Large Washing Machines Are Not Used Efficiently in Europe

Washing machines sold for private households are increasing in capacity. The aim of this study was to assess how these higher capacities are utilised by consumers. A consumer survey was conducted in eleven European countries with more than 5,000 participants who are substantially involved in washing laundry. Questions were asked about their washing machines and washing behaviour. The main outcome is that these new machines are welcomed, but it seems that the consumers are not utilising the larger capacities. This may result in higher energy and water consumption as the new machines are optimised to work most efficiently at maximum load conditions.

Key words: Washing machine, large capacity, europe, consumer behaviour, efficiency


Stichwörter: Waschmaschine, hohe Beladungskapazität, Europa, Verbraucherverhalten, Effizienz

1 Introduction

Laundry washing in consumer home is a process done regularly in almost all households of the world. Nevertheless, the knowledge how this process is done in consumer homes is small [1–11]. The washing machine market in Europe has been undergoing a severe change over the last ten years: The declared capacity (also called “rated capacity”) of how much laundry can be washed at one time is being increased. This trend can be seen as consumer-driven, as it offers the consumer a range of options to use: Larger items can be washed (e.g. duvets or carpets) or more items can be washed at the same time, therefore, the total time taken for laundry may be reduced. This trend may also be seen to be manufacturer-driven as they are selling larger and larger machines to the consumer although the household size in general is reducing and, thus, (assuming the need for laundry treatment of each individual is not changed) would reduce the total amount of laundry to be treated per week for an average household in Europe [12–15].

The question arises, how do consumers really use their washing machines and are there significant differences between using the (old) small washing machines and the (new) washing machines offering larger capacities. This report aims to identify different consumer behaviour associated with the different load capacities of their washing machine.

The trend of increasing capacities can be seen in sales and in market data. Taking data from the European Committee of Domestic Equipment Manufacturers (CECED), the average rated capacity of a washing machine offered in 2003 was 5.0 kg, whereas in 2014 it had increased to 7.5 kg (Fig. 1), a remarkable rise of 50% within roughly one lifetime of a washing machine.

The average household size in Europe (EU-19 for comparison) reduced from 2.4 to 2.3 people per household between 2005 and 2013 (the last year when data are available)¹. Kruschwitz [5] found in a large in-house observation study involving 238 households for four weeks in Germany that “across all households, the result was an average amount of laundry of 5.0 ± 2.0 kg per week and person”. No data are available which would indicate an increase or decrease of the amount of laundry washed in recent years. Therefore, it may be assumed that the total amount of laundry to be washed has been more or less constant over the last decade. Thus, changes in the washing behaviour of consumers owning washing machines of smaller and larger rated capacities may be used to study the influence of this change in machine design.

2 Methodology

The representative EU online survey was conducted between April and May 2015. The aim of the survey was to assess the washing behaviour of over 5,000 households in 11 European countries (Czech Republic, Finland, France, Germany, Hungary, Italy, Poland, Romania, Spain, Sweden and the United Kingdom). A professional market research company² was asked to translate the questionnaires into different languages, recruit respondents from the panel of registered consumers and fulfil the quotas for each country. Translations were checked by native speakers of the EU via Institute for Prospective Technological Studies (JRC-IPTS) of the European Commission. Qualified households were chosen following a predefined quota:

Selected age groups:
- 20–39 years
- 40–59 years
- 60–74 years

¹ See http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do?sessionid=dc6516f0d6q18jgpzpdz76oxr7sa26of+zC7TCAhYDd3-dDhrGyV21- 1100453497 (accessed 4 August 2015).
² Toluna, Frankfurt, Germany.
Household size: 1, 2, 3, 4 and > 4 people
- Involvement in laundry washing: substantial.
- Distribution of gender: more than 50% female.

Furthermore, Eurostat data for each country were used to calculate the population distribution in the respective age class and household size as quotas for the consumer survey distribution in each country.

The participants were asked about their washing machine and washing and drying behaviour, their opinion regarding energy-saving issues and their awareness of information reported on the Energy Label of washing machines and usage of user manuals. Demographic data were additionally recorded. Before starting the analyses, the validity of each dataset was controlled with the aid of two criteria. The first assessed essentially the same information, but was asked in different parts of the questionnaire. One asked simply about “the number of laundry loads washed per week” while the other asked about “the frequency of using different washing programmes per week”. The latter information was coded into numbers and, when summed up, revealed a number of wash cycles per week. Comparing both figures showed the tendency of higher figures of wash cycles for the data calculated from individual wash programmes. Therefore, the difference between both measures was used as one of two indicators for inconsistent answering of the questionnaire. The second exclusion criterion was based on the question “Please indicate all types of information you are able to identify on the (energy) label presented”. Among all the features given, three of them are not on the Energy Label, and if two or all of them were chosen by participants, this criterion was considered to be fulfilled. Datasets were excluded from the following evaluation in the case of inconsistent answers to both criteria being given. After excluding the outlier data, the number of the panel diminished from 5,100 to 4,843.

![Figure 1](image-url)  
Figure 1: Average rated capacities of washing machines on the European market for individual years (source CECED, own calculation)

<table>
<thead>
<tr>
<th>Country</th>
<th>Panel</th>
<th>Valid data</th>
<th>Households</th>
<th>Contribution to total results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Czech Republic</td>
<td>300</td>
<td>283</td>
<td>4,502,431</td>
<td>3%</td>
</tr>
<tr>
<td>Finland</td>
<td>300</td>
<td>288</td>
<td>2,579,781</td>
<td>1%</td>
</tr>
<tr>
<td>France</td>
<td>600</td>
<td>580</td>
<td>27,106,517</td>
<td>16%</td>
</tr>
<tr>
<td>Germany</td>
<td>600</td>
<td>580</td>
<td>40,656,000</td>
<td>23%</td>
</tr>
<tr>
<td>Hungary</td>
<td>300</td>
<td>279</td>
<td>4,105,708</td>
<td>2%</td>
</tr>
<tr>
<td>Italy</td>
<td>600</td>
<td>555</td>
<td>25,007,000</td>
<td>14%</td>
</tr>
<tr>
<td>Poland</td>
<td>600</td>
<td>563</td>
<td>13,567,999</td>
<td>8%</td>
</tr>
<tr>
<td>Romania</td>
<td>300</td>
<td>275</td>
<td>7,470,429</td>
<td>5%</td>
</tr>
<tr>
<td>Spain</td>
<td>600</td>
<td>567</td>
<td>18,083,690</td>
<td>10%</td>
</tr>
<tr>
<td>Sweden</td>
<td>300</td>
<td>294</td>
<td>4,725,279</td>
<td>3%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>600</td>
<td>579</td>
<td>26,414,000</td>
<td>15%</td>
</tr>
<tr>
<td>Total number of households in the sample</td>
<td>5100</td>
<td>4843</td>
<td>174,218,834</td>
<td>100%</td>
</tr>
<tr>
<td>Total number of households in EU-28</td>
<td>–</td>
<td>–</td>
<td>213,656,847</td>
<td>Sample covers 82% of total EU-28</td>
</tr>
</tbody>
</table>

Table 1: Contribution of European countries in the survey (Source for number of households: UNECE Statistical Database, compiled from official national sources)
Furthermore, weighting according to the number of households of each country compared to the sum of all countries investigated was implemented to calculate the EU average results. Table 1 illustrates the contributions of European countries in the survey. These EU averages represent 82% of all households in EU-28.

People were asked “What is the maximum load of laundry in kg which can be washed in your washing machine (information given, for example, in the user manual)?” The answers are coded as given in Table 2 when averages are calculated and referred to as “rated capacity”, as this is the technical term defined in standardisation and regulations.

### Results and Discussion

The age of the washing machine, as reported by the consumers asked, differs a lot between new machines and machines which are almost 40 years old. Differences between the countries can be observed (Fig. 2). These may be explained by differences in the market offers in those countries and a different number of washing cycles carried out. Comparing the average age of the machines with the average rated capacity (Fig. 3) shows a clearly negative correlation, thus, the younger the average machines are, the higher the average rated capacity. This confirms that the trend of increasing capacities is not happening in some countries, but is a European-wide trend.

Therefore, the data in the following analysis are considered to represent this European trend in general, and ana-

<table>
<thead>
<tr>
<th>Maximum rated capacity</th>
<th>Coded load in kg</th>
<th>Occurrence in sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 5 kg</td>
<td>5</td>
<td>26%</td>
</tr>
<tr>
<td>6 kg</td>
<td>6</td>
<td>23%</td>
</tr>
<tr>
<td>7 kg</td>
<td>7</td>
<td>24%</td>
</tr>
<tr>
<td>8 kg</td>
<td>8</td>
<td>14%</td>
</tr>
<tr>
<td>9 kg</td>
<td>9</td>
<td>4%</td>
</tr>
<tr>
<td>More than 9 kg</td>
<td>10</td>
<td>2%</td>
</tr>
<tr>
<td>I don’t know</td>
<td>Excluded</td>
<td>7%</td>
</tr>
</tbody>
</table>

Table 2: Rated capacity coding and occurrence of rated capacities in the sample

Figure 2: Cumulative frequency distribution of the age of washing machines in all countries (how to read: each data point shows what percentage of washing machines are in the households with an age up to the given year)

Figure 3: Correlation between the average age of the washing machine and reported average rated capacity for each country and the European average
analyses are no longer made specifically for each country. Figure 4 shows clearly how the larger rated capacity washing machines have entered households during the past decade. While washing machines which are ten and more years old are mainly of the rated capacity of up to 5 kg load, more and more higher rated capacity machines have entered households, and in 2015, the majority of machines are for washing 7 or 8 kg of load. The rated capacity of 9 and more kg is small, at about 10%, but is also increasing.

Comparing the rated capacities of the washing machines to the size of the households where they are used, a small tendency of increasing capacity with increasing household size can be observed (Fig. 5). This tendency can, at least partly, be explained by the fact that washing machines in larger households are on average younger than in smaller households (Fig. 6), as they are used more often and, therefore, need to be replaced more frequently. The average number of washing cycles throughout all households is 4.4 cycles per week per household, but this number depends a lot on the size of the household (Fig. 6).

Higher rated capacities of washing machines are appreciated by the consumers as the satisfaction with the offered capacity is increasing and the willing to have a higher load capacity for the owner of bigger washing machine is decreasing accordingly (Fig. 7). All the participants were asked how they usually loaded their washing machines for a cotton wash (Fig. 8). A total of two-thirds confirm using the full capacity (which is seen as the most effective and sustainable behaviour) and 7% admit to almost overloading the washing machine.

Correlating those answers with the capacity of the machine reveals that the usage of the full capacity or even overloading does not depend on the rated capacity (Fig. 8). Asking those people who do not fill the washing machine or even overload it (Fig. 9) shows that the reasons are mostly related to the consumers’ concern about the cleaning results and not having much laundry to wash. It is important to note that these reasons do not depend on the size of machine; similar reasons are given by the owners of small and large washing machines. These results seem to indicate that owners of washing machine with larger drum or higher rated capacity are filling these drums to the same degree of ‘fullness’ as owners of machines with smaller drums do. As a consequence, either the number of washing cycles should be lower or the amount of textiles washed is increased depending on the ownership of washing machines with higher

Figure 4 Washing machine rated capacity versus age of the washing machine

Figure 5 Average rated capacity of the washing machine depending on the household size (box-plot given with lowest, 25% percentile, arithmetic average, 75% percentile and maximum value; number is for arithmetic average)
Figure 6  Correlation between average age of the washing machine, average wash cycle per week and household size.

Figure 7  Correlation between rated capacity and satisfaction with the loading capacity of the washing machine.

Figure 8  Correlation between stated loading behaviour and rated capacity.
rated capacities in comparable households. While for the latter there is no evidence the first assumption is investigated further.

Households were asked how many washes are done per week in their household. The answers show a clear dependency on the size of the household (Fig. 10). This reflects that there is a larger amount of laundry to be washed when more people live in the household. As it is not a proportional relationship, it also shows that smaller households have a higher specific washing frequency (per person) than larger households. If the amount of laundry to be washed is not much higher for a single person than for a family member in a larger household, this means that the load per wash cycle must be lower.

How do households wash their laundry when a washing machine with a high-rated capacity is used? Figure 11 shows an almost constant or even slightly increasing number of wash cycles per week with the increasing rated capacity of the washing machine for all household sizes. Data points for 9 kg and more than 9 kg rated capacity are less statistical significant, as only 4%, respectively 2% of households claimed to have such a washing machine at home (Table 2). The only reasonable explanation for these data is that consumers do not put more laundry into their bigger washing machines, but wash (almost) the same amount of laundry independent of the washing machine’s rated capacity. Therefore, the appreciation the consumer expressed for having a bigger capacity does not seem to be transferred into an appropriate action of utilising this higher capacity in performing fewer wash cycles.

Albeit this result is the outcome of indirect deductions made it reveals a first indication of how consumers are using the washing machines with larger capacities. Direct measurements of the actual load in field experiments should be made next to confirm the results.

4 Conclusion

The analysis of this semi-representative survey of consumers in Europe reveal behaviour which is confirming results found by others. This is especially true for the number of wash cycles done which is reported here to be 4.4 wash cycles per week per household were other studies have found similar numbers: Stamminger and Goerdeler published 4.5 washes per week (234 per year) in an average household in Germany, based on an online questioning of
more than 2,000 persons [16]. The Preparatory Studies for Eco-Design Requirements of Energy-Using Products (EuP) have investigated among others the consumer behaviour with washing machines. The data were collected with an online consumer questionnaire in 10 European countries and 4.9 wash cycles per household per week (254 per year) were reported [17]. The report on the European REMODECE project states 270 wash cycles per year, which corresponds to 5.2 wash cycles per week [10]. However no data were published by now which investigated the consumer behaviour especially when larger drums or higher rated capacities of washing machines are used.

Lasic and Stamminger [13] investigated how the energy and water consumption of washing machines at differently rated capacities behave when partial loads are washed. They found that the specific consumption values (per kg load) increase drastically when lower loads are washed. Stamminger and Schmitz [18] report on the measurements of 50 models of washing machines and found that, on average, the consumption at half of the rated capacity was just 17% lower in energy and 21% in water instead of the 50% that could be expected ideally. The consequence for the consumer is that – despite having bought a very efficient washing machine according to the data declared under the European energy labelling – he/she will not get the expected savings in the real usage of the machine when not using the full capacity of the washing machine.

Lasic and Stamminger [12] have also shown the way in which consumers must change their laundry washing behaviour when using washing machines with a high-rated capacity. They simulated the effect of deferring the wash unless a sufficient volume of load to fill (almost) the rated capacity of a large washing machine at a certain washing condition can be utilised. This can mean that washing cycles under specific washing conditions may be deferred by several weeks. However, this also means that there is a possibility for households to postpone their washing time if they increase their stock of textiles.

Another possibility for a more sustainable usage may be in combining the different washing loads (e.g. combining 30 °C, 40 °C and 60 °C washing loads for cotton and other textiles) and by choosing the washing temperature in accordance with the recommendation of the most sensitive item of laundry. In combination with prolonging the washing cycle, the same washing performance at a lower resource consumption may be achieved. Janczak and colleagues [19] have shown that lowering the temperature to the next possible level and prolonging the washing time lead to a remarkable decrease in the energy consumption while the washing performance remains the same.

Alternatively, washing machines may be developed which have a better adjustment of their consumption values to varying load sizes and/or which can guide the consumer to wash larger loads, e.g. by measuring the capacity utilised and giving this information to the consumer either during loading or after the wash.

Policies in the context of reworking the ecodesign regulation [20] and energy labelling [21] may need to respond to this new information to ensure natural resources are used in the most economic way.

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