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# Water and Energy Consumption in Domestic Laundering Worldwide – A Review

A literature review was executed to collect data on the resource consumption connected to domestic laundering processes. Data from literature on water and energy consumption were collected. The study focussed on Europe, as for Europe enough date could be collected for a thorough analysis. However, the limited data available for Japan and the USA were also included and discussed.

**Key words:** Energy consumption, water consumption, domestic laundering, washing, drying

**Weltweiter Wasser- und Energieverbrauch bei der Haushaltswäsche – Ein Übersichtsbeitrag.** Zur Sammlung von Daten über den mit den Waschvorgängen im Haushalt verbundenen Ressourcenverbrauch wurde eine Literaturübersicht erstellt. Es wurden Daten zum Wasser- und Energieverbrauch aus der Literatur gesammelt. Die Studie konzentrierte sich auf Europa, da in Bezug auf Europa genügend Daten für eine gründliche Analyse gefunden werden konnten. Die wenigen verfügbaren Daten für Japan und die USA wurden ebenfalls miteinbezogen und diskutiert.

**Stichwörter:** Energieverbrauch, Wasserverbrauch, Haushaltswäsche, Waschen, Trocknen

## 1 Introduction

TKT, the Dutch Knowledge Centre for the Textile Care Industry, has executed a review study on the sustainability of domestic laundry processing in cooperation with University of Bonn. The study was aimed to supply TKT and the connected trade associations FTN and CINET with a solid base for benchmarking the sustainability of domestic and industrial laundering processes. Sustainability of laundry processing is a key research focus of TKT, as are laundry process optimisation, textile service and textile materials. The review study was limited to the water and energy consumption in domestic washing and drying processes. The project has focussed on domestic laundering in different parts of Europe and has identified the existing geographical differences in resource consumption. Apart from geographical differences, the resource consumption has been studied as a function of the different washing programs (e.g. low, medium and high washing temperatures). The use of tumble drying equipment or line drying and its effect on the energy consumption were also studied. For line drying a differentiation has been made between outdoor line drying and indoor line drying in a heated or non-heated room. Although focussed on Europe, this study also gathered data from USA and Japan, though less detailed.

## 2 Literature Review

### 2.1 Energy consumption in the washing process

The first part of the review is focused on the energy consumption in the washing process. An important point to consider, having a look at the energy and water consumption in domestic laundering throughout the world, are the different types of laundry machines used all over the world. Different machines are in use in different parts of the world. The two main machine types are:

1. Horizontal axis or drum machines
2. Vertical axis or impeller machines

Horizontal axis machines are used in Europe, while vertical axis machines are most widespread in America, Australia and Asia. However, the market share of drum type washing machines is growing throughout the world [1–6]. Drum type machines use in general less water, but more energy. The energy consumption is much lower for the impeller type of machines, because in most vertical machines the washing water is not heated internally and therefore, the laundry process is performed at low temperature (typically 20 °C). Drum type machines, however, have an internal heating system, so washing normally takes place at elevated temperatures [1–6]. Detailed information is available for the energy consumption in Europe, but only limited information was available about the energy consumption in Japan, the USA, and the rest of the world. In Table 1, data on the difference in the use of energy for domestic washing worldwide, are presented [2].

Data regarding the average load of the machine were missing. Only for Japan, data for the average load were presented. The average load of the washing machine in Japan in 2010 appeared to be 3.3 kg/cycle [3]. The ratio of the actual load compared to the maximum load is an important factor in washing machine efficiency. As can be seen, the energy consumption in Turkey is much higher than in other countries, probably because in Turkey mostly horizontal drum machines are used. The energy consumption in China and Japan is very low, because in those countries cold water is used for washing. In Japan, it also appeared to be common to re-use warm water from the bathtub in the washing machine [3].

In Europe, the horizontal drum machine is the most commonly used alternative. A large amount of detailed information on the energy consumption of domestic laundering in Europe can be found in [7, 9]. In [7, 8] an average load of 3.7 kg/cycle was assumed. This is considered to be the average load for the standard cotton washing programme. It is

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clear that the temperature of the washing water is a central factor in the energy consumption of a washing machine. Therefore, in Table 2, not only the average energy consumption for a number of European countries is presented but also the average washing temperature. The energy consumption was expressed in kWh/cycle.

As can be seen, there are some small differences between the data from [7, 8] and [9]. From the table, it is clear that the average washing temperatures, and therefore energy consumption in Southern Europe are lower than in other parts of Europe. While average washing temperatures in Eastern Europe and Scandinavia are relatively high and therefore, the average energy consumption is also high.

| Country | E/kWh $cycle^{-1}$ | Load/kg $cycle^{-1}$ | E/kWh $kg^{-1}$ |
|---|---|---|---|
| Australia | 0.34 | | |
| Canada | 0.43 | | |
| China | 0.1 | | |
| Japan | 0.1 | 3.3 | 0.03 |
| Korea | 0.37 | | |
| Turkey | 1.35 | | |
| USA | 0.43 | | |

**Table 1** Energy consumption in the washing process worldwide [2, 3]

Not all textiles are washed using the same type of washing programmes, for cotton higher temperatures can be used than for synthetics, wool requires low levels of temperature and mechanical action. Also the load for synthetics is lower than for cotton laundry. In [10] an overview is presented on the energy consumption, average washing temperature and the average load for 4 different washing programmes. The results are based on data acquired in Germany and presented in Table 3.

Indeed, load is lower for delicate and wool washing cycles. However, the difference in practice is smaller than to be expected. E.g., the maximum load for delicate wash is defined by the manufacturers to a maximum 2 kg/cycle and for cotton 4.5–6 kg per cycle [10]. Concluding, consumer tend to overload with programmes like delicate, requiring a low textile load, and to underload with programmes, enabling a full load of the machine [10].

### 2.2 Energy consumption in the drying process

With regard to the drying process much less data are available from literature. The information is limited to data related to drying and spinning in Europe. No information was found on energy consumption for laundry drying in the USA. For Japan, an interesting issue is that machine drying is hardly ever used. Although more than 50% of the Japanese households own a washer with a dryer function or a tumble dryer and 67% of washing machines sold are

| Country | T/°C (average) [7, 8] | E/kWh $cycle^{-1}$ [7, 8] | T/°C (average) [9] | E/kWh $cycle^{-1}$ [9] |
|---|---|---|---|---|
| Austria | 43.0 | 0.64 | | |
| Belgium | 42.1 | 0.62 | | |
| France | 39.7 | 0.57 | 41.8 | 0.62 |
| Germany | 42.2 | 0.63 | 45.0 | 0.69 |
| Netherlands | 41.0 | 0.60 | | |
| Switzerland | 42.8 | 0.64 | | |
| Greece | 41.5 | 0.61 | | |
| Italy | 40.4 | 0.59 | 42.2 | 0.63 |
| Portugal; | 36.5 | 0.50 | | |
| Spain | 33.9 | 0.44 | 33.9 | 0.44 |
| Turkey | 42.5 | 0.63 | | |
| Bulgaria | 42.4 | 0.63 | | |
| Czech Republic | 44.3 | 0.67 | 46.0 | 0.71 |
| Hungary | 41.8 | 0.62 | 46.1 | 0.71 |
| Poland | 44.0 | 0.67 | 47.4 | 0.74 |
| Romania | 42.8 | 0.64 | | |
| Slovakia | 43.5 | 0.66 | | |
| Denmark | 43.0 | 0.64 | | |
| Finland | 45.1 | 0.69 | 46.5 | 0.72 |
| Norway | 45.2 | 0.69 | | |
| Sweden | 45.3 | 0.70 | 47.3 | 0.74 |
| Ireland | 39.7 | 0.57 | | |
| UK | 39.0 | 0.56 | 40.5 | 0.59 |

**Table 2** Energy consumption in Europe for domestic laundering according to [7–9]

| Type | T/°C | Load user/kg cycle$^{-1}$ | E/kWh cycle$^{-1}$ | E/kWh kg$^{-1}$ |
|---|---|---|---|---|
| Cotton | 49.7 | 3.18 | 1.02 | 0.32 |
| Mix | 42.2 | 2.64 | 0.66 | 0.25 |
| Easy Care | 39.3 | 2.8 | 0.67 | 0.24 |
| Delicate | 36.5 | 2.36 | 0.76 | 0.32 |
| Wool | 25 | 2.46 | 0.56 | 0.23 |

**Table 3** Energy consumption as a function of washing programmes [10]

washer/dryers, 92% of the owners of these machines state that they never use machine drying [3, 11]!

The first parameter determining the required energy for drying is the residual moisture content after spinning or centrifuging. This residual moisture content is mostly depending on the maximum rotational speed of the drum during centrifuging. The relation between the rotational speed (in rpm), the residual moisture content (RMC) and the energy required for drying in a tumble dryer, $E_{dry,}$ is clearly illustrated in Table 4.

In the same source, also the average spinning speed in a number of European countries is given. There appears to be a considerable difference throughout Europe, from Italy with an average speed of 743 rpm to Sweden with an average speed of 1118 rpm [9]. The data are presented in Table 5.

Comparing the data in Table 5 with those in Table 4, it is clear that average energy required for machine or tumble drying in Italy is much higher than in Sweden.

With regard to drying, it is important to distinguish between line drying and tumble drying. Although it is tempting, and appears logic, to state that line drying requires no energy input, this is not completely true. If line drying occurs in a heated room, the drying of the textiles will cool down the air in the room and therefore, additional room heating is required. Additionally, the humid air will need to be vented outside to avoid condensation on the walls of the room. Extra energy is therefore needed to heat up the room to compensate the heat loss from the water evaporation at the textiles to be dried. Outside line drying and indoor drying in a non-heated room require no additional heating [9]. As to be expected, in Southern Europe a larger part of the laundry is line dried outside than in Western Europe or Scandinavia. In Fig. 1, an overview of the share of the different processes for laundry drying in Europe is presented. A distinction is made between summer and winter, showing that in summer time line drying is more popular than in winter.

| Spin/rpm | Residual moisture content (RMC)/% | $E_{dry}$/kWh kg$^{-1}$ |
|---|---|---|
| 200 | 154 | 1.754 |
| 400 | 118 | 1.346 |
| 600 | 92 | 1.046 |
| 800 | 72 | 0.800 |
| 1000 | 62 | 0.700 |
| 1200 | 56 | 0.640 |
| 1400 | 52 | 0.600 |
| 1600 | 49 | 0.570 |

**Table 4** Relation between spinning speed and energy required for drying [9]

In [9] also two formulas are used to calculate the energy demand for thermal drying (in a heated room) as well as for electrical drying (in a tumble dryer). These formulas are given below:

$$E_{electric}(\mathrm{kWh/year}) = n_{tumble\,dryer} * 3.7 * E_{dry} \quad (1)$$

and:

$$E_{thermal}(\mathrm{kWh/year}) = n_{heated\,room} * 3.7 * \mathrm{RMC}/100 * 2.260/3600 * 2 \quad (2)$$

In which:

$n_{tumble\,dryer}$ = the number of wash cycles per year dried in the tumble dryer (1/year)
$n_{heated\,room}$ = the number of wash cycles per year dried in a heated room (1/year)
$E_{dry}$ = required drying energy for tumble drying as function of residual moisture content (kWh/kg), as presented in Table 4
RMC = residual moisture content (%)
2.260 = evaporation heat of water (kJ/kg)
3.7 = load in kg per wash cycle
2 = correction factor to take into account the energy which goes out with the humidity from the room by ventilation

In Fig. 2 is shown how much energy is spent in total per year on the dying process in a number of European countries. It is clear from the figure that in general, but especially in Eastern Europe, more energy is consumed for line drying in a heated room than for tumble drying. From the graph it is also clear that in Scandinavia and Eastern Europe the energy consumption for drying is higher than in Southern and Western Europe. The energy consumption for tumble drying

| Country | Average spinning speed/rpm |
|---|---|
| France | 919 |
| Germany | 1059 |
| Italy | 743 |
| Spain | 858 |
| Czech Republic | 900 |
| Hungary | 877 |
| Poland | 860 |
| Finland | 1045 |
| Sweden | 1118 |
| UK | 1008 |

**Table 5** Average laundry spinning speed in Europe [9]

in Eastern Europe is very low, due to the limited number of households owning a tumble dryer.[9]

### 2.3 Water consumption

With regard to water consumption in domestic laundering more global data are available. Worldwide there are big differences. In Table 6, some of these data are gathered.

The biggest difference is the difference between the regions using mainly horizontal drum machines (Europe, Turkey) and the regions using mainly vertical/impeller machines like USA and Asia. The water consumption in horizontal drum machines is significantly lower. The water consumption data for Japan differ significantly from source to source. This is because in Japan different type of washing machines are in use with different water consumption figures [13], but is also due to the growing Japanese practice of re-use of warm bath water from the bathing tub in the washing process [3, 14]. In 2010, 58% of the total water used in the washing cycle was re-used bath water, while in 1991 this was less than 20% [14].

## 3 Discussion

In this section, the information as presented in chapter 2 is processed to get an overview of the resource consumption in domestic laundering in different parts of the world. As seen above, most data are available in kWh/cycle of l/cycle. For comparison purposes it is useful to present the consumption per kg of laundry. Furthermore, data from different sources are combined to obtain a complete overview on resource consumption. As the resource consumption appears a strong function of the geographical location, three different regions will be dealt with separately below:

1. Europe
2. USA
3. Japan

Most available data deal with the average resource consumption. However, it is clear that the actual resource consumption is a strong function of the applied washing programmes and/or processed textile. The data available on resource consumption as a function of the washing pro-

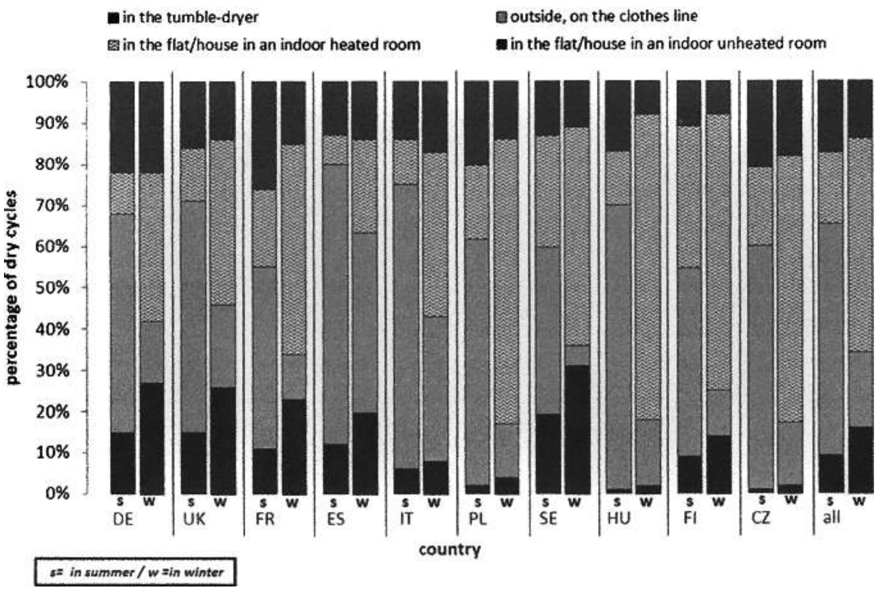


Figure 1 Overview of drying processes in Europe [9]

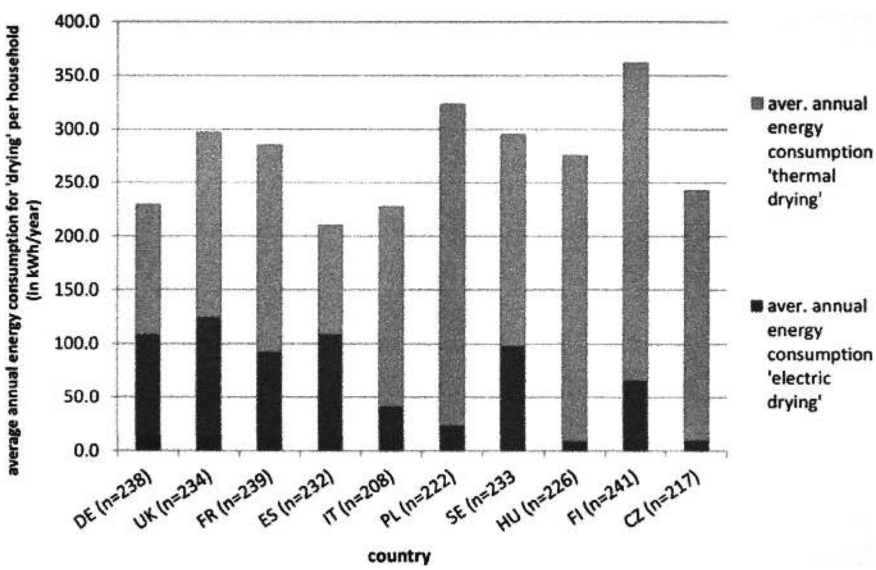


Figure 2 Average annual energy consumption per household for laundry drying [9]

gramme are however limited and will be discussed in a separate paragraph.

### 3.1 Europe

Most data on energy consumption in Europe are presented in kWh/cycle. To get to energy consumption in kWh/kg also the load has to be known. In [2] and [15] a mean load of 3.7 kg/cycle is reported, while in [7] and [8] a load of 75% is mentioned, which is comparable to 3.7 kg/load for a 5 kg washing machine. In Table 7, this load is applied on the data as presented in the tables 2 and 3 to calculate the average energy consumption for washing in Europe in kWh/kg. From Table 7, it is clear that the average energy consumption for washing in Southern Europe are lower than in other parts of Europe. In Eastern Europe and Scandinavia, the average energy consumption for washing is relatively high.

No direct information was available on drying energy consumption in kWh/kg. So, this had to be calculated. As stated before, the energy consumption for drying is a strong function of the drying process applied; tumble drying, outside line drying, line drying inside a non-heated room and line

| Country | Water/L cycle$^{-1}$ [2] | Water/L cycle$^{-1}$ [6] | Water/L cycle$^{-1}$ [3] | Water/L cycle$^{-1}$ [10] |
|---|---|---|---|---|
| Australia | 60 | | | |
| Canada | 144 | | | |
| China | 99 | | | |
| Japan | 120 | | 110 | |
| Korea | 140 | | | |
| Turkey | 60 | | | |
| USA | 144 | 157 | 160 | |
| Europe | | | 75 | |
| Germany | | | | 44 |

**Table 6** Overview of water consumption in domestic laundering in l/cycle worldwide

| Country | E/kWh cycle$^{-1}$ [9, 10] | E/kWh kg$^{-1}$ | E/kWh cycle$^{-1}$ [11] | E/kWh kg$^{-1}$ |
|---|---|---|---|---|
| Austria | 0.64 | 0.17 | | |
| Belgium | 0.62 | 0.17 | | |
| France | 0.57 | 0.15 | 0.62 | 0.17 |
| Germany | 0.63 | 0.17 | 0.69 | 0.19 |
| Netherlands | 0.60 | 0.16 | | |
| Switzerland | 0.64 | 0.17 | | |
| Greece | 0.61 | 0.17 | | |
| Italy | 0.59 | 0.16 | 0.63 | 0.17 |
| Portugal | 0.50 | 0.13 | | |
| Spain | 0.44 | 0.12 | 0.44 | 0.12 |
| Turkey | 0.63 | 0.17 | | |
| Bulgaria | 0.63 | 0.17 | | |
| Czech Republic | 0.67 | 0.18 | 0.71 | 0.19 |
| Hungary | 0.62 | 0.17 | 0.71 | 0.19 |
| Poland | 0.67 | 0.18 | 0.74 | 0.20 |
| Romania | 0.64 | 0.17 | | |
| Slovakia | 0.66 | 0.18 | | |
| Denmark | 0.64 | 0.17 | | |
| Finland | 0.69 | 0.19 | 0.72 | 0.20 |
| Norway | 0.69 | 0.19 | | |
| Sweden | 0.70 | 0.19 | 0.74 | 0.20 |
| Ireland | 0.57 | 0.15 | | |
| UK | 0.56 | 0.15 | 0.59 | 0.17 |

**Table 7** Average energy consumption for washing in Europe in kWh/kg

drying inside a heated room. Only the first and the last process are assumed to contribute to the energy consumption of the drying process. In [9] the average energy consumption for drying (tumble drying and drying in a heated room) per household per year for drying is given for a number of European counties (see Fig. 2). In [9] also the number $N_{wash}$ of washing cycles per household per week are given for the same countries. Combining these results and assuming a mean load of 3.7 kg the average energy consumption per kg of laundry could be calculated. The results of this calculation are given in Table 8. From this table, it is clear that the energy consumption for domestic drying is significantly higher in Eastern Europe and Scandinavia compared to the energy consumption in Southern and Western Europe.

Although in Eastern Europe hardly any laundry is dried in a tumble dryer, the energy consumption for drying is still rather high, due to the large share of the laundry dried inside in a heated room.

Available data on water consumption is limited. The figures are mainly provided in l/cycle, if again we assume that the average load is 3.7 kg, this results in the following data on water consumption (see Table 9). The water consumption is a machine parameter and cannot be influenced by the user.

### 3.2 USA

The data for resource consumption for domestic laundering in the USA are limited. All data are gathered in Table 10. As no data are available on the average load size in the USA, the consumption data are expressed per cycle and not per kg. Data on energy consumption for drying were missing.

The data on water consumption are quite consistent, however a big difference can be seen in the sources providing data on energy consumption. The reason for this big difference is unclear. Water level of consumption is high compared to that in Europe. As data on the energy consumption in the USA are not consistent, a comparison with European data is difficult.

### 3.3 Japan

For Japan more information was available. Again no quantitative information was available on energy consumption for drying. For Japan, an interesting issue is that machine drying is hardly ever used. Although more than 50 % of the Japanese households own a washer with a dryer function or a tumble dryer and 67 % of washing machines sold are washer/dryers, 92 % of the owners of these machines state that they never use machine drying! [3, 11]. However, no actual data on energy consumption for drying were found. Data on energy consumption for washing and water consumption in Japan are presented in Table 11. To convert, the energy and water consumption per cycle to per kg, a load of 3.3 kg/cycle was assumed [14].

Compared to Europe, the water consumption in Japan is rather high, probably due to the more wide-spread use of vertical impeller machines, but the energy consumption is low. This is due to the low washing temperatures and the re-use of bathing water in the washing machines.

### 3.4 Influence of textile and washing programme

The influence of textile and washing programme on resource consumption can be quite diverse. At first, it is to be

| | Source [3] | Source [2] | Source [6] |
|---|---|---|---|
| $E_{wash}$/kWh cycle$^{-1}$ | 2.7 | 0.43 | |
| Water/L cycle$^{-1}$ | 160 | 144 | 157 |

**Table 10** Resource consumption in domestic laundering in USA

| Water/L cycle$^{-1}$ | Water/ L kg$^{-1}$ | $E_{wash}$/ kWh cycle$^{-1}$ | $E_{wash}$/ kWh kg$^{-1}$ |
|---|---|---|---|
| 110 – 120 | 33.3 – 36.4 | 0.1 | 0.03 |

**Table 11** Water and energy consumption for domestic laundering in Japan

| Country | $N_{wash}$/week, household | $E_{dry}$/kWh (household, year)$^{-1}$ | $E_{dry}$/kWh kg$^{-1}$ |
|---|---|---|---|
| France | 3.5 | 283.7 | 0.42 |
| Germany | 3.7 | 227.2 | 0.32 |
| Italy | 4.1 | 227.3 | 0.29 |
| Spain | 3.8 | 207.8 | 0.31 |
| Czech Republic | 3.5 | 243.5 | 0.36 |
| Hungary | 3.6 | 273.9 | 0.40 |
| Poland | 4.1 | 324.1 | 0.41 |
| Finland | 3.9 | 315.9 | 0.49 |
| Sweden | 3.5 | 293.5 | 0.44 |
| UK | 4.1 | 296.7 | 0.37 |

**Table 8** Energy consumption for drying in kWh/kg based on data from [11]

| Country | Water/L cycle$^{-1}$ [3] | Water/L kg$^{-1}$ | Water/L cycle$^{-1}$ [12] | Water/L kg$^{-1}$ | Water/L cycle$^{-1}$ [10] | Water/L kg$^{-1}$ |
|---|---|---|---|---|---|---|
| Europe | 75 | 20.3 | 40.8 – 45.1 | 11.0 – 12.2 | | |
| Germany | | | | | 44 | 11.9 |

**Table 9** Water consumption in domestic laundering in l/kg

expected that the energy consumption for lower temperature washing programmes will be lower as less energy is required for heating up the washing water. Washing of e. g. delicate and sensitive textiles requires low washing temperatures. However, the preferred load for more sensitive and textile materials is lower, which is expected to lead to a higher level of energy consumption and also water consumption. In Table 3, the influence of load and washing temperature on the energy consumption are presented. It is clear that lowering the washing temperature lowers the energy consumption more than a higher loading in the machine does. For textiles for which lower spinning speeds are preferred, probably more energy is used in the drying process. However, for synthetic textile materials a lower energy consumption in drying is expected than for cotton. Available data on the effect of type of textile on resource consumption are limited to Germany. Data on energy consumption for washing and average load for different types of textile are presented in Table 3. The data for average load as a function of textile are used to calculate the water consumption per kg, based on the average water consumption in Germany of 44 l/cycle. The results for the water and energy consumption per kg of laundry are presented in Table 12. No data are available on energy consumption for drying.

| Type | Load user/ kg cycle$^{-1}$ | E/kWh kg$^{-1}$ | Water/ L kg$^{-1}$ |
|---|---|---|---|
| Cotton | 3.18 | 0.32 | 13.8 |
| Mix | 2.64 | 0.25 | 16.7 |
| Easy Care | 2.8 | 0.24 | 15.7 |
| Delicate | 2.36 | 0.32 | 18.6 |
| Wool | 2.46 | 0.23 | 17.9 |

**Table 12** Water and energy consumption as function of textile type

## 4 Conclusions

The first conclusion is that most water and energy consumption data for domestic laundering are available for Europe. On the other hand, data on USA, Japan and the rest of the world are scarce.

Water consumption in Europe is lower compared to the water consumption in Japan and especially in the USA, probably due to the general use of horizontal axis washing machines in Europe, compared to the more widespread use of vertical axis machines in USA and Japan.

Energy consumption for washing is higher in Europe than in Japan, because of the higher washing temperatures.

Within Europe, the energy consumption for washing in Scandinavia and Eastern Europe is rather high compared to that in Western and Southern Europe. This is directly related to the lower average washing temperatures, especially in Southern Europe.

The energy consumption for drying is a strong function of the used drying processes. Only tumble drying and indoor heating in a heated room contribute to the energy consumption for drying. Outdoor drying and indoor drying in a non-heated room does not require an additional energy input.

Energy consumption for drying is high in Scandinavia due to the large share of the laundry being tumble dried, while the high energy consumption for drying in Eastern Europe is mainly caused by the high share of laundry dried in heated rooms. The low energy consumption for drying in Southern Europe is allocated to the high share of the laundry being dried outside the house.

Limited data are available on the influence of the type of textile on resource consumption. However, it was shown that lower washing temperatures lead to lower energy consumption for washing, but a lower machine load results in higher water and energy consumption. For energy consumption, a lower washing temperature has a more pronounced influence than lower values for the average load.

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*Henk Gooijer* received his PhD on the topic of flow resistance of textile materials in 1998 from Twente University in the Netherlands. Since then he has been working in the research of textile processing and textile care. After a few years in industrial research at Stork, a manufacturer of textile processing equipment, he joined TKT in 2004 as Technical Project Manager. TKT is the Dutch technical knowledge centre for the Textile Care Industry, located in Ophemert, the Netherlands. His work at TKT focusses mainly on the sustainability of textile care processes by optimizing water and energy consumption, minimizing textile wear and optimizing the performance of laundering and dry cleaning processes. From 2010 on, he is also teaching and researcher at Saxion University of Applied Sciences in Enschede, the Netherlands. Main areas of his research at Saxion University are surface modification and digital processing of textiles.

*Rainer Stamminger.* After 17 years of practical experience in the development of washing machines and dishwasher with AEG Hausgeräte, Germany Rainer Stamminger was promoted in 2002 as professor for appliance and process engineering at University of Bonn. Main areas of research at University are consumer behaviour of homework with and without using appliances, new products or features, smart appliances, robots for household application and questions of sustainability of housekeeping.

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