	4,15E-05	5,82E-09	1,39E-11	1,74E-04	1,87E-05	0,00E+00	5,96E-01	7,46E-04	0,00E+00	2,88E-11	0,00E+00	0,00E+00	0,00E+00
HDPE B250	5,14E-01	2,57E-07	3,13E-03	3,22E-04	8,31E-07	2,41E-09	1,44E-03	1,73E-03	0,00E+00	1,78E+01	7,66E-03	2,28E-07	2,88E-10	7,69E-07	0,00E+00	0,00E+00
PP I	5,69E+00	0,00E+00	9,33E-02	7,02E-03	4,45E-06	4,62E-09	6,72E-02	2,67E-02	0,00E+00	4,08E+02	1,60E-01	0,00E+00	7,24E-09	0,00E+00	0,00E+00	0,00E+00
PP I	3,74E-02	0,00E+00	6,14E-04	4,62E-05	2,92E-08	3,04E-11	4,42E-04	1,76E-04	0,00E+00	2,69E+00	1,06E-03	0,00E+00	4,76E-11	0,00E+00	0,00E+00	0,00E+00
PS (EPS) B250 (1998)	1,41E+00	7,69E-07	1,04E-02	8,73E-04	3,05E-06	3,89E-08	5,87E-03	1,18E-03	0,00E+00	4,11E+01	2,23E-02	5,06E-07	1,03E-09	1,13E-06	0,00E+00	0,00E+00
PUR semi rigid foam I	1,37E-02	9,15E-11	1,23E-04	1,69E-05	6,46E-07	4,82E-11	9,47E-05	1,88E-05	0,00E+00	2,71E-01	2,33E-03	8,80E-10	1,48E-11	1,45E-08	2,33E-17	0,00E+00
PVC B250	3,97E-01	1,14E-07	4,69E-03	4,39E-04	1,96E-06	2,74E-09	2,50E-03	1,15E-03	0,00E+00	1,19E+01	2,49E-02	2,12E-07	1,04E-09	3,61E-06	0,00E+00	0,00E+00
PVC B250	4,73E-01	1,36E-07	5,59E-03	5,24E-04	2,34E-06	3,27E-09	2,98E-03	1,38E-03	0,00E+00	1,42E+01	2,97E-02	2,53E-07	1,24E-09	4,30E-06	0,00E+00	0,00E+00
adhesive - glue	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Bitumen refinery Europe U	3,27E+00	4,10E-05	2,48E-02	2,18E-03	3,23E-05	5,82E-08	1,72E-02	2,18E-02	0,00E+00	3,05E+02	0,00E+00	9,14E-06	7,82E-09	1,24E-05	1,24E-13	0,00E+00
Concrete I	8,55E-02	1,58E-09	4,46E-04	5,65E-05	1,30E-07	6,96E-10	1,47E-02	1,76E-05	0,00E+00	1,06E+00	2,21E-03	1,50E-08	1,02E-10	2,51E-07	4,03E-16	0,00E+00
Cotton fabric I	9,56E-01	5,70E-08	6,85E-03	8,72E-02	2,00E-04	2,53E-08	2,44E-02	3,05E-02	3,04E-02	4,91E+01	2,76E-01	5,40E-07	8,23E-10	2,13E-04	1,45E-14	0,00E+00

Impact category	greenhouse	ozone layer	acidification	eutrophication	heavy metals	carcinogens	winter smog - P.M.	summer smog - VOCs	pesticides	energy resources	solid waste	Heavy metals (air)	PAHs (air)	Heavy metals (water)	POP (air)	POP (water)
Liquid epoxy resins E	1,94E+00	1,23E-07	5,35E-03	3,04E-03	4,55E-07	8,60E-08	5,07E-03	5,57E-04	0,00E+00	3,39E+01	7,79E-02	6,37E-07	2,32E-09	5,94E-07	8,79E-28	7,05E-14
Cotton fibres I	9,76E-02	4,52E-10	9,03E-04	3,79E-02	1,46E-06	3,15E-10	9,03E-03	4,59E-05	1,37E-02	9,70E+00	2,54E-02	4,28E-09	1,69E-11	3,63E-06	1,15E-16	0,00E+00
Electronics for control units/RER U	4,24E+00	2,29E-07	3,48E-02	6,23E-03	5,85E-04	2,77E-06	3,05E-02	1,61E-03	0,00E+00	9,90E+01	0,00E+00	1,63E-04	0,00E+00	9,53E-04	3,92E-12	0,00E+00
Kraft paper, bleached, at plant/RER U	-9,79E-02	3,51E-08	2,03E-03	1,01E-03	4,72E-06	3,50E-08	1,20E-03	1,20E-04	0,00E+00	1,69E+01	0,00E+00	6,50E-07	0,00E+00	1,54E-05	1,08E-12	0,00E+00
Liquid epoxy resins E	9,52E-01	6,05E-08	2,62E-03	1,49E-03	2,23E-07	4,21E-08	2,49E-03	2,73E-04	0,00E+00	1,66E+01	3,81E-02	3,12E-07	1,14E-09	2,91E-07	4,30E-28	3,46E-14
Electronics for control units/RER U	9,36E-02	5,05E-09	7,69E-04	1,37E-04	1,29E-05	6,12E-08	6,74E-04	3,54E-05	0,00E+00	2,19E+00	0,00E+00	3,60E-06	0,00E+00	2,10E-05	8,65E-14	0,00E+00
Copper, at regional storage/RER U	5,92E-01	4,89E-08	4,32E-02	1,76E-03	1,33E-03	3,44E-06	4,30E-02	5,39E-04	0,00E+00	1,18E+01	0,00E+00	5,45E-04	0,00E+00	3,41E-05	4,48E-12	0,00E+00
Poplar I	2,52E-01	5,14E-09	3,24E-03	5,26E-04	4,41E-07	2,92E-09	7,21E-04	3,78E-04	0,00E+00	5,17E+01	2,13E-01	8,92E-07	1,66E-09	8,14E-07	1,31E-15	0,00E+00
Water demineralized ETH U	4,96E-02	6,52E-08	3,77E-04	1,48E-05	5,05E-07	1,25E-09	3,00E-04	1,57E-05	0,00E+00	1,13E+00	0,00E+00	2,48E-07	3,97E-11	1,08E-06	3,25E-15	0,00E+00
Paint ETH S	9,45E-02	8,07E-08	6,72E-04	2,65E-05	1,09E-05	6,67E-08	5,74E-04	4,31E-05	0,00E+00	1,81E+00	0,00E+00	3,66E-06	6,55E-11	7,05E-07	4,87E-15	0,00E+00
Electricity MV use in UCPTE U	9,19E+00	4,54E-06	6,57E-02	2,24E-03	6,24E-05	2,05E-07	5,49E-02	2,01E-03	0,00E+00	2,18E+02	0,00E+00	1,57E-05	4,48E-09	9,17E-05	5,70E-13	0,00E+00
Heat gas B250	2,01E+00	2,29E-08	2,46E-03	3,14E-04	7,49E-07	1,49E-07	1,06E-03	2,29E-04	0,00E+00	3,39E+01	0,00E+00	3,89E-07	1,60E-09	9,32E-07	0,00E+00	0,00E+00
Truck 28t B250	3,64E+00	4,06E-06	4,94E-02	8,31E-03	5,54E-06	2,84E-08	5,26E-03	9,13E-03	0,00E+00	4,77E+01	0,00E+00	1,92E-06	3,83E-08	1,52E-06	0,00E+00	0,00E+00
Sea ship B250	8,55E-02	9,51E-08	1,30E-03	2,91E-05	1,81E-06	3,96E-09	1,15E-03	8,36E-05	0,00E+00	1,18E+00	0,00E+00	7,83E-07	5,72E-11	6,86E-08	0,00E+00	0,00E+00
Hot rolling, steel/RER U	2,08E+00	1,71E-07	7,04E-03	3,11E-03	2,19E-04	2,41E-07	6,90E-03	1,51E-03	0,00E+00	4,39E+01	0,00E+00	6,11E-06	0,00E+00	2,24E-04	3,05E-12	0,00E+00
Sheet rolling, steel/RER U	1,33E+00	9,58E-08	6,19E-03	2,42E-03	1,81E-04	1,66E-07	5,93E-03	3,65E-04	0,00E+00	2,86E+01	0,00E+00	1,91E-06	0,00E+00	1,36E-03	2,95E-12	0,00E+00
Extruding alum I	8,40E+01	9,07E-06	6,56E-01	2,65E-02	2,63E-04	4,77E-07	4,83E-01	2,80E-02	0,00E+00	1,54E+03	5,15E+00	6,29E-05	2,64E-08	4,22E-04	7,52E-13	0,00E+00
Wire drawing, copper/RER U	9,93E-01	5,35E-08	7,22E-03	5,52E-04	8,53E-05	2,54E-07	6,22E-03	2,96E-04	0,00E+00	2,34E+01	0,00E+00	3,24E-05	0,00E+00	4,74E-05	4,43E-13	0,00E+00
Foaming, expanding/RER U	5,89E-01	7,79E-08	3,18E-03	2,28E-04	2,81E-06	3,22E-08	2,53E-03	5,75E-03	0,00E+00	1,19E+01	0,00E+00	1,93E-06	0,00E+00	2,69E-06	3,61E-14	0,00E+00
Injection	6,08E+00	3,79E-	2,82E-02	4,08E-03	4,80E-	4,36E-07	2,05E-	1,58E-	0,00E+00	1,52E+0	0,00E+0	9,05E-	0,00E+00	8,70E-05	7,87E-	0,00E+0

Impact category	greenhouse	ozone layer	acidification	eutrophication	heavy metals	carcinogens	winter smog - P.M.	summer smog - VOCs	pesticides	energy resources	solid waste	Heavy metals (air)	PAHs (air)	Heavy metals (water)	POP (air)	POP (water)
moulding/RER U		06			05		02	03		2	0	06			13	0
Extrusion PVC I	1,16E-01	0,00E+00	1,77E-03	1,31E-04	1,14E-08	5,27E-11	1,44E-03	3,39E-04	0,00E+00	1,63E+00	4,99E-03	1,27E-12	1,12E-10	0,00E+00	0,00E+00	0,00E+00

Table C.2: DW 12 ps – EoL phase – Output of SimaPro with "Ecoindicator 95 rev EuP method"

Impact category	Unit	Total	Recycling only B250 avoided	Incineration B250 (98) avoided	Landfill B250 (98)
greenhouse	kg CO2	-3,99E+01	-4,32E+01	3,23E+00	1,14E-01
ozone layer	kg CFC11	-1,25E-05	-1,23E-05	-2,06E-07	5,34E-09
acidification	kg SO2	-1,37E-01	-1,34E-01	-2,71E-03	9,05E-05
eutrophication	kg PO4	-1,29E-02	-1,29E-02	-4,06E-05	3,45E-05
heavy metals	kg Pb	-2,84E-04	-2,82E-04	-1,42E-06	7,99E-08
carcinogens	kg B(a)P	-6,88E-06	-6,86E-06	-2,34E-08	4,10E-11
winter smog - P.M.	kg SPM	-8,24E-02	-7,84E-02	-4,03E-03	3,91E-05
summer smog - VOCs	kg C2H4	-3,53E-02	-3,53E-02	-1,67E-05	3,88E-05
pesticides	kg act.subst	0,00E+00	0,00E+00	0,00E+00	0,00E+00
energy resources	MJ LHV	-5,81E+02	-5,60E+02	-2,08E+01	6,94E-02
solid waste	kg	-4,00E+01	-4,00E+01	0,00E+00	0,00E+00
Heavy metals (air)	kg Ni eq	-1,92E-05	-2,00E-05	6,97E-07	2,73E-08
PAHs (air)	kg PAH/20 eq	-5,94E-07	-5,99E-07	5,54E-09	5,29E-11
Heavy metals (water)	kg Hg/20 eq	-8,49E-04	-8,42E-04	-8,00E-06	9,65E-07
POP (air)	kg TE eq	1,04E-10	0,00E+00	1,04E-10	1,29E-14
POP (water)	kg TE eq	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Table C.3: DW 12 ps – Life Cycle – Output of SimaPro with "Ecoindicator 95 rev EuP method"

Impact category	Unit	Total	DW12ps assembling	Electricity LV use UCPTE U	Delivery van (<3.5t) B250	DW12 EoL	DW12 ps Use consumables (per LC)
greenhouse	kg CO2	2,32E+03	2,03E+02	1,76E+03	4,68E+00	-3,99E+01	3,94E+02
ozone layer	kg CFC11	1,23E-03	7,30E-05	1,14E-03	4,98E-06	-1,22E-05	2,69E-05
acidification	kg SO2	1,98E+01	3,11E+00	1,28E+01	1,74E-02	-1,36E-01	4,04E+00
eutrophication	kg PO4	2,68E+00	2,37E-01	4,32E-01	2,00E-03	-1,25E-02	2,02E+00
heavy metals	kg Pb	3,12E-02	3,71E-03	1,38E-02	1,44E-05	-2,88E-04	1,40E-02
carcinogens	kg B(a)P	9,39E-05	2,69E-05	4,23E-05	5,89E-08	-6,89E-06	3,16E-05
winter smog - P.M.	kg SPM	1,70E+01	2,74E+00	1,07E+01	7,02E-03	-8,31E-02	3,62E+00
summer smog - VOCs	kg C2H4	6,24E-01	1,70E-01	3,95E-01	1,31E-02	-3,27E-02	7,89E-02
pesticides	kg act.subst	4,41E-02	4,41E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00
energy resources	MJ LHV	5,12E+04	4,50E+03	4,16E+04	5,99E+01	-5,62E+02	5,63E+03
solid waste	kg	5,61E+01	9,62E+01	0,00E+00	0,00E+00	-4,01E+01	0,00E+00
Heavy metals (air)	kg Ni eq	5,61E-03	9,82E-04	3,34E-03	4,30E-06	-1,99E-05	1,30E-03
PAHs (air)	kg PAH/20 eq	2,41E-06	1,72E-06	1,12E-06	1,64E-07	-5,94E-07	0,00E+00
Heavy metals (water)	kg Hg/20 eq	5,71E-02	3,59E-03	1,78E-02	2,26E-06	-8,55E-04	3,65E-02
POP (air)	kg TE eq	2,83E-09	2,23E-09	3,71E-10	0,00E+00	9,69E-11	1,30E-10
POP (water)	kg TE eq	1,05E-13	1,05E-13	0,00E+00	0,00E+00	0,00E+00	0,00E+00

C.1.1.2 5kg washing machine

Table C.4: WM 5 – Assembling phase – Output of SimaPro with “Ecoindicator 95 rev EuP method”

Impact category	greenhouse	ozone layer	acidification	eutrophication	heavy metals	carcinogens	winter smog - P.M.	summer smog - VOCs	pesticides	energy resources	solid waste	Heavy metals (air)	PAHs (air)	Heavy metals (water)	POP (air)	POP (water)
Unit	kg CO2	kg CFC11	kg SO2	kg PO4	kg Pb	kg B(a)P	kg SPM	kg C2H4	kg act.subst	MJ LHV	kg	kg Ni eq	kg PAH/20 eq	kg Hg/20 eq	kg TE eq	kg TE eq
Total	6,44E+02	1,29E-04	6,13E+00	2,50E-01	3,83E-03	2,88E-05	5,02E+00	2,91E-01	0,00E+00	1,23E+04	2,09E+02	8,36E-04	2,26E-06	5,19E-03	2,15E-09	0,00E+00
Cast iron ETH U	2,80E+01	2,00E-05	2,04E-01	7,46E-03	6,20E-04	3,17E-06	1,77E-01	1,38E-02	0,00E+00	4,29E+02	0,00E+00	2,07E-04	3,32E-07	5,53E-04	3,03E-11	0,00E+00
Crude iron I	5,76E+00	2,67E-08	6,00E-02	5,37E-03	6,32E-05	3,79E-06	3,68E-02	2,77E-03	0,00E+00	1,31E+02	1,30E+00	1,08E-05	2,36E-07	8,35E-06	6,81E-15	0,00E+00
X5CrNi18 (304) I	7,50E+00	1,43E-08	2,90E-01	2,62E-03	2,57E-05	8,14E-07	2,87E-01	9,54E-04	0,00E+00	1,09E+02	2,50E-02	3,75E-06	7,71E-08	3,35E-06	1,12E-10	0,00E+00
X5CrNi18 (304) I	2,18E+00	4,16E-09	8,44E-02	7,62E-04	7,49E-06	2,37E-07	8,35E-02	2,77E-04	0,00E+00	3,15E+01	7,26E-03	1,09E-06	2,24E-08	9,75E-07	3,24E-11	0,00E+00
Steel I	1,41E+01	6,53E-08	1,34E-01	1,20E-02	2,93E-04	9,54E-06	8,80E-02	6,36E-03	0,00E+00	2,78E+02	1,50E-01	4,28E-05	8,88E-07	2,32E-05	1,31E-09	0,00E+00
Steel I	6,91E+00	3,21E-08	6,59E-02	5,87E-03	1,44E-04	4,68E-06	4,32E-02	3,12E-03	0,00E+00	1,36E+02	7,38E-02	2,10E-05	4,36E-07	1,14E-05	6,45E-10	0,00E+00
Aluminium rec. I	2,02E+00	0,00E+00	3,39E-02	4,41E-04	4,64E-09	1,67E-10	3,33E-02	2,57E-03	0,00E+00	2,69E+01	2,99E-01	2,12E-07	3,75E-09	0,00E+00	0,00E+00	0,00E+00
Aluminium rec. I	9,81E-01	0,00E+00	1,64E-02	2,14E-04	2,25E-09	8,10E-11	1,61E-02	1,24E-03	0,00E+00	1,30E+01	1,45E-01	1,03E-07	1,82E-09	0,00E+00	0,00E+00	0,00E+00
Brass, at plant/CH U	2,88E-02	2,23E-09	1,42E-03	6,46E-05	4,09E-05	1,02E-07	1,38E-03	2,01E-05	0,00E+00	5,85E-01	0,00E+00	1,67E-05	0,00E+00	1,41E-06	1,76E-13	0,00E+00
Copper I	2,65E+00	1,64E-10	2,43E-01	1,12E-03	4,00E-08	1,83E-10	2,37E-01	9,76E-05	0,00E+00	3,34E+01	4,72E+01	1,20E-08	2,28E-09	2,60E-08	4,18E-17	0,00E+00
Chromium I	2,20E+01	2,89E-08	9,95E-02	5,60E-03	3,51E-06	1,70E-08	1,02E-01	1,58E-03	0,00E+00	3,39E+02	4,15E-02	5,39E-07	5,47E-09	4,57E-06	7,35E-15	0,00E+00
Copper I	6,60E+00	4,10E-10	6,06E-01	2,80E-03	9,97E-08	4,56E-10	5,91E-01	2,44E-04	0,00E+00	8,33E+01	1,18E+02	2,98E-08	5,68E-09	6,48E-08	1,04E-16	0,00E+00
Nickel I	2,13E-02	1,83E-11	1,32E-03	5,38E-06	1,69E-09	8,76E-12	1,33E-03	1,30E-06	0,00E+00	2,72E-01	2,54E-05	2,17E-10	6,18E-12	2,89E-09	4,66E-18	0,00E+00
Zinc I	4,00E-01	2,53E-08	5,60E-03	1,94E-04	4,16E-06	1,12E-08	4,70E-03	7,64E-05	0,00E+00	5,37E+00	8,61E-02	8,83E-07	3,72E-10	4,15E-06	6,45E-15	0,00E+00
Cardboard duplex/tripl	7,17E-02	1,83E-08	3,52E-04	3,56E-05	3,45E-07	4,53E-09	2,56E-04	2,72E-05	0,00E+00	1,37E+00	1,36E-02	1,36E-07	7,30E-11	1,03E-07	0,00E+00	0,00E+00
PS (EPS) B250 (1998)	1,86E+00	1,02E-06	1,37E-02	1,15E-03	4,03E-06	5,14E-08	7,75E-03	1,55E-03	0,00E+00	5,43E+01	2,95E-02	6,68E-07	1,35E-09	1,50E-06	0,00E+00	0,00E+00

Impact category	greenhouse	ozone layer	acidification	eutrophication	heavy metals	carcinogens	winter smog - P.M.	summer smog - VOCs	pesticides	energy resources	solid waste	Heavy metals (air)	PAHs (air)	Heavy metals (water)	POP (air)	POP (water)
Kraft paper, bleached, at plant/RER U	-4,94E-03	1,77E-09	1,02E-04	5,11E-05	2,39E-07	1,77E-09	6,04E-05	6,06E-06	0,00E+00	8,51E-01	0,00E+00	3,28E-08	0,00E+00	7,80E-07	5,44E-14	0,00E+00
PE (LDPE) I	2,05E-01	0,00E+00	3,18E-03	3,03E-04	1,36E-07	1,63E-10	2,18E-03	1,52E-03	0,00E+00	1,52E+01	7,17E-03	0,00E+00	3,28E-10	0,00E+00	0,00E+00	0,00E+00
PP I	8,81E-03	0,00E+00	1,44E-04	1,09E-05	6,88E-09	7,14E-12	1,04E-04	4,14E-05	0,00E+00	6,32E-01	2,48E-04	0,00E+00	1,12E-11	0,00E+00	0,00E+00	0,00E+00
Poplar I	1,12E-01	2,29E-09	1,44E-03	2,34E-04	1,96E-07	1,30E-09	3,21E-04	1,68E-04	0,00E+00	2,30E+01	9,48E-02	3,97E-07	7,36E-10	3,62E-07	5,83E-16	0,00E+00
ABS I	4,24E+00	1,26E-06	2,24E-02	2,39E-03	1,34E-06	2,59E-08	1,26E-02	2,65E-03	0,00E+00	1,09E+02	1,53E-01	0,00E+00	9,58E-09	0,00E+00	0,00E+00	0,00E+00
EPDM rubber ETH U	5,91E+00	1,94E-05	4,96E-02	3,72E-03	1,60E-04	6,23E-07	4,10E-02	2,85E-02	0,00E+00	1,91E+02	0,00E+00	2,99E-05	5,08E-09	1,19E-04	2,37E-12	0,00E+00
PA 6 I	5,23E-02	0,00E+00	1,12E-04	1,65E-05	7,17E-08	2,57E-10	3,31E-05	4,17E-05	0,00E+00	1,05E+00	8,44E-05	4,53E-08	1,20E-11	0,00E+00	0,00E+00	0,00E+00
PA 66 GF30 I	5,45E-03	5,00E-10	3,64E-05	3,99E-06	3,62E-09	1,11E-12	1,45E-05	5,98E-07	0,00E+00	5,85E-02	2,26E-04	0,00E+00	2,30E-12	1,82E-08	0,00E+00	0,00E+00
PA 66 I	1,17E+00	9,67E-08	7,30E-03	9,11E-04	5,89E-07	4,04E-10	2,81E-03	1,44E-04	0,00E+00	1,26E+01	2,95E-02	0,00E+00	8,13E-10	1,08E-06	0,00E+00	0,00E+00
PC I	1,13E+00	4,14E-07	5,76E-03	6,65E-04	2,40E-07	9,22E-10	2,69E-03	4,64E-04	0,00E+00	2,17E+01	4,28E-02	0,00E+00	1,49E-09	0,00E+00	0,00E+00	0,00E+00
PC 30% glass fibre I	1,09E-02	3,83E-09	5,69E-05	6,47E-06	5,18E-09	1,12E-11	2,72E-05	4,30E-06	0,00E+00	2,08E-01	4,22E-04	3,85E-10	1,39E-11	9,71E-10	1,55E-18	0,00E+00
PE (HDPE) I	1,06E-02	0,00E+00	1,47E-04	1,49E-05	7,93E-09	2,01E-12	8,99E-05	9,39E-05	0,00E+00	8,51E-01	3,60E-04	0,00E+00	1,35E-11	0,00E+00	0,00E+00	0,00E+00
HDPE B250	9,63E-02	4,82E-08	5,88E-04	6,04E-05	1,56E-07	4,52E-10	2,70E-04	3,25E-04	0,00E+00	3,33E+00	1,44E-03	4,28E-08	5,40E-11	1,44E-07	0,00E+00	0,00E+00
PP granulate average B250	1,12E+01	8,76E-06	1,08E-01	8,21E-03	2,65E-05	8,27E-08	6,55E-02	2,40E-02	0,00E+00	4,36E+02	1,86E-01	7,06E-06	8,33E-09	2,41E-05	0,00E+00	0,00E+00
PP granulate average B250	5,23E+00	4,11E-06	5,04E-02	3,85E-03	1,24E-05	3,88E-08	3,07E-02	1,12E-02	0,00E+00	2,04E+02	8,71E-02	3,31E-06	3,91E-09	1,13E-05	0,00E+00	0,00E+00
PP granulate average B250	3,94E-03	3,09E-09	3,79E-05	2,90E-06	9,36E-09	2,92E-11	2,31E-05	8,45E-06	0,00E+00	1,54E-01	6,55E-05	2,49E-09	2,94E-12	8,50E-09	0,00E+00	0,00E+00
PP GF30 I	7,74E-02	1,87E-10	1,17E-03	8,99E-05	1,41E-07	1,35E-10	8,33E-04	3,04E-04	0,00E+00	4,85E+00	2,63E-03	1,18E-08	8,72E-11	2,98E-08	4,76E-17	0,00E+00
PVC B250	5,04E-01	1,44E-07	5,96E-03	5,58E-04	2,49E-06	3,48E-09	3,17E-03	1,47E-03	0,00E+00	1,51E+01	3,16E-02	2,70E-07	1,32E-09	4,58E-06	0,00E+00	0,00E+00
PB B250 (1998)	3,17E-02	1,14E-08	2,49E-04	1,89E-05	2,72E-08	1,09E-10	1,50E-04	5,23E-05	0,00E+00	7,60E-01	8,35E-04	8,90E-09	2,11E-11	2,11E-08	0,00E+00	0,00E+00
Bitumen refinery Europe U	2,05E-02	2,57E-07	1,55E-04	1,36E-05	2,02E-07	3,64E-10	1,08E-04	1,36E-04	0,00E+00	1,91E+00	0,00E+00	5,72E-08	4,90E-11	7,78E-08	7,75E-16	0,00E+00
Concrete I	1,24E+00	2,30E-08	6,48E-03	8,21E-04	1,89E-06	1,01E-08	2,13E-01	2,55E-04	0,00E+00	1,54E+0	3,20E-02	2,18E-07	1,48E-09	3,64E-06	5,85E-15	0,00E+0

Impact category	greenhouse	ozone layer	acidification	eutrophication	heavy metals	carcinogens	winter smog - P.M.	summer smog - VOCs	pesticides	energy resources	solid waste	Heavy metals (air)	PAHs (air)	Heavy metals (water)	POP (air)	POP (water)
										1						0
Electronics for control units/RER U	1,57E+00	8,49E-08	1,29E-02	2,31E-03	2,17E-04	1,03E-06	1,13E-02	5,96E-04	0,00E+00	3,67E+01	0,00E+00	6,05E-05	0,00E+00	3,54E-04	1,45E-12	0,00E+00
PP granulate average B250	5,35E-02	4,20E-08	5,16E-04	3,94E-05	1,27E-07	3,97E-10	3,14E-04	1,15E-04	0,00E+00	2,09E+00	8,90E-04	3,38E-08	4,00E-11	1,16E-07	0,00E+00	0,00E+00
Glass (white) B250	1,38E+00	1,26E-06	8,07E-03	6,04E-04	8,34E-05	8,98E-09	4,86E-03	1,25E-03	0,00E+00	2,18E+01	1,23E-01	4,09E-06	2,84E-09	1,42E-06	0,00E+00	0,00E+00
Gravel I	2,18E-04	8,05E-12	2,39E-06	3,36E-07	6,62E-10	3,54E-12	6,09E-07	1,33E-07	0,00E+00	2,85E-03	1,20E-05	7,63E-11	8,53E-13	1,27E-09	2,05E-18	0,00E+00
Lubricating oil, at plant/RER U	2,78E-02	2,40E-08	2,49E-04	1,35E-04	3,90E-07	2,33E-09	2,01E-04	1,44E-04	0,00E+00	2,28E+00	0,00E+00	9,00E-08	0,00E+00	7,44E-07	6,81E-15	0,00E+00
Kraft paper, bleached, at plant/RER U	-5,08E-02	1,82E-08	1,05E-03	5,26E-04	2,45E-06	1,82E-08	6,22E-04	6,23E-05	0,00E+00	8,76E+00	0,00E+00	3,38E-07	0,00E+00	8,02E-06	5,60E-13	0,00E+00
Copper I	6,69E-01	4,15E-11	6,15E-02	2,84E-04	1,01E-08	4,62E-11	5,99E-02	2,47E-05	0,00E+00	8,45E+00	1,19E+01	3,02E-09	5,76E-10	6,57E-09	1,06E-17	0,00E+00
Poplar I	2,52E-01	5,14E-09	3,24E-03	5,26E-04	4,41E-07	2,92E-09	7,21E-04	3,78E-04	0,00E+00	5,17E+01	2,13E-01	8,92E-07	1,66E-09	8,14E-07	1,31E-15	0,00E+00
Water demineralized ETH U	3,32E-01	4,37E-07	2,52E-03	9,91E-05	3,39E-06	8,35E-09	2,01E-03	1,05E-04	0,00E+00	7,55E+00	0,00E+00	1,66E-06	2,66E-10	7,23E-06	2,18E-14	0,00E+00
Lubricating oil, at plant/RER U	4,38E-02	3,78E-08	3,93E-04	2,12E-04	6,15E-07	3,68E-09	3,17E-04	2,28E-04	0,00E+00	3,60E+00	0,00E+00	1,42E-07	0,00E+00	1,17E-06	1,07E-14	0,00E+00
Electricity MV use in UCPTE U	1,54E+01	7,60E-06	1,10E-01	3,74E-03	1,04E-04	3,44E-07	9,20E-02	3,36E-03	0,00E+00	3,64E+02	0,00E+00	2,63E-05	7,50E-09	1,54E-04	9,55E-13	0,00E+00
Heat gas B250	3,22E+00	3,69E-08	3,96E-03	5,05E-04	1,20E-06	2,39E-07	1,71E-03	3,68E-04	0,00E+00	5,45E+01	0,00E+00	6,26E-07	2,57E-09	1,50E-06	0,00E+00	0,00E+00
Truck 28t B250	5,38E+00	6,00E-06	7,30E-02	1,23E-02	8,20E-06	4,20E-08	7,78E-03	1,35E-02	0,00E+00	7,05E+01	0,00E+00	2,84E-06	5,67E-08	2,25E-06	0,00E+00	0,00E+00
Sea ship B250	1,20E-01	1,33E-07	1,82E-03	4,08E-05	2,53E-06	5,54E-09	1,61E-03	1,17E-04	0,00E+00	1,65E+00	0,00E+00	1,10E-06	8,01E-11	9,60E-08	0,00E+00	0,00E+00
Hot rolling, steel/RER U	2,49E+00	2,05E-07	8,44E-03	3,73E-03	2,63E-04	2,88E-07	8,28E-03	1,81E-03	0,00E+00	5,27E+01	0,00E+00	7,33E-06	0,00E+00	2,69E-04	3,65E-12	0,00E+00
Sheet rolling, steel/RER U	1,07E+00	7,67E-08	4,96E-03	1,94E-03	1,45E-04	1,33E-07	4,75E-03	2,92E-04	0,00E+00	2,29E+01	0,00E+00	1,53E-06	0,00E+00	1,09E-03	2,37E-12	0,00E+00
Extruding alum I	4,69E+02	5,06E-05	3,66E+00	1,48E-01	1,47E-03	2,66E-06	2,69E+00	1,56E-01	0,00E+00	8,57E+03	2,87E+01	3,51E-04	1,47E-07	2,36E-03	4,20E-12	0,00E+00
Wire drawing, copper/RER U	4,29E-01	2,31E-08	3,12E-03	2,39E-04	3,69E-05	1,10E-07	2,69E-03	1,28E-04	0,00E+00	1,01E+01	0,00E+00	1,40E-05	0,00E+00	2,05E-05	1,91E-13	0,00E+00

Impact category	greenhouse	ozone layer	acidification	eutrophication	heavy metals	carcinogens	winter smog - P.M.	summer smog - VOCs	pesticides	energy resources	solid waste	Heavy metals (air)	PAHs (air)	Heavy metals (water)	POP (air)	POP (water)
Foaming, expanding/RER U	3,54E-01	4,68E-08	1,91E-03	1,37E-04	1,69E-06	1,94E-08	1,52E-03	3,46E-03	0,00E+00	7,17E+00	0,00E+00	1,16E-06	0,00E+00	1,61E-06	2,17E-14	0,00E+00
Injection moulding/RER U	10,01081	6,25E-06	0,046411	0,006722	7,91E-05	7,18E-07	0,033831	0,002601	0	250,801	0	1,49E-05	0	0,000143	1,3E-12	0
Extrusion PVC I	0,067083	0	0,001029	7,58E-05	6,61E-09	3,05E-11	0,000833	0,000197	0	0,947131	0,00289	7,33E-13	6,5E-11	0	0	0

Table C.5: WM 5 – EoL phase – Output of SimaPro with "Ecoindicator 95 rev EuP method"

Impact category	Unit	Total	Recycling only B250 avoided	Incineration B250 (98) avoided	Landfill B250 (98)
greenhouse	kg CO2	-6,58E+01	-6,75E+01	8,93E-01	7,90E-01
ozone layer	kg CFC11	-2,33E-05	-2,33E-05	-4,93E-08	4,31E-08
acidification	kg SO2	-2,71E-01	-2,70E-01	-8,92E-04	5,12E-04
eutrophication	kg PO4	-1,92E-02	-1,94E-02	2,96E-06	1,53E-04
heavy metals	kg Pb	-4,39E-04	-4,38E-04	-1,24E-06	3,15E-07
carcinogens	kg B(a)P	-3,67E-05	-3,67E-05	-6,30E-09	2,96E-10
winter smog - P.M.	kg SPM	-1,85E-01	-1,84E-01	-1,08E-03	1,26E-04
summer smog - VOCs	kg C2H4	-5,61E-02	-5,64E-02	6,88E-06	2,82E-04
pesticides	kg act.subst	0,00E+00	0,00E+00	0,00E+00	0,00E+00
energy resources	MJ LHV	-9,62E+02	-9,70E+02	7,77E+00	5,39E-01
solid waste	kg	-4,92E+01	-4,92E+01	0,00E+00	0,00E+00
Heavy metals (air)	kg Ni eq	-3,81E-05	-3,83E-05	3,76E-08	1,56E-07
PAHs (air)	kg PAH/20 eq	-9,06E-07	-9,08E-07	1,58E-09	4,24E-10
Heavy metals (water)	kg Hg/20 eq	-1,08E-03	-1,08E-03	-2,38E-06	1,77E-06
POP (air)	kg TE eq	2,98E-11	0,00E+00	2,97E-11	5,52E-14
POP (water)	kg TE eq	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Table C.6: WM 5 – Life Cycle – Output of SimaPro with "Ecoindicator 95 rev EuP method"

Impact category	Unit	Total	WM 5kg assembling	Electricity LV use UCPTE U	Delivery van (<3.5t) B250	WM 5kg EoL	WM 5kg use materials (per LC)
greenhouse	kg CO2	3,42E+03	6,44E+02	1,93E+03	6,86E+00	-5,66E+01	8,95E+02
ozone layer	kg CFC11	1,44E-03	1,29E-04	1,25E-03	7,29E-06	-2,13E-05	7,73E-05
acidification	kg SO2	2,46E+01	6,13E+00	1,41E+01	2,55E-02	-2,49E-01	4,59E+00
eutrophication	kg PO4	1,75E+00	2,50E-01	4,74E-01	2,93E-03	-1,66E-02	1,04E+00
heavy metals	kg Pb	3,70E-02	3,83E-03	1,52E-02	2,11E-05	-3,75E-04	1,83E-02
carcinogens	kg B(a)P	1,27E-04	2,88E-05	4,64E-05	8,63E-08	-3,67E-05	8,81E-05
winter smog - P.M.	kg SPM	2,04E+01	5,02E+00	1,18E+01	1,03E-02	-1,74E-01	3,81E+00
summer smog - VOCs	kg C2H4	1,02E+00	2,91E-01	4,34E-01	1,91E-02	-4,62E-02	3,23E-01
pesticides	kg act.subst	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
energy resources	MJ LHV	7,80E+04	1,23E+04	4,57E+04	8,77E+01	-8,43E+02	2,07E+04
solid waste	kg	1,69E+02	2,09E+02	0,00E+00	0,00E+00	-4,01E+01	0,00E+00
Heavy metals (air)	kg Ni eq	8,02E-03	8,36E-04	3,67E-03	6,30E-06	-3,35E-05	3,55E-03
PAHs (air)	kg PAH/20 eq	2,96E-06	2,26E-06	1,23E-06	2,41E-07	-7,77E-07	1,00E-10
Heavy metals (water)	kg Hg/20 eq	7,05E-02	5,19E-03	1,95E-02	3,31E-06	-8,89E-04	4,66E-02
POP (air)	kg TE eq	2,84E-09	2,15E-09	4,08E-10	0,00E+00	2,59E-11	2,52E-10
POP (water)	kg TE eq	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00