Preparatory study for Kettles implementing the Ecodesign Working Plan 2016-2019

Task 3: Users

Request for services N° ENER/C4/FV 2019-467/06/FWC 2015-619 LOT1/05 in the context of the Framework Contract N° ENER/C3/2015-619 Lot 1

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IEC	International Electrotechnical Commission
MEErP	Methodology for Ecodesign of Energy-related Products
UK	United Kingdom

3. TASK 3: USERS

Users affect the environmental impact of electric kettles especially during the use phase. In line with the MEErP methodology [Kemna 2011], their influence on the life-cycle performance of kettles is analysed within this Task 3 across five subtasks. These subtasks cover the direct energy consumption (Subtask 3.1) as well as indirect energy consumption effects (Subtask 3.2) of the kettles during the use phase, user influence on end-of-life behaviour (Subtask 3.3), the relevance of local infrastructure (Subtask 3.4) and a set of conclusions (Subtask 3.5) for the following steps within this preparatory study.

3.1. Subtask 3.1: System aspects affecting direct energy consumption during the use phase

The aim of Subtask 3.1 is to detail the influence of users on the **direct impact** of kettles on the environment and resources during the use phase. Direct impact means any impact that is directly linked to the operation of the kettle. This analysis has different levels of scoping, starting from a "strict product approach", followed by an "extended product approach", passing to a "technical system approach" and finally concluding in a "functional system approach". These different scoping levels can summarized as follows:

- **Strict product approach:** In the strict product approach, the system boundary is limited to the electric kettle itself. Its operating conditions are nominal as defined in traditional standards.
- **Extended product approach:** In the extended product approach, the influence of the kettle usage and real-life deviations from test standards are covered.
- **Technical system approach:** When viewed from the technical system perspective, the kettle is embedded in its surrounding system.
- **Functional approach:** In the functional system approach, the basic service of a kettle to provide boiled water is maintained, yet other ways to satisfy this need are reviewed, as well.

3.1.1. Strict product/component scope

The strict product approach is the most restrictive point of view with regard to user influence on product performance, as it is based on nominal operating conditions as defined in energy-related standards.

As per the results of Task 1, there is no established standard dealing with the energy efficiency of electric kettles. Yet the standard IEC 60530:1975 ('Methods for measuring the performance of electric kettles and jugs for household and similar use') (including amendments) [IEC 1975] has been pointed out as an approach that could be extended towards energy-related aspects. In lack of another specific standard or methodology, IEC 60530:1975 will therefore be used as a proxy to discuss kettles from a strict product scope. Though the standard is not designed for energy-related measurements, it underlines basic requirements/assumptions that a standard or a methodology on energy consumption/efficiency will also require. Based on the following discussion of user behaviour on the environmental performance of kettles, suggestion for extending the current methodological approach will be provided in the final section of this task.

IEC 60530:1975, followed by two amendments, describes a set of measurements for kettles and related conditions for measurement. While some measurements focus on physical properties of the kettles (e.g. its cord length), other aspects like the 'time to boil 1 litre of water' and the 'time to boil water capacity' seem very relevant for a potential extension towards energy consumption. Combined with additional measurements on electricity consumption, the standard or a derived methodology might serve as a reference for energy performance indications.

As the focus of the existing measurements foreseen by the standard is on boiling time, some requirements particularly deal with time-related aspects of use. The main standardized operating conditions for measuring the time for boiling 1 litre of water for kettles with a water capacity above this value are the following:

- The kettle should be preconditioned at a temperature of 23 ± 2°C.

- The kettle is to be filled with 1 litre of cold water at 15 ± 1°C.
- All controls should be set to a maximum position[1] and the kettle is to be switched on directly after filling. The time to raise the temperature 80°C above its initial value is to be determined and rounded to the nearest 10 seconds.
- For temperature measurements, there are specific requirements to the position and type of the required sensor.

The time to boil to capacity is determined in the same way, but based on the stated capacity or, in lack of this, a capacity measurement of the kettle as further detailed in the standard.

Another measurement of potential relevance for the environmental performance within the standard is the determination of the minimum quantity of boiled water for kettles with an immersed heating element. This value reflects how much water must be boiled at a minimum when operating the kettle.

It should be noted that assumptions as made for the measurements of boiling time are a regular element in standards to ensure a harmonized and objectively repeatable result on the one hand and to simplify the complex reality on the other hand. Here, they serve as a basis to structure the subsequent discussion of user influence on direct consumption of kettles in real-life. In view of this, some of the aspects mentioned in IEC 60530:1975 (e.g. the position of the sensor for measuring temperature) are irrelevant to a common user while there are others that a kettle user can actually influence, including the:

- Amount of water for boiling
- Settings of controls including a target temperature
- Cold water temperature
- Starting temperature of the empty kettle

3.1.2. Extended product approach

The aim of viewing the product from an 'extended product approach' in this section is to point out where real-life behaviour may deviate from the 'ideal' conditions as given in default calculations, in this case IEC 60530:1975. This discussion follows the items mentioned in the previous section and aims to contrast the assumptions with evidence on real-life usage.

Amount of water for boiling

The standard focuses on the time for boiling a pre-defined amount of water, i.e. 1 litre or nominal capacity. Yet usage patterns of kettles in general may vary. In an in-depth investigation of kettle usage in 14 houses in the United Kingdom [Murray et al. 2016], a seasonal shift of kettle usage was observed for example. Monitoring data on kettle utilization across one year suggests a slight increase during winter and holiday periods. Further investigations by hours of day suggests differences between working days and weekends (Figure 3-1). Among others, a general shift towards later hours in the morning and less evident peaks at certain hours later in the day have been observed during the weekend as compared to weekdays [Murray et al. 2016]. Since the study is limited to the sample households, there is no evidence on whether the changes are mirrored for example in boiled water consumption at offices where the inhabitants might alternately consume it during working days instead. Yet the data underlines a general variation in boiled water consumption.

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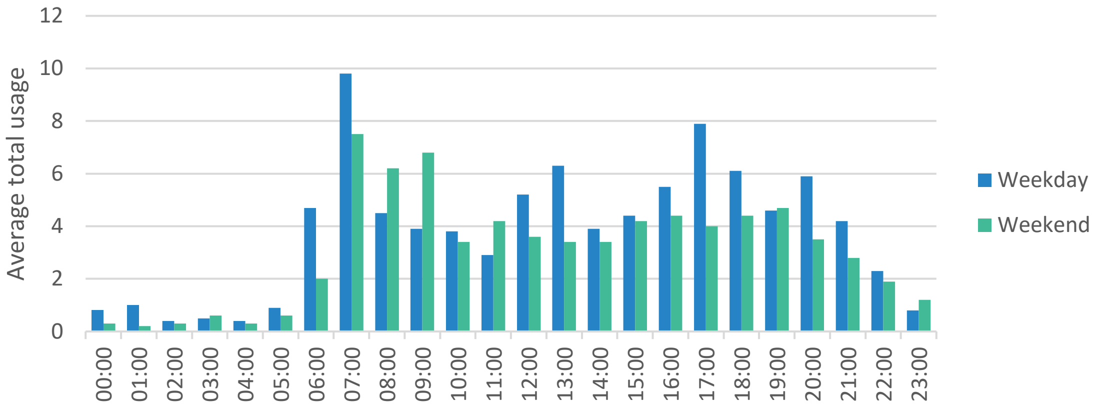
[1] Due to the focus of the standard on boiling time, the reason for this setting is likely derived from the aim of indicating the minimum time for boiling.

Figure 3-1: Distribution of kettle usage across 14 houses in October 2014 by hour and type of day (Data source: Murray et al. 2016)



Further information on kettles use is available is available from surveys in Germany and the United Kingdom. The data for Germany [Prakash et al. 2020] is based on responses to a consumer survey on obsolescence covering five types of domestic appliances including electric kettles. In this survey from 2013/2014, 692 participants answered questions relating to electric kettles. The data for the United Kingdom [EST 2013] contains self-reported information of consumers using an online tool. This survey also included a question on kettle utilization. While no specific indications on the number of answers to this question are yielded in the source, the report points out a high number of responses (86 171 participants) obtained for the report in general.

Figure 3-2 shows the data from the German study, indicating that about 64% of the users use the kettle as least once per day. The values in Figure 3-3 from the United Kingdom point to a higher share of 84%[2] with at least one use per day. Data presented in [Murray et al. 2016] suggests an average 6 kettles uses per house and day.

In sum, the data suggests that kettles are used considerably more often than once per day, at least in the United Kingdom. While this data does not provide indications on the actual amount of water used for boiling for each utilization, it underlines the variation in kettle utilization in real-life.

Figure 3-2: Use of kettles according to a consumer survey in Germany (Data: [Prakash et al. 2020]; Question: 'How often did you use this kettle as a rule? If you do not know, please estimate a value.', n=688)

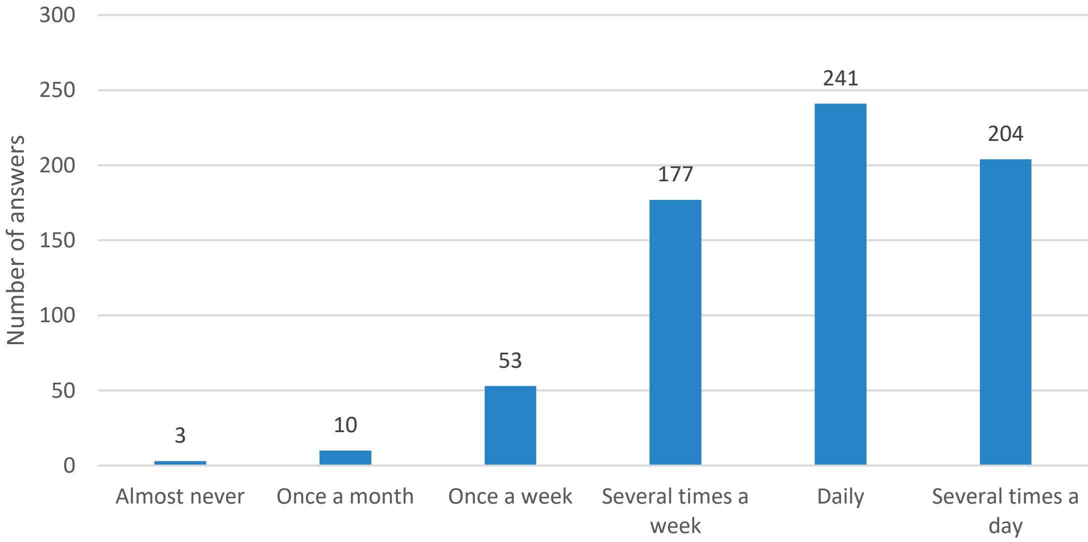
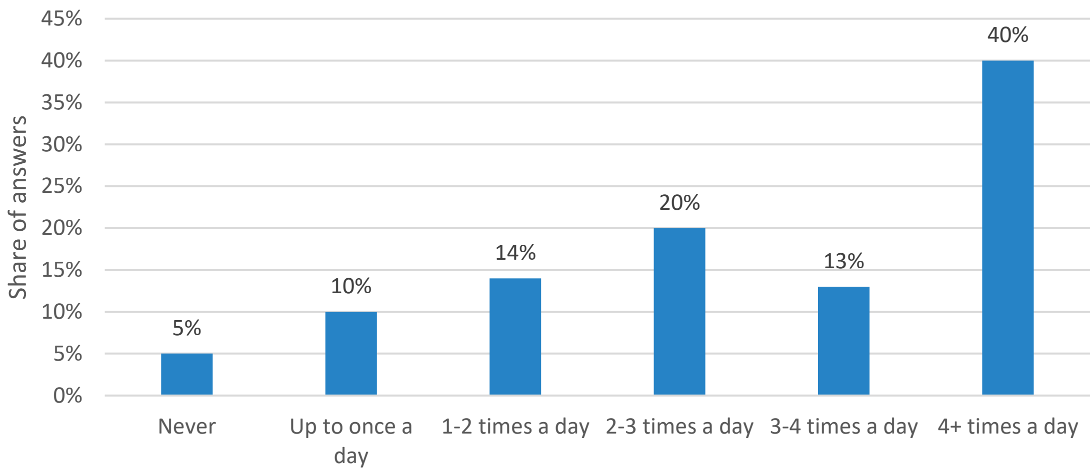


Figure 3-3: Number of kettles uses per household and day according to a household survey in the United Kingdom[2] (Data: [EST 2013]; Question: 'How many times does your household use the kettle each week?'; n: not specified)



The considerable variation in the number of uses per day has also been pointed out elsewhere [bio et al. 2015].

A crucial parameter for the determination of the environmental performance of electric kettles is their annual usage. Both literature and comments from the stakeholder consultation show some variation in the actual usage data. One of the concern of stakeholders is that a simple transfer of figures from specific regions like the United Kingdom on usage patterns to the rest of Europe might lead to an overestimation of kettle use. For this reason, the available indications on the average consumption of electric kettles from various source have been put together here in a structured manner. These indications differ in quality, some being based on survey and statistics, others simple assumptions used in other contexts, yet they provide some insights on expected kettle usage.

In total, 15 such indications on boiled water consumption from electric kettles have been collected (Figure 3-4). It should be noted that most of these values specify gross consumption, i.e. the amount of water heated in a kettle. One source refer to net consumption, i.e. the amount actually used as boiled water by consumers. The difference between gross and net is due to 'overboiling' (see below). One of the sources did not provide sufficient details to conclude on whether the indication is gross or net. The individual indications are:

- **Case 1:** According to [bio et al. 2015], the UK Energy Saving Trust determined the annual electricity consumption of electric kettles based on measurements in 412 households. The average resulting consumption is 167 kWh/year. Assuming an average consumption for boiling in an electric kettle of 0.12 kWh/l translates into an overall consumption per kettle and year of 1392 litres.
- **Case 2**: Also according to [bio et al. 2015], the UK Market Transformation Programme assumes a gross volume of 1542 litres per year and household. Under the assumption that 'overboiling' causes about one third of total boiled water consumption, a net value of 1000 litres per year and household is identified a proxy value.
- **Case 3**: [bio et al. 2015] also refers to another study on 250 households in the UK and provides a value of 168 kWh/year per kettle. With the same assumption on specific consumption of 0.12 kWh/l, this yields 1400 litres per year.
- **Case 4**:_Another investigation [Gallego Schmid et al. 2018] assumes a functional unit of 1542 litres of gross boiled water, referring to the figures also mentioned in case 2.
- **Case 5**: During the stakeholder consultation for this study, the UK test magazine 'Which?' indicated that data by their members points to six uses per day. With 1 litre per fill, this translates to 2190 litres gross consumption per year. Yet the authors also point out that this might not be representative nor might it reflect lower usage patterns in Europe.

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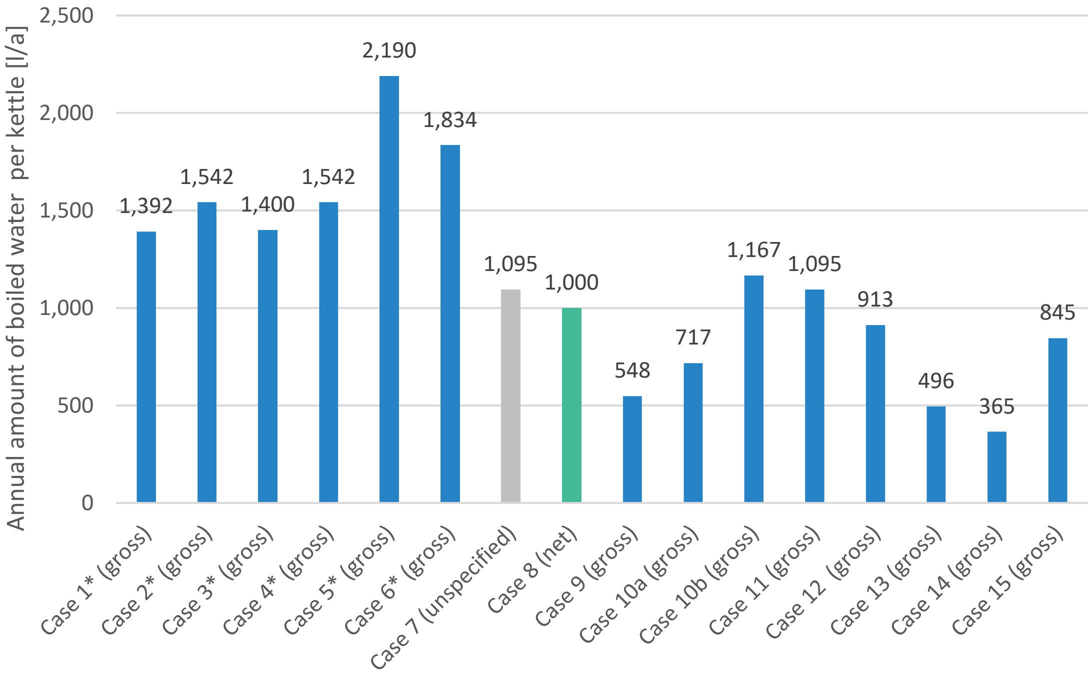
[2] Please note that figures in the publication add up to 102%.

- **Case 6**: Based on the previously shown user surveys and additional assumptions, some estimates on gross consumption can also be derived. Using the UK survey data (Figure 3-3) and further assumptions ("up to once a day" is chosen as 0.5 uses per day, "4+ uses" is considered as 4.5 uses per day and for the remaining ones, the middle is chosen; consumption is 0.12 kWh/l again), an annual (gross) consumption of 1834 litres per year can be derived.
- **Case 7**: An investigation on the environmental labelling on kettles [Schüler; Grießhammer 2009] assumes an average demand of 3 litres of boiled water per two-person-household, translating into 1095 litres per year. In this investigation, the value is considered as a conservative, i.e. low estimate.
- **Case 8**: Another source referenced in [bio et al. 2015] indicates a net consumption of 1000 litres for boiling water with 650 litres for hot drinking and 350 litres for cooking. Yet there is no clear indication of whether this consumption is to be covered by electric kettles only.
- **Case 9**: In a comparison between electric kettles and stovetop kettles [Ayoub, Irusta 2014], a functional unit of boiling 0.5 litres water 3 times a day on each weekday is assumed. This translates into a gross consumption of 548 litres per year.
- **Case 10**: For illustrating the overall impact of kettles, a Swedish study [Energimyndigheten 2018] uses the example of two fully filled vessels per day between 1 and 1.7 litres. With the previous specific consumption (0.12 kWh/l), this translates into a gross consumption of 717 respectively 1167 litres per year.
- **Case 11**: In a screening life cycle assessment investigation [Grzesik; Guca 2011], a kettle for operation in Poland is assumed to operate three times a day for boiling 1 litre of water. This translates into 1095 litres of gross consumption per year.
- **Case 12**: In its test of electric kettles, the German magazine test [test 2013] uses a proxy value of 2.5 litres per day for illustrating energy demand and costs of various types of water heating options. On an annual basis, this translates into an annual gross demand of 913 litres.
- **Case 13**: Another input from the stakeholder consultation was received by the European association APPLiA who sees a realistic estimate in 1.7 uses per day with an average gross filling of 0.8 litres. This translates into 496 litres per year and kettle.
- **Case 14**: Within the methodology by topten [topten.ch 2017], the assumption for determining the overall demand of an electric kettle is based on assuming boiling 1 litre per day, resulting in an annual gross consumption of 365 litres.
- **Case 15**: Assuming for the German survey data (Figure 3-2) that "several times" means 3 times (resulting in 1.36 uses per day) and assuming further that a kettle with a capacity of 1.7 litres filled completely (resulting in 2.31 litres/day), this leads to an annual (gross) consumption of 845 litres.

The indications of cases 1 to 6 in Figure 3-4 were given in context with the UK, while the cases 7 to 15 are provided for other geographical areas. Despite the mentioned limits, the data seems to support the statement that the consumption in the UK is higher than in the other regions. The simple average for the remaining regions is about 800 litres of gross consumption per day. This roughly corresponds to about two uses of a 1.7 litre kettles per day filled to 2/3 of its capacity. In conclusions based on available data, a functional unit of 800 litres per electric kettle and year is considered as a suitable proxy. For the sake of completeness, it should be noted that the consumption varies by individual kettle. Some might not be regularly used while other might be under intensive regular use, e.g. in office kitchen or hotel lobbies.

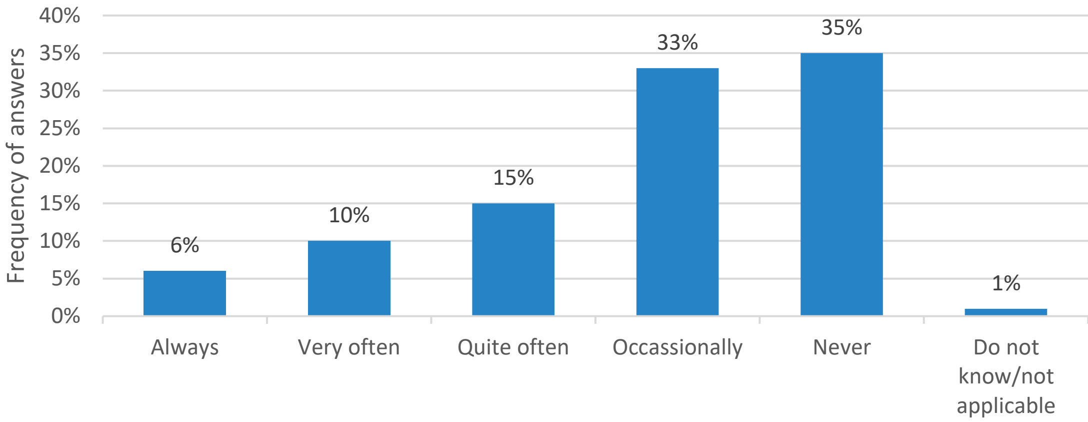
Figure 3-4: Indications on annual amount of boiled water according to various sources (Data sources and assumptions: see text; blue: gross values; green: net value; grey: unspecified; *: in context of UK values)



Another aspect related to kettle usage and user influence is descaling. Descaling of kettles is needed in case of hard water in the local water supply. Descaling is usually performed by cleaning the kettle with a cleaning agent at elevated temperatures, i.e. the kettle is turned on. Thereafter, the kettle needs rinsing, usually boiling the kettle with clean water several times before re-using it for drinking water. This will lead to an additional direct energy and water consumption. In terms of the frequency for descaling, a recommended frequency of descaling in case of normal kettles use up to 5 times a day ranges from a monthly to a quarterly basis depending on water hardness. Following the assumptions from Task 1, the overall consumption for descaling lies in the area of 1 to 2% of overall energy consumption.

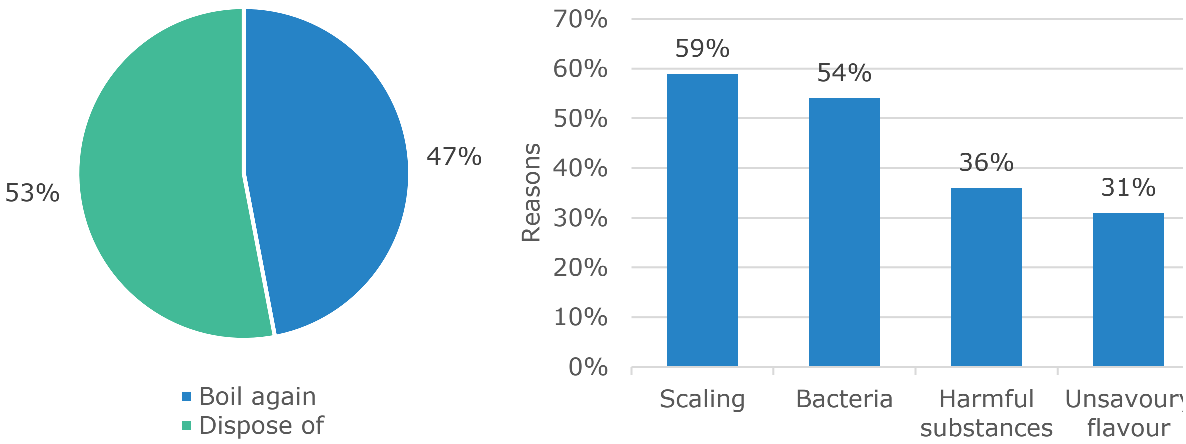
There is evidence for a considerable impact on direct energy due to 'overboiling'. 'Overboiling' is caused by a behaviour where the actually needed amount of boiled water is smaller than the amount of water filled and heated up in the kettle. Evidence on the occurrence of this phenomenon can be found in a survey in the United Kingdom by the British Department for Business, Energy & Industrial Strategy [BEIS 2020]. Its 'Public Attitudes Tracker' is a survey that is carried out four times a year. In the most recent wave of the survey, a representative sample of 1,851 adults were asked, among others, about energy-related behaviour including a specific question on their use of kettles. Figure 3-5 shows the results for boiling water in a kettle. The results underline that nearly two-thirds (65%) of the participants at least occasionally boil too much water in a kettle (result of preceding survey in March 2019: 61%). With regard to an extension to the standard or establishing an energy-related methodology for kettles, the approach could indicate whether any design features to minimize overboiling have been put into place.

Figure 3-5: Share of overboiling according to a household survey in the UK (Data: [BEIS 2020]; Question: 'How often, if at all, do you personally do any of the following … Boil the kettle with more water than you are going to use?', n=1851)



Next to the resulting direct impact on energy consumption due to heating more water than needed, this behaviour also entails an increase in water consumption if water is not 'reboiled'. Some indication on the relevance of 'reboiling' can be found in a press release by SGS Institut Fresenius [SGS group 2017]. According to a survey among 500 persons in Germany, the majority (53%) disposes of remaining water after boiling it. Various reasons are provided for this behaviour, including scaling in the kettle (59% of answers), fear of bacteria growing the water (54% of answers), a fear of accumulating harmful substances from the inner kettle in the water (36% of answers) and an unsavoury taste of the water (31% of answers).

Figure 3-6: Use of 'overboiled' water according to a survey in Germany (Data: [SGS group 2017]; Question: 'Do you boil water from the kettle again?', n=500)



This suggests that a considerable share of the boiled water is disposed of and that some energy might be "lost" in case of reheating if the water was still warmer than ambient temperature. With regard to potential design options as discussed later in Task 6, this could imply that an improved insulation of kettles to reduce energy losses might benefit from accompanying information on issues related to re-using boiled water. Yet it should also be noted that still nearly half of the users indicated that they re-boil water anyways.

This discussion of aspects related to the amount of boiled water shows that the standard is making a simplification of reality when focusing on a particular amount of water for boiling only.

Settings of controls including a target temperature

With regard to the setup of the standard, a rather narrow behaviour is chosen with a maximisation of control settings and the specified increase in temperature of 80°C.

This is a simplification for energy demand measurement. Water kettles generally allow users to interrupt the heating process at any given moment, e.g. to avoid an excessive release of vapour or to reduce noise close to the boiling point or simply as a manual mean to adjust temperature levels. Information on such behaviour, however, is limited and likely also difficult to integrate in a standard. No data seems to be available on manual switch-off by users, but it was pointed out during the stakeholder consultation, that this behaviour is considered as unlikely because of the automatic switch as a main feature of a kettle.

More advanced kettles also allow for setting desired target temperatures instead of fixed temperature levels (see also Tasks 2.4.1 and 4.1.2.5). If a lower or higher temperature than 95°C is chosen (as a result from the basic 15°C default temperature and the 80°C increase in the standard), this will have a direct impact on energy consumption. In a study on the environmental performance of kettles [Gallego Schmid et al. 2018], a distribution of 73% of consumption at 100°C, 22% at 90°C and 5% at 80°C has been used. The market analysis in Task 2 has yet shown that sales for kettles with temperature control are still limited and no published quantitative data on actual temperature setting have been found and no data on this seems available from stakeholders during the consultation either.

However, with a general trend towards smarter and IT-enabled products, there could be an increasing number of kettles offering this functionality. An energy-related standard or methodology for electric kettles might consider different target temperature levels for the calculation of energy demand (e.g. a weighted target temperature collective).

Another aspect related to temperature levels is the warm keeping function in some kettles. This allows the user to select a mode of operation where the water temperature is maintained at a specified level after regular boiling stops, i.e. the kettle will reheat the water when it drops below a specified temperature. No data on the utilization of the warm keeping function could be identified, but the same principle might apply as for 'overboiling': If the water kept warm is not used, the warm keeping function leads to excessive resource consumption. For a limited sample of kettles, the duration for warm keeping function has been identified as between 15 and 40 minutes (Energimyndigheten 2018).

Considering all aspects with a regard to a future methodology for determining the performance of kettles, it seems advisable to foresee a more differentiated view in a standard to come with regard to target temperatures and warm keeping to enhance capturing real-word behaviour.

User impact on the starting temperature of the empty kettle

The assumed "starting temperature of the empty kettle" is also a simplifying assumption. In real-world behaviour, a kettle might still be filled with remaining water from the last boiling (see also Figure 3-5). Furthermore, the assumed temperature of the kettle might deviate from reality since many factors affect this temperature.

- In case water the kettle was recently used, the kettle might still have a higher temperature as the assumed 23°C plus tolerance.

- Based on the location of use, the user might place the kettle in a particular warm location (e.g. close to an oven, heat outlet of a fridge, radiator or in the sunlight) or cold location (e.g. close to an air conditioner vent, near an open window in winter). This could affect the assumed starting temperature.

While all these issues related to user behaviour can lead to deviations from the standard, the benefits from considering varied starting temperatures of empty kettles seem limited.

User impact on cold water temperature

With regard to the "cold water temperature", the actual temperature can vary in different ways based on user behaviour:

- Water temperature varying with intensity of use: Independently of a particular intervention by a user, water temperature may vary. In a summer with previous little water use, water may have adopted elevated temperatures of the building after staying in a rather warm pipe heated by the general warmer ambient temperature for some time. In another case, much water might have been consumed recently, thus leading to water that passed an underground and thus rather cool pipe network for some time, thus leading to a lower consumption.

- Water temperature consciously changed by user: A user might also fill a kettle by selecting a hot water position at a tab, expecting for example a shorter heating time or a decrease in electricity use if the tab water is heated by other means.

- Composite temperature of water: Finally, the kettle might not have been emptied entirely. Thus, some water with an elevated temperature from the last use might remain in the kettle, thus affecting the resulting temperature in the kettle when new water is added.

While these points affect energy consumption in real-life, they also seem difficult to capture and quantify. Thus, an average assumption on cold water temperature seems justified for simplifying reality.

Other aspects related to applying the standard

There are also circumstances when applying the standard that do not necessarily meet the reality of users:

- First, there is no specification on the status of the lid. For minimizing boiling time and ensuring proper operation (e.g. the proper working of the automatic switch-off), it is likely closed during the test. A closed lid is also needed to prevent scalding hazards due to hot water spitting. In practice, however, kettles could also be switched on with an open lid.

- Second, it seems likely that the test will be operated on new kettles. In practice, real-world kettles may not be regularly cleaned by the user, leading to scaling of the kettle. Scaling can affect the thermal conductivity of an "empty" vessel and thus affect the energy consumption of a kettle. However, no information on the magnitude of this effect could be identified.

- Third, a keeping warm function as available for some kettles is not covered by the standard. Maintaining the high water temperature may entail addition energy consumption for re-boiling over a specific interval of time. A similar situation as for "overboiling" can occur, i.e. the water is kept warm but not used by the user in the end.

3.1.3. Technical systems approach

The technical system approach extends the scope of the analysis further and aims to consider kettles as a part of a larger system. Since electric kettles are stand-alone devices, there seems no particular aspects relevant to this product group. A first aspect is the aforementioned water temperature from the tap, which can affect direct energy consumption. A second aspect it the "thermal load" character of the kettle which might affect indirect energy consumption of a building (see section 3.2). If the kettle is combined with a water filter, the filter might need regular replacement, also depending on the local water properties. In sum, the project teams could not identify any user-related aspects on direct energy consumption from the technical system approach.

3.1.4. Functional systems approach

The functional systems approach shall cover other ways to provide the same services as an electric kettle. According to Task 1, the "main function of an electric kettle is to heat water either to boiling or pre-set temperature. The functional unit is the amount of boiled water." Furthermore, the kettle might offer the possibility to keep boiled water warm for some time.

In general, boiled water is used for many purposes in food preparation. Accordingly, there are many products for specific purposes that may also deliver boiled water as a core feature ("boiled water essential feature for the product"), as additional feature to another core feature ("boiled water accompanying addition") or also as a non-design feature ("product requires boiled water, but boiled water is only a 'side-effect'") (see also product scoping in Task 1.2):

Core features:

- Stove-top kettles

- Mounted electric water heaters

- Hot water dispensers
- Urns and similar vessels

Additional feature:

- Electric tea or coffee machines including derivate products
- Microwave ovens

Non-design feature:

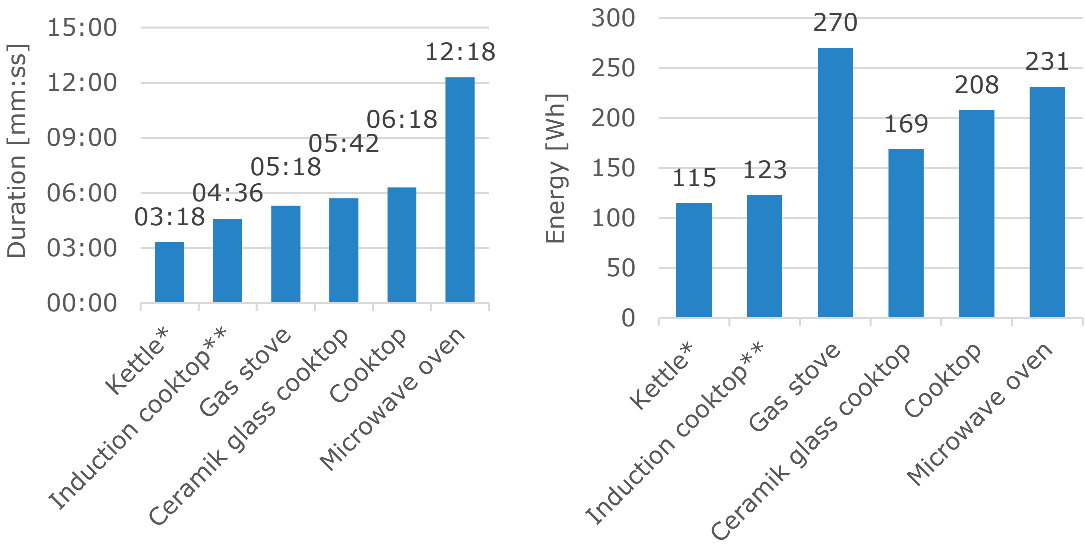
- Other stove-top kettles (e.g. cooking pans; pressure cookers; slow cookers; steam cookers)
- Products with other core usages that might heat water (e.g. egg boilers; rice cookers; milk heaters)

Even though ‘non-design feature’ products could yield boiled water, it seems rather unlikely that users would use these broadly as a regular substitute for electric kettles. In case of products with ‘additional features’, using them as a substitute is more likely than for the previous group. Yet, depending on the product, some aspects might limit their use, e.g. the achievable temperature, the available maximum volume per use, the boiling time and depending on the product, the boiled water might also adopt the flavour of the ‘core’ product (e.g. hot water from coffee machines).

The products with the same basic core features as the electric kettles are most likely used as a substitute for electric kettles. According to the market estimates for urns (Task 2), their relevance as a substitute for kettles seems negligible for consumers, also due to the expected larger storage vessels. Household hot water dispensers might serve as a substitute for electric boilers. Yet their current sales volume has been identified as negligible compared to electric kettles (Task 2). Indications on the performance of other ways for boiling water is given in a general comparison of the German consumer magazine ‘test’ [test 2013]. There, different ways of boiling water are compared which includes the duration and energy demand to boil water (Figure 3-7). In terms of boiling time, the electric kettle is attributed with the shortest time, followed by the induction cooktop (without boosting function). Other options for boiling water (e.g. other types of cooktops, microwave ovens) follow, but take longer and use more final energy according to the provided data.

In sum, when concluding on electric kettles from a functional perspective, users might most likely use traditional cooktop kettles as an alternative to operating electric kettles. However, stand-alone plug-in hot water dispensers might serve as substitutes only for some usages (especially limited amount of hot water needed) and they are currently not sold broadly.

Figure 3-7: Comparison for boiling water for 1 litre of water using different products Warentest (Data: [test 2013]: *: average of tested products; **: without booster function)



3.2. Subtask 3.2 - System aspects affecting indirect energy consumption during the use phase with indirect energy consumption effect

The aim of this subtask is to report on any **indirect** consumption effects during the use phase that affect the environment and resources. The operation of particular products (e.g. windows) might affect the energy consumption of other systems, thus causing an indirect consumption in these systems.

In general, the operation of electric kettles causes an energy transfer from the electrical grid to water with the result of obtaining boiled water. Due to losses, some of this energy is dissipated to the environment, e.g. through the vessel of the kettle and by steam emanating from the boiling process. Depending on the local operating conditions and the use of the water, this might affect the energy needed for heating (in winter) and cooling/air conditioning (in summer). Yet the magnitude of the impact does not only depend on the local environment, but also on the actual use of the water. A few example for illustration: A user might drink some hot water and then move to another location, thus dislocating also part of the energy used for boiling. In another scenario, the boiled water might be poured down an outlet. These examples hint at the difficulty in tracking where the thermal energy taken actually ends up. Furthermore, the additional net effect on any heating/cooling systems seems difficult to quantify in a generalized manner. The effects might even themselves out depending on the actual location and heating/cooling requirements.

With regard to the order of magnitude of the thermal impact, a rough estimate can be provided. Assuming:

- an average energy demand for boiling 1 litre of water of about 0,12 kWh (warm keeping function not considered),
- the previously mentioned consumption of 1500 litres per year and household (including overboiling) and
- further that the energy does not leave the location where the kettle is located,

the thermal impact would be about 180 kWh/year. For comparison: this value is in the area of the specific heating demand for heating 1 m²/year in an average building.

Due to the thus relatively limited impact, the considerable heterogeneity with regard to the need for heating and cooling buildings, the multitude of different heating and cooling technologies and especially the aforementioned uncertainties, it is suggested not to further consider the indirect energy consumption of electric kettles on heating/cooling of the building.

3.3. Subtask 3.3 - End-of-Life behaviour

The aim of this subtask is to identify, retrieve and analyse data and to report on consumer behaviour regarding end-of-life aspects from an average European perspective.

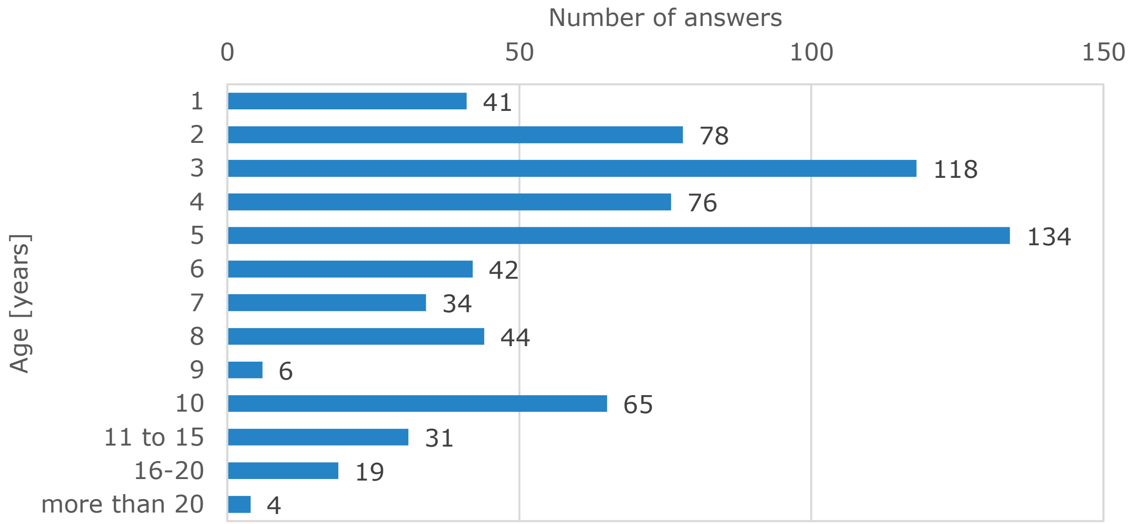
3.3.1. Product use & stock life

With regard to the lifetime of electric kettles, the corresponding analysis of the Ecodesign Working Plan study [bio et al. 2015] points out that the electric kettle market is very competitive and that price is more important than durability despite an effort by reputable brands to provide reliable products. Difference in product quality by brands were also pointed out by the UK-based test magazine 'Which?' [Williams 2020]. Based on a survey of its members, the analysis points out that well above 90% of the products of the top brand do not show any faults after three years of operation while the least reliable brand had about 70% of products still in operation after the same time.

Manufacturers of elevated quality kettles with concealed heating elements are reported to design their products for up to 20,000 uses [bio et al. 2015]. This corresponds to seven years of operation assuming eight uses per day according to the cited study. Lower priced models are reported to have a lifetime of 3 years, yet an average aggregate lifetime of 5 years have been assumed in the Working Plan study [bio et al. 2015]. Further evidence on kettle lifetime is available based on consumer survey data for the Netherlands. For hot water and coffee making products, a median lifespan of 7.0 years in the year 2000 and a value of 6.4 for the year 2005 is referred to [Bakker et al. 2014]. A survey for the German Environment Agency [Prakash et a. 2020] points in a similar direction. Figure 3-8 shows the age distribution of replaced kettles as indicated by survey participants. The results illustrate well the heterogeneity in kettle lifetimes; the average replacement cycle was determined at 5.7 years in the study with a standard deviation of 4.2 years.

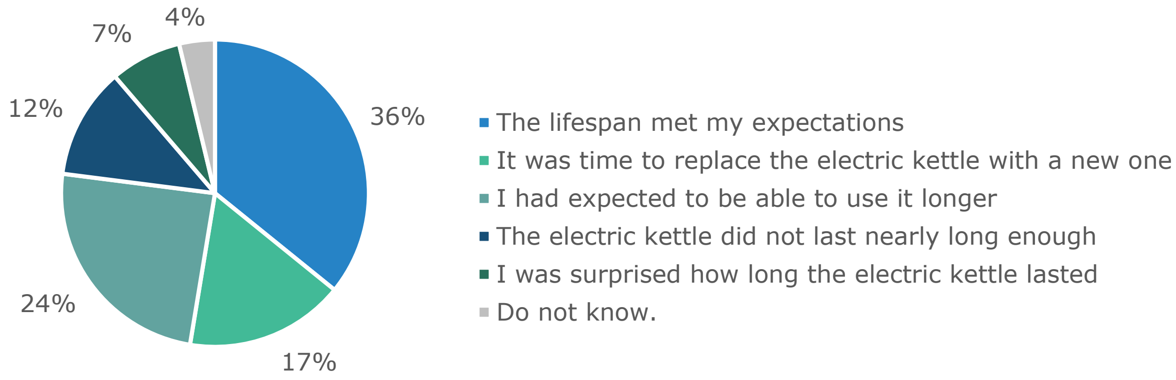
To conclude, an average lifetime assumption of 6 years seems to be a suitable order of magnitude to capture the average real-life usage of electric kettles for the study. In the individual case, considerably shorter or longer observed lifetimes are possible.

Figure 3-8: Age distribution of kettles according to a consumer survey in Germany (Data: [Prakash et a. 2020]; Question: 'How old was the kettle? If you do not know, please estimate a value [in years].', n=692)



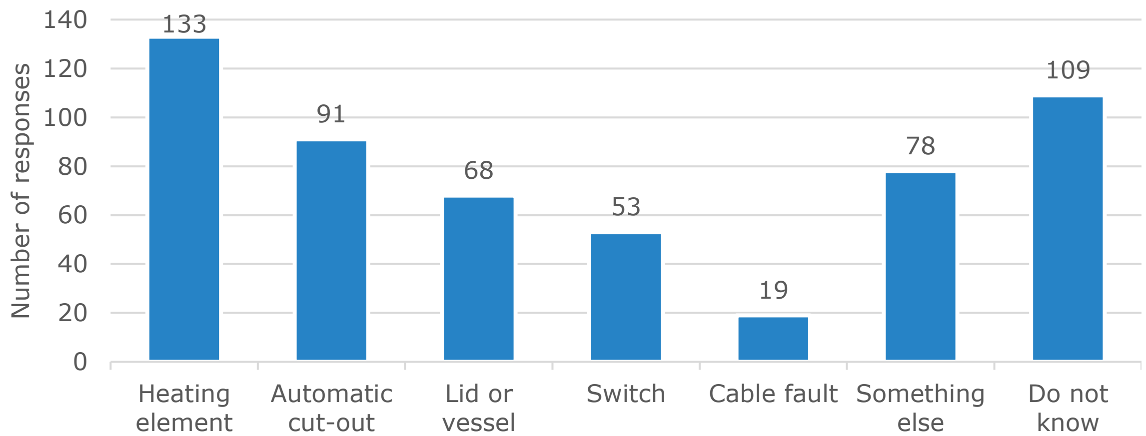
Further interesting results with regard to user behaviour is given in the German study [Prakash et al. 2020]. This study also investigates on the perception of the achieved lifetimes. Specifically, the survey participants were asked about their satisfaction with the lifespan of the kettle. More than half of the participants indicated that their lifetime expectations were met (36%) or that they saw the need to replace the existing kettle (17%). More than one third pointed out that they expected a longer lifetime (24%) or that the lifetime was well below expectations (12%). About 7% of the participants, on the contrary, were surprised on the long lifetime. This seems to suggest that consumers are generally satisfied with the lifetime of current kettles, though there might be a tendency for preferring longer lifetimes.

Figure 3-9: Satisfaction with kettle lifetime according to a consumer survey in Germany (Data: [Prakash et al. 2020]; Question: 'How satisfied were you with the lifespan of this electric kettle?'; n=692)



An investigation into the reasons for disposing of the kettle [Prakash et al. 2020] points to defects in various areas. Problems with the heating element of the automatic switching off were the most often mentioned answers (Figure 3-10). In the survey by the UK test magazine 'Which?' [Williams 2020], a broken lid was the most commonly reported error mentioned by the participants (problem in 15% of cases). Yet it should be noted that while the German study focuses on disposed kettles, the UK survey does not necessitate a prior disposal.

Figure 3-10: Defects of kettles according to a consumer survey in Germany (Data: [Prakash et al. 2020]; Question: "What exactly was wrong with the electric kettle?"; n=473, multiple answers possible)

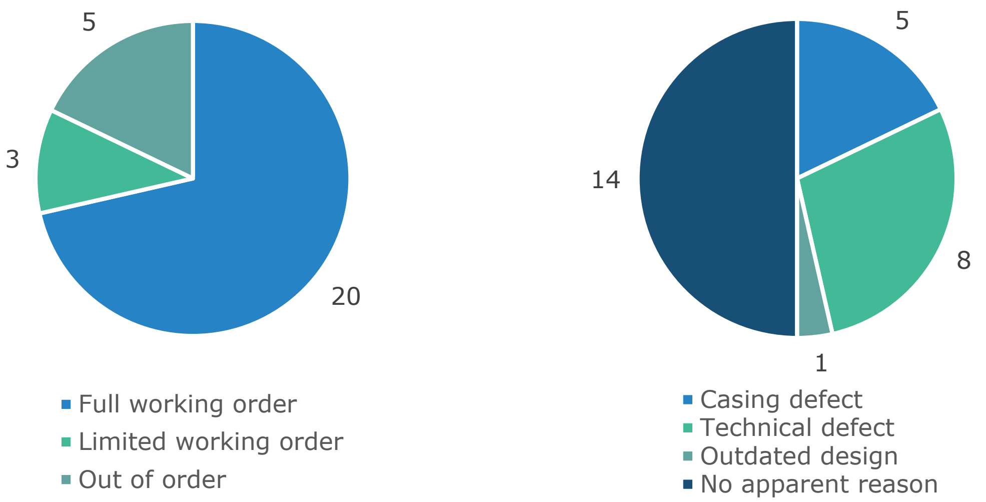


Further information on the end-of-life of kettles from a user perspective can be derived from another set of information mentioned in the German study [Prakash et al. 2020]. It reports on an analysis of 28 electric kettles collected at a local waste collection point close to Bonn, Germany, in 2013/2014. These kettles were further investigated at the local University. Figure 3-11 shows the result of this investigation: Most of the kettles (20) did not show any obvious faults that affected their utilization/function; a few (3) were classified as operating with limits (e.g. due to a broken switch that had to be manually held down/released) and the remaining kettles (5) were identified as broken. Based on these results combined with a review of external design and appearance as well as an internal inspection, the study concluded on probable reasons for disposal. The analysis of the sample concludes that for half (14) of the kettles, no apparent reason for disposal could be identified, yet 9 of them showed heaving scaling. Technical defects were identified as probable reason of disposal for 8 further kettles, defects of the casing for 5 kettles[3] and for 1 kettle, an

[3] The study mentioned that it could only be ensured for two kettles that the external damage did not originate from rough handling at the waste collection/recycling centre.

outdated design was pointed out. It has furthermore been pointed out that no connection between disposal and the nature of the product as branded or non-branded product was found [Prakash et al. 2020].

Figure 3-11: Working order test results (left) and the probable cause for disposal (right) of a sample of disposed electric kettles collected from a local waste collection point in Germany (Data: [Prakash et al. 2020])

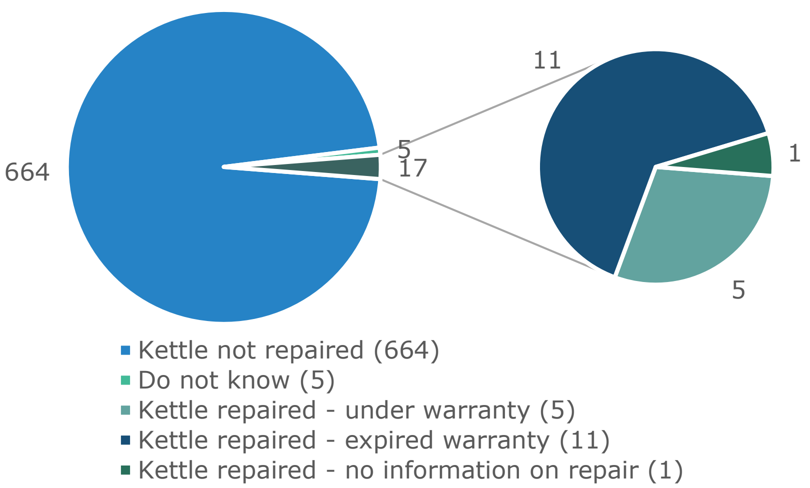


Stakeholders pointed out during the consultation that at least in the United Kingdom and Germany, manufacturers offer breakfast sets of filter coffee machines, toasters and electric water kettles in the same design. This might lead to early replacements of the devices in case consumers change all of them at the same time.

3.3.2. Repair and maintenance practice

With regard to maintenance and repair practice, the price of appliances will be a very important criterion since any repair will likely compete with the purchase of a new product. According to available data, repairs of kettles are carried out rather seldom. According to the German survey [Prakash et a. 2020], less than 3% of all kettles undergo repair and less than 1% were repaired under the warranty period. In conclusion, repairs of electric kettle are rather uncommon.

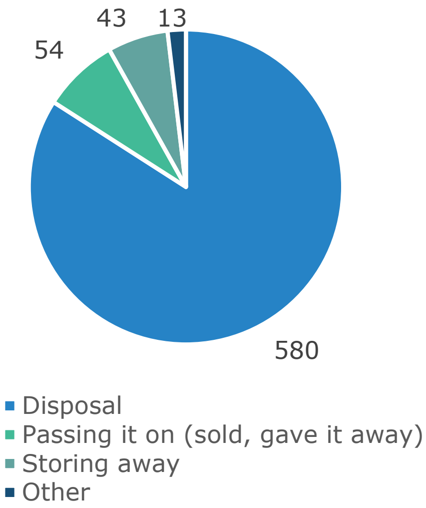
Figure 3-12 : Repair of electric kettles according to a consumer survey in Germany (Data: [Prakash et al. 2020]; Questions: 'Was the electric kettle ever repaired? ', 'Was the repair carried out during the warranty period?'; n=686 (first question), 17 (second question))



3.3.3. Collection rates

Generally, information on collection rates for electric kettles seem limited. Again, the survey results of the German study [Prakash et al. 2020] provide some indications on the disposal respectively second hand utilization of electric kettles. Offered a set of choices, most of the participants indicated that their kettles were directly disposed of (84%).

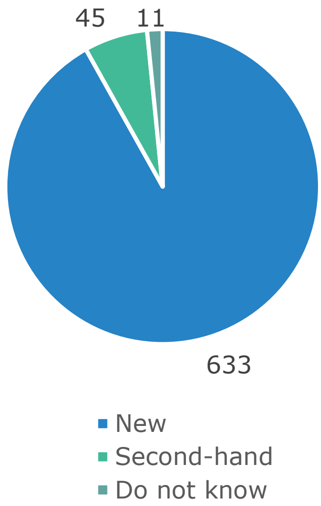
Figure 3-13 : Behaviour in case of putting kettle out of commission according to a consumer survey in Germany (Data: [Prakash et al. 2020]; Question: 'What did you do with the old kettle?', n=690)



3.3.4. *Estimated second hand use*

Due to the relatively low price of basic kettles, the hypothesis by the project team is that the second hand market for electric kettles is limited. The survey for the German Environmental Agency [Prakash et al. 2020] shows that nearly 92% of the respondents bought the kettle new while less than 7% bought the kettle second hand (Figure 3-14). This seems to support the initial hypothesis of a low passing on of kettles.

Figure 3-14 : Acquisition of the most recently acquired kettle according to a consumer survey in Germany (Source: [Prakash et al. 2020]; Question: 'Was the kettle bought new or second-hand?', n=689)



3.3.5. *Best practice in sustainable product use, amongst other regarding the items above*

Based on the previously discussed items, a summary of best practices by manufacturers to support a sustainable user behaviour with regard to electric kettles can be given.

- Since overboiling is a major source for energy and water waste, it is of particular relevance for user behaviour. Strategies therefore aim at optimizing the filling levels of the kettle that the uses chooses. Technical means to do so are for example water indicators or integrated displays.

- In case of kettles with warm-keeping functions, alarms and automatic turn-off functions after a set duration could improve the environmental performance in this mode of operation.
- Other conceivable strategies are related to smart functions provide users with feedback on kettle utilization (see Section 4.1.4.1/Task 4).
- In view of avoiding a shift from electric to stove-top kettles, a suggestion by stakeholders is to point out the time to boil a particular amount of water (e.g. 1 cup, 1 litre) as compared to a typical stove. This could support the use of kettles as fast and environmentally well-performing mean for cooking water.
- Another factor that appears relevant for kettle lifetimes is scaling. As indicated by the cited studies, scaling appears to be a relevant factor for an early disposal of electric kettles. Best practice therefore supports the user in descaling the kettle. Shipping a descaler has been mentioned by stakeholders as a suggestion in the context of encouraging users for regular descaling.

3.4. Subtask 3.4 - Local infrastructure

The aim of this subtask is to identify, retrieve and analyse data and thereby to report on barriers and opportunities relating to any local infrastructure needed for the operation of kettles.

3.4.1. Energy infrastructure

Kettles as defined in Task 1 are devices connected to the electrical grid via a plug. There is no particular influence of kettles users on the energy infrastructure.

3.4.2. Water infrastructure

Kettles are commonly used to boil water from a tap. As mentioned earlier, users might affect the direct energy consumption of kettles if they fill them with warm water from the tap.

Depending on the local setup for heating tap water (e.g. via decentralized boiler vs. a centralized without circulation; operation by electricity or other energy carrier), obtaining hot water from the tap might require opening the tap for some time, thus leading to increases in water consumption and energy losses.

With regard to the role of the water infrastructure and local water supply, it should also be mentioned that harder water might increase scaling and the need for descaling. It might influence energy demand (see also section 3.1.2) and the use of scale filters.

3.4.3. Telecom infrastructure

Recent “smart kettles” may require wireless connections (e.g. bluetooth, wifi), e.g. for linking them to a smartphone app. These models offer services as traditional kettles via additional manual controls, e.g. for selecting certain temperature levels or a warm keeping function.

In general, this additional functionality and its impact on IT infrastructure/energy consumption of mobiles is in general similar to other “smart home devices” and it thus not seem to be of particular relevance.

3.4.4. Installation

As the electrical kettles as defined in Task 1 only need to be connected to a plug socket, no physical installation (e.g. wall mounting, piping) is relevant for this product group. Smart devices might yet need to undergo a setup procedure (e.g. pairing with smartphone).

3.4.5. Physical environment

Within the aspect entitled “physical environment”, the MEErP points out to analyse sharing opportunities for the products. No particular data on sharing opportunities of kettles could be identified. Yet there are several aspects mentioned earlier that give an indication on the likelihood of sharing: Kettles are relatively low-priced products. This is underlined by the observation that a substantial share of kettles still operational is disposed of. Few users buy second-hand kettles and kettles are often used several times a day.

While it is technically conceivable to share kettles, the combination of the previous aspects suggest that few users will tend to share the product outside of their household. In an office kitchen or similar location, kettles might be run a shared equipment. This should not be perceived as additional or new sharing opportunity but a long-established characteristic of shared kitchens.

3.5. Subtask 3.5 - Recommendations

The aim of this subtask is to provide recommendations on a refined product scope and on barriers and opportunities for Ecodesign considering user behaviour.

3.5.1. Recommendations on the refined product scope

Based on the analysis of user behaviour, the following recommendations for the refined product scoping are made:

- The analysis of user behaviour has shown a considerable variety in kettle utilization. The subsequent analysis should therefore take into consideration different usage intensities of kettles in Task 4/5.
- Overboiling has been identified as an important aspect. If available, measures to reduce overboiling should be considered in the design options developed in Tasks 6 of this study.
- Some indications on short-lifed products were found. Impact of short(er) lifetimes might also be included as a sensitivity in the scenario analysis in Task 7.
- While at the current state, there is little evidence on the actual boiling temperature selected by users, different temperature profiles for kettles with a temperature selection function/indicator could be included in Tasks 6/7, also including the consideration of a warm keeping function.

3.5.2. Recommendations on Ecodesign

Based on the discussion on the role of users, some more general recommendations for the subsequent Ecodesign process should be made:

- Overboiling is a related to user behaviour. Measures for reducing overboiling could in general be considered as well as heating water not beyond required temperature levels.
- Care should be taken that measures taken within Ecodesign do not cause a substantial shift of users towards using cooktop operation.
- Measures addressing the lifetime of the products might be included in the scenario analysis in Task 7.

Other recommendations concern a potential development of a method to assess energy consumption/energy efficiency measurements based of the basic concepts of standard IEC 60530:1975:

- The standard currently focuses on boiling time as a key result. For determining energy demand, the measurements should be extended to include power measurements. If energy consumption is to be considered, a warm keeping should also be considered in the standard.
- The temperature setup in the standard is limited to a fixed increase of 80 K to a temperature of about 95°C. More advanced modern kettles also allow selecting other target temperatures. The inclusion of a representative target temperature profile (where relevant) should be considered.
- The fixed increase by 80 K should be reconsidered. In practice, a kettle will not stop heating at a fixed temperature, but at the temperature specified by the controller. This temperature should be used, also for a target temperature profile. Combined with that, the standard should also determine this automatic shut-off temperature.
- Overboiling has been identified as a major source of energy losses. Measures to prevent overboiling should also be noted as a requirement in the standard when analysing a kettle.
- As mentioned, the methodology does not explicitly specify the status of the lid and on scaling. This should be added to avoid ambiguity.

References for Task 3

Ayoub, A.; Irusta, C. (2014): Comparison between Electric Kettle and Stovetop Kettle. Life Cycle Assessment - Group LCA 2. Universiteit Gent.

bio et al. (ed.) (2015): Preparatory Study to establish the Ecodesign Working Plan 2015-2017 implementing Directive 2009/125/EC. Task 3 Final Report. 8. Electric kettles. bio/Öko-Institut e.V./ERA for the European Commission, DG Enterprise and Industry.

Department for Business, Energy & Industrial Strategy [BEIS] (ed.) (2020): BEIS Public Attitudes Tracker (March 2020, Wave 33, UK). Online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/884028/BEIS_PAT_W33_-_Key_findings_Final_.pdf. Last accessed: 22.06.2020.

energy saving trust [EST] (ed.) (2013): at home with water. Brochure. Online: http://energysavingtrust.org.uk/sites/default/files/reports/AtHomewithWater(7).pdf. Last accessed: 22.06.2020.

Energimyndigheten (ed.) (2018): Vattenkokare. Online: http://www.energimyndigheten.se/tester/tester-a-o/vattenkokare/. Accessed: 13.08.2020.

Gallego Schmid, A.; Jeswani, H. K.; Mendoza, J. M. F.; Azapagic, A. (2018): Life cycle environmental evaluation of kettles: Recommendations for the development of eco-design regulations in the European Union. In: Science of the Total Environment, 625, pp. 135-146.

Grzesik, K; Guca, K. (2011): Screening Study of Life Cycle Assessment (LCA) of the Electric Kettle with SimaPro Software***. In: Geomatics and Environmental Engineering 5 (3), pp. 57-68.

IEC [International Electrotechnical Commission] (ed.) (1975): IEC 60530. Méthodes de mesure de l'apititude à la function des bouilloires électriques à usages domestiques et analogues. Methods for measuring the performance of electric kettles and justs for household and similar use. Première edition. First edition. 1975-01.

Kemna R. (2011): Methodology for Ecodesign of Energy-related Products. MEErP 2011. Methodology report. Part 1: Methodology. COWI/VHK for the European Commission, DG Enterprise and Industry.

Murray, D. M.; Liao, J.; Stankovic, L.; Stankovic, V. (2016): Understanding usage patterns of electric kettle and energy saving potential. In: Applied Energy 171 (2016), pp. 231-242. dx.doi.org/10.1016/j.apenergy.2016.03.038.

Prakash, S.; Dehoust, G.; Gsell, M.; Schleicher. T.; Stamminger, R. (2020): Influence on the service life of products in terms of their environmental impact: Establishing an information base and developing strategies against "obsolescence". Final report. Project No. (FKZ) UFOPLAN 3713 32 315. Report No. EF001182/ENG. Oeko-Institut/University Bonn for the German Environment Agency.

Schüler, D.; Grießhammer, R. (2009): PROSA - Wasserkocher. Kriterien für das Umweltzeichen für klimarelevante Produkte und Dienstleistungen. Öko-Institut.

SGS group (ed.) (2017): Wegkippen oder Wiederaufkochen? Deutsche uneins vorm Wasserkocher. Online: https://www.sgsgroup.de/de-de/news/2017/05/wasserkocher-studie-ist-mehrfach-aufgekochtes-wasser-schaedlich. Accessed: 22.06.2020.

test (ed.) (2013): Einfach schnell heiß. test 1/2013. pp. 69-73.

topten.ch (ed.) (2017): Wasserkocher: Methodik von Topten. topten.ch. 12/2017 Bush.

Williams, A. (2020): Top kettle brands for 2020. Website of Which?. Online: https://www.which.co.uk/reviews/kettles/article/top-kettle-brands. Last accessed: 25.06.2020.

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