



Preparatory Study and Impact Assessment support study on professional dishwashers

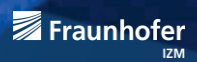
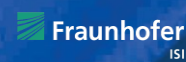
Draft Report of
Preparatory Study (PS) Phase I+II
MEErP Tasks 1-7
Version 1

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1. Introduction



This preparatory study describes the results of the assessment of professional dishwashers as part of the regulatory process under the Ecodesign for Sustainable Products Regulation (ESPR). The structure of this report adheres to the MEErP 2011 methodology (Kemna, 2011) and takes into account the forthcoming 2024 revision of MEErP (Gama Caldas et al., 2022) and is complemented by elements of the Digital Product Passport methodology. The aims and objectives of the project and a general methodological overview are detailed below.

1.1. Prior work and political context

1.1.1. Prior work: Preparatory study for ecodesign requirements of energy-using products - Lot 24: Professional washing machines, dryers and dishwashers (2011)

In 2011, the Commission published a preparatory study on a possible ecodesign measure for professional washing machines, dryers and dishwashers (Lot 24).¹ On the basis of that study and a preliminary impact analysis, the Commission discussed the results in the Ecodesign Consultation Forum in 2013, concluding that there was a significant energy, carbon and water saving potential, no existing measures addressing that potential and that the product group would also otherwise eligible for measures. The main problem was the lack of appropriate measurement standards for this product group, so upon the subsequent Consultation Forum in 2014, the Commission decided to postpone regulatory measures and the development of delegated acts until such test standards were developed, and issued a standardisation mandate, which was completed in 2017.²

In the preparatory study for the 2022-2024 Ecodesign and Energy Labelling Working Plan, an update of the environmental improvement potential for professional dishwashers was assessed. The benefits were estimated to remain significant in 2030. As a result, the Commission announced its intention to develop measures for professional dishwashers and included this product category in the current Ecodesign and Energy Labelling Working Plan.³

¹ See <https://www.eceee.org/ecodesign/products/lot24-professional-wet-appliances/>

² See EN 50593:2017(MAIN) Electric dishwashers for commercial use - Test methods for measuring the performance. The work resulted later in the standard EN IEC 63136:2019 Electric dishwashers for commercial use - Test methods for measuring the performance (successor of EN 50593:2017)

³ See SWD(2022) 101 final and Official Journal 2022/C 182/01

1.1.2. Political context

The Ecodesign and Energy Labelling Working Plan 2022-2024 is a key part of the EU's energy efficiency and wider 'European Green Deal' objectives, including the Circular Economy agenda. It was adopted by the Commission on 30 March 2022 and builds on the work carried out since the adoption of the first Ecodesign Directive 2009/125/EC. It also covers the work required under the Energy Labelling Framework Regulation (EU/2017/1369) and takes into account the progress made with the European Product Registry for Energy Labelling (EPREL). The plan focuses on the ecodesign of energy-related products and lays out the priorities and planning for future regulation. The plan strengthens the focus on the circularity aspects of ecodesign, following the example set in the previous Working Plan. It sets harmonised rules for 'energy-related products' on aspects such as energy consumption, water consumption, emission levels, and material efficiency. These rules stimulate both demand for and supply of more sustainable products while reducing energy consumption significantly.

The Ecodesign for Sustainable Products Regulation (ESPR) entered into force on 18 July 2024. The ESPR Regulation builds on the previously existing Ecodesign Directive 2009/125/EC, expanding the ecodesign requirements for specific product groups as it enables the setting of performance and information requirements for almost all categories of physical goods placed on the EU market. The framework will allow for the setting of a wide range of requirements, including on:

- Product durability, reusability, upgradability and reparability
- Presence of substances that inhibit circularity
- Energy and resource efficiency
- Recycled content
- Remanufacturing and recycling
- Carbon and environmental footprints
- Information requirements, including a Digital Product Passport

For the pending work under the Ecodesign and Energy Labelling Working Plan 2022-2024 which included the product category Professional Dishwashers, it was decided that this product category will not fall under the transitional regime according to Article 79 of the ESPR but will be covered by the new Working Plan of the ESPR⁴. With the ESPR Regulation, the Commission is now preparing for the addressing of specific measures for professional dishwashers by means of delegated act.

⁴ Online information session of the Commission on the Ecodesign for Sustainable Products Regulation (ESPR), held on 22 May 2024

1.2. Objectives of this preparatory study

Within this context, DG Environment launched a preparatory study on professional dishwashers to assess the feasibility of proposing ESPR requirements (e.g., Ecodesign and/or (Energy) Labelling or mandatory public procurement criteria) for this product group. The study also investigates the environmental impacts and the ecodesign requirements that can be introduced to the product to improve certain products aspects as listed in Article 5 of Regulation (EU) 2024/1781 (durability, reliability, reusability, upgradeability, reparability...). This study will provide the necessary information for the identification of the policy options to be analysed in the subsequent impact assessment.

Overall objectives of the study can be summarised as follows:

- Conduct an ecodesign preparatory study analysing the technical, economic, environmental, market and societal aspects of professional dishwashers following the MEErP methodology Tasks 1-7;
- Carry out an Impact Assessment support study to support the potential adoption of the regulatory measure(s);
- Based on the findings of the Preparatory and Impact Assessment studies, where appropriate, provide input and support to the development of draft proposal of ESPR Delegated Act(s) and/or Energy Labelling Delegated Act(s) for professional dishwashers;
- Provide ad-hoc technical expertise and technical support to the Commission.

The current report covers MEErP Tasks 1 to 7 (Scope, Market, Users, Technologies, Environment, Economics, Scenarios) and shall serve as input for the second stakeholder meeting and following stakeholder consultation.

2. Methodology

2.1. Methodology background

The preparatory study follows the MEErP methodology, which has been applied to around 40 groups of energy-related-products in the framework of the Ecodesign Directive 2019/125/EC and shall also be applied in the context of preparatory studies under the ESPR. The MEErP consists of 7 tasks:

- Task 1: Scope
- Task 2: Markets
- Task 3: Users
- Task 4: Technologies
- Task 5: Environment
- Task 6: Economics
- Task 7: Scenarios

A new version of the MEErP methodology has been published (Gama Caldas et al., 2024). The revised MEErP is intended to incorporate material efficiency and environmental aspects more systematically and to update the EcoReport tool. The 2024 MEErP method considers the 16 impact categories used in the Environmental Footprint (EF) method, in an effort to harmonise the JRC EcoReport tool with the Product Environmental Footprint Category Rules (PEFCRs) (Gama Caldas et al., 2022). Additional potential environmental impacts can be included and by default, the primary energy consumption is included since the methodology is used to analyse energy-related products in which energy consumption plays a vital. For instance, recyclability and recycled content will be input parameters and can be modelled in the end-of-life (EOL) scenario. Furthermore, material efficiency aspects are planned to be modelled consistently and systematically by introducing a discrete scoring system where the specific values are calculated.

2.2. Approach of this preparatory study

2.2.1. Stakeholder consultation

To collect data and exchange with stakeholders, the following means of consultation have been implemented so far.

- An online platform was established to allow sharing information on the study with stakeholders. This platform can be found under <https://ecodesign-commdishwashers.eu/en>. Among others, a registration option was provided to stakeholders on the platform to allow collecting data on interested stakeholders so that they could be informed of the project proceedings.
- At the on-set of the study, initial interviews with stakeholders were held to allow a first identification of aspects that had changed since the 2011 preparatory study.
- To collect information regarding MEERP Tasks 1-4, two stakeholder consultations have been held:
 - o A first online consultation was held between mid July 2024 and 6 September 2024 to collect information on the scope of appliances addressed in this study and resulting legislation. The consultation used an online survey tool to collect information on a set of questions, see Appendix 1, for the questions asked.
 - o A second consultation was held between 16 September 2024 and 22 October 2024 with its focus being the collection of data for MEERP tasks 2-4. Here too, an online survey tool was used to collect information for a set of questions, see Appendix 2, for the questions asked. Furthermore, an excel file was used to collect more detailed numerical data in tabular form for some of the questions, see Appendix 3, for the questions asked.
- A first stakeholder meeting was held on 10 December 2024 in Brussels to discuss the preliminary results of MEERP Tasks 1-4. Written stakeholder feedback and further information was collected by end of January 2025.
- A third online consultation was held between 5 April 2025 and 9 May 2025 to collect information on Design Options (MEERP Task 6) and Substances of Concern (SoC).
- The second stakeholder meeting will be held on 1 July 2025 in Brussels to discuss the revised results of MEERP Tasks 1-4 and the preliminary results of MEERP Tasks 5-7.

3. MEErP Task 1 – Scope

3.1. Objectives of MEErP Task 1

Aim of MEErP Task 1 is to define the product category and the system boundaries of the ‘playing field’ for ecodesign. The preparatory study provides a detailed overview of existing legislation, voluntary schemes and standards for professional dishwashers with the aim to define the functional unit of the product group and the possible scope of a potential regulation. MEErP Task 1 is a very important step in a preparatory study. It provides suggestions to define the scope and possible exemptions from the scope. It also provides or proposes definitions of the subject matter of the study, ideally based on existing standards, links it to existing legislation and identifies prevailing gaps to be filled by the delegated acts to be drafted.

During the stakeholder consultations for this project, it became apparent that the scope of this study needed to be adjusted from professional dishwashers to commercial dishwashers. For this reason, the term '**commercial dishwasher**' will be used exclusively throughout the following text. For further information in this respect see **Section 3.2.2.6**.

3.2. Product category and performance assessment

3.2.1. Commercial dishwashing process

As the basis for all subsequent analysis steps, the commercial dishwashing process is briefly described first. The entire dishwashing process, e.g. in a large canteen, consists of several steps which are depicted in the following **Figure 3-1**.

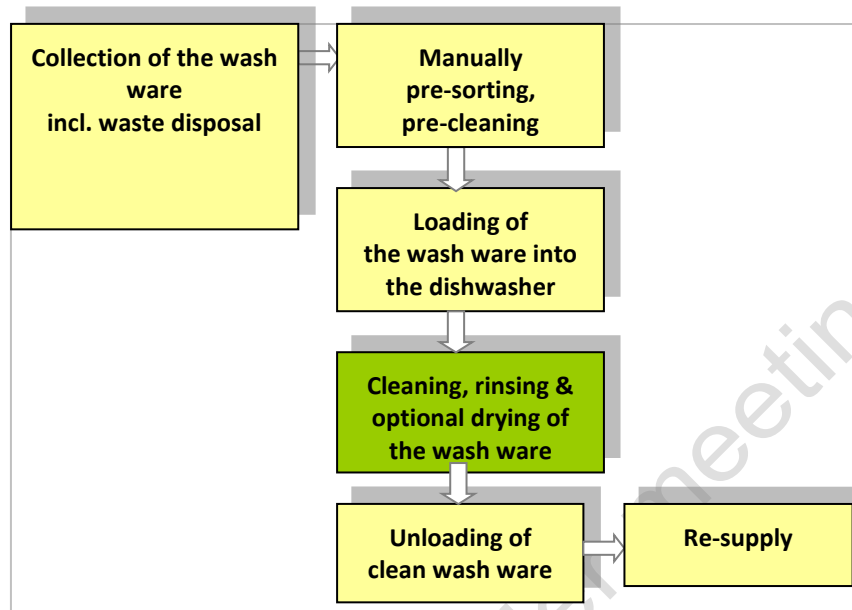


Figure 3-1: Different steps of a commercial dishwashing process.

Source: Own figure according to VGG-brochure 'Gewerbliches Geschirrspülen und Hygiene' (commercial dishwashing and hygiene), March 2006.

Only the technical cleaning and drying process and the machines used for this are in the focus of the preparatory study at hand (green box), although from customers' and costs' perspective the manual parts of the dishwashing process might be also of interest.⁵

The study also concentrates on the dishwashing machine itself and does not consider the different water quality which has an influence on the result of the dishwashing process. Most of the machines are supplied with a separate water treatment system or this can be delivered on demand⁶. Finally, the analysis ignores external accessories kits not being components of the dishwashing machines, but usually supplied together with the machines (e.g. clearing station, admission table, and external racks).

According to the VGG glossary⁷ 'dishes' is a collective term for containers and vessels which are used for preparing, cooking, arranging and serving food. It includes plates, cups, saucers and bowls made of various materials. Next to 'dishes' dishwashers are also used to clean, rinse and dry glasses, cutlery, black cookware, and other cooking utensils. The more general term of all these items that may be cleaned by a dishwasher is 'wash ware'. According to the VGG glossary,

⁵ In a dishwashing process, 60% to 80% of the total costs are caused by labour costs. Source: aid Infodienst: Küche und Technik – Handbuch für gewerbliche Küchen. [Kitchen and Technology – Guide for commercial kitchens]; Bonn 2005.

⁶ Regarding dishwasher categories 1 and 2 (cf. section 3.2.3.7), the water treatment system can be part of the machine itself or equipped separately. For the other categories, water treatment systems are usually separate. Hood type machines (category 3, cf. section 3.2.3.7) are also available with integrated water softener.

⁷ See 'Commercial dishwashing: glossary of terms (technical information sheet No. 1)' published by Commercial Dishwashing Association, January 2008.

179 'wash ware' constitutes all components which are cleaned in the dishwasher. Their shape and
180 material must be suitable for cleaning by machine.

181 In our study, we will use 'wash ware' as superordinated term for the different kinds of items to
182 be cleaned.

183 Treatment agents like detergents and rinse aids serve to clean, disinfect, rinse and descale wash
184 ware of large-scale catering establishments.

185 Detergents come as liquid form, powder mixtures, solid blocks and in paste . Their primary
186 purpose is to remove food particles from wash ware completely.

187 The function of the rinse aid is to reduce the surface tension of the water in the final freshwater
188 rinse cycle and, by lowering the interfacial tension, to achieve a uniform wetting of the cleaned
189 wash ware. This, together with the heat stored up in the wash ware itself (from the hot
190 detergent solution or a separate feed of hot drying air) means that rapid drying of the wash ware
191 is achieved. This results in spotless, gleaming and dry surfaces on the wash ware (AKGGS, 2021).

192 3.2.2. Definition of commercial dishwashers

193 In the following, existing definitions for commercial dishwashers are presented. In addition,
194 basic differences between commercial and household dishwashers are described in order to
195 properly define the scope of this preparatory study.

196 3.2.2.1. Ecodesign regulation on household dishwashers

197 The Commission Regulation⁸ with regard to ecodesign requirements for household dishwashers
198 provides the following definition: 'household dishwasher' means a machine which cleans and
199 rinses tableware, and which is declared by the manufacturer in the Declaration of Conformity to
200 comply with Directive 2014/35/EU of the European Parliament and of the Council (13) or with
201 Directive 2014/53/EU of the European Parliament and of the Council.

202 In this definition for household dishwashers, reference is made to the Low Voltage Directive
203 2014/35/EU (see **Section 3.4.1.2**) as well as to the Radio Equipment Directive 2014/53/EU that
204 needs to be considered if radio equipment is incorporated and permanently affixed into the
205 product as it can be the case with 'smart' dishwashers, see **Section 3.4.1.7**).

⁸ COMMISSION REGULATION (EU) 2019/2022 of 1 October 2019 laying down ecodesign requirements for household dishwashers pursuant to Directive 2009/125/EC of the European Parliament and of the Council amending Commission Regulation (EC) No 1275/2008 and repealing Commission Regulation (EU) No 1016/2010; <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R2022>

3.2.2.2. Distinction according to Machinery Directive

Against this background, a possible general delimitation between household appliances and commercial appliances is provided by the Machinery Directive 2006/42/EC,⁹ in force since 29th December 2009. It clarifies the borderline between machinery for household and for commercial use in order to provide greater legal certainty. Whereas for the latter machinery the scope of the Machinery Directive applies, in Article 1 (2) k 'household appliances intended for domestic use' are explicitly excluded therefrom. They belong to low voltage electrical and electronic machinery with an electrical supply within the voltage limits of the Low Voltage Directive (between 50 and 1000 V for alternating current or between 75 and 1500 V for direct current) and therefore must fulfil the safety objectives of the Low Voltage Directive (2014/35/EU, see **Section 3.4.1.2**).

Concerning the exclusion of household appliances intended for domestic use from the scope of this preparatory study, the following clarifications are given in the '*Guide to application of the Machinery Directive 2006/42/EC*'.¹⁰

The expression 'household appliances' designates equipment intended for housekeeping functions such as washing, cleaning, heating, cooling, cooking, etc. Examples of household appliances include washing machines, dishwashers, vacuum cleaners and machinery for food preparation and cooking.

The exclusion concerns appliances 'intended for domestic use', in other words, intended for use by private persons (consumers) in the home environment. Thus, appliances for the housekeeping functions mentioned above that are intended for commercial or industrial use are not excluded from the scope of the Machinery Directive.

While it is possible for a private consumer to acquire an appliance intended for commercial use or for a commerce to acquire an appliance intended for domestic use, the criterion to be considered for determining the 'intended use' is the use intended and stated by the manufacturer of the appliance in his product information or his Declaration of Conformity (DoC). Evidently, this statement must accurately reflect the foreseeable use of the product.¹¹

In general, the design and construction of machinery must consider the intended use. Recital 15 of the Machinery Directive stresses that the machinery manufacturer must consider whether the machinery is intended to be used by a professional or a non-professional operator or is intended to provide a service to consumers. Annex I of the directive describes essential health and safety requirements relating to the design and construction of machinery, i.e. of appliances for commercial or industrial use.

⁹ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2006L0042:20091215:EN:PDF>

¹⁰ Guide to application of the Machinery Directive 2006/42/EC <https://osha.europa.eu/en/legislation/-guidelines/guide-application-machinery-directive-200642ec>

¹¹ I.c., page 54/337

Due to inadequacies and inconsistencies in the product coverage and conformity assessment procedures, the provisions of the Machinery Directive were improved and adapted and will repeal Directive 2006/42/EC with effect from 20 January 2027. Since rules setting out requirements for products within the scope of the Directive should be of uniform application for all operators across the Union, and not give room for divergent implementation by Member States, the Directive was replaced by a regulation (Regulation (EU) 2023/1230; (European Parliament und Council, 2023a).

Under the new Regulation:

Household appliances intended for domestic use that fall under the scope of the Low Voltage Directive (2014/35/EU) are excluded from the new regulation, which means that the regulation – like the current Machinery Directive – does not apply to dishwashers intended for domestic use.

Dishwashers intended for commercial use are not excluded and will therefore be in the scope of the new regulation starting from 20 January 2027 (European Parliament und Council, 2023b; 2023a).

In summary, the Machinery Directive provides a legal principle to distinguish between devices for use in households on the one side and commercial use on the other side.

3.2.2.3. Definition according to ISO, IEC and EN standards

In **EN IEC 63136:2019** a **commercial dishwasher** is defined as follows: ‘electric dishwasher that is specially designed for use in commercial environments and that cleans and rinses dishes, glasses, cutlery, and, in some cases, cooking utensils by chemical, mechanical, thermal and electrical treatment¹²’. More details on the scope and the objectives of this standard can be found in **Section 3.3.1.1**.

EN 17735:2022 provides a definition for the term **dishwashing machine**: ‘appliance that is specially designed for use in professional environments and that cleans and rinses plates, glasses, cutlery, and, in some cases, cooking utensils by chemical, mechanical and thermal means’.

Despite the existing definitions mentioned above, there is no official or standardised definition or delimitation between the terms professional, commercial, and industrial. CENELEC TC59X proposed that the term ‘commercial’ shall be used in connection with *market and market segments*. The term ‘professional’, however, shall be used in connection with *equipment* designed for use in commercial segments.

¹² Some advanced commercial dishwashers may use electrical processes such as electrolysis to generate cleaning agents (e.g., ozone or electrolyzed water) directly in the machine, enhancing cleaning and disinfection without traditional chemicals.

3.2.2.4. Definition according to labelling schemes

Commercial dishwashers are currently not explicitly covered by the EU energy label or ecolabel scheme. In the U.S. Energy Star (cf. **Section 3.4.5.5**), however, the following definition for dishwashing machines can be found¹³: ‘A machine designed to clean and sanitise plates, pots, pans, glasses, cups, bowls, utensils, and trays by applying sprays of detergent solution (with or without blasting media granules) and a sanitizing rinse.’

3.2.2.5. Distinction between commercial and household dishwashers according to functional performance and technological differences

With regard to functional performance and technological differences, the boundary between household and commercial use is fluent. There is a semi-professional context, where some requirements of the household and some of the commercial context apply.

In *private households*, a dishwasher usually runs on average 280 cycles per year, i.e. more than 5 times per week.¹⁴ Household dishwashers run with fresh water for each programme cycle meaning that for each cycle, the whole process water has to be heated. Further, in household dishwashers, the wash ware is often not cleaned directly after the meals so that the soil is rather dried; thus, dishwashers for households usually have a longer soaking time; for these reasons, standard programmes of household dishwashers usually have longer cycle times of up to 3 hours. However, the duration of the programme is of less importance to private users as the device runs e.g. overnight or between two meals. Household dishwashers are designed to clean various kinds of wash ware (dishes, cutlery, glasses, pots and pans) at the same time, i.e. they usually have rather unspecific programmes for general use (even though some have special programmes for glasses or ‘intense’ programmes for highly soiled pots and pans).

In the *commercial context*, the specific requirements according to space or type of wash ware differ considerably compared to household use, leading to a variety of different types of commercial dishwashers varying in e.g. size and capacity (number of wash ware or racks to be cleaned per hour). Compared to household use, usually a higher number of items must be cleaned in commercial dishwashers. Thus, they are operated more often (in case of batch

¹³ <https://www.energystar.gov/sites/default/files/2024-08/Commercial%20Dishwashers%20Version%203.0%20Specification%20Rev.%20-%20September%202021.pdf>

¹⁴ Total number of standard cleaning cycles per year as used in the ‘Method for calculating the Energy Efficiency Index, Cleaning Efficiency Index, and the Drying Efficiency Index’ in the COMMISSION REGULATION (EU) No 1016/2010 of 10 November 2010 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for household dishwashers. Official Journal of the European Union L 293/31 from 11.11.2010

dishwashers¹⁵) or for longer times (in case of conveyor-type dishwashers¹⁶). Moreover, in the commercial context the programmes are required to be much faster than in private households.

The time requirement leads to the use of a tank system, where the detergent solution, i.e. the process water including the detergent in the required concentration, for the cleaning step is stored in a wash tank at high temperatures. The tank system saves the time used otherwise to heat up the water before each cleaning cycle. During operation the detergent solution is circulated through the dishwasher by means of a pump; to reuse the detergent solution for the next cleaning cycles, the water is reused and may be filtered to various intensities. The detergent solution is not changed between the cycles, but only partly replaced by hot fresh water from the final rinse step (so called regeneration of detergent solution). The water in the tank is usually changed once a day or after each working shift.

Using a water-change system instead of a tank system makes sense in applications which are very similar to household use, like Kindergartens or pre-schools, where the number of items to be cleaned per day is rather small (compared to other commercial applications). Tank machines would not make sense due to this small amount of wash ware. As the time requirements in this context are higher than in households, the programme cycles are shorter than in household dishwashers (from approximately 5 to less than 30 minutes). The faster programmes compared to household appliances usually lead to a higher energy consumption of these appliances.

Sometimes only one specific type of wash ware has to be cleaned or there is enough space and needed capacity to use several dishwashers in parallel, resulting in much more specialised dishwashers compared to household use. In bars or taverns, for example, mainly glasses must be cleaned. Therefore, special glass washers are used. In canteens, a large number of wash ware has to be cleaned. For this purpose, often several dishwashers are used, with each dishwasher being specialised for a certain kind of wash ware. In large-scale catering establishments the pots and pans used are usually much bigger compared to those used in private households and thus require more spacious dishwashers.

Further differences between appliances for household and commercial use are:

- The **connected load** (commercial dishwashers are available with higher load and three phases connectivity (400 V)¹⁷.

¹⁵ Programme automats are dishwashers where the different steps of the dishwashing process are conducted consecutively in time. The rack(s) with the wash ware stay(s) in the same position during the whole dishwashing programme.

¹⁶ Conveyor-type dishwashers are dishwashers where the different steps of the dishwashing process are allocated to several individual treatment zones, i.e. the wash ware is transported through these zones, which are constructed as chambers, with openings in the transport direction. They are operated continuously within a certain period of time.

¹⁷ According to stakeholder feedback, the connected load and the power requirements do not really discriminate between household and commercial dishwashers. Even though 400 V is the majority configuration, there are many category 2 dishwashers that do not require three-phase power.

- The **detergent dosage** (manual dosing of cleaning agent in case of household dishwashers, use of tabs possible, vs. automatic detergent dosage in case of commercial dishwashers).
- The **distribution channels** (commercial appliances are sold directly by the manufacturers or via specialised gastronomy trade).
- The **price** (production costs of commercial appliances are usually higher than household dishwashers).

The following **Table 3-1** gives an overview of a possible delimitation between household, commercial water change dishwashers and other commercial dishwashers.

Table 3-1 shows that there are only minor differences between household and commercial water change dishwashers (main differences are the shorter running times of the programmes and the possibility to connect to higher load in case of commercial water change dishwashers). However, there are significant differences between domestic dishwashers and commercial water change dishwashers on the one hand and other commercial dishwashers on the other hand.

After this general delimitation of commercial dishwashers, the following sections describe the individual commercial products in more detail.

Table 3-1: Main product groups of dishwashers according to customer segment.

Group	Domestic dishwashers	Commercial water change dishwashers	Other commercial dishwashers
Target group / Applications	Private households	Caring & Nursing homes (elderly & kindergarten), B&B, "bar" with low turnover	E.g. bakeries, bars, bistros, bread & bakery operations, butcheries, cafeterias, canteens, care homes, caterers, community centres, food processing operations, food retailing; hospitals, hotels, institutional kitchens, kindergartens & pre-school, marine, meat processing operations, restaurants, schools, supermarkets, etc.
Wash ware	Dishes, glasses, cutlery and further kitchen utensils	Dishes, glasses, cutlery and further kitchen utensils	Dishes, glasses, cutlery, crockery, black cookware, further kitchen utensils of large-scale catering establishments

Group	Domestic dishwashers	Commercial water change dishwashers	Other commercial dishwashers
Temporal requirements	No special requirements regarding running times (cycle times up to 3 hours)	Short running times per cycle (5 to 30 min) through higher thermal, mechanical or chemical action	Very short running times per cycle (from below 1 minute per cycle) / high dishwashing capacity per hour
Water intake	Freshwater intake for each step in the programme.	Freshwater intake for each step in the programme.	Freshwater intake only for final rinse (smaller volume than for freshwater system dishwasher)
Water treatment	Treatment by a built-in water softener	Treatment by a built-in water softener (optional)	Treatment by a built-in water softener (optional), intensive filtration of the detergent solution for re-use in several cycles (tank operation)
Operating principle	Discontinuous operation in cycles	Discontinuous operation in cycles	Discontinuous operation in cycles or continuous operation
Cleaning and hygienic requirements	Good cleaning efficiency important	Good cleaning efficiency important and hygienic requirements to be met	Good cleaning efficiency important and hygienic requirements to be met
Number of racks to be cleaned at once	Dishwashing on two or three levels possible (loading of two or three racks possible)	Dishwashing on two or three levels possible (loading of two or three racks possible)	Dishwashing usually on one level (two racks for undercounter models are available), in conveyor-type dishwashers continuous cleaning of racks possible)
Type of programmes	Rather unspecific programmes for various items to be cleaned in one cycle	Rather unspecific programmes for various items to be cleaned in one cycle	Usually, specific programmes or specific appliances for different kinds of items to be cleaned.
Detergent dosage	Manual detergent dosing	Manual or automatic detergent dosing	Automatic detergent dosing
Effort for maintenance	Low effort for cleaning of dishwasher	Low effort for cleaning of dishwasher	At least daily cleaning of machine necessary ¹⁸
Power supply, heating system	Normal load connection	Normal or high load connection	Usually high load and three phases (400 V) connection; partly additionally alternative energy sources (steam, warm water connection)

¹⁸ Machines have to be cleaned carefully after each end of operations (i.e. emptying of the tanks, cleaning of the interiors, the filter systems, the water intake and outlet, the partition curtains and the spraying systems). The reason is to avoid depositions in the machine and on the wash ware as these might accelerate the settling and breeding of microorganisms.

Group	Domestic dishwashers	Commercial water change dishwashers	Other commercial dishwashers
Product categories	Typical dimension: height x width x depth 850 x 600 x 600 mm	Typical dimension: height x width x depth 850 x 600 x 600 mm	Variable dimensions depending on amount and type of items to be cleaned and spatial possibilities.

3.2.2.6. Definition of commercial dishwashers used in this study

In the Lot 24 preparatory study from 2011, the term ‘professional’ has been used as super-ordinated term for dishwashing appliances used in commercial and / or industrial market segments. Based on the Ecodesign Regulation on household dishwashers and the Machinery Directive, professional dishwashers were defined as follows:

‘Professional dishwasher’ means a machine which cleans, rinses, and dries wash ware like dishware, glassware, cutlery, and other utensils connected to the preparation, cooking, arrangement or serving of food (including drinks) by chemical, mechanical, and thermal means; which is connected to electric mains and which is designed to be used principally for commercial and industrial purposes as stated by the manufacturer in the Declaration of Conformity (DoC).

As a reference to the Machinery Directive (see **Section 3.2.2.2**) is required in the DoC, this definition provides a clear delimitation from household appliances as defined in the [Regulation on ecodesign requirements for household dishwashers \(EU\) 2019/2022](#) (see also **Section 3.2.2.1**):

‘Household dishwasher’ means a machine which cleans and rinses tableware, and which is declared by the manufacturer in the Declaration of Conformity to comply with Directive 2014/35/EU of the European Parliament and of the Council (13) or with Directive 2014/53/EU of the European Parliament and of the Council.

As this definition differs from recently established definitions for commercial dishwashers (notably in EN IEC 63136:2019), it is necessary to clarify which one is most appropriate for the current preparatory study and for a possible future product regulation.

This aspect was an important subject of the 1st stakeholder consultation of the current preparatory study. According to the feedback from many stakeholders, the definition of ‘commercial dishwashers’ as used in the EN IEC 63136 standard would be more appropriate and should be preferred. In this context, stakeholders suggested that it should be considered that appliances designed exclusively for industrial purposes (e.g. bottle-cleaning machines used in the food industry or machines used in other manufacturing processes) shall generally not be covered by the products subject to this preparatory study. Therefore, ‘commercial’ should be used in the definition instead of ‘professional’. Stakeholders also recommended that the definition used by ENERGY STAR should be avoided, as this standard and its definitions are not relevant for Europe. According to the written feedback received from stakeholders on the draft Task 1-4 study report, it was mentioned that many dishwasher models do not dry the washed

items. Therefore, the definition should be altered so that it does not exclude models that only clean and rinse, but do not dry.

Moreover, as part of the 1st stakeholder consultation it was also asked if the term 'non-household' would be a feasible way of unambiguously delimiting professional / commercial / industrial dishwashers from household dishwashers. Following their argumentation on the definition, many stakeholders pointed out that the term 'non-household' alone would be not sufficient for the delimitation as it does not exclude the industrial appliances. In all standards 'commercial' is used to differentiate from household dishwashers, hence introducing an additional wording is not considered to be purposeful. To avoid overlapping, misunderstanding or misuse of the definition the term 'commercial (non-household, non-industrial) dishwashing machines' was proposed. On the other hand, there was also feedback from some stakeholders, who were in favour of the term 'non-household'. Nevertheless, for the purpose of avoiding confusion, we suggest that the term 'non-household' should be avoided.

During the 1st stakeholder consultation, the question was raised how an external party (e.g. consumers, market surveillance) can clearly identify whether a dishwasher is a household or a professional / commercial appliance. According to stakeholder feedback, this can be achieved by referring to the intended use of the appliance as declared by the manufacturer in the instruction for use and the Declaration of Conformity. In this respect, the reference to the Machinery Directive (2006/42/EC) is a key identifier, as it excludes household appliances intended for domestic use. However, a clear delimitation between commercial and domestic use based on technical parameters (e.g. stainless steel housing) is not possible. One of the main reasons for this consideration was seen in the fact that components, materials and features typical for commercial dishwashers are also offered for household appliances (and vice versa), thus creating a grey area that is not clearly defined.

According to stakeholder feedback, it is important to note that commercial dishwashers are generally not designed for industrial use, as safety standards do not cover this application. The designers of safety standards therefore do not consider risks from industrial use in their risk analyses, and manufacturers' documentation explicitly excludes industrial use. For this reason, industrial appliances are excluded from the scope of this study. The formulation on 'appliances designed exclusively for industrial purposes' (e.g. bottle-cleaning machines or machines used in manufacturing processes) provided in Note 104 of IEC 60335-2-58 (see **Section 3.3.1.2**) sufficient to distinguish between commercial and industrial appliances

Based on the overall stakeholder feedback, it was concluded that the Lot 24 definition should be altered for the purposes of the analytical steps of this preparatory study as follows:

'Commercial dishwasher' means a machine which cleans, rinses, and *optionally* dries wash ware like dishware, glassware, cutlery, and other utensils connected to the preparation, cooking, arrangement or serving of food (including drinks) by chemical, mechanical, and thermal means; which is connected to electric mains and which is designed to be used principally for commercial (*non-household, non-industrial*) purposes as stated by the manufacturer in the Declaration of Conformity (DoC).

3.2.3. Classification of commercial dishwashers

3.2.3.1. European PRODCOM classification

PRODCOM is a system for the collection and dissemination of statistics on the production of manufactured goods. It is based on a product classification called the Prodcom List of the European Community¹⁹ which consists of about 4,500 headings relating to manufactured products.

The products are detailed on an 8-digit level; digits 1 to 4 refer to the NACE classification in which the producing enterprise is normally classified. Further to the 2008 review of the NACE codes, the following **Table 3-2** lists the code classifications PRODCOM List 2024.

Table 3-2: Extract from PRODCOM list 2024.

Code	Description
28.29	Manufacture of other general-purpose machinery n.e.c.
28.29.50	Dish washing machines, of the industrial type
28.29.50.00	Non-domestic dish-washing machines
28.29.85	Parts of dish washing machines and machines for cleaning, filling, packing or wrapping
28.29.85.10	Parts of dish washing machines

Source: Eurostat.

From a practical point of view and against the overall aim of the preparatory study, the table shows that PRODCOM categorisations will be too rough to provide a basis for defining a clear scope of commercial dishwashers. For example, among the dishwashers there is no further differentiation regarding capacity or other functional performance parameters.

3.2.3.2. European customs classification

The *Harmonised Commodity Description and Coding System (HS)* of tariff nomenclature is an internationally standardised system of names and numbers for classifying traded products developed and maintained by the World Customs Organisation (WCO). The HS Nomenclature comprises about 5,000 commodity groups. The HS is a six-digit nomenclature. The first four digits are referred to as the heading. The first six digits are known as a subheading. Individual countries may extend a HS number to eight or ten digits for customs or export purposes. Based on the Harmonised System nomenclature, there is further comprised the *Combined nomenclature (CN)*²⁰ which is used to classify goods when being declared to customs in the Community. Each

¹⁹ <https://op.europa.eu/en/web/eu-vocabularies/dataset/-/resource?uri=http://publications.europa.eu/resource/dataset/prodcom2024>

²⁰ https://taxation-customs.ec.europa.eu/customs-4/calculation-customs-duties/customs-tariff/-combined-nomenclature_en

CN subdivision has an eight-digit code number, the CN code, followed by a description. The CN also include preliminary provisions, additional section or chapter notes and footnotes relating to CN subdivisions.

According to the European customs classification, the following product categories for dishwashers are distinguished, which are shown in **Table 3-3**.

Table 3-3: Classifications of dishwashers according to the HS-Classification.

Code	Description
84.22	Dish washing machines; machinery for cleaning, drying, filling, closing, sealing, capsuling or labelling bottles, cans, boxes, bags, etc, machinery for aerating beverages
	Dishwashing machines
84.22.11.00	Of the household type
84.22.19.00	Of other than household type
84.22.20.00	Machinery for cleaning or drying bottles or other containers

Source: World Customs Organisation.²¹

As for the PRODCOM list, this classification will also be too rough to provide a basis for defining a clear scope of commercial dishwashers. For example, there is no further differentiation regarding capacity or other functional performance parameters.

3.2.3.3. International Patent Classification

The International Patent Classification (IPC) is a hierarchical patent classification system created under the Strasbourg Agreement (1971) and updated on a regular basis by a Committee of Experts, consisting of representatives of the Contracting States of that Agreement and observers from other organisations, such as the European Patent Office. The Strasbourg Agreement is one of several treaties administered by the World Intellectual Property Organisation (WIPO). Patent publications from all the Contracting States (and also most others) are each assigned at least one classification term, indicating the subject to which the invention relates, and may also be assigned further classification and indexing terms to give further details of the contents.

Each classification term consists of a symbol, such as A01B 1/00. The first letter is the 'section symbol' consisting of a letter from A to H²². This is followed by a two-digit number to give a 'class symbol'. The second letter indicates the 'subclass' which is then followed by a 1 to 3 digit 'group

²¹ <https://www.wcotradetools.org/en/harmonized-system>

²² A: Human Necessities; B: Performing Operations, Transporting; C: Chemistry, Metallurgy; D: Textiles, Paper; E: Fixed Constructions; F: Mechanical Engineering, Lighting, Heating, Weapons; G: Physics; H: Electricity

467 number', an oblique stroke and a number of at least two digits representing a 'main group' or
 468 'subgroup' (see **Table 3-4**).²³

469 **Table 3-4: Classification of dishwashers according to International Patent Classification (IPC).**

A47L 15/00	Washing or rinsing machines for crockery or table-ware
A47L 15/02	. with circulation and agitation of the cleaning liquid in the cleaning chamber containing a stationary basket
A47L 15/04	. . by reciprocating movement of the cleaning chamber
A47L 15/06	. . by means of an impeller in the chamber
A47L 15/08	. . by application of a pressure effect produced by pumps
A47L 15/10	. . by introducing compressed air or other gas into the liquid
A47L 15/12	. . by a boiling effect
A47L 15/13	. . using sonic or ultrasonic waves
A47L 15/14	. with stationary crockery baskets and spraying devices within the cleaning chamber
A47L 15/16	. . with rigidly-mounted spraying devices
A47L 15/18	. . with movably-mounted spraying devices
A47L 15/20	. . . Swingable spraying devices
A47L 15/22	. . . Rotary spraying devices
A47L 15/23	 moved by means of the sprays
A47L 15/24	. with movement of the crockery baskets by conveyors
A47L 15/26	. with movement of the crockery baskets by other means
A47L 15/28	. . by lowering and lifting only
A47L 15/30	. . by rotating only
A47L 15/32	. . . rotated by means of spraying water
A47L 15/33	. . . with moving baskets submerged in the cleaning fluid
A47L 15/34	. . by lowering and lifting combined with a rotating movement
A47L 15/36	. . by a sideways motion
A47L 15/37	. with crockery cleaned by brushes
A47L 15/39	. . with brushes on movable supports
A47L 15/42	. Details
A47L 15/44	. . Devices for adding cleaning agents
A47L 15/46	. . Devices for the automatic control of the different phases of cleaning
A47L 15/48	. . Drying arrangements
A47L 15/50	. . Racks

²³ <https://www.wipo.int/edocs/pubdocs/en/wipo-guide-ipc-2024-en-guide-to-the-international-patent-classification-2024.pdf>

The comparison with the former statistical product classification schemes European PRODCOM and Customs classification clearly shows that the IPC scheme offers the most detailed graduation by product design and applications; for example, items A47L 15/42 to A47L 15/50 being parts of commercial dishwashers are supplementary parts even not supplied by manufacturers of dishwashers but by different suppliers (e.g. devices for adding cleaning agents are produced by special manufacturers of dosing equipment). The IPC classification provides an overview of the diversity of commercial dishwashing appliances. It distinguishes e.g. between machines with stationary and moving racks (e.g. conveyor-type machines) and provides further details on working techniques of dishwashers (e.g. with or without brushes; different kinds of spraying devices or circulation techniques of the cleaning liquid).

3.2.3.4. Categories according to ISO, IEC and EN standards

There are no ISO standards covering commercial or commercial dishwashers.

Based in its definition of commercial dishwashers (see **Section 3.2.2.3**) **IEC 60335-2-58** distinguishes dishwashers between:

- Batch dishwasher: ‘appliance in which the various processes are carried out sequentially on a single load’, and
- Conveyor (rack or flight) dishwasher: ‘appliance in which the various processes, e.g. washing, rinsing etc., are carried out, the load being moved through the various operations automatically’.

Using the same fundamental categories, EN 17735 distinguishes dishwashing machines between:

- Batch dishwashing machine: ‘dishwashing machine, in which the wash ware carrier loaded with wash ware stays in the same treatment zone during the cleaning process’, and
- Conveyor dishwashing machine: ‘dishwashing machine in which the wash ware carriers loaded with wash ware are automatically conveyed through the machine during the cleaning process’.

As for batch dishwashing machines, a further distinction is made between the following machine designs:

- Dishwashing machine in which recirculated detergent solution is used for the detergent circulation process and fresh water is used for the freshwater rinsing; the freshwater rinsing circuit is separate from the detergent circulation circuit, and
- Dishwashing machine in which fresh water is used in each detergent circulation or rinsing process; the rinsing circuit is not necessarily separate from the detergent circulation circuit.

Conveyor dishwashing machines are further distinguished between the following machine designs:

- Rack conveyor dishwashing machine: dishwashing machine in which racks loaded with wash ware are conveyed through the machine automatically by a rack transporting system, and
- Flight conveyor dishwashing machine: dishwashing machine in which the wash ware is conveyed through the machine automatically on an endless conveyor.

Since the scope of **EN IEC 63136** is limited to manually loaded undercounter one-tank and one-tank hood-type electrically heated dishwashing machines for washing plates, dishes, glassware, cutlery and similar articles, this standard only provides a distinction between these two categories:

- Undercounter one-tank dishwasher: 'manually loaded, programmable, undercounter front loader with typically one detergent circulating zone and a freshwater rinsing process', and
- Hood-type dishwasher: 'manually loaded, programmable, hood-type, pass-through machine with typically one detergent-circulating zone and a freshwater rinsing process'.

3.2.3.5. Labelling categories

As already stated in **Section 3.2.2.4**, commercial dishwashers are currently not explicitly covered by the EU energy label or ecolabel scheme.

However, the U.S. Energy Star (cf. **Section 3.4.5.5**)²⁴ distinguishes the following categories of dishwashing machines:

- 'Undercounter': A machine with an overall height 38 inches or less, in which a rack of dishes remains stationary within the machine while being subjected to sequential wash and rinse sprays and is designed to be installed under food preparation workspaces. Under counter dishwashers can be either chemical or hot water sanitizing, with an internal booster heater for the latter. For purposes of this specification, only those machines designed for wash cycles of 10 minutes or less can qualify for ENERGY STAR.
- 'Single tank, door type': A stationary rack machine designed to accept a standard 20 inch x 20 inch dish rack which requires the raising of a door to place the rack into the wash/rinse chamber. Closing of the door typically initiates the wash cycle. Subcategories of single tank, stationary door type machines include single rack; double rack; pot, pan and utensil washers (PPU); chemical dump and fill type; and hooded wash compartment ('hood type'). Single tank, door type models can be either chemical or hot water sanitizing, with an internal or external booster heater for the latter.

²⁴ <https://www.energystar.gov/sites/default/files/2024-08/Commercial%20Dishwashers%20Version%203.0%20Specification%20Rev.%20-%20September%202021.pdf>

- Single tank conveyor: A conveyor machine that includes a tank for wash water followed by a sanitising rinse (pumped or fresh water). This type of machine does not have a pumped rinse tank. This type of machine may include a prewashing section ahead of the washing section and an auxiliary rinse section, for purposes of reusing the sanitizing rinse water, between the wash and sanitizing rinse sections. Single tank conveyor dishwashers can be either chemical or hot water sanitizing, with an internal or external booster heater for the latter.
- Multiple tank conveyor: A conveyor type machine that includes one or more tanks for wash water and one or more tanks for pumped rinse water, followed by a sanitizing rinse. This type of machine may include a pre-washing section before the washing section and an auxiliary rinse section, for purposes of reusing the sanitizing rinse water, between the power rinse and sanitizing rinse section. Multiple tank conveyor dishwashers can be either chemical or hot water sanitizing, with an internal or external booster heater for the latter.
- Flight type conveyor: A conveyor machine where the dishes are loaded directly on the conveyor rather than transported within a rack. This machine is also referred to as a rackless conveyor.'

3.2.3.6. Functional performance classification

Building on the categorisation in the IPC and standards, commercial dishwashers are classified in this section according to functional performance parameters. To better understand the differences between the described categories, first an overview of the primary and secondary functions and important framework requirements of commercial dishwashers is given. Then the main properties to distinguish between different commercial dishwashers are described. Finally, six product categories are identified as a result of this analysis of functions and the respective properties of commercial dishwashers.

Primary and secondary functions of commercial dishwashers

In general, the *primary function* of a dishwasher is to clean, rinse, and dry a certain amount of dishware, glassware, cutlery, and / or cooking utensils by chemical, mechanical, thermal and electric means within a given time and with respect to the spatial possibilities (see definition of dishwashers in **Section 3.2.2**). Primary performance parameters are the cleaning and hygienic performance.

Important *secondary functions* that must be met by commercial dishwashers are related to the costs in use, they include:

- Short programme duration,
- Energy efficiency,
- Water efficiency, and
- Low detergent consumption.

In contrast to household dishwashers there are some *framework requirements* that must be considered and that vary largely for different customer groups of commercial dishwashers. These framework requirements are:

- Number of items to be cleaned,
- Types of items to be cleaned, and
- Spatial requirements.

While short running cycles are an important requirement for almost each commercial application, the other requirements might be very different depending on the application. These variations in the framework requirements that must be met by commercial dishwashers are the main reason for a range of different product categories on the market, compared to e.g. dishwashers for household use which are quite similar regarding the design (i.e. mainly undercounter dishwashers using fresh water for each dishwashing cycle, with a capacity of 12-14 place settings).

Main properties of commercial dishwashers

The following properties of commercial dishwashing can be used to facilitate the classification of commercial dishwashers into different categories (see **Section 3.2.3.7**):

Water supply: water-change operation vs. tank systems (one-tank or multi-tank):

Devices with *water-change operation* use fresh water for each step of the programme (prewash (optional), cleaning, and final rinsing). They are similar to domestic appliances and have similar dimensions but are designed concerning their performance and durability exclusively for the commercial sector.

Devices with *tank systems* are either one-tank or multi-tank machines. In *one-tank dishwashers* the detergent solution for the cleaning step is stored in a reservoir tank at high temperatures; the final rinsing is conducted with hot fresh water. During operation the detergent solution is circulated through the dishwasher by means of a pump, the water is reused and may be filtered to various intensities. The detergent solution is not changed between two programme cycles, but only partly replaced by hot fresh water from the final rinsing step (so called regeneration of detergent solution). The water in the tank is usually changed once a day or after each working shift. The pre-cleaning is usually conducted manually, e.g. with rinsing hoses before the wash ware is put into the dishwasher. *Multi-tank dishwashers* comprise at least one prewash zone using a reservoir tank, one cleaning zone using a reservoir tank, and a final rinse step using hot fresh water. Before the items are put into the machine, only loose waste and leftovers are manually removed. Tank dishwashers do not make sense if only a small number of items must be cleaned, as time requirements are usually not as high and tank dishwashers need more effort for the cleaning of the appliance itself.

Operating principle of machine dishwashing: batch dishwashers vs. conveyor-type dishwashers

In case of *batch dishwashers*, the different steps of the dishwashing process are conducted consecutively. The racks with the wash ware stay in the same position during the whole dishwashing programme. In case of *conveyor-type dishwashers* the different steps of the

dishwashing process are allocated to several individual treatment zones, i.e. the wash ware is transported through these zones, which are constructed as chambers, with openings in the transport direction. Batch dishwashers need much less space than the spacious conveyor-type dishwashers. However, the latter allow for continuous dishwashing of large numbers of wash ware in a short time.

Type of loading (regarding batch dishwashers): front loading vs. pass through

In case of batch dishwashers two types can be distinguished: either the rack(s) is/are put into and taken out of the dishwasher from the front (*front loading dishwasher*), or the rack(s) is/are put into the dishwasher from one side and is/are taken out of the dishwasher from the other side (*pass through or 'hood type' dishwasher*). Depending on the spatial requirements, available space, and organisation of the dishwashing process (number of personnel, storing capacity of soiled wash ware, hygienic requirements²⁵ and total amount of wash ware to be cleaned in a certain timeframe), these differences might impact the choice of machine categories by customers: The front-loading automats need less space than pass through dishwashers; the latter are ergonomically easier to operate. Further, a separation of a dirty and a clean area is possible when using the pass-through type.

Type of wash ware: dishes, glasses, cutlery, pots and pans, utensils, etc.

Some customers must clean a certain type of items or use several dishwashers at once (e.g. bars usually mainly must clean glasses, in large kitchens several dishwashers for different types of wash ware may be used in parallel). This means that commercial dishwashers are usually more specialised regarding the wash ware compared to dishwashers for household use. Pot dishwashers for instance operate with extremely high scavenging pressure to dissolve incrustations. They can therefore not be loaded with glass or ordinary crockery.

In addition to these distinguishing criteria between different categories of commercial dishwashers, dishwashers also vary according to the following criteria. These criteria, however, do not justify further product categories (too little technological difference or these differences inherently come along with one of the above-mentioned properties):

Means of transport (relevant for conveyor-type dishwashers): rack conveyor vs. flight type

In case of *rack conveyor* the items to be cleaned are put into racks which are transported through the dishwasher. The items can be sorted in advance of dishwashing. In case of *flight type dishwashers*, the items to be cleaned are put directly on a conveyor belt which continuously moves through the dishwasher. The items can either be sorted after dishwashing, when unloading the machine or, if there are several flight type dishwashers for a different kind of items, in advance of the dishwashing process.

Number of racks that can be cleaned at the same time (relevant for batch dishwashers):

²⁵ According to stakeholder feedback, hygienic requirements have to be assured independently of the product type. Therefore, hygienic requirements should not be part of the list of parameters for choosing between the two types of loading for batch dishwashers. Instead, the hygienic performance shall be independent of the type of loading.

In case of batch dishwashers with water-change operation (see above), it is possible to put two racks at the same time into the appliance (like in case of dishwashers for household use). In batch dishwashers with tank system (front loaders or pass through) usually only one rack can be cleaned as the tank also needs space and only one level for the rack is possible. However, there are also pass through appliances, where two racks can be cleaned next to each other at the same time. These appliances are like two pass through appliances connected next to each other. Furthermore, for undercounter models two racks are available.

Size / format: undercounter, cupboard size or large conveyor-type dishwashers

Obviously, the different construction types come along with different sizes and formats of the different dishwashers. Pass through dishwashers are usually cupboard size, whereas front loading devices might be undercounter or also cupboard size.

Way of utilisation: stationary or mobile

Most commercial dishwashers are used stationary in kitchens, bistros, or similar locations. There are, however, also dishwashers that can be used on mobile devices (like in vehicles, tents, or similar locations). These devices are usually one-tank undercounter front loaders or one-tank pass through dishwashers. There are only minor technological differences to those for stationary use, e.g. they can be operated at lower surrounding temperatures, or the water can be removed completely. Therefore, dishwashers for mobile use are subsumed under the respective category of dishwashers for stationary use.

3.2.3.7. Categories of commercial dishwashers used in this study

Within the Lot 24 preparatory study, the following six categories were derived from the analysis of functions and framework requirements and the respective properties of commercial dishwashers in the previous sections. Also, other information (e.g. from the official product categories or from standards) were considered for this categorisation.

Given the high level of approval expressed in the 1st stakeholder consultation, this categorisation is also used for the forthcoming tasks in the present preparatory study.

It is important to note that the categorisation does not include an industrial category. According to stakeholder feedback, commercial dishwashers are generally not designed for industrial use, such as machines used in the food industry for cleaning receptacles/containers used as packaging for final products (e.g. bottle-cleaning machines), and machines used in manufacturing processes. Appliances for industrial use were described by stakeholders as highly individual and very different from commercial use.

Furthermore, ‘appliances designed exclusively for industrial purposes’ are explicitly excluded from the scope of IEC 60335-2-58 (see **Section 3.3.1.2**). Interestingly, however, this term is based only on the description of the exclusion in the scope of IEC 60335-2-58 (provided in its Note 104), but there is no formal definition provided in the Terms and Definitions section of IEC 60335-2-58 or elsewhere.

Taking all the above into account, many stakeholders argue that industrial equipment should be excluded from the scope of this preparatory study (see also related questions in **Section 2.2.1**).

Category 1: Undercounter water-change dishwashers

These manually, front loaded batch dishwashers use fresh water for each step of the programme (prewash (optional), cleaning, final rinsing). These dishwashers are similar to domestic appliances and have similar dimensions but are designed exclusively for the commercial sector. They are approved in accordance with the Machinery Directive and intended for use, e.g. in catering establishments, day- and child-care and elderly care facilities. Main differences to domestic appliances are shorter programme durations and the possibility to connect them to higher loads (400 V).

The different steps of the dishwashing process are conducted consecutively in time, the racks with the items to be cleaned staying in the same position during the whole dishwashing programme. Usually, two racks can be put into the dishwasher from the front side.

As for dishwashers for household use, these devices are designed to clean various kinds of items (dishes, cutlery, and glasses) at the same time, i.e. they usually have rather unspecific programmes for general use. They are undercounter dishwashers, with only small differences in size and capacity, which can be sub-categorised in free standing, integrated, fully integrated and built-in models as in case of dishwashers for household use. Typical dimensions are (height/width/depth): 850 mm (without lit 820 mm) / 600 mm / 600 mm.

Category 2: Undercounter one-tank dishwashers

These manually front-loaded batch dishwashers use one reservoir tank with detergent solution for cleaning, and fresh water for the final rinsing. The detergent solution is constantly filtrated / regenerated. The pre-cleaning is usually conducted manually before the items are put into the dishwasher.

The different steps of the dishwashing process are conducted consecutively in time, the racks with the items to be cleaned stay in the same position during the whole dishwashing programme. Usually, only one rack²⁶ can be placed into the dishwasher (loading and unloading from the front side), as the tank needs space as well. The appliances are undercounter dishwashers that can be constructed as 'generalists' for different items (dishes, glasses, and cutlery) or in specialised versions, i.e. only for dishes, for glasses or for cutlery respectively.

Category 3: Hood-type dishwashers

These one-tank pass through dishwashers use one reservoir tank with detergent solution for cleaning, and fresh water for the final rinsing. The detergent solution is constantly filtrated / regenerated. Pre-cleaning is conducted manually, e.g. with rinsing hoses before the items are put into the dishwasher. The different steps of the dishwashing process are conducted consecutively in time, the racks with the items to be cleaned stay in the same position during the whole dishwashing programme. The rack(s) is/are put into the dishwasher from one side

²⁶ Also models with two racks are available.

and is/are taken out of the dishwasher from the other side. Only *one rack* can be cleaned on one level, as the tank also needs space. There are appliances, where *two racks* can be cleaned next to each other at the same time. The appliances are usually constructed to clean different items: dishes, glasses, cutlery, pots and pans, utensils, etc.

Category 4: Utensil / pot dishwashers

These dishwashers are especially constructed for the cleaning of other items than dishes, glasses and cutlery, i.e. black cookware, pots, pans, containers, trays, or other mostly large utensils. The cleaning performance is usually higher, e.g. by means of higher scavenging pressure or other stronger mechanical and chemical treatment.

Two construction types can be distinguished:

- Front loading dishwashers,
- Pass through dishwashers.

Both types are one-tank dishwashers (i.e. they use one reservoir tank with detergent solution for cleaning, and fresh water for the final rinsing, if necessary manual pre-cleaning). The pass-through dishwashers are usually loaded manually; however, some manufacturers offer special roll containers that can be filled outside the machine and then pushed into the dishwasher. The dimensions are often bigger than those of undercounter front loaders or pass through dishwashers for dishes, glasses, and cutlery as the items to be cleaned are bulkier, too.

A special type of these dishwashers is the so-called **granulate dishwasher**. In these dishwashers (both front loaders and pass through) the mechanical cleaning is intensified through scouring of the wash ware (mainly black cookware) with plastic granules of different size. A granule collector catches the plastic pellets during the granule washing programme. The granules can be subsequently cleaned out in a sink with a pipe-mounted sprayer.

Category 5: One-tank conveyor-type dishwashers

The different steps of the dishwashing process are allocated to several individual treatment zones, i.e. the items to be cleaned are transported through these zones, which are constructed as chambers, with openings in the transport direction. These dishwashers use one reservoir tank for cleaning and fresh water for the final rinsing. Pre-cleaning may be conducted manually. The dishwashers can be used for different wash ware: dishes, glasses, cutlery, black cookware (pots and pans), utensils, etc. Two different transport systems are available:

In case of the *rack conveyor system* the wash ware is put into racks which are transported through the dishwasher. The items can be sorted in advance of dishwashing. The pre-cleaning is usually conducted manually with rinsing hoses before the items are put into the dishwasher.

In case of *flight type dishwashers*, the wash ware is put directly on a conveyor belt which continuously moves through the dishwasher. The items can either be sorted after dishwashing, when unloading the machine or, if there are several flight type dishwashers for a different kind of items, in advance of the dishwashing process. Before the items are put into the machine, usually only loose waste and leftovers are manually removed.

Category 6: Multi-tank conveyor-type dishwashers

The different steps of the dishwashing process are allocated to several individual treatment zones, i.e. the items to be cleaned are transported through these zones, which are constructed as chambers, with openings in the transport direction. These dishwashers comprise at least one prewash zone using a reservoir tank, one cleaning zone using a reservoir tank and a final rinse step using fresh water. After the final rinse step often a drying zone is added (as an option). The dishwashers can be used for different wash ware: dishes, glasses, cutlery, black cookware (pots and pans), utensils, etc. As with one-tank conveyor-type dishwashers, two different transport systems are available:

- Rack conveyor system (see above at one-tank conveyor-type dishwashers).
- Flight type dishwashers (see above at one-tank conveyor-type dishwashers).

A special type of multi-tank conveyor-type dishwashers are dishwashers for the commercial cleaning of reusable boxes and containers. Serially produced dishwashers for standard packaging boxes and container dishwashers can be assigned to the commercial dishwashers.

Also, as part of the 2011 preparatory study, key functional and performance parameters were compiled for the six different categories. In the context of the 1st stakeholder consultation in 2024, this table has also been subject to revision. The following **Table 3-5** shows the overview updated according to stakeholder feedback.

785 **Table 3-5: Overview of commercial dishwasher categories according to functional and performance parameters.**

	Category 1 Undercounter water-change dishwasher	Category 2 Undercounter one-tank dishwasher	Category 3 Hood-type dishwasher	Category 4 Utensil / Pot dishwasher	Category 5 One-tank conveyor-type dishwasher	Category 6 Multi-tank conveyor-type dishwasher
Main properties						
Water supply	water-change operation	tank system / one-tank	tank system / one-tank	tank system / one-tank	tank system / one-tank	tank system / multi-tank
Operating principle of dishwashing machine	batch dishwasher	batch dishwasher	batch dishwasher	batch dishwasher	conveyor-type dishwasher	conveyor-type dishwasher
Type of loading	front loading	front loading	pass through	front loading or pass through	pass through	pass through
Type of wash ware to be cleaned	dishes, glasses, cutlery, pots and pans, utensils	mainly plates, glasses, cups, cutlery	mainly plates, glasses, cups, cutlery	black cookware, large utensils	mainly plates, glasses, cups, cutlery, trays	mainly plates, glasses, cups, cutlery, trays
Further properties						
Means of transport	n.a.	n.a.	n.a.	n.a.	rack conveyor or flight type	rack conveyor or flight type
Number of racks to be cleaned at the same time	two (on two levels)	one (on one level) or two (on two levels)	one or two (on one or two levels)	one or two (on one level)	n.a.	n.a.
Size / format	undercounter	undercounter	cupboard size	undercounter or cupboard size	large conveyor-type dishwashers	large conveyor-type dishwashers
Way of utilisation	stationary	stationary or mobile	stationary or mobile	stationary	stationary	stationary
Heat sources	electricity	electricity	electricity	electricity, low pressure steam or hot water	electricity, low pressure steam or hot water, (natural gas - negligible)	electricity, low pressure steam or hot water, (natural gas - negligible)
Variants	Freestanding and built-under models	freestanding and built-under models		granulate dishwasher for black cookware	dishwasher for cleaning of reusable boxes and containers	dishwashers for cleaning of reusable boxes and containers

786 n.a. = not applicable

787 Source: Task 4 report of the 2011 preparatory study on professional dishwashers; updated according to feedback from the 2nd stakeholder consultation (in **red colour**)

3.3. Test standards for commercial dishwashers

The present preparatory study examines whether standards exist for environmental parameters or other relevant aspects that were not yet relevant in the previous 2011 preparatory study. For this purpose, a comprehensive update of the existing standards has been carried out, highlighting also where standards are missing and where amendments are required (e.g. in form of disclosure of product information or the update of minimum requirements due to technological improvements as well as the link to other interdependent aspects). This may contribute to the elimination of potential loopholes in the market.

Special focus has been set on the European initiative that has taken place in the meantime: The preparatory study to the Ecodesign and Energy Labelling Working Plan 2022-2024 informed that CENELEC created an appropriate sub-working group CLC TC59X WG2.1 on commercial dishwashers with a focus on clusters of the base cases products as defined in the preparatory study. The work resulted in the standard EN IEC 63136:2019 Electric dishwashers for commercial use - Test methods for measuring the performance (successor of EN 50593:2017).

In addition to the international level, we also included the consideration of standards existing on the Member State level (without any EU foundation), such as in Germany that published a new standard for hygiene (DIN 10544).

In addition to the literature review, this sub-task was mainly built on stakeholder input by consulting standardisation and market experts as well as manufacturers. In the following, the results of the analysis are presented broken down by subject area.

3.3.1. Performance and safety

3.3.1.1. EN IEC 63136 (International)

EN IEC 63136:2019/AC:2021-04 Electric dishwasher for commercial use – Test methods for measuring the performance

This international standard covers standard manually loaded under-counter one-tank and one-tank hood-type electrically heated dishwashing machines for washing plates, dishes, glassware, cutlery and similar articles. These machines are used in commercial kitchens, such as restaurants, canteens, hospitals and in businesses such as bakeries, butchers' shops, etc.

It does not apply to:

- Undercounter water-change dishwashers,
- Commercial dishwashers with transport systems (flight-type and rack conveyor dishwashers) and utensil washers as well as
- Appliances designed exclusively for industrial purposes.

Hence it is only applicable to Categories 2 and 3 as defined in **Section 3.2.3.7**.

EN IEC 63136 has been prepared by subcommittee 59A: Electric dishwashers, of IEC technical committee 59: Performance of household and similar electrical appliances. EN 50593:2017 has served as a basis for the elaboration of this standard.

Its main objective is to identify and define the principal performance characteristics of electric dishwashers for commercial use and to describe the standard methods of measuring these characteristics.

For the corresponding performance test, the standard specifies the detergent concentration, the reference detergent and rinse aid, as well as the quality and number of wash ware used for test purposes.

This standard also describes how to determine the amount of electrical energy and water used by the dishwasher for filling, running and the time required to complete a given programme, which is used to measure cleaning performance. In this context, the start-up time and the electrical power of the 'ready to use' mode are measured.

Currently, rinse performance is still missing in this standard. TC 59X/WG 02-01 currently working on this topic.

3.3.1.2. IEC 60335 (International)

EN 60335-1:2012 and its amendments: Household and similar electrical appliances - Safety - Part 1: General requirements

This international standard has been prepared by IEC Committee 61 (Safety of household and similar electrical appliances) and covers safety issues of household and similar electrical appliances. Part 1 defines general requirements and is common to all electric motor appliances.

EN 60335-2-58:2005 + A1:2008& A11:2010 + A2:2015 + A12:2016: Household and similar electrical appliances - Safety - Part 2-58: Particular requirements for commercial electric dishwashing machines

Part 2 deals with the safety of electrically operated commercial dishwashing machines for washing plates, dishes, glassware, cutlery and similar articles, with or without means for water heating or drying. The rated voltage being not more than 250 V for single-phase appliances connected between one phase and neutral, and 480 V for other appliances. Appliances within the scope of this standard are used in restaurants, canteens, hospitals, and commercial enterprises such as bakeries, butcheries, etc. Examples of appliances within the scope of this standard are batch dishwashers (Categories 1 to 4) and conveyor dishwashers (Categories 5 and 6).

IEC 60335-2-58 is to be used in conjunction with the IEC 60335-1 and its amendments as it supplements or modifies the corresponding clauses. The current fourth edition of Part 2 cancels and replaces the third edition published in 2002 including its Amendment 1 (2008) and its Amendment 2 (2015).

As far as is practicable, this standard deals with the common hazards presented by these types of appliances. For example, concerning the aspect of stability and mechanical hazards, conveyor dishwashers shall not start automatically after doors or lids have been closed.

It should be noted that this standard does not apply to appliances intended for domestic use, nor to 'appliances designed exclusively for industrial purposes, for example machines used in the food industry for cleaning receptacles that serve as packaging for final products (e.g. bottle-cleaning machines), and machines used in manufacturing processes.' Sterilisers and washer-disinfectors used to treat medical materials are also excluded from the scope.

Moreover, it must be noted that in many countries additional requirements are specified by the national health authorities, the national authorities responsible for the protection of labour, the national water supply authorities, and similar authorities.

3.3.1.3. EN 50416 (Europe)

EN 50416:2016+A1:2015 Household and similar electrical appliances - Safety - Particular requirements for commercial electric conveyor dishwashing machines

This European standard deals with the safety of electrically operated commercial conveyor dishwashing machines for washing plates, dishes, glassware, cutlery, and similar articles (e.g. trays, food containers), with or without means for water heating or forced hot air drying. The rated voltage of the covered appliances is not more than 250 V for single-phase machines connected between one phase and neutral and 480 V for other machines. These machines are used for example in restaurants, canteens, hospitals, and commercial enterprises such as bakeries, butcheries, etc. Examples of such machines are flight type dishwashers, and rack conveyor dishwashers. These machines are designed to be connected to hot and/or cold-water supply.

Requirements to avoid back-siphonage of non-potable water into the public water supply are specified in Annex CC. Machines making use of steam or hot water for heating purposes are also within the scope of this standard. EN 50416 shall be read in conjunction with EN 60335-1:2012 and its amendments.

This standard does not apply to

- Appliances intended for household use,
- Machines which are moveable,
- Gas heating appliances which are part of conveyor dishwashing machines,
- Machines intended for disinfection,
- Machines intended to be used on board of sea-going vessels and aircraft,
- Machines designed exclusively for industrial purposes, for example machines used in the food industry for cleaning receptacles that serve as packaging for final products (e.g. Bottle-cleaning machines), and machines used in manufacturing processes,

- 895 - Separately driven transport devices not confined in the machine, and
- 896 - Machines intended to be used in locations where special conditions prevail, such as
- 897 the presence of a corrosive or explosive atmosphere (dust, vapour, or gas).

898 3.3.1.4. ASTM International Standards (USA / International)

899 The American Society for Testing and Materials (ASTM) International, originally known as the
 900 'American Society for Testing and Materials', is an international standards organisation that
 901 develops and publishes voluntary consensus technical standards for a wide range of materials,
 902 products, systems, and services. In 2001, ASTM changed its name to ASTM International to
 903 reflect global participation in ASTM and worldwide use of its standards. The application of ASTM
 904 standards is voluntarily except for publicly funded areas in the USA²⁷.

905 ASTM International has no role in requiring or enforcing compliance with its standards. The
 906 standards, however, may become mandatory when referenced by an external contract,
 907 corporation, or government. For example, ASTM Standards F1696 and F1920 are referenced in
 908 the U.S. ENERGY STAR criteria and used by manufacturers to obtain an ENERGY STAR
 909 qualification or rating (cf. **Sections 3.4.5.5**).

910 The following ASTM International standards refer to commercial dishwashers, sorted in
 911 ascending order. They have been developed by Technical Committee F26 on Food Service
 912 Equipment²⁸ and belong to the work of the following subcommittees:

- 913 - F26.01: Cleaning and Sanitation Equipment,
- 914 - F26.06: Productivity and Energy Protocol,
- 915 - F26.05: Life Cycle Cost and Sustainability.

916 ASTM F857–17: Standard specification for hot water sanitizing commercial dishwashing
 917 machines, stationary rack type

918 This specification covers the material, design, and performance requirements pertinent to the
 919 construction of spray-type, stationary rack commercial dishwashing machines that are manually
 920 loaded yet automatically controlled to uniformly wash, rinse, and sanitise eating and drinking
 921 utensils. Representative production models of the washers shall pass performance, operation,

²⁷ ASTM standards are voluntary in the sense that their use is not mandated by ASTM. However, government regulators often give voluntary standards the force of law by citing them in laws, regulations and codes. In the United States, the relationship between private-sector standards developers and the public sector has been strengthened with the 1995 passage of the National Technology Transfer and Advancement Act (Public Law 104-113). The law requires government agencies to use privately developed standards whenever it is at all possible. Source: www.astm.org

²⁸ 'Food service equipment is apparatus intended for use in commercial and institutional establishments for handling, storage, preparation, cooking, holding, display, dispensing, and/or the serving of food which, at the time of serving, is ready for direct consumption on or off the premises. Also included are cleaning, sanitation and ancillary items associated with food preparation and service.' Source: <http://www.astm.org/COMMIT/SCOPES/F26.htm>

922 leakage, and energy and productivity tests, and should function satisfactorily as specified.
923 Certification, product marking, and packaging are also considered.

924 ASTM F858–18: Standard specification for hot water sanitizing commercial dishwashing
925 machines, single tank, conveyor rack type

926 This specification covers the material, design, and performance requirements pertinent to the
927 construction of spray-type, stationary rack commercial dishwashing machines that are manually
928 fed yet automatically controlled to uniformly wash, rinse, and sanitise eating and drinking
929 utensils. Representative production models of the washers shall pass performance, operation,
930 leakage, and energy and productivity tests, and should function satisfactorily as specified.
931 Certification, product marking, and packaging are also considered.

932 ASTM F859–21: Standard specification for heat-sanitizing commercial dishwashing machines,
933 multiple tank, conveyor rack type

934 This specification covers multiple tank automatic rack-type commercial dishwashing machines.
935 Dishwashing machines shall be of the following types, styles, and classes, as specified: Type I-
936 this machine shall be designed and supplied to accept the feeding of soiled tableware from the
937 right side, when facing the front of the machine; and Type II-this machine shall be designed and
938 supplied to accept the feeding of soiled tableware from the left side, when facing the front of
939 the machine. Style 1 - steam heated; Style 2 - electrically heated; Style 3 - gas-heated; and Style
940 4 - pre-wash unit. Class A - injectors; Class B - heat exchange coils; Class C - natural gas; and Class
941 D - LP gas. The construction requirements; electrical, steam and gas equipment requirements;
942 lubrication requirements; treatment and painting requirements; and performance requirements
943 are presented in detail.

944 ASTM F860–07(2018)e1: Standard specification for hot water sanitizing commercial dishwashing
945 machines, multiple tank, rackless conveyor-type

946 This specification covers multiple-tank, automatic rack less conveyor type, commercial
947 dishwashing machines. These machines can be classified into two types: Type 1 machines shall
948 be designed and supplied to accept the feeding of soiled tableware from the right side, when
949 facing the front of the machine while Type II shall be designed and supplied to accept the feeding
950 of soiled tableware from the left side, when facing the front of the machine. The dishwashing
951 machines have three kinds of styles: Style 1 is a steam heated machine, with two classes namely
952 Class A which uses injectors and Class B which uses heat exchange coils. Style 2 is an electrically
953 heated dishwashing machine. Style 3 on the other hand is gas heated with two classes namely
954 Class C which uses natural gas and Class D which uses LP gas. In addition, these dishwashing
955 machines can be classified into three groups according to size and capacity: Group A, Group B,
956 and Group C. Materials used in the manufacture of these machines shall consist of corrosion-
957 resistant steel, corrosion resisting material, nickel-copper alloy, and plastics. The dishwashing
958 machine shall be complete so that when connected to the specified source of power, water
959 supply, heating means (steam, electric, or gas), drainage, detergent, and rinse agent feeder as
960 applicable, the unit can be used for its intended function. Dishwashers shall be rigid, quiet in
961 operation, free from objectionable vibration, and so constructed as to prevent objectionable
962 splashing of water to the outside of the machine. Operational test, leakage test, and
963 performance profiles shall be done to determine the overall efficiency of the dishwashing
964 machine.

965 ASTM F953-19 Standard specification for commercial dishwashing machines (stationary rack,
966 dump type) chemical sanitizing

967 This specification covers manually fed, spray-type, stationary rack, automatically controlled,
968 dump type, chemical sanitizing commercial dishwashing machines. Dishwashing machines shall
969 be of the following types, styles, classes: type I - Straight-through model, 34 in. nominal table
970 height. This machine is used in line with table on each side, type II - Corner model, 34 in. nominal
971 table height. This machine is used in corner placement forming a 90° table on each side, and
972 type III - Under counter, front load. This machine may be installed under counters; style A - single
973 rack, and style B - double rack. No leakage shall occur when tested at pressures up to 125 % of
974 the manufacturer's recommended supply line pressure. The dishwasher materials, construction,
975 operation cycle, electrical equipment, lubrication, and coating shall meet the requirements
976 prescribed.

977 ASTM F1021-18: Standard specification for feeders, detergent, rinse agent, and sanitizing agent
978 for commercial dishwashing and glass washing machines

979 This specification covers detergent feeders, rinse additive feeders, and sanitizing agent feeders
980 intended to automatically maintain the concentration of additives in the wash, recirculated
981 rinse, or non-recirculated rinse water of commercial spray- type dishwashing and glass washing
982 machines. Detergent, rinse additive, and sanitizing agent feeders shall be of the following types
983 and styles: Types I, II, III, IV, V, and VI; and Style I; II; III; IV; V; and VI. Materials used shall be free
984 from defects that would adversely affect the performance or maintainability of individual
985 components or of the overall assembly. The feeder shall be complete so that when connected
986 to the specified source of power (electrical or water, or both), the unit can be used for its
987 intended function. Feeders shall be tested in accordance with specified requirements.

988 ASTM F1114-22: Standard specification for heat sanitizing commercial pot, pan, and utensil
989 washing machines, stationary rack, water-driven rotary spray type

990 This specification covers the material, design, and performance requirements pertinent to the
991 construction of water-driven rotary spray type, stationary rack commercial pot, pan, and utensil
992 washing machines that are manually fed yet automatically controlled to uniformly wash, rinse,
993 and heat-sanitize food preparation utensils. Representative production models of the washers
994 shall pass performance, operation, leakage, and energy and productivity tests, and should
995 function satisfactorily as specified. Certification, product marking, and packaging are also
996 considered.

997 ASTM F1202-22: Standard specification for washing machines, heat sanitizing, commercial, pot,
998 pan, and utensil vertically oscillating arm type

999 This specification covers the requirements for manually fed, motor-driven vertically oscillating
1000 arm type, automatically controlled, commercial pot, pan, and utensil washing machine (also
1001 referred to as 'the washer'). The washer is of one rack capacity (Type I) and is available in either
1002 Style A (one door/front loading) or Style B (three door/pass-through with front load door). Heat
1003 shall be provided to the washer through steam (Style 1) by injection (Class A) or heat exchange
1004 coil (Class B) or through electric means (Style 2). The washer and its components shall be
1005 manufactured free of defects. Piping and fittings shall be manufactured from corrosion-resisting
1006 material or heat-resisting plastic material. Valves, spray assemblies, and overflow drain shall be

manufactured from corrosion-resisting materials. Tank and housing shall be constructed of corrosion-resistant steel. Scrap trays (strainers), access door/s, and legs shall be constructed of corrosion-resistant steel or other corrosion-resisting material. The pump motor shall be mounted on the tank or rigid steel base, with the pump casing being of cast iron or corrosion-resisting material. When specified, a final rinse booster heater and/or detergent feeder may be provided. The washer shall be operated at ambient room temperature. Tests for performance standards and operational compliance as well as for noise level, leakage, energy, and productivity requirements shall be performed and shall conform to the requirements specified.

ASTM F1203-06: Standard specification for washing machines—pot, pan, and utensil, heat sanitizing, commercial rotary conveyor-type

This specification covers manually fed, motor-driven rotary conveyor type, automatically controlled, commercial pot, pan, and utensil washing machines. The washer shall be of the following type, and class as specified. Motor-driven continuous rotary conveyor: type I - one door (front loading); type II - one or two door (pass-through corner operation); and type III - one or two door (pass-through straight-line operation). Style and class: style 1 - steam heated; style 2 - electric heat; class A - injection; and class B - heat exchange coil. The design, construction, and performance requirements of the washing machine are presented in detail. The operational test; leakage test; and energy and productivity test shall be performed to meet the requirements prescribed.

ASTM F1696-20: Standard test method for energy performance of stationary-rack, door-type commercial dishwashing machines

This test method covers the evaluation of the energy and water consumption of single-rack, door-type commercial dishwashers (hereafter referred to as dishwashers). Dishwashers may have a remote or self-contained booster heater²⁹. This test method does not address cleaning or sanitizing performance. It is applicable to both hot water sanitizing and chemical sanitizing stationary rack machines, which includes undercounter single rack machines, upright door-type machines, pot, pan and utensil machines, freshwater rinse machines and fill-and-dump machines. Dishwasher tank heaters are evaluated separately from the booster heater. Machines designed to be interchangeable in the field from high temperature and low temperature (that is, Dual Sanitizing Machines) and vice versa, shall be tested at both settings. Machines should be set for factory settings. If a dishwasher includes a booster heater as an option, energy should be sub metered separately for the booster heater. When the test method specifies to use the data plate or manufacturer's recommendations, instructions, specifications, or requirements, the information source shall be used in the following order of preference and documented in the test report: data plate, user manual, communication with manufacturer.

ASTM F1920-20: Standard test method for performance of rack conveyor, commercial dishwashing machines

This test method evaluates the energy and water consumption of rack conveyor, commercial dishwashing machines, hereafter referred to as dishwashers. Dishwashers may have remote or

²⁹ According to stakeholder feedback, remote booster heaters are not well known, or at least not common, in the European market. This is one reason why figures from the US are not comparable.

self-contained booster heater. This procedure does not address cleaning or sanitizing performance. It is applicable to both hot water sanitizing and chemical sanitizing rack conveyor machines, which include both single tank and multiple tank machines. Rackless conveyors (i.e. flight type machines) are included. Dishwasher tank heaters are evaluated separately from the booster heater. Machines designed to be interchangeable in the field from high temperature and low temperature (i.e. Dual Sanitizing Machines) and vice versa, shall be tested at both settings. Machines should be set for factory settings. If a dishwasher includes a prewash tank heater as an option, energy should be submetered separately for the prewash tank heater. This test method may be used for dishwashers with steam coil tank or booster heat, but not dishwashers with steam injection tank or booster heat. When the test method specifies to use the data plate or manufacturer's recommendations, instructions, specifications, or requirements, the information source shall be used in the following order of preference and documented in the test report: data plate, user manual, communication with manufacturer.

ASTM F2687-13: Standard practice for life cycle cost analysis of commercial food service equipment

This standard practice for life cycle cost analysis of commercial food service equipment is designed for producers and end-users to utilise when forecasting and (or) evaluating the life cycle costs of equipment by accounting for tangible differences in operating and maintenance costs of commercial food service equipment. Results of the analysis detailed in this standard practice are intended for budgetary purposes. The results may also be used to compare projected life cycle cost of different models from a single manufacturer, or models manufactured by multiple suppliers, or to establish when it is cost effective to replace a specific equipment versus incurring continued maintenance expenses. Major categories included in this analysis include total purchase price, service and repair costs, preventative maintenance costs, utility operating costs and disposal costs. The results may be quantified as a yearly running total and a net present value. Inputs for this life cycle analysis will need to come from a variety of sources, including manufacturers, service agents, utility companies, and end users. Not all input variables need to be considered for effective analysis. To avoid skewing the results, sections where reliable estimates are not available should be left out of the analysis. The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

ASTM F2916-19: Standard practice for environmental impact analysis of commercial food service equipment

This practice for analysing the environmental impact of food service equipment is intended to document the performance of food service equipment using attributes that are indicators of the appliance's environmental impact. It includes, but is not limited to, cooking, ware washing, refrigeration, ventilation, and mechanical equipment that use energy or water in a typical commercial cooking application. The method assigns points for each attribute and calculates a total score for the appliance. A specifier or purchaser of the appliance may use the individual results for certain attributes that are important in their analysis of the environmental impact of product. The results may also be used to compare the environmental impact of one model to another of the same type of equipment. The total score is not intended to provide a positive or negative judgment of a certain appliance's environmental impact. This analysis includes

attributes that occur in the manufacturing, use, and disposal of a product. This standard does not claim to address all the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

Summarising conclusions

ASTM standards correspond to the following commercial dishwasher categories as defined in **Section 3.2.3.7** and compiled in **Table 3-6**.

Table 3-6: ASTM standards and corresponding dishwasher categories.

Lot 24 categories	Corresponding ASTM standards ³⁰
Cat. 1: Undercounter water-change	F1696 Hot water sanitizing / chemical sanitizing; stationary single-rack door type: freshwater rinse machines
Cat. 2: Undercounter one-tank	F1696 Hot water sanitizing / chemical sanitizing; stationary single-rack door type: undercounter single-rack machines
Cat. 3: Hood-type dishwasher	F1696 Hot water sanitizing / chemical sanitizing; stationary single-rack door type: upright door-type machines
Cat. 4: Utensil/pot dishwasher	F1114 Heat sanitizing, stationary rack; pot, pan and utensil washing machines; water driven rotary spray F1202 Heat sanitizing; pot, pan and utensil washing machines; motor-driven vertically oscillating arm type F1696 Hot water sanitizing / chemical sanitizing; stationary single-rack door type: pot, pan and utensil machines
Cat. 5: Conveyor-type, one-tank	F858 Hot water sanitizing, single tank, automatic conveyor rack type F1203 Heat sanitizing; pot, pan and utensil washing machines; motor-driven rotary conveyor type F1920 Hot water sanitizing / chemical sanitizing; rack conveyor; single tank machines
Cat. 6: Conveyor-type, multi-tank	F859 Heat-sanitizing, multiple-tank, automatic conveyor rack type F860 Hot water sanitizing, multiple-tank, automatic rackless conveyor type F1920 Hot water sanitizing / chemical sanitizing; rack conveyor; multiple tank machines
Cat. 1-4	F857 Hot water sanitizing, stationary rack type
Cat. 1-6	F2687 Standard practice for life cycle cost analysis of commercial food service equipment F2916: Standard practice for environmental impact analysis of commercial food service equipment
-*	F953 Chemical sanitizing, stationary rack, dump type

Source: Lot 24 Task 1 Report, updated according to current research

* Note: The present preparatory study does not consider chemical sanitizing machinery

Summarising, ASTM standards cover material, design, and performance requirements for the different dishwasher categories addressed. The standards are typically used by end-use customers such as the US federal government when purchasing products from manufacturers. They are a means to ensure the customers receive a consistent product each time they place an order.

The standards include the following issues:

³⁰ Note: ASTM standards operate with hot water *sanitizing* processes in comparison to dishwashers in scope of this preparatory study being defined as machines operating with cleaning principle

- 1106 - Description of the material, design, and construction requirements such as metal
- 1107 types and thickness,
- 1108 - Descriptions of the different styles such as straight thru and corner type,
- 1109 - Various heat sources such as electric, steam or gas,
- 1110 - Details that should be specified when ordering a dishwasher,
- 1111 - Performance requirements stating the machines must conform to the requirements
- 1112 of Organisational Safety and Health Administration (OSHA), UL 921 (safety
- 1113 requirements, see **Section 3.3.1.5**), and NSF/ANSI 3 (hygienic performance, see
- 1114 **Section 3.3.2.1**),
- 1115 - Maximum noise level of the dishwasher only, when operating, exclusive of loading,
- 1116 unloading, and servicing,
- 1117 - Requirements for appropriate markings such as the operating times, temperatures,
- 1118 etc.

1119 Finally, there is typically a reference to performance profiles such as operating energy
1120 consumption, water consumption, and productivity.

1121 ASTM specifications apply to hot water and chemical *sanitizing* machines (for further details:
1122 see Task 6). These machines and processes, commonly used on the US market, generally require
1123 higher (sanitizing) temperatures compared to the (cleaning) temperatures of dishwashers in
1124 Europe³¹. This higher thermal minimum requirement results in higher energy consumption and
1125 lower efficiency, respectively. Therefore, the ASTM standards are regarded to be not
1126 appropriate to cover European requirements and market trends and are not applied by
1127 European manufacturers.

1128 3.3.1.5. UL 921 (USA / Canada)

1129 UL 921 Standard for commercial dishwashers

1130 This standard covers commercial, freestanding, undercounter, and counter-insert dishwashers,
1131 utensil-washers, and glasswashers intended for use in commercial establishments, such as
1132 kitchens of restaurants and hospitals, where they are not intended to be accessible to the public.
1133 The currently valid version of this standard is the 8th edition, which was published in 2020. The
1134 standard sets requirements in the areas of construction, safety, performance, rating and
1135 marking, as well as installation instructions. The specified performance tests do not cover any
1136 requirements regarding energy, water or detergent consumption or the cleaning and hygienic
1137 performance.

³¹ Hot water sanitizing: according to NSF/ANSI minimum washing temperatures of 66 to 74°C are required depending on the dishwashing machine category; cleaning: according to EN 17735 washing temperatures of 60 to 65°C are required.

3.3.2. Hygiene

3.3.2.1. NSF/ANSI 3 (International / USA / Canada)

NSF/ANSI 3-2023: Commercial warewashing equipment

This standard establishes minimum public health and sanitation requirements for the materials, design, construction, and performance of commercial warewashing machines and their related components.

It applies to commercial dishwashing, glass washing, and pot, pan, bottle washing and utensil washing machines that wash their contents by applying sprays of detergent solutions, with or without blasting media granules, and sanitise their contents by applying sprays of hot water or chemical sanitizing solutions.

Stationary rack and conveyor machines are covered under this Standard. Equipment components and materials covered under other NSF or NSF/ANSI Standards or criteria shall also comply with the requirements herein.

This standard sets the requirements regarding:

- Materials used in the manufacture of warewashing machines (e.g. corrosion resistance, smoothness and cleanability etc.),
- Design and construction (e.g. general sanitation requirements, temperature indicating devices at the wash tanks, thermostatic control of the water temperature in the tanks, etc.),
- Performance (soil removal, sanitisation efficacy (hot water and chemical sanitizing), thermostat differential of dishwashing, glass washing and pot, pan and utensil washing machines, including description of test method as well as rinse effectiveness) and
- Manufacturer's specifications (data to be stated on a data plate (e.g. minimum temperature of wash water in the tank, minimum and maximum pressure in the final sanitizing rinse line, etc.), equipment labelling (however, no information requirements on energy and water consumption but only regarding the intended use), and operating instructions.

Both for hot water and chemical sanitizing machines requirements regarding the water temperature and pressure are set.

NSF/ANSI 3-2023 additionally contains requirements and exemptions for warewashing equipment provided with a security package (e.g. for use in prisons etc.) and for warewashing equipment for use in marine environments (under shipboard conditions).

NSF/ANSI 3-2023 specifications apply to hot water and chemical sanitizing machines commonly used on the US market. These appliances generally require higher (sanitizing) temperatures compared to the (cleaning) temperatures of dishwashers in Europe. This higher thermal minimum requirement results in higher energy consumption and lower efficiency, respectively.

1175 Therefore, this standard is regarded to be not appropriate to cover European requirements and
1176 market trends.

1177 3.3.2.2. NSF/ANSI 29 (International / USA / Canada)

1178 NSF/ANSI 29-2021 Detergent and chemical feeders for commercial spray-type dishwashing
1179 machines

1180 This standard establishes minimum public health and sanitation requirements for chemical
1181 sanitizing feeders, detergent feeders, rinse agent feeders, and similar devices for commercial
1182 spray-type dishwashing machines that automatically maintain the concentration of additives in
1183 the prewash, wash, pumped rinse, or final rinse of commercial spray-type dishwashing
1184 machines. The requirements by this standard cover:

- 1185 - The materials used,
- 1186 - The design and construction,
- 1187 - The performance (e.g. Hydrostatic test, maintenance of solution concentration,
1188 reliability, chemical resistance, etc.) And
- 1189 - The installation, operation and maintenance instructions (manual, operating
1190 instructions).

1191 This standard established and adopted by NSF as minimum voluntary consensus standard is used
1192 internationally as well as an American National Standard (ANS).

1193 3.3.2.3. EN 17735 (European)

1194 EN 17735:2022: Commercial dishwashing machines – Hygiene requirements and testing

1195 This European standard is the first to provide a standard that defines the hygiene requirements
1196 for the operation of commercial dishwashers and the procedures for corresponding tests on the
1197 dishwashers and contains guidelines for the hygienic and proper operation, care, and
1198 maintenance of dishwashers. It has been prepared by Technical Committee CEN/TC 429 'Food
1199 hygiene — Commercial warewashing machines — Hygiene requirements and testing'.

1200 EN 17735 is applicable to dishwashers used in commercial environments for cleaning items in
1201 contact with food, such as plates, crockery, glassware, cutlery, reusable containers, and similar
1202 items. These can be found in cafés, restaurants, canteens, hospitals, snack bars and bars, etc.
1203 The standard is not applicable to household dishwashers, washer-disinfectors for the
1204 reprocessing of medical devices and machines for industrial use.

1205 The hygiene requirements for commercial dishwashers defined by EN 17735 include, for
1206 example, specifications for the planning and design of the various machine types (programme
1207 and conveyor dishwashers). Information is provided on hygienic and commercial operation,
1208 cleaning and disinfection of the wash ware and care and maintenance of the machines. It also
1209 describes the basic hygiene principles for the spatial arrangement of the dishwashers in the
1210 kitchen area and the organisation of the wash ware cycle.

1211 According to stakeholder feedback, there is no European legal obligation to use EN 17735. There
1212 may be specific and varying requirements depending on the kitchen's location (country, region,
1213 or municipality). Currently, food operators have the legal obligation to comply with the
1214 provisions and requirements of food legislation, but the way they comply and demonstrate
1215 compliance is more a matter of process than of focusing on specific dishwashing machine
1216 characteristics.

1217 3.3.2.4. DIN 10510 / 10511 / 10512 / 10522 /10544 (Germany)

1218 This family of standards covers hygienic requirements regarding the construction, operation and
1219 maintenance of different types of commercial dishwashers.

1220 Most of the content of these German standards has been incorporated into EN 17735 (see
1221 **Section 3.3.2.3**). The previous German standards for the hygiene requirements for commercial
1222 dishwashing DIN 10510, 10511 and 10512 were withdrawn as a result. Only DIN 10522 remains.

1223 For points that are included in the previous German standards but not in EN 17735, such as type
1224 testing with glass, a residual standard is published by the responsible DIN committee in the form
1225 of DIN 10544.

1226 DIN 10522:2006 Food hygiene – Professional cleaning of reusable boxes and reusable containers
1227 for unpackaged foodstuffs – Hygiene requirements, testing

1228 This standard defines minimum hygiene requirements regarding the professional cleaning of
1229 reusable boxes and reusable containers for unpackaged foodstuffs and describes the test
1230 procedures for the hygienic operation of dishwashers used for these purposes.

1231 DIN 10522 continues to apply unchanged, as its scope of application for reusable crates and
1232 reusable containers used to store and transport unpackaged food within the commercial sector
1233 is not covered by EN 17735.

1234 DIN 10544:2024-07 Food hygiene - Commercial dishwashing machines - Additional hygiene
1235 requirements and testing

1236 This German standard is applicable to commercial dishwashers that fall within the scope of
1237 EN 17735 (see **Section 3.3.2.3**). DIN 10544 supplements the content of EN 17735 with the
1238 following points:

- 1239 - Type testing for the cleaning of drinking vessels (e.g. glasses, cups ...),
- 1240 - Extraordinary testing of dishwashers (to support the operator),
- 1241 - Inspection of the cleaning of cutlery on special wash ware carriers,
- 1242 - Cleaning of reusable packaging for delivery to and use by end consumers.

3.3.3. Noise

3.3.3.1. EN IEC 60704 (International)

EN IEC 60704-1:2021 Household and similar electrical appliances - Test code for the determination of airborne acoustical noise - Part 1: General requirements

This international standard applies to electric appliances (including their accessories or components) for household and similar use, supplied from mains or from batteries. By 'similar use' is understood the use in conditions similar to those found in households, for example in inns, coffee houses, tea rooms, hotels, barber or hairdresser shops, launderettes, etc., if not otherwise specified in the IEC 60704-2 series. It does not apply to appliances, equipment, or machines designed exclusively for industrial or commercial purposes.

EN IEC 60704-2-3:2021: Household and similar electrical appliances - Test code for the determination of airborne acoustical noise - Part 2-3: Particular requirements for dishwashers

This standard applies to single-unit electric dishwashers for household and similar use, with or without automatic programme control, for cold and/or hot water supply, for detachable or permanent connection to water supply or sewage systems, intended for placing on the floor against a wall, for building-in or placing under a counter, a kitchen worktop or under a sink, and for mounting to a wall or on a counter. Limitations for the use of this test code are given in IEC 60704-1.

3.3.3.2. ISO 3744 (International)

ISO 3744:2010 Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Engineering methods for an essentially free field over a reflecting plane

This international standard specifies methods for determining the sound power level or sound energy level of a noise source from sound pressure levels measured on a surface enveloping the noise source (machinery or equipment) in an environment that approximates to an acoustic free field near one or more reflecting planes. The sound power level (or, in the case of noise bursts or transient noise emission, the sound energy level) produced by the noise source, in frequency bands or with frequency A-weighting applied, is calculated using those measurements. The methods specified in ISO 3744:2010 are suitable for all types of noise (steady, non-steady, fluctuating, isolated bursts of sound energy, etc.) defined in ISO 12001.

ISO 3744:2010 is applicable to all types and sizes of noise source (e.g. stationary or slowly moving plant, installation, machine, component, or sub-assembly), provided the conditions for the measurements can be met.

The test environments that are applicable to measurements made in accordance with ISO 3744:2010 can be located indoors or outdoors, with one or more sound-reflecting planes present on or near which the noise source under test is mounted. The ideal environment is a completely open space with no bounding or reflecting surfaces other than the reflecting plane(s)

1280 (such as that provided by a qualified hemi-anechoic chamber), but procedures are given for
1281 applying corrections (within limits that are specified) in the case of environments that are less
1282 than ideal.

1283 Information is given on the uncertainty of the sound power levels and sound energy levels
1284 determined in accordance with ISO 3744:2010, for measurements made in limited bands of
1285 frequency and with frequency A-weighting applied. The uncertainty conforms to ISO
1286 12001:1996, accuracy grade 2 (engineering grade).

1287 3.3.3.3. ISO 3746 (International)

1288 ISO 3746:2010 Acoustics – Determination of sound power levels and sound energy levels of noise
1289 sources using sound pressure – Survey method using an enveloping measurement surface over a
1290 reflecting plane

1291 This international standard specifies methods for determining the sound power level or sound
1292 energy level of a noise source from sound pressure levels measured on a surface enveloping a
1293 noise source (machinery or equipment) in a test environment for which requirements are given.
1294 The sound power level (or, in the case of noise bursts or transient noise emission, the sound
1295 energy level) produced by the noise source with frequency A-weighting applied is calculated
1296 using those measurements. The methods specified in ISO 3746:2010 are suitable for all types of
1297 noise (steady, non-steady, fluctuating, isolated bursts of sound energy, etc.) defined in ISO
1298 12001. ISO 3746:2010 is applicable to all types and sizes of noise source (e.g. stationary or slowly
1299 moving plant, installation, machine, component, or sub-assembly), provided the conditions for
1300 the measurements can be met.

1301 The test environments that are applicable for measurements made in accordance with ISO
1302 3746:2010 can be located indoors or outdoors, with one or more sound-reflecting planes
1303 present on or near which the noise source under test is mounted.

1304 Information is given on the uncertainty of the sound power levels and sound energy levels
1305 determined in accordance with ISO 3746:2010, for measurements made with frequency A-
1306 weighting applied. The uncertainty conforms to that of ISO 12001:1996, accuracy grade 3
1307 (survey grade).

1308 3.3.3.4. ISO 4871 (International)

1309 ISO 4871:1996 Acoustics – Declaration and verification of noise emission values of machinery
1310 and equipment

1311 This international standard gives information on the declaration of noise emission values,
1312 describes acoustical information to be presented in technical documents and specifies a method
1313 for verifying the noise emission declaration.

3.3.3.5. ISO 9614 (International)

ISO 9614-2:1996 Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 2: Measurement by scanning

This international standard specifies a method for measuring the component of sound intensity normal to a measurement surface which is chosen so as to enclose the noise source(s) of which the sound power level is to be determined.

3.3.3.6. ISO 11204 (International)

ISO 11204:2010 Acoustics – Noise emitted by machinery and equipment – Determination of emission sound pressure levels at a work station and at other specified positions applying accurate environmental corrections

This international standard specifies a method for determining the emission sound pressure levels of machinery or equipment, at a work station and at other specified positions nearby, in any environment which meets certain qualification requirements. A work station is occupied by an operator and may be located in open space, in the room where the source under test operates, in a cab fixed to the source under test, or in an enclosure remote from the source under test. One or more specified positions may be located in the vicinity of a work station, or in the vicinity of an attended or unattended machine. Such positions are sometimes referred to as bystander positions. Emission sound pressure levels are determined as A-weighted levels. Additionally, levels in frequency bands and C-weighted peak emission sound pressure levels can be determined in accordance with ISO 11204:2010, if required.

A method is given for determining a local environmental correction (subject to a specified limiting maximum value) to be applied to the measured sound pressure levels to exclude the effects of reflections from reflecting surfaces other than the plane on which the source under test is placed. This correction is based upon the mean sound pressure level on a measurement surface, the sound pressure level measured at a specified position, and either an environmental correction or the equivalent absorption area of the test room.

With the method specified in ISO 11204:2010, results of accuracy grade 2 (engineering grade) or accuracy grade 3 (survey grade) are obtained. Corrections are applied to background noise and as described above, to the acoustic environment. Instructions are given for the mounting and operation of the source under test and for the choice of microphone positions for the work station and for other specified positions. One purpose of the measurements is to permit comparison of the performance of different units of a given family of machines, under defined environmental conditions and standardised mounting and operating conditions.

The method specified in ISO 11204:2010 is suitable for all types of noise (steady, non-steady, fluctuating, isolated bursts of sound energy, etc.) defined in ISO 12001. The method specified in ISO 11204:2010 is applicable to all types and sizes of noise sources.

The type of test environment influences the accuracy of the determination of emission sound pressure levels. ISO 11204:2010 is applicable to an indoor or outdoor environment with one or more reflecting planes present, meeting specified requirements. These requirements on the

room are less strict than those of ISO 11201, in particular regarding the acoustical quality of the environment. ISO 11204:2010 is applicable to work stations and other specified positions where emission sound pressure levels are to be determined.

Appropriate positions where measurements may be made include the following: a) work station located in the vicinity of the source under test; this is the case for many industrial machines and domestic appliances; b) work station within a cab which is an integral part of the source under test; this is the case for many industrial trucks and earth-moving machines; c) work station within a partial or total enclosure (or behind a screen) supplied by the manufacturer as an integral part of the source under test; d) work station partially or totally enclosed by the source under test – this situation may be encountered with some large industrial machines; e) bystander positions occupied by individuals not responsible for the operation of the source under test, but who may be in its immediate vicinity, either occasionally or continuously; f) other specified positions, not necessarily work stations or bystander positions. The work station may also lie on a specified path along which an operator moves.

3.3.4. Electromagnetic fields, electromagnetic compatibility (EMC)

3.3.4.1. IEC 62233 (International)

EN 62233:2008 - Measurement methods for electromagnetic fields of household appliances and similar apparatus with regard to human exposure

This international standard deals with electromagnetic fields up to 300 GHz and defines methods for evaluating the electric field strength and magnetic flux density around household and similar electrical appliances, including the conditions during testing as well as the measuring of distances and positions. Appliances may incorporate motors, heating elements or their combination, may contain electric or electronic circuitry, and may be powered by the mains, by batteries or by any other electrical power source. Appliances include such household electrical appliances, electric tools, and electric toys. Appliances that are not intended for regular household use but may nevertheless be approached by the public or may be used by laymen are within the scope of this standard. This standard includes specific elements to assess human exposure:

- Definition of sensor,
- Definition of measuring methods,
- Definition of operating mode for appliance under test,
- Definition of measuring distance and position.

The measurement methods specified are valid for appliances that range from 10 Hz to 400 kHz. In the frequency range above 400 kHz and below 10 Hz, appliances in the scope of this standard are deemed to comply without testing, unless otherwise specified within the IEC 60335 series.

EN IEC 61000-3-2:2019 + A1:2021- Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)

This part of IEC 61000 applies to the limitation of harmonic currents fed into the public low-voltage supply system. It specifies limits for the harmonic components of the input current that can be caused by equipment (apparatus, devices) tested under specified conditions. It is applicable to electrical and electronic devices (equipment, installations) which have an input current of up to and including 16 A per conductor and which are intended for connection to the public low-voltage distribution network.

EN 61000-3-3:2013 + A1:2019 + A2:2021 + A2:2021/AC:2022 - CSV Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection

This international standard applies to the limitation of voltage fluctuations and flicker impressed on the public low-voltage system. It specifies limits of voltage changes which may be produced by an equipment tested under specified conditions and gives guidance on methods of assessment. It is applicable to electrical and electronic equipment having an input current equal to or less than 16 A per phase, intended to be connected to public low-voltage distribution systems of between 220 V and 250 V line to neutral at 50 Hz, and not subject to conditional connection. IEC 61000-3-3 has the status of a product family standard within the IEC 61000 series. This third edition cancels and replaces the second edition published in 2008. This edition constitutes a technical revision which takes account of the changes made in IEC 61000-4-15:2010.

3.3.4.2. EN 50366 (Europe)

EN 50366:2003 Household and similar electrical appliances – Electromagnetic fields – Methods for evaluation and measurement

This European standard contains several test methods by which the magnetic field emissions from products can be compared to the general public restrictions and levels over the frequency range of 10 Hz to 400 kHz.

3.3.4.3. EN IEC 55014 (Europe)

EN IEC 55014-1:2021 Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus - Part 1: Emission

This standard specifies requirements for the emission of radiofrequency disturbances from household appliances, electric tools, and similar apparatus. Specifically, the standard applies to:

- Household appliances,
- Electric tools,
- Similar apparatus designed for use in residential, commercial, and light industrial environments.

It aims to ensure electromagnetic compatibility by limiting radio frequency emissions from common electrical and electronic devices used in homes and similar environments and provides

1427 manufacturers with the technical specifications needed to design and test products to meet EMC
1428 regulatory requirements.

1429 EN IEC 55014-2:2021 Electromagnetic compatibility - Requirements for household appliances,
1430 electric tools and similar apparatus - Part 2: Immunity - Product family standard

1431 This standard specifies electromagnetic immunity requirements for household appliances,
1432 electric tools, and similar apparatus. Specifically, the standard applies to:

- 1433 - Household appliances,
- 1434 - Electric tools,
- 1435 - Similar apparatus powered by AC or DC (including battery-powered devices).

1436 It covers the frequency range of 0 Hz to 400 GHz and specifies immunity requirements for:

- 1437 - Continuous electromagnetic disturbances,
- 1438 - Transient electromagnetic disturbances,
- 1439 - Both conducted and radiated disturbances.

1440 3.3.5. Gas

1441 This section is only included for the sake of completeness, given the disappearance of newly
1442 built gas-fired dishwashers from the EU market.

1443 3.3.5.1. UL 921 (USA / Canada)

1444 UL 921 Standard for commercial dishwashers

1445 This standard covers commercial, freestanding, undercounter, and counter-insert dishwashers,
1446 utensil-washers, and glass washers using water as the principal cleaning medium, hereafter
1447 referred to as dishwashers.

1448 The contents of the standard have already been described in **Section 3.3.1.5**. However, this
1449 standard covers not only electric dishwashers, but also the gas-handling, gas-burning, and gas-
1450 control features of gas-fired dishwashers having inputs of 400,000 Btu (420 MJ) per hour or less,
1451 limited to 0.5 psig (3.45 kPa) inlet pressure for use with natural gas, manufactured gas, mixed
1452 gas, propane gas, liquefied petroleum gases, or LP gas-air mixtures. Thus, UL 921 provides
1453 further construction and performance³² and marking requirements being unique to gas-fired
1454 dishwashers.

³² This refers to general requirements, test gases, test pressures and burner adjustments test, normal operation, undervoltage combustion test, combustion air failure test, burner operating characteristics test, pilot ignition systems test, direct ignition systems tests, and flue gas temperature for draft hood appliances test.

3.4. Legislation and environmental labelling

Commercial dishwashers are already covered by a wide range of legislation at a European level, as well as by individual Member States and at an international level by third countries. Some of the regulations relate to health or safety aspects (e.g., Low Voltage Directive), while other regulations address environmental aspects or labelling (e.g. WEEE Directive, RoHS, REACH, F-Gas Regulation, Water Framework Directive, Regulation on Detergents).

3.4.1. European legislation

3.4.1.1. Machinery Directive (MD) 2006/42/EC and Regulation (EU) 2023/1230

The Machinery Directive 2006/42/EC (European Parliament and Council, 2006a) is a revised version of Directive 98/37/EC and Member States shall apply the provisions necessary to comply with it from 29th December 2009. The Directive aims at harmonising health and safety requirements applicable to machinery, and at ensuring the free circulation of machinery on the Community market. Machinery is defined as ‘an assembly, fitted with or intended to be fitted with a drive system other than directly applied human or animal effort, consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application’³³.

Before placing machinery on the market and/or putting it into service, the manufacturer or his authorised representative shall ensure that ‘a risk assessment is carried out in order to determine the health and safety requirements which apply to the machinery. The machinery must then be designed and constructed taking into account the results of the risk assessment.’ In addition, obligations regarding the provision of technical documentation and of necessary information such as instructions as well as obligations regarding the processes of the declaration of conformity are defined.

Conformity with the requirements of the Directive is guaranteed by the official CE marking which shall be affixed to the machinery ‘visibly, legibly and indelibly in accordance with Annex III’. Other markings which are likely to ‘mislead third parties as to the meaning or the form of the CE marking, or both, shall be prohibited’.

One objective of the review of the Machinery Directive was to clarify the borderline between the scope of the Machinery Directive (MD) and the former Low Voltage Directive (LVD) 2006/95/EC³⁴, meanwhile recast as Directive 2014/35/EU, in order to provide greater legal certainty (European Commission, 2024b). Categories of low voltage electrical and electronic machinery that are excluded from the scope of the Machinery Directive are listed in Article 1 (2)

³³ There are some additions to this definition, but these are not relevant for the device group under consideration here, as this is covered by the first definition.

³⁴ Formerly Directive 73/23/EEC as amended.

(k) and they include ‘household appliances intended for domestic use’. When such machinery has an electrical supply within the voltage limits of the Low Voltage Directive (between 50 and 1000 V for alternating current or between 75 and 1500 V for direct current), it must fulfil the safety objectives of the LVD and not of the Machinery Directive. Therefore, household dishwashers are considered to be outside the scope of this directive. Whether a machine is to be considered a ‘household appliance intended for domestic use’ would depend on how the manufacturer has specified the machine in its declaration of conformity or product information (European Commission, 2024b).

In contrast, within this power rating, a machine specified by the manufacturer as intended for commercial or industrial use as well as machinery beyond these voltage limits would need to comply with requirements of the Machinery Directive. This is clarified in the Commission’s guidance document: ‘Thus appliances for the housekeeping functions [...] that are intended for commercial or industrial use are not excluded from the scope of the Machinery Directive’ (European Commission, 2024b). The Machinery Directive therefore applies to all commercial dishwashers as long as they are not intended for use in households and are also within the voltage range of the LVD. For the delimitation between machinery for household and commercial use, see also **Section 3.2.2**.

Due to inadequacies and inconsistencies in the product coverage and conformity assessment procedures, the provisions of the Machinery Directive were improved and adapted and will repeal Directive 2006/42/EC with effect from 20 January 2027. Since rules setting out requirements for products within the scope of the Directive should be of uniform application for all operators across the Union, and not give room for divergent implementation by Member States, the Directive was replaced by a regulation (Regulation (EU) 2023/1230; European Parliament und Council, 2023b; 2023a). Under the new Regulation:

Household appliances intended for domestic use that fall under the scope of the Low Voltage Directive (2014/35/EU) are excluded from the new regulation, which means that the regulation – like the current Machinery Directive – does not apply to dishwashers intended for domestic use. Dishwashers intended for commercial use are not excluded and will therefore be in the scope of the new regulation starting from 20 January 2027 (European Parliament und Council, 2023b; 2023a).

3.4.1.2. Low Voltage Directive (LVD) 2014/35/EU

The initial Low Voltage Directive (LVD) 73/23/EEC was revised and recast as 2006/95/EC and later again as Directive 2014/35/EU (EU 2014b). Compliance with its provisions shall ‘ensure a high level of protection of public interests, such as health and safety of persons, of domestic animals and property, and to guarantee fair competition on the Union market’ concerning the electrical equipment within certain voltage limits. The directive requires such equipment to be protected against hazards arising from the electrical equipment itself as well as against hazards caused by external influences. The directive covers ‘all risks arising from the use of electrical equipment, not just electrical ones, but also mechanical, chemical (such as, in particular, emission of aggressive substances) and all other risks. The LVD also covers health aspects of noise and vibrations, and ergonomic aspects as far as ergonomic requirements are necessary to protect against hazards in the sense of the LVD’ (European Commission 2018a).

The LVD covers electrical equipment designed for use with a voltage rating of between 50 V and 1000 V for alternating current and between 75 V and 1500 V for direct current (if not excluded in Annex II). As explained in European Commission (2018a), these voltage ratings refer to the voltage of the electrical input or output, not to voltages that may appear inside the equipment (European Commission 2018a).

As they are not listed under the exceptions, all dishwashers – intended for commercial or for domestic use – that are within the corresponding voltage rating of the directive are therefore subject to its requirements.

3.4.1.3. Electromagnetic Compatibility (EMC) Directive 2014/30/EU

The initial Directive 2004/108/EC has been revised and recast as Directive 2014/30/EU (European Parliament und Council, 2014) on the harmonisation of the laws of the Member States relating to electromagnetic compatibility. It regulates the electromagnetic compatibility (EMC) of both apparatus and fixed installations, where ‘apparatus’ means ‘any finished appliance or combination thereof made available on the market as a single functional unit, intended for the end-user and liable to generate electromagnetic disturbance, or the performance of which is liable to be affected by such disturbance’ and ‘fixed installations’ means ‘a particular combination of several types of apparatus and, where applicable, other devices, which are assembled, installed and intended to be used permanently at a predefined location’. Commercial dishwashers can fall under both of these categories and as they are not listed among the defined exceptions, they fall within the scope of the directive if they fulfil the definitions. According to the directive, equipment must be designed and manufactured in such a way that electromagnetic compatibility is ensured, i.e.

(a) ‘the electromagnetic disturbance generated does not exceed the level above which radio and telecommunications equipment or other equipment cannot operate as intended’ and

(b) ‘it has a level of immunity to the electromagnetic disturbance to be expected in its intended use which allows it to operate without unacceptable degradation of its intended use’.

3.4.1.4. Restriction of Hazardous Substances Directive (RoHS) 2011/65/EU

Directive 2002/95/EC was reviewed and recast as Directive 2011/65/EU (European Parliament und Council, 2011) on the restriction of the use of certain hazardous substances in electrical and electronic equipment (commonly referred to as the Restriction of Hazardous Substances Directive or RoHS). The Directive restricts the presence of the hazardous substances specified in its Annex II in various types of electronic and electrical equipment (EEE). It currently restricts 10 substances while a few additional substances are under consideration for future restriction.

The restrictions apply to EEE belonging to the categories set out in RoHS Annex I, which differ somewhat from those covered by the related Directive 2012/19/EU (WEEE). One of the categories of Annex I in scope of the RoHS Directive is category 1 ‘Large Household Appliances’, to which certain dishwashers could be assigned. Commercial machines not considered to be under category 1 would be expected to fall under category 11 for ‘Other EEE not covered by any

of the categories above' and thus to still be in scope. The Commission's 'Frequently Asked Questions' document (European Commission, 2012) on RoHS and WEEE Directives clarifies as well that commercial and industrial equipment is covered by the RoHS Directive³⁵.

According to Article 4(6) of the Directive, the Article 4(1) substance restrictions do not apply to the applications listed in Annexes III and IV. Article 5(1)(a) and (b) ensure that materials and components can be included in these lists of applications under certain conditions if the inclusion does not weaken the environmental and health protection afforded by Regulation (EC) No 1907/2006 and if one of the following conditions is fulfilled:

- a) 'their elimination or substitution via design changes or materials and components which do not require any of the materials or substances listed in Annex II is scientifically or technically impracticable',
- b) 'the reliability of substitutes is not ensured',
- c) 'the total negative environmental, health and consumer safety impacts caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof'.

Currently, there are close to 100 exemptions listed in Annex III and IV of the RoHS Directive³⁶. In Task 4 (Technical analysis of existing products) of this preparatory study, we will evaluate whether there are existing exemptions which are of importance for the scope of this study. The Directive was recently subject to a review process; however, the process has not concluded (status October 2024) and it cannot be estimated whether changes shall be introduced to RoHS or not.

3.4.1.5. Waste Electrical and Electronic Equipment Directive (WEEE) 2012/19/EU

The Waste Electrical and Electronic Equipment Directive (WEEE Directive) was introduced as European Community Directive 2002/96/EC. Following a review, it was recast as Directive 2012/19/EU (WEEE, 2012). The aim of the directive is 'protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste from electrical and electronic equipment (WEEE)'. It contains provisions on the design, collection, treatment, recycling, and disposal of WEEE as well as on financial aspects. The responsibility for the management of waste electrical and electronic equipment is assigned to the manufacturers and partly also to the distributors.

³⁵ Based on FAQ 6.3 'Does RoHS 2 apply to EEE for professional and industrial use?', Answer: 'Yes. RoHS 2, just as RoHS 1, does not distinguish between EEE for consumer use and EEE for professional and industrial use. In some cases, however specific exclusions (Article 2(4)) or timelines (Article 4(3), 4(4) and 4(5)) may apply.'

³⁶ Exemptions listed under Annex IV only apply to medical devices and/or monitoring and control equipment (Category 8 and 9 respectively) whereas exemptions listed under Annex III can apply to all EEE. In both cases, the scope of an exemption can be further restricted to specific EEE categories, devices or components.

Since 15 August 2018, the Directive has applied to all electrical and electronic equipment with the exception of the appliances listed in Article 2(3) and 2(4). All electrical and electronic appliances concerned are assigned to different categories in Annex III, including the category 'Large equipment (any external dimension more than 50 cm)'. According to Annex IV, this category includes 'Dish washing machines'. These are therefore within the scope of the directive.

Very large and complex commercial dishwashing machines could possibly be exempted from the Directive if they can be considered as 'large-scale fixed installations'. There is no clear definition in the directive as to the size above which this is the case. There are also no clear criteria in the FAQ document for the WEEE Directive (European Commission, 2014), but reference is made to the FAQ document for the RoHS Directive (European Commission, 2012). There it is emphasised that the decision as to whether an installation is to be classified as 'large-scale' must be examined on a case-by-case basis and that the burden of proof lies with the economic operator. However, various criteria for the decision are also provided, including the possibility of transporting the installation in an ISO 20-foot container (5.71 m x 2.35 m x 2.39 m). If the sum of the parts of the machine is too large to be transported in such a container, it can be considered 'large-scale'. This may apply to large commercial dishwashers. The other criteria for 'large-scale fixed installations' are set out in Article 3(1)(c) of the Directive:

'large-scale fixed installation' means a large-size combination of several types of apparatus and, where applicable, other devices, which:

- a) are assembled, installed and de-installed by professionals,
- b) are intended to be used permanently as part of a building or a structure at a pre-defined and dedicated location; and
- c) can only be replaced by the same specifically designed equipment'.

Article 4 stipulates that Member States shall 'encourage cooperation between producers and recyclers and measures to promote the design and production of EEE, notably in view of facilitating re-use, dismantling and recovery of WEEE, its components and materials.' Furthermore, they shall 'take appropriate measures so that the ecodesign requirements facilitating re-use and treatment of WEEE established in the framework of Directive 2009/125/EC are applied and producers do not prevent, through specific design features or manufacturing processes, WEEE from being re-used, unless such specific design features or manufacturing processes present overriding advantages, for example, with regard to the protection of the environment and/or safety requirements.' These specifications are not very specific, but this could change as a result of the coming review of the WEEE Directive to be launched shortly.

Article 8 of the directive requires Member States to ensure that proper treatment of all separately collected WEEE takes place. This includes, among other things, the removal of all liquids and a selective treatment in accordance with Annex VII. Annex VII lists substances, mixtures and components that must be removed from the collected WEEE (e.g. batteries, mercury containing components and external electric cables). The design of the appliances should ideally take this into account, but the directive does not make any direct statements on

1641 this though in some cases it is under the regime of other legislation (e.g. RoHS regarding mercury
1642 or the Batteries Regulation for batteries). Minimum recovery targets to be achieved by
1643 producers in accordance with Article 11 are listed in Annex V.

1644 Articles 12 and 13 refer to the financing of waste management of equipment in scope of the
1645 directive. At present this however does not include fee-modulation which could have a more
1646 substantial impact on design. It is thus not further detailed here.

1647 3.4.1.6. Water Framework Directive (WFD) 2000/60/EC

1648 The purpose of the Water Framework Directive (WFD) (European Parliament und Council, 2020)
1649 is to provide a framework for the protection of inland surface waters, transitional waters, coastal
1650 waters and groundwater. More concretely, this framework is intended to prevent further
1651 deterioration and protect the status of aquatic ecosystems as well as other related ecosystems;
1652 to promote the sustainable use of water resources; to reduce discharges, emissions and losses
1653 of priority substances and to contribute to the mitigation of floods and droughts. The water
1654 management is based on so-called 'river basins', which are defined as 'area[s] of land from which
1655 all surface run-off flows through a sequence of streams, rivers and, possibly, lakes into the sea
1656 at a single river mouth, estuary or delta'.

1657 In addition to direct protective measures, the Member States are obliged to take into account
1658 the principle of recovery of the costs of water services, including environmental and resource-
1659 related costs, having regard to an economic analysis and in accordance with the polluter-pays
1660 principle. This means that the Water Framework Directive introduces two important economic
1661 principles. On the one hand, Member States should ensure that water pricing policies provide
1662 adequate incentives for users to use water resources efficiently and that the various sectors (e.g.
1663 industry, households, agriculture) make an appropriate contribution to covering the costs of
1664 water services, taking into account the polluter-pays principle. On the other hand, the Member
1665 States themselves are obliged to draw up an economic analysis of water use in accordance with
1666 Annex III.

1667 Articles 4, 10, 11 and 16 and Annexes V, VIII, IX and X address chemical pollution. By identifying
1668 priority substances, the Water Framework Directive focuses on pollutants that pose a significant
1669 risk to or through the aquatic environment. The substances are identified through risk
1670 assessments that examine scientific evidence of the substances' hazardous properties, their
1671 contamination of European waters and other factors (e.g. quantities used). Of the 45 chemicals
1672 identified as priority substances, 21 are designated as priority hazardous substances due to their
1673 persistence, bioaccumulation and toxicity. The list of priority substances is reviewed by the
1674 European Commission at least every six years to enable the inclusion of further substances of
1675 concern. Emissions, discharges and losses of priority substances into water bodies are to be
1676 gradually reduced and priority hazardous substances are to be completely phased out within 20
1677 years.

1678 It is assumed that the priority substances could be contained in the discharges of dishwashing
1679 appliances if used in the detergents applied during washing processes. In this case, the Water
1680 Framework Directive is considered relevant for the product group of commercial dishwashers.

3.4.1.7. Radio Equipment Directive (RED) 2014/53/EU

The former Radio and Telecommunications Terminal Equipment Directive 1999/5/EC was repealed by the Radio Equipment Directive (RED) 2014/53/EU (European Union, 2014). The RED establishes a regulatory framework for the making available on the market and putting into service in the Union of radio equipment. 'Radio equipment' is defined as 'an electrical or electronic product, which intentionally emits and/or receives radio waves for the purpose of radio communication and/or radiodetermination, or an electrical or electronic product which must be completed with an accessory, such as antenna, so as to intentionally emit and/or receive radio waves for the purpose of radio communication and/or radiodetermination'. A guidance document provided by the Commission (European Commission, 2018b) makes statements on 'non-radio electrical products functioning with radio equipment': 'Electrical or electronic products whose function is not to intentionally emit or receive radio waves for the purpose of radio communication and/or radiodetermination (in this section referred to as 'non-radio product') may function with radio equipment'. According to the document, such products are within the scope of RED, if 'the radio equipment is (a) incorporated into the non-radio product; and (b) permanently affixed to the non-radio product'.

This can be the case with 'smart' dishwashers. In this case, they must comply with the regulations of the Directive, for example, they must be manufactured in such a way that they fulfil the essential requirements in Article 3.

3.4.1.8. Packaging Directive 2018/852/EU (repealed by Regulation (EU) 2025/40)

The purpose of the Packaging Directive (European Parliament and Council, 1994) was to harmonise the rules on packaging and packaging waste management in order to prevent or reduce the environmental impact of such waste, thereby ensuring a high level of environmental protection and the functioning of the internal market. The latest version of the directive (including the amendments up to 2018) set out measures aimed at the prevention, reuse, recycling, and other forms of recovery of packaging waste and, as a result, a reduction in the final disposal of waste. 'The directive covers all packaging placed on the European market and all packaging waste, whether it is used or released at industrial, commercial, office, shop, service, household or any other level, regardless of the material used' (European Union, 2025). On this basis it is concluded that packaging of commercial dishwashers would be in scope of this legislation.

Though Article 4 of the directive addressed prevention, it remained vague for most packaging aside from carrier plastic bags for which specific requirements have been included through the 2015 amendment of the directive. Among other things, the directive defined basic requirements for packaging (in accordance with Article 9 and detailed in Annex II) and stipulated that Member States should take further preventive measures to avoid the generation of packaging waste and to minimise its environmental impact (in accordance with Article 11). Measures also concerned reuse, recovery, and recycling as well as return, collection and recovery systems. There were also labelling requirements for identifying and classifying the materials. Further requirements were defined, for example concerning the concentration levels of heavy metals and the provision of information to packaging users.

3.4.1.9. Regulation (EU) 2025/40 on packaging and packaging waste

In November 2022, the Commission proposed to revise the Packaging Directive and has published a proposal for a Regulation on packaging and packaging waste which entered into force on 19 December 2024. The shift from a directive to a regulation means among others that manufacturers are directly obligated by the legislation, as opposed to a directive which needs to be transferred to national legislation, thus obliging Member States to ensure that e.g., manufacturers adhere to specific requirements. New articles require all packaging to be recyclable, set recycled content targets for packaging relevant for the use of plastics, require the amount of packaging to be reduced as well as a shift to reusable packaging. The requirements for the design of packaging are more specific, detailed in Article 5 to Article 11 and regarding the labelling, marking and information requirements in Article 12 to Article 14, whereas in the former directive many requirements remained vague in nature. These requirements affect manufacturers of packaging directly as specified in Article 15 of the regulation.

3.4.1.10. Regulation (EU) 528/2012 – Biocidal Products

The Biocide Directive 98/8/EC was reviewed and recast as Regulation (EU) 528/2012 (European Parliament und Council, 2012) concerning the making available on the market and use of biocidal products. This Directive concerns:

- a) the establishment at Community level of a positive list of active substances which may be used in biocidal products;
- b) the authorisation of biocidal products;
- c) the mutual recognition of authorisations within the Community;
- d) the placing on the market for use of biocidal products within one or more Member States; and
- e) the placing on the market of treated articles.

A biocidal product is defined as ‘any substance or mixture, in the form in which it is supplied to the user, consisting of, containing or generating one or more active substances, with the intention of destroying, deterring, rendering harmless, preventing the action of, or otherwise exerting a controlling effect on, any harmful organism by any means other than mere physical or mechanical action’ or ‘any substance or mixture, generated from substances or mixtures which do not themselves fall under the first indent, to be used with the intention of destroying, deterring, rendering harmless, preventing the action of, or otherwise exerting a controlling effect on, any harmful organism by any means other than mere physical or mechanical action.’ Treated articles that have a primary biocidal function shall be considered biocidal products as well.

If such substances are used in detergents or cleaning agents in commercial dishwashers, the regulation is considered relevant for this product group. In addition, biocidal products could also be used in wooden packaging for commercial dishwashing appliances.

Furthermore, the regulation also sets limits on the content of phosphates and other phosphorus compounds (as specified in Annex VIa) and contains obligations concerning information and labelling as well as specifications concerning testing methods.

3.4.1.11. Regulation (EC) 517/2014 – Fluorinated GHG

The former Regulation (EC) 842/2006 was repealed by Regulation (EU) 517/2014 (European Parliament and Council, 2014), which has been repealed by the Regulation (EU) 2024/573 of 7 February 2024 on fluorinated greenhouse gases. The objective of this regulation is to protect the environment by reducing emissions of fluorinated greenhouse gases. To achieve this objective, it

- a) 'Establishes rules on containment, use, recovery, and destruction of fluorinated greenhouse gases, and on related ancillary measures,
- b) imposes conditions on the placing on the market of specific products and equipment that contain, or whose functioning relies upon, fluorinated greenhouse gases,
- c) imposes conditions on specific uses of fluorinated greenhouse gases; and
- d) establishes quantitative limits for the placing on the market of hydrofluorocarbons.'

This includes provisions concerning the labelling and disposal of products and equipment containing those gases; the reporting of information on those gases; the control of uses and the placing on the market prohibitions of the products and equipment; and the training and certification of personnel and companies involved in activities provided for by this regulation. Annex I to this regulation contains a list of the fluorinated greenhouse gases currently covered by this regulation, together with their global warming potentials.

Requirements that are particularly relevant with regard to the design of devices are provisions on labelling. Article 12 specifies that 'products and equipment that contain, or whose functioning relies upon, fluorinated greenhouse gases shall not be placed on the market unless they are labelled.' This only applies to certain products, including heat pumps. The required labelling must contain specific information detailed in Article 12. For commercial dishwashers, this regulation applies in those cases when the appliances are equipped with heat pumps containing refrigerants.

Concerning reclaimed or recycled fluorinated greenhouse gases, they 'shall be labelled with an indication that the substance has been reclaimed or recycled, information on the batch number and the name and address of the reclamation or recycling facility'. Producers of fluorinated compounds are obliged to take all necessary precautions to limit emissions of fluorinated greenhouse gases to the greatest extent possible. This concerns production, transport, and storage.

Article 11 prohibits the placing on the market of the products and equipment listed in Annex III. These include, inter alia: 'Non-refillable containers for fluorinated greenhouse gases used to service, maintain or fill refrigeration, air-conditioning or heat-pump equipment, fire protection systems or switchgear, or for use as solvents' (date of prohibition: 4 July 2007).³⁷ The same

³⁷ The prohibition does not apply 'to equipment for which it has been established in ecodesign requirements adopted under Directive 2009/125/EC that due to higher energy efficiency during its

article specifies that ‘non-hermetically sealed equipment charged with fluorinated greenhouse gases shall only be sold to the end user where evidence is provided that the installation is to be carried out by an undertaking certified in accordance with Article 10’. Conversely, fluorinated greenhouse gases in heat pumps must be contained in hermetically sealed components if they are contained in appliances that are not installed by specialised personnel (this applies to household appliances, for example).

Article 12 lays down provisions on labelling as well as on product and equipment information. It specifies that ‘products and equipment that contain, or whose functioning relies upon, fluorinated greenhouse gases shall not be placed on the market unless they are labelled.’ This applies to certain products, including heat pumps. The mandatory labelling must include information on the presence of fluorinated greenhouse gases, the accepted industry designation or chemical name, quantities used or intended to be used, associated CO₂ equivalents and the global warming potential. Where applicable, it must also contain a reference that the fluorinated greenhouse gases are contained in hermetically sealed equipment and information on the tested leakage rate of electrical switchgears and compliance with limit values. This information must also be included in instruction manuals for the products and equipment concerned. If products and equipment contain fluorinated greenhouse gases with a global warming potential of 150 or more this information must also be included in descriptions used for advertising. There are also specifications as to where and how the labelling must be affixed.

Article 14 sets out requirements for the prefilling of equipment (e.g. heat pumps) with hydrofluorocarbons that are related to the quota system: ‘From 1 January 2017 refrigeration, air conditioning and heat pump equipment charged with hydrofluorocarbons shall not be placed on the market unless hydrofluorocarbons charged into the equipment are accounted for within the quota system referred to in Chapter IV.’ This results in documentation and control obligations for the manufacturers and importers of such equipment. By issuing the declaration of conformity, manufacturers and importers are responsible for compliance with the relevant regulations.

Chapter 4 defines requirements regarding the quantities of hydrofluorocarbons placed on the market, the associated quota system and the registration process and transfer of quotas. Chapter 5 contains provisions on reporting obligations regarding production, import, export, feedstock use, and destruction of the substances listed in Annexes I or II.

3.4.1.12. Regulation (EC) 1275/2008 – Standby / Networked Standby Regulation (EU) 2023/826

The Regulation (EC) 1275/2008 (European Commission, 2008), according to its latest amendment of 1 March 2021, sets out eco-design requirements for the electric power consumption in standby and off mode and for networked standby. According to the latest amendments, it applies to electrical and electronic household and office equipment. Equipment

operation, its lifecycle CO₂ equivalent emissions would be lower than those of equivalent equipment which meets relevant ecodesign requirements and does not contain hydrofluorocarbons.’

placed on the market with a low voltage external power supply (less than 6 volts)³⁸ to work as intended is excluded from the Regulation.

‘Electrical and electronic household and office equipment’ is defined as energy-using products which:

- a) are made commercially available as a single functional unit and are intended for the end-user,
- b) fall under the list of energy-using products of Annex I,
- c) are dependent on energy input from the mains power source in order to work as intended; and
- d) are designed for use with a nominal voltage rating of 250 V or below, also when they are marketed for non-household or non-office use.

In the original version of the Regulation, dishwashing machines were listed in Annex I and therefore fell within the scope of the Regulation. However, following the amendment by Commission Regulation (EU) 2019/2023 of 1 October 2019, dishwashing machines are no longer listed in Annex I. Therefore, commercial dishwashers would not fall into the scope of this regulation even if they fulfil criteria a) to d) (e.g. in some cases at camping grounds). Dishwashers designed for other groups than end-users are not in the scope of the regulation anyway.

Regulation (EC) No 1275/2008 was repealed by Regulation (EU) 2023/826 of 17 April 2023 with effect from 9 May 2025. This new regulation, according to its Annex II, does not cover household dishwashers covered by Commission Regulation (EU) 2019/2022. Dishwashers designed for use other than in the households are not covered by the regulation anyway. Therefore, this new Regulation is also not considered relevant for the product group commercial dishwashers of this review study.

3.4.1.13. Regulation (EC) 1907/2006 – REACH

The REACH Regulation (EC) 1907/2006 (European Parliament and Council, 2006b) concerns the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH). Its purpose is to ensure a high level of protection of human health and the environment, as well as the free circulation of substances on the internal market while enhancing competitiveness and innovation. It lays down provisions on certain substances as well as mixtures. The provisions shall apply ‘to the manufacture, placing on the market or use of such substances on their own, in mixtures or in articles and to the placing on the market of mixtures’. Hazardous substances that are relevant for commercial dishwashers will be analysed in MEERP Task 4 and Task 5.

³⁸ ‘Low voltage external power supply’ is defined as ‘an external power supply with a nameplate output voltage of less than 6 volts and a nameplate output current greater than or equal to 550 milliamperes’.

3.4.1.14. Regulation (EU) 2016/426 – Gas Appliances

The former Gas Appliance Directive 2009/142/EC (GAD) was repealed by Regulation (EU) 2016/426 on appliances burning gaseous fuels (European Parliament und Council, 2016). It regulates appliances burning gaseous fuels used for cooking, refrigeration, air-conditioning, space heating, hot water production, lighting or washing, and also forced draught burners and heating bodies to be equipped with such burners. The regulation applies to appliances as well as fittings and according to the Commission's guidance document, this includes dishwashing machines (European Commission, 2024a).

The regulation obliges manufacturers to ensure that appliances or fittings that they place on the market or appliances that they use for their own purposes are designed and manufactured in accordance with the essential requirements set out in Annex I. This includes, among other things, safety requirements including a risk analysis and corresponding risk minimisation measures as well as information obligations. In addition, there are requirements regarding technical documentation and processes for the declaration of conformity, as well as for the provision of information (e.g. the affixing of a type, batch or serial number or other identification mark, manufacturer's details, instructions for use and safety information).

3.4.1.15. Regulation (EU) 2024/1252 – Critical raw materials

The Critical Raw Materials Act (CRM Act) is a regulation aimed 'to improve the functioning of the internal market by establishing a framework to ensure the Union's access to a secure, resilient and sustainable supply of critical raw materials, including by fostering efficiency and circularity throughout the value chain' (European Parliament und Council, 2024).

To achieve this goal, the regulation sets out measures to:

- a) 'lower the risk of supply disruptions related to critical raw materials likely to distort competition and fragment the internal market,
- b) improve the Union's ability to monitor and mitigate the supply risk related to critical raw materials, and
- c) ensure the free movement of critical raw materials and products containing critical raw materials placed on the Union market while ensuring a high level of environmental protection and sustainability, including by improving their circularity.'

Commercial dishwashers are affected by the regulation as they may contain critical raw materials and in particular permanent magnets which are specifically addressed by the regulation. According to Article 28, a conspicuous, clearly legible and indelible label shall indicate whether the products contain one or more permanent magnets and whether the magnets contained belong to one of the following types: (i) neodymium-iron-boron; (ii) samarium-cobalt; (iii) aluminium-nickel-cobalt; (iv) ferrite. In case one or more such are included, additional information must be provided on a data carrier present on or in the product, providing data on

1903 the responsible legal party, data on the magnet weight, type and location and instructions for
1904 its dismantling.³⁹

1905 The requirements set out in Article 28 shall apply from two years after the entry into force of
1906 the implementing act referred to in paragraph 2. If a product passport is required for a product
1907 in accordance with another Union legal act, the relevant information should be recorded
1908 therein. The information needs to be complete, up-to-date, and accurate and remain available
1909 for a period at least equal to the product's typical lifetime plus 10 years.

1910 Article 29 contains provisions on the recycled content of permanent magnets. The requirements
1911 shall apply from 24 May 2027 or two years after the still pending entry into force of the
1912 delegated act referred to in paragraph 2, whichever is the later. Article 29 obliges operators who
1913 place on the market products containing one or more permanent magnets in accordance with
1914 Article 28 (1) to publish on a on a free-access website the content of neodymium, dysprosium,
1915 praseodymium, terbium, boron, samarium, nickel and cobalt recovered from post-consumer
1916 waste that is present in the incorporated permanent magnets. The information obligation
1917 applies from a total weight of all permanent magnets contained of 0.2 kg. By 24 May 2026, the
1918 Commission shall adopt rules for the calculation and verification of the share of corresponding
1919 raw materials. Furthermore, the Commission shall adopt rules as to minimum shares of the raw
1920 materials neodymium, dysprosium, praseodymium, terbium, boron, samarium, nickel, and
1921 cobalt recovered from post-consumer waste that must be present in the permanent magnet
1922 incorporated in relevant products referred.

1923 According to Article 33, the requirements of Articles 28 and 29 must be taken into account in
1924 the conformity assessment procedure and the associated required technical documentation.

1925 According to Article 24, by 24 May 2025, Member States are to identify large companies
1926 operating on their territory that use strategic raw materials to manufacture various products,
1927 including heat pumps. The companies identified in this way are obliged to carry out a specific
1928 risk assessment of their raw material supply chain for strategic raw materials at least every three
1929 years. Depending on the result, companies may be obliged to take mitigation measures. They
1930 can also be obliged by the Member States to submit a report to their board of directors. As heat
1931 pumps are contained in certain commercial dishwashing appliances, this requirement could
1932 apply in some cases.

1933 3.4.2. European ecolabelling

1934 There is no **EU Ecolabel** for household or commercial dishwashers themselves, but for industrial
1935 and institutional dishwasher detergents (European Commission, n.d.). The label's criteria for this
1936 product group relate to dosage requirements, toxicity to aquatic life, biodegradability and the
1937 sustainable sourcing of palm oil components. Furthermore, they include restricted or banned

³⁹ If the incorporated permanent magnets are exclusively contained in one or more electric motors incorporated in the product, the information referred to may be replaced by information on the location of those electric motors.

1938 substances, packaging requirements and requirements for the fitness for use, automatic dosing
1939 systems, user information and information appearing on the EU label (EU Ecolabel, 2024).

1940 Best Environmental Management Practices for Tourism addressing dishwashing, part of the
1941 European EMAS Program

1942 Since 2016, under the European Commission EMAS programme, ‘Optimised dishwashing,
1943 cleaning and food preparation’ is addressed by Best Environmental Management Practices for
1944 Tourism (BEMP) (European Union, 2016). This requires EMAS-registered organisations in the
1945 tourism sector to take the relevant sectoral reference documents into account.

1946 BEMPs addressing ‘Optimised dishwashing, cleaning and food preparation’ are ‘to select
1947 efficient washing equipment, including trigger-operated low-flow pre-rinse spray valves,
1948 efficient dishwashers and connectionless steamers, and to monitor and benchmark water
1949 consumption in kitchen/restaurant’ (European Union, 2016).

1950 Furthermore, the BEMP details several performance indicators and their considered
1951 benchmark of excellence, which are shown in **Table 3-7**.

1952

Table 3-7: Specific criteria for optimised dishwashing, cleaning, and food preparation in tourism facilities.

Environmental performance indicators	Benchmark of excellence
Kitchen water consumption per dining guest (l/dining guest)	Implementation of a kitchen water management plan that includes monitoring and reporting of total kitchen water consumption normalised per dining guest, and the identification of priority measures to reduce water consumption.
Percentage of ecolabelled dishwashing and kitchen cleaning chemicals (%)	
Green procurement of efficient kitchen equipment (y/n)	At least 70 % of the purchase volume of chemical cleaning products (excluding oven cleaners) for dishwashing and cleaning are ecolabelled (e.g. EU Ecolabel)

Source: Reproduced out of European Union (2016).

Though these requirements are relevant for kitchens using commercial dishwashing appliances, it is understood to refer to the total consumption of the facility and not to consumptions at machine level.

3.4.3. Legislation at Member State level

This section deals with the subjects as above, but for legislation that has been indicated as being relevant at the Member State level.

3.4.3.1. French Code de la Consommation (Consumption Law), Art. L111-4 on information about the availability of spare parts

In France, manufacturers or importers are obliged by Article L111-4 of the 'Code de la Consommation'⁴⁰ to provide information on the availability of spare parts to the seller. The seller in turn must inform the consumer of the availability of spare parts when the goods are purchased (Ministère de l'Économie, des Finances et de l'Industrie et Ministère chargé du Budget et des Comptes publics, 2021). These information obligations concern contracts other than distance and off-premises contracts and do not therefore have to appear on the websites of professional sellers. Nevertheless, where the supply of spare parts accompanies the marketing of a good, it is considered in the interests of professionals to ensure that this information is communicated to consumers, including on the websites of manufacturers and professional sellers. The corresponding articles were later modified by further laws, which reduce the time limit for the supply of spare parts by the manufacturer or importer from two months to fifteen days, and introduce a period of availability that may not be less than five years from the time the spare parts for a certain category of electronic and electrical equipment are placed on the market. (Ministère de l'Économie, des Finances et de l'Industrie et Ministère chargé du Budget et des Comptes publics, 2021). As the law is located in a chapter of the Environmental Code that relates to consumer information, it is assumed that the regulations are not relevant for commercial dishwashers.

⁴⁰ https://www.legifrance.gouv.fr/codes/article_lc/LEGIARTI000032227346/

3.4.3.2. French Code de la Consommation (Consumption Law), Art. L. 213-4-1 on planned obsolescence

In France, planned obsolescence is prohibited under Article L441-2 of the 'Code de la Consommation'⁴¹. Planned obsolescence is defined there as the use of techniques – including software – by which the person responsible for placing a product on the market deliberately seeks to shorten its lifespan. Articles L441-3 and L441-4⁴² lay down prohibitions on the use of techniques that prevent the repair of devices or that restrict the access of specialised personnel (for repair, reuse or repurpose) to spare parts, instructions, technical information, or other tools necessary for the repair of products. The Article does not specify if it is also applicable to appliances not intended for the use in households.

Article 16⁴³ of the 'LOI n° 2020-105 du 10 février 2020 relative à la lutte contre le gaspillage et à l'économie circulaire' imposes an obligation on manufacturers, importers, distributors, or other marketers of electrical equipment to provide a reparability index, including the parameters that made it possible to create this index. Sellers are obliged to use this index to inform customers about the reparability of products. This regulation already applies to dishwashers (Ministère de l'économie des finances et de la souveraineté industrielle et numérique, 2024). From 1 January 2024, a more general durability index should be used for certain products. It will replace the reparability index for these products and also evaluate other indicators such as the reliability and robustness of the products⁴⁴. So far, however, the durability index has only been applied to washing machines and televisions and not yet to dishwashers (Ministère de la Transition écologique et de la Cohésion des territoires, 2024). As the aim of the indexes is to inform consumers, the regulation is considered relevant only for appliances intended for household use.

3.4.4. Labelling at Member State level

3.4.4.1. Blue Angel (Germany)

The Blue Angel also has no award criteria dishwashers per se, but for the product group 'automatic dishwashing detergents' (RAL gGmbH, 2022). However, the scheme is only applicable to detergents for household dishwashers and detergents for commercial use, provided that they are comparable to household dishwashers in terms of machine size and use. The label is therefore not considered relevant for the product group of commercial dishwashers.

⁴¹ https://www.legifrance.gouv.fr/codes/article_lc/LEGIARTI000044330817/2021-11-17/

⁴² https://www.legifrance.gouv.fr/codes/article_lc/LEGIARTI000044330859/2021-11-17/

⁴³ https://www.legifrance.gouv.fr/jorf/article_jo/JORFARTI000041553781

⁴⁴ https://www.legifrance.gouv.fr/jorf/article_jo/JORFARTI000041553781

2011 3.4.4.2. Nordic Swan (Scandinavia)

2012 The Nordic Swan label does not have schemes related to dishwashers themselves, however,
 2013 there is a scheme for dishwasher detergents for commercial use. Complete dishwasher
 2014 detergents, multi-component systems, rinse aids and soaking agents for commercial use in
 2015 institutional and large-scale kitchens can be labelled and criteria include among others⁴⁵ (Nordic
 2016 Swan, n.d.):

- 2017 - 'Environmental properties (ecotoxicity and biodegradability) of the chemicals used
 2018 in the products.
- 2019 - Health properties of the chemicals used in the products. For example, no use of
 2020 perfumes, CMR-classified substances, or other particularly problematic substances
 2021 such as endocrine disruptors and suspected endocrine disruptors on lists from the
 2022 EU and national authorities.
- 2023 - Efficiency tests.
- 2024 - Recyclable design of the packaging (and reuse of larger packaging) which
 2025 contributes to a circular economy.'

2026 3.4.4.3. Sustainable Energy Authority (Ireland)

2027 The Sustainable Energy Authority of Ireland (SEAI) has established incentives to encourage
 2028 businesses to invest in energy saving technologies⁴⁶. In the form of an accelerated capital
 2029 allowance (ACA), businesses purchasing certain commercial dish washing devices are eligible for
 2030 a tax benefit, aside from the related energy savings associated with such equipment. The ACA
 2031 scheme allows purchasing companies that pay corporation tax or income tax on trading or
 2032 professional income in Ireland to deduct the full cost of the equipment from their profits in the
 2033 year of purchase (as opposed to the standard deductions spread over a longer period). On this
 2034 basis, the SEAI has published documents with criteria for 'Commercial Dishwashers'⁴⁷.

2035 Commercial dishwashers are defined as 'equipment constructed in stainless steel for use in
 2036 commercial kitchens and to clean and sanitise dishes, plates, utensils, glasses, trays, cups, and
 2037 bowls'. To be eligible for the tax benefit, the following conditions must be met (seai, n.d.):

- 2038 - All equipment and/or components must be CE marked as required by the specific
 2039 EU directive(s) and comply with requirements of RoHS and WEEE Directives.
- 2040 - Appliances must have a certain maximum water consumption and a maximum idle
 2041 energy rate as specified in **Table 3-8**.

⁴⁵ For the full list of criteria see Nordic Ecolabelling (2024)

⁴⁶ For further details, see: (seai, n.d.).

⁴⁷ See: (seai, n.d.).

- 2042 - Appliances must incorporate a heat-recovery system to preheat rinse water to a
 2043 minimum temperature of 40° C (concern only Single and Multiple Tank Rack
 2044 Conveyor Dishwashers).

2045 **Table 3-8: Maximum water consumption and maximum idle energy rates.**

Dishwasher Type	Water Consumption (litres pre rack)	Idle Energy Rate (kW per hour) ⁴⁸
Under-counter	≥3.0	≥0.9
Stationary Single Tank Door	≥3.0	≥1.0
Single & Multiple Tank Rack Conveyor	≥2.9	≥2.6

2046 Source: seai (n.d.).

2047 3.4.4.4. European consumer association tests and consumer information 2048 portals

2049 There are organisations in various countries that publish test reports for household appliances
 2050 (e.g., Stiftung Warentest in Germany, Que choisir in France, Altroconsumo in Italy or OCU in
 2051 Spain). It is assumed that these are only aimed at private users and are therefore not relevant
 2052 in the context of this study.

2053 3.4.5. Third country legislation and labelling

2054 Again, this section deals with the subjects as above, but for legislation and measures in Third
 2055 Countries (extra-EU) that have been indicated by stakeholders (NGOs, industry, consumers) as
 2056 being relevant for the product group.

2057 3.4.5.1. Minimum Energy Performance Standards (Australia)

2058 Concerning energy efficiency, a wide range of products are already regulated in Australia. New
 2059 products are regularly being considered for regulation or other programmes as well. However,
 2060 until now there were no Minimum Energy Performance Standards for commercial dishwashers.
 2061 Labelling requirements exist, but only apply to household appliances (Australian Government,
 2062 2024). New Greenhouse and Energy Minimum Standards for dishwashers were registered in
 2063 October 2024 (Australian Government, 2024), but it is not clear if they apply to commercial
 2064 appliances.

⁴⁸ Taken exactly as written in the original source.

3.4.5.2. Declaration of the energy and water consumption as well as the cleaning performance in accordance with the Federal Energy Efficiency Ordinance (Switzerland)

In Switzerland, declaration requirements were introduced for commercial dishwashers, which came into force in 2024 (Swiss Federal Office of Energy, 2023). From then on, energy and water consumption as well as the cleaning performance must be declared in the technical documentation as well as on a freely accessible website in accordance with the European standard EN IEC 63136:2019. Switzerland is thus taking on a pioneering role, as there are no such requirements in the EU to date. However, an energy label for commercial dishwashers does not exist (Swiss Federal Office of Energy, 2023).

The declaration requirements are intended to enable the sector to better estimate operating costs and choose particularly efficient appliances. As these normally have a higher purchase price, this is particularly important in order to make overall costs more transparent. The requirements apply to new electrical appliances for commercial use. Existing appliances are exempt from the requirements. Appliances purchased abroad and directly imported must fulfil the requirements (energieschweiz, 2023).

The following types of appliances are affected by the obligation (energieschweiz, 2023):

- Single-tank undercounter dishwashers
- Single-tank pass-through dishwashers closed by a hood

Not affected types of appliances are (energieschweiz, 2023):

- Water-changing undercounter dishwashers
- Rack conveyor and flight type dishwashers
- Utensil dishwashers

The following product information needs to be declared (energieschweiz, 2023):

- The indication whether the appliance has an integrated heat recovery or not
- An explanation of how the integrated heat recovery works, if there is one
- The test results in accordance with the European standard EN IEC 63136:2019 concerning electric dishwashers for commercial use. These include
 - o Energy consumption for initial filling x.xxx kWh (kilowatt hours)
 - o Water consumption for initial filling x.x L (litres)
 - o Initial filling time x s (seconds)
 - o Number of plates per rack and cycle x (number)
 - o Cleaning performance with the standard cleaning cycle x % (per cent)
 - o Resoiling performance in particles per plate x particles/plate (particles per plate)

2100	○ Energy consumption per cycle	x.xxx	kWh (kilowatt hours)
2101	○ Water consumption per cycle	x.x	L (litres)
2102	○ Average programme and cycle duration	x	s (seconds)
2103	○ Electricity consumption of standby mode	x	kW (kilowatts)

2104 3.4.5.3. Energy Technology List (UK)

2105 The UK Energy Technology List (ETL) is a government-backed scheme designed to encourage the
 2106 use of highly energy-efficient commercial dishwashers, including undercounter and hood-type
 2107 models. Administered by the Department for Energy Security and Net Zero, the ETL provides a
 2108 list of independently verified products that meet strict energy and water efficiency criteria,
 2109 positioning them within the top 25% of the market in their respective categories. To be included,
 2110 dishwashers must demonstrate low energy and water consumption per cycle (e.g. ≤0.4 kWh and
 2111 ≤3.4 litres for undercounter models; ≤0.6 kWh and ≤3 litres for hood-type models), limited
 2112 standby power use and high cleaning performance (≥90%). Hygiene and sanitation standards
 2113 must also be met.⁴⁹

2114 The voluntary scheme encourages transparency by publishing detailed performance data for
 2115 each listed product, enabling buyers to easily compare models. Products are tested to
 2116 recognised standards (such as EN IEC 63136 and EN 17735), and the listing process is free
 2117 for manufacturers, though third-party verification may be required. The ETL is updated monthly
 2118 and is referenced increasingly in public procurement, with Parliament considering making ETL
 2119 listing mandatory for public sector purchases. The scheme supports the net zero goals of the
 2120 United Kingdom by incentivising the uptake of energy-saving technologies in professional
 2121 kitchens. This provides buyers with confidence and drives market innovation towards greater
 2122 sustainability.

2123 3.4.5.4. Appliance and Equipment Standards Program (USA)

2124 The Building Technologies Office (BTO) implements minimum energy conservation standards for
 2125 more than 60 categories of appliances and equipment. There are standards for household
 2126 dishwashers and for commercial clothes washers but not for commercial dishwashers (US DOE,
 2127 2022). It is therefore understood that this standard is not relevant for the product group in the
 2128 focus of this study.

2129 3.4.5.5. Energy Star Label (USA)

2130 ENERGY STAR® is a US government-backed symbol for energy efficiency. The label provides
 2131 information to help consumers and businesses make well-informed decisions.

⁴⁹ See <https://etl.energysecurity.gov.uk/products/professional-foodservice-equipment/undercounter-dishwashers> as well as <https://etl.energysecurity.gov.uk/products/professional-foodservice-equipment/hood-type-dishwashers>.

The US EPA Energy Star Program has a product specification for commercial dishwashers which is currently in its 3th version (US EPA/DOE, 2021). Certification to this label requires the manufacturer of a dish washing appliance to comply with the eligibility criteria, which define the minimum performance requirements and test procedures for verifying a minimum level.

A dishwashing machine is defined as a 'machine designed to clean and sanitise plates, pots, pans, glasses, cups, bowls, utensils, and trays by applying sprays of detergent solution (with or without blasting media granules) and a sanitizing rinse' (US EPA/DOE, 2021). The following machine types are differentiated and specified in the document:

- Stationary Rack Machine
 - o Under Counter
 - o Glasswashing
- Single Tank, Door Type
 - o Pot, Pan, and Utensil (PPU)
 - o Dump and Fill
- Conveyor Machine
 - o Single Tank Conveyor
 - o Multiple Tank Conveyor
 - o Flight Type Conveyor
- Heat Recovery Machine

These machine types are eligible for ENERGY STAR with the following exceptions: Only undercounter machines designed for wash cycles of 10 minutes or less are eligible. The Version 3.0 specification only covers electric models. High temperature PPU machines and non-PPU, dual sanitizing are eligible as well. Dishwashers intended for use in residential or laboratory application are not eligible under this product specification as well as 'PPU and Flight Type products which are only rated for low temperature operation, steam, gas, and other non-electric models'.

The energy and water performance requirements are listed in **Table 3-9**.

Table 3-9: Energy and Water Efficiency Requirements.

a) ENERGY STAR Requirements for Commercial Dishwashers			
Machine Type	Low Temperature Efficiency Requirements		
	Idle Energy Rate*	Washing Energy	Water Consumption**
Under Counter	≤ 0.25 kW	≤ 0.15 kWh/rack	≤ 1.19 GPR
Stationary Single Tank Door	≤ 0.30 kW	≤ 0.15 kWh/rack	≤ 1.18 GPR
Single Tank Conveyor	≤ 0.85 kW	≤ 0.16 kWh/rack	≤ 0.79 GPR
Multiple Tank Conveyor	≤ 1.00 kW	≤ 0.22 kWh/rack	≤ 0.54 GPR
b) ENERGY STAR Requirements for Commercial Dishwashers			
	High Temperature Efficiency Requirements		
	Idle Energy Rate*	Washing Energy	Water Consumption**
Under Counter	≤ 0.30 kW	≤ 0.35 kWh/rack	≤ 0.86 GPR
Stationary Single Tank Door	≤ 0.55 kW	≤ 0.35 kWh/rack	≤ 0.89 GPR
Pot, Pan, and Utensil (PPU)	≤ 0.90 kW	≤ 0.55 + 0.05 × SF _{rack} †	≤ 0.58 GPSF
Single Tank Conveyor	≤ 1.20 kW	≤ 0.36 kWh/rack	≤ 0.70 GPR
Multiple Tank Conveyor	≤ 1.85 kW	≤ 0.36 kWh/rack	≤ 0.54 GPR
Single Tank Flight Type	Reported	Reported	GPH ≤ 2.975x + 55.00
Multiple Tank Flight Type	Reported	Reported	GPH ≤ 4.96x + 17.00

*Idle results should be measured with the door closed and represent the total idle energy consumed by the machine including all tank heater(s) and controls. The most energy consumptive configuration in the product family shall be selected to test the idle energy rate. Booster heater (internal or external) energy consumption shall be measured and reported separately, if possible, per ASTM F1696-20 and ASTM F1920-20 Sections 10.8 and 10.9, respectively.

**GPR = gallons per rack; GPSF = gallons per square foot of rack; GPH = gallons per hour; x = maximum conveyor speed (feet/min as verified through NSF 3 certification) × conveyor belt width (feet). However, if booster energy cannot be measured separately it will be included in the idle energy rate measurements.

† PPU Washing Energy is still in format kWh/rack when evaluated; SF_{rack} is Square Feet of rack area, same as in PPU water consumption metric.

Source: US EPA/DOE (2021).

4. MEErP Task 2 – Markets

4.1. Objectives of MEErP Task 2

The aim of MEErP Task 2 is to provide market and cost inputs for the calculation of the EU-wide environmental impact of the commercial dishwashers product group, to provide insight in the latest market trends, to establish a practical data set of prices and rates to be used in a Life Cycle Cost (LCC) calculation and to make recommendations on a potentially refined product scope in MEErP Task 1, as well as composing indications for the development on Base Cases in MEErP Task 5, e.g. by assessing the most relevant product categories from the economic / commercial perspective.

MEErP Task 2 shall include a description of the market trends including amongst others channels to market, general trends in product design and product features, major players and the market share, business models, geographical distribution of production, distribution channels (retail versus wholesale), the number of employees, role of installation services, role of repair and maintenance (service models), share of SMEs in production and indication of the segments of the markets that SMEs are operating in, supplemented by information on market and logistical support of recyclability and availability of amounts of recycled materials related to the market size.

To facilitate the potential Impact Assessment support study, data also needs to be collected on public markets (relevant for GPP), international markets, competition issues and competitiveness of relevant EU sectors.

4.2. Generic economic data

The PRODCOM database is useful for an initial analysis as it is transparent and publicly available data provided by Member States of the EU on manufacturing and production information within the EU.

4.2.1. EU Production

4.2.1.1. Unit volume

In 2023, 380,000 commercial dishwashers were produced according to Prodcom data. **Table 4-1** presents the number of units produced from 2014 to 2023, highlighting the locations of major manufacturing centres. However, it is important to note that data for several Member States is missing; therefore, the total should be interpreted with caution. The data is also visualised in **Figure 4-1**, which clearly illustrates that the primary producers within the EU-27 are Italy and Germany. This figure has been relatively stable over the past 10 years, with some larger fluctuations in the number of units produced in Italy. Together they account for 93 % of the total

EU-27 members. Other notable countries producing more than 1,000 units per year include Sweden and Spain, although their numbers are significantly lower than those of Italy and Germany. These four Member States together account for 99.6 % of all units produced within the EU-27.

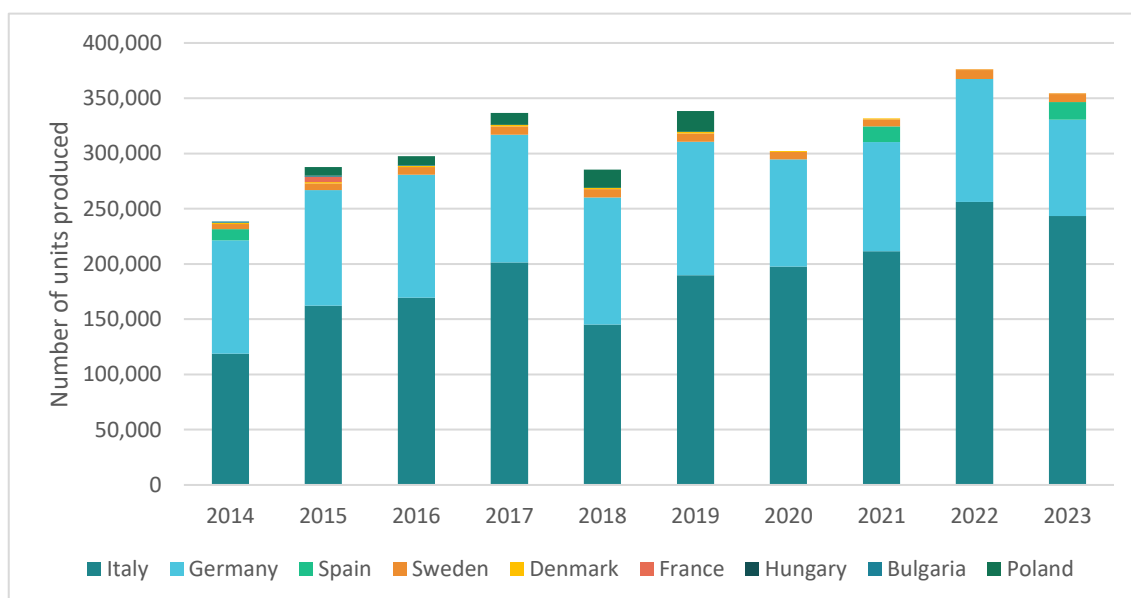


Figure 4-1: Number of units produced from 2014-2023 per country.

Source: Prodcom.

Another country that produced a notable number of commercial dishwashers from 2015 to 2019 was Poland. However, it remains unclear whether Poland has completely ceased production of dishwashers after 2019 or simply stopped reporting data. In the next chapter, it is shown how this creates a discrepancy when analysing the estimated sales in Poland, suggesting that Poland likely stopped reporting data on their commercial dishwasher production.

An additional indication of missing data is the share of unaccounted units, which compares the EU-27 total directly retrieved from Prodcom with the sum of values from individual countries. In 2020, the first year for which data on Poland was no longer available, the share of unaccounted units increased. In both 2020 and 2022, when no data was available for both Spain and Poland, the share was the highest compared to other years. While these two countries likely do not account for the entire unaccounted share, they could explain a significant portion of it in the years where no data is available for either or both of the countries.

2224 **Table 4-1: Production in thousands of units per country from 2014 to 2023.**

Country	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Bulgaria	1.1	0.7	0.6	:	:	:	:	:	:	:
Denmark	1.2	1.1	1.0	1.2	1.3	1.4	0.9	0.6	0.6	0.5
France	:	4.9	:	:	:	:	:	:	0.2	0.2
Germany	102.6	104.8	111.2	115.5	115.2	120.8	97.1	98.7	111.3	87.3
Hungary	0.0	0.3	0.2	0.2		0.0	0.0	0.0	0.0	0.0
Italy	118.8	162.2	169.6	201.5	145.1	189.9	197.7	211.6	256.1	243.3
Poland	:	7.9	7.9	10.7	16.3	18.9	:	:	:	:
Spain	10.2	:	:	:	:	:	:	14.3	:	16.0
Sweden	4.7	5.8	6.9	7.5	7.4	7.5	6.5	6.4	8.1	7.1
EU-27 Total	248.4	284.0	315.9	359.1	312.3	363.5	335.3	360.0	425.0	380.0
Share unaccounted units	4.0 %	-1.3 %	5.8 %	6.2 %	8.7 %	6.9 %	9.9 %	7.9 %	11.5 %	6.7%

2225 ‘:’ signifies that the information is unavailable either because it is confidential or estimated or both. All other EU 27 Member States have reported a zero-production quantity over the whole
 2226 period. Countries for which all recorded years report either 0 or ‘:’ values have been excluded.

2227 Source: Prodcum custom database extracted 16 October 2024 https://ec.europa.eu/eurostat/databrowser/view/ds-056120__custom_13323487/default/table?lang=en

4.2.1.2. Sales value

Figure 4-2 shows the value of commercial dishwashers produced according to Prodcum. The sales value of commercial dishwashers produced in the EU amounted to about 940 million Euro in 2023. This is approximately 2.5 times higher than the sales value of commercial washing machines and approximately 4.5 times the sales value of commercial dryers.

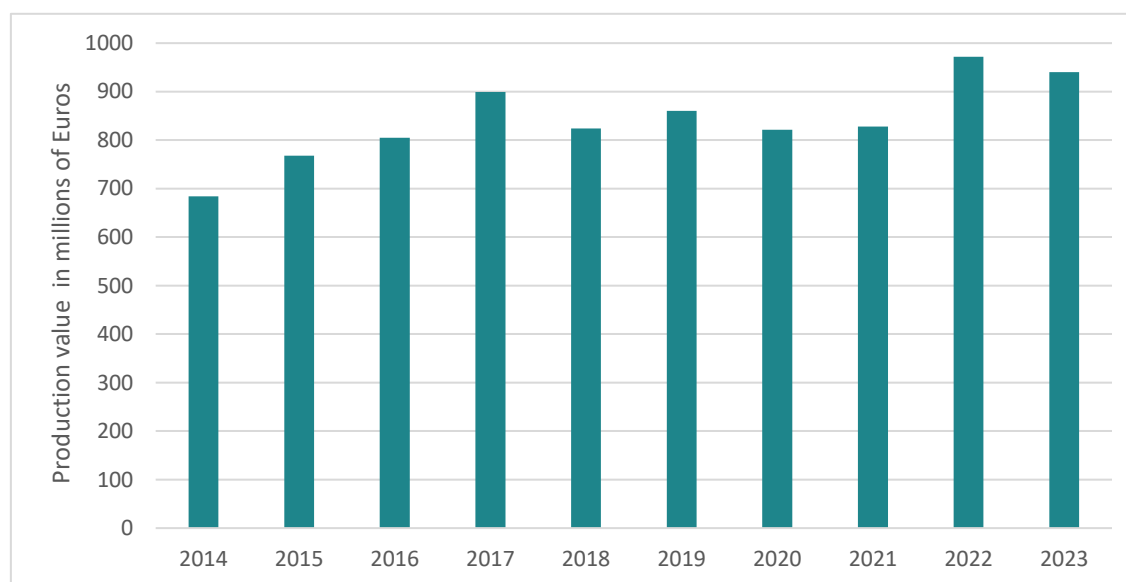


Figure 4-2: Value of EU-produced commercial dishwashers in EU-27, 2014-2023.

Source: Prodcum.

The sales data by Member State show a key distinction between the volume of units produced and the value of the sales. **Table 4-2** shows Germany as having the highest sales in the EU, surpassing Italy, which was shown in **Table 4-1** to produce almost 3 times as many machines. This difference can be explained by the difference in the value or type of the machines.

Germany and Italy have the largest market value, followed by Spain and Sweden. Together the four countries account for 99.1 % of the total market value.

Table 4-2: Value of commercial dishwashing machines produced in EU-27 by country (in millions of Euros).

Country	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Bulgaria	2.5	1.8	2.5	:	:	:	:	:	:	:
Denmark	10.3	11.0	9.6	11.8	13.4	17.3	13.0	6.2	6.6	6.7
France	:	19.6	:	:	:	:	:	:	1.1	1.0
Germany	415.5	436.9	463.4	491.4	500.4	516.4	416.8	416.4	502.1	447.7
Hungary	0	0.2	0.2	0.2	:	0	0	0	0	0
Italy	180.0	226.7	237.5	293.4	199.4	209.0	295.6	324.2	347.0	384.8

Country	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Poland	:	5.0	6.1	8.9	13.2	16.2	:	:	:	:
Slovenia	0	0	0	0	0	:	2.3	:	:	:
Spain	12.7	:	:	:	:	:	:	18.3	:	26.4
Sweden	36.0	41.4	45.5	49.0	47.3	47.4	44.6	42.7	50.7	48.5
EU27 Total	683.9	768.2	805.2	899.5	823.9	860.3	821.5	828.0	972.0	940.0
Share unaccounted units	3.9 %	3.3 %	5.0 %	5.0 %	6.1 %	6.3 %	6.0 %	2.4 %	6.6 %	2.7 %

‘:’ signifies that the information is unavailable either because it is confidential or estimated or both. All other EU 27 Member States have reported a zero production quantity over the whole period. Countries for which all recorded years report either 0 or ‘:’ values have been excluded.

Source: Prodcom custom database extracted 16 October 2024 https://ec.europa.eu/eurostat/databrowser/view/ds-056120_custom_13323487/default/table?lang=en

4.2.1.3. Share of market represented by public sector customers

No publicly available data provides information on the share of sales made to public-sector customers.

The feedback obtained from stakeholders on the topic during the consultation held between September and October 2024 led to very scarce feedback:

One large manufacturer stated that it sold ca. 5 % of its turnover to public sector customers. Two manufacturers in the same group provided very contrasting figures, which may indicate a sharing of the market among subsidiaries of that group:

- One manufacturer in the group sold ca. 25 % of its turnover to public sector customers.

- The other answering manufacturer of the same group did not sell to institutional customers.

One difficulty stated by one manufacturer is that the resellers of products do not provide feedback to the manufacturers on their sales.

External data is also scarce, but an estimate was made based on data regarding the global commercial dishwasher market per end-user as shown in **Table 4-3**. Among the categories, educational institutions and hospitals/healthcare facilities could partly represent the public sector. Data on the share of private versus public sector in both of these end-users is not available for 2023, so proxies were used. For hospitals and healthcare facilities an estimate was used based on a 2008/2009 OECD study, which includes the share of publicly owned hospitals per country⁵⁰. In the absence of a total EU-27 figure, the average of the available EU-27 countries

⁵⁰ OECD (2010). Health Systems Institutional Characteristics: A Survey of 29 OECD Countries

was used, which was 72 %⁵¹. For educational institutions, the share of primary to tertiary educational participation of students in public institutions in 2022 was used as information on the number of public schools was unavailable. The share of students in public school was approximately 80 %. As a result, the total estimate of the share of the public sector would be approximately 23.6 %, which is close to the number indicated by one of the stakeholders.

It is also important to note that the public sector could also include other institutions other than educational institutions and hospitals, which could result in a higher share of commercial dishwashers in the public sector. The results may also differ per Member State.

Table 4-3: Global commercial dishwashers market by end-user 2023 in USD million and the estimated share of the public sector.

End-user	2023 (USD Million)	Share of public sector (USD Million)
Restaurants/Pubs	1,179	
Hospitals and Healthcare Facilities	674	488
Educational Institutions	440	352
Commercial Kitchens and Catering	307	
Bars and Cafes	265	
Corporate Cafeterias	220	
Bakeries/Pastry Shops	154	
Others	320	
Total	3,558	840

Source: Global Market Insights (left column); own estimations (right column)

4.2.1.4. Unit value

Commercial dishwashers have a unit value that varies significantly depending on the Member State. **Table 4-4** illustrates the range of unit values for commercial dishwashers for the Member States where data is available. The EU average unit value is € 2,474. Notable differences exist between the main producing Member States, which could be attributed to the types of dishwashing machines predominantly manufactured in each country.

⁵¹ Eurostat (2022). Pupils and students enrolled by education level, sex, type of institution and intensity of participation.

2288 **Table 4-4: Unit value of commercial dishwashing machines by country.**

Country	Unit value (in Euros)
Germany	5,127
Italy	1,582
Spain	1,647
Sweden	6,841
EU-27 Total	2,474

2289 Source: Prodcom.

2290 **4.2.2. Extra-EU Trade**

2291 **Table 4-5** presents the import and export values of trade with countries outside the EU-27.
 2292 **Figure 4-3** clearly illustrates the trade balance, highlighting that the EU-27 exports significantly
 2293 more than it imports. Several countries were identified by more than one stakeholder as key
 2294 destinations for EU-27 dishwasher exports outside the EU-27. These include Australia, Israel,
 2295 Norway, Switzerland, the UK, and the USA.

2296 **Table 4-5: International trade in millions of Euros.**

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Import	26.9	25.0	26.6	29.3	33.9	35.9	31.0	31.8	36.2	34.6
Export	239.4	251.1	257.9	249.1	265.1	270.6	205.1	224.3	313.6	286.4
Trade balance	212.5	226.0	231.3	219.8	231.2	234.7	174.1	192.4	277.4	251.7

2297 Source: Comext.

2298 **Figure 4-3** show a clear dip during the COVID-19 pandemic. A recovery surge could explain why
 2299 the values for 2022 are exceptionally high, even exceeding those of 2023. However, it remains
 2300 to be seen in future years whether this decline from 2022 to 2023 will continue or stabilise.



Figure 4-3: Import, export, and trade balance of EU-27 and countries outside of EU-27.

Source: Comext.

4.2.3. EU apparent consumption = production + import - export

Table 4-6 provides an overview of EU-27 apparent consumption per country, calculated as production minus imports plus exports. For each country where production was ‘:’, it has been assumed it is zero. This method is used because exact data is not available. However, it has led to some issues, as certain values show negative results. Poland, for example, exhibits a significant negative value. As mentioned earlier, it seems highly likely that Poland stopped reporting production data. For 2023, Poland's production data is recorded as 0, which could explain the large negative value.

Table 4-6: EU apparent consumption in value and quantity per country in 2023.

	Value (in M€)	Quantity (in units)
Austria	21.2	6,538
Belgium	10.0	20,289
Bulgaria	1.3	2,998
Croatia	5.7	2,984
Cyprus	0.9	2,385
Czechia	9.5	-20,409
Denmark	10.7	-3,699
Estonia	1.3	-234
Finland	11.1	3,566
France	111.4	54,397

	Value (in M€)	Quantity (in units)
Germany	196.6	52,517
Greece	1.9	8,798
Hungary	4.4	6,255
Ireland	4.2	246
Italy	136.2	45,555
Latvia	1.1	601
Lithuania	0.1	-64
Luxembourg	3.9	1,136
Malta	0.7	1,162
Netherlands	35.9	9,755
Poland	-21.9	-23,100
Portugal	2.0	6,626
Romania	3.9	3,360
Slovakia	-3.8	-7,826
Slovenia	-1.7	-179
Spain	35.6	39,544
Sweden	30.3	6,939
EU27 Total	688.3	275,016

2313 Source: Prodcom

2314 4.3. Market and stock data

2315 4.3.1. Average Product Life (in years), in service, and a rough 2316 indication of the spread (e.g. standard deviation)

2317 Informed by the 2024 stakeholder consultation, the average estimated product lifespan is
2318 approximately 12 years, with a range extending from 7 to 17 years. However, it is important to
2319 note that differences exist between product types. Stakeholders were asked to estimate the
2320 average expected initial lifetime (in years) for each dishwasher category (without considering
2321 the extension of lifetime through refurbishment). The median of the results is shown in **Table**
2322 **4-7**.

2323

Table 4-7: Estimated lifespan of commercial dishwasher categories.

Category	Product type	Estimated lifespan in years (2024)
Category 1	Undercounter water-change	12
Category 2	Undercounter one-tank	8
Category 3	Hood-type	8
Category 4	Utensil/Pot	9
Category 5	Conveyor-type one-tank	11
Category 6	Conveyor-type multi-tank	15

Source: according to stakeholder consultation from 2008 study and 2024 stakeholder consultation.

4.3.2. Installed base

The number of commercial dishwashers currently in the field should be determined by the accumulation of units entering and leaving the stock each year. This figure is unknown, as the number of units exported and imported at the EU-27 level is not provided, neither by Prodcum (which reports trade figures per Member State, including intra-EU trade, which is not relevant for this study) nor by Comext (which provides data in value, but not in units). For this reason, we will use EU apparent consumption data (= production + import - export). This gives the total amount of goods available in the EU market, which includes both domestically produced and imported goods, minus the goods exported out of the EU.

As shown in **Table 4-8**, the category shares are based on 2023 EU-wide sales data provided by the industry association APPLIA Italia, but only for Italian manufacturers, as no data from other countries was available. Therefore, this data cannot be extrapolated to represent the entire EU market. Another limitation is that Italian manufacturers do not produce "undercounter water-change" models. To address this, the share for this category was estimated using the same proportions applied in the 2011 study, which was based on the NAFEM Size and Shape of the Industry Report 2010—assigning 3 % to undercounter water-change.

Table 4-8: Share of sales per category.

Category	Product type	Share of sales
1	Undercounter water-change	3 %
2	Undercounter one-tank	65 %
3	Hood-type	24 %
4	Utensil/Pot	5 %
5	Conveyor-type one-tank	2 %
6	Conveyor-type multi-tank	1 %

Source: APPLIA Italia (2023).

2344 In **Table 4-9**, an overview is given of the estimated number of units sold per year. The stock is
 2345 based on the share of sales and the lifespan of each category.

2346 **Table 4-9: Stock in 2023 based on share of sales and lifespan (in grey) of each category.**

Year	EU-27 Total (units)	1 (units)	2 (units)	3 (units)	4 (units)	5 (units)	6 (units)
2008	285,192	8,556	185,375	68,446	14,260	5,704	2,852
2009	198,162	5,945	128,805	47,559	9,908	3,963	1,982
2010	229,551	6,887	149,208	55,092	11,478	4,591	2,296
2011	221,021	6,631	143,664	53,045	11,051	4,420	2,210
2012	43,027	1,291	27,968	10,326	2,151	861	430
2013	111,600	3,348	72,540	26,784	5,580	2,232	1,116
2014	135,901	4,077	88,336	32,616	6,795	2,718	1,359
2015	183,849	5,515	119,502	44,124	9,192	3,677	1,838
2016	201,993	6,060	131,295	48,478	10,100	4,040	2,020
2017	266,542	7,996	173,252	63,970	13,327	5,331	2,665
2018	197,338	5,920	128,270	47,361	9,867	3,947	1,973
2019	242,883	7,286	157,874	58,292	12,144	4,858	2,429
2020	237,785	7,134	154,560	57,068	11,889	4,756	2,378
2021	278,957	8,369	181,322	66,950	13,948	5,579	2,790
2022	296,963	8,909	193,026	71,271	14,848	5,939	2,970
2023	275,016	8,250	178,760	66,004	13,751	5,500	2,750
Stock 2023	2,040,759	74,156	1,298,360	479,394	109,066	48,577	31,206

2347 Source: Prodcorn.

2348 4.3.3. Annual sales growth rate

2349 Again, looking the measurement used in the EU sales and trade paragraph, since no sales value
 2350 is available, the growth rate from 2022 to 2023 is -0.9 %, while the average annual growth rate
 2351 from 2014 to 2023 is 3.9 %.

2352 4.3.4. New & Replacement sales (derived)

2353 To determine the replacement and new sales, the number of units in year 1 (calculated as 2023
 2354 – lifespan) is compared with the number of units at the end of their lifespan (2023). The lifespan
 2355 varies by category, as shown in **Table 4-9**. For each category, we compare the sales in 2023 with
 2356 the sales in year 1 (highlighted in grey) and sum the results across all categories. Consequently,
 2357 the **total number of replacement sales in 2023 is 194,471 units**, while the **total number of new**
 2358 **sales is 80,545 units**.

4.4. Market trends

4.4.1. General market trends

Manufacturer brochures and websites were analysed to identify important product-specific developments and trends in commercial dishwashers, in order to update the information already gathered in the 2011 study.

It should be noted that not all innovative features presented hereafter are easy to implement in all market segments. Indeed, some of these features induce higher upfront costs, that may be beyond the purchasing capacity of some customers, in particular those subject to intense price pressure, such as the catering and hospitality industry.

4.4.1.1. Processing capacity

The **Table 4-10** below provides the typical processing capacities of commercial dishwashers, per cycle and per year.

Table 4-10: Processing capacity of commercial dishwashers, per category.

Product category	Number of dishes per cycle	Number of cycles per year	Number of dishes per year
1: Undercounter water-change	18 – 50	1,000	18,000 – 50,000
2: Undercounter one-tank	18 – 20	18,000 – 74,500	324,000 – 1,490,000
3: Hood-type	18 – 20	25,500 – 44,700	459,000 – 894,000
4: Utensil/pot	N/A	9,000 – 12,000	N/A
5: One-tank conveyor-type	2,000 – 3,600 dishes / hour	2,700 hours	5,400,000 – 9,720,000
6: Multi-tank conveyor-type	4,000 – 4,900 dishes / hour	2,700 hours	10,800,000 – 13,230,000

Source: Stakeholder feedback received during the second consultation September – October 2024.

4.4.1.2. Energy and water consumption

The general evolution of the market goes in the direction of a reduction in energy and water consumption. The main argument is that of energy consumption, because of its high price.

The main technical features that lead to a reduction in **energy** consumption are listed in the **Table 4-11** below.

Table 4-11: Claimed energy savings per technical feature of the machine.

Technical feature	Claimed energy savings (%)
Heat recovery from wastewater	10
Heat recovery from condensation of process steam and from exhaust air	15
Heating using a heat pump instead of an electric resistor	35
Double-skinned construction	(not specified)

2379 Source: Website of Winterhalter GmbH, accessed on 13 November 2024.

2380 The main technical features that lead to a reduction in **water** consumption are listed in the **Table**
 2381 **4-12**.

2382 **Table 4-12: Claimed water savings per technical feature of the machine.**

Technical feature	Claimed water savings (%)
Water nozzle geometry	Up to 25
Eco programme	Up to 15

2383 Source: Website of Winterhalter GmbH, accessed on 13 November 2024.

2384 4.4.1.3. Detergents

2385 Some suppliers of commercial dishwashers (mainly those targeting that market segment only)
 2386 provide their own detergent products, whereas others rely on third-party suppliers.

2387 The detergent products supplied by manufacturers of dishwashers perform the following
 2388 functions:

- 2389 - Washing,
- 2390 - Rinsing and drying aids.

2391 The rinsing and drying aids have become mainstream. They provide proper drying and good
 2392 visual appearance of the substrates.

2393 The market of detergent products evolves towards:

- 2394 - Adaptation to the water 'hardness' (= concentration in calcium carbonate),
- 2395 - Higher concentration,
- 2396 - Recyclable plastic containers,
- 2397 - Biodegradability,

- 2398 - Avoidance of chlorine, of phosphates and of EDTA (Ethylenediaminetetraacetic
2399 acid, a chelator of calcium that is criticised for being poorly biodegradable, bio-
2400 accumulative⁵² and toxic in case of ingestion).

2401 4.4.1.4. Wastewater treatment

2402 The treatment of the wastewater after its use in the machine is in general an integral part of the
2403 dishwasher, as it is the feature that enables the re-use of the water over several cycles (and
2404 hence a strong overall reduction in water use). The manufacturers hence increasingly offer in
2405 addition the filters and other equipment needed to perform this function.

2406 4.4.1.5. Evolution of energy performance over time

2407 Some stakeholders provided figures on the ratio between the energy consumption of the
2408 average **new** product and the energy consumption of the **average product installed**, i.e. in stock.
2409 The average age of the units in stock is close to half the lifetime duration of the product (as
2410 identified in **Section 4.3.1**). This ratio is an indication on the progress made in energy
2411 consumption over that period of time.

2412 **Table 4-13** below displays the figures provided by stakeholders. When a figure was provided by
2413 a manufacturer, this figure is retained. When no manufacturer provided data, the figures
2414 received from a technical university are provided, with the caveat that they may be of low
2415 reliability, considering the contradiction between the figures provided by that university
2416 compared to those by manufacturers in the cases where both are available.

2417 **Table 4-13: Ratio between energy consumption of new products and that of the average**
2418 **products in stock.**

Category of dishwasher	Ratio: Energy consumption of new product / Energy consumption of product in stock	Typical age of product in stock (= lifetime / 2)
1. Undercounter water-change	0.9	6 – 7.5 years
2. Undercounter one-tank	1.0	2.5 – 5 years
3. Hood-type	1.0	2.5 – 5 years
4. Utensil/pot dishwashers	0.95	2.5 – 5 years
5. One-tank conveyor-type	0.7*	5 – 6 years
6. Multi-tank conveyor-type	0.7*	5 – 6 years

⁵² Margarete Bucheli-Witschel, Thomas Egli, Environmental fate and microbial degradation of aminopolycarboxylic acids, FEMS Microbiology Reviews, Volume 25, Issue 1, January 2001, Pages 69–106, <https://doi.org/10.1111/j.1574-6976.2001.tb00572.x>

2419 (*) Low reliability: figures provided by technical university.

2420 Source: Stakeholder consultation survey n°2, performed between September and October 2024.

2421 4.4.1.6. Marketing of commercial dishwashers and technological features

2422 In relation to influencing customer behaviours, important aspects of manufacturers'
2423 communications regarding commercial dishwashers are:

- 2424 - Functionality (speed, hygiene, cleanliness, and aspect of the washed crockery and
2425 utensils),
- 2426 - Economic and environmental aspects of the use phase (i.e. costs of energy and
2427 water consumption),
- 2428 - Uptime of the appliance (e.g. reliability, robustness, long lifetime, ease, and speed
2429 of maintenance operations)
- 2430 - Comfort / ergonomics for the personnel using the machine (e.g. motorised hood for
2431 Category 3 "Hood-type dishwashers").

2432 4.4.2. Market channels and production structure

2433 The commercial dishwasher market is above all a business-to-business (B2B) market and has
2434 some key characteristics.

2435 4.4.2.1. Sales and distribution

2436 The majority of smaller manufacturers typically sell and distribute their products to catering
2437 equipment dealers/distributors who stock and sell several brands of commercial dishwashers
2438 and usually other types of catering equipment supplies (ovens, refrigerators, plates, utensils,
2439 etc). This is particularly applicable for smaller machines such as the undercounter and hood-type
2440 machines. The catering equipment distribution and supplier network for small commercial
2441 dishwasher machines is very convoluted as several supply routes are available depending on the
2442 type of end user, the end application and the type of machine bought. Because of the
2443 competition and the saturation of the market, the choice of distribution strategies is very
2444 important which is why many different ones have been developed. Machines may be purchased
2445 directly from the manufacturers, via wholesalers, various kinds of retailers or on the second-
2446 hand market. For this reason, manufacturers of small appliances generally do not keep close
2447 track of where their products end up.

2448 Commercial dishwashers sold directly to users from the manufacturer tend to be larger
2449 dishwashers (conveyor-type) and are usually tuned to customer-specific specifications or
2450 requirements upon purchase. They indeed require more intensive support services (training,
2451 servicing).

2452 Catering equipment dealers often service and maintain the dishwasher products and can also
2453 be dedicated (affiliate) suppliers of one or a few particular dishwasher brands. They do not
2454 operate walk in shops but make site visits to the customers. Companies include mostly SMEs

with large businesses as well comprising the operators. Equipment may be sold through several channels depending on the company: in dedicated retail outlets, online or as part of a full project management service.

4.4.2.2. Manufacturers

The B2B nature of the commercial dishwasher market makes it much less transparent than the household dishwasher market. This poses difficulties when attempting to characterise the market in terms of sales, stock, prices and even brands. As there is not a large number of commercial dishwasher manufacturers, it is considered relevant to list them for the sake of characterising the market.

The **Table 4-14** below provides a non-exhaustive list of manufacturers, based on the members' lists of some national associations of equipment manufacturers. Companies identified as 'large' are those with presence in several Member States.

Table 4-14: Non-exhaustive list of EU-based manufacturers of commercial dishwashers.

Name of the company	Large company	Member State of headquarters
Miele & Cie. KG	Y	DE
Meiko	Y	DE
Hobart GmbH	Y	DE
Winterhalter Gastronom GmbH	Y	DE
Onnera S.Coop	Y	ES
ALI Group	Y	IT
Electrolux Professional AB	Y	SE
Nor:disk Clean Solutions AB	Y	SE
EKU Grossküchentechnik GmbH		DE
PALUX AG		DE
Stierlen GmbH		DE
Jemi S.A.		ES
Sammic S.L.		ES
Angelo Po Grandi Cucine s.p.a. (part of Marmon Retail Technologies Company)		IT – USA
Adler s.p.A.		IT
Aristarco S.p.A.		IT
BSD S.p.A		IT
Elframo S.p.A		IT
InoxBim		IT
Omniwash s.r.l.		IT
Silanos s.r.l		IT

Name of the company	Large company	Member State of headquarters
SMEG S.p.A.		IT
Wexiödisk AB		SE

2468 Source: Web sites of national manufacturers' associations, consulted on 14 November 2024:

- 2469 - HKI - Industrieverband Haus-, Heiz- und Küchentechnik
- 2470 - EFCM Italy
- 2471 - Branschforeningen For Storkoksleverantörer (BFS)
- 2472 - FELAC

2473 In general, these companies provide **maintenance** and **repair** services of their own products, in
 2474 addition to the manufacture of new products. In addition, the company sandoro GmbH, a
 2475 subsidiary of Winterhalter, has been identified as performing **refurbishment** services, i.e. the
 2476 processing of used equipment to make them into fully operational equipment with an extended
 2477 lifetime.

2478 4.4.2.3. Industry associations

2479 The European Federation of Catering Equipment Manufacturers (EFCM)⁵³ gathers the
 2480 manufacturers of all catering equipment, which includes equipment for food preparation,
 2481 cooking, refrigeration and washing of dishes and utensils. It is represented in the European
 2482 policy-making field by the federation of technology industries Orgalim⁵⁴. Its national members
 2483 are:

- 2484 - SYNETAM - Union des Fabricants D'Equipements et D'Ustensiles pour les Arts
 2485 Culinaires des Grandes Cuisines⁵⁵ (France)
- 2486 - HKI - Industrieverband Haus-, Heiz- und Küchentechnik⁵⁶ (Germany)
- 2487 - SEEME - (Association of Catering Equipment Companies)⁵⁷ (Greece)
- 2488 - IFSA - Irish Foodservice Suppliers Alliance⁵⁸ (Ireland)

⁵³ <https://www.efcem.info/>

⁵⁴ <https://orgalim.eu/en/>

⁵⁵ <http://www.syneg.org/>

⁵⁶ <http://hki-online.de/de>

⁵⁷ <https://seeme.com.gr/>

⁵⁸ <http://www.ifsa.eu.com/>

- 2489 - EFCCEM Italy⁵⁹ (Italy);
- 2490 - BFSN - Bransjeforening for Storkjøkkenleverandører i Norge⁶⁰ (Norway)
- 2491 - APIRAC⁶¹ (Portugal);
- 2492 - Branschforeningen For Storköksleverantörer (BFS)⁶² (Sweden);
- 2493 - FELAC - Federación Española de Asociaciones de Fabricantes de Maquinaria para
- 2494 Hostelería, Colectividades e Industrias Afines⁶³ (Spain)
- 2495 - FEA - Food Service Equipment Association⁶⁴ (United Kingdom).
- 2496 In addition, two associations and one dedicated branch of a larger association exist in Germany
- 2497 to represent dishwasher manufacturers:
- 2498 - AKGGS "Arbeitskreis Gewerbliches Geschirrspülen" (Working Group Commercial
- 2499 Dishwashing)⁶⁵
- 2500 - Verband der Hersteller von gewerblichen Geschirrspülmaschinen e.V.⁶⁶
- 2501 - ZVEI Fachabteilung Gewerbliche Spültechnik (German Electro and Digital Industry
- 2502 Association – Technical department commercial dishwashing)⁶⁷

2503 4.4.3. Trends in product design / features

2504 The consultation of manufacturers in 2024 provided the feedback of **Table 4-15** below on the

2505 presence of resource-saving technical features of commercial dishwashers (saving of energy or

2506 of materials – along the Circular Economy paradigm).

2507

⁵⁹ <http://www.efcemitalia.it/>

⁶⁰ <http://www.bfsn.no/>

⁶¹ <http://www.apirac.pt/>

⁶² <http://bfs.se/>

⁶³ <http://www.felac.com/>

⁶⁴ <http://www.fea.org.uk/>

⁶⁵ <https://www.akggs.de/en>

⁶⁶ <https://vgg-online.de/>

⁶⁷ <https://www.zvei.org/verband/fachverbaende/fachverband-elektro-haushalt-grossgeraete/gremien>

2508 **Table 4-15: Presence of resource-saving technical features of commercial dishwashers.**

Technical feature	Category of feature	Number of manufacturers citing the feature as present	
		in their products	in all products of the market
Heat exchanger	Energy saving	7	5
Automatic dosing of detergents	Detergent saving	7	5
Improved thermal insulation	Energy saving	7	5
Improved rinsing systems	Customer satisfaction	7	3
Improved maintainability / repairability / capacity to be upgraded or refurbished (ease of dis-assembly and re-assembly, ease of access to servicing area, modular design)	Circular Economy	6	5
Additional warm/hot water connection	Energy saving	6	4
Waste water heat recovery	Energy saving	6	4
Improved ergonomics of operation (load carrying, temperature, humidity, noise)	Working conditions	6	3
Heat pump	Energy saving	4	2
Steam-operated heating	Energy saving	4	2
Recovery of wash water	Water saving	3	3
Wash process with lower temperature	Energy saving	3	2
Electronic stop controls (disconnect the machine from the mains supply at Programme end or after last user activity)	Energy saving	3	2
Reduced wear and stress imposed on dishes / utensils	Circular Economy	3	0
Use of recycled metals	Circular Economy	2	2
Improved recyclability (avoidance or clear marking of substances of concern, separability of parts made of different materials)	Circular Economy	2	1
Automatic adaptation of programme to load and to soiling level of dishes / utensils	Energy + water + detergent saving	2	0
Automatic weighing system/ automatic load control	Energy + water + detergent saving	1	1
Gas-operated heating	Energy saving	0	1
Use of recycled plastics	Circular Economy	0	0
High-yield pumps and dishwashing systems	Energy + water + detergent saving	(*)	(*)
Filtering and screening systems for the preparation of the rinsing water	Water saving	(*)	(*)
Optimised use of rinse water and optimised water flow in the machine	Water saving	(*)	(*)

2509 **Legend:** (*) Absent from the consultation survey, but provided in: Arbeitskreis Gewerbliches Geschirrspülen (2021)
2510 “Praxishandbuch Gewerbliches Geschirrspülen, <https://www.akggs.de/de/handbuch>

2511 Source: Stakeholder consultation survey n°2, performed between September and October 2024. A total of 7
2512 manufacturers provided answers to these questions.

As can be seen in this table, the features most implemented relate to energy and water saving, which has an immediately positive impact on operating costs by the customer. Similarly, the Circular Economy feature most implemented relates to ease of maintenance and repair, which has a direct impact on availability of the appliance, and hence on the daily operations of the customer. On the other hand, features having mainly an environmental impact but none on the customer's experience or profit (e.g. use of recycled materials, recyclability) are less popular.

4.4.4. Innovations

The study enabled the consultant team to identify some innovative concepts in the field of commercial dishwashing. Further BAT will be described in Task 4.

4.4.4.1. Granule dishwashing

The Swedish-based company Nor:disk developed **granule-based** dishwashing for the removal of dirt from cooking utensils, which often are difficult to clean⁶⁸. The granules are used as a complement to water and detergent, and do not replace them. The cylinder-shaped granules have been developed to have the adequate shape, density and hardness to remove dirt, while still preserving the surface of the utensils. They are used in conjunction with a dedicated family of dishwashers and exist in two versions: fossil-based plastics and a 'bio' version based on calcium salt, rapeseed oil and biodegradable polyesters that is claimed to be biodegradable in soils.

Stakeholders other than the manufacturer of these machines expressed environmental and health concerns regarding the usage of these granules in their non-bio, plastic-based version:

- The plastic debris from the non-bio granules, if they remain on cooking pans after wash are suspected to cause health hazards.
- Similarly, the plastic debris resulting from the abrasion of the plastic granules is considered to be difficult to catch by filters, and hence susceptible to generate micro-plastics pollution to the environment.

4.5. Consumer expenditure base data

4.5.1. Average EU end-user prices

The average unit price of dishwashing equipment, based on Eurostat data, is provided in **Section 0** above. An investigation made in the online catalogues of resellers of products led to the maximum end-user prices per segment listed in **Table 4-16**.

⁶⁸ <https://www.nordiskclean.com/products-services/products/>

2543 **Table 4-16: Observed end-user prices of commercial dishwashers.**

Product category	Minimum observed price (EUR excl. VAT)	Maximum observed price (EUR excl. VAT)	Member State and reseller
1: Undercounter water-change	1,632.00	4,290.00	FR (Pro-Electro)
1: Undercounter water-change 2: Undercounter one-tank °	975.74	6,798.00	FR (Metro)
	1,556.00	5,249.00	DE (Gastro Hero)
	1,486.13	4,167.00	EE (FourniResto)
	995.99	6,527.99	UK* (Industrial Warewashers.com)
	1,319.52	2,778.19	PL (GastroProdukt)
2: Undercounter one-tank	1,770.00	9,547.00	FR (Pro-Electro)
3: Hood-type	1,640.27	10,921.00	FR (Metro)
	2,727.00	11,298.00	DE (Gastro Hero)
	1,799.99	16,799.99	UK* (Industrial Warewashers.com)
	5,679.00	18,434.00	FR (Pro-Electro)
4: Utensil/pot dishwashers	2,346.00	15,497.99	UK* (Industrial Warewashers.com)
	3,609.00	16,679.00	DE (Gastro Hero)
	8,069.00	18,929.00	FR (Pro-Electro)
5: One-tank conveyor-type	10,679.99	15,899.99	UK* (Industrial Warewashers.com)
	11,249.00	15,749.00	DE (Gastro Hero)
6: Multi-tank conveyor-type	17,299.99	28,649.99	UK* (Industrial Warewashers.com)
	13,069.00	32,449.00	DE (Gastro Hero)

2544 (°) Online sellers often do not provide in a clear way whether the dishwasher uses freshwater or a recycled water
 2545 tank

2546 (*) Based on 1 GBP = 1.20 EUR (Source European Central Bank:
 2547 [https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-](https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-gbp.en.html)
 2548 [graph-gbp.en.html](https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-gbp.en.html))

2549 Source: Own elaboration, based on consultation of online suppliers of dishwashers performed on 18 November
 2550 2024.

2551 4.5.2. Consumer prices of consumables

2552 4.5.2.1. Electricity costs

2553 The electricity rate in EU depends on the consumption and therefore will vary depending on the
 2554 customer types (which can be attributed to certain product types too). Two consumption bands

for the electricity rate at industrial rates (IA – < 20 MWh and IB – 20-499 MWh) are presented below. These are the relevant consumption bands for the commercial dishwashers, as results from the computations made in Tasks 3 and 4.

The cost of electric energy for industrial users has experienced very strong variations, starting with the aggression war of Russia against Ukraine in February 2022. Following the restrictions to the import of natural gas from Russia in the EU, the prices of this commodity have risen sharply, and then decreased, following the successful implementation of measures reducing the EU's dependency on Russian fossil fuels (the RePowerEU programme). Dependent on the share of natural gas in the mix of the suppliers of electric energy in the EU, this evolution in the price of natural gas has resulted more or less parallel evolutions in the price of electricity to industrial consumers – the higher the dependency, the stronger the correlation between the prices of natural gas and of electricity. Governments have intervened to mitigate this impact to companies, essentially by introducing reductions to the taxes applicable to electricity, but this has not been sufficient to fully dampen the impact of the rising cost of electric energy⁶⁹.

Consequently, it is not relevant to define a representative price for electric energy, based on an average of latest available data, and which would be valid for the Life Cycle Costing of the implementation of Ecodesign requirements to be implemented in the future.

The tables below (**Table 4-17** and **Table 4-18**) hence present the price of electricity at two dates:

In the first semester of 2021, before the international tensions on the gas market led to an increase in its price. At the latest available date, namely the first semester of 2024, which witnesses a slow decrease of the electric energy price compared to the peaks observed in the first semester of 2023.

The Life-Cycle Costing exercise will hence need to make assumptions about the future evolution in the price of electric energy.

Table 4-17: Price of electric energy for non-household uses, in EUR/kWh (prices excluding VAT and other recoverable taxes and levies), Consumption band IA = annual consumption below 20 MWh.

Member State	Electricity price in EUR / kWh (excluding VAT and other recoverable taxes and levies). Band IA (annual consumption below 20 MWh)	
	Semester 1 - 2021	Semester 1 - 2024
Austria	0.1768	0.2668
Belgium	0.2294	0.2762
Bulgaria	0.1131	0.1359
Croatia	0.1411	0.2787
Cyprus	0.1726	0.2783

69 Trinomics, Enerdata, E3Modelling, Öko Institut, LBST, Atico Estudio (2024) Study on energy prices and costs– 2024 edition

Member State	Electricity price in EUR / kWh (excluding VAT and other recoverable taxes and levies). Band IA (annual consumption below 20 MWh)	
Czechia	0.1970	0.3091
Denmark	0.1554	0.1662
Estonia	0.1279	0.2218
Finland	0.0947	0.1292
France	0.1764	0.2526
Germany	0.2492	0.3293
Greece	0.1834	0.2605
Hungary	0.1300	0.2254
Ireland	0.2513	0.3242
Italy	0.2777	0.3483
Latvia	0.1996	0.2481
Lithuania	0.1530	0.2923
Luxembourg	0.1663	0.1647
Malta	0.2398	0.1882
Netherlands	0.1923	0.3104
Poland	0.1732	0.3309
Portugal	0.1947	0.2242
Romania	0.1219	0.1751
Slovakia	0.2171	0.2844
Slovenia	0.1551	0.2340
Spain	0.2322	0.2433
Sweden	0.1260	0.1777
EU-27 countries (from 2020)	0.2093	0.2843

Source: Eurostat (2024), Electricity prices for non-household consumers - bi-annual data (from 2007 onwards).
Online data code: nrg_pc_205. https://doi.org/10.2908/NRG_PC_205.

Custom dataset:
https://ec.europa.eu/eurostat/databrowser/view/nrg_pc_205_custom_13397870/default/table?lang=en

Table 4-18: Price of electric energy for non-household uses, in EUR/kWh (prices excluding VAT and other recoverable taxes and levies), Consumption band IB = annual consumption from 20 MWh to 499 MWh.

Member State	Electricity price in EUR/kWh (excl. VAT and other recoverable taxes and levies). Band IB (annual consumption from 20 to 499 MWh)	
	Semester 1 - 2021	Semester 1 - 2024
Austria	0.1403	0.2326
Belgium	0.1569	0.2075
Bulgaria	0.1018	0.1248
Croatia	0.1205	0.2455
Cyprus	0.1610	0.2603
Czechia	0.1363	0.2298
Denmark	0.0985	0.1113
Estonia	0.1017	0.1546
Finland	0.0842	0.1146
France	0.1450	0.2451
Germany	0.2043	0.2723
Greece	0.1588	0.2020
Hungary	0.1098	0.2522
Ireland	0.1816	0.3032
Italy	0.1790	0.2444
Latvia	0.1255	0.1730
Lithuania	0.1174	0.1999
Luxembourg	0.1188	0.2182
Malta	0.1518	0.1557
Netherlands	0.1532	0.2677
Poland	0.1341	0.2534
Portugal	0.1400	0.1569
Romania	0.1143	0.1726
Slovakia	0.1510	0.2264
Slovenia	0.1121	0.1946
Spain	0.1404	0.1784
Sweden	0.0856	0.1106
EU-27 countries (from 2020)	0.1562	0.2299

Source: Eurostat (2024), Electricity prices for non-household consumers - bi-annual data (from 2007 onwards).
Online data code: nrg_pc_205. https://doi.org/10.2908/NRG_PC_205.

Custom dataset:

https://ec.europa.eu/eurostat/databrowser/view/nrg_pc_205_custom_13397870/default/table?lang=en

2594 4.5.2.2. Water costs

2595 The New International Benchmarking Network for Water and Sanitation Services (New IBNet)⁷⁰,
 2596 set up by the World Bank, provides an international benchmark for the price of water, by
 2597 obtaining data from utilities. The

EU Member State	Price per m3 in EUR for a consumption of 15 m3/month		
	Average, based on population served	Minimum	Maximum
Austria	2.07	1.67	2.84
Belgium	2.82	2.06	3.43
Bulgaria	1.36	0.56	2.38
Croatia	1.73	0.80	3.18
Cyprus	1.60	1.56	1.66
Czech Republic	2.57	1.98	3.19
Denmark	3.19	2.52	4.53
Estonia	1.42	0.71	1.72
Finland	2.52	2.04	3.89
France	2.05	0.65	2.94
Germany	2.95	2.19	3.85
Greece	1.06	0.64	1.69
Hungary	0.81	0.52	1.17
Italy	1.37	0.36	2.77
Latvia	1.14	0.95	1.44
Lithuania	1.26	0.53	2.00
Luxembourg	3.15	3.15	3.15
Malta	2.73	2.73	2.73
Netherlands	2.21	1.84	2.44
Poland	1.38	0.78	1.98
Portugal	1.53	0.78	2.72
Romania	1.33	0.61	1.96
Slovakia	1.47	1.20	1.83

⁷⁰ <https://newibnet.org/about-us-0>

EU Member State	Price per m ³ in EUR for a consumption of 15 m ³ /month		
Slovenia	1.22	0.99	1.49
Spain	1.89	0.72	2.42
Sweden	2.90	1.27	4.06
EU 27*	1.91	0.36 (IT)	4.53 (DK)

2598 below provides the average (based on population served) and extreme prices per m³ of water,
 2599 based on a consumption of 15 m³ per month, for all EU-27 Member States (except Ireland).

2600 **Table 4-19: Average, minimum and maximum prices of water from utilities in EU Member**
 2601 **States, in EUR/m³, for a consumption of 15 m³/month.**

EU Member State	Price per m ³ in EUR for a consumption of 15 m ³ /month		
	Average, based on population served	Minimum	Maximum
Austria	2.07	1.67	2.84
Belgium	2.82	2.06	3.43
Bulgaria	1.36	0.56	2.38
Croatia	1.73	0.80	3.18
Cyprus	1.60	1.56	1.66
Czech Republic	2.57	1.98	3.19
Denmark	3.19	2.52	4.53
Estonia	1.42	0.71	1.72
Finland	2.52	2.04	3.89
France	2.05	0.65	2.94
Germany	2.95	2.19	3.85
Greece	1.06	0.64	1.69
Hungary	0.81	0.52	1.17
Italy	1.37	0.36	2.77
Latvia	1.14	0.95	1.44
Lithuania	1.26	0.53	2.00
Luxembourg	3.15	3.15	3.15
Malta	2.73	2.73	2.73
Netherlands	2.21	1.84	2.44
Poland	1.38	0.78	1.98

EU Member State	Price per m ³ in EUR for a consumption of 15 m ³ /month		
Portugal	1.53	0.78	2.72
Romania	1.33	0.61	1.96
Slovakia	1.47	1.20	1.83
Slovenia	1.22	0.99	1.49
Spain	1.89	0.72	2.42
Sweden	2.90	1.27	4.06
EU 27*	1.91	0.36 (IT)	4.53 (DK)

<https://tariffs.ib-net.org/sites/IBNET/VisualSearch?RegionId=3&Weight=0&ServiceId=2&YearId=0&perPage=50>

(*) At EU scale: simple average from all national averages, absolute minimum and absolute maximum observed across all Member States.

Exchange rate 1 EUR = 1.08 USD from: European Central Bank

https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-usd.en.html observed on 22 October 2024.

Source: New International Benchmarking Network for Water and Sanitation Services (New IBNet).

4.5.2.3. Detergent costs

The market in Europe (European Union 27 + UK + CH + NO) for household detergents for dishwashing was split in 2023, as described by the European Association of detergents and maintenance products (AISE), is summarised in **Table 4-20** below.

Table 4-20: EU (+UK+CH+NO) market of household detergents for dishwashing, 2023.

Category of household dishwashing detergent	Value of European market in 2023 (EUR bio.)	% of total
Automatic dishwashing	3.6	62.1 %
Hand dishwashing	2.2	37.9 %
All	5.8	100.0 %

Source: European Association of detergents and maintenance products (AISE) A.I.S.E. in Facts and Figures 2024, available at: <https://aise.eu/app/uploads/2024/06/A.I.S.E.-in-Facts-and-Figures-2024.pdf>.

The data for non-household products, i.e. those relevant for our study, provided by AISE (same source) does not provide the breakdown per category. The overall market for professional 'kitchen and catering' detergents is however provided and amounted to **EUR 2.0 bio.** in 2023, experiencing a +6 % growth compared to 2022 values.

The investigation of online resellers leads to the prices per litre of washing detergents and of rinsing agents in the **Table 4-21** below.

Table 4-21: Prices per litre of washing detergent and of rinsing agents.

Type of product	Minimum observed price (EUR excl. VAT / litre)	Maximum observed price (EUR excl. VAT / litre)	Member State and reseller
Washing detergent	3.90	3.90	FR (Best-Hygiene.com)
	4.09	6.67	DE (Gastro-Hero)
	1.87	5.82	FR (RueDeLHygiene.fr)
	3.40	4.10	DE (Intergastro.de)
Rinsing agent	2.80	2.80	FR (Best-Hygiene.com)
	3.90	4.91	FR (RueDeLHygiene.fr)
	2.15	7.00	DE (Intergastro.de)

2624 Source: Consultation of online resellers of detergent products, consulted 18 November 2024.

2625 From the composition of some 'packaged deals' offered online⁷¹, it appears that ca. 6 to 7 litres
 2626 of washing detergent are used for 1 litre of rinsing agent. The amount of detergent (and of
 2627 rinsing agent) needed per cycle or per dish were not provided in the information collected.

2628 The concentration of detergent has been suggested by manufacturers as being the following (for
 2629 details of the consumption values used in this study, see **Section 5.2.3**):

- 2630 - For all categories except categories 2 and 3:
 - 2631 ○ 3 g detergent per litre of washing water and
 - 2632 ○ 0.3 g rinse aid per litre of rinsing water.
- 2633 - For categories 2 (Undercounter one-tank dishwashers) and 3 (Hood-type
 2634 dishwashers): around 6 to 7.5 g detergent and 0.6 to 0.75 g rinse aid per cycle (18
 2635 dishes).
- 2636 - When using powder or tablets: tablets 16 g/cycle, powder 20 g/cycle.

2637 When computing the consumption of detergents, the following considerations deserve being
 2638 observed:

- 2639 - In appliances of Category 1 – Undercounter water-change dishwashers, the
 2640 detergent is only used in the cleaning step during the entire cycle. In the other
 2641 programme steps, only fresh water is used, and the rinse aid is only used in the final
 2642 rinse. Therefore, the consumption of detergent can be computed easily as it is
 2643 determined by the amount of detergent (resp. of rinsing agent) needed per litre of
 2644 freshwater used for washing (resp. for rinsing).
- 2645 - In tank-based dishwashers (i.e. in Categories 2 – Undercounter one-tank
 2646 dishwashers, 3 – Hood-type dishwashers and 4 – Utensil / pot dishwashers) a
 2647 saturated detergent solution is kept available at all times. In these cases, the
 2648 computation of the amount of detergent is more complex, as it implies assumptions
 2649 on the rate at which the detergent loses its washing capacity (and hence needs to

⁷¹ E.g. <https://www.chefook.com/fr/produits-de-lavage/>

- 2650 be regenerated), which itself depends on the soiling status of the dishes / utensils
 2651 being washed.
- 2652 - In conveyor-type dishwashers (i.e. in Categories 5 – One-tank conveyor-type
 2653 dishwashers and 6 – Multi-tank conveyor-type dishwashers) very large quantities
 2654 of detergent / rinsing agent are used, which are delivered to the appliances via
 2655 entire dosing systems, at a rate controlled by the appliance.
- 2656 - In the case of Category 4 – Utensil / pot dishwashers, some types are primarily
 2657 cleaned with the granules, resulting in lower detergent consumption.

2658 4.5.3. Repair and Maintenance costs

2659 In the previous preparatory study of 2011, stakeholders had commented that service contracts
 2660 are usually included as part of the purchase of professional dishwashing products. The exact
 2661 nature of the contracts can vary and depends on the type of equipment, complexity, and capital
 2662 cost. Normally, more sophisticated and expensive machines have more elaborate and
 2663 comprehensive service contracts to help ensure a long product lifetime and payback period on
 2664 capital investments.

2665 For smaller appliances, dealers or wholesalers may provide warranty services to clients on behalf
 2666 of the manufacturer, or they may also provide the warranty services at their own expense as
 2667 part of the dealer arrangement between the manufacturers. For larger more complex products,
 2668 especially conveyor-type dishwashers, the manufacturer typically services the product as these
 2669 products are also typically sold directly from the manufacturer themselves.

2670 As a preliminary estimate of the maintenance and service costs of commercial dishwashing
 2671 appliances, an indication can be taken from the size of the new equipment market versus the
 2672 'spares and service' (spare parts including accessories, repairs, and maintenance) market in the
 2673 UK. In total, the UK spares and service market was 44 % of the value of the new foodservice
 2674 equipment market in 2006.⁷² This indicates that for the entire lifetime of a foodservice product,
 2675 the total **maintenance costs are 44 % of the initial purchase costs**. This value will be used to
 2676 estimate the life cycle costs of dishwashing products later in the study (it is therefore assumed
 2677 that the commercial dishwashers have average maintenance and repairs costs, in comparison
 2678 with other foodservice equipment, including prime cooking and refrigeration equipment).

2679 Stakeholders have indicated that maintenance costs per year are inferior to 5 % of the
 2680 purchasing price of the appliance. Based on a lifetime of ca. 10 years (as identified in
 2681 **Section 4.3.1**), this sums up to less than 50 % of the purchase cost over the lifetime of the
 2682 product, which is coherent with the estimate above.

2683 Stakeholders have commented that the most common items for maintenance on commercial
 2684 dishwasher products are water pumps, control panels, heating elements and doors. All of these
 2685 components in commercial dishwashers are easily replaceable and generally justify

⁷² Catering Equipment Suppliers' Association (CESA) 2007, The UK Market for Foodservice Equipment – The authoritative report on the UK market

2686 maintenance rather than replacing the entire dishwasher. According to manufacturers, the most
2687 common cause for commercial dishwasher breaking is operator misuse or abuse.

2688 4.5.4. Installation costs

2689 The installation costs apply mainly to the larger equipment (categories 5 and 6: conveyor
2690 dishwashers) that is large and complex, with some on-site adaptation and customisation.
2691 However, even smaller appliances may require installation work that, dependent on the delivery
2692 contract, may add installation costs to the cost of the purchase of the equipment itself.

2693 The stakeholders provided no data in the survey regarding these installation costs.

2694 4.5.5. Disposal tariffs/ taxes (€/product)

2695 In general, most professional catering service establishments need a working dishwasher for
2696 daily operation. As a result, for all replacement sales, the old dishwasher unit is removed at the
2697 same time as the new unit is provided.

2698 Stakeholders have commented that many commercial dishwasher units can be refurbished and
2699 resold as second-hand products by dealers in a fairly buoyant second-hand market (around 5-
2700 10 % of the annual sales, according to manufacturers' estimates). These products generally are
2701 given new water pumps, control panels and heating elements, as the most common items to
2702 fail.

2703 According to stakeholders, dishwashers that are not refurbished are almost always recycled for
2704 scrap parts. A large majority of the materials in commercial dishwashers is valuable metallic
2705 parts (stainless steel, in particular for austenitic stainless steel, i.e. containing nickel) and the
2706 value for scraps is high. As a result, most dealers or manufacturers will offer to remove the old
2707 dishwashers on purchase and delivery for new dishwashers and may even provide the customer
2708 with a discount for the salvaged product.

2709 As a result, this study will assume the disposal costs for commercial dishwashers are 0 Euro per
2710 product.

2711 4.6. Recommendations

2712 4.6.1. Refined product scope from the economical/ commercial 2713 perspective

2714 No market has been identified as 'niche' in the study. The larger the appliances (typically:
2715 categories 5 and 6 – conveyor dishwashers), the smaller their numbers. However, their
2716 processing capacity per unit and duration of operation per year result in an annual throughput
2717 that is also ca. 10 times larger (cf. **Section 4.4.1.1**). Thus, the environmental impact of the whole

2718 stock of these appliances needs to be assessed in detail further in the study to check whether
2719 they deserve being discarded from the scope of the study or not.

2720 **4.6.2. Barriers and opportunities for Ecodesign from the**
2721 **economical/ commercial perspective**

2722 Based on the technical features already present in the existing products on the market (cf.
2723 **Section 4.4.3**), the main opportunities for ecodesign could consist in:

2724 - Consolidating the already dominant features to ensure that they are the norm for
2725 all products present on the market:

2726 ○ Wastewater heat recovery using a heat exchanger,

2727 ○ Automatic dosing of detergents,

2728 ○ Improved thermal insulation,

2729 ○ Improved maintainability / repairability / capacity to be upgraded or
2730 refurbished (ease of dis-assembly and re-assembly, ease of access to
2731 servicing area, modular design),

2732 ○ Additional warm/hot water connection, if not already provided, with
2733 adapted water temperature controls able to cope with higher temperature
2734 of externally supplied water.

2735 - Introducing some features that would provide a clear environmental benefit, even
2736 if they still are not often present:

2737 ○ Use of recycled metals, taking care of potential issues regarding hygiene,

2738 ○ Improved recyclability (avoidance or clear marking of substances of
2739 concern without duplicating existing legislation such as REACH, separability
2740 of parts made of different materials).

2741 The exact trade-offs between these requirements, which can be conflicting, will be determined
2742 in subsequent stages of the study.

5. MEErP Task 3 – Users

5.1. Objectives of MEErP Task 3

Objective of MEErP Task 3 is the identification, retrieval, and analysis of data on user (= professional customers) behaviour and associated environmental impacts during the use phase of commercial dishwashers in scope. User behaviour can be influenced by product design and information. Relevant user parameters are an important input for the assessment of the environmental impacts of the products in scope during their use and end-of-life phase. Task 3 of the MEErP deals with system aspects of the use phase of energy related products (ErP) with direct or indirect energy consumption effect. In addition, the consumption of water and detergents and the occurrence of microplastics in the wastewater stream from dishwashers plays a role in this type of appliance. Further, information on the End-of-Life behaviour and local infrastructure in the context of commercial dishwashers is collected in this task.

In the 2011 preparatory study, it was clearly identified that the energy and water consumption in the use phase were most relevant for many of the environmental impacts investigated for commercial dishwashers. However, at that time there were no test standards available to measure the performance of commercial dishwashers on a comparable basis. The data provided by different stakeholders were not based on standardised values. Against this background, MEErP Task 3 focuses its analysis on the question if there are significant differences between the ideal consumption (as stated in some of the technical data sheets) and the consumption in practice during the use phase. The aim of this preparatory study is also to investigate whether more precise values can now be determined for the parameters that could not be specified in the 2011 preparatory study or could only be specified on the basis of assumptions, if the standards developed in the meantime are now applied.

Compared to household dishwashers, commercial dishwashers are very expensive to purchase and are used more intensively or for significantly longer periods of time. As a result, and due to the fact that the use phase of the appliances accounts for a large part of the total energy consumption and most of the environmental pollution, there is a fundamental risk that existing appliances will be operated with significant efficiency disadvantages compared to new appliances. On the other hand, this work package should also examine the extent to which users are willing to refurbish their existing equipment or, conversely, to purchase refurbished appliances. Although, according to stakeholder feedback, refurbishment will not upgrade the appliances towards higher efficiency standards but only bring them again to an acceptable technical and hygiene state, the measure might be environmentally beneficial in terms of a circular economy. Finally, in order to facilitate the potential modelling of impacts on the repair sector in the Impact Assessment support study, Task 3 will also seek for information with regard to the average number of hours per year for maintenance and/or repair of the appliances.

5.2. Applications, typical capacity and use intensity of commercial dishwashers

5.2.1. Applications and market segments

Different customer requirements result in a range of commercial dishwasher categories available on the market. **Table 5-1** gives an overview of the main applications and the respective capacity ranges of these dishwasher categories thus providing a first indication of a possible use intensity of commercial dishwashers.

Table 5-1: Main applications and market segments of commercial dishwashers according to spatial requirements.

Dishwasher category	Applications / Market Segments	Main operator / User type	Spatial requirements
No 1 Undercounter water-change	Bars, bistros, (small) restaurants and pubs, motorway service areas, hospitals, hotels and guest houses, club houses, institutional kitchens, and similar business environments	Trained or at least supervised personnel	Rather limited space available / required
No 2 Undercounter one-tank	(Small) restaurants, hotels, conference centres, bars, clubhouses, gas filling stations, motorway service areas, day-care-homes, bakeries, butcheries, old age homes	Trained or at least supervised personnel	Rather limited space available / required
No 3 Hood-type	Institutional kitchens, care homes, bars, school and small company canteens, filling stations, motorway service areas, restaurants, bakeries, butcheries	Trained or at least supervised personnel	Requires a medium amount of space. Used in separate kitchen or dishwashing rooms
No 4 Utensil/Pot	Institutional kitchens, bread and bakery, industry butcheries, hypermarkets	Trained personnel	Requires a medium amount of space
No 5 Conveyor-type one-tank	Medium company canteens, hospitals, cafeterias, caterers, hotels	Trained personnel	Requires a medium to large amount of space
No 6 Conveyor-type multi-tank	Large company or university canteens, hospitals, cafeterias, caterers, airports and institutional kitchens	Trained personnel	Requires a large amount of space

Source: Task 3 report of Lot 24, 2011

According to the Task 3 report of the 2011 preparatory study the six categories of commercial dishwashers are used in the following segments which is still valid according to 2024 stakeholder feedback:

Undercounter water-change appliances (category 1) are intended for commercial use due to their short programme run times and high cleaning performance. They are mostly used in bars, small restaurants and pubs, hotels, and guest houses or business environments. They are typically not intended for private use or an environment that is very close to the private household sector, e.g. offices, community centres and clubhouses. Also, this category of

2797 commercial dishwashing machines must be used only by trained or at least supervised personnel
2798 according to EN 60335-2-58, despite what happens in the field.

2799 Undercounter tank machines (category 2) are usually used in bars, bistros, small restaurants,
2800 offices, clubhouses, hotels, conference centres, gas stations, motorway service stations, day-
2801 care homes, bakeries, butcheries, and elderly homes. According to stakeholder feedback, it is
2802 mandatory – and so typically stated in the documentation – that only trained, or at least
2803 supervised persons are allowed to use the dishwasher of this category. Due to the shorter cycle
2804 time, they have a higher capacity than commercial water-change models. They make only sense
2805 if a certain amount of wash ware has to be cleaned as the water in the tank has to be heated
2806 and the dishwasher is kept in ‘ready to use’ mode between the dishwashing cycles.

2807 Hood-type dishwashers (category 3) are more ergonomically to handle compared to
2808 undercounter dishwashers as the racks are put on a table next to the dishwasher and pushed
2809 into the machine after loading. The filled (quite heavy) rack usually does not have to be carried
2810 by the user but only the empty ones. They are used if enough space is available and usually if
2811 more wash ware is to be cleaned compared to undercounter dishwashers. They are more
2812 seldom used in small restaurants or bars. According to stakeholder feedback, it is mandatory –
2813 and so typically stated in the documentation – that only trained, or at least supervised persons
2814 are allowed to use the dishwasher of this category.

2815 Utensil/pot dishwashers (category 4) are used to clean heavily soiled pots and pans and other
2816 large utensils. They are used by trained personnel in institutional kitchens, restaurants, bread
2817 and bakery industries, butcheries, hypermarkets etc.

2818 Conveyor-type dishwashers with one or more tanks (categories 5 and 6) require a relatively large
2819 number of items to be cleaned per day and also a large amount of space. They are only used by
2820 trained staff in medium and large company canteens, hospitals, caterers, and hotels.

2821 All commercial dishwasher categories 1-6 are operated by trained, instructed staff which is also
2822 specified in the Machinery Directive and also written in every instruction manual for the
2823 respective devices. It has to be noted that the personnel who operates the machine, often
2824 changes regularly.

5.2.2. Use intensity of commercial dishwasher categories

5.2.2.1. Capacity range of commercial dishwashers

Table 5-2 below gives an overview of the capacity ranges, i.e. the number of dishes washed per hour, for the different categories of commercial dishwashers. The left column shows the data from the 2011 preparatory study, while the right column shows the feedback retrieved from the stakeholder consultation and an analysis of product data sheets.

It appears that the performance information is not based on standard methods (at least they are not mentioned); some data sheets include a note that the values given may vary depending on local conditions (water inlet temperature / power supply) and feedback from one manufacturer in the 2024 stakeholder consultation is that they don't have information on operator usage that would give a 'typical' standard or average as the real application varies widely from operator to operator. One stakeholder informs that the average use depends a lot on the market segment where a similar machine is placed. Further, for category 2 and 3 dishwashers, there is a kind of sub-segmentation between low and intensive usage ranges.

Table 5-2: Capacity ranges and typical capacities of the six categories of commercial dishwashers.

Dishwasher category	Capacity range (in brackets: typical capacity); values 2011 [dishes/hour]	Capacity range (in brackets: typical capacity); updated values 2024 [dishes/hour] ⁷³
No 1 Undercounter water-change	80-300 ⁷⁴ (200)	285-500 (350)
No 2 Undercounter one-tank	300-800 (550)	220-850 (550)
No 3 Hood-type	500-1,300 (860)	180-2,510 (720)
No 4 Utensil/Pot	10-30 cycles/ hour ⁷⁵ (20 cycles/ hour)	7-30 cycles/hour (15 cycles/hour)

⁷³ According to the analysed product datasheets available on the manufacturers' websites, capacity is mostly given in 'racks per hour' with 18 dishes (standard plates) per rack (categories 2, 3, 5 and 6). However, 2024 stakeholder feedback suggests that it would be preferable to always refer to 'cycles per hour' for dishwasher categories 1 to 4. For category 1, a conversion factor of 19 dishes per rack was found in the datasheets. According to stakeholder input the capacity is 25 dishes per rack, with 2 racks washed per cycle.

⁷⁴ Different throughput rates with cold water supply at 15°C or cold and hot water supply (hot water 65°C).

⁷⁵ The capacity of utensil/pot dishwashers is measured in cycles per hour as no dishes, but large cooking utensils are cleaned that considerably vary in size.

Dishwasher category	Capacity range (in brackets: typical capacity); values 2011 [dishes/hour]	Capacity range (in brackets: typical capacity); updated values 2024 [dishes/hour] ⁷³
No 5 Conveyor-type one-tank	1,500-2,000 ⁷⁶ (1,750)	800-2,520 (1,800)
No 6 Conveyor-type multi-tank	1,700-6,000 ⁷⁷ (3,600)	900-8,000 (3,600)

Sources: left column: Task 3 report of Lot 24, 2011; right column: stakeholder consultation and review of manufacturers' product datasheets, 2024.

One stakeholder confirms that there is no, or very little performance/capacity information based on standards or scientific publications; thus, such data are almost exclusively provided by the dishwasher manufacturers themselves. There are sometimes different and divergent interpretations of the basic data that are used so it appears that the term 'dishes per hour' has been interpreted differently, which is probably why the manufacturers' specifications vary so widely. As all categories of commercial dishwashers clean a large variety of wash ware, it would appear that the specification 'dishes per hour' is based on different items (possibly dessert plates, saucers, coffee cups etc.) in the load.

The stakeholder further informs that a 'unit' for specifying the capacity is the number of racks to be washed per hour. As there is a wide variety of different racks, the standard rack (500 x 500 mm) made of plastic with a single plate load is usually used here. This 'standard plate load' refers to 18 dinner plates (based on the load from EN 63136 with 'standard plates' of 240 mm diameter). This load could be, and to some extent has been, used to provide a degree of comparability between the categories. To ensure that this basis is clearly defined, the stakeholder recommended that the term 'plates per hour' rather than 'dishes per hour' should be used consistently with a standardised standard load of 18 dinner plates to compare capacities as a 'unit' to which everything is converted. This would work for all categories except for category 4 which focuses on pots and pans and is slightly different from the others, all of which have the same extensive wash ware (from cutlery to porcelain and glasses). However, according to the stakeholder, a pure plate load does not reflect the real conditions, but only approximately 20 percent of the load whereas around 80 percent is other wash ware. Although a standard mixed load would be useful, there is currently not much further information on the real conditions of use.

Based on a review of product datasheets for category 1 (undercounter water-change), it appears that there is no typical average capacity, but that there are rather two capacity classes; a smaller one with approximately 285 dishes per hour (15 racks à 19 dishes per hour) and a larger one of approximately 456 dishes per hour (24 racks à 19 dishes per hour). The load per wash cycle is very mixed. In the other categories, each rack tends to be washed with a single type of dishes. For the purposes of this study, it was initially assumed that the smaller category is more

⁷⁶ Some dishwashers of category 5 on the market use extreme high capacity of up to 5,000 dishes per hour. This is however not considered as 'typical' capacity range.

⁷⁷ Some dishwashers of category 6 on the market use extreme high capacity of up to 14,000 dishes per hour. This is however not considered as 'typical' capacity range.

prevalent in the market and is therefore taken as the typical capacity. According to 2024 stakeholder feedback, this type of machine, unlike the other categories, cleans two racks at a time. Stakeholder feedback therefore suggested a typical standard capacity of 350 dishes per hour under ideal conditions, i.e. a basic setting with the most commonly used programme, where 7 full cycles of each 8 minutes would be possible within one hour (based on 50 dishes per two racks), not considering partial cycles.

For category 2, the initial values of the 2011 preparatory study were mostly confirmed by the 2024 stakeholder consultation. Depending on the product portfolio of individual manufacturers, the capacity range has widened slightly at the lower and the upper limits. Feedback on the typical capacity was still around 540, 550 or 600 dishes per hour with one manufacturer stating that these figures were only theoretical and would be lower (more like 360 dishes per hour) if loading and unloading of the machine was considered. Another manufacturer stated that in recent years, for category 2, programmes with lower productivity (as low as 72 dishes per hour) have been required to achieve more stringent hygienic results. This also applies to category 3.

For category 3 (hood-type), the analysis of the data sheets now shows a wider range compared to the 2011 data. Hood-type dishwashers with a capacity of 10 cycles per hour, i.e. 180 plates per hour, were found at the lower end and machines with a capacity of 60 to 70 cycles per hour (1,080 to 1,680 plates per hour). There are also special editions on the market (double width machines which are according to stakeholder's feedback absolutely non-standard), able to clean two racks in parallel with capacities of 120 to 140 racks per hour, i.e. 2,160 to 2,510 plates per hour at the upper end. The typical capacity within this range seems to be 60 cycles per hour, i.e. 1,080 dishes per hour. These capacities are those given in the product data sheets for plates; for cleaning glassware, the capacities of the machines appear to be higher. Stakeholder feedback, however, suggests that the initial assumption of 60 cycles per hour as a 'typical capacity' is too high. One stakeholder confirmed that the 2011 data is still valid for category 3 dishwashers. Therefore, a capacity of 40 cycles per hour (i.e. 720 plates per hour) is used for further calculations, which is slightly lower than the 2011 value, but reflects a capacity commonly listed in product data sheets, converted to the value of 18 plates per rack.

Based on a review of product datasheets for category 4 (utensils/pots), the overall capacity range for this category has also widened compared to the 2011 data. At the lower end, there could be as few as 7 cycles per hour, while at the upper end, large machines with 30 cycles per hour were found. Stakeholder feedback suggested a typical capacity of 10 to 15 cycles per hour.

For category 5 (flight type), stakeholder feedback largely confirmed the initial 2011 data for the typical capacity (1,600 or 1,800 dishes per hour). The overall capacity range has widened at the lower and the upper end compared to 2011. For category 6, some stakeholders confirmed the initial 2011 data including the typical capacity, while also providing data on a wider range at both the lower and upper ends.

5.2.2.2. Annual number of dishes washed

For comparison, **Table 5-3** still shows the estimated use intensity in cleaned dishes per year for the different categories of commercial dishwashers as presented in the 2011 preparatory study. The data are based on the following parameters:

- 2913 - Maximum capacity: number of dishes per cycle (categories 1, 2 and 3) and number
2914 of dishes per hour (categories 5 and 6),
- 2915 - number of wash cycles per day (applicable to categories 1 to 4),
- 2916 - estimated time span per day in active mode (applicable to categories 5 and 6),
- 2917 - estimated number of working days per year, and
- 2918 - estimated typical workload (in %).

2919 These input data were used to calculate the annual number of dishes⁷⁸ (category 4: cycles)
2920 cleaned per category, which served as input for the further calculations of the energy, water,
2921 and detergent consumption per dish and/or per cycle and also per year under ideal and real
2922 conditions.

2923 **Table 5-3: Typical intensity of use of the different dishwasher categories (2011).**

Dishwasher category	Average capacity per cycle or per hour ⁷⁹	Number of cycles per day	Time in active mode per day ⁸⁰	Working days per year	Typical workload of rack/belt ⁸¹	Number of dishes / cycles per year
No 1 Undercounter water-change	30 dishes/cycle ⁸²	5	1h 30	200	80%	24,000 dishes
No 2 Undercounter one-tank	18 dishes/cycle	55	1h 50	300	80 %	237,600 dishes
No 3 Hood-type	18 dishes/cycle	80	2h 40	300	80 %	345,600 dishes

⁷⁸ For comparison of the capacity rating and typical use intensities of commercial dishwasher categories, the term 'dishes' usually refers to standard sized plates of the same size.

⁷⁹ In case of rack (basket) dishwashers the capacity is mostly given in 'racks per hour'. In case of belt conveyor dishwashers, the capacity is given in dishes per hour. Here, 'dishes per hour' is chosen to make the numbers comparable between the categories and because the capacity in racks per hour is ambiguous as the rack size (i.e. the number of dishes per rack) varies between manufacturers. Assumed conversion factors in the 2011 study: 30 dishes per rack (category 1) and 18 dishes per rack (categories 2, 3, 5 and 6).

⁸⁰ Calculations based on stakeholder feedback (2011) with regard to distributed usage of different programme durations.

⁸¹ The typical workload is included in this table to calculate the typical number of dishes cleaned per year. Its influence on the specific consumption values will be considered in the following sections.

⁸² Undercounter water-change dishwashers work with two racks. These are usually designed for a mixed loading, i.e. including cups, saucers, large and small plates plus cutlery. For reasons of better comparability with the other dishwasher categories in the 2011 preparatory study a capacity of 30 dishes was taken as basis.

Dishwasher category	Average capacity per cycle or per hour ⁷⁹	Number of cycles per day	Time in active mode per day ⁸⁰	Working days per year	Typical workload of rack/belt ⁸¹	Number of dishes / cycles per year
No 4 Utensil/Pot	Not applicable	30	2h 08	300	60 %	9,000 cycles
No 5 Conveyor-type one-tank	1,750 dishes/hour	not applicable	3h 30	330	75 %	1,515,900 dishes
No 6 Conveyor-type multi-tank	3,600 dishes/hour	not applicable	4h 30	330	75 %	4,009,500 dishes

Two stakeholders commented that the initially proposed calculation (time in active mode multiplied by the capacity per hour) is the wrong approach for batch dishwashers, i.e. categories 1 to 4, and should be based on the number of cycles per day and working days per year. The initial approach is also questioned as the feedback received on the duration of the active mode for batch dishwashers such as categories 2 to 4 could only be estimated or calculated by multiplying the number of cycles by a certain cycle time, however this would have to be defined. According to the stakeholders, the cycle time is very individual and could therefore not lead to comparable data.

It is also confirmed by another stakeholder feedback that the 'time in active mode per day' is not defined which could lead to misinterpretation and failures in the following calculations. According to one stakeholder, the time in active mode depends on the length of the cycles. When this stakeholder provided initial data to this study, the length considered was the 'programme time', not the 'cycle time'. The latter would be more suitable but must be measured according to IEC EN 63136 and is usually higher than the programme time due to rack changes and the reestablishment of working temperatures.

Based on the updated typical capacities in **Table 5-2** above and further stakeholder feedback from the 2024 online survey and written stakeholder feedback to the draft Task 1-4 study report, **Table 5-4** shows an update of the estimated use intensity in cleaned dishes per year for the different categories of commercial dishwashers that will be used for the further purposes of this study. For categories 1 to 4, the estimated number of cycles per day multiplied by the working days per year will be taken to calculate the annual number of cleaned wash ware.

Table 5-4: Typical intensity of use of the commercial dishwasher categories (2024).

Dishwasher category	Number of cycles per day	Number of dishes (plates) per cycle	Working days per year	Typical workload of rack ⁸³	Number of dishes or cycles per year
No 1 Undercounter water-change	7	50	200	75 %	52,500 dishes
No 2 Undercounter one-tank	55	18	300	80 %	237,600 dishes
No 3 Hood-type	110	18	300	80 %	475,200 dishes
No 4 Utensil/Pot	30	No information available	300	60 %	9,000 cycles
No 5 Conveyor-type one-tank	1,800	8h 00	330	80 %	3,801,600 dishes
No 6 Conveyor-type multi-tank	3,600	8h 00	330	80 %	7,603,200 dishes

Sources: Derived from 2024 stakeholder input.

For category 1 (undercounter water-change), calculations use the 'typical' capacities shown in

Table 5-2 (50 dishes per two racks in one cycle), assuming 7 cycles per day, 200 working days per year and 75 percent of work load. This results in 39,375 dishes cleaned per year (52,500 dishes per year if not considering the typical workload of only 75 %).

Stakeholder feedback on category 2 (undercounter one-tank) was contradictory, probably because the number of cycles per day depends strongly on the type of foodservice operation and the overall capacity of the dishwasher used. While few stakeholders agreed with the initial 2011 values as an average normal use, one stakeholder considered the initial 55 cycles per day to be probably above average; also, because not always standard dishes / plates are washed but other objects (glasses, cups, ...). On the contrary, one stakeholder suggests that even 250 cycles per day and 5 hours per day in active mode should be considered as average. Another stakeholder suggests 3 hours per day in active mode for chains or heavy duty, which would be significantly higher than the 2011 data. Finally, one stakeholder suggests 40 cycles per hour (assuming 18 dishes per cycle) and 1.5 hours per day in active mode. However, 720 dishes per hour would be significantly higher than the typical capacity shown in

Table 5-2 (550 dishes per hour), which is also based on stakeholder feedback. For further calculations for category 2 dishwashers, 55 cycles per day at a capacity of 18 plates per cycle, i.e. 990 plates per day are considered, resulting in 237,600 dishes cleaned per year when considering a workload of 80 % (same value as in 2011).

For category 3 (hood-type), some stakeholders agreed with the initial values from the 2011 study as an average for normal use. However, there was also feedback that 80 cycles per day (2011 data) was probably an underestimate, with one stakeholder suggesting that 150 cycles per day

⁸³ The typical workload is included in this table to calculate the typical number of dishes cleaned per year. Its influence on the specific consumption values will be considered in the following sections.

and 3 h 50 per day in active mode should be considered. For heavy use, another stakeholder even suggests a working time of 4.5 hours per day, resulting in 800,000 dishes to be cleaned per year. In its product brochure, the manufacturer Hobart uses 100 cycles per day at 2,160 dishes per hour and 312 working days per year to calculate the energy savings of its hood-type machine⁸⁴. Another stakeholder suggests 60 cycles per hour at 18 dishes per cycle. Weighing all the varying information, the study team decided to choose a value of 110 cycles per day⁸⁵ at 18 plates per cycle, resulting in 475,200 dishes per year at a typical workload of 80%.

For category 4 (utensils/pots), some stakeholders agreed with the initial values presented in the 2011 study. Another stakeholder suggested a higher number of hours in active mode (4 hours per day). Using a typical capacity of 15 cycles per hour as shown in

Table 5-2, this would result in 60 cycles per day which was questioned by other stakeholders (see the comment above on the challenges of using the time in active mode for the calculations). One stakeholder commented for this category of commercial dishwashers that the number of cycles per day depends very much on the typology of the end user (butchery, bakery, food lab, or other). Therefore, due to the lack of more specified data, for this category the 2011 values, i.e. 30 cycles per day, will be used for the further calculations.

For categories 5 and 6, one stakeholder confirmed the initial data from the 2011 study, another one sees too much variability in the applications to make a meaningful estimate. One stakeholder considers that the time in active mode should not be considered less than 9 hours per day. On the other hand, three stakeholders considered an active mode of no less than 9 hours per day as an average to be definitely too high, which in their opinion has definitely not doubled since the 2011 study. Another stakeholder suggested to reduce the time in active mode to 8 hours and the time in ready-to-use mode to be 4 to 6 hours, with a typical duration of 4.5 hours. Combined, this would be around 12 hours, which would be in line with the typical operating times of large users of category 5 and 6 commercial dishwashers, which could be between 10 and 18 hours (canteens, hotels, hospitals).

One stakeholder considers the typical rack or conveyor load for these dishwasher types to be 80 % rather than 75 % and the typical capacity to be slightly lower for category 5 (1,600 dishes per hour) and higher for category 6 (4,500 dishes per hour) compared to the 2011 values. The stakeholder feedback further explained that there are typically two scenarios for these categories: Large organisations (using large flight-type equipment) usually have a strong focus on efficiency. They often buy two units and use only one at off-peak times and switch both on at peak times. They usually have enough space to do this and are organised so that the dishes are piled up and washed together, ensuring that the machine(s) work(s) at full load. In contrast,

⁸⁴ Source: https://www.hobart-spuelmaschinen-gastroxtrem.de/media/pdf/f9/94/0f/HB_146232cfc1702d03_Prospekt_PR-778-K_AUP.pdf, page 10; however, according to the manufacturer's information, the calculation is based on a hood-type machine with double-rack capacity.

⁸⁵ This value would consider the stakeholder feedback that the initial 80 cycles per day would be underestimated; it would be a similar result to the suggested typical 720 dishes per hour (i.e. 40 cycles per hour) at the initially assumed active time of 2:40 hours; and it is still below the heavy-usage scenario.

3005 small organisations with a lot of dishes to wash often use a smaller, undersized dishwasher. As
3006 a result, their machine always runs at full load.

3007 To calculate the updated data, the typical capacity values as shown in

3008 **Table 5-2** were taken, and the other data were replaced by the stakeholder input. In particular,
3009 due to the estimated longer time in active mode per day, the total number of dishes cleaned per
3010 year with these machine types significantly increased compared to the 2011 values.

3011 5.2.3. Detergent consumption and consumables

3012 Standards EN IEC 63136 and EN 17735 define 'chemical treating agents', e.g. definition 3.5 of EN
3013 17735 states 'treating agent: product used to clean and/or sanitise and/or rinse and/or descale
3014 wash ware in dishwashing machines' with Note 1 to entry: 'Examples of treating agents are:
3015 detergent, rinse aid and granules.'⁸⁶

3016 According to 2024 stakeholder feedback, the term 'chemical' was used in the text of the
3017 standard to differentiate detergent and rinse aid from granules. Whereas granules are
3018 considered treating agents, they are reused in the machine several times. Therefore, some
3019 stakeholders suggest that the only relevant chemical treating agents for commercial
3020 dishwashers are detergent and rinse aid. One stakeholder asked if salt is a consumable for
3021 appliances with water softener, however, this was not mentioned at all by the stakeholder
3022 feedback.

3023 One stakeholder informs that in special cases the customer will use chemicals to remove stains
3024 of lime or starch. Overall, the quantities of chemicals used for these purposes are negligible.
3025 Another stakeholder specifies that some additives or deliming agents may be used generally
3026 once a time (e.g. during periodic maintenance) but not during normal operation. For the
3027 calculation of environmental impacts in MEErP Task 5, however, these consumables are not
3028 considered as being negligible.

3029 According to the preparatory study of 2011, the use of the types of detergents and rinse aids
3030 available depends on the type and size of the dishwashing machine, but in the majority of
3031 commercial dishwashing machines the dosage of the detergent and rinse aid is made
3032 automatically. There is a focus on safe dosing applications via closed systems, i.e. no customer
3033 contact with the product.

3034 According to 2024 stakeholder feedback, the category 1 dishwashers typically use a detergent
3035 and rinse aid in one product, mainly in powder or tablet form. Categories 2 to 6 mainly use liquid
3036 dosing, or alternatively solids in an automatic dosing system.

3037 According to the 2011 preparatory study, there are differences in water hardness across Europe
3038 and even within countries. These result in the need for different detergents products or different
3039 dosing levels to cope with the water hardness. Country differences also exist in the type of soil

⁸⁶ It has to be noted that the standard detergent and rinse aid in the EN IEC 63136 and EN 17735 are not based on any modern formulation.

that needs to be cleaned. For example, Germany tends to need products that can handle with high levels of starch whereas the UK is more concerned with tea and coffee staining and the ability to clean them. Customer perception of product effectiveness can depend on whether the product can clean these specific soils. Together with different cost acceptance by customers, these lead to significant variations in product dosage over various European countries.

The 2011 preparatory study stated that the concentration of detergent is usually between 2 and 4 g/litre and the concentration of rinse aid is about 0.2 to 0.5 g/litre. During the course of that study, stakeholders agreed on an average value for the composition and the use of detergent and rinse aid across different EU countries. Therefore, for all dishwasher categories the concentration of detergent of 3.00 g/litre, and concentration of rinse aid of 0.35 g/litre had been considered (see update below). Rinse aid consumption was not regarded separately. It was assumed that rinse aid is directly correlated with the water and detergent consumption and therefore it was integrated in the detergent consumption. An integrated detergent and rinse aid concentration of 3.35 g/litre was assumed in 2011.

One stakeholder in the 2024 consultation stated that, to their knowledge, the concentration of both detergents and rinse aids has decreased over the years. The products (which are then diluted in the dishwasher) are more concentrated for sustainability reasons and, therefore, need to be diluted more before use. Another stakeholder suggested a concentration of 0.30 g/litre for the rinse aid (0.1 g/litre for machines with a reverse osmosis system).

- Concentration of detergent: 3.00 g/litre,

- Concentration of rinse aid: 0.30 g/litre.

The initial proposal of using an 'integrated detergent and rinse aid concentration of 3.30 g/litre' for this study was questioned; according to 2024 stakeholder feedback this does not make sense from the technical point of view as detergent and rinse aid are quite different chemicals, with different formulations, different uses, and different dosing systems. Also, in some applications rinse aid may be unnecessary.

Another stakeholder informed that for category 2 to 6 machines an integrated detergent concentration may be misleading because the full amount of detergent is only needed during filling of the dishwasher. In this time no rinse aid is needed. During the cleaning cycle only rinse aid has to be dosed into the fresh water for the rinsing step/zone. During the cleaning process only a part of the tank filling will be changed due to the rinsing water (depending on various parameters). Therefore, according to the stakeholder's view, the full 3 g/litre detergent concentration has not to be considered for each litre of (fresh) water consumption. This aspect will be considered in the following calculations (see **Section 5.3.2** and **Section 5.4.1.4**).

In contrast to categories 2 to 6, the values for the 'concentration of detergent' (3 g/litre) cannot be used for category 1. **Category 1** dishwashers mainly use detergent in the form of a **tablet (16 g per cycle) or powder (20 g per cycle)**.

With regard to consumables, one stakeholder informs that also some types of water treatments like cartridge filters can be considered dishwashers consumables. However, as there is not information on its material composition and the overall application, this type of consumables will not be considered in the calculation of environmental impacts in MEerP Task 5.

5.3. Ideal user behaviour

5.3.1. Ideal operating conditions and user behaviour

Information by manufacturers about energy, water and detergent consumption of commercial dishwashers is usually given under 'ideal' use conditions. This means, that:

- The machine is in an optimum condition,
- Manual external pre-washing of the dishes is not included,
- The initial filling (including its energy, water, and detergent consumption) and preheating of the machine is not included,
- 'standard' crockery is used (e.g. Porcelain plates flat coupe measuring 240 mm in diameter with a certain degree of soiling), while under real-life conditions the crockery may vary from user to user,
- The dishwasher capacity is fully used,
- The detergent and rinse aid are used in the required form and concentration, and
- The most frequently used dishwashing programme is used,
- Energy consumption in low-power modes (e.g. 'ready to use' or left-on mode) is not included,
- The appliances run continuously,
- The cleaning of the machine at the end of the day is not included.

5.3.2. Energy, water and detergent consumption under ideal conditions

For comparison, **Table 5-5** still shows the estimated energy, water, and detergent / rinse aid consumption in continuous use per 100 dishes for the different categories of commercial dishwashers as presented in the **2011 preparatory study**.

The figures show the consumption values of average technology dishwashers (excluding specific BAT) available on the market back in 2011. The data have been used to calculate the energy, water and detergent consumption during the use phase under ideal conditions in order to give an impression of the environmental relevance of the different dishwasher categories and to subsequently determine the influence of other user behaviour parameters that were not considered under ideal conditions (see **Section 5.4**)

Table 5-5: Specific energy, water, and detergent consumption of average dishwashers during continuous use under ideal conditions (2011).

Dishwasher category	Energy consumption (in brackets: range)	Water consumption (in brackets: range)	Detergent / rinse aid consumption (in brackets: range)
	kWh/100 dishes ⁸⁷	litre/100 dishes	g/100 dishes
No 1 Undercounter water-change	4.3 ⁸⁸	80	268
No 2 Undercounter one-tank	1.6 (1.2-2.0)	16 (equals 2.9 l/cycle)	54
No 3 Hood-type	1.7 (1.5-2.0)	16	54
No 4 Utensil/Pot	0.5 kWh per cycle	5.2 litre per cycle	17 g per cycle
No 5 Conveyor-type one-tank	2.0 (1.8-2.3)	13 (11-15)	44
No 6 Conveyor-type multi-tank	2.0 (1.6-2.3)	12 (11-13)	40

Source: Task 3 report of 2011 preparatory study on commercial dishwashers.

Based on stakeholder feedback from the 2024 online survey, **Table 5-6** shows an update of the specific energy, water and detergent (including rinse aid) consumption of average dishwashers during continuous use under ideal conditions for the different categories of commercial dishwashers that will be used for the further purposes of this study. One stakeholder remarked that in general, detergent and rinse aid consumption is less than what was presented in the final report of 2011, however, not providing updated values.

For category 1, stakeholder feedback suggests lower energy and water consumption compared to the 2011 data. Whereas in the 2011 study, the 'universal' programme was considered as the basis (see **Table 5-5**), as the study at that time referred to 'semi-commercial dishwashers' for category 1, **Table 5-6** refers to commercial dishwashers, with the 'most commonly used dishwashing programme' considered as the 'short' programme. The values for energy consumption given in the table below refer to appliances without hot water connection. According to stakeholder feedback, by connecting the appliance to hot water supply, energy consumption can even be reduced further, to below 1.5 kWh per 100 dishes. For detergents, the values are related to powder or tab detergents (20 g per cycle), with no liquid dosing. In contrast to categories 2 to 6, category 1 mainly uses detergents in the form of a tablet (16 g per cycle) or powder (20 g per cycle). With 20 g/cycle and 50 dishes/cycle, the detergent consumption is 40 g per 100 dishes. All the referred values for category 1 dishwashers in the table below are based on 'ideal conditions', i.e. a basic setting in the most commonly used programme.

⁸⁷ In case of category 4, values are given per cycle.

⁸⁸ Programme 'Universal', cold water supply (direct electricity consumption of the dishwasher is lower when connected to warm water supply (1.7 kWh/100 dishes)).

Table 5-6: Specific energy, water, detergent, and rinse aid consumption of commercial dishwashers under ideal conditions (2024).

Dishwasher category	Energy consumption (in brackets: range)	Fresh water consumption (in brackets: range); tank machines: only freshwater for rinse cycle	Rinse aid consumption	Detergent consumption
	kWh/100 dishes ⁸⁹	litres/100 dishes	g/100 dishes	g/100 dishes
No 1 Undercounter water-change	2.2 (2.0-2.5)	35 (35-50)	40 (integrated detergent and rinse aid)	
No 2 Undercounter one-tank	2.0 (1.5-2.5)	16.72 (11-19.4) (equals 3 l per cycle à 18 dishes)	5.0	50
No 3 Hood-type	2.0 (2.02-2.1)	13 (12-14)	3.9	39
No 4 Utensil/Pot	0.85 (0.7-1.0) kWh per cycle	6 (5.0-7.0) litres per cycle	1.8 g per cycle	15 g per cycle
No 5 Conveyor-type one-tank	2.0 (1.8-2.3)	12 (11-13)	3.6	32
No 6 Conveyor-type multi-tank	2.0 (1.6-2.3)	8 (7-9)	2.4	22

Source: Stakeholder feedback from the 2024 survey.

One stakeholder agrees with the 2011 values for categories 2, 3, and 4. However, some stakeholders provided updated data for these categories.

For category 2, for example, for the energy consumption a range of 1.5 to 2.5 kWh per 100 dishes was provided with suggested averages of 1.5, 1.65 and 2.2 kWh; for the purposes of the study, the mathematical mean of the range (2.0 kWh) seems to be appropriate. For the water consumption, one stakeholder believes that 2.5 litres/cycle is closer to the actual situation. There seems to be a large gap between low-tier (single wall, pressure booster) and top-tier machines (double wall, atmospheric booster). Other stakeholders even go lower with 11 to 13.3 litres per 100 dishes; the value of 12.2 litres per 100 dishes equals 2.2 litres per cycle. However, one stakeholder stated that these reported water consumption values per 100 dishes and per cycle appear to be significantly understated – both the typical value of 2.2 and especially the maximum range value of 2.4 are lower than expected. The product datasheets that were cross-checked for this product category give different information on the water consumption (litres per rack or litres per cycle, some even without any unit)⁹⁰. For example, the water consumption

⁸⁹ In case of category 4, values are given per cycle.

⁹⁰ According to stakeholder feedback, the meaning of the two units (litres per rack or litres per cycle) was initially identical, as in the past for category 2 and 3 dishwashers only 'single rack' machines were available. Today, 'single rack' machines still represent the standard for these categories on the market. The difference between 'litres per rack' and 'litres per cycle' arises for appliances housing two racks and thus washing two racks in one cycle. It is pointed out that double-rack machines are not the 'standard' appliances on the market, and that the second rack might not be filled with

of category 2 dishwashers was found to be between 2.0 and 3.5 litres per cycle according to the analysed product datasheets. For the further calculations, a value of 3.0 litres per cycle, i.e. 16.7 litres per 100 dishes was taken which is still close to the 2011 data.

Regarding the consumption of detergents and rinse aids, two stakeholders suggested a lower consumption of 40 grams and one stakeholder only 34 grams per 100 dishes for category 2 dishwashers. One stakeholder points out that the detergent concentration for categories 2 and 3, i.e. undercounter single-tank and hood-type dishwashers is required according to EN IEC 63136 and for utensil/pot dishwashers according to ENAK (per cycle) at 3 ± 0.3 g/l (with a detergent density of 1.35 g/ml); this translates to a concentration of 2.2 ml/l. Regarding rinse aid, while the standard does not specify density, it is typically 1 g/ml, and therefore the concentration would be 0.30 g/l. However, the actual detergent and rinse aid consumption is likely to vary from these standard conditions.

For category 3 (hood-type dishwashers), stakeholders suggest a slightly higher energy consumption (around 2.0 kWh per 100 dishes) compared to the 2011 data. On the other hand, the water consumption seems to be lower now, at 2.4 to 2.6 litres per cycle, i.e. approximately 12 to 14 litres per 100 dishes. Finally, the detergent and rinse aid consumption are lower than in 2011, ranging from 34 to 44 grams per 100 dishes. For the further calculations, an average of 13 litres per 100 dishes was considered.

For category 4 (utensil/pot dishwashers), both the stakeholder inputs for energy and the water consumption appear to be slightly higher compared to the 2011 data.

Finally, for categories 5 and 6, one stakeholder informs that due to the wide range of conveyor-type machines there are no data that referring to x/100 dishes, but proposes to discuss a calculation approach to obtain the data in the best way according to EN 17735 as a reference. However, it has to be noted that EN 17735 focuses on hygiene and not on consumption measurements such as energy consumption, etc. Only one stakeholder suggests that the energy consumption for category 6 could be half of what was reported in 2011. As this was not confirmed by other stakeholders, the study will use the existing values for further calculations. For both categories, lower values were proposed for the water and detergent consumption compared to 2011 data. For category 6, a water consumption of 8 litres per 100 dishes appears to be closer to the actual situation.

Based on the 2024 stakeholder feedback in **Section 5.2.3** above suggesting a separate rather than integrated application of detergent and rinse aid consumption, the detergent and rinse aid consumption under ideal conditions will be calculated for tank operated dishwashers (categories 2 to 6) as follows:

‘standard’ dishes (plates) of 240 mm diameter. In the case of a category 2 dishwasher with two racks, for example, one rack is used for washing cups and the second one is used for washing small dishes, not for 240 mm dishes. Suggestion of the stakeholder is therefore to use the unit ‘litres/cycle’ (assuming a standard of one rack per cycle and 18 dishes per rack) in order to calculate the water consumption per 100 plates. This would allow to evaluate each case individually to determine if an appliance houses two racks, if both can house ‘standard’ dishes simultaneously, and how many standard dishes they can accommodate.

- For the rinse aid consumption, it is assumed that the standard concentration of 0.3 g/litre is applied to the freshwater consumption of the rinse cycles that is required to rinse the corresponding number of dishes.

- For the detergent consumption during cycle based or continuous operation of the dishwashers the values provided through stakeholder feedback for the integrated detergent and rinse aid consumption per 100 dishes reduced by the rinse aid consumption are taken. The additional detergent consumption due to the first fill and refills of the wash tank are only considered under real-life consumptions (see **Section 5.4.1.4**).

Based on the annual number of dishes or cycles given in **Table 5-2**, which were considering a 'typical' share of partial workload, i.e., real life conditions, the following **Table 5-7** shows on the basis of the number of dishes or cycles per year (ideal conditions without partial workload) the updated annual consumption of energy, water and detergent (including rinse aid) for each of the six dishwasher categories under ideal conditions in 2024.

Table 5-7: Annual energy, water, detergent and rinse aid consumption of commercial dishwashers under ideal condition in 2024.

Dishwasher category	Number of dishes or cycles per year	Energy consumption	Fresh water consumption	Rinse aid consumption	Detergent consumption
		kWh/year	litres/year	kg/year	kg/year
No 1 Undercounter water-change	70,000	1,540	24,500	28 (integrated detergent and rinse aid)	
No 2 Undercounter one-tank	297,000	5,940	49,510	15	149
No 3 Hood-type	594,000	11,880	77,220	23	232
No 4 Utensil/Pot	9,000 cycles	7,650	54,000	16	137
No 5 One-tank conveyor-type	4,752,000	95,040	570,240	171	1,540
No 6 Multi-tank conveyor-type	9,504,000	190,080	760,320	228	2,053

Source: Calculated based on stakeholder inputs from the 2024 survey.

Due to the increased ideal number of cycles or dishes cleaned per year in all dishwasher categories (values in the 2011 study were based on 'typical use intensities' which were considering a partial workload), there is also an increase in the consumption of energy, water and detergent including rinse aid under assumed ideal conditions.

An undercounter water-change dishwasher (category 1) cleaning about 70,000 dishes per year will consume about 1,540 kWh energy and 24,500 litres of water during continuous operation under ideal conditions. The numbers of cycles are connected with a detergent and rinse aid consumption of 28 kg per year. The energy and water consumption of a multi-tank conveyor-

type dishwasher is of a different order: around 190,080 kWh of energy and 760,320 litres of water, plus 2.3 tonnes of together detergent and rinse aid, are used to wash around 9.5 million dishes per year under ideal conditions.

5.4. Real life user behaviour

Dishwasher datasheets usually state energy, water, and detergent/rinse aid consumption under ideal conditions as described in **Section 5.3**. However, there are several reasons why there are significant differences between ideal and actual consumption:

- **User behaviour** during continuous operation is usually not 'ideal':
 - Customer segments: Machines are used differently depending on the customer segment.
 - Partial workload: Racks and belts are not fully loaded, resulting in higher specific consumption per capacity.
 - Use of other programmes: Consumption data usually represent the consumption of the most used programme, but the machines are also used in other programmes. In addition, the machines are used with different crockery than the standard crockery, due to changes in customer behaviour in company canteens since the end of the Covidien pandemic.
 - Maloperation: Errors in user behaviour lead to increased consumption. Several types of misuse can be distinguished (e.g. double cleaning in case of insufficient cleaning results; incorrect dosage of detergent and rinse aid).
 - Manual pre-rinsing: many items of wash ware are actually prewashed once by hand before loading them into the dishwasher.
- The energy and water used for the **initial filling** of the tanks (water and detergent consumption, heating) and for heating and cleaning the machines are not included in the consumption data which only include the water consumption for rinsing.
- When the dishwasher is switched on, it often operates in **low-power modes** (e.g. 'ready to use' or 'left-on' mode), which can represent a relatively long period of time and corresponding additional energy consumption.

In the following sections these parameters are described in more detail and their possible influence compared to the consumption under ideal conditions is shown. Unlike household dishwashers, where the environmental impacts can be related to a single wash cycle, a large part of the environmental impact of commercial dishwashers occurs outside the actual cleaning cycle: for example, filling the tanks, waiting times (ready-to-use mode) with water reheating between cycles, and reusing the rinse water between cycles. In order to be able to consider these aspects, stakeholder feedback suggested to introduce 'daily user patterns' for the various categories. These patterns consist of a number of cycles (or for continuous conveyor machines on-times) spread during the day, with various intervals between the cycles. The total number of

cycles per year should lead to the total number of dishes washed. The assumed real-life pattern(s) will then be used to calculate the various impacts of the machines.

5.4.1. Influence of user behaviour

It has to be noted, however, that the following use data provided by manufacturers are estimated or, at best, based on a very small set of data points, as manufacturers have very little contact with final users (with a very few exceptions), mostly due to the nature of the distribution channels (typically manufacturer-importer-dealer-final user). There is no feedback available from stakeholders representing the customers of commercial dishwashers.

5.4.1.1. Partial loads

Based on the 2011 preparatory study of professional dishwashers (Lot 24), **Table 5-8**

Table 5-8 shows the average additional consumption of energy, water, and detergent/rinse aid (in percent) at typical workloads compared to full load use of the appliances.

Table 5-8: Additional consumption at real-life workload (2011 data).

Dishwasher category	Average workload	Increase of ... due to partial workload		
		specific energy consumption	specific water consumption	specific detergent / rinse aid consumption
No 1 Undercounter water-change	80 %	15 %	25 %	25 %
No 2 Undercounter one-tank	80 %	7.5 %	25 %	25 %
No 3 Hood-type	80 %	7.5 %	25 %	25 %
No 4 Utensil/Pot	60 %	7.5 %	30 %	30 %
No 5 Conveyor-type one-tank	75 %	10 %	10 %	10 %
No 6 Conveyor-type multi-tank	75 %	10 %	10 %	10 %

Source: Task 3 report of Lot 24, 2011.

For categories 2, 3, and 4, one stakeholder of the 2024 consultation considers that values from the year 2011 are still valid, another stakeholder confirms the 2011 values for categories 2 to 6. Another manufacturer states that they don't have any information on operator usage that would provide a typical standard or average, as the actual application varies greatly from operator to operator. One stakeholder informs that their data consistently shows that partial workload has a high impact on the overall efficiency of the appliance.

One stakeholder estimated that the average capacity utilisation of category 5 and 6 dishwashers is closer to 80 % than 75 %, while another stakeholder stated that the utilisation is close to 100 %

at peak times. According to the 2011 preparatory study, it was assumed that a proportion of conveyor-type dishwashers (categories 5 and 6) would detect empty spaces in the rack or on the conveyor and consequently use less water for the rinse cycle, resulting in reduced energy, water, and detergent consumption. Despite the partial adaptation of the dishwashing process, it was estimated in 2011 that the reduced load would lead to an increase in energy, water, and detergent consumption of around 10 % at 75 % workload⁹¹.

However, one stakeholder of the 2024 consultation informed that appliances with comprehensive empty-space detection capabilities are extremely rare or potentially even non-existent. In practice, most systems can only identify larger unoccupied zones, such as entire empty rows on the conveyor belt (for flight type dishwashers) or large gaps between racks (on rack conveyor dishwashers). Therefore, it was recommended that the figures should be carefully verified in any subsequent technical evaluations. Another stakeholder has the opinion that the integration of partial loads is absolutely relevant: At peak times, the racks are fully and sometimes even overloaded. During normal business operations, however, the racks are often only partially loaded. Due to the short programme times or because the appliances are running anyway (categories 5 and 6), dirty dishes are washed at any time and there is no collecting and waiting until a rack is full. Therefore, according to the stakeholder's opinion, the proportion of only partially loaded racks is higher.

Finally, two stakeholders pointed out a likely methodological error in the way how the energy, water, and detergent consumption under 'real life conditions' was calculated in the 2011 study and also in the draft version of this report presented at the first stakeholder meeting. The 'number of dishes or cycles per year' was compared to the 'annual energy consumption per appliance (kWh)'. This was done by multiplying the total annual capacity of an appliance under ideal conditions by the 'average workload' to convert the total annual capacity under ideal conditions to the annual number of dishes under 'real' conditions. Based on these values, the factors given in

Table 5-8 above for 'increase of energy / water / detergent consumption due to partial workload' were applied to calculate the resulting 'additional energy consumption (kWh/year) due to partial workload'. Based on the 2024 stakeholder feedback, this approach cannot apply as partial loading does not change the energy consumption or the water or detergent consumption due to the same programmes running with the same parameters. According to the stakeholder's information, the energy consumption is even slightly better with partial loads, as a lower wash load mass (with a high heat capacity) has to be heated up with the wash liquor. Therefore, they suggest that in

Table 5-8 above the percentage '0 %' must be consistently entered for each partial area. Partial loading can therefore only achieve a share of the possible total annual capacity with the same number of wash cycles per year, but these cycles have not consumed more energy, water or detergent due to partial loading. The confusion is probably due to the fact that the *specific* energy consumption per dish or plate naturally increases with a partial load (higher energy

⁹¹ In 2011 at that time according to DIN 10510:2008 (Professional dishwashing with multi-tank conveyor-type dishwashers – Hygiene requirements, procedure testing; page 17); meanwhile, this standard is withdrawn and integrated in EN 17735, see **Section 3.3.2**.

consumption per dish). On the one hand, this would already be clearly described with the reciprocal value of the 'average workload' (e.g. factor 75 % (0.75) leads to a specific increase of 33 % ($1/0.75 = 1.33$)) and on the other hand, this factor may no longer be used in the calculations for an adjustment of the energy consumption, as the number of dishes washed has already been reduced by 25 % to 'real life conditions'.

The study team considers this feedback to the 2011 approach to be valid and therefore uses the following approach to calculate the impact of partial loads in real-life for the current study: The estimated annual energy, water and detergent consumption under ideal conditions is still used, but these values are applied to a lower annual number of washed dishes due to partial loading (reference to updated 2024 data, see **Table 5-9**). In this sense, the *specific* energy, water, and detergent consumption per washed dish increases accordingly.

Table 5-9: Energy, water, detergent and rinse aid consumption at partial loads (2024).

Dishwasher category	Average workload	Number of dishes or cycles per year at partial load	Consumption of ... at partial load			
			Energy consumption (kWh/year)	Water consumption (litres/year)	Rinse aid consumption (kg/year)	Detergent consumption (kg/year)
No 1 Undercounter water-change	75 %	52,500 dishes	1,540	24,500	28 (integrated detergent and rinse aid)	
No 2 Undercounter one-tank	80 %	237,600 dishes	5,940	49,510	15	149
No 3 Hood-type	80 %	475,200 dishes	11,880	77,220	23	232
No 4 Utensil/Pot	60 %	9,000 cycles	7,650	54,000	16	137
No 5 Conveyor-type one-tank	80 %	3,801,600 dishes	95,040	570,240	171	1,540
No 6 Conveyor-type multi-tank	80 %	7,603,200 dishes	190,080	760,320	228	2,053

Source: Calculated based on stakeholder input from 2024 consultation.

The following **Table 5-10** shows the resulting effect of partial loading under real-life conditions on the specific consumption of energy, water and detergent / rinse aid per 100 dishes.

Table 5-10: Specific energy, water, detergent, and rinse aid consumption of commercial dishwashers under real-life (partial load) conditions (2024).

Dishwasher category	Specific energy consumption (partial load)	Specific water consumption (partial load)	Specific detergent / rinse aid consumption (partial load)	Specific detergent consumption (partial load)
	kWh/100 dishes ⁹²	litre/100 dishes	g/100 dishes	g/100 dishes
No 1 Undercounter water-change	2.93	46.7	53 (integrated detergent and rinse aid)	
No 2 Undercounter one-tank	2.5	20.8	6	63
No 3 Hood-type	2.5	16.3	5	49
No 4 Utensil/Pot	1.42 kWh per cycle	10 litres per cycle	3 g per cycle	25 g per cycle
No 5 Conveyor-type one-tank	2.5	15.0	5	41
No 6 Conveyor-type multi-tank	2.5	10.0	3	27

Source: Calculated based on stakeholder input from 2024 consultation.

5.4.1.2. Use of other programmes

The performance of the dishwashing process depends on four factors:

- thermal action (i.e. water temperature),
- mechanical action,
- chemical action (i.e. detergent concentration), and
- cycle time.

The selection of the dishwashing programme also influences the energy, water, and detergent/rinse aid consumption. In the 2011 preparatory study, in addition to the 'standard'

⁹² In case of category 4, values are given per cycle.

programme⁹³, i.e. most commonly used programme at that time, two other common programmes were defined for the six categories of commercial dishwashers, as shown in the table below, each with a short and a long running cycle. These programmes differed from the basic programme mainly in terms of duration and corresponding cleaning performance. To achieve a good hygienic result, the detergent needs some time to dissolve the soil. Therefore, a minimum wash time is required.

Commercial dishwashers are generally characterised by high cleaning performance with short programme durations. According to the 2011 preparatory study, a single wash cycle (without drying) in the basic programme of a tank-type dishwasher typically takes around 120 seconds. In order to achieve a good cleaning result, the other factors need to be adjusted accordingly. Short cycles of between 60 and 90 seconds are associated with a reduced cleaning performance of the dishwashing process, as the other influencing parameters (water temperature, mechanical action, and detergent concentration) are kept constant compared to the basic programme. As a result, shorter cycles are usually only used for less soiled dishes. Correspondingly, longer wash cycles have a better cleaning performance and are usually used for more heavily soiled dishes. The situation is slightly different water-change machines.

As it is easier to change, for example, the water temperature (as there is no need to heat a full wash tank), shorter programme durations do not necessarily result in lower cleaning performance, as they can be combined with higher temperatures. Depending on the type of dishes to be washed, the degree of soiling and the time requirements of the situation, several programmes can be selected.

According to 2024 stakeholder feedback, however, these findings from the 2011 preparatory study are no longer fully applicable today. Thanks to modern electronics, multiple parameters can nowadays be adjusted for each washing programme, extending beyond just the programme time. This flexibility applies not only to category 1 machines but also to categories 2 to 6. Users can select from various programmes based on time requirements, specific situations, types of items to be washed, and degrees of soiling. Importantly, it is no longer accurate to assume that shorter programs necessarily result in lower cleaning performance.

Other stakeholders state that the current machines are equipped with electronic controls that make it easy to create customised programmes and even symbols that meet customer needs or priorities. This could be high capacity, perfect cleaning or drying results, specific wash ware needs, low noise, or low energy consumption. Hygiene is always a priority. But according to the Sinner Circle, it is possible to optimally control temperature, mechanics, time, and chemicals to meet customer priorities. Since this is very individual, it is not possible for the responding stakeholders to give a percentage figure. Therefore, the figures in **Table 5-11** below are considered workable for the average user behaviour.

According to stakeholder feedback, 'more stringent hygiene results' or 'hygiene-focused programmes' can be referred to as 'thermal-disinfection programmes'. Thermal disinfection is

⁹³ In 2011, there was no mandatory standard / standard programme for measuring the energy, water, and detergent consumption of commercial dishwashers. Therefore, the text in this section referring to the 2011 data uses the term 'standard' programme which is equivalent to the most used programme.

more frequently required by national health services in some countries for dishwashing machines used in foodservice operations in wards with specific risks. For example, in UK it was mandated after several *Escherichia coli* outbreaks. During the COVID-19 pandemic, thermal disinfection was viewed by both users and manufacturers as an effective method to address the public's heightened demand for robust hygiene assurance. One stakeholder pointed out that the thermal-disinfection programmes (i.e. very long-running programmes) are only used under certain conditions, for example, a norovirus outbreak. Another stakeholder details that some machines have special 'high hygiene' cycles with higher consumption, mostly to comply with some specific requests by specific users (most of which rely on US standard which normally require higher temperatures). There are also shorter, less energy-consuming cycles, which should be used only for 'less dirty' objects. As it is impossible to say which cycle is used with which frequency, the stakeholder therefore recommends that special programmes should not be included in the calculation of actual use, as they are not the typical programmes used to wash normally soiled dishes. However, according to the stakeholder, hygiene could be a next trend, but is still in development.

The following table (based on the 2011 preparatory study), shows a shorter and a longer programme compared to the basic setting ('universal' programme) for undercounter water-change machines with the same characteristics as commercial tank dishwashers: in the case of the shorter programme the other parameters are (mainly) kept constant, resulting in a lower cleaning performance (i.e. suitable for less soiled dishes) and lower consumption parameters. The situation is reversed for the longer programme. The key parameters set out in **Table 5-11**, based on feedback from stakeholders in 2011, are:

- Duration of the wash cycle,
- Frequency of use of the different programmes,
- Impact of other programmes on energy, water and detergent consumption compared to the basic setting (assumed to be 100 %).

The original table from the 2011 preparatory study was part of the 2024 stakeholder consultation and stakeholders were asked to provide feedback or update the data. It can be seen that, depending on the technology and the dishwashing process the consumption of energy, water, and detergent/rinse aid in the long and short running cycles can be different compared to the 'standard' programme. However, the overall impact of these differences is quite small compared to the total real-life consumption of energy and water (see rows 'Average consumption in comparison to standard consumption' in the table below).

One stakeholder confirmed an increased amount of washing programmes. Diversification of the programmes is caused by performance test requirements (EN IEC 63136) but also due to the fact that new types of wash ware were introduced into the market, e.g. reusable cups, bowls etc. which require a special treatment to achieve the required hygiene result.

3411 **Table 5-11: Programme selection and its influence on energy, water, and detergent**
 3412 **consumption (2011, 2024).**

Type of programme		Duration of programme	Share of programme	Relative consumption of		
				Energy	Water	Detergent
No 1: Undercounter water-change						
A	Basic setting	8 min (16 min)	45% (80%)	-	-	-
B	Short running programme	5 min (6 min)	45% (10%)	-36.4%	- 54.3%	0%
C	Long running programme	35-60 min (20 min)	10% (10%)	+36.4%	+72%	0%
Average consumption in comparison to standard consumption				87%	83%	100%
No 2: Undercounter one-tank						
A	Basic setting	120 sec	70%	-	-	-
B	Short running programme	60-90 sec (60 sec)	25%	-10%	0%	0%
C	Long running programme	240 sec (180 sec); up to 630 sec for thermal-disinfection programmes	5%	+10%	0%	0%
Average consumption in comparison to standard consumption				98%	100%	100%
No 3: Hood-type						
A	Basic setting	84-120 sec (120 sec)	80%	-	-	-
B	Short running programme	45-60 sec (60 sec)	15%	-10%	0%	0%
C	Long running programme	150-210 sec (180 sec); up to 630 sec for thermal-disinfection programmes	5%	+10%	0%	0%
Average consumption in comparison to standard consumption				99%	100%	100%
No 4: Utensil / Pot dishwashers						
A	Basic setting	150-360 sec	60%	-	-	-
B	Short running programme	90-180 sec	10% (5%)	-10%	0%	0%
C	Long running programme	300-540 sec, up to 1,200 sec	30% (35%)	+10%	0%	0%
Average consumption in comparison to standard consumption				102%	100%	100%
No 5: One-tank conveyor-type						

Type of programme		Duration of programme	Share of programme	Relative consumption of		
A	Basic setting	40-120 sec (120 sec)	80% (90%)	-	-	-
B	Short running programme	90 sec	10%	-25%	-25%	-25%
C	Long running programme	180 sec	10% (0%)	+50%	+50%	+50%
Average consumption in comparison to standard consumption				103%	103%	103%
No 6: Multi-tank conveyor-type						
A	Basic setting	24-120 sec (120 sec)	80%	-	-	-
B	Short running programme	12-90 sec (90 sec)	10%	-25%	-25%	-25%
C	Long running programme	40-180 sec (180 sec)	10%	+50%	+50%	+50%
Average consumption in comparison to standard consumption				103%	103%	103%

Source: 2011 preparatory study; stakeholder feedback from the 2024 survey; text in red: updated data compared to 2011 values.

5.4.1.3. Maloperation

Maloperation of commercial dishwashers can affect the energy, water, detergent, and rinse aid consumption. The main reasons for incorrect operation of commercial dishwashers are as follows:

- The wrong programme has been selected and the washing process must be repeated because the result is not satisfactory.
- The concentration of the detergent and rinse aid is insufficient, and the result is not acceptable. The washing process must be repeated. This happens when the detergent or rinse aid container is empty, and the user does not pay attention to the corresponding signal.
- The detergent concentration is too high, resulting in cords and stripes (detergent residue on the dishes).
- Flight type dishwashers tend to stop when the items are not removed at the end of the belt. If such breaks occur and the machine is not put into standby (ready-to use or left-on) mode, the specific energy and water consumption increases significantly.

The dosage of the detergent and rinse aid can be determined by

- Specialist service providers,
- the dishwasher manufacturer or
- the operators of the dishwashers.

In the first two cases, detergent misdosing is rare, because service providers and manufacturers have a strong interest in achieving good dishwashing results using as little detergent as possible and will therefore take great care to ensure that the correct concentration of detergent and rinse aid is available. One stakeholder confirms that this is true when the dosage of chemicals is provided by the manufacturer, particularly if they sell or recommend a specific chemical. However, according to the stakeholder's view this does not apply to service providers unaffiliated with manufacturers, especially if they sell the chemicals themselves, as their interest would be in selling more chemicals. In their experience, the use of unsuitable chemicals and/or their misdosing is one frequent form of maloperation. In the third case, incorrect dosing may occur from time to time, e.g. in the case of untrained personnel.

The impact of operator error is difficult to quantify as it can vary greatly from user to user and also depends on how the dishwashing process is organised in general. For example, in market segments with commercial dishwashers, where manual programme settings and dosage are used by untrained personnel, the error rate may be higher than in market segments with highly trained personnel and machines with higher degree of automation. In the absence of differentiated feedback from customers, the 2011 preparatory study assumed that the impact on the energy, water and detergent consumption is on average in the range of +10 % of the nominal consumption of the dishwashers for categories 1 to 4 and +5 % of the nominal consumption of the dishwasher for categories 5 and 6.

While more than half of the stakeholders who responded to the 2024 survey felt that the values from 2011 were still valid, some stakeholders disagreed with these assumptions.

One stakeholder argued that it is extremely difficult to estimate these percentages. Without having any real, solid data to support this claim and with the caveat that there is a huge variation in each category depending very much on the specific installation/type of customer, the stakeholder estimates that the impact of misuse on conveying machines (categories 5 and 6) should be higher, at least taking into account the fact that these machines quite often do not work at full load and thus some energy is wasted on empty spaces (even if many machines today have some means to prevent/limit this kind of misuse). However, this effect on partial workload is already considered in **Section 5.4.1.1**.

Two stakeholders confirm +10 % for category 1 as these machines are mainly used by untrained users and because there are many more individual programmes depending on the very different loads (including having 2 racks per cycle). On the other hand, for categories 2 to 4 they suggest that the impact of misuse is lower than in 2011, at +5 %, as the automatic programme starts after the door is closed, making misuse impossible. On this aspect, however, another stakeholder questioned how the starting of the programme after closing the door relates to preventing misuse. The above listed aspects of potential misuse rather relate to customer behaviour beyond the automatic programme (additional cycles due to insufficient cleaning results, and similar).

Although in individual cases, different tolerances may be necessary in individual cases for specific types of equipment, as noted by one stakeholder, for the purposes of this study an average value needs to be established to provide a rough estimate of the potential impact of maloperation. Based on the 2024 stakeholder feedback, the following values will be used:

- 3476 - Category 1: +10 % of the nominal consumption of the dishwashers
- 3477 - Categories 2 to 4: +5 % of the nominal consumption of the dishwashers
- 3478 - Categories 5/6: +7.5 % of the nominal consumption of the dishwashers

3479 5.4.1.4. Manual pre-rinsing of wash ware

3480 According to the 2011 preparatory study, the *manual* pre-cleaning of the wash ware outside the
 3481 machine (one stakeholder informed that pre-cleaning is available, for example, for a certain
 3482 model of hood type machines) as well as the manual cleaning of the dishwashing machines after
 3483 the running cycles might cause considerably further water and energy consumption in the whole
 3484 washing process. The inclusion of the whole process from dirty to clean (including the manual
 3485 pre-soak and pre-cleaning of the wash ware outside the machine as well as the manual machine
 3486 cleaning) would be rather desirable. However, the water and energy⁹⁴ consumption is strongly
 3487 dependent on the specific user behaviour, the soiling of the wash ware and the machines, the
 3488 existing infrastructure, and other factors⁹⁵. Further, there is no standard measurement method
 3489 and at that time no reliable data to record the average consumption through external pre-
 3490 cleaning of the wash ware or cleaning of the machines. Thus, the manual process steps outside
 3491 the dishwashing machines were excluded from the scope and were not included in the
 3492 consumption values under real-life usage conditions of the 2011 study.

3493 For the updated 2024 preparatory study, a study by Kerschgens et al. (2021) can be taken as
 3494 information basis. They conducted an independent survey on commercial dishwasher usage in
 3495 Germany and Denmark in 200 commercial enterprises and analysed inter alia the manual pre-
 3496 rinsing of items.

3497 The study informs that in passthrough or hood-type and conveyor dishwashers the dishes are
 3498 usually rinsed in the washing rack with the help of a hand spray during pre-washing. A
 3499 preliminary test was carried out to determine the water flow of a spray and the average time
 3500 required to rinse a washing rack. These values were used to calculate an average consumption
 3501 of 0.39 litres/rack. Based on the cleaning cycles per day, the water consumption for pre-rinsing
 3502 hood-type and conveyor dishwashers (categories 3, 5, and 6) was calculated according to the
 3503 following equation:

$$3504 \text{ water consumption}_{\text{hood \& conveyour type}} = 0.39 \text{ litres} * \text{rinse cycles per day}$$

3505 In the case of commercial single-tank and water-change machines (categories 1 and 2) there is
 3506 no separate technical structure for pre-rinsing. Each item to be washed is pre-rinsed individually.

⁹⁴ Energy consumption: due to the use of warm water for cleaning.

⁹⁵ For example, the use of active filter systems can reduce the dirtiness of the wash water through the separation of food residues during the dishwashing process and transporting them out of the machine.

The value of 0.73 litres/item was assumed in that study. The water consumption for pre-rinsing per day for water-change and single tank dishwashers is calculated according to the following equation:

$$\text{water consumption}_{\text{undercounter}} = 0.73 \text{ litres} * \Sigma \text{ washing-up items per day}$$

Kerschgens et al. (2021) found that more than 70 % of establishments in the 'catering' sections pre-rinse their items. More than two-thirds of the businesses in the 'canteens' category and 50 % in the nursing sector pre-rinse all their items. Around 30 % of the hotel establishments do pre-rinse every item. Also, one-third of the day-care centres also pre-rinses all their items. In summary, almost half of the businesses surveyed in that study said that they prerinse all their dishes before putting them in the dishwasher (the reasons for the pre-rinsing behaviour were not further questioned in the study; it could be done, for example, because users are dissatisfied with the cleaning result, it could be done on the instructions of a supervisor, or it is done because of the technical setup in the dishwashing kitchen).

Regarding the water consumption per day during pre-rinsing Kerschgens et al. (2021) calculated that the half of the hotels uses between 20 and 150 litres of water for pre-rinsing. Half of the nursing facilities surveyed consume between 20 and 170 litres of water. An average of 200 litres of water is used for pre-rinsing in day-care centres. Some day-care centres even use up to 700 litres of water. An average of 80 litres of water is used for pre-rinsing in canteens.

Finally, the study references the following water consumption per 100 items for pre-rinse in litres (**Table 5-12**, left column). Based on the annual number of dishes washed per year under real-life conditions (see

Table 5-9) and assuming 50 % as average share of manual pre-rinsing of all dishes according to Kerschgens et al. (2021), the additional water consumption is between 21,000 and 228,000 litres per year depending on the dishwasher category (**Table 5-12**, right column). For simplification, it is further assumed that the manual pre-rinsing is done with cold water, i.e. there is no additional energy consumption for using hot water.

Table 5-12: Additional water consumption for pre-rinse.

Dishwasher category	Additional water consumption for pre-rinse (litres per 100 items)	Additional water consumption for pre-rinse (litres per year)
No 1 Undercounter water-change	81	21,263
No 2 Undercounter one-tank	86	102,168
No 3 Hood-type	21	49,896
No 4 Utensil/Pot	no information	no information
No 5 Conveyor-type one-tank	6	114,048

Dishwasher category	Additional water consumption for pre-rinse (litres per 100 items)	Additional water consumption for pre-rinse (litres per year)
No 6 Conveyor-type multi-tank	6	228,096

3534 Source: Kerschgens et al. (2021).

3535 5.4.1.5. Use of other wash ware than standard plates

3536 According to Kerschgens et al. (2021) who conducted an independent survey on commercial
 3537 dishwasher usage in Germany and Denmark in 200 commercial enterprises, the share of plates
 3538 in the surveyed enterprises only makes about 20 to 25 % among the distribution of the different
 3539 kinds of wash ware. Other items are for example cutlery, cups, glasses, plastic dishes, and others.
 3540 The businesses participating reported that 26 to 46 % of their daily items to be washed up
 3541 consist of cutlery. The second largest share of the total items to be washed up, are plates (16 to
 3542 25 %). Children's day-care centres have the highest proportion of dishes made of plastic – about
 3543 14 %. Pots, chopping-boards, cooking utensils and bowls make up only a small proportion
 3544 (between 1.0 % and 2.5 %) of all dishes to be washed.

3545 The impact of wash ware different to standard items in real life user behaviour compared to
 3546 ideal (standard use) could be for example a different number of dishes per cycle and year or the
 3547 use of different programmes. However, as no detailed information on these effects is available,
 3548 these impacts are not considered in the following calculations of the real-life consumption.

3549 5.4.2. Influence of initial filling and heating of tanks

3550 The consumption data for commercial dishwashing machines under ideal conditions (see
 3551 **Section 5.3.2**) do not include the initial filling and heating of the wash tanks at the start of the
 3552 process (applicable to all tank machines, i.e. categories 2 to 6). This amount of energy (for the
 3553 heating of the water), water (**Section 5.3.2** only includes the water consumption of the
 3554 freshwater rinsing) and detergent needs to be considered as it may represent a significant part
 3555 of the consumption figures. Of course, the importance depends on the intensity of use of the
 3556 dishwashers. The more dishwashing cycles (or hours of cleaning) performed, the lower the
 3557 proportion of energy and water used for the initial filling and heating of the wash tanks.

3558 It is also relevant whether the first filling is done with cold or hot water (see **Section 5.6.1**). In
 3559 the case of hot water, according to stakeholder feedback, a minimum of additional energy is
 3560 needed compared to cold water connection in order to hold the temperature. For the further
 3561 calculations, however, this is assumed to be negligible and is therefore not considered.

3562 In order to calculate the annual water and energy demand of the initial filling and heating of the
 3563 wash tanks the following parameters must be specified:

- 3564 - Number of working days per year,

- 3565 - Number of working shifts per day (as the wash tanks have to be emptied and refilled
3566 each time)⁹⁶,
- 3567 - Volume of the wash tanks,
- 3568 - Share of the cold water and hot water connections of commercial dishwashers (see
3569 **Table 5-26**)
- 3570 - Temperature of inlet water (15 °C) and operating temperature of wash tanks
3571 (60 °C), i.e. the temperature difference for heating the inlet water is 45 K. In the
3572 case of hot water load, no direct energy is required by the dishwasher itself to heat
3573 the detergent solution of the first load (the environmental impact should be
3574 calculated by considering the average upstream chains of hot water provision),
3575 however, a minimum of additional energy is needed compared to cold water
3576 connection in order to hold the temperature (considered negligible for the further
3577 calculations),
- 3578 - Heat capacity of water, which is 4.19 kJ/(kg*K), and
- 3579 - Efficiency of the cold-water heating process which is assumed to be 90 %, i.e. an
3580 assumed 10 % efficiency loss of the machine and boiler.

3581 **Table 5-13** shows the parameters for the different dishwasher categories with updated
3582 information from the 2024 analysis of product datasheets and stakeholder consultation.

3583 **Table 5-13: Input parameters for calculation of consumption through initial filling and heating**
3584 **of wash tanks (2024).**

Dishwasher category	Number of working days per year ⁹⁷	Number of working shifts per day	Volume of wash tank(s) ⁹⁸ (in brackets: assumed average)	Operating temperature of wash tank(s) ⁹⁸ (in brackets: assumed average)
No 1 Undercounter water-change	200	2	n.a.	n.a.
No 2 Undercounter one-tank	300	2	8-25 litres (15)	55-65°C (60°C)
No 3 Hood-type	300	2	14-60 litres (40)	55-65°C (60°C)

⁹⁶ The initial fills per day depend on the level of soiling. One shift always takes place, and often a second filling at shift change. One stakeholder informs that the number of initial fills varies significantly among different types of Food Service facilities. This variation is influenced by several factors as for example the menu (which determines the type of food residuals on dishes), the pre-treatment of dishes before washing, the Food Service facilities' internal procedures and the attention paid by the operators to washing solution conditions. However, in the end, the assumed two working shifts per day as average were confirmed by 2024 stakeholder feedback.

⁹⁷ cf. Table 5-3

⁹⁸ cf. machine characteristics as shown in Section 6.2.2

Dishwasher category	Number of working days per year ⁹⁷	Number of working shifts per day	Volume of wash tank(s) ⁹⁸ (in brackets: assumed average)	Operating temperature of wash tank(s) ⁹⁸ (in brackets: assumed average)
No 4 Utensil / Pot	300	2	60-130 litres (100)	55-65°C (60°C)
No 5 One-tank conveyor-type	330	2	70-130 litres (120)	55-65°C (60°C)
No 6 Multi-tank conveyor-type	330	2	130-750 litres, with an average of 100-400 litres per single tank (a machine can have multiple tanks) (250)	55-65°C (60°C)

3585 n.a. not applicable

3586 With these assumptions the annual energy consumption (i.e. only the direct energy demand by
 3587 the dishwasher itself), water and detergent consumption of two tank loads and the initial
 3588 heating of the tank water can be calculated. The total amount of tank water is split according to
 3589 the shares of cold water and hot water connections referenced in **Table 5-26**, assuming that this
 3590 share of available connections is comparable to the real-life usage of the hot water connection.

3591 The column 'cold water fills' shows the direct energy demand of the dishwasher, i.e. the amount
 3592 of electricity required to heat the cold water at 15 °C to a temperature of 60 °C inside the
 3593 dishwasher itself. For the filling with 'hot water', no direct energy demand of the dishwasher is
 3594 required as the water is heated outside of the dishwasher. The related energy consumption will
 3595 be considered when calculating the total environmental impacts in Task 5.

3596 Further, it is assumed that in addition to the detergent and rinse aid consumption under
 3597 continuous operation as already calculated in **Section 5.3.2**, the tank fills at the start of a work
 3598 shift also include an initial detergent load (without rinse aid) according to the detergent
 3599 concentration of 3 g/l as listed in **Section 5.2.3**.

3600 **Table 5-14: Energy, water, and detergent consumption for two fills and heating of wash tanks**
 3601 **(2024).**

Dishwasher category	Water consumption				Energy consumption	Detergent consumption
	Total consumption of tank fills	Share: cold water consumption	Share: hot water consumption	Cold water fills	Hot water fills*	
	litres/year	litres/year	litres/year	kWh/ year	kWh/ year	kg/ year
No 1 Undercounter water-change	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Dishwasher category	Water consumption				Energy consumption	Detergent consumption
No 2 Undercounter one-tank	9,000	7,200	1,800	419	*	27
No 3 Hood-type	24,000	18,000	6,000	1,048	*	72
No 4 Utensil/Pot	60,000	42,000	18,000	2,444	*	180
No 5 One-tank conveyor-type	79,200	47,520	31,680	2,765	*	238
No 6 Multi-tank conveyor-type	165,000	99,000	66,000	5,761	*	495

3602 n.a. not applicable

3603 * hot water heating requires indirect energy demand outside of the dishwasher; the environmental impacts will be

3604 modelled in Task 5

3605 5.4.3. Influence of low-power modes consumption

3606 According to stakeholder feedback, the following different modes need to be distinguished for
3607 commercial dishwashers (tank dishwashers, categories 2 to 6):

- 3608 - 'Active mode', i.e. when the machine is performing a wash cycle,
- 3609 - A significant part of energy consumption happens between the cycles with two
3610 completely different situations:
 - 3611 ○ 1) The machine is heating up ('ready to use mode'), i.e. the temperature
3612 settings shall be reached before performing a washing cycle. Ready-to-use
3613 mode, where water in the tank and/or the boiler is kept warm but not
3614 currently performing a washing cycle. In this mode, a washing cycle can be
3615 started whenever needed.
 - 3616 ○ 2) The operational temperatures are already reached, the water in the tank
3617 and/or the boiler has not to be further kept warm and thus the energy
3618 consumption is almost zero (only display/control circuits or a LED are active,
3619 while loads such as heating elements are not active).
- 3620 - Off-mode, when the dishwasher is disconnected, i.e. not electrically supplied.

3621 Off-mode energy consumption and also the energy consumption when the machine is neither
3622 disconnected nor in the ready to use mode are not taken into account: For the smaller
3623 dishwashers, the off-mode consumption is negligible compared to the total energy

consumption.⁹⁹ According to the 2011 preparatory study, large conveyor-type dishwashers are disconnected from the circuit by a power switch so no power is consumed in off-mode at all. Therefore, off-mode has not been considered in the following sections and tasks. In the 2024 stakeholder consultation, all responding stakeholders confirmed that off-mode consumption is not relevant for commercial dishwashers (less than 1 kWh per year).

For household dishwashers, the aim is to reduce the standby consumption when the user does not switch off the appliance after use by setting low standby ecodesign requirements. Usually, this does not affect the usability of the appliance.

For commercial dishwashers, under real conditions, the appliances are usually switched on at the start of the work shift to establish the operating status. According to stakeholder feedback this happens regardless of the fact that soiled dishes are due to be washed in the foreseeable coming period. This means that the appliances (i.e. in this case tank dishwashers in categories 2 to 6) are in a so called 'ready to use' mode for a longer period of time (sometimes several hours depending on the business) and are heated up which means a significant energy consumption without the appliances being used at all. The higher consumption of the so called 'ready to use' mode of commercial dishwashers compared to the standby consumption of household appliances is due to the continuous heating of the tank in order to avoid long preheating times. Due to their wash tank that has to be preheated and kept on a certain heat level, categories 2 to 6 have to be kept in a so called 'ready to use' mode between the dishwashing cycles. For categories 2 and 3, the measurement of the power consumption of the 'ready to use' mode is specified in EN IEC 63136 (see **Section 3.3.1.1**).

Category 1 machines do not have a 'ready to use' mode; due to their water-change technology they can be used immediately. However, they may not be switched off immediately at the end of the programme and therefore remain in 'left-on mode' for some time. The 2024 stakeholder consultation confirmed the category 1 values. Further, a stakeholder informed that when loading and unloading, the device is in 'left-on-mode' and consumes around 0.004 to 0.005 kW (half of the 0.01 kW assumed in the study). No later than 10 minutes after the user's last action, the device goes into standby mode, which reduces energy consumption even further. Therefore, these values were considered negligible.

In the 2011 preparatory study, the time in 'ready to use' mode for tank dishwashers and the 'left on' mode for water-change dishwashers of each category was calculated (see **Table 5-15**), based on the assumptions of the average active running time as shown in **Table 5-3** and the stakeholder feedback on the total time switched on¹⁰⁰.

⁹⁹ Assumption of the 2011 preparatory study: Cat. 1 is comparable to household dishwashers. Within the initial Ecodesign preparatory study for household dishwashers, the off-mode consumption of household dishwashers has been calculated with 0.00016 kWh/h for 8,000 hours/year being in off-mode: resulting in an annual off-mode consumption of around 1 kWh. In the commercial context, this consumption might even be lower as machines are more often operating thus reducing the hours in off-mode.

¹⁰⁰ According to stakeholders' feedback in 2011, the machines of category 2 to 6 are usually switched on for approximately 10 hours a day, while category 1 is switched on for 4 hours.

The current preparatory study did not update the different time clusters but rather asked for feedback on the calculated 2011 data. Based on the stakeholder feedback in 2024, different values were provided for the daily time that the machines are switched on from the start until the end of the daily work shift¹⁰¹, and also slightly different estimates for the hours per day that the commercial dishwashers are in 'ready to use' mode. On the other hand, only small deviations were reported by stakeholders for the consumption ranges of the 'ready to use' mode for tank dishwashers and 'left on' mode for water-change dishwashers compared to the 2011 values.

Table 5-15: Typical time and consumption of low-power modes (ready-to-use mode, left-on mode) of commercial dishwashers (2024).

Dishwasher category	Average time switched on in hours per day	Time in low power modes in hours per day		Low-power mode consumption (range in kW)
		Ready to use mode	Left-on-mode	
No 1 Undercounter water-change	4,0	n.a.	2.6	0.01
No 2 Undercounter one-tank	10 14	6 12	n.a.	0.1-0.3
No 3 Hood-type	10 14	7 10	n.a.	0.2-0.45
No 4 Utensil / Pot	10 12	7 11	n.a.	0.1-1.00
No 5 One-tank conveyor-type	10 15	4 6	n.a.	0.8-2.1
No 6 Multi-tank conveyor-type	10 15	4 6	n.a.	1.5-2.2

Source: Stakeholder feedback from the 2024 survey.

n.a. not applicable

As can be seen, dishwashers with higher capacities and more intensive use have shorter times in ready-to-use mode. On the other hand, their power consumption is higher, mainly due to energy losses from the tanks. Keeping the water tanks at high temperatures causes losses through convective heat transfer and steam generation. Additional consumption can be caused by the ventilation system and the electronic control system. Multi-tank conveyor dishwashers have the highest ready-to-use mode consumption.

The average energy consumption of water tank machines in ready-to-use mode is estimated to be around 2 kW. Water-change dishwashers (category 1) have very low energy consumption values in their 'left on' mode.¹⁰²

¹⁰¹ The time when the machines are switched on covers the total work shift, incl. the cycle periods and the ready-to-use or left-on mode until the machine is switched off at the end of the day.

¹⁰² Note: Formally, commercial dishwashers do not fall under the Commission Regulations (EC) No. 1275/2008 and (EU) 2023/826 on standby and networked standby, cf. Task 1).

5.4.4. Energy, water and detergent consumption under real-life usage conditions

The following **Table 5-16** summarises the different influencing parameters of the above sections and shows the annual consumption of energy, water, detergent, and rinse aid for each of the six dishwasher categories under real-life usage conditions. The results show that under real-life conditions the additional consumption of energy, water, detergent, and rinse aid might be significantly higher compared to ideal conditions. The higher water consumption values in comparison to 2011 values can be explained by the effect of considering the manual pre-rinsing of the wash ware. For the tank-type machines, the 2011 preparatory study only considered one initial filling of the tanks per day in its calculation of the energy and water consumption, although the data suggest two shifts per day. The one additional tank filling per day makes a significant contribution to the total energy and water consumption. Also, the energy consumption of tank-type machines due to their 'ready to use' mode has not been included in the calculation of the real-life energy consumption in 2011. Finally, for categories 3, 5 and 6, the cycle times and the number of dishes washed per year have increased significantly compared to the 2011 values, according to stakeholder feedback.

Further stakeholder feedback suggests that an increase in consumption compared to the 2011 data is also directly related to the different market segmentation post-pandemic and less trained personnel. This picture is still consolidating.

Table 5-16: Annual energy, water, and detergent consumption (real life conditions) (2011, 2024).

Dishwasher categories	Number of dishes or cycles per year	Annual energy consumption per appliance (kWh)	Annual water consumption per appliance (litres)	Annual detergent consumption per appliance (kg)	Annual rinse aid consumption per appliance (kg)
No 1 Undercounter water-change	52,500 (24,000)	1,503 (1,254)	43,990 (25,920)		31* (87)
No 2 Undercounter one-tank	237,600 (237,600)	6,969 (5,253)	163,153 (55,822)	183 (188)	16
No 3 Hood-type	475,200 (345,600)	14,066 (8,258)	154,977 (86,650)	315 (292)	24
No 4 Utensil / Pot	9,000 cycles (9,000) cycles	12,115 (8,913)	116,700 (89,520)	324 (294)	17
No 5 One-tank conveyor-type	3,801,600 (1,515,900)	109,463 (37,703)	820,512 (255,686)	1,931 (865)	188
No 6 Multi-tank conveyor-type	7,603,200 (4,009,500)	217,597 (102,229)	1,229,448 (643,645)	2,753 (2,146)	251

* integrated detergent and rinse aid consumption for Category 1 Undercounter water-change machines

Source: own calculations.

3700 The tables **Table 5-17** to **Table 5-20** below show in detail the additional energy, water, and
3701 detergent consumption due to partial workload, use of different programmes, maloperation,
3702 first fill, and standby.

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3703 **Table 5-17: Additional energy consumption (real life conditions).**

Dishwasher category	Ideal energy consumption (kWh/year)	Additional energy consumption (kWh/year) due to...				Real energy consumption (kWh/year)	Specific energy consumption real-life (kWh/100 dishes)
		...different programmes	...mal-operation	...initial tank fills (cold water)	...standby		
No 1 Undercounter water-change	1,540	-196	154	n.a.	5	1,503	2.86
No 2 Undercounter one-tank	5,940	-119	297	419	432	6,969	2.93
No 3 Hood-type	11,880	-119	594	1,048	663	14,066	2.96
No 4 Utensil/Pot	7,650	153	383	2,444	1,485	12,115	1.35
No 5 Conveyor-type one-tank	95,040	2,376	7,128	2,765	2,153	109,463	2.88
No 6 Conveyor-type multi-tank	190,080	4,752	14,256	5,761	2,747	217,597	2.86

3704 * Categories 2 to 6: standby = consumption due to 'ready to use' mode

3705

3706 **Table 5-18: Additional water consumption (real life conditions).**

Dishwasher category	Ideal water consumption (litres/year)	Additional water consumption (litres/year) due to...					Real water consumption	Specific water consumption real life (litres/100 dishes)
		...different programmes	...mal-operation	...initial tank fills (cold and warm water)	...manual pre-rinsing	...standby		
No 1 Undercounter water-change	24,500	-4,223	2,450	n.a.	21,263	n.a.	43,990	84
No 2 Undercounter one-tank	49,510	0	2,475	9,000	102,168	n.a.	163,153	69
No 3 Hood-type	77,220	0	3,861	24,000	49,896	n.a.	154,977	33
No 4 Utensil/Pot	54,000	0	2,700	60,000	no information	n.a.	116,700	13
No 5 Conveyor-type one-tank	570,240	14,256	42,768	79,200	114,048	n.a.	820,512	22
No 6 Conveyor-type multi-tank	760,320	19,008	57,024	165,000	228,096	n.a.	1,229,448	16

3707

3708 **Table 5-19: Additional detergent consumption (real life conditions) of dishwasher categories.**

Dishwasher category	Ideal detergent consumption (kg/year)	Additional detergent consumption (kg/year) due to...				Real detergent consumption (kg/year)	Specific detergent consumption real life (g/100 dishes)
		...different programmes	...mal-operation	...initial tank fills	...standby		
No 1 Undercounter water-change	28	0	3	n.a.	n.a.	31	59
No 2 Undercounter one-tank	149	0	7	27	n.a.	183	77
No 3 Hood-type	232	0	12	72	n.a.	315	66
No 4 Utensil/Pot	137	0	7	180	n.a.	324	36
No 5 Conveyor-type one-tank	1,540	38	115	238	n.a.	1,931	51
No 6 Conveyor-type multi-tank	2,053	51	154	495	n.a.	2,753	36

3709

3710 **Table 5-20: Additional rinse aid consumption (real life conditions) of dishwasher categories.**

Dishwasher category	Ideal rinse aid consumption (kg/year)	Additional rinse aid consumption (kg/year) due to...				Real rinse aid consumption	Specific rinse aid consumption real life (g/100 dishes)
		...different programmes	...mal-operation	...initial tank fills	...standby		
No 1 Undercounter water-change	see above, integrated detergent and rinse aid						
No 2 Undercounter one-tank	15	0	1	n.a.	n.a.	16	7
No 3 Hood-type	23	0	1	n.a.	n.a.	24	5
No 4 Utensil/Pot	16	0	1	n.a.	n.a.	17	2
No 5 Conveyor-type one-tank	171	4	13	n.a.	n.a.	188	5
No 6 Conveyor-type multi-tank	228	6	17	n.a.	n.a.	251	3

3711

5.4.5. Best practice in sustainable product use

The 2011 preparatory study identified a number of measures to optimise user behaviour and consumption parameters of commercial dishwashers. These included:

- Training, incentives, and responsibilities of machine operators
- Automated information and control systems
- One-button machines for ease of use and to reduce misuse. However, on this point, stakeholder feedback informs that a 'one-button' solution, while aiming to reduce misuse, is not suitable for category 1 dishwashers and would contradict sustainability goals by ignoring the efficiency gains achieved through programme-specific adjustments. The trend in appliances is shifting towards more programmes tailored to specific dish types and materials, driven by the need to optimise energy and water consumption while meeting diverse customer requirements. With advancements in materials for wash ware, such as plastics and glass, the demand for application-specific programmes that ensure both effective and gentle cleaning is steadily increasing according to the stakeholder's information. In this context, optimised user guidance through symbol-based graphical user interfaces (GUIs) enhances ease of use.
- Sensor systems to regulate the water consumption.
- Sensor systems to regulate the detergent concentration (added based on 2024 stakeholder feedback).
- Automatic programmes that detect the degree of soiling and adjust the programme parameters automatically. Reduces manual pre-rinsing and touch-up at the end. Also prevents incorrect programme selection (less programmes).
- Recyclable packaging (for smaller appliances).

A more detailed discussion of these partly technical improvement options (Best Available Technologies, BAT) will be provided in Task 4.

5.5. End-of-Life behaviour

5.5.1. Product use & stock life

Stakeholder feedback from the 2024 consultation (**Table 5-21**) suggests that commercial dishwashers are used for a relatively long time, with differences between the six categories (see also **Table 4-7** in **Section 4.3.1**). This should also be seen in the context of the high intensity of use compared to household dishwashers. One stakeholder states that the machines are repaired for as long as it is economically viable and then scrapped which means that the life time shown below can be considered as the life of the stock (time between purchase and disposal).

3746 **Table 5-21: Estimated lifespan according to stakeholder consultation (2024).**

Category	Median of estimated lifespan in years (in brackets: range of answers)
Category 1 Undercounter water-change	12 (7-15)
Category 2 Undercounter one-tank	8 (7-10)
Category 3 Hood-type	8 (7-10)
Category 4 Utensil/Pot	9 (8-10)
Category 5 Conveyor-type one-tank	11 (10-15)
Category 6 Conveyor-type multi-tank	15 (10-17)

3747 Source: Stakeholder consultation 2024.

3748 **5.5.2. Maintenance and repair practice**

3749 According to the 2011 preparatory study, high-capacity commercial dishwashers are usually
3750 serviced regularly. The maintenance of the machines has a preventive function, and signs of
3751 wear and tear can be detected and remedied at an early stage. Companies with a high demand
3752 for dishwashing, and therefore a high risk in case of failure, usually have a service and inspection
3753 contract with the manufacturer or a specialised service provider. This seems to be less common
3754 for the smaller undercounter dishwashers. Due to the relatively high initial cost of commercial
3755 dishwashers, it is likely that damaged machines will be repaired rather than replaced. At some
3756 point, however, the user will replace the machine with a new one. The maintenance and repairs
3757 are almost exclusively done at the customers' premises. No additional transport of the devices
3758 is necessary. In this context, it is important that customer service can provide a qualified
3759 technician quickly when needed.

3760 The table below shows the stakeholder feedback on estimates of the average number of
3761 maintenance operations per year per dishwasher category. The range is quite wide with
3762 manufacturers' estimates tending to be at the lower end (1 to 4 maintenance operations per
3763 year). According to one manufacturer, there are specifications for each machine regarding the
3764 scope and intervals of maintenance, but the manufacturer usually does not know whether the
3765 operator is following these specifications.

3766 One stakeholder suggests that a reason for the wide ranges of repair and maintenance actions
3767 could be due to the lack of a definition of what is meant by 'maintenance' and 'repair'. For
3768 example, it is not clear if it only includes the manufacturer's service activities (e.g. according to
3769 the specifications for each machine regarding the scope and intervals of maintenance) or also
3770 things that the customer does on their own (such as regular cleaning of the appliance).

3771 Therefore, it is suggested to take the median as the number of 'planned, predictive maintenance
3772 actions per year', without the regular cleaning actions undertaken by the customers.

According to stakeholder feedback, the initially estimated average frequency of repair or maintenance actions (**Table 5-22**) (i.e. the median value of the received answers from the stakeholder consultation) are questioned, especially for categories 2 and 3, as such a high number of actions (4.5 maintenance actions per year and 55 repair actions over lifetime) would not be accepted by a customer. The responding stakeholders consider a number between one or two actions per year as realistic values. The values were reduced according to this feedback (for repair actions based on the estimated lifespan of 8 years, see **Table 4-7**), however, it has to be noted that all values are still very rough estimates as more detailed information is not available. With the initially listed frequencies of repair ranging from 4 to 55, another stakeholder asks for a categorisation of the failures/causes, which could be critical, whether it's due to machine issues or user errors, and the types of repairs.

Table 5-22: Estimated average frequency of maintenance and repair actions (2024).

Category	Estimated average frequency of maintenance actions (numbers per year) (in brackets: range)	Estimated average frequency of repair actions (numbers during lifetime) (in brackets: range)
Category 1 Undercounter water-change	1.5 (1-10)	12 (1-15)
Category 2 Undercounter one-tank	2 (1-15)	16 (1-60)
Category 3 Hood-type	2 (1-15)	16 (1-60)
Category 4 Utensil/Pot	2 (1-18)	4 (1-50)
Category 5 Conveyor-type one-tank	3 (1-30)	4 (1-75)
Category 6 Conveyor-type multi-tank	3 (1-30)	4 (1-75)

Source: Stakeholder consultation 2024.

There are also examples of commercial dishwashers designed to make maintenance easier: For example, there are machines that don't need to be moved for maintenance, thanks to the front panel access to the components.¹⁰³ Typical treatment at the end of the first service life of commercial dishwashers is, for example a check of the sealings, tubes and settings and parameters for the hygienic cleaning result.

Based on 2024 stakeholder feedback, the following table provides an overview of the most important priority parts for each dishwasher category in terms of repair needs and spare parts (**Table 5-23**). These are related to the dosing system, electronics, switches, pumps, thermostats and temperature sensors, heating elements, and for categories 5 and 6 also conveyor belts and curtains.

¹⁰³ [https://tools.electroluxprofessional.com/Mirror/Doc/BR/BR_BR-9JE00171_1_5_1_21_EPR-Glasswasher-Undercounter-Brochure_25-06-2024_LR%20\(1\).pdf?version=1731707140](https://tools.electroluxprofessional.com/Mirror/Doc/BR/BR_BR-9JE00171_1_5_1_21_EPR-Glasswasher-Undercounter-Brochure_25-06-2024_LR%20(1).pdf?version=1731707140)

3796 **Table 5-23: Most important priority parts in terms of necessary repairs / spare parts.**

Category	Most important priority parts in terms of necessary repairs / spare parts
Category 1 Under-counter water-change	Parts of the dosing system are maintenance parts. Parts related to the water circulation system e.g. circulation pump, piping. Electronics and dosing pumps.
Category 2 Under-counter one-tank	Parts of the dosing system are maintenance parts. Parts related to the water circulation system e.g. circulation pump, piping. Electronics and dosing pumps. Pumps, heating elements, chemical dispensers, printed circuit boards (PCBs) Thermostats and temperature sensors
Category 3 Hood-type	Parts of the dosing system are maintenance parts. Parts related to the water circulation system e.g. circulation pump, piping. Electronics and dosing pumps. Pumps, heating elements, chemical dispensers, printed circuit boards (PCBs) Boiler thermostats and boiler pressure switches.
Category 4 Utensil/Pot	Parts of the dosing system are maintenance parts. Parts related to the water circulation system e.g. circulation pump, piping. Electronics and dosing pumps. Pumps, heating elements, printed circuit boards (PCBs) Pump contactors and boiler pressure switches.
Category 5 Conveyor-type one-tank and Category 6 Conveyor-type multi-tank	Parts of the dosing system are maintenance parts. Parts related to the water circulation system e.g. circulation pump, piping. Electronics and dosing pumps. Pumps, heating elements, printed circuit boards (PCBs) Temperature sensors and boiler heating elements. Conveyor belts, curtains

3797 Source: 2024 stakeholder feedback.

3798 Stakeholders were also asked on typical upgrade and repair activities, required time and costs
3799 of the repair of commercial dishwashers. It has to be noted that the values and information
3800 provided below are only exemplary for a few repair activities performed by responding
3801 stakeholders and therefore cannot be generalised to the whole sector.

3802 **Upgrade activities**, time to carry this out and average cost of spare part:

- 3803 - Category 1: values in the same range as for categories 2 and 3
- 3804 - Categories 2 / 3: Installation of pumps for detergent; 1 hour; 200 €
- 3805 - Categories 5 / 6: Installation of pumps for detergent and rinse aid; 2 hours; 350 €

3806 **Repair activities**, time to carry this out and average cost of spare part:

- 3807 - Category 1: values in the same range as for categories 2 and 3
- 3808 - Category 2:
 - 3809 ○ Replacement of the regulation thermostat; 0.5 hour; 40 €
 - 3810 ○ Replacement of probes; 0.5 hour; 55 €
 - 3811 ○ Replacement of a component (not specified); 0,75 hour; 100 €
- 3812 - Category 3:
 - 3813 ○ Replacement of boiler safety thermostat; 0.5 hour; 54 €

- 3814 ○ Replacement of boiler pressure switch; 1 hour; 54 €
- 3815 ○ Replacement of a component (not specified); 0,75 hour; 100 €
- 3816 - Category 4:
 - 3817 ○ Replacement/Checks auxiliary pump contactor; 0.5 hour; 47 €
 - 3818 ○ Replacement of boiler pressure switch; 1 hour; 54 €
 - 3819 ○ Replacement of a component (not specified); 0,75 hour; 100 €
- 3820 - Categories 5 and 6:
 - 3821 ○ Replacement of probes; 1 hour; 24 €
 - 3822 ○ Replacement of boiler heating elements; 1 hour; 150 €

3823 When asked about the average labour rate for carrying out the upgrade and/or repair activities,
 3824 stakeholders replied that this depended heavily on the labour rates in each country. Further,
 3825 sharing exact details could probably be traced back to a single manufacturer. The range
 3826 suggested was between 60, 90 and 130 Euros per hour in Europe. One stakeholder indicated
 3827 that, as a manufacturer, their repair interventions are not very frequent and are invoiced to the
 3828 dealer, not to the end-user.

3829 5.5.3. Estimated second hand use

3830 According to the 2011 preparatory study, customers can sell the dishwasher on the second-hand
 3831 market if their dishwashing needs change over time. Disadvantage for buyers may be that they
 3832 usually do not get a warranty for the product. In some cases, manufacturers or their dealers may
 3833 act as intermediaries when one of their customers wants to trade in a working appliance and
 3834 another customer is looking for a used appliance. The 2011 study report estimates that the
 3835 market for used dishwashers is around 5 to 10 % of annual sales.

3836 However, stakeholder feedback from the 2024 survey suggests that most dishwashers do not
 3837 have a second life in this sense. They are repaired for as long as it is economically viable and
 3838 then scrapped. For example, in categories 5 and 6, heavily used dishwashers are scrapped after
 3839 8 to 10 years when they are no longer repairable. In about half of the listings, the transport
 3840 dishwashers have a service life of 15 years or more. Even for components, there does not seem
 3841 to be a trade in used spare parts, as is the case for example in the automotive sector.

3842 5.5.4. Collection rates, by fraction

3843 At the end of their use time, the commercial dishwashers become e-waste. Consequently, they
 3844 are professionally dismantled and then disposed of properly, as required by the WEEE Directive.

3845 Stakeholder feedback from the 2024 consultation suggests that refurbishment is not practiced
 3846 as refurbished equipment is not in demand for hygiene reasons. Regular maintenance leads to
 3847 a significant increase in lifetime and this approach is generally used for high-priced commercial
 3848 dishwashers. Refurbishment of used equipment is the exception and is usually only carried out

on relatively new equipment as the machines really wear out at the end of their life. One manufacturer thinks that categories 2 and 3 could potentially be refurbished.

Almost no commercial dishwasher will end up in landfill, as the materials (mostly stainless steel) are too valuable. For this reason, the products are always recycled for parts or materials.

Stakeholder feedback suggests the following market shares for end-of-life treatment for all categories of commercial dishwashers:

- Recycling: 85 %
- Incineration: 12 %
- Landfill: 3 %

According to the 2011 preparatory study, large dishwashers are usually taken back by the manufacturer of the new machine at the end of their life as most of the machine is made of valuable stainless steel. The machine is sold to recycling companies. The smaller undercounter machines will be collected by certified scrap dealers.

According to the stakeholder feedback from the preparatory study in 2011, the owner of the old dishwasher will usually receive a small amount of money from the scrap dealer, in the range of 50 to 100 Euro, depending on the raw material prices. Calculations based on scrap prices at that time resulted in about 80 Euro for a category 2 dishwasher. Due to the increase in metal prices in recent years, the revenue might be higher today, at around 110 Euro as shown in **Table 5-24**.

Table 5-24: Estimation of revenues from scrap metal fraction exemplified for an undercounter one-tank dishwasher (category 2).

Material / Component	Weight in g	Revenues from scrap (€/kg) ¹⁰⁴	Resulting revenues
Stainless steel	49,760	1.70	84,59 €
Pumps (copper)	2,500	6.80	17.00 €
Pumps (stack of sheets)	2,500	0.05	0.13 €
Pumps (stainless steel wave)	2,250	1.70	3.83 €
Pumps (Al)	2,250	1.10	2.48 €
Cable (copper)	1,100	4.20	4.62 €
Total		112.64 €	

Source: own calculations based on Bill of Material (see section 6.3.1.2) and current prices of scrap

However, 2024 stakeholder feedback informed that the stainless-steel scrap price of 1.70 €/kg seems high or at least of the highest scrap price over the years. The scrap price is very different between austenitic and ferritic stainless steel (which is half to third of the price of austenitic stainless-steel scrap).

¹⁰⁴ <https://schrottpreise-aktuell.org/>, sighted on 18/11/2024

According to stakeholder feedback, the recycling rate of stainless steel is indeed generally high due to the commercial value of stainless-steel scrap. Nevertheless, not all stainless-steel components are recycled in order to produce again stainless steel. In particular there is a loss of ferritic stainless steel, which is often downcycled into carbon steel production, as ferritic stainless-steel scrap (contrary to austenitic stainless-steel scrap) cannot be magnetically separated from carbon steel scrap which is of much lower value. This can be a problem when end-of-life appliances are dismantled and shredded, as the stainless content often ends up being mixed with the carbon steel content which represents a loss of opportunity to properly recycle the chromium contained in stainless steel in a new stainless-steel production cycle.

5.6. Local Infrastructure

5.6.1. Water supply

The water for the dishwashing process can be obtained from municipal supplies. According to 2024 stakeholder feedback, commercial dishwashers are designed to be connected to portable water. There is no warranty of function if water from self-supply, i.e. from wells, springs, rivers, or even rainwater is used which would have to be pre-treated before use in dishwashers. Water acts as a heating medium, a transport medium and a solvent for detergents and soil, as well as transmitting the mechanical action of the dishwasher to the dishes.

Commercial dishwashers can be connected either to a cold and/or hot water supply. Most water-change dishwashers (category 1) have two valves (**Table 5-25**), allowing them to be connected either to cold tap water only or to both cold and hot tap water. A small proportion of category 1 appliances is equipped with only one valve. According to stakeholder feedback in 2011, connection to hot water only is not useful as low temperature programmes are also available and in these cases the temperature of the hot water would be too high; furthermore, if heat recovery is included, the appliance requires cold water at the inlet. Whereas 2024 stakeholder feedback informed that water treatment systems (softening) do not necessarily technically require a cold-water connection. Connection to a hot water tap is more common for category 1 as more water needs to be heated to the desired temperature per cycle (**Table 5-26**).

According to the 2011 preparatory study, one-tank undercounter and hood-type dishwashers (categories 2 and 3) mostly have only one valve for the water supply. Both the water for the initial filling of the wash tanks and the water for continuous operation are taken from this valve. This allows either cold or hot water to be supplied. Again, based on 2011 data, a small percentage of hood-type, utensil/pot and one-tank conveyor-type dishwashers (categories 3, 4 and 5) and a large percentage of multi-tank conveyor-type dishwashers have two (or more) valves, with the first valve being used for continuous operation and the other(s) for the separate filling of the tank(s). It is then possible to have the initial filling of the wash tanks hot warm water and use cold water for the continuous wash cycle. Filling the tanks with hot water results in a shorter initial heating time of the wash tanks to be in the 'ready to use' mode.

Table 5-25: Number of water inlet valves of commercial dishwashers.

Dishwasher category	1 valve	2 or more valves
No 1 Undercounter water-change	10 %	90 %
No 2 Undercounter one-tank	100 %	0 %
No 3 Hood-type	99 %	1 %
No 4 Utensil/Pot dishwashers	80 %	20 %
No 5 One-tank conveyor-type	60 %	40 %
No 6 Multi-tank conveyor-type	20 %	80 %

3912 Source: 2011 preparatory study for commercial dishwashers with update from 2024 stakeholder feedback.

3913 The following table gives an overview of possible options and the share of dishwashers sold or
3914 installed with the respective option. Both data provided in

3915 Table 5-25 and Table 5-26 were considered feasible according to 2024 stakeholder feedback.
3916 One stakeholder further informed that typically, the primary difference between appliances
3917 designed for hot water versus cold water connections is the lower tank heating element power.
3918 Appliances with hot water connection have a standard power heating element as the base
3919 configuration. For cold water connections, customers can request higher-power heating
3920 elements. Based on the current description, one might assume that cold water connections are
3921 most requested (and/or water softeners, reverse osmosis systems, or heat recovery systems are
3922 more prevalent). However, from the stakeholder's experience this assumption is not accurate.

3923 **Table 5-26: Water connection of commercial dishwashers.**

Dishwasher category	Only cold water connection	Cold and hot water (continuous operation)	Hot water (initial filling) Cold water (final rinse)	Only hot water connection (for initial filling and final rinse)
No 1 Undercounter water-change	50 %	50 %	-	-
No 2 Undercounter one-tank	80 %	-	-	20 %
No 3 Hood-type	75 %	-	-	25 %
No 4 Utensil/Pot dishwashers	70 %	-	5 %	25 %
No 5 One-tank conveyor-type	60 %	-	35 %	5 %
No 6 Multi-tank conveyor-type	60 %	-	35 %	5 %

3924 Source: 2011 preparatory study for commercial dishwashers with update from 2024 stakeholder feedback

3925 Typical water inlet temperature is 15 °C (cold water). Tank temperatures are between 55 °C and
3926 65 °C (warm water) (see **Section 6.2.2**). One stakeholder informed that for categories 3, 4, 5 in
3927 the case of heat recovery, the rinse circuit is mandatory fed with cold water. Without heat
3928 recovery, however, it is up to the customer who choose in the order phase.

In general, hot water connection leads to shorter programme times and lower energy consumption of the dishwasher itself. For undercounter water-change dishwashers, stakeholder feedback suggested that most of the appliances are connected to the customer's hot and cold water supply in order to benefit from these advantages. However, the overall environmental and economic advantage of the connection to hot water supply strongly depends on the type of water heating outside the appliance and other infrastructural parameters, like length and insulation of the stub water line.

5.6.2. Energy supply / water heating

There are different options for heating the water inside the dishwasher. Based on stakeholder feedback from the 2024 consultation, the following table shows the proportion of dishwashers sold or installed with different types of water heating. The basic option is electric heating. Undercounter and hood-type dishwashers (categories 1, 2 and 3) are only available with electric heating. According to stakeholders, other types of heating do not make sense as they would require too much effort for little benefit, as the throughput is lower, and the necessary infrastructure is often not available.

Stakeholders confirmed that the initial data from the 2011 preparatory study are still up to date for categories 1 to 3. For categories 4 and 5, the share of electricity for water heating has actually increased, in category 4 close to 100 % and in category closer to 95 % electricity and 5 % low pressure steam. Electricity is also increasingly used for water heating in category 6, with figures ranging from 80 to 90 %.

Tank heating with natural gas no longer plays a role. One reason for this may be the strict building regulations regarding ambient air conditions. The stakeholder survey did not reveal any information on the use of solar energy to heat water tanks, so this approach does not seem to be used in practice yet.

Table 5-27: Types of water heating in commercial dishwashers (2011, 2024).

Dishwasher category	Electricity in %	Low pressure steam and hot water in %	Natural gas in %
No 1 Undercounter water-change	100	-	-
No 2 Undercounter one-tank	100	-	-
No 3 Pass through ('hood type')	100	-	-
No 4 Utensil / Pot dishwashers	98-100 (90-95)	0-2 (5-10)	-
No 5 One-tank conveyor-type	90-100 (~80)	0-10 (20)	0 (0-1)
No 6 Multi-tank conveyor-type	85-90 (~70)	10-15 (30)	0 (0-1)

Source: Stakeholder feedback from the 2024 survey; text in red: updated data compared to 2011 values

3955 **5.6.3. Telecom**

3956 A number of commercial dishwashers are now equipped with features that allow them to be
3957 connected and 'smart'. This allows the user to know when the machine is on, whether it is under-
3958 or oversised, control the cycle time, operator waiting time and total working time, and
3959 consumption values. It also allows remote diagnosis in the event of fault or breakdown.

3960 **5.6.4. Installation / Physical environment**

3961 There is no specific information available on the availability and level of knowledge or training
3962 of installers. At least the larger dishwashers in categories 2 to 6 need to be installed by trained
3963 personnel.

3964 Unlike commercial washing machines and tumble dryers, which can be used in shared laundries,
3965 there appear to be no shared solutions for commercial dishwashers.

3966 **5.7. Aspects to consider at later stages of the study**

- 3967 ○ Definition of 'cycle time' and 'programme time'

6. MEErP Task 4 – Technologies

6.1. Objectives of MEErP Task 4

MEErP Task 4 treats the technical analysis of the current commercial dishwashers on the EU market with the aim to provide general inputs for the definition of the base case(s) in MEErP Task 5 as well as the identification of the improvement potential in MEErP Task 6. For this purpose, this task will also look for information on BAT (Best Available Technology) / BNAT (Best Not Yet Available Technology). The technologies will be analysed with regard to the material inventory in the dishwashers by collecting data on the respective Bill of Materials (BOM) in order to define the relevant Base Cases in MEErP Task 5.

6.2. Technical product description in the use-phase

As part of the technical product description in the use-phase, particular attention was paid to the analysis of the energy and water consumption of commercial dishwashers and the use of detergents to fulfil their intended purpose, namely the cleaning of dishes and crockery in a B2B context. In close relation to the market analysis of MEErP Task 2, the current products on the market were thoroughly analysed and described regarding their technical specifications, different technologies (e.g. for heat supply) and functioning in the use phase. The analysis of the technical parameters was adapted to the parameters for testing the functional performance of dishwashers as specified in the standard (see MEErP Task 1.2 and **section 3.3.1**, respectively).

6.2.1. Main operating principles of commercial dishwashers

The following **Table 6-1** gives an overview of the six categories defined in MEErP Task 1 and their main properties. A more detailed description on the classification of commercial dishwashers can be found in Task 1 (see **section 3.2.3.7**).

3991 **Table 6-1: Categorisation of commercial dishwashers.**

Category- Number	Water supply	Number of tanks	Operating principle	Type of loading	Type of wash ware
Category 1 Undercounter water-change	Water-change operation	0	Program automats	Front loaders	Mainly dishes, glasses, cups, cutlery.
Category 2 Undercounter one-tank	Tank operation	1		Pass-through	
Category 3 Hood-type				Front loaders and pass-through	
Category 4 Utensil/pot				Conveyor-type	n.a.
Category 5 Conveyor-type one-tank			n.a.		
Category 6 Conveyor-type multi-tank		2 and more			

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3993 n.a. = not applicable

3994 Source: Task 4 report of 2011 preparatory study on professional dishwashers, adapted.

3995 There are differences between each of the six categories; however, some of the categories can
 3996 be grouped together: e.g. all dishwashers of categories 2 to 6 work with a tank system, where
 3997 the detergent solution is circulated within the machine and not fully changed between the
 3998 dishwashing cycles. On the contrary, dishwashers of category 1 use fresh water for each cycle.
 3999 Similar groups of certain properties apply for other aspects, like operating principle, type of
 4000 loading, etc.

4001 Regarding the technology there is no essential difference between the dishwasher categories
 4002 under consideration. Most important components of all categories are:

- 4003 - Containment and support structure;
- 4004 - Tanks and / or boilers;
- 4005 - Heating elements;
- 4006 - Motor and pumps;
- 4007 - Spray arms;
- 4008 - Filter system;
- 4009 - Control and display, electronics and sensors, electrics, and
- 4010 - Where applicable, heat exchangers or heat pumps.

4011 Major components of a commercial dishwasher, such as the external panelling and the tank, are
 4012 made of stainless steel. According to stakeholder input, the stainless steel grades used are
 4013 mainly austenitic (304/1.4307; 1.4301) for corrosion resistance, but some ferritic stainless steel

grade are also used (like 430/1.4016), as well as molybdenum-rich austenitic grades (316L/1.4404).

Historically, also washing and rinsing water circuits, piping, jets, filters and the support structure were also made of stainless steel. However, stakeholders report that these components have been replaced by plastics in recent years. Nevertheless, as shown in **section 6.3.1**, stainless steel and galvanised steel sheet are still the dominant materials for all dishwasher categories, with a share of 57 % for category 1 and even more than 70 % for categories 2 to 6 (measured as a percentage of the net weight, excluding packaging).

In the following sections, the principal function of dishwashers with water-change operation (**Section 6.2.1.1**) and tank operation (**Section 6.2.1.2**) is described. Dishwashers with tank operation can further be subdivided into batch dishwashers and conveyor-type dishwashers. **Section 6.2.1.3** summarises the differences between water-change and tank operated dishwashers.

6.2.1.1. Water-change operation

Commercial dishwashers with water-change operation use fresh water for each cleaning and rinsing cycle. The different stages of the programme, such as detergent recirculation and rinse aid, are carried out one after the other. However, there is no physical separation of the appliances into different zones (AKGGS, 2021).

Figure 6-1 provides an overview of the construction and principal function of dishwashers with water-change operation.

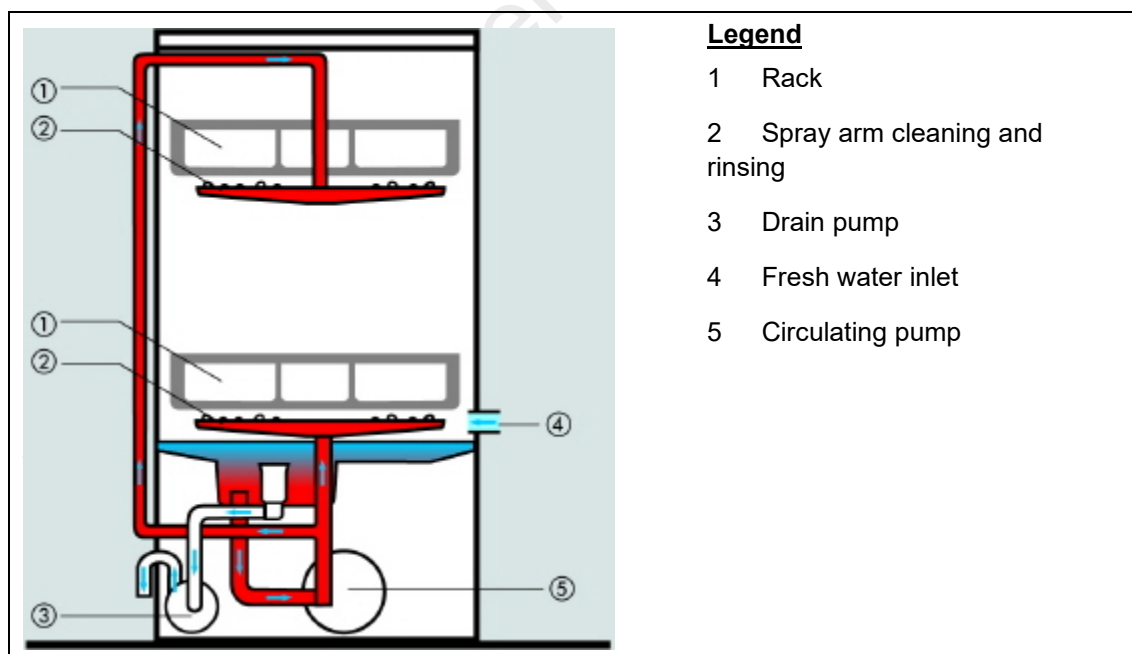


Figure 6-1: Construction of an undercounter water-change dishwasher (category 1).

Source: Task 4 report of 2011 preparatory study on professional dishwashers.

The following steps can be distinguished in the dishwashing cycle:

- Pre-wash period: rinsing with cold water (optional);

- 4038 - Wash period: spraying with warm/hot leach;
- 4039 - Final rinse period: rinsing with hot water and rinse aid;
- 4040 - Drying period: drying by use of fresh air or by the residual heat of the final rinse
- 4041 period.

4042 In general dishwashers work with the mechanical force of water jets. The water jets spray
4043 against every spot on the dish surface, separate the food-soil from the dish and wash it away.
4044 The water is circulated and again sprayed onto the dishes.

4045 Dishwashers of this category work with one set of rotating spray arms for both cleaning and
4046 rinsing (2). Sideward-pointing nozzles are placed on the spray arms to create an inclined plane
4047 of water jets to clean the dishes and rotate the spray arms through the backlash of the water.

4048 The water is drawn from the fresh water inlet (4) and heated in the wash chamber by means of
4049 heating coils. It is then pumped into the spray arms by a circulating pump (5). The drained
4050 detergent solution is collected, and large dirt and food particles are removed through a filter to
4051 avoid damage or blockage of the narrow jet nozzles. The filtered detergent solution is then
4052 pumped into the spray arms (2) again. After the wash period the detergent solution is drained
4053 by a drain pump (3). For the final rinse, fresh water is used that has to be heated using heating
4054 coils.

4055 6.2.1.2. Tank operation

4056 Commercial dishwashers with tank operation can be subdivided into batch dishwashers with
4057 one-tank (categories 2-4) and conveyor-type dishwashers (categories 5 and 6), either one- or
4058 multi-tank. Batch dishwashers need much less space than the spacious conveyor-type
4059 dishwashers. However, the latter allow continuous dishwashing of large amounts of dishes in a
4060 short time.

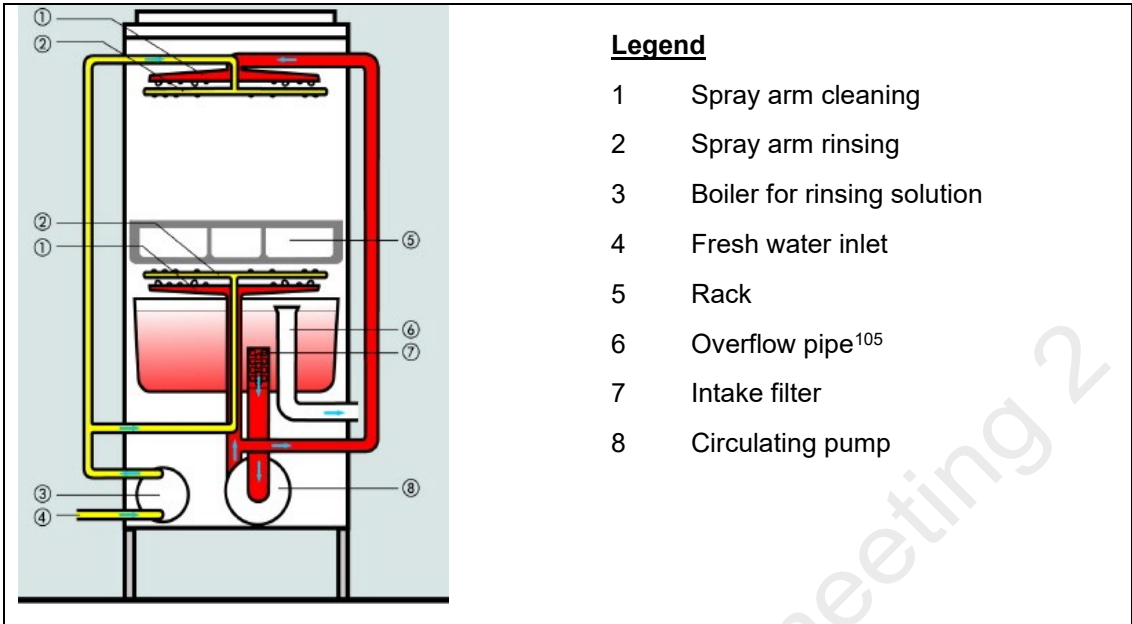
4061 Batch dishwashers (one-tank)

4062 The following steps can be distinguished in a dishwashing process of one-tank batch
4063 dishwashers:

- 4064 • Wash period: spraying with warm/hot leach (usually between 55°C and 65°C);
- 4065 • Final rinse period: rinsing with hot water and rinse aid (usually between 80 and 85°C;
- 4066 in case of special glasswashers also lower temperatures between 60 and 65°C
- 4067 possible);
- 4068 • Drying period: drying by use of fresh air or by the residual heat of the final rinse
- 4069 period; this period often takes place outside the machine; machines with internal
- 4070 drying cycle (using zeolite technology) are available;
- 4071 • The pre-cleaning is usually performed manually before the items are put into the
- 4072 dishwasher.

4073 **Figure 6-2** gives an overview of the construction and principal function of tank operated
4074 dishwashers.

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Figure 6-2: Construction of a one-tank batch dishwasher (categories 2 to 4).

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Source: Task 4 report of 2011 preparatory study on professional dishwashers.

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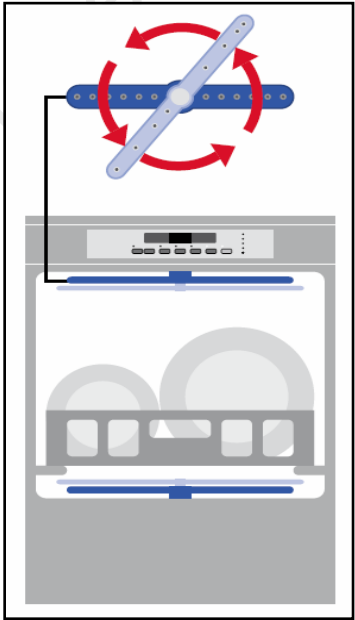
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Tank operated batch dishwashers work with the mechanical force of water jets. However, they use two separate water cycles and therefore usually work with two sets of rotating spray arms (principle: see **Figure 6-3** below) that are each placed on the top and the bottom of the tub (see **Figure 6-2** above): one set for cleaning (1, red), and one set for rinsing (2, yellow).



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Figure 6-3: Circular movement of the spray arms in tank operated batch dishwashers (categories 2 to 4).

Source: Task 4 report of 2011 preparatory study on professional dishwashers.

¹⁰⁵ Overflow pipes are still available, but less common. The current standard is pumped drain.

At the beginning of the day the wash tanks of tank operated dishwashers have to be filled with detergent solution and heated to operating temperature (usually between 55 and 65°C). During the day, standby energy consumption occurs because the tank temperature has to be kept on the defined temperature level by the tank heating system ('ready to use' mode).

During the dishwashing process, the stored detergent solution is continuously pumped into the spray arms for cleaning (1) by the circulating pump (8). The drained detergent solution is collected, and large dirt and food particles are removed through a filter (7) (usually a set of different filters) to avoid damage or blockage of the narrow jet nozzles (see also **Figure 6-4**). The filtered detergent solution is then pumped into the spray arms for cleaning (1) again. The detergent solution is not changed between two programme cycles, but only partly replaced by hot fresh water from the final rinse process (so-called regeneration of detergent solution).

For the rinse process, hot fresh water heated in a separate boiler (3) is sprayed onto the dishes through a different set of spray arms (2). The excess detergent solution (through additional water from final rinse process) is drained through pumped drain. Once a day or after each working shift the detergent solution in the wash tank is fully changed.

Figure 6-4 shows the filter and heating system of a one-tank batch dishwasher.



Figure 6-4: Filter and heating system of an undercounter one-tank dishwasher (category 2).

Source: Task 4 report of 2011 preparatory study on professional dishwashers.

Conveyor-type (one-tank / multi-tank)

In principle, the dishwashing process of a conveyor-type dishwasher is the same compared to tank operated batch dishwashers. The following steps can be distinguished in a dishwashing process:

- Pre-wash period: rinsing with cold water;
- Wash period: spraying with warm/hot leach (usually between 55 and 65°C);
- Intermediate-rinse period: removal of leach with warm water;

- Final rinse period: rinsing with hot water and rinse aid (usually between 80 and 85°C);
- Drying period: drying by use of fresh air or by the residual heat of the final rinse period, might take place outside the machine.

The main difference to batch dishwashers is that with conveyor-type dishwashers the different steps of the dishwashing process are allocated to several individual treatment zones, i.e. the wash ware is transported through these zones. Depending on the type of dishes, the degree of soiling and the available space, conveyor-type dishwashers are provided with one or several wash tanks.

In **Figure 6-5**, a multi-tank flight type appliance with one pre-wash zone and one cleaning zone is shown. The red lines in the graph show the temperature of the water (light red) and the dishes (dark red) in the different zones.

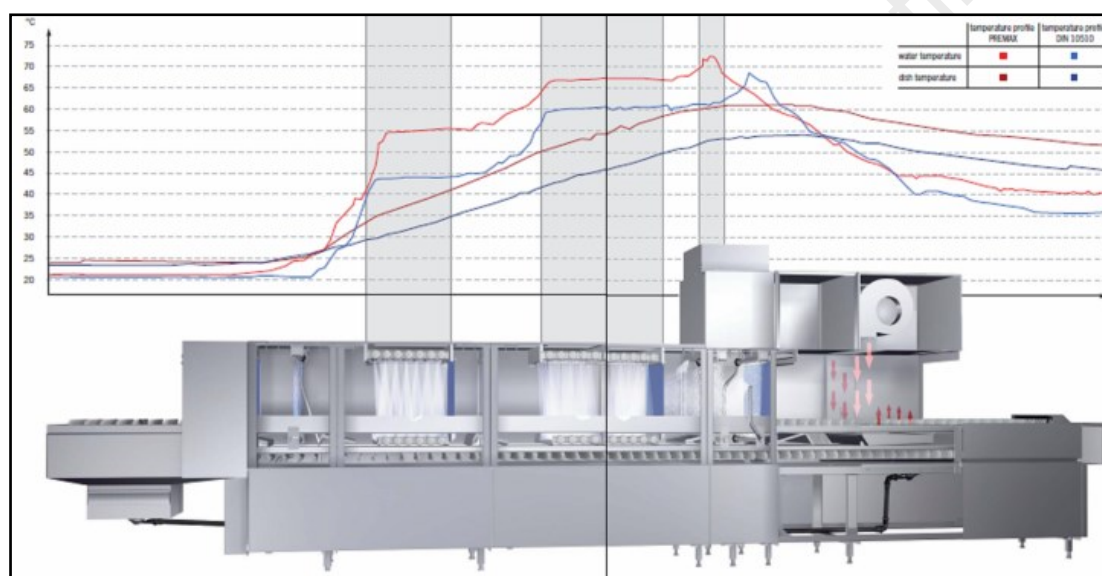


Figure 6-5: Example of a multi-tank conveyor-type dishwasher (category 6).

Source: Task 4 report of 2011 preparatory study on professional dishwashers.

As with one-tank batch dishwashers the wash tank(s) of conveyor-type dishwashers have to be filled with detergent solution and heated to operating temperature (around 40°C for the pre-wash period and between 55 and 65°C for the wash period) at the beginning of the day/shift. During the day, standby consumption occurs because the tank temperature has to be kept on the defined temperature level ('ready to use' mode).

The different steps of the dishwashing programme work in principle as in batch dishwashers:

For the pre-washing and for the cleaning process, detergent solution is stored in the wash tanks from where it is continuously pumped into the spray arms by a circulating pump. The drained detergent solution is collected, and large dirt and food particles are removed through filters to avoid damage or blockage of the jet nozzles. The filtered detergent solution is then pumped into the spray arms again. The detergent solution is not changed between two programme cycles, but only partly regenerated. For the rinse process, hot fresh water heated in a separate boiler is sprayed onto the dishes through another set of spray arms. The excess detergent solution

(through additional water from final rinse process) is drained through an overflow pipe at the first of the wash tanks (counter flow principle: the fresh water is used for rinsing, replacing water in the last wash tank. Excess water from this tank flows into the previous wash tank and so on). At the end of the dishwasher there might also be a drying zone, where the dishes are dried by hot air (see red arrows in **Figure 6-5** above). Once a day or after each working shift the detergent solution in the wash tank is fully changed.

In contrast to batch dishwashers, the spray arms in conveyor-type dishwashers do not rotate but are usually fixed tubes on top and bottom of the dishwashing channel. In some machines, the spray arms are also installed at the sides to achieve uniform wetting (see **Figure 6-6**).

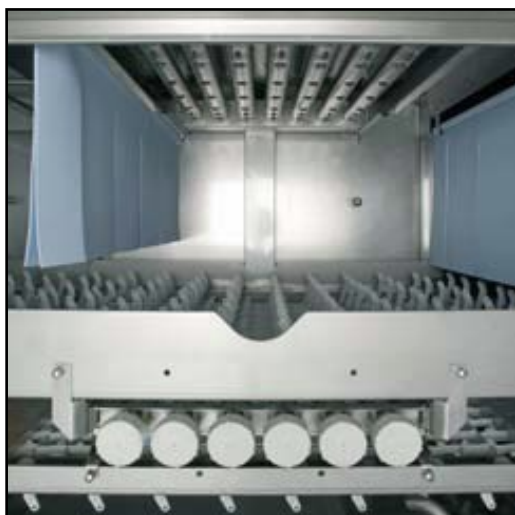


Figure 6-6: Arrangement of wash arms and nozzles.

Source: Task 4 report of 2011 preparatory study on professional dishwashers.

Two different conveyor systems are available:

- *Rack conveyor dishwashers* (**Figure 6-7**, left): the wash ware is put into racks which are manually put into the machine and then automatically transported through the dishwasher.
- *Flight type dishwashers* (**Figure 6-7**, right): the wash ware is put directly on a conveyor belt which continuously moves through the dishwasher.



Figure 6-7: Principle of a rack conveyor dishwasher (left) and a conveyor-type dishwasher (right).

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Source: Task 4 report of 2011 preparatory study on professional dishwashers.

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Based on rather different capacity requirements and the economic consequences, conveyor-type dishwashing machines are equipped with quite different technological features. In Task 6 (Best available technologies) the differences and their impact on energy and water consumption are described in detail, while the following **Table 6-2** only provides a short overview¹⁰⁶.

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Table 6-2: Different configuration of a multi-tank conveyor-type dishwasher (category 6).

	Model A Series	Model B Series
Energy Management	n. a.	x
Heat recovery exhaust air	optional	x
Insulation	optional	x
Heat pump	n. a.	optional
Optimised final rinse	n. a.	x
Water consumption management	n. a.	x
Data documentation	optional	x

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n. a. = not available for the model; x = technology is part of the series or option

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6.2.1.3. Differences between water-change and tank operated dishwashers

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A fundamental difference exists between water-change (category 1) and tank operated dishwashers (categories 2–6): While dishwashers in category 1 use fresh water for each step of the programme, all other machines work with a tank system of one (categories 2–5) or more tanks (category 6).

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The advantage of tank operation compared to water-change dishwashers is that the detergent solution in the wash tank is kept at a constant temperature thus enabling much shorter cleaning cycles and a high throughput per hour as the detergent solution does not have to be heated each time before a dishwashing cycle. Higher water temperatures and higher pressure additionally shorten the cleaning process itself. Depending on the connected load (230 or 400 Volt), cycle times and thus the capacity of the same dishwasher vary to a certain extent. Because the detergent solution is only regenerated and not fully replaced they also use less water per dishwashing cycle, resulting in lower energy and detergent consumption.

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Stakeholders point out, however, that the water-change (fresh water) system also offers advantages, with its flexibility and hygienic washing performance being highlighted. As it has no storage tank, water is only heated on demand. As a result, it consumes virtually no energy between wash cycles. This benefits users who have irregular needs throughout the day and only

¹⁰⁶ Note: Example by one manufacturer; other manufacturers might have different sets of optional configurations.

wash at peak times. Due to its operating principle, it constantly provides the same hygienic cleaning performance. With no holding tank, there is hardly any debris accumulation in the wash chamber, making water changes and self-cleaning programs superfluous throughout the day.

Table 6-3 gives a summary of the differences between water-change and tank operated dishwashers.

Table 6-3: Comparison of freshwater and tank system.

Aspect	Water-change (freshwater) system	Tank system
Principal function	Fresh water for every washing and rinsing step	Fresh water only for rinsing
Filtration	Water filtration necessary	filtration to various intensities necessary
Programme duration	Medium to long, as the heating of water needs some time.	Very short duration possible, as hot water is stored in wash tanks.
Output per hour	Medium to low	High
Capacity	Two racks possible	Usually only one rack / conveyor belt
Water and energy consumption	Higher, as fresh water is used for each cycle which has to be heated.	Lower, as water is recycled and used for several cycles / racks.
Standby losses	0.01 kW	0.01 kW

According to stakeholder feedback the “ready to use loss” should be amended as an additional parameter in **Table 6-3**. However, as no corresponding data had been provided by stakeholders and could not be found elsewhere, it was not possible to follow this recommendation.

6.2.2. Existing products

For each of the categories defined in Task 1 (see **section 3.2.3.7**), the technical description of existing products on the market is given below.

6.2.2.1. Category 1: Undercounter water-change dishwashers

The following **Figure 6-8** shows a typical undercounter water-change dishwasher.



Figure 6-8: Undercounter front loader with water-change operation (category 1).

Source: Miele.

Table 6-4 gives an overview of the characteristics of a typical appliance of this category. This table is based on the original table from the 2011 preparatory study and has been updated with stakeholder feedback from the 2024 online survey, as well as further written feedback from stakeholders on the draft Task 1–4 study report. The same applies to the following tables for the main characteristics of the other dishwasher categories.

Table 6-4: Main characteristics of a typical undercounter water-change dishwasher (category 1) (2011, 2024).

Main characteristics	Data from 2011 preparatory study, Task 4 report	Updated data according to stakeholder input from the current study
Programme		
Number of dishwashing programmes	10 (dishwashing process can be adjusted to task)	10-13 (dishwashing process can be adjusted to task)
Washing capacity, ideal	2–20 racks/h (depending on programme)	2–24 racks/h (depending on programme, 2 racks per cycle)
Cycle time	6–27 minutes (depending on programme)	5-60 minutes (depending on programme)
Programme temperature	Depending on programme (between 20–60°C, rinsing temperature up to 93°C)	Depending on programme (between 46-70°C , rinsing temperature up to 93°C)
Construction details		
Height/width/depth	820/600/600 mm	820/600/600 mm (U-unit) 835/600/600 mm (free-standing with lid)
Weight (without packaging)	ca. 50 kg	ca. 50 kg
Tank volume	not applicable	not applicable (rinsing system without a tank)
Electricity and water connection		
Voltage	Normal (230 V) or high-load connection (400 Volt) possible	Normal (230 V) or high-load connection (400 Volt) possible
Total load	9 kW	9 kW
Power of pump	0.4 kW	0.2-0.8 kW, typical 0.6 kW

Source: Task 4 report of 2011 preparatory study on professional dishwashers; updated with current stakeholder data in **red colour**.

6.2.2.2. Category 2: Undercounter one-tank dishwashers

Figure 6-9 shows a typical undercounter one-tank dishwasher.



Figure 6-9: Manually loaded undercounter front loader with one-tank (Category 2).

.Source: Task 4 report of 2011 preparatory study on professional dishwashers.

In case of undercounter one-tank dishwashers, usually only one rack can be placed into the dishwasher (loading and unloading from the front side), as the tank needs space as well. Undercounter dishwashers can be constructed as 'generalists' for different items (dishes, glasses, and cutlery) or as specialised versions, i.e. only for dishes, for glasses or for cutlery respectively. As the temperature and mechanical action vary for different adjustments, the related energy and water consumption varies to a certain extent. For example, glasswashers are also available in smaller dimensions (undercounter models that are only 415 to 475 mm wide). These models are often used in bar areas. The basic mode of operation is the same as in the 600 mm wide models; however, they usually work with lower temperatures to avoid damage of the sensitive wash ware.

Table 6-5 gives an overview of the characteristics of a typical category 2 undercounter one-tank dishwasher.

Table 6-5: Main characteristics of a typical undercounter water-change dishwasher (category 2).

Main characteristics	Data from 2011 preparatory study, Task 4 report	Updated data according to stakeholder input from the current study
Programme		
Number of dishwashing programmes	3	1-10
Washing capacity, ideal	40 racks/h (with 400 Voltage) 25 racks/h (with 230 Voltage)	Theoretical maximum capacity: 40 racks/h, the capacity is not related to the input voltage Taking into account loading and unloading, in real life a maximum of 20-30 racks/h is possible
Cycle time	60-360 sec (with 400 Voltage) 140 / 180 / 360 sec (with 230 Voltage)	60-240 sec. (with 400 Voltage) 90-140 / 120-180 / 240-360 sec. (with 230 Voltage) Hygiene-focused-programmes may have duration up to 10 minutes
Tank temperature	usually between 55°C and 65°C	usually between 55°C and 65°C
Boiler temperature	usually between 80°C and 85°C (glasswashers: also 60-65°C possible)	usually between 80°C and 85°C (glasswashers: also 60-65°C possible)
Construction details		
Height/width/depth	820/600/650 mm (glasswashers: 415-475 mm width)	820/600/600-650 mm (glasswashers: 725 mm height, 415-475 mm width)
Weight (without packaging)	ca. 70 kg (glasswashers: ~ 50 kg)	ca. 55-95 kg (glasswashers: ~ 50 kg), depending on model, variants and chosen options
Tank volume	7-20 litres, average 15 litres	8-25 litres, average 15 litres
Electricity and water connection		
Voltage	230 Volt or 400 Volt	220-230 Volt or 380-415 Volt
Total load	With 400 Voltage: 7.7 kW With 230 Voltage: 3.6 kW	With 400 Voltage: 6.0-11 kW With 230 Voltage: 1.8-4.1 kW
Power of pump	0.2-0.8 kW, typical 0.6 kW	0.2-0.8 kW, typical 0.5-0.75 kW

Source: Task 4 of 2011 preparatory study on professional dishwashers; updated with current stakeholder data highlighted in red colour.

6.2.2.3. Category 3: Hood-type dishwashers

Figure 6-10 shows a typical hood-type (pass-through) dishwasher.



Figure 6-10: One-tank pass-through (hood-type) dishwasher (category 3).

Source: Task 4 report of 2011 preparatory study on professional dishwashers.

In case of hood-type dishwashers the racks are put into the dishwasher from one side and are taken out of the dishwasher from the other side. As in case of other tank dishwashers, only one rack can be cleaned at one level, as the tank also needs space. There are appliances, however, where two racks can be cleaned next to each other, integrated in one housing at the same time. Such appliances are like a double or twin appliance.

Hood-type dishwashers are ergonomically easier to operate than undercounter dishwashers, because the filled racks stay at working level and can easily be moved into and out of the dishwasher. Additionally, the separation of a dirty and a clean area is possible when using the pass-through type. They are usually constructed as 'generalists' for different items, such as dishes, glasses, cutlery, etc.

Table 6-6 gives an overview of the main characteristics of this category.

Table 6-6: Main characteristics of a typical undercounter water-change dishwasher (category 3).

Main characteristics	Data from 2011 preparatory study, Task 4 report	Updated data according to stakeholder input from the current study
Programme		
Number of dishwashing programmes	3	3-9

Main characteristics	Data from 2011 preparatory study, Task 4 report	Updated data according to stakeholder input from the current study
Washing capacity, ideal	60 racks/h	Theoretical maximum capacity: 60-80 racks/h Taking into account loading and unloading, in real life a maximum of 20-40 racks/h or even more is possible, depending on the selected cycle as well as different sizes and options
Cycle time	60-180 sec	45-180 sec hygiene-focused-programmes may have duration up to 10 minutes
Tank temperature	usually between 55°C and 65°C	usually between 55°C and 65°C
Boiler temperature	usually between 80°C and 85°C	usually between 80°C and 85°C (glasswashers also 60-65°C possible)
Construction details		
Height/width/depth (with open door)	2 000/760/820 mm	1,550-2,000/746-760/755-820 mm different dimensions possible depending on chosen model and options
Weight (without packaging)	ca. 120 kg	100-200 kg, depending on chosen model and options
Tank volume	16-60 litres, average 40 litres	14-60 litres, average 40 litres
Electricity and water connection		
Voltage	400 Volt	400 Volt, also 230 V and multiple supply is available
Total load	7 kW	7-14 kW
Power of pump	0.75-1.5 kW, typical 0.9 kW	0.75-1.5 kW, typical 0.9 kW

Source: Task 4 of 2011 preparatory study on professional dishwashers; updated with current stakeholder data highlighted in red colour.

6.2.2.4. Category 4: Utensil / pot dishwashers

Figure 6-11 shows a typical utensil / pot dishwasher.



Figure 6-11: Example of an utensil / pot dishwasher (category 4).

Source: Task 4 report of 2011 preparatory study on professional dishwashers.

The main difference to one-tank undercounter and pass-through dishwashers is that utensil / pot dishwashers are especially constructed for the cleaning of items other than dishes, glasses and cutlery, i.e. black cookware, pots, pans, containers, trays or other mostly large utensils. Therefore, the dimensions are often larger than those of undercounter front loaders or pass-through dishwashers for dishes, glasses and cutlery as the items to be cleaned are also bulkier. Further, the cleaning performance is usually higher, e.g. by means of higher scavenging pressure or other stronger mechanical and chemical treatment in order to dissolve incrustations. Due to their high scavenging pressure, they cannot be loaded with glass or ordinary crockery.

Two construction types can be distinguished:

- Front loading dishwashers;
- Pass-through dishwashers.

The pass-through dishwashers are usually loaded manually; however, some manufacturers offer special roller containers that can be filled outside the machine and then pushed into the dishwasher.

Table 6-7 gives an overview of the main characteristics of this category.

Table 6-7: Main characteristics of a typical undercounter water-change dishwasher (category 4).

Main characteristics	Data from 2011 preparatory study, Task 4 report	Updated data according to stakeholder input from the current study
Programme		
Number of dishwashing programmes	3	3- ~~4~~
Washing capacity, ideal	20 racks/h	20- ~~40~~ racks/h
Cycle time	90–540 sec	90–540 sec, longer cycle times are possible
Tank temperature	usually between 55°C and 65°C	usually between 55°C and 65°C
Boiler temperature	usually between 80°C and 85°C	usually between 80°C and 85°C
Construction details		
Height/width/depth (with open door)	2 000/876/900 mm	1,991-2,000/876/900 mm for small models, larger dimensions are possible
Weight (without packaging)	ca. 200 kg	200- ~~280~~ kg
Tank volume	60-130 litres, average 100 litres	60-130 litres, average 100 litres
Electricity and water connection		
Voltage	400 Volt	400 Volt
Total load	13.0 kW	13.0- ~~18.0~~ kW
Power of pump	typical 1.6 kW	typical 2.2-2.5 kW, 2 x 2.5 kW is possible

Source: Task 4 of 2011 preparatory study on professional dishwashers; updated with current stakeholder data highlighted in red colour.

A special type of pot dishwasher is the so called granulate dishwasher. With these dishwashers (both front loaders and pass-through) the mechanical cleaning is intensified through scouring of the wash ware (mainly black cookware) with plastic granules of different size. A granule collector catches the plastic pellets during the granule washing programme.

Figure 6-12 shows the working principle of granulates.



Figure 6-12: Granulates to foster the cleaning process.

Source: Task 4 report of 2011 preparatory study on professional dishwashers.

The granules can subsequently be cleaned out in a sink with a pipe-mounted sprayer. The special advantage of this process is that less water and energy is needed to clean the pots and other black cookware. Pre-rinsing is not necessary. Granulates are reused in the machine. After about 2,500 cycles they are worn out and have to be replaced.

Table 6-8 shows the main characteristics of an exemplary granulate dishwasher. As this type of dishwasher was not covered by the 2nd stakeholder consultation, values from the 2011 preparatory study on professional dishwashers, Task 4 report, are presented, updated with current product data sheets from manufacturers as well as with written stakeholder feedback to the draft Task 1-4 study report.

Table 6-8: Main characteristics of an exemplary pot dishwasher with granulate.

Main characteristics	Data from 2011 preparatory study, Task 4 report	Updated data according to recent data sheets and stakeholder input from the current study
Programme		
Number of dishwashing programmes	3	3-6
Cycle time	120–310 sec	4-15 cycles
Tank temperature	usually between 55°C and 65°C	usually between 55°C and 65°C
Boiler temperature	usually between 80°C and 85°C	usually between 80°C and 85°C
Construction details		
Loading volume	190 litres	190 litres
Height/width/depth (with open door)	2,400/850/900 mm	1,700-2 400/850-950/900-1,160 mm
Weight (without packaging)	413 kg	350-413 kg
Tank volume	83 litres	83-90 litres
Electricity and water connection		
Voltage	400 Volt	400 Volt
Total load	15 kW	15 kW
Power of pump	2.6 kW	2.2-3.5 kW

Source: Task 4 of 2011 preparatory study on professional dishwashers; updated with current stakeholder data highlighted in red colour.

6.2.2.5. Category 5: One-tank conveyor-type dishwashers

Figure 6-13 shows a typical one-tank conveyor-type dishwasher.



Figure 6-13: One-tank rack conveyor dishwasher (Category 5).

Source: Task 4 report of 2011 preparatory study on professional dishwashers.

One-tank conveyor-type dishwashers use one wash tank for cleaning and fresh water for the final rinsing. Pre-cleaning is normally performed manually (i.e. outside the dishwasher). The detergent and rinse aid are automatically dosed from a reservoir. The dishwashers can be used for different wash ware: dishes, glasses, cutlery, more seldom also for black cookware (pots and pans) and utensils.

Table 6-9 gives an overview of the main characteristics of this category.

Table 6-9: Main characteristics of a typical undercounter water-change dishwasher (category 5).

Main criteria	Data from 2011 preparatory study, Task 4 report	Updated data according to stakeholder input from the current study
Programme		
Number of dishwashing programmes	2–3	1–5
Washing capacity, ideal	70–110 racks/h	70–110 racks/h
Cycle time -> Programme time	90–180 sec.	40–180 sec.
Tank temperature	usually between 55°C and 65°C	usually between 55°C and 65°C
Boiler temperature	usually between 80°C and 85°C	usually between 80°C and 85°C
Construction details		
Width/depth/height	1,300/800/1,420 mm (without preparing zone)	1,120-1,300/800-920/1,420-1,785 mm (without preparing zone)
Depth/height of passage height	500/460 mm	500-720/450-490 mm
Weight (without packaging)	ca. 900 kg	200-900 kg
Tank volume	110-130 litres, average (120 litres)	70-130 litres, average (120 litres)

Main criteria	Data from 2011 preparatory study, Task 4 report	Updated data according to stakeholder input from the current study
Electricity and water connection		
Voltage	400 V	400 V
Power of pump	typical 1.5 kW	typical 1.2-1.7 kW

Source: Task 4 of 2011 preparatory study on professional dishwashers; updated with current stakeholder data highlighted in **red colour**.

According to information provided by stakeholders, the cycle time is not a valid metric for category 5. Instead, the programme time (in sec) or the transport speed (in m/min) would be more suitable metrics. For the transport speed, values in the range from 0.6-1.2 m/min can be found in current data sheets of manufacturers.

6.2.2.6. Category 6: Multi-tank conveyor-type dishwashers

Figure 6-14 shows a typical multi-tank conveyor-type dishwasher.

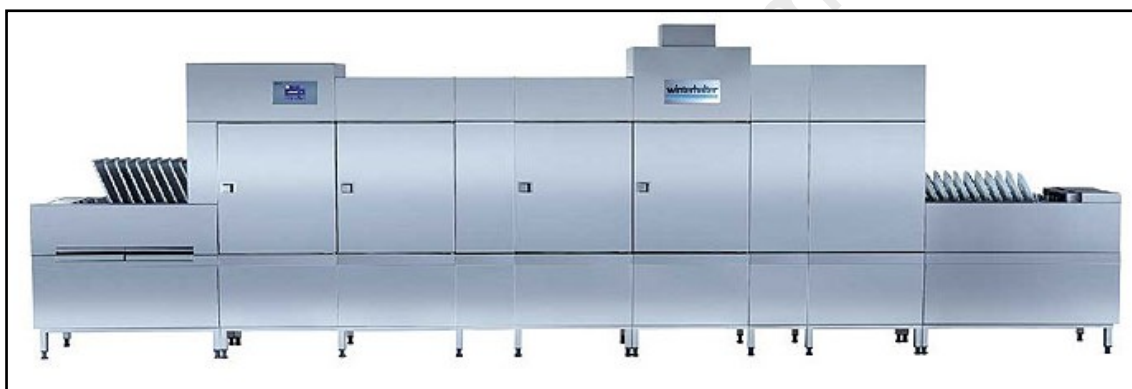


Figure 6-14: Multi-tank flight-type conveyor dishwasher (category 6).

Source: Task 4 report of 2011 preparatory study on professional dishwashers.

Category 6 dishwashers comprise at least one pre-wash zone using a wash tank, one cleaning zone using a wash tank and a final rinse step using fresh water. These dishwashers can be used for different wash ware: dishes, glasses, cutlery, and more seldom black cookware (pots and pans) and utensils.

Multi-tank dishwashers are usually a combination of different modules for pre-washing and cleaning. These modules can be quite different in size and determine the washing capacity of the machine (plates/hour). Also, the passage width and height can be different.

Table 6-10 gives an overview of the main characteristics of this category.

4342 **Table 6-10: Main characteristics of a typical multi-tank conveyor dishwasher (category 6).**

Main criteria	Data from 2011 preparatory study, Task 4 report	Updated data according to stakeholder input from the current study
Programme		
Number of dishwashing programmes	3	3-10
Washing capacity	1,700–6,000 dishes/h	1,700–6,000 dishes/h
Cycle time -> Programme time	90–180 sec.	18–180 sec.
Tank temperature	usually between 55°C and 65°C	usually between 55°C and 65°C
Boiler temperature	usually between 80°C and 85°C	usually between 80°C and 85°C
Construction details		
Width (without packaging)	4,700–7,400 mm (without preparing zone)	3,500–7,400 mm (without preparing zone), the dimensions can also be beyond that range since the variety of options is very high
Depth/height of passage height	Different modules available	530-720/450-490 mm, different modules available
Weight	ca. 1,300 kg	660-1,300 kg
Tank volume	130-750 litres, average 230 litres	130-750 litres, average 100-400 litres per single tank, a machine can have multiple tanks
Electricity and water connection		
Voltage	400 Volt	230-400 Volt
Total load	39–51 kW	33–51 kW, depending on models and options
Power of pump	no data available	0.3-3.0 kW, a machine can have multiple pumps

Source: Task 4 of 2011 preparatory study on professional dishwashers; updated with current stakeholder data highlighted in red colour.

According to information provided by stakeholders, the cycle time is not a valid metric also for category 6. Instead, the programme time (in sec.) or the transport speed (in m/min) would be more suitable metrics. For the transport speed, values in the range from 0.8-1.6 m/min can be found in current data sheets of manufacturers.

Generally it can be noted that the number of programmes has increased in recent years, particularly within the high-end segment of electronically controlled machines. Manufacturers have confirmed this trend of programme diversification. As part of the development of materials for washing items (e.g. plastics and glass), the demand for application-specific washing programmes that clean effectively yet gently is increasing. However, one stakeholder also mentioned that, ultimately, only one or two programmes are used, as it is not possible to constantly change programmes during business operations.

6.2.3. Products with standard improvement (design) options

The manufacturers and suppliers of commercial dishwashers offer their products, if at all, in categories 1 to 4 as a sort of standard solution, whereas in the case of products in categories 5 and 6, there are often several product lines of appliances with additional options that can be ordered. These additional options are used to address customer-specific operating conditions and/or local infrastructure conditions. Against this background, it is not possible to make a systematic and clear distinction between equipment features that are standard design options and features that can be clearly assigned to a BAT.

Heat exchanger

According to the manufacturers, heat exchangers are used in the majority of the appliances (see chapter 4.4.3), so that an allocation to standard improvement (design) options is obvious for this option.

However, from a technical point of view, 'heat exchanger' is a generic term because there are significantly different types of heat exchangers used in commercial dishwashers. Without claiming to be exhaustive, heat exchangers can be used as follows:

- Recovery of waste heat from the wastewater flow.
- Recovery of waste heat from the moisture-laden air inside the appliance (vapours).

Heating of the cleaning and rinsing water in cases where the appliance is supplied with thermal energy in the form of low pressure steam and hot water. However, this is only the case for a small percentage of the appliances in categories 4 to 6 (see **Table 5-27** in **section 5.6.2**) and the relevance is consistently rated as declining by the manufacturers.

In addition, heat exchangers are technically divided into recuperators (where the two media are passed through separate spaces) and regenerators (where the hot and cold media pass alternately through the heat-storing body), as in the case of Zeolite(R) technology. Finally, heat exchangers vary in their design (from simple plate heat exchangers to so-called water-pocket heat exchangers to complex tube bundle heat exchangers) and in the way the media are directed (counterflow versus co-current flow versus cross-flow).

Improved thermal insulation

Improving the insulation of the equipment also appears to be a standard improvement option. Insulation generally has two effects: it can improve the energy efficiency of the equipment by reducing heat loss, and it can improve working conditions in the dishwashing area (scullery).

Clarification is needed for the further processing of the study with regard to whether improved thermal insulation is used in all appliance categories, what specific savings can be achieved and whether recycling is hampered by, for example, composite materials that are difficult to separate.

Additional warm/hot water connection, steam-operated heating and gas-operated heating

The option of heating the operating fluids for cleaning and rinsing in commercial dishwashing machines using gas, steam or hot water is a standard improvement option. However, the data in **Table 5-27, section 5.6.2** indicate that electric heating is at a high level and continues to increase.

Feedback from stakeholders (i.e. manufacturers) on the identified standard improvement options as presented above was mixed and partly contradictory, probably mainly due to the different portfolios of appliances they produce. However, the majority of the above mentioned options were confirmed. Nevertheless, some manufacturers noted that some features, such as the hot water connection, are already standard in most of their appliances. One stakeholder pointed out that heat exchangers, improved thermal insulation and steam-operated heating should be considered Best Available Technology (BAT). Gas-operated heating, on the other hand, does not have to be considered at all.

Regarding the standard improvement option of an additional warm/hot water connection, the question arises as to whether using a local steam or hot water supply provides advantages over electric heating of operating fluids for cleaning and rinsing, from a holistic energy perspective. According to stakeholder feedback, this question cannot be easily answered, as it depends on the hot water and steam energy sources present at the customer site. The assessment also depends on the individual situation of the appliance operator (e.g. pipe length). Some stakeholders even doubt whether a steam (or hot water) supply for heating is realistic or advantageous. Steam production and distribution is considered to be the most expensive form of energy. In Europe, it is deemed outdated unless there is a geothermal source or a combined heat and power plant available nearby. With regard to hot water supply, it is up to the operating company whether it is willing to provide piping close to the machine, which cannot be influenced by the machine supplier. Additional product variance would make manufacturing more difficult, resulting in higher costs for the manufacturer and customer. Another stakeholder pointed out that steam or hot water generation must be particularly efficient, e.g. with the help of renewable energy or heat pumps, for this to be advantageous from a holistic energy perspective. Similar discussions have already taken place regarding a separate hot water connection for household appliances.

6.2.4. Best Available Technology (BAT)

As part of a comprehensive research, the following design features were assigned to the category of Best Available Technology (BAT).

6.2.4.1. Heat recovery (wastewater and vapours)

Generally speaking, systems for utilising waste heat are not yet among the standard options for improvement; they are usually additional options or system components for commercial dishwashers that can be selected. From a technical point of view, there are two heat sources that can be used for recovery: firstly, waste heat from wastewater and, secondly, waste heat from vapours, i.e. the warm, moisture-laden air inside the appliance. In the case of appliances in categories 5 and 6, the wastewater is already being used due to the design, as the water flow

4433 is directed against the direction of the dishes. Manufacturers apparently use different concepts
4434 for heat recovery. Specifically, systems are offered with and without heat pumps. According to
4435 the manufacturers, the controlled air flow within the appliances is of particular importance for
4436 the question of how heat recovery can be achieved.

4437 To our knowledge, specific and comparable data on effectiveness (i.e. what proportion of the
4438 waste heat is used) and efficiency (i.e. how high are the costs of heat recovery in relation to the
4439 benefits) are not yet available and will need to be clarified with the relevant manufacturers in
4440 the further course of the study. In addition, it is necessary to investigate which systems can be
4441 used in which categories of appliances.

4442 In addition, heat storage systems such as zeolite technology should be further investigated.
4443 These can be considered as a BAT for domestic dishwashers and an application of this technology
4444 for commercial category 1 appliances is conceivable.

4445 There are alternative concepts and technologies without an additional consumable like zeolite,
4446 that can also achieve good consumption values. In some cases, systems are used where the air
4447 to be dried is mixed with ambient air, or systems that enable a kind of recirculation operation.

4448 According to stakeholder feedback, heat recovery is feasible in principle for category 1
4449 dishwashers, but only for programmes with high cleaning and rinsing temperatures. A large
4450 temperature difference is required for energy recovery to be energy-efficient. For all other
4451 categories, heat recovery is available for most products, at least as an option.

4452 The disadvantage of zeolite technology is that it is heavily covered by patents. Free use as BAT
4453 is therefore not considered to be possible. Furthermore, one stakeholder noted that this
4454 technology has the additional drawback of generating zeolite dust during use, which requires
4455 the use of additional equipment such as dust collectors. Also, zeolite is consumed over time and
4456 needs to be refilled or replaced.

4457 6.2.4.2. Automatic adaptation of programme to load and to soiling level 4458 of dishes / utensils

4459 Several manufacturers offer automatic detection of empty spaces on the conveyor belts or
4460 unfilled racks as an additional option for category 5 and 6 machines. The devices can reduce
4461 rinsing to the areas where the dishes are actually located. This should result in significant savings
4462 of fresh water and rinse aid.

4463 In general, further clarification is needed with stakeholders as to which automatic adjustment
4464 options in line with BAT are available for which appliance categories and what energy, water and
4465 detergent savings could be achieved as a result.

4466 Stakeholders commented in this respect that an automatic programme for recognising loads and
4467 soils is a feasible solution that would provide practical benefits. It should be noted, however,
4468 that additional sensors would be required in the devices. Automatic adjustment for category 1
4469 dishwashers is not currently available. For categories 2 and 3, automatic detection of the rack
4470 via magnetic sensors allows the correct cycle to be performed depending on the items to be
4471 washed on that rack, such as dishes, glasses or bottles. In the case of conveyor appliances, a

reed sensor can detect whether each row or rack position contains items to be washed (or whether a rack is present) and activate the relevant phase when needed. The additional cost of the sensors should also be taken into account. This is why many manufacturers currently offer a wide range of programmes, enabling them to meet customer needs as closely as possible without exceeding economic limits.

In this context, stakeholders also mentioned that some manufacturers produce their own cleaning and care products alongside the appliances to enable improved coordinated process technology. This system solution opens up new possibilities for dosing high-concentrate products, e.g. by integrating them into machines and adapting the process parameters. This could lead to innovative business models as part of a sustainability strategy, for example by increasing efficiency through optimised consumption and precise dosing, which reduces resource consumption.

6.2.4.3. Water treatment (demineralisation and reverse osmosis)

Several manufacturers of commercial dishwashers offer integrated or additional water treatment systems. Two different processes are offered:

- the so-called demineralisation (here, all minerals are removed from the water and replaced with ions that do not form any residues on the washed items) and
- reverse osmosis systems (here, water is passed under high pressure through a membrane that retains almost all substances).

According to stakeholder feedback, water treatment is already state of the art. A built-in water softener comes as standard with category 1 appliances and is available as an optional extra with category 2 and 3 devices. Reverse osmosis is an optional extra for category 1 machinery.

6.2.4.4. Cleaning with lower temperature

Another way to reduce the specific energy requirement is to clean at lower temperatures, as the lower temperature gradient compared to the environment reduces heat loss. The 2011 preparatory study showed that in Europe, the hygienic requirements of the dishwashing process are met by thermal means. This means that no special disinfectants are required in the cleaning or rinsing agents.

According to stakeholder feedback, low-temperature cleaning is not a reasonable option due to environmental concerns. When temperatures are reduced, the other parameters of Sinner's circle must also be adjusted. However, customers do not want the cycle time to be extended. Increasing the mechanical action would lead to increased energy consumption, which is also undesirable. The only remaining options would be to increase the chemical concentrations or alter the composition of the detergents (e.g. by using active chlorine or other bleaching agents). This would have a negative impact on the ecosystem. In this context, the regulatory requirements in Northern Europe (higher rinse temperatures) and hygiene requirements (log-stage reduction of microorganisms) must also be considered.

4509 Additionally, one stakeholder pointed out that low-temperature cleaning cannot be considered
4510 Best Available Technology (BAT) in this study because it is a feature of the detergent rather than
4511 the dishwasher itself.

4512 6.2.5. Best Not yet Available Technology (BNAT)

4513 A patent research has been carried out to identify technologies or technological features that
4514 are currently under research and development or in the early stages of commercialisation. These
4515 Best Not yet Available Technologies (BNAT) are currently not widely used, but have the potential
4516 to enable significant advances in environmental performance. The research resulted in the
4517 following innovations:

4518 6.2.5.1. Supercritical carbon dioxide cleaning

4519 Patent number: CN105686777A

4520 Origin: China

4521 Year of publication: 2016

4522 This technology for dishwashers utilises supercritical carbon dioxide as a cleaning medium,
4523 offering high cleanliness and environmental benefits. The design includes a cleaning seal
4524 chamber, ultrasonic transducers and a separation kettle for efficient cleaning.

4525 Reference: <https://patents.google.com/patent/CN105686777A/en>

4526 6.2.5.2. Combined ultrasonic and spray cleaning

4527 Patent number: KR20230085690A

4528 Origin: South Korea

4529 Year of publication: 2023

4530 This dishwasher technology integrates ultrasonic cleaning with traditional spray methods,
4531 aiming to enhance cleaning efficiency and reduce water and energy consumption.

4532 Reference: <https://patents.google.com/patent/KR20230085690A/en>

4533 6.2.5.3. Closed loop heat pump drying

4534 Patent number: EP3542114B1

4535 Origin: Europe

4536 Year of publication: 2020

The core of this technology is a drying system that incorporates a heat pump assembly operating with a primary fluid, connected to multiple heat sources and sinks to improve the energy efficiency of drying processes.

Reference: <https://patents.google.com/patent/EP3542114B1/en>

6.2.5.4. Enzyme cleaning agents

Patent number: EP3542114B1

Origin: Germany

Year of publication: 2014

This invention relates to a detergent for dishwashers comprising enzymes, phosphorus-free complexing agents, non-ionic surfactants, propylene glycol and other components. The formulation is claimed to increase the cleaning efficiency while being environmentally friendly.

Reference: <https://patents.google.com/patent/DE102012107728A1/en>

With regard to the potential for significant improvements in environmental performance, stakeholders provided heterogeneous feedback. While one stakeholder confirmed relevant potentials in this respect, another considered the presented technologies to be rather unpromising. For instance, ultrasonic cleaning requires complete immersion of the washing items and, as such, a complete redesign of all appliances and operating procedures.

In terms of the different technological approaches, the stakeholder provided the following detailed feedback:

- Supercritical CO₂ cleaning: Initial investigations into possible applications are publicly available. However, it is not possible to completely remove food ingredients. Current general conditions rule out its use in areas where unskilled people handle dishwashers.
- Combined ultrasonic and spray cleaning: Ultrasound alone is not effective in removing a wide range of soiling types, including baked-on and denatured soils. Cleaning agent ingredients (e.g. alkalis and surfactants) dissolve these soils on the surface so they can be more easily removed. This is also a highly bespoke system that can only be implemented in hood-type dishwashers. In this case, it would be a new appliance rather than an optional retrofittable feature for existing appliances.
- Closed loop heat pump drying: This is a drying system with improved energy efficiency that is used in industrial applications, such as in the chemical, textile, food, wood and paper industries. However, it is not specifically designed for use in category 1 dishwashers and its implementation in 60 cm niche devices is limited. However, this technology is already available in category 5 and 6 dishwashers from almost all manufacturers.
- Enzyme cleaning agents: A detergent specially developed for dishwashers. This cleaner formulation contains a particularly high proportion of enzymes. Several

4574 cleaners with similar formulations are already on the market. However, these are
4575 often still not suitable for commercial users as the dissolution time is still too short.

4576 Concerning further BNAT candidates, stakeholders pointed out that disclosing potential
4577 innovations like BNAT could reveal sensitive information about ongoing research and
4578 development projects, which could result in a competitive disadvantage.

4579 6.3. Production, distribution, end-of-life

4580 This section covers the following aspects:

- 4581 • Product weight and Bills-of-Materials;
- 4582 • Energy use of manufacturing;
- 4583 • Primary scrap/waste produced during manufacturing;
- 4584 • Volume and weight of the packaged product;
- 4585 • Means of transport employed;
- 4586 • Technical product life (time-to-failure of critical parts);
- 4587 • Material flows and collection effort at end-of-life (secondary waste), to landfill/
4588 incineration/ recycling/ re-use.

4589 6.3.1. Product weight and Bills-of-Materials

4590 In the following, the Bill-of-Materials (BOM) for each of the commercial dishwasher categories
4591 is presented, as defined in Task 1 (see **section 3.2.3.7**).

4592 6.3.1.1. Category 1: Undercounter water-change dishwashers

4593 According to stakeholder input, the material composition is equivalent to that of a household
4594 dishwasher as described in the preparatory study on washing machines and dishwashers (Lot
4595 24). Therefore, the BOM has been taken from the 2011 preparatory study on professional
4596 dishwashers, Task 4 report, see **Table 6-11**.

4597 **Table 6-11: Material composition of an undercounter water-change dishwasher (category 1) -**
4598 **2011 values.**

Material / component	weight in g	weight in ratio %	Material category
Stainless Steel	24,560	51.0	3-Ferrous
Steel Sheet galvanised	403	0.8	3-Ferrous
Cast Iron	2,303	4.8	3-Ferro
Polypropylen (PP)	4,980	10.3	1-BlkPlastics

Material / component	weight in g	weight in ratio %	Material category
Polyamid (PA)	399	0.8	2-TecPlastics
Polymethylmetacrylate (PMMA)	6	0.0	2-TecPlastics
Acrylonitrile Butadiene Styrene (ABS)	751	1.6	1-BlkPlastics
Polystyrene (PS)	512	1.1	1-BlkPlastics
Styropor expandable polystyrene (EPS)	40	0.1	1-BlkPlastics
Polybutylene Terephthalate (PBT)	35	0.1	1-BlkPlastics
Polyvinylchlorid (PVC)	403	0.8	1-BlkPlastics
EPDM-rubber	524	1.1	1-BlkPlastics
POM	230	0.5	1-BlkPlastics
PE	187	0.4	1-BlkPlastics
Plastics others	268	0.6	1-BlkPlastics
Aluminium	273	0.6	4-Non-ferro
Cu wire	1,006	2.1	4-Non-ferrous
CuZn38 cast	23	0.0	4-Non-ferrous
Chrom	71	0.1	4-Non-ferrous
Bitumen	6,089	12.6	7-Misc.
Concrete	1,263	2.6	7-Misc.
Cotton	452	0.9	7-Misc.
Epoxy	609	1.3	2-TecPlastics
Wood	2,034	4.2	7-Misc.
others (paper)	285	0.6	7-Misc.
Electronics (control)	448	0.9	6-Electronics
Total net	48,154	100.0	

According to the input received during the 2024 online survey, concrete is not used in category 1 dishwashers. Furthermore, wood and others (paper) are considered to be part of the packaging. Therefore, these materials have been removed from the BOM and the weight ratio has been updated accordingly.

Based on written stakeholder feedback on the draft Task 1–4 study report, the total weight of category 1 dishwashers ranges from 57 kg (U-unit, without racks) to 79 kg (free-standing unit, with racks). On average, 65 kg can be assumed. The proportion of stainless steel is considered to be lower on average, with more galvanised steel sheet being used instead. Depending on the variant, the ratio of stainless steel to galvanised steel sheet is approximately 50:50. In this context, the 'ferrous' material category should be increased to better reflect the actual weight distribution (with a proposed range of 54 % to approximately 60 %). Furthermore, it was confirmed that bitumen (5 kg) and small amounts of cotton (less than 1 kg) are used in the devices.

Table 6-12 shows the updated BoM according to the stakeholder feedback provided.

Table 6-12: Material composition of an undercounter water-change dishwasher (category 1) - 2024 values.

Material / component	weight in g	weight in ratio %	Material category
Stainless Steel	18,500	28.5	3-Ferrous
Steel Sheet galvanised	18,500	28.5	3-Ferrous
Polypropylen (PP)	10,211	15.7	1-BlkPlastics
Polyamid (PA)	818	1.3	2-TecPlastics
Polymethylmetacrylate (PMMA)	12	0.0	2-TecPlastics
Acrylonitrile Butadiene Styrene (ABS)	1,540	2.4	1-BlkPlastics
Polystyrene (PS)	1,050	1.6	1-BlkPlastics
Styropor expandable polystyrene (EPS)	82	0.1	1-BlkPlastics
Polybutylene Terephthalate (PBT)	72	0.1	1-BlkPlastics
Polyvinylchlorid (PVC)	826	1.3	1-BlkPlastics
EPDM-rubber	1,074	1.7	1-BlkPlastics
POM	472	0.7	1-BlkPlastics
PE	383	0.6	1-BlkPlastics
Plastics others	550	0.8	1-BlkPlastics
Aluminium	560	0.9	4-Non-ferrous
Cu wire	2,063	3.2	4-Non-ferrous
CuZn38 cast	47	0.1	4-Non-ferrous
Chrom	146	0.2	4-Non-ferrous
Bitumen	5,000	7.7	7-Misc.
Cotton	927	1.4	7-Misc.
Electronics (control)	2,167	3.3	6-Electronics
Total net	65,000	100.0	

6.3.1.2. Category 2: Undercounter one-tank dishwashers

The following table shows the parts list of a typical category 2 dishwasher. The shares of the different materials and the category to which the materials are assigned are presented. The dataset is again taken from the Lot 24 Task 4 report, see **Table 6-13**.

Table 6-13: Material composition of an undercounter one-tank dishwasher (category 2) - 2011 values.

Material / component	Weight in g	Fraction in %	Material category according to MEEuP
Stainless steel	49,760	71.2	3-Ferrous
Polypropylene (PP)	4,565	6.5	1-BlkPlastics
Polyamide (PA)	500	0.7	2-TecPlastics
Epoxy	1,000	1.4	2-TecPlastics
Acrylonitrile Butadiene Styrene (ABS)	70	0.1	1-BlkPlastics
Pumps (copper)	2,500	3.6	4-Non-ferrous
Pumps (stack of sheets)	2,500	3.6	3-Ferrous
Pumps (stainless steel wave)	2,250	3.2	3-Ferrous
Pumps (Al)	2,250	3.2	4-Non-ferrous
Cable (copper)	1,100	1.6	4-Non-ferrous
Cable sheath (PVC)	600	0.9	1-BlkPlastics
Cable sheath (silicone, EPDM)	300	0.4	1-BlkPlastics
Electronics (control)	500	0.7	6-Electronics
Gaskets (EPDM)	2,040	2.9	1-BlkPlastics
Total net	69,935	100.0	

The data from the Lot 24 Task 4 report was confirmed and updated using stakeholder feedback from the 2024 online survey, as well as written feedback from stakeholders on the draft Task 1–4 study report. This resulted in a slightly lower weight and a different material composition (less stainless steel and more polymers instead). Stakeholders confirmed the substitution of steel with polymers as a market trend for category 2 dishwashers. Regarding the total weight, however, it should be noted that there is considerable variation due to differences in the size, features and performance of the machines. Therefore, it is difficult to define a typical category 2 appliance.

Table 6-14 shows the updated BoM according to the stakeholder feedback provided.

Table 6-14: Material composition of an undercounter one-tank dishwasher (category 2) - 2024 values.

Material / component	Weight in g	Fraction in %	Material category according to MEEuP
Stainless steel	44,530	65.2	3-Ferrous
Polypropylene (PP)	4,733	6.9	1-BlkPlastics
Polyamide (PA)	500	0.7	2-TecPlastics
Acrylonitrile Butadiene Styrene (ABS)	635	0.9	1-BlkPlastics
Pumps (copper)	2,447	3.6	4-Non-ferrous
Pumps (stack of sheets)	2,447	3.6	3-Ferrous
Pumps (stainless steel wave)	2,203	3.2	3-Ferrous
Pumps (Al)	2,203	3.2	4-Non-ferrous
Aluminium	350	0.5	4-Non-ferro
Cable (copper)	1,200	1.8	4-Non-ferrous
Cable sheath (PVC)	300	0.4	1-BlkPlastics
Cable sheath (silicone, EPDM)	150	0.2	1-BlkPlastics
Electronics (control)	3,900	5.7	6-Electronics
Gaskets (EPDM)	2,670	3.9	1-BlkPlastics
Total net	68,268	100.0	

6.3.1.3. Category 3: Hood-type dishwashers

The following table shows the BOM of a typical dishwasher of category 3, the shares of the different materials and the category to which the materials are assigned. Also this dataset is taken from the 2011 preparatory study on professional dishwashers, Task 4 report, see **Table 6-15**.

Table 6-15: Material composition of a hood-type dishwasher (category 3) - 2011 values.

Material / component	Weight in g	Weight in ratio %	Material category
Stainless steel	93,090	79.1	3-Ferrous
Polypropylene (PP)	4,310	3.7	1-BlkPlastics
Polyamide (PA)	1,000	0.8	2-TecPlastics
Epoxy	800	0.7	2-TecPlastics
Acrylonitrile Butadiene Styrene (ABS)	70	0.1	1-BlkPlastics

Material / component	Weight in g	Weight in ratio %	Material category
Pumps (copper)	3,000	2.5	4-Non-ferrous
Pumps (stack of sheets)	3,000	2.5	3-Ferrous
Pumps (stainless steel wave)	2,500	2.1	3-Ferrous
Pumps (Al)	3,000	2.5	4-Non-ferrous
Cable (copper)	1,700	1.4	4-Non-ferrous
Cable sheath (PVC)	1,000	0.8	1-BlkPlastics
Cable sheath (silicone, EPDM)	500	0.4	1-BlkPlastics
Electronics (control)	600	0.5	6-Electronics
Gaskets (EPDM)	3,085	2.6	1-BlkPlastics
Total net	117,655	100.0	

According to stakeholder input, a relatively wide weight range (100–200 kg) has been reported, depending on the model (one or two racks), performance, and optional configuration. For example, there are models with a single or double skin, different inlet heights, and certain options, such as heat recovery. Furthermore, it should be noted that there are also hood-type machines that can hold two racks at the same time and are therefore bigger and heavier. As with category 2, it is difficult to define a typical appliance.

Against this background, the following **Table 6-16** shows the updated BoM, which represents the average of the data ranges provided by the stakeholders.

Table 6-16: Material composition of a hood-type dishwasher (category 3) - 2024 values.

Material / component	Weight in g	Weight in ratio %	Material category
Stainless steel	112,045	75.4	3-Ferrous
Polypropylene (PP)	6,805	4.6	1-BlkPlastics
Polyamide (PA)	1,550	1.0	2-TecPlastics
Acrylonitrile Butadiene Styrene (ABS)	635	0.4	1-BlkPlastics
Pumps (copper)	3,848	2.6	4-Non-ferrous
Pumps (stack of sheets)	3,848	2.6	3-Ferrous
Pumps (stainless steel wave)	2,957	2.0	3-Ferrous
Pumps (Al)	3,848	2.6	4-Non-ferrous
Aluminium	2,000	1.3	4-Non-ferro
Cable (copper)	1,381	0.9	4-Non-ferrous

Material / component	Weight in g	Weight in ratio %	Material category
Cable sheath (PVC)	813	0.5	1-BlkPlastics
Cable sheath (silicone, EPDM)	406	0.3	1-BlkPlastics
Electronics (control)	5,000	3.4	6-Electronics
Gaskets (EPDM)	3,543	2.4	1-BlkPlastics
Total net	148,678	100.0	

4650 6.3.1.4. Category 4: Utensil / pot dishwashers

4651 The following table shows the BOM of a typical dishwasher of category 4 (without granulates¹⁰⁷),
 4652 the shares of the different materials and the category to which the materials are assigned. The
 4653 dataset is again taken from the 2011 preparatory study on professional dishwashers, Task 4
 4654 report, see **Table 6-17**.

4655 **Table 6-17: Material composition of a utensil / pot dishwasher (category 4) - 2011 values.**

Material / component	Weight in g	Weight in ratio %	Material category
Stainless steel	165,000	80.1	3-Ferrous
Polypropylene (PP)	3,000	1.5	1-BlkPlastics
Polyamide (PA)	4,000	1.9	2-TecPlastics
Epoxy	0	0.0	2-TecPlastics
Ethylene Propylene Dien M-class rubber (EPDM)	4,000	1.9	1-BlkPlastics
Acrylonitrile Butadiene Styrene (ABS)	0	0.0	1-BlkPlastics
Pumps (copper)	5,000	2.4	4-Non-ferrous
Pumps (stack of sheets)	4,000	1.9	3-Ferrous
Pumps (stainless steel wave)	3,000	1.5	3-Ferrous
Pumps (Al)	5,000	2.4	4-Non-ferrous
Cable (copper)	2,400	1.2	4-Non-ferrous
Cable sheath (PVC)	1,400	0.7	1-BlkPlastics
Cable sheath (silicone, EPDM)	1,100	0.5	1-BlkPlastics
Electronics (control)	2,100	1.0	6-Electronics
Gaskets, etc. (EPDM)	6,000	2.9	1-BlkPlastics
Total net	206,000	100.0	

107 Granulate dishwashers are not seen as typical for category 4 but rather as special case. The material composition is thus based on a pot dishwasher without granulates. Granulate dishwashers will be further analysed in Task 6.

Similar to the previous categories, stakeholders generally confirmed the category 4 data from the 2011 preparatory study on professional dishwashers. As no specific changes were proposed in the 2024 online survey or in written stakeholder feedback on the draft Task 1–4 study report, the values from the 2011 preparatory study were left unchanged.

6.3.1.5. Category 5: One-tank conveyor-type dishwashers

Table 6-18 shows the BOM of a typical dishwasher of category 5, the shares of the different materials and the category to which the materials are assigned. The dataset is again taken from the 2011 preparatory study on professional dishwashers, Task 4 report.

Table 6-18: Material composition of a one-tank conveyor-type dishwasher (category 5) - 2011 values.

Material / component	Weight in g	Weight in ratio %	Material category
Stainless steel	642,250	72.06	3-Ferrous
Polypropylene (PP)	55,500	6.23	1-BlkPlastics
Polyamide (PA)	6,140	0.69	2-TecPlastics
Polyvinyl chloride (PVC)	4,600	0.52	1-BlkPlastics
Polystyrene (PS)	4,430	0.50	1-BlkPlastics
Acrylonitrile Butadiene Styrene (ABS)	5,000	0.56	1-BlkPlastics
Pumps (copper)	16,825	1.89	4-Non-ferrous
Pumps (stack of sheets)	15,625	1.75	3-Ferrous
Pumps (stainless steel wave)	12,335	1.38	3-Ferrous
Pumps (Al)	17,470	1.96	4-Non-ferrous
Condenser (Al)	4,720	0.53	4-Non-ferrous
Condenser (Cu)	7,080	0.79	4-Non-ferrous
Ventilator, fan (Al)	17,440	1.96	4-Non-ferrous
Ventilator, fan (Cu)	10,160	1.14	4-Non-ferrous
Drive motor (Al)	4,000	0.45	4-Non-ferrous
Drive motor (Cu)	5,000	0.56	4-Non-ferrous
Cable (copper)	16,300	1.83	4-Non-ferrous
Cable sheath (PVC)	8,640	0.97	1-BlkPlastics
Cable sheath (silicone, EPDM)	5,170	0.58	1-BlkPlastics
Electric contactor (copper)	10,000	1.12	4-Non-ferrous
Electronics (control)	9,800	1.10	6-Electronics
Gaskets (EPDM)	12,800	1.44	1-BlkPlastics
Total net	891,285	100.00	

What applies to Category 4 also holds true for Category 5: As no specific changes were proposed in the 2024 online survey or in written stakeholder feedback on the draft Task 1–4 study report, the values from the 2011 preparatory study were left unchanged. However, it needs to be noted that category 5 (one-tank) conveyor-type dishwashers are also available with a steam heating system. In this case the additional material input for the heating system is estimated to be 150 kg (mainly stainless steel).

6.3.1.6. Category 6: Multi-tank conveyor-type dishwashers

Table 6-19 shows the BOM of a typical dishwasher of category 6, the shares of the different materials and the category to which the materials are assigned. The dataset is again taken from the 2011 preparatory study on professional dishwashers, Task 4 report (2011 values).

Table 6-19: Material composition of a multi-tank conveyor-type dishwasher (category 6) – 2011 values.

Material / component	Weight in g	Weight in ratio %	Material category
Stainless steel	980,000	76.3	3-Ferrous
Polypropylene (PP)	58,000	4.5	1-BlkPlastics
Polyamide (PA)	18,660	1.5	2-TecPlastics
Epoxy	0	0.0	2-TecPlastics
Ethylene Propylene Dien M-class rubber (EPDM)	12,000	0.9	1-BlkPlastics
Acrylonitrile Butadiene Styrene (ABS)	0	0.0	1-BlkPlastics
Pumps (copper)	39,020	3.0	4-Non-ferrous
Pumps (stack of sheets)	37,070	2.9	3-Ferrous
Pumps (stainless steel wave)	25,370	2.0	3-Ferrous
Pumps (Al)	44,880	3.5	4-Non-ferrous
Cable (copper)	19,800	1.5	4-Non-ferrous
Cable sheath (PVC)	11,440	0.9	1-BlkPlastics
Cable sheath (silicone, EPDM)	8,360	0.7	1-BlkPlastics
Electronics (control)	15,400	1.2	6-Electronics
Gaskets, etc. (EPDM)	15,000	1.2	1-BlkPlastics
Total net	1,285,000	100.0	

Stakeholders noted that category 6 dishwashers are generally equipped with heat recovery. The corresponding lines from category 5 (see **Table 6-18**) have therefore been added to its BoM, as shown in **Table 6-20** below. Furthermore, it should be noted that multi-tank conveyor-type dishwashers are also available with a steam heating system. In this case, the additional material input for the heating system is estimated to be 200 kg, mainly stainless steel.

Table 6-20: Material composition of a multi-tank conveyor-type dishwasher (category 6) – 2024 values.

Material / component	Weight in g	Weight in ratio %	Material category
Stainless steel	980,000	72.9	3-Ferrous
Polypropylene (PP)	58,000	4.3	1-BlkPlastics
Polyamide (PA)	18,660	1.4	2-TecPlastics
Ethylene Propylene Dien M-class rubber (EPDM)	12,000	0.9	1-BlkPlastics
Acrylonitrile Butadiene Styrene (ABS)	0	0.0	1-BlkPlastics
Pumps (copper)	39,020	2.9	4-Non-ferrous
Pumps (stack of sheets)	37,070	2.8	3-Ferrous
Pumps (stainless steel wave)	25,370	1.9	3-Ferrous
Pumps (Al)	44,880	3.3	4-Non-ferrous
Condenser (Al)	4,720	0.4	4-Non-ferrous
Condenser (Cu)	7,080	0.5	4-Non-ferrous
Ventilator, fan (Al)	17,440	1.3	4-Non-ferrous
Ventilator, fan (Cu)	10,160	0.8	4-Non-ferrous
Drive motor (Al)	4,000	0.3	4-Non-ferrous
Drive motor (Cu)	5,000	0.4	4-Non-ferrous
Cable (copper)	19,800	1.5	4-Non-ferrous
Cable sheath (PVC)	11,440	0.9	1-BlkPlastics
Cable sheath (silicone, EPDM)	8,360	0.6	1-BlkPlastics
Electric contactor (copper)	10,000	0.7	4-Non-ferrous
Electronics (control)	15,400	1.1	6-Electronics
Gaskets, etc. (EPDM)	15,000	1.1	1-BlkPlastics
Total net	1,343,400	100.0	

6.3.1.7. Overview of all dishwasher categories

An overview of the material input in the different categories of professional dishwashers is shown in the following **Table 6-21** and **Table 6-22** (both absolute values and shares of material categories according to MEerP, excluding packaging material).

Table 6-21: Material input for the different categories of commercial dishwashers (material categories according to MEErP, including packaging).

Materials-category	Unit	Cat. 1	Cat. 2	Cat. 3	Cat. 4	Cat. 5	Cat. 6
Bulk Plastics	g	16,260	8,488	12,201	15,500	96,140	104,800
TecPlastics	g	830	500	1,550	4,000	6,140	18,660
Ferrous	g	37,000	49,180	118,849	172,000	670,210	1,042,440
Non-ferrous	g	2,815	6,200	11,077	12,400	108,995	162,100
Electronics	g	2,167	3,900	5,000	2,100	9,800	15,400
Misc.	g	5,927	0	0	0	0	0
Total weight	g	65,000	68,268	148,678	206,000	891,285	1,343,400

For classification details see the legend to the following table.

Table 6-22: Share of material categories (according to MEEuP) for the different categories of commercial dishwashers (including packaging).

Materials-category	Unit	Cat. 1	Cat. 2	Cat. 3	Cat. 4	Cat. 5	Cat. 6
Bulk Plastics	g	25.0 %	12.4 %	8.2 %	7.5 %	10.8 %	7.8 %
Tec Plastics	g	1.3 %	0.7 %	1.0 %	1.9 %	0.7 %	1.4 %
Ferrous	g	56.9 %	72.0 %	79.9 %	83.5 %	75.2 %	77.6 %
Non-ferrous	g	4.3 %	9.1 %	7.5 %	6.0 %	12.2 %	12.1 %
Electronics	g	3.3 %	5.7 %	3.4 %	1.0 %	1.1 %	1.1 %
Misc.	g	9.1 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
Total weight	g	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %

Cat. 1 Undercounter front loaders with water-change operation

Cat. 2 Undercounter front loaders with one-tank

Cat. 3 Hood-type dishwashers

Cat. 4 Utensil / pot dishwashers

Cat. 5 One-tank conveyor-type dishwashers

Cat. 6 Multi-tank conveyor-type dishwashers

In all categories, the share of ferrous metal (mainly stainless steel) is with approximately 57 % to 84 % predominant.

International standards like ASTM or NSF/ANSI as well as standards in Europe (for example DIN 10510) require the use of corrosion resistant material for surfaces exposed to wash and rinse water according to the intended use environment (cf. MEERP Task 1).

6.3.2. Assessment of the energy use of manufacturing

Concerning the energy used for the production of commercial dishwashers, only one stakeholder provided data for categories 2 to 6. The values are shown in the **Table 6-23** below.

Table 6-23: Energy use of manufacturing for the different categories of commercial dishwashers.

Commercial dishwasher category	Energy use of manufacturing (kWh / unit)
Category 1: Undercounter water-change dishwashers	no data available ¹⁰⁸
Category 2: Undercounter one-tank dishwashers	30
Category 3: Hood-type dishwashers	36
Category 4: Utensil/pot dishwashers	40
Category 5: One-tank conveyor-type dishwashers (belt/rack)	250
Category 6: Multi-tank conveyor-type dishwashers (belt/rack)	300

Unfortunately, there is no publicly available data on this aspect. According to stakeholder feedback, determining the energy consumption involved in manufacturing appliances is very labour-intensive, which is why this data is generally unavailable. Even a detailed evaluation of individual appliances would be very time-consuming, if not impossible. Energy consumption also depends heavily on the manufacturer's level of vertical integration, i.e. whether components are produced in-house or sourced externally. If it is desired to collect such data, there is no clear definition of what is meant by 'energy use in manufacturing'. For example, it is unclear to what extent the energy consumption of external suppliers for the production of components for the appliances should be taken into account.

6.3.3. Assessment of the primary scrap production during sheet metal manufacturing

As shown in **section 6.3.1**, the Bill of Material of commercial dishwashers contains a high proportion of metals, in particular stainless steel. Against this background, the primary scrap

¹⁰⁸ Due to the data gap, the value of category 2 was used as an proxy value for category 1 in MEERP Task 5.

4725 generated during sheet metal production is considered to be a relevant parameter for the
4726 overall environmental performance of commercial dishwashers.

4727 In this respect, the EcoReport Tool dataset for steel sheet stamping and bending stamping and
4728 bending single route, assumes a default value of 5% loss.

4729 However, according to stakeholder feedback, it can be assumed that the pre-consumer stainless
4730 steel scrap produced in the manufacturing process has a recycling rate close to 100 %, thanks to
4731 an effective scrap market for stainless steel.

4732 6.3.4. Packaging materials

4733 In the 2011 preparatory study on commercial dishwashers, Task 4 report, packaging materials
4734 were included in the BOM of the different dishwasher categories. For the purpose of the present
4735 report, these 2011 values have been summarised in a separate overview (see following **Table**
4736 **6-24**).

4737 **Table 6-24: Average type and weight of the packaging in the different categories of commercial**
4738 **dishwashers - 2011 values.**

Commercial dishwasher category	EPS (weight in g)	PE-Foil (weight in g)	Wood (weight in g)	Cardboard (weight in g)
Category 1: Undercounter water-change dishwashers	724	172	1,011	635
Category 2: Undercounter one-tank dishwashers	500	-	6,000	2,750
Category 3: Hood-type dishwashers	500	-	12,250	4,750
Category 4: Utensil/pot dishwashers	500	-	16,000	3,500
Category 5: One-tank conveyor-type dishwashers (belt/rack)	2,940	-	63,500	15,500
Category 6: Multi-tank conveyor-type dishwashers (belt/rack)	5,290	-	141,180	33,530

4739 (Source: Based on final conclusions as presented in Tables 5, 7, 9, 12, 14, and 16 of the Task 4 report of the 2011
4740 preparatory study on professional dishwashers).

4741 The partially wide range of individual packaging materials reflects the differences between
4742 dishwashers from different manufacturers.

4743 Several stakeholders emphasised that the exact weights depend heavily on the individual
4744 models and options selected, the destination country and the required means of transport (e.g.
4745 ocean freight). For category 6 in particular, quantities can vary significantly depending on how
4746 many parts the appliance is split into for shipping, and the number of parts depends on the
4747 length of the appliance.

In general, optimising packaging in a more sustainable way is an important issue for manufacturers. For example, the total volume of packaging materials has been reduced (e.g. EPS), and various materials have been replaced with those made from renewable resources. Furthermore, adjustments and reductions will continue to be made in this area in future, with various internal projects being carried out by manufacturers to prepare for the Packaging and Packaging Waste Regulation (PPWR).

Based on the figures in the above table and stakeholder feedback from the 2024 online survey, as well as written feedback from stakeholders on the draft Task 1–4 study report, the following **Table 6-25** shows an update on the average type and weight of packaging for commercial dishwashers.

Table 6-25: Average type and weight of the packaging in the different categories of commercial dishwashers - 2024 values.

Commercial dishwasher category	EPS (weight in g)	PE-Foil (weight in g)	Wood (weight in g)	Cardboard (weight in g)	Other materials (weight in g)
Category 1: Undercounter water-change	518	8	4,500	2,520	45 (PP plastic strip)
Category 2: Undercounter one-tank	500 - 1120	250	3,000 – 6,000	2,750 – 13,500	308 – 1,000 (PP plastic strip); 0 – 750 (PET)
Category 3: Hood-type	500 - 688	-	12,250 – 18,000	4,750 – 13,500	77 – 1,000 (PP plastic strip); 0 – 1,200 (PET)
Category 4: Utensil/pot	500 - 600	-	13,500 - 18,000	3,500 – 11,000	77 – 1,000 (PP plastic strip); 0 – 1,371 (PET)
Category 5: One-tank conveyor-type dishwashers	2,940	90 – 6,000	63,500 – 98,000	0 – 15,500	11,000 (iron)
Category 6: Multi-tank conveyor-type dishwashers	5,290	150 – 8,000	125,000 - 270,000	0 – 33,530	15,000 (iron)

Source: Based on final conclusions as presented in Tables 5, 7, 9, 12, 14, and 16 of Task 4 report of the 2011 Preparatory Study on Professional dishwashers; updated according to feedback from 2024 online survey and written stakeholder feedback to the draft Task 1-4 study report.

6.3.5. Volume and weight of the packaged product

The following table shows an overview of the average volume and weight of the final packaged product. These values are used to calculate the environmental impacts resulting from distribution. The dataset is again taken from the 2011 Preparatory Study on Professional dishwashers, Task 4 report (2011 values).

Several stakeholders provided feedback on this dataset, resulting in an updated dataset (2024 values) presented in

4770 **Table** 6-26 that once more mirrors a wide range of differences between dishwashers from
4771 various manufacturers.

4772

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Table 6-26: Average volume and weight of the final packaged product in the different categories of commercial dishwashers (2011, 2024).

Commercial dishwasher category	Average volume of the final packaged product	Average volume of the final packaged product	Average weight of the final packaged product	Average weight of the final packaged product
	2011 values	2024 values	2011 values	2024 values
Category 1: Undercounter water-change dishwashers	0.40 m ³	0.48 m ³	ca. 50 kg	72.5 kg
Category 2: Undercounter one-tank dishwashers	0.48 m ³	0.47 - 0.60 m ³	ca. 80 kg	50 - 110 kg, depending on model, variants and chosen options
Category 3: Hood-type dishwashers	1.03 m ³	1.03 – 2.4 m ³	ca. 135 kg	135 - 255 kg, depending on model, variants and chosen options
Category 4: Utensil/pot dishwashers	4.95 m ³	1.6 – 4 m ³	ca. 225 kg	320-420 kg, depending on model, variants and chosen options
Category 5: One-tank conveyor-type dishwashers (belt/rack)	12.25 m ³	2 - 12.25 m ³	ca. 975 kg	ca. 975 kg other values possible depending on model, variants and chosen options
Category 6: Multi-tank conveyor-type dishwashers (belt/rack)	16.58 m ³	16.58 - 22 m ³	ca. 1,465 kg	ca. 1,465 kg other values possible depending on model, variants and chosen options

Source: Task 4 report of 2011 Preparatory Study on Professional dishwashers; updated according to feedback from 2024 online survey and written stakeholder feedback to the draft Task 1-4 study report highlighted in red colour .).

6.3.6. Actual means of transport employed in shipment of components, sub-assemblies and finished products

Depending on data availability, the means of transport employed in shipment of components, sub-assemblies and finished products as well as corresponding distances have to be modelled according to the PEF guidance (European Commission, 2018a). For example, for the transport of

the finished product it needs to be clarified, which transport scenarios apply to the distribution of commercial dishwashers (see following **Figure 6-15**).

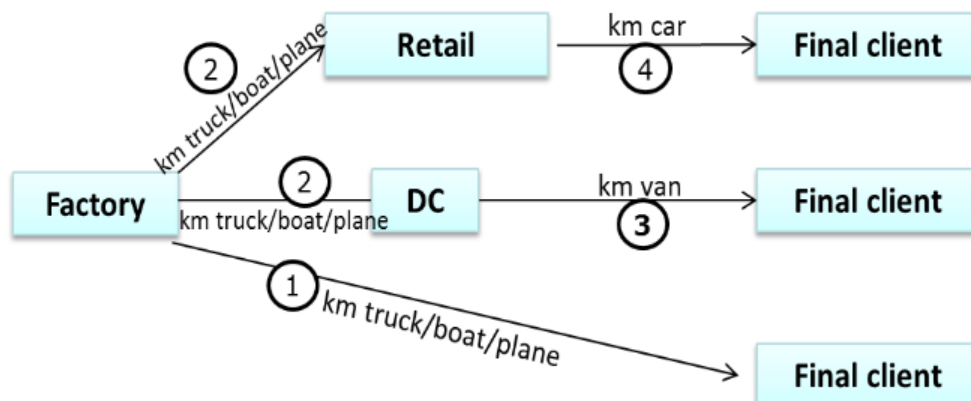


Figure 6-15: Default transport scenario according to PEFCR (European Commission, 2018a).

It is assumed that only direct delivery to the final client and delivery via a distribution center (DC, see figure above) are applicable for commercial dishwashers.

In case of direct delivery to the final client, the following modelling parameters apply:

- In case of a local supply chain: 1,200 km by truck (>32 t, EURO 4);
- In case of a intracontinental supply chain: 3,500 km by truck (>32 t, EURO 4);
- In case of international supply chain: 1,000 km by truck (>32 t, EURO 4) and 18,000 km by ship (transoceanic container).

The next step in the analysis is therefore to clarify the distribution structure for commercial dishwashers and the proportion of the individual supply chain scenarios (local/intracontinental/international).

According to stakeholder input, land shipping is the most appropriate approach for commercial dishwashers within the EU study scope. Sea and air freight have special requirements, such as the addition of a foil that fully covers the product. However, sea and air shipping are not common within EU shipping and should therefore not be considered.

6.3.7. Technical product life

The product life of commercial dishwashers as well as the most important priority parts in terms of necessary repairs / spare parts have already been covered in **sections 5.5.1** and **5.5.2**.

6.3.8. Technical analysis of the end-of-life phase

This section provides considerations regarding the end-of-life material flows of the commercial dishwashers for handling as pure waste (landfill, pyrolytic incineration), heat recovery (non-hazardous incineration optimised for energy recovery), recycling and/or re-use.

At the end of their lifetime (for details, cf. MEErP Task 3), almost no commercial dishwasher will end at a landfill, as materials are too valuable. For this reason, most products will either be refurbished or recycled for scrap parts or materials. We assumed that only 5 % by weight of the products are not recovered (i.e. go to landfill) during the end-of-life phase. Indeed, in principle, almost all materials in the dishwashers' composition are recovered (assumption: 95 % in post-WEEE conditions according to MEErP) and follow one of the following options:

- Metals are recycled;
- Paper, cardboard, and plastics are incinerated (thermal recycling with possible benefits of energy recovery) or mechanically recycled. Plastics may also be directly reused;
- Other types of waste (concrete, bitumen) go to landfill. Hazardous waste consists only of electronic components, which are considered easy to disassemble and are in limited quantity (around 1 % of the total weight).

The plastic share of commercial dishwashers is mostly less than 10 % related to its overall weight (see Table 6-22). Regarding the recovered plastic fraction, the following end-of-life management options were estimated for all categories, based on stakeholders' feedback:

- Thermal recycling: 70 %.
- Material (or mechanical) recycling: 29 %
- Re-use, closed loop recycling: 1 %

Printed wiring boards (PWB) are used in dishwashing machines of all categories. According to stakeholder information, these parts are easy to dismantle and are completely recycled by certified scrap dealers.

If a dishwasher with an installed heat pump is dismantled, specialised technicians will extract the refrigerant from the heat pump. In this process, only a technically unavoidable, small amount of refrigerant will escape.

6.4. Aspects beyond MEErP

Beyond the aspects foreseen under the current methodology for energy-related products, the study team will also consider further specific aspects with relevance to the new regulatory scheme under ESPR, especially Article 5 on ecodesign requirements and on Article 8ff. on a Digital Product Passport (DPP).

6.4.1. Analysis of critical raw materials and substances of concern

This relates in particular to the presence of critical raw materials (CRM) and the analysis of potential substances of concern (SoC). Within this context, the following substances were covered by the desk research and the 2nd stakeholder consultation in 2024.

6.4.1.1. Refrigerants

Dishwashers of categories 3, 5 and 6 can be equipped with a heat pump containing refrigerants. The refrigerants used are R-134a (tetrafluorodichlorethene), R-407C (a hydrofluorocarbon blend of R-32, R-125, and R-134a), R-513a and others with an average filling of approx. 1.5 kg. According to stakeholder feedback, refrigerants are not used in the other dishwasher categories 1 to 4. As the use of heat pumps is considered as BAT (Best Available Technology), this aspect will be further elaborated in Task 6.

6.4.1.2. Mercury

According to stakeholders, the dishwashers of all six categories do not contain mercury. All materials used within the products comply with the restrictions set out in the RoHS Directive (cf. **section 3.4.1.4**).

6.4.1.3. Silver ions

According to stakeholders, the dishwashers of all six categories do not contain silver ions. There is no need of silver ions in dishwashers, because there are other possibilities (temperature, chemistry, steam) to guarantee hygienic standards.

6.4.1.4. Permanent magnets (containing neodymium)

According to input received during the 2nd stakeholder consultation in 2024, permanent magnets containing neodymium are used in drive and fan motors, microswitches (reed contact), sensors for detecting fill levels, spray arm speeds, position detection of sieves, flaps, floats, flow meters, etc. Ferrite-based permanent magnets are also used in cutlery lifting magnets, electric pumps as well as sensors.

With regard to the corresponding quantities, stakeholders reported for motors 6 magnets of 11.5 g each or 4 magnets of 3.4 g each (NdFeB), for reed magnets approx. 100 g, for door locks 1.5 g (NdFeB). Drain pumps contain 38.5 g (ferrite), sensors contain various ferrite magnets of approx. 1 g each, cutlery lifting magnet approx. 5-10 kg (ferrite).

Regarding the advantages of permanent magnets (containing neodymium), stakeholders mentioned their effectiveness, reliability and affordability. Alternatives for motors are considered to be inferior in terms of efficiency, performance and energy consumption. For many applications, contactless signal or force transmission using permanent magnetism is seen as a solution with no known alternatives. Where mechanically activated door switches are used, the risk of malfunction due to dirt / vapour / chemicals and mechanical influences is considered to be high. In the case of reed switches, magnet-based components reduce the failure rate by operating in harsh and dirty conditions. Disadvantages of neodymium-based permanent magnets are corrosion problems. This is not the case with ferrite-based permanent magnets.

6.4.1.5. Other critical raw materials

Stakeholders mentioned copper, which is used in wires, as well as several other critical raw materials used in electronic boards and circuits.

6.4.1.6. Other substances of concern

According to stakeholder input, lead is contained in copper and brass alloys as well as in heating elements. Furthermore, boric acid, PTFE and PVDF were mentioned. This information is applicable to all dishwashing categories.

Furthermore, it must be noted that many more critical raw materials (CRMs) and substances of concern (SoCs) are commonly used in dishwashing appliances. These contain generic electronic parts, among other components, and are connected to the drinking water system. Substances that should be present in almost all standard appliances include, for example, the following (CAS No):

- 7439-92-1
- 22673-19-4
- 1317-36-8
- 127-19-5
- 96-45-7

In addition to that, PFAS is considered to be a widespread issue and likely to be present in various components of commercial dishwashing appliances. Currently, it is assumed by stakeholders that producing an appliance without PFAS is technically impossible.

6.4.2. Analysis of circular economy aspects

Beyond these aspects foreseen under the current methodology for energy-related products, the study team will also consider further specific aspects within the context of circular economy with relevance to the new regulatory scheme under ESPR, especially Article 5 on ecodesign requirements and on Article 8ff. on a Digital Product Passport, which are the following:

Special focus on existing design approaches for circular economy (durability, reliability, reparability, maintenance, refurbishment) and resource efficiency, as well as current materials, components or technologies potentially impeding a circular approach, such as:

- Integrated components like electronics;
- Existing application of recycled materials;
- Remanufacturing and recycling technologies;
- Application of novel production technologies like 3D-printing, relevant in terms of environmental impacts or availability of spare parts for commercial dishwashers;

4908 - Existing approaches of the commercial dishwasher's sector to develop Digital
4909 Product Passports¹⁰⁹.

4910 In terms of reparability, the importance of spare parts is obvious. For the possibility to estimate
4911 the impact of maintenance and repair, the MEeRP methodology foresees taking a present
4912 percentage of the impacts of the materials as inputs to the Bill of Materials. In the 2011
4913 preparatory study, a default value = 1 % was taken as percentage for all categories. This estimate
4914 was confirmed by the feedback from the 2nd stakeholder consultation in 2024.

4915 In this context, a manufacturer emphasised the importance of supplying spare parts for the full
4916 lifetime of the appliances, even after production has ceased. In many cases, these parts are
4917 available well beyond the lifetime.

4918 6.4.3. Analysis and consideration of DPP-induced requirements

4919 6.4.3.1. DPP-requirements and options to decide for existing EPREL 4920 system or new DPP system

4921 The ESRP outlines several requirements for the Digital Product Passport (DPP) in Chapter III,
4922 Articles 9 to 15:

- 4923 - Article 9 Digital product passport;
- 4924 - Article 10 Requirements for the digital product passport;
- 4925 - Article 11 Technical design and operation of the digital product passport;
- 4926 - Article 12 Unique identifier;
- 4927 - Article 13 Digital product passport registry;
- 4928 - Article 14 Web portal for data in the digital product passport;
- 4929 - Article 15 Customs controls relating to the digital product passport.

4930 Two exceptions are specified in the ESRP 2024/1781, Article 9, paragraph 4, regarding cases
4931 when a DPP is not required:

- 4932 - '4. When setting the requirements related to the digital product passport, the
4933 Commission may exempt product groups from the requirement to have a digital
4934 product passport where:
- 4935 - technical specifications of the digital product passport are not available in relation
4936 to the essential requirements included in Articles 10 and 11; or

109 Currently the JRC is developing a methodology for the preparation of a DPP. When available and if still possible, this method will be used within this study for the analysis and proposal of DPP requirements and design.

4937 - other Union law includes a system for the digital provision of information related
 4938 to a product group which the Commission considers achieves the objectives
 4939 referred to in paragraph 3, points (a) and (b).'

4940 Regarding Article 9, paragraph 4, the EPREL database serves as a system under Union law for the
 4941 digital provision of information. Currently, commercial dishwashers are not included in the
 4942 EPREL system. However, there is potential for using the EPREL system, as the product group is
 4943 similar to household dishwashers, especially considering that the revised MEErP methodology is
 4944 not yet available. The EPREL system operates on a centralised database, with information
 4945 accessible via a website and a QR code linking to the website's information. EPREL focuses on
 4946 energy-related information, meaning that other ecodesign-related information is currently not
 4947 included. Therefore, EPREL may not be sufficient for all product groups with new system or
 4948 information requirements.

4949 There are three main options to meet DPP and information requirements, exemplified in the
 4950 following **Table 6-27** and described below:

4951 **Table 6-27: Different options to meet DPP system and information requirements.**

	System			Information		
	EPREL system	EPREL system extended	DPP System	EPREL	EPREL extended	DPP
Industrial and professional laundry appliances		x	x		x	x
Household washing machines and household washer-dryers	x			x	x	
Household dishwashers	x			x	x	
Commercial dishwashers		x	x		x	x

4952 • The product group already exists within the EPREL system, meaning the exemption
 4953 from DPP requirements according to ESPR 2024/1781, Article 9, paragraph 4(b)
 4954 applies. In this case, the EPREL system can be used, but there may be new
 4955 information that is relevant. While the EPREL system is sufficient, the information it
 4956 contains needs to be expanded.

4957 • The product group is not yet included in EPREL, but the EPREL system and/or
 4958 information might still be sufficient. In this case, the EPREL system can be extended
 4959 by adding a new product category with similar information and system features
 4960 (e.g., QR code).

4961 • The product group is not present in EPREL, and there are requirements that EPREL
 4962 cannot meet. In this situation, the requirements must be evaluated, and the DPP
 4963 system and information design specified. For example, a QR code may not be
 4964 sufficient, and an RFID chip that can be read during recycling might be necessary.

The approach for analysing DPP and information requirements was not yet available within the revised MEERP methodology at the time of the analysis of Tasks 1-4.

For the next steps this study will follow, to the extent possible, the envisaged JRC approach, based on the JRC 'Call for Tender EC-JRC/SVQ/2024/MVP/1837 - Technical Assistance in Defining Requirements for the Inclusion of Data and Information in the Digital Product Passport (DPP)'. The call foresees the use of so-called 'use cases' to define the necessary DPP information and system. DPP use cases are specific objectives that can be achieved with the DPP for (environmental or economic) benefit. The following **Table 6-28** shows the use case developed in the Battery Pass and CIRPASS projects for the electronics sector. There is also a qualitative assessment (rating) by experts.

Table 6-28: Exemplary DPP use cases at certain stages and their relevance.

DPP use case	Stage	Rating
Reliable communication of ESG data	Business	High
Informed purchasing decisions	Consumer	High
Eased servicing	Business / Repair	Medium
Precise risk assessment for transport	Transport	None
More efficient recycling processes	Recycling / Reuse	Low
Simplified residual value determination	Reuse	Medium
Streamlined trade of waste	Recycling	Medium
Efficient data exchange and reporting	Business	Low
Increased end-of-life collection	Consumer	Low
Industry benchmarking	Business	High
Accurate market overview	Business	Low
Informed policy design	Business	High

This use case-oriented approach will make it possible to determine whether specific use cases, such as 'more efficient recycling processes' are relevant. For example, relevance may arise when waste products contain several hazardous substances or valuable materials, such as CRMs. Providing this information to recyclers is critical to effectively sorting products within the waste stream. It is therefore important to ensure that the necessary data is included in the Digital Product Passport (DPP), or another system for the digital provision of information which the Commission considers achieves the DPP objectives. The use case also includes considerations for the DPP system.

For the DPP system, the type of data carrier is particularly important. A QR code may be suitable for larger products that are unlikely to be exposed to dirt or wear and tear, as it ensures that the code remains readable throughout the life cycle of the product. For smaller products, where a QR code may not be practical, an RFID chip may be required.

4988 The logic for deriving use case based DPP information and DPP system aspects will need to be
4989 defined by the JRC as part of a harmonised methodology under the revised MEErP. Following
4990 this logic, use cases and associated DPP requirements will be provided in Task 5 of this
4991 Preparatory Study. The use case approach takes into account, among other factors, the
4992 relevance of the CRM content and information required for specific stakeholders, the data
4993 carrier (QR code or RFID chip) and the DPP registry. It is important to note that the harmonised
4994 approach to the analysis of DPP requirements will be introduced with the revision of the MEErP.
4995 Therefore, this analysis is qualitative and addresses DPP essentials, but will not include the full
4996 quantitative analysis of stakeholder-specific DPP requirements.

4997 The design measures developed under Task 6 of the Preparatory Study will include the
4998 information to be included into the DPP, or another system for the digital provision of
4999 information which the Commission considers achieves the DPP objectives.

5000

7. MEErP Task 5 – Environment

7.1. Objectives of MEErP Task 5

7.1.1. Introduction to the study

This study aims to provide an objective assessment of the environmental Life Cycle Assessment (LCA) and Life Cycle Costs (LCC) for commercial dishwasher appliances. The foundation of this analysis is the establishment of a 'Base Case' (BC), a conceptual representation of the average product or product category for the EU market. The BC is essential for conducting environmental and cost assessments efficiently, given practical constraints such as data availability, time, and budget. The results of this study will serve as a baseline for evaluating design options for ecodesign requirements in Task 6 of the Methodology for the ecodesign of energy-related products (MEErP). Additionally, the BC approach will be critically assessed in Task 7 for its applicability across different market segments through impact and sensitivity analyses.

In addition to the LCA and LCC analyses, a new task has been introduced to identify Substances of Concern. This task encompasses a stakeholder consultation process and a subsequent evaluation of the need for information and performance requirements. A concise overview of its findings appears immediately after the conclusion of the LCA and LCC sections, with further details laid out in the **Appendix 7 – Substances of Concern**.

7.1.1.1. Environmental analysis

The assessment serves to quantify the environmental impacts and associated life cycle cost of a BC product throughout its lifecycle. This includes the entire process from the extraction of raw materials to the disposal of components at the end of life. The key method employed for this assessment is Life Cycle Assessment (LCA), which entails:

- **Life cycle inventory development:** Detailing all incoming and outgoing material and energy flows for each lifecycle stage – design and manufacturing, transportation, usage, and end-of-life processing through the life cycle inventory per BC.
- **Impact aggregation:** Aggregating these flows over the product's lifetime to compute total environmental impacts. This computation uses a functional unit that aligns with the product's performance in its intended application.
- **Environmental indicators:** The study employs 16 predefined environmental indicators established for all ecodesign studies under the MEErP review, with detailed descriptions provided later in the report.

LCA calculations are performed using the latest version (1.6) of the EcoReport Tool (ERT) to ensure accuracy and consistency.

The LCA approach offers the advantage of a comprehensive understanding of the resources consumed and the environmental side effects caused by a product. However, its inherent challenge lies in accounting for the variability in life cycles across products in a market. To address this, BCs approximate the 'average' product and serve as a basis for extrapolating the environmental impacts across the entire market for the product category under review.

7.1.1.2. Life Cycle Cost (LCC)

As part of the study, the Life Cycle Costs (LCC) for each BC will be calculated using the structured methodology outlined in the MEERP. The LCC analysis encompasses key cost elements over the product's lifecycle, including product price and operational costs. Both the LCA and LCC calculations are then scaled to the EU-27 level for each BC. This broader market-based perspective allows for an evaluation of implications at scale. This dual approach ensures the study delivers actionable insights for stakeholders, facilitates robust policy development, and identifies opportunities to optimise both environmental and economic outcomes across the market.

7.1.1.3. New considerations in environmental analysis and LCC

This assessment incorporates updates introduced to the MEERP process based on the review and the new aspects resulting from the Ecodesign for Sustainable Products Regulation (ESPR). These updates address:

- **Lifetime Extension:** Factors such as durability, reliability, reusability, upgradability, reparability, maintenance, and refurbishment.
- **Material Efficiency:** Considerations such as recycled content usage.

The ERT has been revised to integrate these elements, enabling more comprehensive evaluations of environmental impacts and LCCs.

7.1.2. Data quality and sensitivity analysis

The study is based on data extrapolated from literature and stakeholder input. While every effort has been made to ensure accuracy, variations in real-world performance introduce an element of approximation that cannot be entirely avoided. To maintain transparency, the quality and sources of each data point used are documented for the BC according to the criteria indicated in **Table 7-1**.

Table 7-1: Data quality scoring.

Data source	Data quality scoring
Stakeholder input (Graulich et al., 2025)	High quality
Scientific literature	High quality
Previous preparatory study (2011)	Medium quality
Expert judgement	Medium quality
Literature	Medium quality
Internet search	Fair quality

The sensitivity analysis in Task 5 will assess the impact of assumptions on the results, ensuring consistency and reliability.

7.1.3. Study outcomes

The LCA and LCC calculations for the Base-cases are rooted in the findings of Tasks 1 to 4. Together, the BCs serve as essential reference points for the subsequent stages of the study, including Task 6 (design options) and Task 7 (scenarios).

Acknowledging the inherent uncertainties, this study provides the most robust and reliable estimates to date regarding the environmental impacts and life cycle costs of commercial dishwashers within the EU.

7.2. Product-specific inputs / Definition of Base Cases

This subsection defines and describes the Base Cases, building on insights from previous tasks of this study, the 2011 preparatory study and stakeholder input. BCs do not represent individual real-world products but are instead an amalgamation of characteristics. When two or more products share similar Bills of Materials (BOM) and technical parameters, they may be grouped into a single BC.

The number of BCs remains the same as in the 2011 preparatory study and are considered valid according to stakeholder feedback. It enables an efficient market analysis and captures the full technological diversity of commercial dishwashers. Although the MEERP methodology generally recommends one or two BCs to represent the entire EU market for a given product category, this study has identified 6 BCs (**Table 7-2**). This approach ensures both a detailed representation of the market and analytical clarity. Specific details per BC are provided in **Table 7-3** to **Table 7-8**. The main sources of the data used in the BC definition are the following two reports:

- Preparatory study and impact assessment support study on commercial dishwashers – Tasks 1-4 (current report)
- Preparatory studies for Ecodesign Requirements of Energy-using products – Lot 24: Professional Washing Machines, Dryers and Dishwashers – Part: Dishwasher, (Rüdenauer. Ina et al., 2011)

Table 7-2: Overview of Base Cases for commercial dishwashers.

Dishwasher Base Cases
BC1: Undercounter water-change dishwasher
BC2: Undercounter one-tank dishwasher
BC3: Hood-type dishwashers
BC4: Utensil pot dishwasher
BC5: One-tank conveyor-type dishwasher
BC6: Multi-tank conveyor-type dishwasher

5094 Data in the following tables (**Table 7-3** to **Table 7-8**) is derived from the Task 1-4 in this report.

5095 **Table 7-3: Overview of Base Case 1: Undercounter water-change dishwasher.**

Description	Characteristic
Applications / Market segments	Bars, bistros, (small) restaurants and pubs, motorway service areas, hospitals, hotels and guest houses, club houses, institutional kitchens, and similar business environments
Main operator / User type	Trained or at least supervised personnel.
Spatial requirements	Rather limited space available / required
Typical capacity (dishes/hour)	350
Typical capacity (dishes/cycle)	50
Cycles per day	7
Product weight (kg)	65
Lifetime (years)	12
Average price (€)	3,148
Annual sales (units per year)	23,404
Maintenance and repair costs (€/lifetime)	1,385
Energy consumption wash (kWh/cycle)	1.07
Water consumption (litres/cycle)	31.42
Detergent consumption (kg per cycle)	0.022
Rinsing agent consumption (kg per cycle)	-

5096 **Table 7-4: Overview of Base Case 2: Undercounter one-tank dishwasher.**

Description	Characteristic
Applications / Market segments	(Small) restaurants, hotels, conference centres, bars, clubhouses, gas filling stations, motorway service areas, day-care-homes, bakeries, butcheries, old age homes.
Main operator / User type	Trained or at least supervised personnel.
Spatial requirements	Rather limited space available / required
Typical capacity (dishes/hour)	550
Typical capacity (dishes/cycle)	18
Cycles per day	55
Product weight (kg)	68.3
Lifetime (years)	8
Average price (€)	5,659
Annual sales (units per year)	162,012
Maintenance and repair costs (€/lifetime)	2,490
Energy consumption wash (kWh/cycle)	0.42
Water consumption (litres/cycle)	9.8
Detergent consumption (kg per cycle)	0.011
Rinsing agent consumption (kg per cycle)	0.001

5097 **Table 7-5: Overview of Base Case 3: Hood-type dishwashers.**

Description	Characteristic
Applications / Market segments	Institutional kitchens, care homes, bars, school and small company canteens, filling stations, motorway service areas, restaurants, bakeries, butcheries.
Main operator / User type	Trained or at least supervised personnel.
Spatial requirements	Requires a medium amount of space. Used in separate kitchen or dishwashing rooms.
Typical capacity (dishes/hour)	720
Typical capacity (dishes/cycle)	18
Cycles per day	110
Product weight (kg)	148.68
Lifetime (years)	8
Average price (€)	8,662
Annual sales (units per year)	77,252
Maintenance and repair costs (€/lifetime)	3,812

Description	Characteristic
Energy consumption wash (kWh/cycle)	0.43
Water consumption (litres/cycle)	4.7
Detergent consumption (kg per cycle)	0.010
Rinsing agent consumption (kg per cycle)	0.001

5098 **Table 7-6: Overview of Base Case 4: Utensil/pot dishwashers.**

Description	Characteristic
Applications / Market segments	Institutional kitchens, bread and bakery, industry butcheries, hypermarkets.
Main operator / User type	Trained personnel
Spatial requirements	Requires a medium amount of space
Typical capacity (cycles/hour)	15
Cycles per day	30
Product weight (kg)	206
Lifetime (years)	9
Average price (€)	10,855
Annual sales (units per year)	3,080
Maintenance and repair costs (€/lifetime)	4,776
Energy consumption wash (kWh/cycle)	1.35
Water consumption (litres/cycle)	12.96
Detergent consumption (kg per cycle)	0.036
Rinsing agent consumption (kg per cycle)	0.002

5099 **Table 7-7: Overview of Base Case 5: One-tank conveyor-type dishwashers.**

Description	Characteristic
Applications / Market segments	Medium company canteens, hospitals, cafeterias, caterers, hotels.
Main operator / User type	Trained personnel.
Spatial requirements	Requires a medium to large amount of space
Typical capacity (dishes/hour)	1,800
Cycles per day	Continuous operation
Product weight (kg)	891.285
Lifetime (years)	11
Average price (€)	13,394

Description	Characteristic
Annual sales (units per year)	7,728
Maintenance and repair costs (€/lifetime)	5,894
Energy consumption wash (kWh/hour)	42.09
Water consumption (litres/cycle)	310.8
Detergent consumption (kg per hour)	0.732
Rinsing agent consumption (kg per hour)	0.071

5100 **Table 7-8: Overview of Base Case 6: Multi-tank conveyor-type dishwashers.**

Description	Characteristic
Applications / Market segments	Large company or university canteens, hospitals, cafeterias, caterers, airports, and institutional kitchens.
Main operator / User type	Trained personnel
Spatial requirements	Requires a large amount of space
Typical capacity (dishes/hour)	3,600
Cycles per day	Continuous operation
Product weight (kg)	1,343.4
Lifetime (years)	15
Average price (€)	22,867
Annual sales (units per year)	1,540
Maintenance and repair costs (€/lifetime)	10,062
Energy consumption wash (kWh/hour)	83.73
Water consumption (litres/cycle)	465.7
Detergent consumption (kg per hour)	1.043
Rinsing agent consumption (kg per hour)	0.095

5101 7.3. Product-specific inputs

5102 In this section, the specific inputs for the ERT are described per life cycle stage of the Base Cases.
5103 Detailed input tables per Base Case are in **Appendix 4 – Inputs for LCA / LCC per Base Case.**

7.3.1. Raw materials

The life cycle phase Raw Materials is the production of all materials of the product, according to the Bill of Materials (BoM, see **Appendix 4 – Inputs for LCA / LCC per Base Case**). For all raw material inputs, the default ERT recycled content (R1) was modelled. For several raw materials, no specific dataset was available, and a proxy dataset was used instead (**Table 7-9**). For one raw material, cotton, no dataset or possible proxy dataset was available and thus the material was excluded (cut-off). For cast iron production, only one dataset was available ('cast iron electric arc furnace route, from steel scrap, secondary production single route, at plant > 2.06 % carbon content') which gave an error in the tool. To include the environmental impacts of cast iron production, the dataset was manually added as a user dataset (with the same environmental impact per impact category as the original dataset) to include the full impact of cast iron production. However, no dataset for recycling was available.

Table 7-9: Overview of missing datasets and proxies used for raw materials.

Missing dataset	Proxy dataset modelled
Polyamide (PA)	11-Nylon 6 fibre extrusion into fibre production mix, at plant 5% loss, 3,5 MJ electricity
Polybutylene Terephthalate (PBT)	12-Polyethylene terephthalate (PET), petrochemical based polymerisation of ethylene glycol and terephthalic acid production mix, at plant petrochemical based
POM	12-Polyethylene terephthalate (PET), petrochemical based polymerisation of ethylene glycol and terephthalic acid production mix, at plant petrochemical based
Plastics others	16-Polypropylene (PP), petrochemical based polymerisation of bio-fossil propylene production mix, at plant petrochemical based
Pumps (stack of sheets)	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel
Cotton	No relevant dataset available – Cut-off

7.3.2. Packaging

Packaging per Base Case was modelled in the ERT based on the specific input data for each Base Case (**Appendix 4 – Inputs for LCA / LCC per Base Case**). For some Base Cases, no data was available. For wood, a proxy was used (**Table 7-10**).

Table 7-10: Overview of missing datasets and proxies used for packaging.

Missing dataset	Proxy dataset modelled
Wood	284-Plywood box; attaching veneer layers; production mix, at plant; 5% moisture

7.3.3. Manufacturing & Assembly

The manufacturing of the raw materials (e.g. polypropylene granulates) into a component was modelled with a process (e.g. injection moulding for plastics) in the Manufacturing & Assembly life cycle. The datasets used are provided per Base Case in **Appendix 4 – Inputs for LCA / LCC per Base Case**. For several raw materials however, proxy datasets were used as no specific manufacturing process was available (**Table 7-11**).

Table 7-11: Overview of missing and proxy datasets used for manufacturing.

Missing dataset	Proxy dataset modelled
Polyamide (PA)	8-Injection moulding plastic injection moulding production mix, at plant for PP, HDPE and PE
Polymethyl methacrylate (PMMA)	
Acrylonitrile Butadiene Styrene (ABS)	
Styropor expandable polystyrene (EPS)	
Polybutylene Terephthalate (PBT)	
Polyvinyl chloride (PVC)	
EPDM-rubber	
POM	
PE	
Plastics others	
Polystyrene (PS)	3-Blow moulding blow moulding production mix, at plant PET, HDPE and PP
Bitumen	Excluded, no relevant dataset
Cotton	Excluded, cut-off material

In addition, the electricity consumption for assembly of the product was included in this life cycle. The electricity consumption was derived from stakeholder data that was provided for all Base Cases except BC1. An assumption was made that the electricity consumption for the assembly of the product in BC1 is the same as in BC2.

7.3.4. Distribution

Distribution of the product was modelled with the product weight including the packaging with transport modes and distances according to PEF default values (European Commission, 2013) (**Table 7-12**) as no stakeholder specific data was available. The transport distances are based on the assumption of a local (within the EU) supply chain scenario, where the supplier is also located in the EU.

5140 **Table 7-12: Transport scenarios for all Base Cases.**

Description	Distance	Unit	Mode of transport
From supplier to factory	130	km	Truck
	240	km	Train
	270	km	Ship
Factory to final client	1,200	km	Truck

5141 **7.3.5. Use phase**

5142 In the use phase, energy (both electricity and heat), water and detergent use (if applicable) were
5143 modelled according to the input data derived from Task 1 to 4 in this report. Real life annual
5144 energy, water and detergent use were modelled as inputs for the LCA instead of ideal conditions,
5145 as described in **Table 7-13**. Detailed data input and calculations can be found in **Appendix 4 –**
5146 **Inputs for LCA / LCC per Base Case.**

5147 **Table 7-13: Use phase input data for dishwasher Base Cases.**

Use phase input	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Electricity consumption (incl. standby mode when applicable)	kWh/year	1,508.2	7,401.2	14,379.2	13,055.2	100,669.6	187,704.3
Heat consumption for water heating (within machine)	kWh/year	0	0	0	242.3	10,946.3	32,639.5
Heat consumption for external water heating (outside the machine)	kWh/year	0	94.05	313.5	940.5	1,655.3	3,448.5
Water consumption	m ³ /year	43.99	163.15	154.98	116.7	820.5	1,229.45
Detergent consumption	kg/year	31	183	315	324	1,931	2,753
Rinsing agent consumption	kg/year	0	16	24	17	188	251

5148 Total energy use was provided, which was subdivided into electricity and heat for internal
5149 heating of water. The shares are based on **Table 5-27** of Tasks 1-4 of the current preparatory
5150 study and provided in the input tables in **Appendix 4 – Inputs for LCA / LCC per Base Case**. In
5151 addition, for some Base Cases, hot water supply (heated up outside the machine) was included.

Electricity was modelled with an EU general dataset ('243-Electricity grid mix 1 kV to 60 kV technology mix consumption mix, to consumer 1 kV to 60 kV'). Additionally, heat was modelled with a dataset for natural gas boiler ('253-10 kW central heating (ch) boiler production, fuelled by natural gas, condensing boiler 10 kW Capacity lifespan 20 y production mix 1 MJ of thermal energy') for which the heat consumption of each Base Case was back calculated to the heat power output (as this is the format to model it in the ERT) with the default efficiency of 105 %.

7.3.6. Maintenance and repair

Maintenance and repair were modelled for all Base Cases with the default value of 1 % spare parts of raw materials inputs.

7.3.7. End-of-Life (EoL)

The End-of-Life (EoL) of the product is calculated with a simplified circular footprint formula, incorporated in the ERT. For this, the BoM inputs and the additional spare parts indicated at the maintenance and repair life cycle are included to calculate both the EoL impacts for recycling of materials and credits for avoiding use of primary materials. Default values of the ERT for recyclability (R2) and the allocation factor (A coefficient) were used. Impacts of energy recovery and disposal to landfill were excluded in the ERT to simplify the EoL calculations (European Commission, 2024).

7.3.8. Life cycle costs (LCC)

For the economic input parameters, data was derived from stakeholders, the previous preparatory study (Lot 24, Rüdenauer et al., 2011) or literature data. The specific inputs are provided per Base Case in **Appendix 4 – Inputs for LCA / LCC per Base Case**. One of the parameters for the LCC is the escalation rate, which is the real (inflation-corrected) annual growth of running costs. The running costs included in the ERT are the costs for electricity, heat, water, and detergent (**Table 7-14**). The escalation rate can be calculated from the extrapolated prices growth rate after correcting for inflation (using historical data both for prices and for inflation). Eurostat data for the years 2014 - 2024 was used for the prices of the energy, water, detergent, and general inflation (harmonised index of consumer prices, HICP, Table 11-61). For all prices, EU-27 data was taken. For heat, natural gas prices were used, as heat was modelled with a natural gas boiler for all Base Cases. Based on Tasks 1-4 of this study, maintenance costs over the lifetime represent 44 % of the initial purchase price of the product while no installation costs were provided and therefore not included. An overview of the calculation is provided in **Appendix 4 – Inputs for LCA / LCC per Base Case**.

Table 7-14: Life cycle costing input data for all washing machine Base Cases.

Use phase input	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Product price	Euro/unit	3,148	5,659	8,662	10,855	13,394	22,867
Fuel rate (gas, oil, wood)	Euro/MJ	0.023					
Electricity rate	Euro/kWh	0.257					
Water rate	Euro/m ³	1.91					
Detergent price	Euro/kg	4.2					
Rinsing agent price	Euro/kg	3.9					
Repair and maintenance costs	Euro/unit	1,385	2,490	3,811	4,776	5,894	10,061

7.4. Base Case Environmental Impact Assessment

In this section, the life cycle assessment results for each Base Case are presented, followed by a contribution analysis of the main contributors to the life cycle environmental impact for each Base Case, and an interpretation of these results.

The environmental impacts of the Base Cases were calculated using the MEErP ERT (version 1.6) and the data inputs presented in the previous section and **Appendix 4 – Inputs for LCA / LCC per Base Case**. The results are presented in the MEErP format, following the Product Environmental Footprint (PEF) impact assessment method, as calculated in the ERT. Sixteen environmental impact categories are available in the ERT, which are:

- Climate change, total, in kg CO₂-equivalent
- Ozone depletion, in kg CFC-11-equivalent
- Human toxicity, cancer, in CTUh
- Human toxicity, non-cancer, in CTUh
- Particulate matter, in disease incidence
- Ionising radiation, human health, in kBq U235-equivalent
- Photochemical ozone formation, human health, in kg NMVOC-equivalent
- Acidification, in mol H⁺-equivalent
- Eutrophication, terrestrial, in mol N-equivalent
- Eutrophication, freshwater, in kg P-equivalent
- Eutrophication, marine, in kg N-equivalent
- Ecotoxicity, freshwater, in CTUe
- Land use, in pt
- Water use, in m³ water-equivalent of deprived water
- Resource use, minerals and metals, in kg Sb-equivalent

- 5210 - Resource use, fossils, in MJ
- 5211 The LCA results are reported for each impact category and each life cycle stage:
- 5212 - Raw materials
- 5213 - Manufacturing
- 5214 - Distribution
- 5215 - Packaging
- 5216 - Use
- 5217 - Maintenance and repair
- 5218 - End-of-life (impacts and credits)
- 5219 A detailed breakdown of the results is provided in **Appendix 5 – Results of LCA / LCC per** .

5220 7.4.1. Results overview LCA

5221 **Table 7-15** and **Table 7-16** contain an overview of the impact of commercial dishwashers for the
 5222 total life cycle impact and per year of use respectively. It can be observed from the tables that
 5223 BC5 and BC6 have the highest energy use. As a consequence, BC5 and BC6 also have the highest
 5224 impact across all impact categories, whereas Base Cases BC1 and BC2 have the lowest impact
 5225 across all impact categories. This can be attributed mainly to the size of each product and the
 5226 higher nominal capacity. Specifically, BC5 and BC6 are the heaviest products and BC1 and BC2
 5227 are the least heavy. Furthermore, products with higher nominal capacity (BC5 and BC6) have a
 5228 higher energy, water, detergent and rinsing agent consumption, leading to higher impacts across
 5229 most impact categories compared to products with a lower weight and nominal capacity (e.g.
 5230 BC1 and BC2).

5231 When observing the results per year of use (**Table 7-15** and **Table 7-16**), in general, Base Cases
 5232 BC5 and BC6 still show the highest impact per year of use, while Base Cases BC1 and BC2 show
 5233 the lowest impact per year of use. However, when observing the results per cleaned dish, BC5
 5234 and BC6 show the lowest impact due to the large number of dishes cleaned per year (**Table**
 5235 **7-17**). For BC4, the results are presented per cycle as no number of cleaned dishes is relevant
 5236 for this type of machine.

5237 **Table 7-15: Total life cycle impact per commercial dishwasher Base Case total lifetime.**

Environmental aspect	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Energy consumption							
Electricity	kWh	2.13E+04	5.57E+04	1.13E+05	1.07E+05	1.08E+06	2.77E+06
Thermal energy	MJ	0.00E+00	2.57E+03	8.59E+03	3.65E+04	4.75E+05	1.86E+06
PEF Impact categories							
Climate change, total	kg CO ₂ eq.	1.00E+04	2.65E+04	5.19E+04	5.16E+04	5.13E+05	1.33E+06

Environmental aspect	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Ozone depletion	kg CFC-11 eq.	1.49E-05	4.39E-05	6.41E-05	6.45E-05	5.46E-04	1.18E-03
Human toxicity, cancer	CTUh	5.88E-06	2.48E-05	4.60E-05	5.72E-05	3.16E-04	6.08E-04
Human toxicity, non-cancer	CTUh	8.14E-05	2.09E-04	3.09E-04	2.98E-04	2.64E-03	6.11E-03
Particulate matter	disease incidence	3.74E-04	1.03E-03	1.95E-03	1.94E-03	1.80E-02	4.39E-02
Ionising radiation, human health	kBq U235 eq.	3.90E+03	1.02E+04	2.05E+04	1.95E+04	1.97E+05	5.02E+05
Photochemical ozone formation, human health	kg NMVOC eq.	1.83E+01	4.94E+01	9.36E+01	9.20E+01	8.82E+02	2.20E+03
Acidification	mol H+ eq.	3.25E+01	8.83E+01	1.71E+02	1.68E+02	1.60E+03	3.97E+03
Eutrophication, terrestrial	mol N eq.	6.77E+01	1.85E+02	3.55E+02	3.49E+02	3.33E+03	8.22E+03
Eutrophication, freshwater	kg P eq.	1.45E-01	4.20E-01	5.67E-01	5.71E-01	4.80E+00	1.03E+01
Eutrophication, marine	kg N eq.	7.25E+00	2.06E+01	3.80E+01	3.78E+01	3.53E+02	8.53E+02
Ecotoxicity, freshwater	CTUe	5.39E+04	1.47E+05	2.74E+05	2.68E+05	2.55E+06	6.25E+06
Land use	pt	1.66E+05	3.56E+05	5.86E+05	7.10E+05	6.39E+06	1.16E+07
Water use	m ³ water eq. of deprived water	1.23E+04	3.16E+04	3.99E+04	3.63E+04	3.32E+05	7.55E+05
Resource use, minerals and metals	kg Sb eq.	4.03E-02	9.96E-02	1.61E-01	1.94E-01	1.20E+00	2.21E+00
Resource use, fossils	MJ	1.70E+05	4.49E+05	8.87E+05	8.77E+05	8.76E+06	2.27E+07

5238

5239 **Table 7-16: Total life cycle impact per commercial dishwasher Base Case per year of use.**

Environmental aspect	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Energy consumption							
Electricity	kWh	1.78E+03	6.97E+03	1.41E+04	1.19E+04	9.85E+04	1.85E+05
Thermal energy	MJ	0.00E+00	3.21E+02	1.07E+03	4.05E+03	4.32E+04	1.24E+05
PEF Impact categories							
Climate change, total	kg CO ₂ eq.	8.35E+02	3.32E+03	6.49E+03	5.73E+03	4.66E+04	8.86E+04
Ozone depletion	kg CFC-11 eq.	1.24E-06	5.49E-06	8.01E-06	7.17E-06	4.96E-05	7.84E-05
Human toxicity, cancer	CTUh	4.90E-07	3.10E-06	5.74E-06	6.36E-06	2.87E-05	4.06E-05

Environmental aspect	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Human toxicity, non-cancer	CTUh	6.78E-06	2.62E-05	3.86E-05	3.31E-05	2.40E-04	4.07E-04
Particulate matter	disease incidence	3.11E-05	1.29E-04	2.44E-04	2.15E-04	1.64E-03	2.93E-03
Ionising radiation, human health	kBq U235 eq.	3.25E+02	1.28E+03	2.56E+03	2.17E+03	1.79E+04	3.35E+04
Photochemical ozone formation, human health	kg NMVOC eq.	1.53E+00	6.17E+00	1.17E+01	1.02E+01	8.01E+01	1.47E+02
Acidification	mol H+ eq.	2.71E+00	1.10E+01	2.13E+01	1.86E+01	1.45E+02	2.65E+02
Eutrophication, terrestrial	mol N eq.	5.64E+00	2.32E+01	4.44E+01	3.88E+01	3.02E+02	5.48E+02
Eutrophication, freshwater	kg P eq.	1.20E-02	5.25E-02	7.09E-02	6.34E-02	4.36E-01	6.88E-01
Eutrophication, marine	kg N eq.	6.05E-01	2.58E+00	4.75E+00	4.20E+00	3.21E+01	5.68E+01
Ecotoxicity, freshwater	CTUe	4.49E+03	1.84E+04	3.42E+04	2.97E+04	2.32E+05	4.17E+05
Land use	pt	1.38E+04	4.45E+04	7.32E+04	7.89E+04	5.81E+05	7.73E+05
Water use	m ³ water eq. of deprived water	1.03E+03	3.95E+03	4.98E+03	4.03E+03	3.02E+04	5.03E+04
Resource minerals and metals	kg Sb eq.	3.35E-03	1.25E-02	2.01E-02	2.16E-02	1.09E-01	1.47E-01
Resource fossils	MJ	1.42E+04	5.62E+04	1.11E+05	9.74E+04	7.97E+05	1.51E+06

Table 7-17: Total life cycle impact per commercial dishwasher Base Case per number of cleaned dishes per year (note, for BC4 results are per cycle).

Environmental aspect	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Number of cleaned dishes	#	52,500	37,600	475,200	9,000 (cycles per year)	3,801,600	7,603,200
Energy consumption							
Electricity	kWh	3.38E-02	2.93E-02	2.96E-02	1.32E+00	2.59E-02	2.43E-02
Thermal energy	MJ	0.00E+00	1.35E-03	2.26E-03	4.50E-01	1.14E-02	1.63E-02
PEF Impact categories							
Climate change, total	kg CO ₂ eq.	1.59E-02	1.40E-02	1.37E-02	6.37E-01	1.23E-02	1.17E-02
Ozone depletion	kg CFC-11 eq.	2.36E-11	2.31E-11	1.68E-11	7.96E-10	1.30E-11	1.03E-11

Environmental aspect	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Human toxicity, cancer	CTUh	9.33E-12	1.30E-11	1.21E-11	7.06E-10	7.55E-12	5.33E-12
Human toxicity, non-cancer	CTUh	1.29E-10	1.10E-10	8.12E-11	3.68E-09	6.31E-11	5.36E-11
Particulate matter	disease incidence	5.93E-10	5.42E-10	5.13E-10	2.39E-08	4.30E-10	3.85E-10
Ionising radiation, human health	kBq U235 eq.	6.20E-03	5.39E-03	5.39E-03	2.41E-01	4.71E-03	4.40E-03
Photochemical ozone formation, human health	kg NMVO C eq.	2.91E-05	2.60E-05	2.46E-05	1.14E-03	2.11E-05	1.93E-05
Acidification	mol H ⁺ eq.	5.16E-05	4.65E-05	4.49E-05	2.07E-03	3.82E-05	3.48E-05
Eutrophication, terrestrial	mol N eq.	1.08E-04	9.76E-05	9.33E-05	4.31E-03	7.95E-05	7.20E-05
Eutrophication, freshwater	kg P eq.	2.29E-07	2.21E-07	1.49E-07	7.04E-06	1.15E-07	9.04E-08
Eutrophication, marine	kg N eq.	1.15E-05	1.08E-05	1.00E-05	4.66E-04	8.43E-06	7.48E-06
Ecotoxicity, freshwater	CTUe	8.56E-02	7.76E-02	7.21E-02	3.31E+00	6.11E-02	5.48E-02
Land use	pt	2.63E-01	1.87E-01	1.54E-01	8.76E+00	1.53E-01	1.02E-01
Water use	m ³ water eq. of deprived water	1.96E-02	1.66E-02	1.05E-02	4.48E-01	7.94E-03	6.62E-03
Resource use, minerals and metals	kg Sb eq.	6.39E-08	5.24E-08	4.23E-08	2.40E-06	2.87E-08	1.94E-08
Resource use, fossils	MJ	2.70E-01	2.36E-01	2.33E-01	1.08E+01	2.10E-01	1.99E-01



5242 7.5. Base Case Environmental Impact Assessment

5243 7.5.1. Contribution analysis per Base Case

5244 This section contains a detailed analysis on the contribution of each life cycle stage to the life
 5245 cycle impact per Base Case. Furthermore, a contribution analysis is performed in the two highest
 5246 contribution life cycle stages, namely use stage and raw materials production, per Base Case.

7.5.1.1. BC1: Undercounter water-change dishwasher

The detailed results for BC1 are presented in **Appendix 11.5.1**. In this chapter the contribution analyses of the full results and of the two highest contributing life cycle stages are presented in detail.

The majority of the lifetime impact of the undercounter water-change dishwasher is derived from the use phase and the raw materials input (to different degrees for the various impact indicators) (**Figure 7-1**). Use phase is the top contributor to most impact indicators (83 to 99 %), with the exception of the impact indicators 'Land use' and 'Resource use, minerals and metals', where the raw materials provide the main contribution followed by the use phase (**Figure 7-1**).

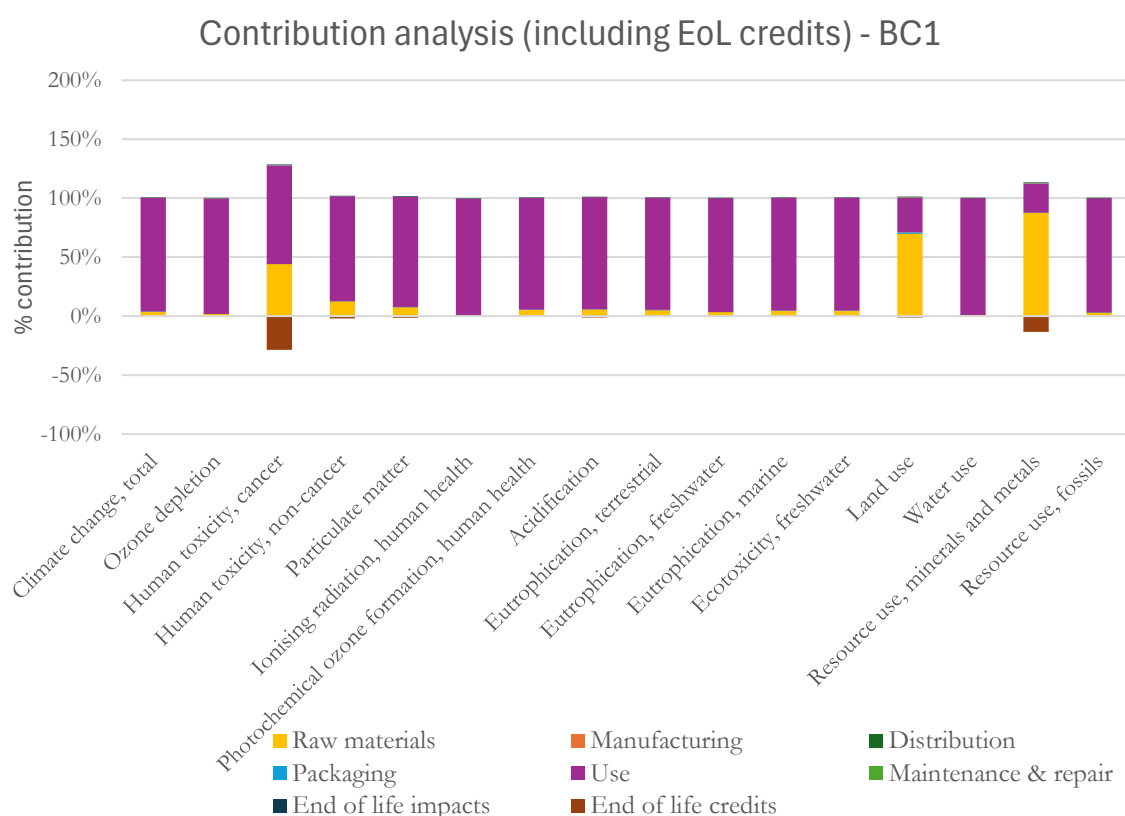


Figure 7-1: Contribution analysis (including EoL credits), BC1.

In the use phase, the major contributor to most impact indicators, including climate change, is electricity use. However, for several other impact categories, such as 'Ozone depletion', 'Human toxicity, cancer', 'Human toxicity, non-cancer', 'Eutrophication, freshwater' and 'Water use' the water use¹¹⁰ of commercial dishwashers contributes the most (51 to 75 %) (**Figure 7-2**). Detergent use is highest contributor to the impact category 'Resource use, minerals and metals'.

¹¹⁰ The reason for the contribution of water use to the impact categories 'Human toxicity, cancer' and 'Human toxicity, non-cancer' is unclear to the study team and raised with the European Commission.

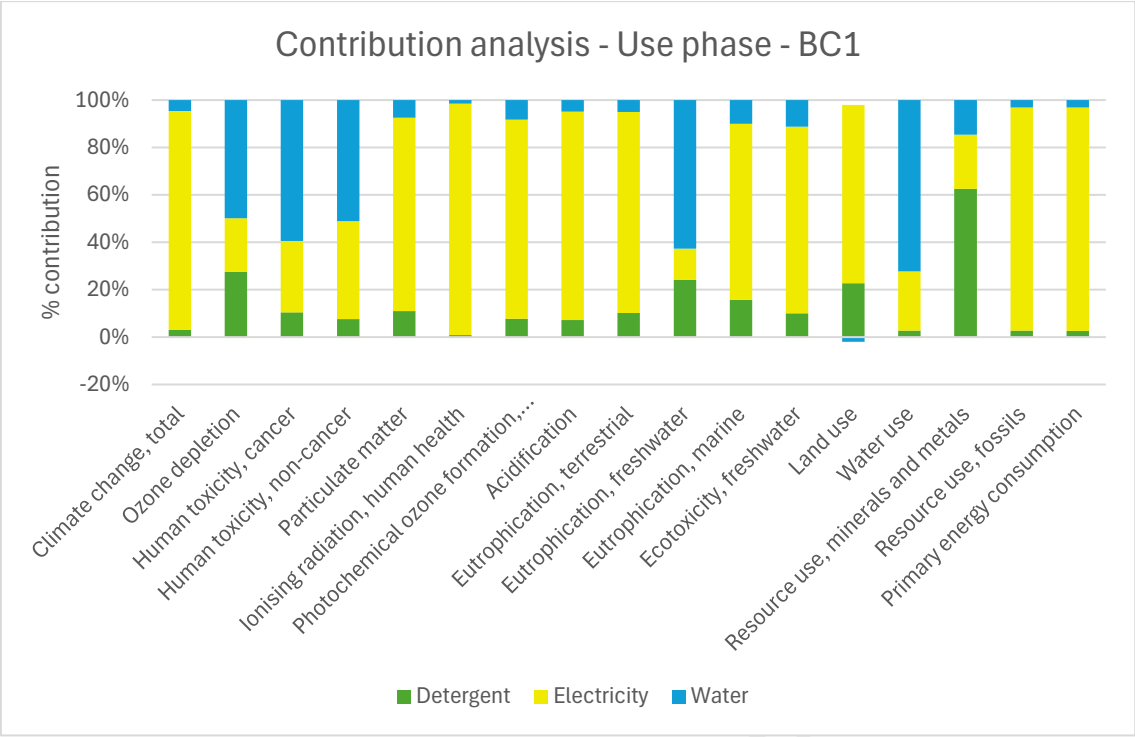


Figure 7-2: Contribution analysis – Use phase, BC1.

The major contribution of the raw materials to most impact categories is from the production of electronics (printed wiring board) (Figure 7-3). However, polypropylene is the top contributing material to the impact category 'Ozone depletion' and is also significantly contributing to 'Eutrophication, fresh water'; and copper contributes 99 % to the 'Land use' impact category. Furthermore, stainless steel contributes 94 % to 'Human toxicity, cancer' (Figure 7-3).

In the End-of-Life (EoL) modelling, a credit for recycling of raw materials is included as calculated with the circular footprint formula. For BC1, the credit contributes negatively (i.e. lowering the impact) mainly for 'Human toxicity, cancer' and 'Resource use, minerals and metals' (Figure 7-1) as a consequence of a credit for stainless steel due to its recyclability. Additionally, credits for aluminium and the printed wiring board also contribute to lowering the overall lifetime impact of BC1.

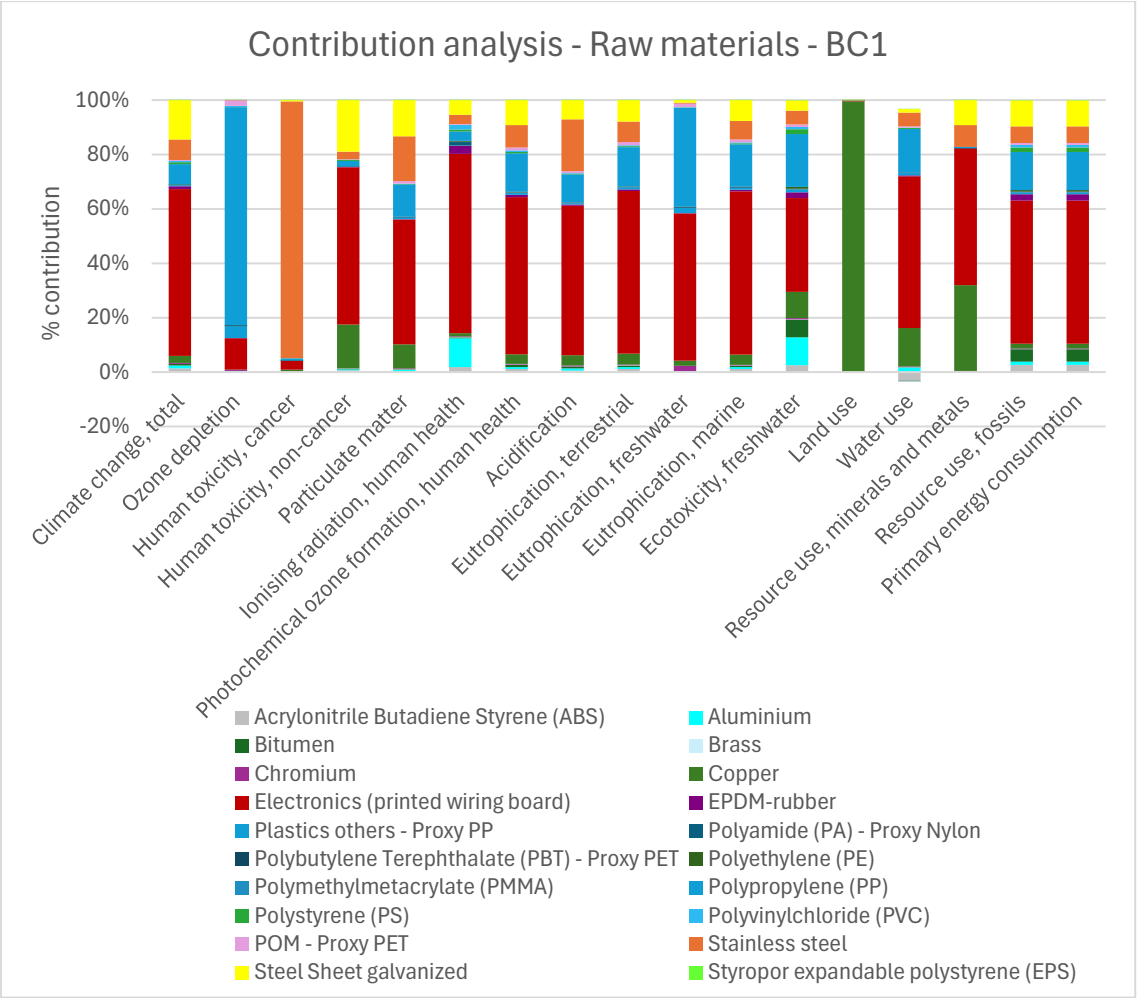


Figure 7-3: Contribution analysis – Raw materials, BC1.

7.5.1.2. BC2: Undercounter one-tank dishwasher

The detailed results for BC2 are presented in **Appendix 11.5.2**. In this chapter the contribution analyses of the full results and of the two highest contributing life cycle stages are presented in detail.

The majority of the lifetime impact of the undercounter one-tank dishwasher is derived from the use phase and the raw materials input (to different degrees for the various impact indicators) (**Figure 7-4**). Use phase is the top contributor to most impact indicators (>95 %), with the exception of the impact indicators ‘Human toxicity, cancer’, ‘Land use’ and ‘Resource use, minerals and metals’, where the raw materials provide the main contribution followed by the use phase (**Figure 7-4**).

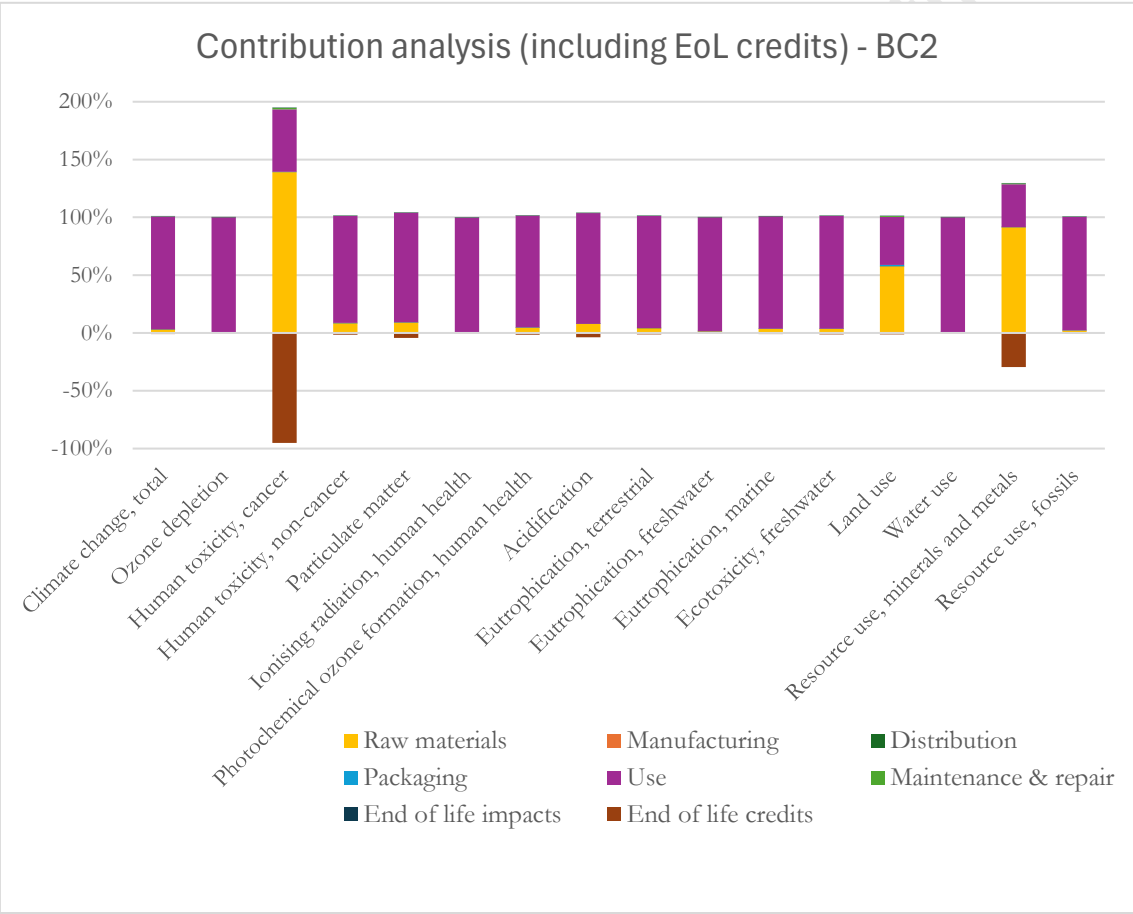
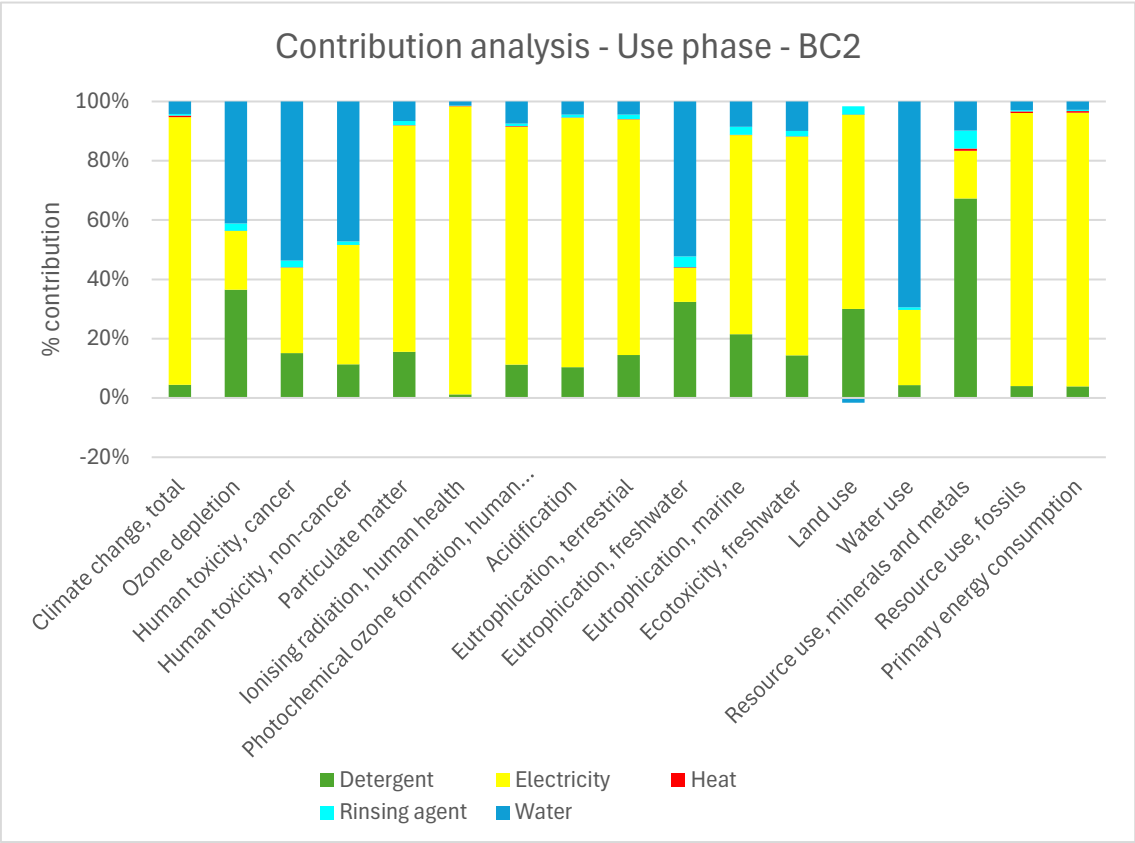


Figure 7-4: Contribution analysis (including EoL credits), BC2.

In the use phase, the major contributor to most impact indicators, including climate change, is electricity (Figure 7-5). However, for several other impact categories, such as ‘Ozone depletion’, ‘Human toxicity, cancer’, ‘Human toxicity, non-cancer’, ‘Eutrophication, freshwater’ and ‘Water use’¹¹¹ water is the dominant contributor (41 to 69 %). Finally, detergent use is the main contributor to the impact indicator ‘Resource use, minerals and metals’ (67 %) (**Figure 7-5**).

¹¹¹ The reason for the contribution of water use to the impact categories "Human toxicity, cancer" and "Human toxicity, non-cancer" is unclear to the study team and raised with the European Commission.

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Figure 7-5: Contribution analysis – Use phase, BC2.

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The major contribution of the raw materials to most impact categories is from the production of electronics (printed wiring board) and stainless steel (**Figure 7-6**). However, polypropylene is the top contributing material to the impact category ‘Ozone depletion’ and copper contributes 99.4 % to the ‘Land use’ impact category (**Figure 7-6**). Furthermore, aluminium is the third highest contributor to the impact categories ‘Ionising radiation, human health’ and ‘Ecotoxicity, freshwater’.

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In the End-of-Life (EoL) modelling, a credit for recycling of raw materials is included as calculated with the circular footprint formula. For BC2, the credit contributes negatively (i.e. lowering the impact) mainly for ‘Human toxicity, cancer’ and ‘Resource use, minerals and metals’ (**Figure 7-4**) as a consequence of a credit for stainless steel due to its recyclability. Additionally, credits for aluminium and the printed wiring board also contribute to lowering the overall lifetime impact of BC2.

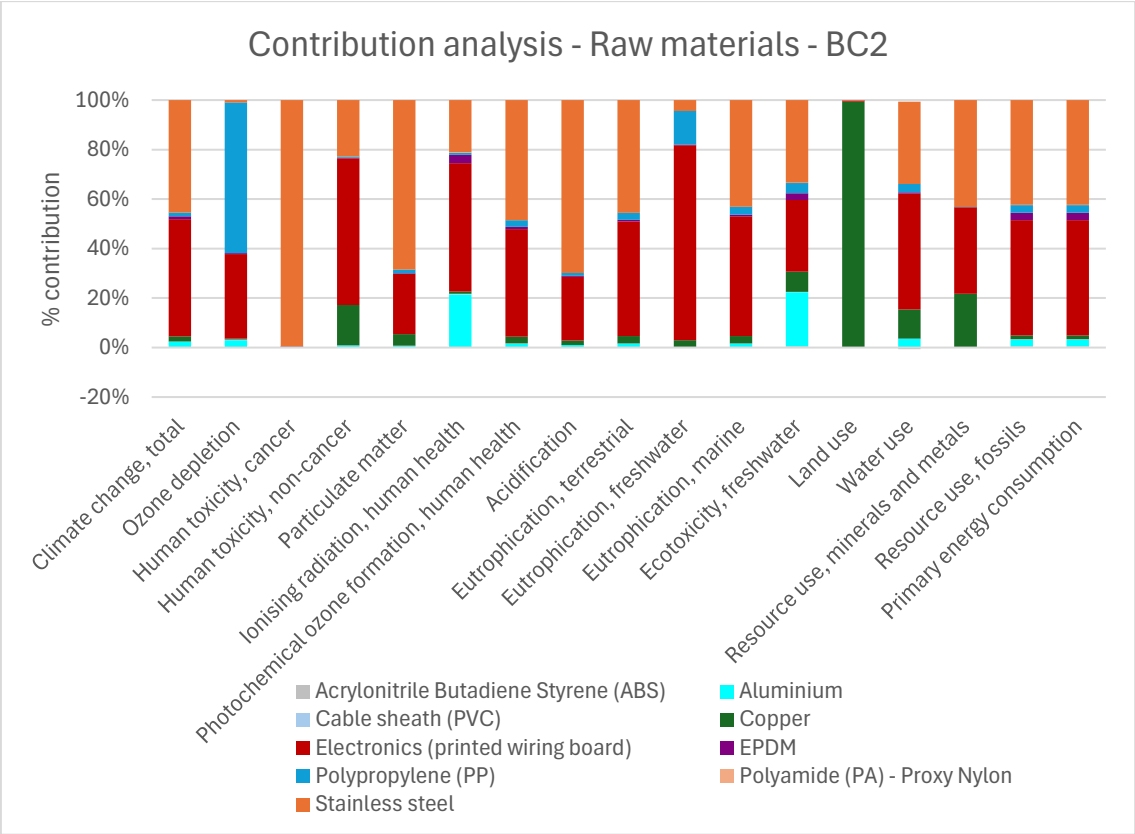


Figure 7-6: Contribution analysis – Raw materials, BC2.

7.5.1.3. BC3: Hood-type dishwasher

The detailed results for BC3 are presented in **Appendix chapter 11.5.3**. In this chapter the contribution analyses of the full results and of the two highest contributing life cycle stages are presented in detail.

The majority of the lifetime impact of the hood-type dishwasher is derived from the use phase and the raw materials input (to different degrees for the various impact indicators) (**Figure 7-7**). Use phase is the top contributor to most impact indicators (>92 %), with the exception of the impact indicators ‘Human toxicity, cancer’, ‘Land use’ and ‘Resource use, minerals and metals’, where the raw materials provide the main contribution followed by the use phase (**Figure 7-7**).

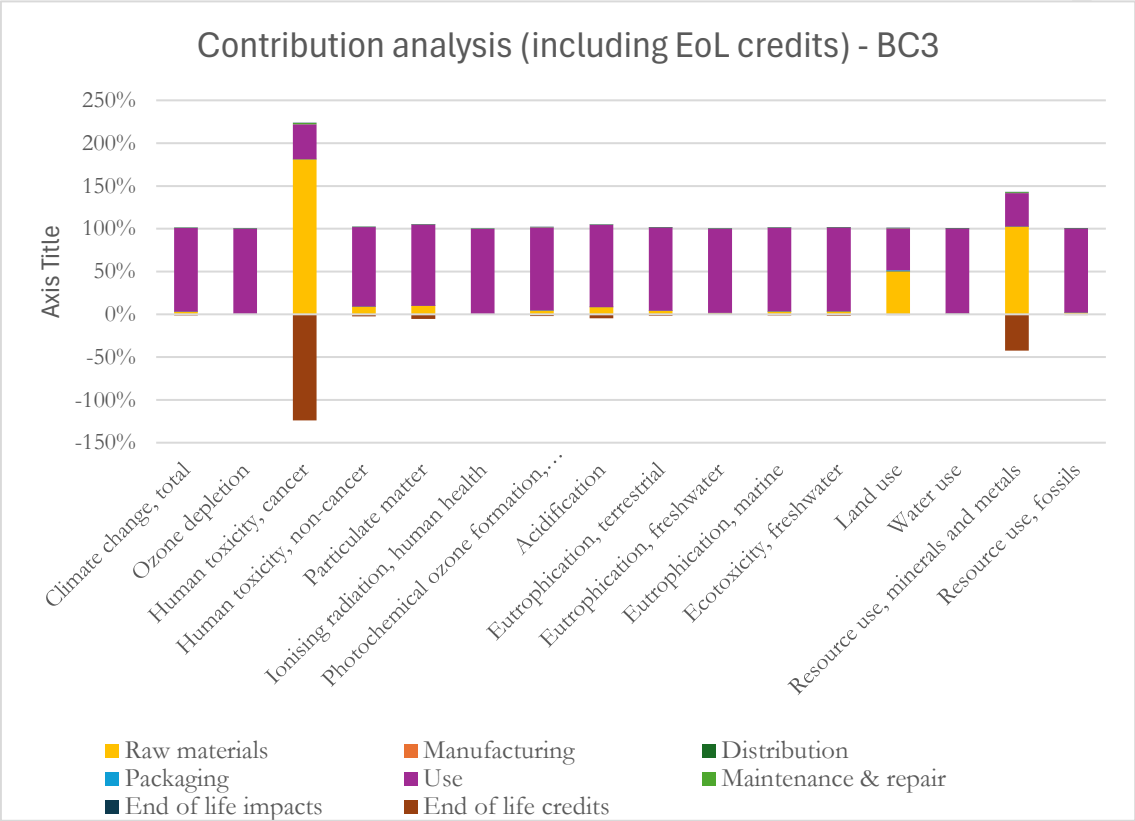


Figure 7-7: Contribution analysis (including EoL credits), BC3.

In the use phase, the major contributor to most impact indicators, including climate change, is electricity. However, for several other impact categories, such as ‘Ozone depletion’, ‘Eutrophication, freshwater’ and ‘Resource use, minerals and metals’ detergent use contributes the most (41 to 68 %). Finally, water use is the highest contributor to the impact category ‘Water use’ (**Figure 7-8**).

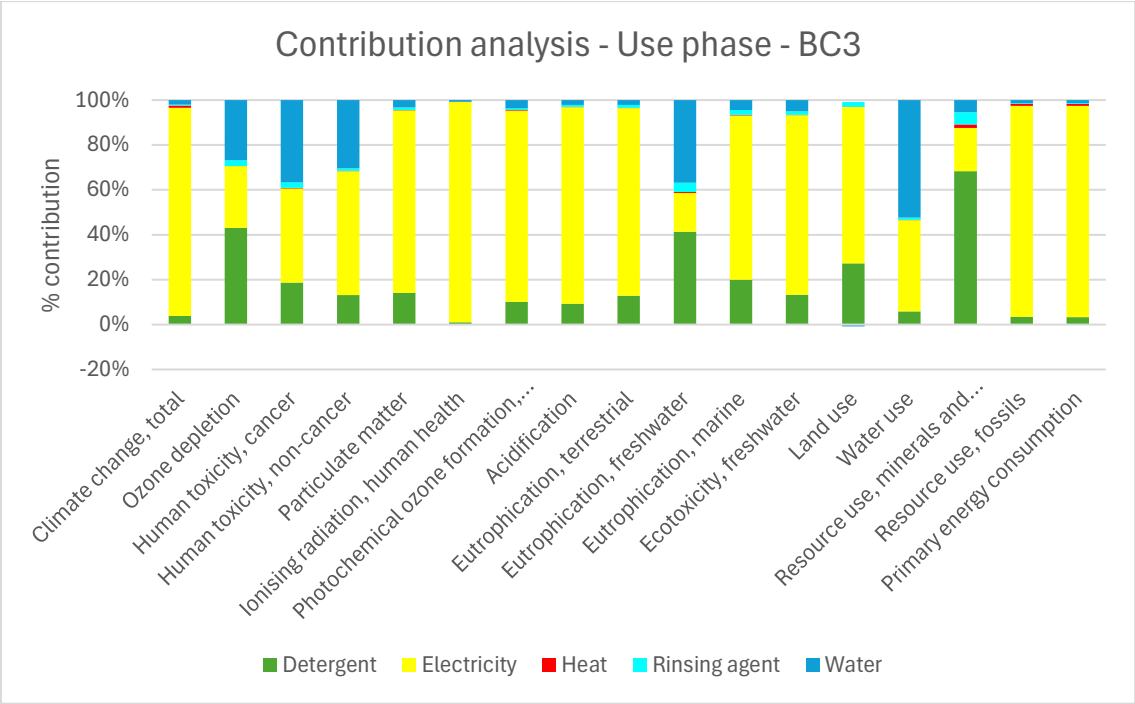


Figure 7-8: Contribution analysis – Use phase, BC3.

The major contribution of the raw materials to most impact categories is from the production of electronics (printed wiring board) and stainless steel (Figure 7-9). However, polypropylene is the top contributing material to the impact category 'Ozone depletion' and copper contributes 99 % to the 'Land use' impact category (Figure 7-9). Furthermore, aluminium is the third highest contributor to the impact categories 'Ionising radiation, human health' and 'Ecotoxicity, freshwater'.

In the End-of-Life (EoL) modelling, a credit for recycling of raw materials is included as calculated with the circular footprint formula. For BC3, the credit contributes negatively (i.e. lowering the impact) mainly for 'Human toxicity, cancer' and 'Resource use, minerals and metals' (Figure 7-7) as a consequence of a credit for stainless steel due to its recyclability. Additionally, credits for aluminium and the printed wiring board also contribute to lowering the overall lifetime impact of BC3.

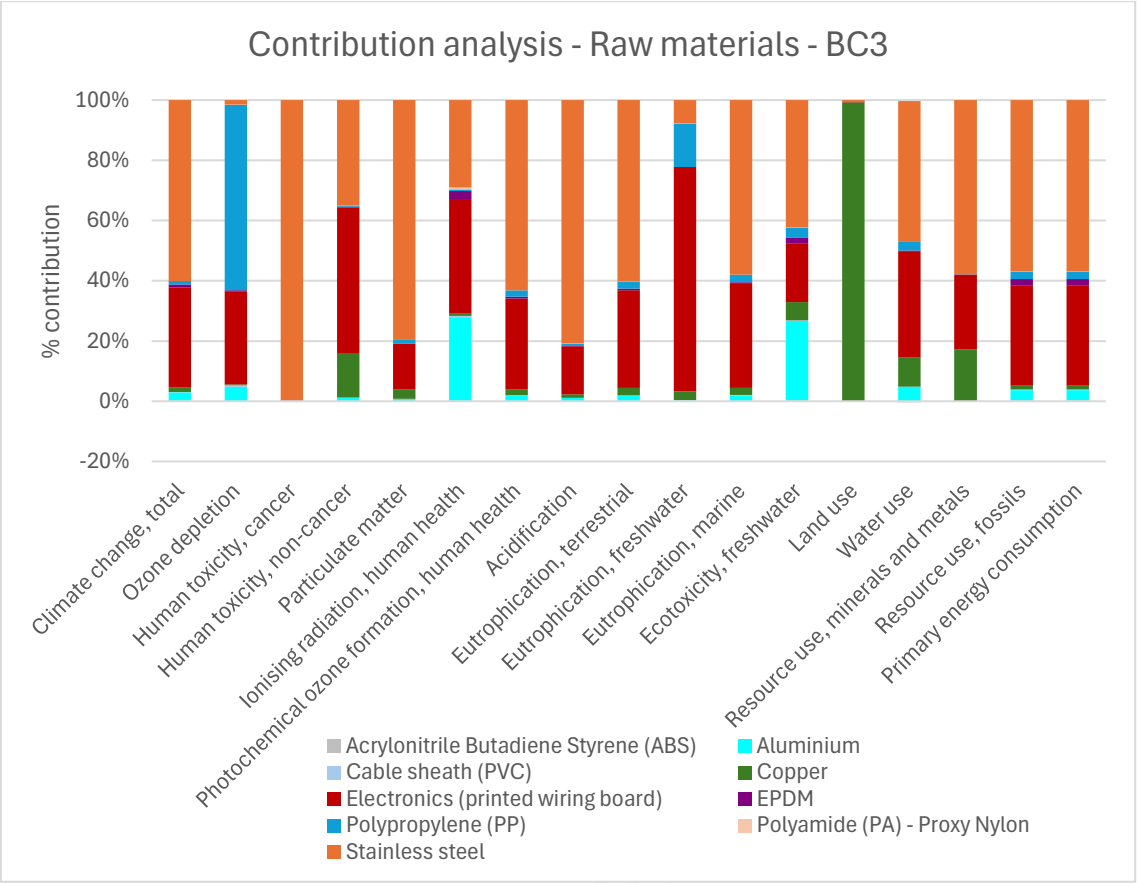


Figure 7-9: Contribution analysis – Raw materials, BC3.

7.5.1.4. BC4: Utensil/pot dishwasher

The detailed results for BC4 are presented in **Appendix chapter 11.5.4**. In this chapter the contribution analyses of the full results and of the two highest contributing life cycle stages are presented in detail.

The majority of the lifetime impact of the utensil/pot dishwasher is derived from the use phase and the raw materials input (to different degrees for the various impact indicators) (**Figure 7-10**). Use phase is the top contributor to most impact indicators (>91 %), with the exception of the impact indicators 'Human toxicity, cancer', 'Land use' and 'Resource use, minerals and metals', where the raw materials provide the main contribution followed by the use phase (**Figure 7-10**).

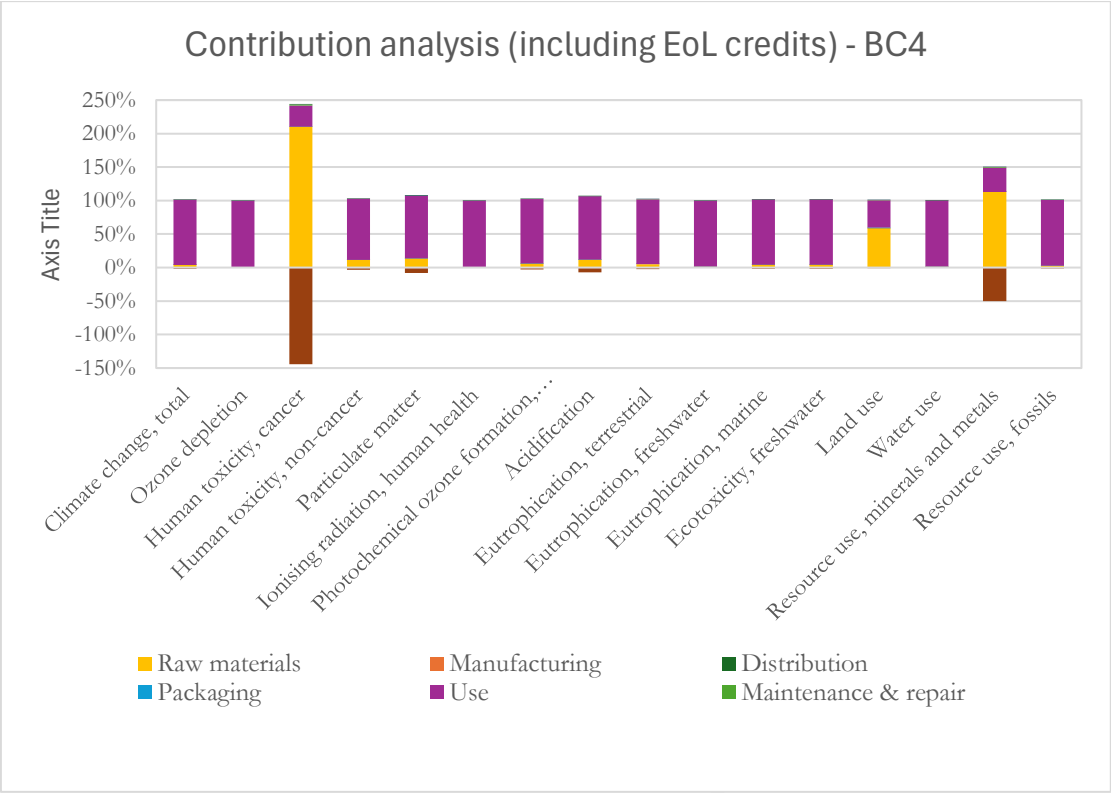


Figure 7-10: Contribution analysis (including EoL credits), BC4.

In the use phase, the major contributor to most impact indicators, including climate change, is electricity. However, for several other impact categories, such as 'Ozone depletion', 'Eutrophication, freshwater' and 'Resource use, minerals and metals' detergent use contributes the most (47 to 70 %). Water use is the highest contributor to the impact category 'Water use' (Figure 7-11).

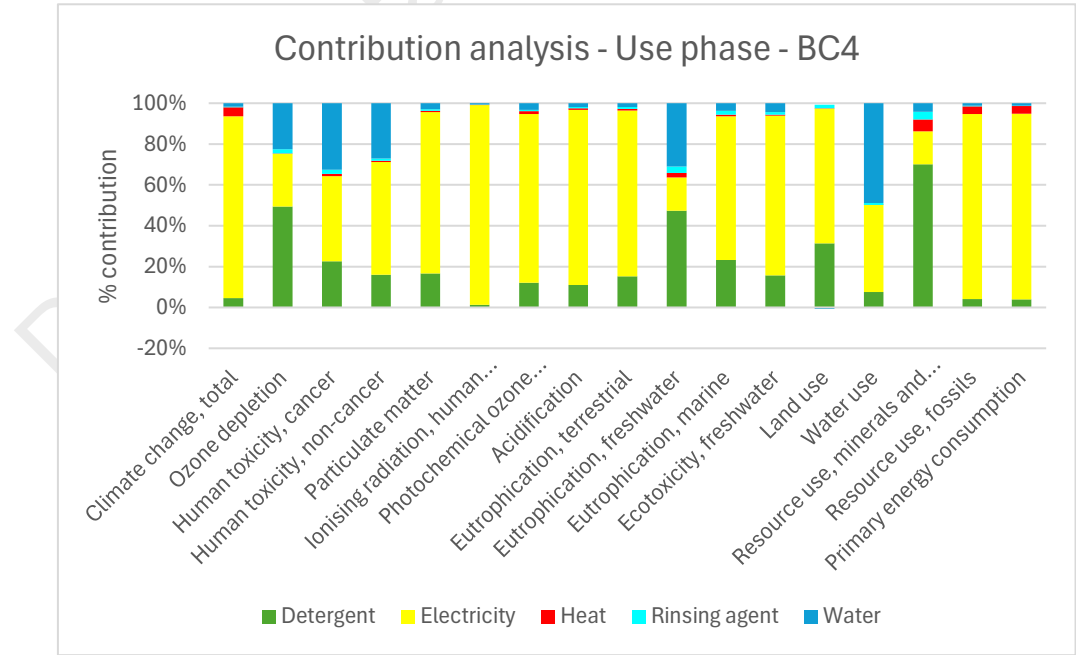


Figure 7-11: Contribution analysis – Use phase, BC4.

The major contribution of the raw materials to most impact categories is from stainless steel followed by the production of electronics (printed wiring board) (Figure 7-12). Copper contributes by 99 % to the 'Land use' impact category (Figure 7-12). Furthermore, aluminium is the third largest contributor to the impact categories 'Ionising radiation, human health' and 'Ecotoxicity, freshwater' while polypropylene is the third largest contributor to the impact category 'Ozone depletion'.

In the End-of-Life (EoL) modelling, a credit for recycling of raw materials is included as calculated with the circular footprint formula. For BC4, the credit contributes negatively (i.e. lowering the impact) mainly for 'Human toxicity, cancer', 'Resource use, minerals and metals', 'Particulate matter' and 'Acidification' (Figure 7-10) as a consequence of a credit for stainless steel due to its recyclability. Additionally, credits for aluminium and the printed wiring board also contribute to lowering the overall lifetime impact of BC4.

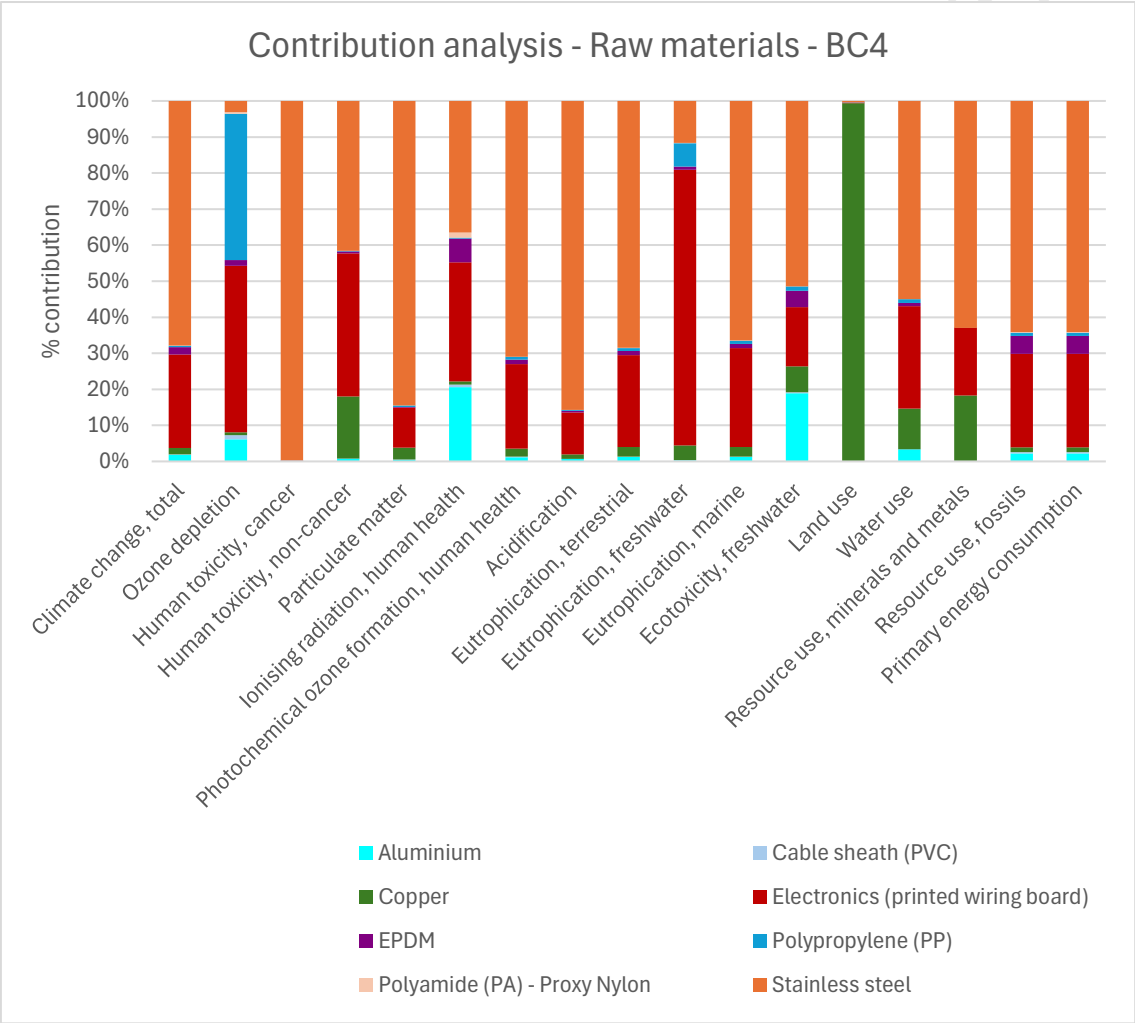


Figure 7-12: Contribution analysis – Raw materials, BC4.

7.5.1.5. BC5: One-tank conveyor-type dishwasher

The detailed results for BC5 are presented in **Appendix chapter 11.5.5**. In this chapter the contribution analyses of the full results and of the two highest contributing life cycle stages are presented in detail.

The majority of the lifetime impact of the one-tank conveyor-type dishwasher is derived from the use phase and the raw materials input (to different degrees for the various impact indicators) (**Figure 7-13**). Use phase is the top contributor to most impact indicators (>96 %), with the exception of the impact indicators 'Human toxicity, cancer', 'Land use' and 'Resource use, minerals and metals', where the raw materials provide the main contribution followed by the use phase (**Figure 7-13**).

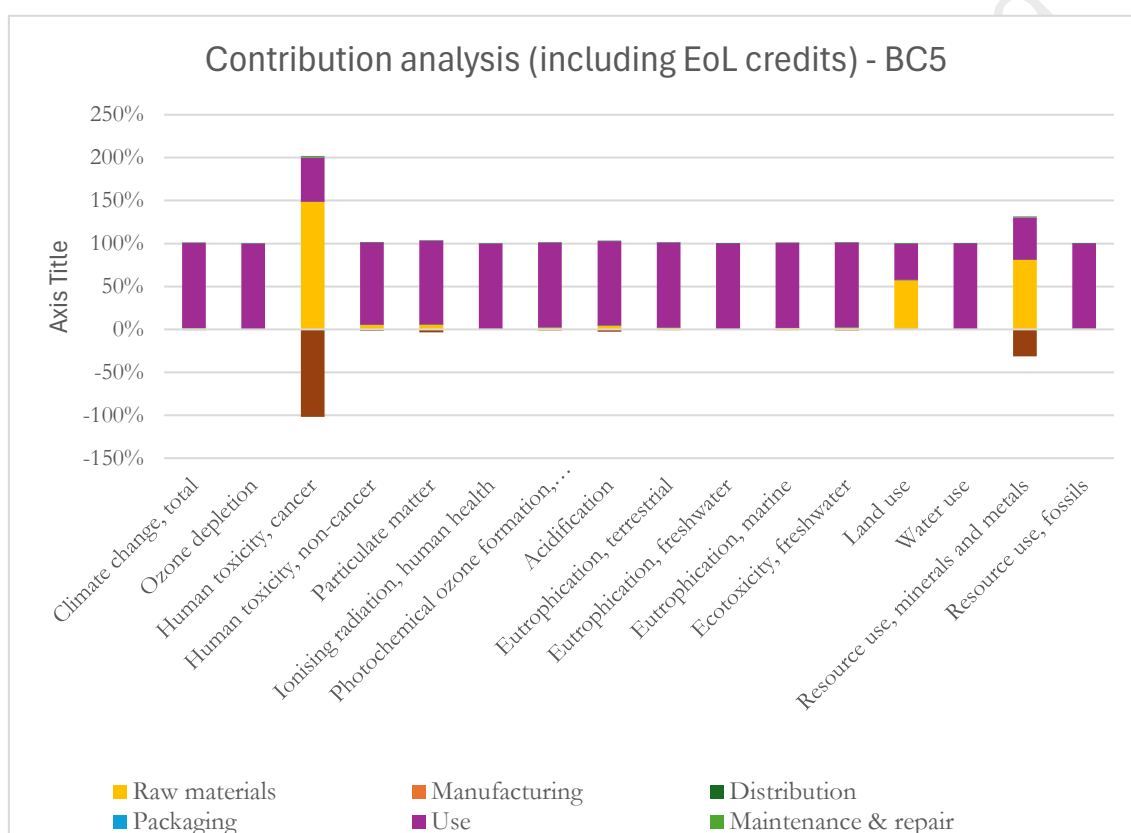


Figure 7-13: Contribution analysis (including EoL credits), BC5.

In the use phase, the major contributor to most impact indicators, including climate change, is electricity. However, for the impact categories, such as 'Ozone depletion', 'Eutrophication, freshwater' and 'Resource use, minerals and metals' detergent use contributes the most (40 to 61 %) (**Figure 7-14**). Finally, water use is the highest contributor to the impact category 'Water use'.

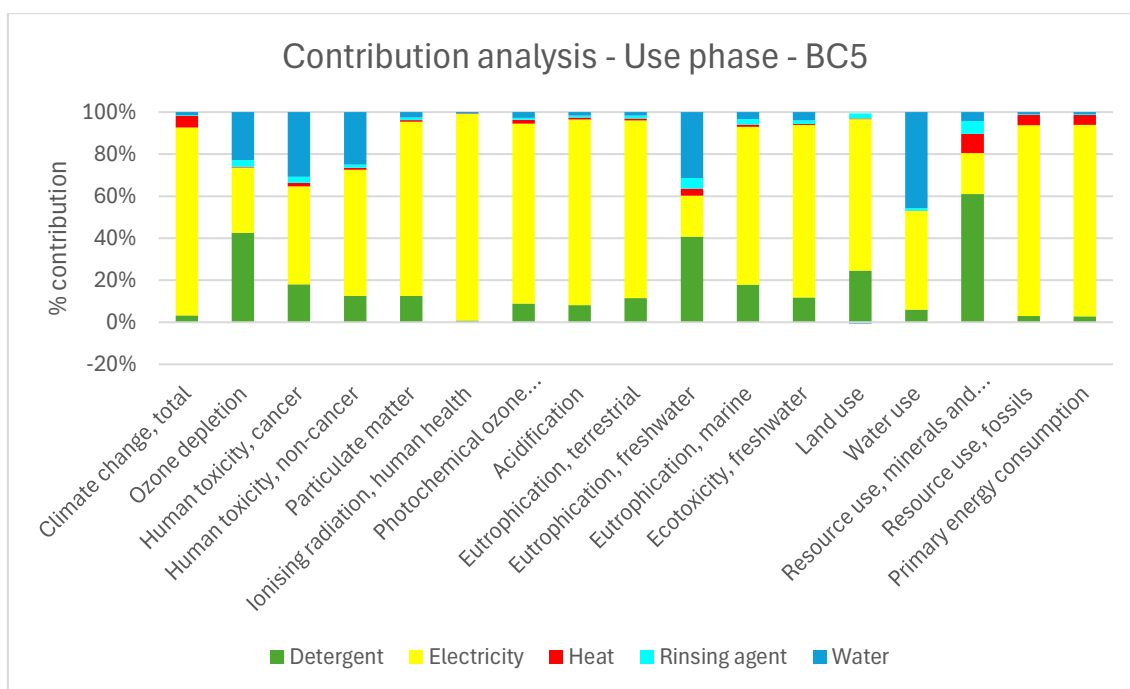


Figure 7-14: Contribution analysis – Use phase, BC5.

The major contribution of the raw materials to most impact categories is from stainless steel followed by the production of electronics (printed wiring board) (Figure 7-15). However, there are exceptions for certain impact categories. Specifically, polypropylene is the top contributing material to the impact category 'Ozone depletion' and copper (used in and summarised from different components, such as cables and ventilator) contributes 99.8 % to the 'Land use' impact category (Figure 7-15). Furthermore, aluminium is the third largest contributor to the impact categories 'Ionising radiation, human health' and 'Ecotoxicity, freshwater' (Figure 7-15).

In the End-of-Life (EoL) modelling, a credit for recycling of raw materials is included as calculated with the circular footprint formula. For BC5, the credit contributes negatively (i.e. lowering the impact) mainly for 'Human toxicity, cancer', 'Resource use, minerals and metals', 'Particulate matter' and 'Acidification' (Figure 7-13) as a consequence of a credit for stainless steel due to its recyclability. Additionally, credits for aluminium and the printed wiring board also contribute to lowering the overall lifetime impact of BC5.

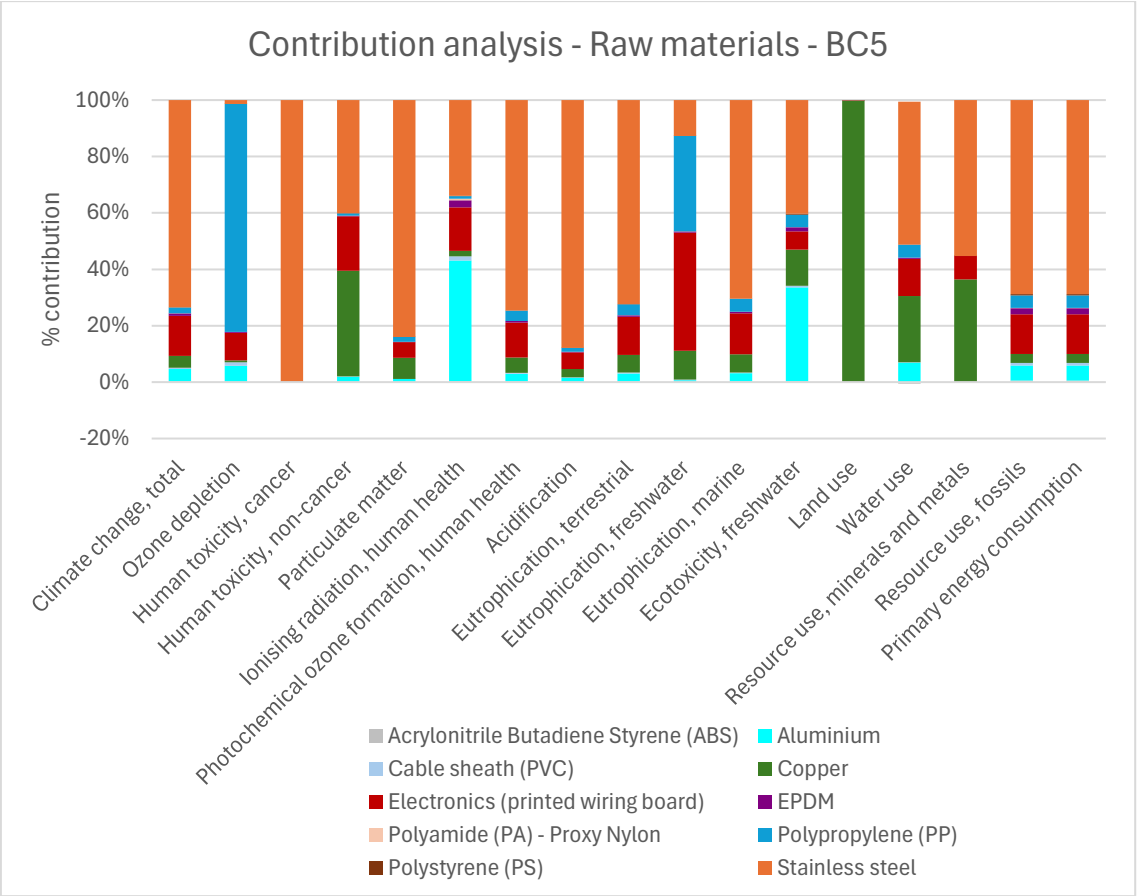


Figure 7-15: Contribution analysis – Raw materials, BC5.

7.5.1.6. BC6: Multi-tank conveyor-type dishwasher

The detailed results for BC6 are presented in **Appendix chapter 11.5.6**. In this chapter the contribution analyses of the full results and of the two highest contributing life cycle stages are presented in detail.

The majority of the lifetime impact of the one-tank conveyor-type dishwasher is derived from the use phase and the raw materials input (to different degrees for the various impact indicators) (**Figure 7-16**). Use phase is the top contributor to most impact indicators (>97 %), with the exception of 'Human toxicity, cancer' and 'Resource use, minerals and metals', where the raw materials provide the main contribution followed by the use phase (**Figure 7-16**).

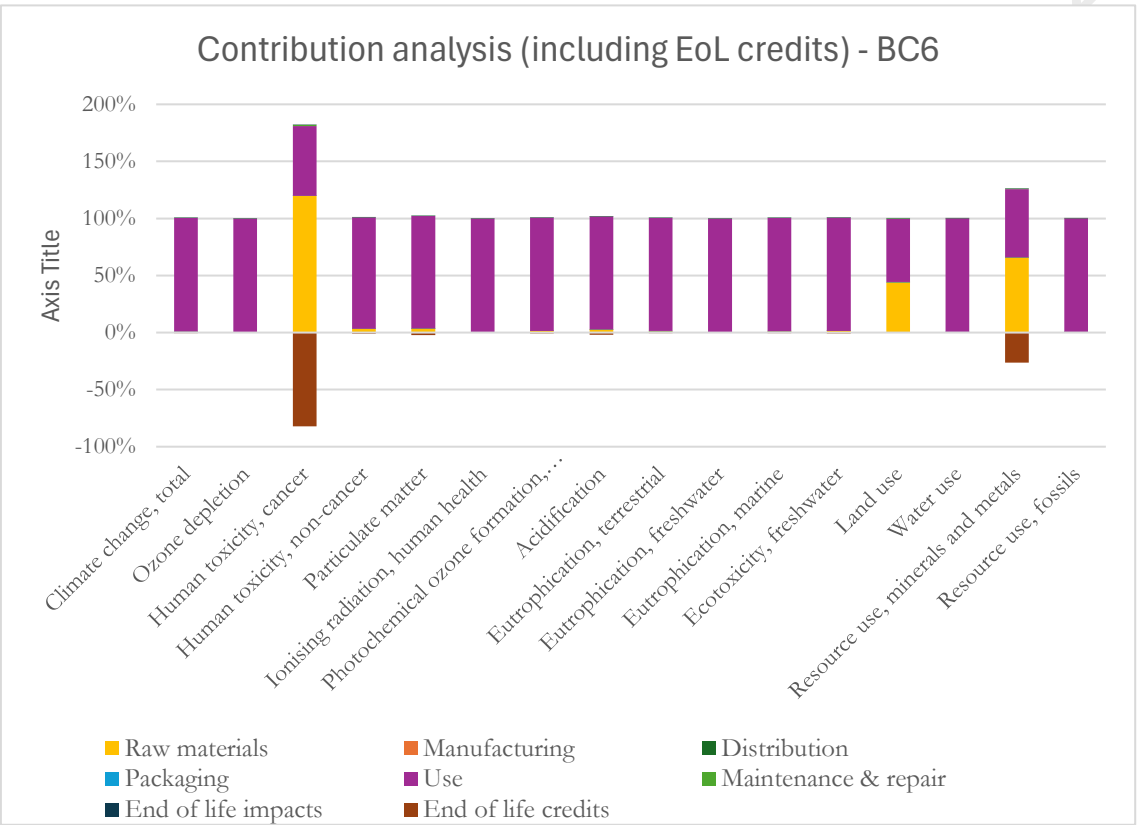


Figure 7-16: Contribution analysis (including EoL credits), BC6.

In the use phase, the major contributor to most impact indicators, including climate change, is electricity. However, for several other impact categories, such as 'Ozone depletion', 'Eutrophication, freshwater' and 'Resource use, minerals and metals' detergent use contributes the most (37 to 53 %) (**Figure 7-17**).

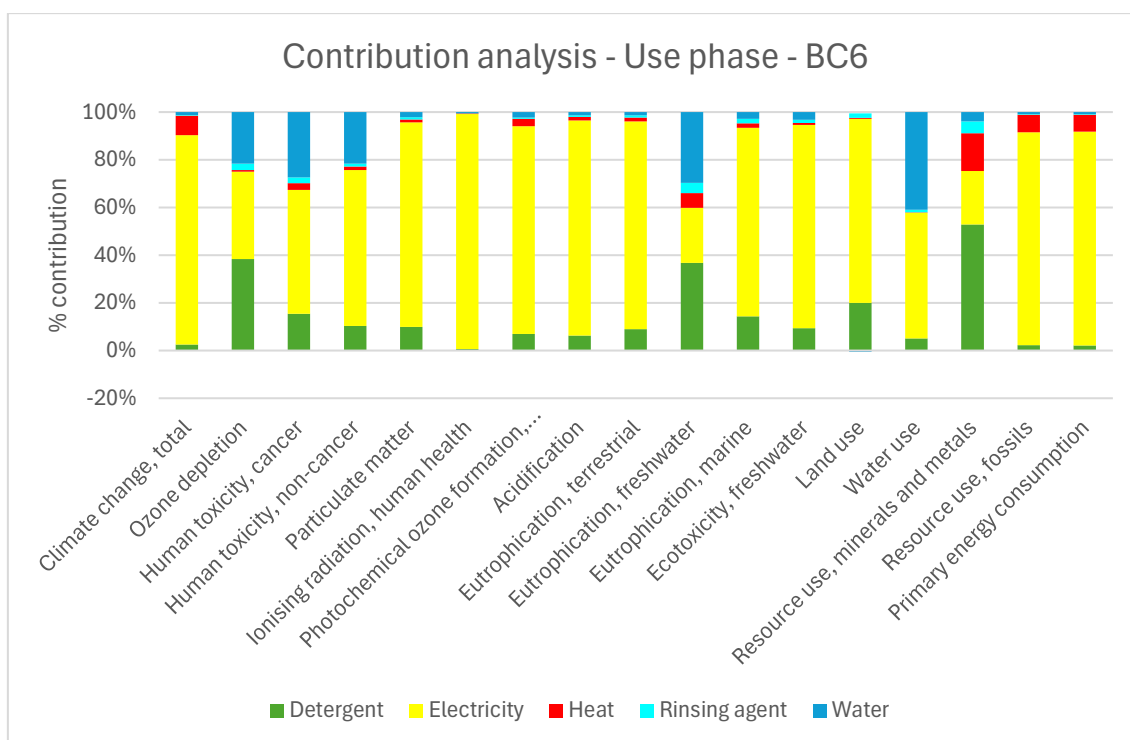


Figure 7-17: Contribution analysis – Use phase, BC6.

The major contribution of the raw materials to most impact categories is from stainless steel (Figure 7-18). However, there are exceptions for certain impact categories. Specifically, the top contributing raw material for 'Ozone depletion' is polypropylene (74 %) and for 'Ionising radiation, human health' it is aluminium. Copper (used in several components such as pumps and cables) contributes 99 % to the 'Land use' impact category and the production of electronics (printed wiring board) contributes 48 % to the 'Eutrophication, freshwater' impact category (Figure 7-18).

In the End-of-Life (EoL) modelling, a credit for recycling of raw materials is included as calculated with the circular footprint formula. For BC6, the credit contributes negatively (i.e. lowering the impact) mainly for 'Human toxicity, cancer', 'Resource use, minerals and metals', 'Particulate matter' and 'Acidification' (Figure 7-16) as a consequence of a credit for stainless steel due to its recyclability. Additionally, credits for aluminium and the printed wiring board also contribute to lowering the overall lifetime impact of BC6.

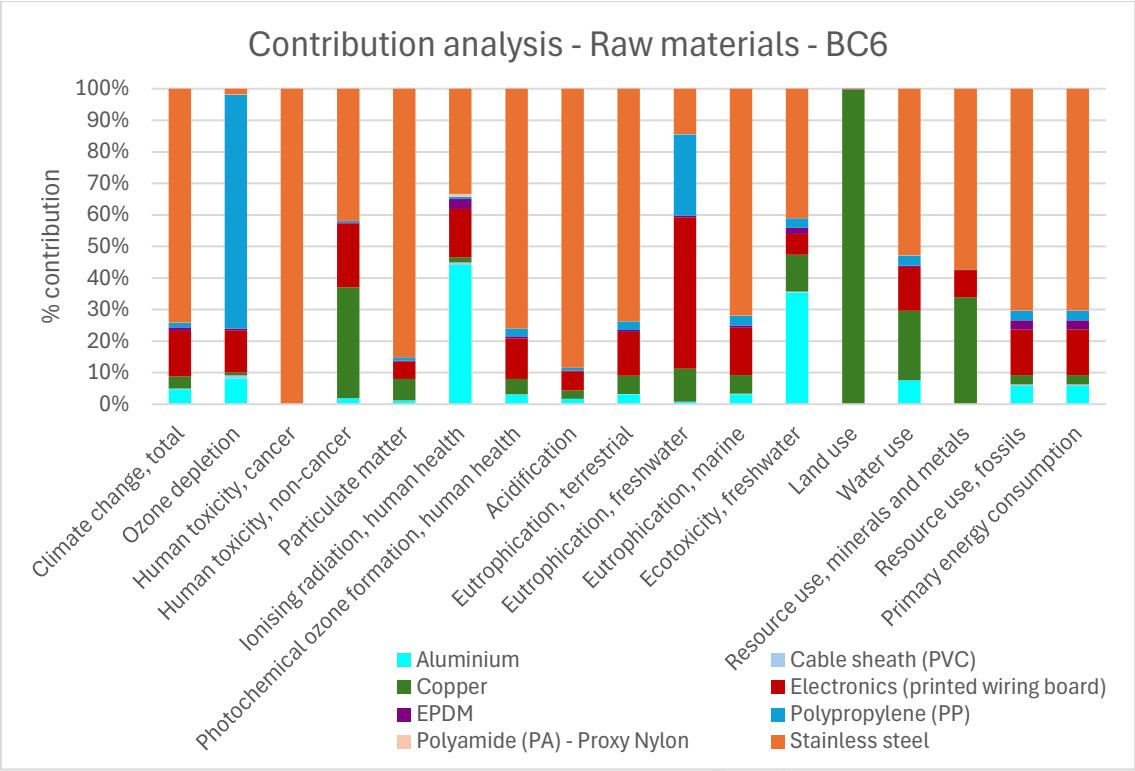


Figure 7-18: Contribution analysis – Raw materials, BC6.

7.6. Base Case Life Cycle Costs for consumer

In this section, the life cycle costs for each Base Case are presented, followed by a contribution analysis per Base Case of the main contributors to the life cycle costs.

7.6.1. Results overview LCC

The life cycle costs of each Base Case were calculated with the purchase price, installation costs, repair & maintenance costs as well as the running costs for electricity, water, natural gas (as heating source) and detergent (Table 7-18; per Base Case in Appendix 5 – Results of LCA / LCC per). For all Base Cases, the repair & maintenance costs were included as 44 % of the purchase price while no installation costs were included. The total costs per year are calculated in the ERT by dividing the product price and repair/maintenance cost by the lifetime of the machine and discounting the running costs to their net present value (based on present worth factor) to obtain the total costs per year.

It can be observed from the data that depending on the machine, EU customers are spending between € 3,148 and 22,867 in the purchase of the product. Each time a consumer makes a buying decision, the decision is not just on a purchase price but on the total Life Cycle Costs (LCC) of the product, which also includes the total running costs discounted to their net present value (between € 604 – 58,303 per year depending on the Base Case).

Clearly, the life costs for Base Case BC6 are the highest of all base cases, which is mainly due to the size of the machine (and thereby the product price), and high water and detergent use in the life cycle.

Table 7-18: Total life cycle costs per Base Case.

Product aspect	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Purchase and installation costs							
Product price	EUR	3,148	5,659	8,662	10,855	13,394	22,867
Running costs							
Electricity	EUR/year	411	7	23	86	910	2,540
Natural gas	EUR/year	0	1,665	3,375	2,829	23,184	42,419
Water	EUR/year	76	290	277	207	1,435	2,096
Detergent	EUR/year	117	718	1,243	1,266	7,462	10,368
Rinsing agent	EUR/year	0	57	89	62	677	880
Repair & maintenance costs per lifetime	EUR	1,385	2,490	3,811	4,776	5,894	10,061
Total running costs	EUR/year	604	2,738	5,007	4,450	33,668	58,303
Total life cycle costs	EUR/year	982	3,861	6,566	6,187	35,422	60,498

7.7. Contribution analysis LCC

A contribution analysis was performed to analyse the main contributors to the total costs per year per Base Case. For this, the product price and repair/maintenance cost were divided by the lifetime to obtain the costs per year. The running costs are already provided per year in the ERT.

7.7.1. BC1: Undercounter water-change dishwasher

The life cycle costs of the undercounter water-change dishwasher were calculated with the inputs of product price, electricity, water and detergent costs. In addition, repair and maintenance costs over lifetime were included as 44 % of the purchase price. The main contribution to the costs per machine (on a yearly basis) is the costs for electricity (41.9 %), followed by the product price (26.7 %) (**Figure 7-19**).

Thus, each time a consumer makes a buying decision, the decision is not just on a purchase price of € 3,148, but on the total Life Cycle Costs (LCC) of the product - including running costs (electricity, water, and detergent costs) discounted to their net present value – which is on average € 604 per year.

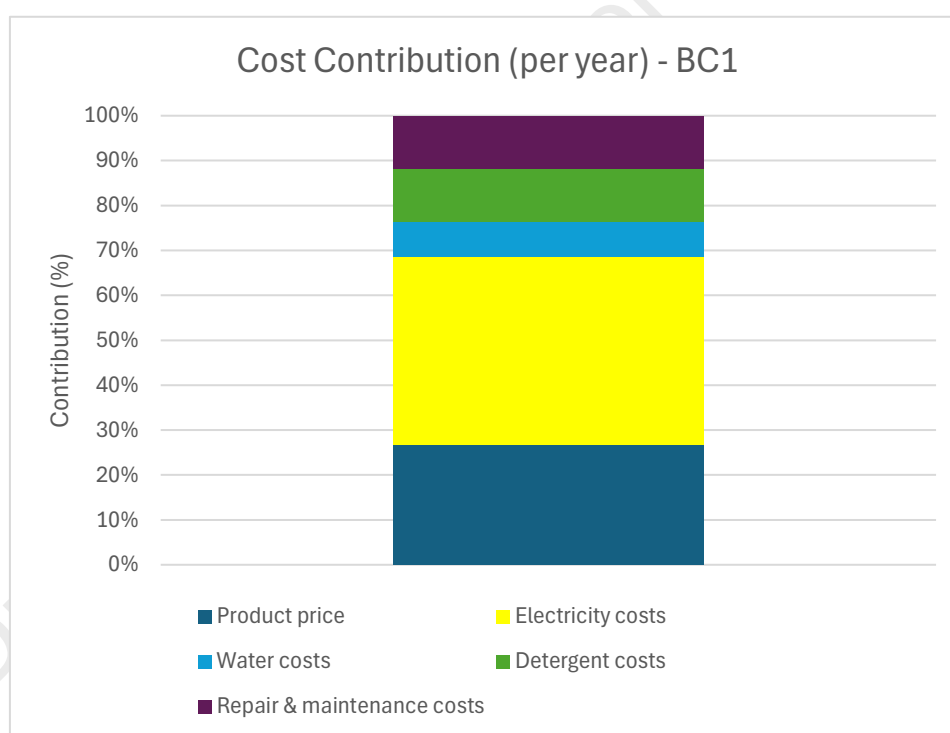


Figure 7-19: Cost contribution (per year), BC1.

7.7.2. BC2: Undercounter one-tank dishwasher

The life cycle costs of the undercounter one-tank dishwasher were calculated with the inputs of product price, electricity, fuel (natural gas), water, detergent and rinsing agent costs. In addition, repair and maintenance costs over the lifetime were included as 44 % of the purchase price. The main contribution to the costs per machine (on a yearly basis) is the costs for electricity (44 %), followed by the detergent costs and the product price (19 %) (**Figure 7-20**).

Thus, each time a consumer makes a buying decision, the decision is not just on a purchase price of € 5,659, but on the total Life Cycle Costs (LCC) of the product – including running costs (electricity, natural gas for heating, water, detergent and rinsing agent costs) discounted to their net present value – which is on average € 2,738 per year.

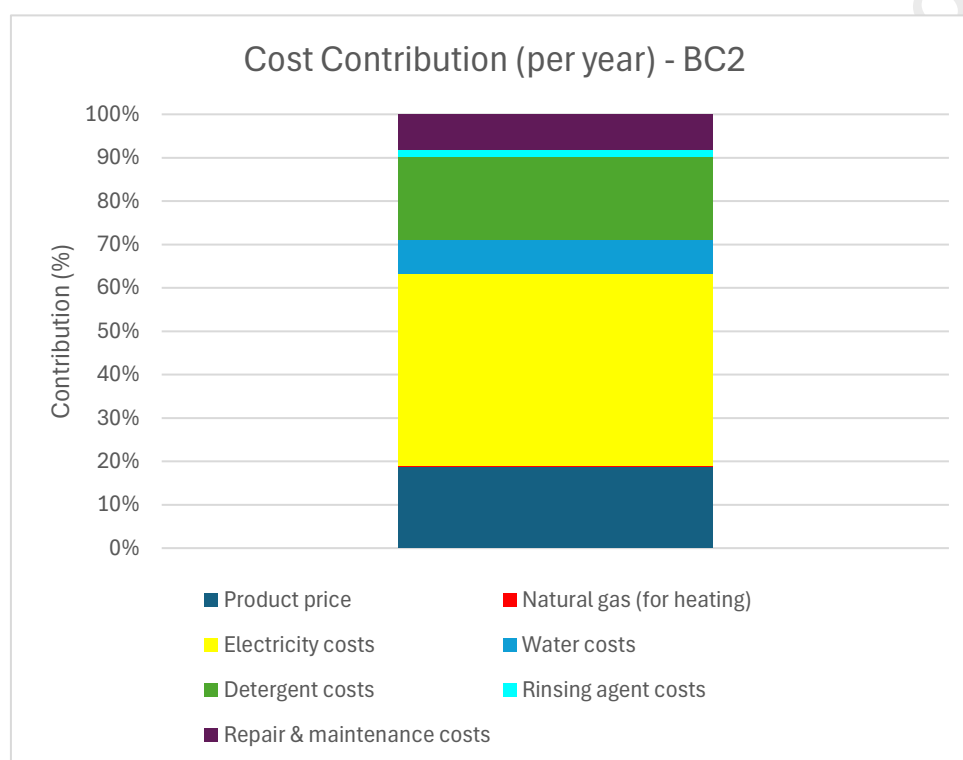


Figure 7-20: Cost contribution (per year), BC2.

7.7.3. BC3: Hood-type dishwashers

The life cycle costs of the hood-type dishwasher were calculated with the inputs of product price, electricity, fuel, water, detergent and rinsing agent costs. In addition, repair and maintenance costs over the lifetime were included as 44 % of the purchase price. The main contribution to the costs per machine (on a yearly basis) is the costs for electricity (51 %), followed by the detergent costs (19 %) and product price (17 %) (**Figure 7-21**).

Thus, each time a consumer makes a buying decision, the decision is not just on a purchase price of € 8,662, but on the total Life Cycle Costs (LCC) of the product – including running costs (electricity, natural gas for heating, water, detergent and rinsing agent costs) discounted to their net present value – which is on average € 5,007 per year.

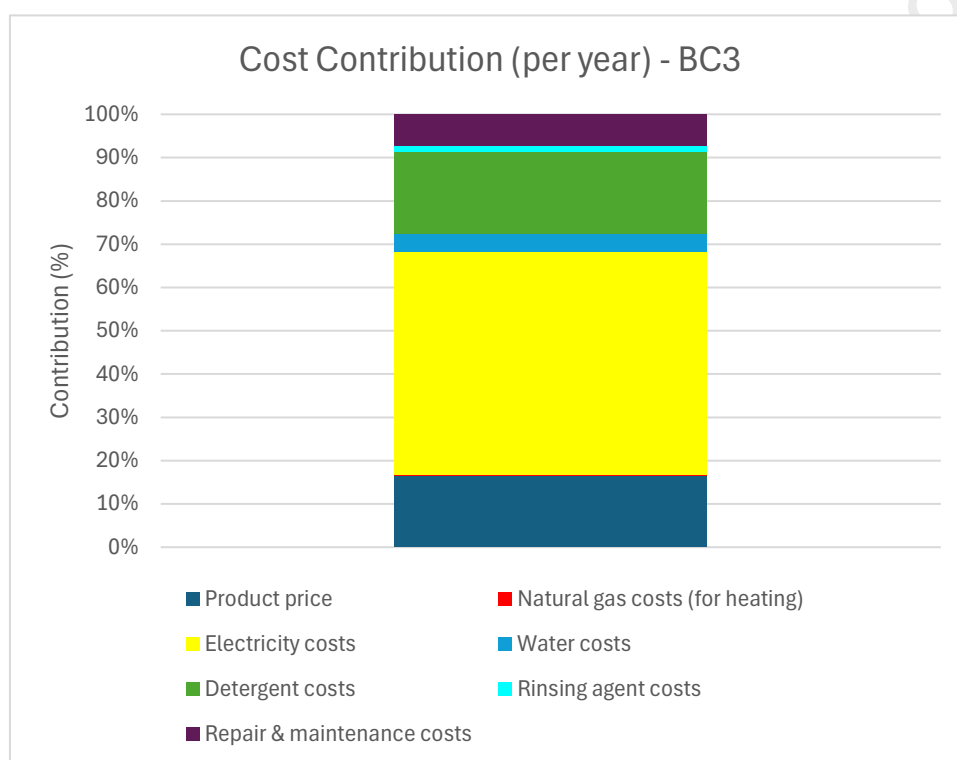


Figure 7-21: Cost contribution (per year), BC3.

7.7.4. BC4: Utensil pot dishwasher

The life cycle costs of the utensil/pot dishwasher were calculated with the inputs of product price, electricity, fuel (natural gas), water, detergent and rinsing agent costs. In addition, repair and maintenance costs over lifetime were included as 44 % of the purchase price. The main contribution to the costs per machine (on a yearly basis) is the costs for electricity (46 %), followed by the detergent costs (21 %) and product price (20 %) (**Figure 7-22**).

Thus, each time a consumer makes a buying decision, the decision is not just on a purchase price of € 10,855, but on the total Life Cycle Costs (LCC) of the product – including running costs (electricity, natural gas for heating, water, detergent and rinsing agent costs) discounted to their net present value – which is on average € 4,450 per year.

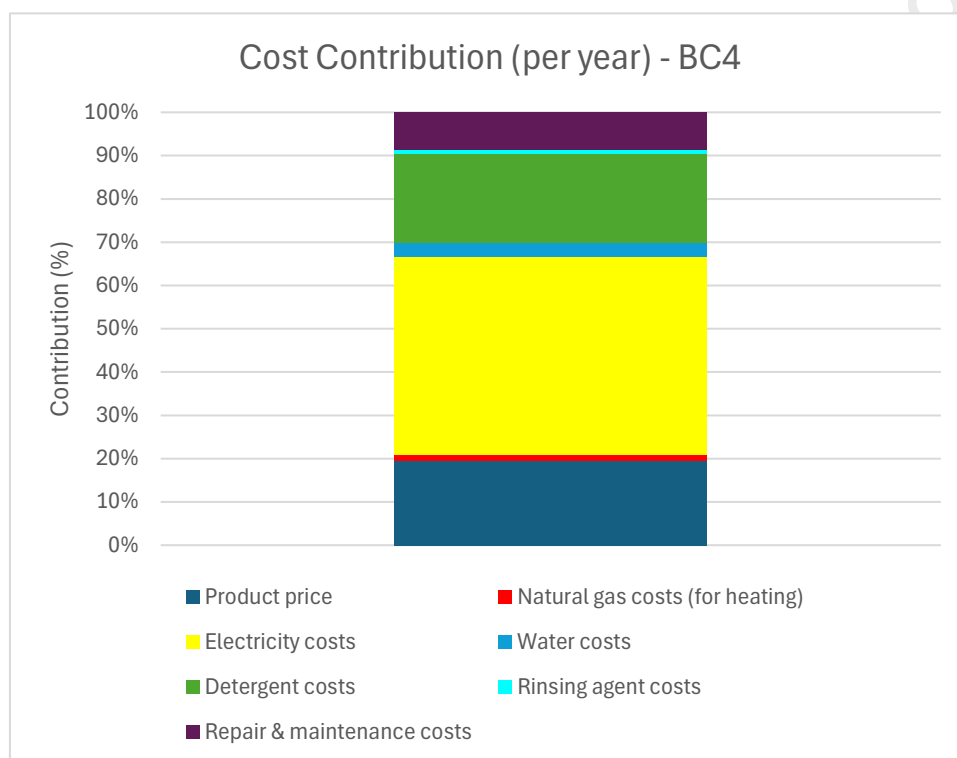


Figure 7-22: Cost contribution (per year), BC4.

7.7.5. BC5: One-tank conveyor-type dishwasher

The life cycle costs of the one-tank conveyor-type dishwasher were calculated with the inputs of product price, electricity, fuel (natural gas), water, detergent and rinsing agent costs. In addition, repair and maintenance costs over lifetime were included as 44 % of the purchase price. The main contribution to the costs per machine (on a yearly basis) is the costs for electricity (66 %), followed by the detergent (21 %) (**Figure 7-23**).

Thus, each time a consumer makes a buying decision, the decision is not just on a purchase price of € 13,394, but on the total Life Cycle Costs (LCC) of the product - including running costs (electricity, natural gas for water heating, water, detergent and rinsing agent costs) discounted to their net present value – which is on average € 33,668 per year.

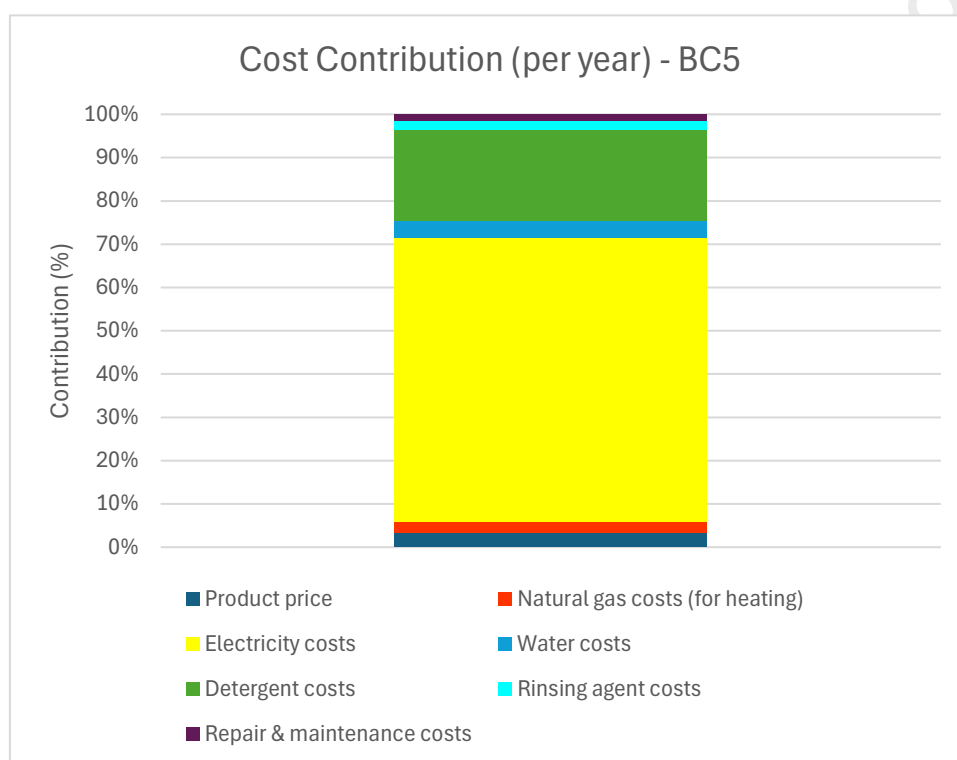


Figure 7-23: Cost contribution (per year), BC5.

7.7.6. BC6: Multi-tank conveyor-type dishwasher

The life cycle costs of the multi-tank conveyor-type dishwasher were calculated with the inputs of product price, electricity, fuel (natural gas), water, detergent and rinsing agent costs. In addition, repair and maintenance costs over lifetime were included as 44 % of the purchase price. The main contribution to the costs per machine (on a yearly basis) is the costs for electricity (70 %), followed by the detergent (17 %) (**Figure 7-24**).

Thus, each time a consumer makes a buying decision, the decision is not just on a purchase price of € 22,867, but on the total Life Cycle Costs (LCC) of the product - including running costs (electricity, natural gas for water heating, water, detergent and rinsing agent costs) discounted to their net present value – which is on average € 58,303 per year.

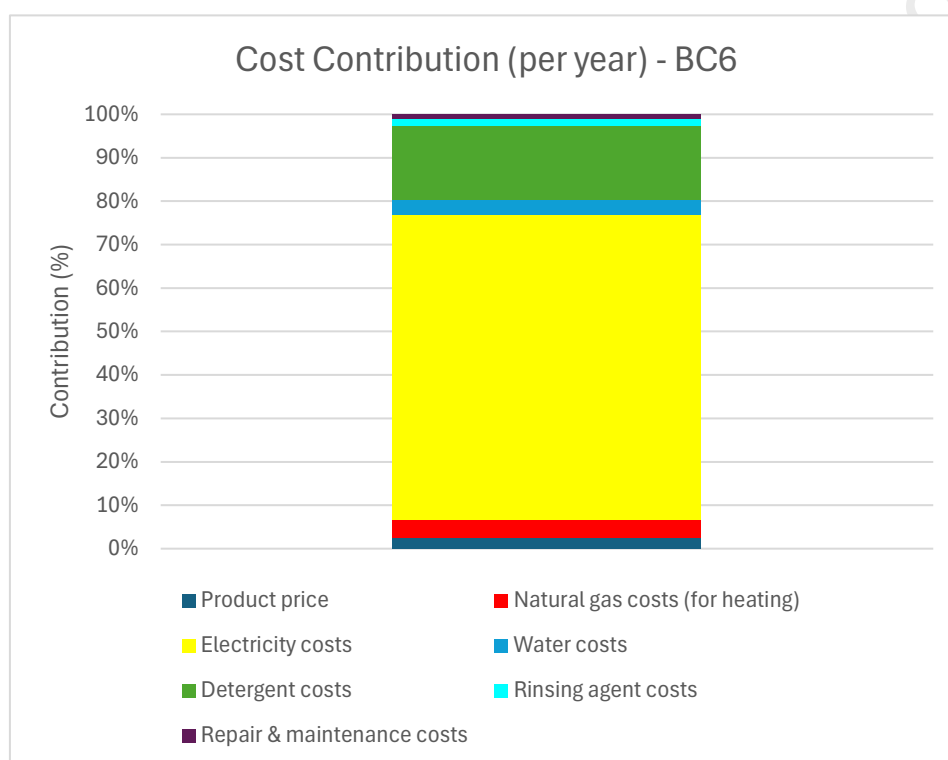


Figure 7-24: Cost contribution (per year), BC6.

7.8. EU Totals

In this section, the environmental and costs impacts on EU total level are presented. For this, the per product impact are multiplied by the annual sales or the number of units in stock in the EU (**Table 7-19**) to obtain the impact of all new products of the Base Case in the reference year in the EU and the impact of the total stock of the Base Case. The annual sales numbers are taken from **Table 4-9**. The number of units in stock is calculated by the ERT using the unit sales for the last 30 years. Due to lack of sales data for the years 1993 to 2007, an average number of sales between years 2008 to 2023 has been assumed. All data on EU level per Base Case are provided in the **Appendix 11.5**, with a summary in the sections below.

Table 7-19: Total EU stock numbers (as calculated in the ERT) and latest annual sales for all Base Cases.

Base Case	Unit	EU Stock	Latest annual sales
BC1	mln. Units	0.078	0.008
BC2	mln. Units	1.191	0.179
BC3	mln. Units	0.440	0.066
BC4	mln. Units	0.101	0.014
BC5	mln. Units	0.048	0.006
BC6	mln. Units	0.031	0.003

7.8.1. Life cycle assessment (LCA)

As summary table, **Table 7-20** provides a comparison between all Base Cases in their environmental impact (expressed with the PEF impact categories) and the energy consumption of the EU stock. From the table, it can be observed that BC6 and BC2 have the highest energy consumption and environmental impacts at the EU level. BC6's results are mainly due to its higher energy consumption and greater use of raw materials compared to the other BCs. In contrast, BC2's significant impact is largely driven by its high annual sales, which result in substantial stock accumulation. Specifically, BC6 has the highest impact at the EU level in terms of energy consumption and certain impact categories such as 'Climate change'. BC2 shows the highest impact in seven impact categories, including 'Ozone depletion' and 'Land use'.

Table 7-20: Summary environmental impacts EU stock.

Main life cycle indicators	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Energy consumption							
Electricity	kWh	1.66E+09	6.64E+10	4.95E+10	1.08E+10	5.23E+10	8.71E+10
Thermal energy	MJ	0.00E+00	3.06E+09	3.78E+09	3.69E+09	2.29E+10	5.82E+10

Main life cycle indicators	Unit	BC1	BC2	BC3	BC4	BC5	BC6
PEF Impact categories							
Climate change, total	kg CO ₂ eq	7.82E+08	3.16E+10	2.28E+10	5.22E+09	2.48E+10	4.17E+10
Ozone depletion	kg CFC-11 eq	1.16E+00	5.22E+01	2.82E+01	6.54E+00	2.63E+01	3.69E+01
Human toxicity, cancer	CTUh	4.59E-01	2.95E+01	2.02E+01	5.80E+00	1.52E+01	1.91E+01
Human toxicity, non-cancer	CTUh	6.36E+00	2.49E+02	1.36E+02	3.02E+01	1.27E+02	1.92E+02
Particulate matter	disease incidence	2.92E+01	1.23E+03	8.57E+02	1.96E+02	8.69E+02	1.38E+03
Ionising radiation, human health	kBq U235 eq	3.05E+08	1.22E+10	9.00E+09	1.98E+09	9.50E+09	1.58E+10
Photochemical ozone formation, human health	kg NMVOC eq	1.43E+06	5.88E+07	4.11E+07	9.32E+06	4.26E+07	6.90E+07
Acidification	mol H ⁺ eq	2.54E+06	1.05E+08	7.50E+07	1.70E+07	7.71E+07	1.25E+08
Eutrophication, terrestrial	mol N eq	5.29E+06	2.21E+08	1.56E+08	3.54E+07	1.61E+08	2.58E+08
Eutrophication, freshwater	kg P eq	1.13E+04	5.00E+05	2.49E+05	5.78E+04	2.32E+05	3.24E+05
Eutrophication, marine	kg N eq	5.67E+05	2.45E+07	1.67E+07	3.83E+06	1.70E+07	2.68E+07
Ecotoxicity, freshwater	CTUe	4.21E+09	1.76E+11	1.20E+11	2.71E+10	1.23E+11	1.96E+11
Land use	pt	3.14E+03	1.19E+05	7.06E+04	1.97E+04	5.79E+04	6.94E+04
Water use	m ³ water eq. of deprived water	1.33E+10	5.35E+11	3.90E+11	8.88E+10	4.23E+11	7.12E+11
Resource use, minerals and metals	kg Sb eq	7.82E+08	3.16E+10	2.28E+10	5.22E+09	2.48E+10	4.17E+10
Resource use, fossils	MJ	1.16E+00	5.22E+01	2.82E+01	6.54E+00	2.63E+01	3.69E+01

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Table 7-21: Summary environmental impacts EU new product.

Main life cycle indicators	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Energy Consumption							
Electricity	kWh	1.76E+08	9.96E+09	7.43E+09	1.47E+09	5.96E+09	7.63E+09
Thermal energy	MJ	0.00E+00	4.59E+08	5.67E+08	5.01E+08	2.61E+09	5.10E+09
PEF Impact Categories							
Climate change, total	kg CO ₂ eq	8.26E+07	4.74E+09	3.43E+09	7.09E+08	2.82E+09	3.66E+09
Ozone depletion	kg CFC-11 eq	1.23E-01	7.84E+00	4.23E+00	8.87E-01	3.00E+00	3.23E+00
Human toxicity, cancer	CTUh	4.85E-02	4.43E+00	3.03E+00	7.87E-01	1.74E+00	1.67E+00
Human toxicity, non-cancer	CTUh	6.72E-01	3.74E+01	2.04E+01	4.09E+00	1.45E+01	1.68E+01
Particulate matter	disease incidence	3.08E+00	1.84E+02	1.29E+02	2.66E+01	9.90E+01	1.21E+02
Ionising radiation, human health	kBq U235 eq	3.22E+07	1.83E+09	1.35E+09	2.69E+08	1.08E+09	1.38E+09
Photochemical ozone formation, human health	kg NMVOC eq	1.51E+05	8.83E+06	6.18E+06	1.26E+06	4.85E+06	6.05E+06
Acidification	mol H ⁺ eq	2.68E+05	1.58E+07	1.13E+07	2.31E+06	8.78E+06	1.09E+07
Eutrophication, terrestrial	mol N eq	5.59E+05	3.32E+07	2.34E+07	4.80E+06	1.83E+07	2.26E+07
Eutrophication, freshwater	kg P eq	1.19E+03	7.50E+04	3.74E+04	7.85E+03	2.64E+04	2.84E+04
Eutrophication, marine	kg N eq	1.37E+09	6.37E+10	3.87E+10	9.76E+09	3.51E+10	3.19E+10
Ecotoxicity, freshwater	CTUe	1.02E+08	5.65E+09	2.63E+09	4.99E+08	1.83E+09	2.08E+09
Land use	pt	3.32E+02	1.78E+04	1.06E+04	2.67E+03	6.59E+03	6.08E+03
Water use	m ³ water eq. of deprived water	1.40E+09	8.03E+10	5.85E+10	1.21E+10	4.82E+10	6.24E+10
Resource use, minerals and metals	kg Sb eq	8.26E+07	4.74E+09	3.43E+09	7.09E+08	2.82E+09	3.66E+09
Resource use, fossils	MJ	1.23E-01	7.84E+00	4.23E+00	8.87E-01	3.00E+00	3.23E+00

7.8.2. Life cycle costs

Table 7-22 shows the total annual expenditure for all EU consumers (EU-27) in the purchase and operation of all Base Case products. In terms of annual expenditure, the EU-27 running costs range from 83 million Euro (BC1) to 4,912 million Euro (BC2). The purchase costs range from 26 to 1,012 million Euro per year (**Table 7-22**).

The running costs of all Base Cases are higher than their purchase costs. The results are dependent on the specific energy, water and detergent / rinsing agent consumption of each product and the costs are discounted to their net present value. Specifically, the running costs per year entail 57 to 96 % of the total annual EU-27 expenditure. On the other hand, purchase costs entail 3 to 31 % of the total annual EU-27 expenditure.

Table 7-22: Total annual expenditure in the EU-27.

Product aspect	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Purchase and installation costs							
Product price	mln. EUR/year	26	1,012	572	149	74	63
Running costs							
Electricity	mln. EUR/year	30	2,131	1,588	309	1,222	1,491
Natural gas	mln. EUR/year	0	9	11	9	48	89
Water	mln. EUR/year	7	371	130	23	76	74
Detergent	mln. EUR/year	10	919	585	138	393	365
Rinsing agent	mln. EUR/year	0	73	42	7	36	31
Repair & maintenance costs per lifetime	mln. EUR/year	10	398	224	58	28	24
Total running costs	mln. EUR/year	47	3,503	2,356	486	1,775	2,050
Total life cycle costs	mln. EUR/year	83	4,912	3,152	694	1,877	2,136

7.9. Sensitivity analysis

In this section, the sensitivity of the LCA and LCC results is checked with several sensitivity analyses, for one Base Case (Undercounter one-tank dishwasher, BC2) as this Base Case has the

5592 highest sales volume per year in the EU. Both sensitivity of results to the input data and
 5593 sensitivity of some datasets was included.

5594 7.9.1. Sensitivity analysis for BC2

5595 To determine the sensitivity of the LCA and LCC results, for one Base Case (Undercounter one-
 5596 tank dishwasher, BC2) several sensitivity analyses were performed. As the main impact of all
 5597 Base Cases is derived from the use phase followed by the raw materials, the focus of these
 5598 analyses was on these life cycle stages. In addition, sensitivity analyses for the product aspects
 5599 as indicated in Article 5 of the ESPR Regulation (EU) 2024/1781 were included as well. An
 5600 overview of the sensitivity analysis is in **Table 7-23**.

5601 **Table 7-23: Sensitivity analyses for BC2.**

Scenario #	Product aspect	Life cycle stage	Modelling change
S1	Energy reduction	Use phase	10 % less energy use (same division between electricity and heat as in original data)
S2	Water reduction	Use phase	10 % less water use
S3	Detergent reduction	Use phase	10 % less detergent + rinsing agent use
S4	Resource use and resource efficiency + Recycled content	Manufacturing + EoL	R1 at: - Polypropylene: 10 % - Stainless steel: 10 % - Electronics: 10 % - Copper: 10 % - Aluminium: 40 % (is already at 30 % default) Materials that contribute >10 % for at least 2 impact categories in Raw Materials life cycle (dishwasher components combined)
S5	Resource use and resource efficiency (Lighter product)	Manufacturing + EoL	10 % less weight for all BoM inputs and Manufacturing (except for electricity in assembly)
S6	Repairability	Maintenance and Repair	% of spare parts at 20 %

Scenario #	Product aspect	Life cycle stage	Modelling change
S7	Recyclability	EoL	R2 at: - Stainless steel: 100 % - Polypropylene: 15 % - Electronics: 65 % - Copper: 15 % - Aluminium: 100 % Materials that contribute >10 % for at least 2 impact categories to the raw materials life cycle; increase by 15 % points
S8	Costs	LCC	Increase product price and maintenance costs by 10 %
S9	Dataset stainless steel recycling	EoL	Different secondary stainless-steel dataset (2 options, with a different environmental impact)

Full overview of the results is in the **Appendix 6 – Results sensitivity analysis BC2**. A textual summary is provided below.

As the main impact of the machines is from the use phase, sensitivity of the data for energy, water, detergent and rinsing agent use were tested (Scenarios S1-S3). A 10 % reduction of each showed a maximum effect of around ~9 % reduction for climate change for energy, with lower effect on water (-0.4 %) and detergent/rinsing agent use (-0.5 %) on this impact category. For the scenario of less water use, a maximum reduction of 6.9 % was observed for the impact category 'Water use', and a maximum of 3.8 % reduction in the 'Ozone depletion' impact category for lower detergent/rinsing agent use. Thus, the sensitivity of the LCA results by the use phase input data ranges from minimal to medium depending on the impact category. With regards to the costs, the reduction was relatively significant for energy (4.4 %), primarily due to the majority of the LCC impact in this Base Case arising from electricity costs (**Figure 7-20**).

Second largest contributor to the life cycle impact was the raw materials phase. The sensitivity of the results by reducing the weight of input materials from the BoM by 10 % (Scenario S5), a total reduction for all life cycles together was at most around 6 % for 'Resource use, minerals and metals', although specifically for certain life cycles separately (raw materials, End-of-Life, maintenance and repair as well as manufacturing and assembly) variable reductions can be observed, ranging from 8 to 10 %. Thus, with regards to the use of resources / materials, correct BoM data is important in determining the environmental impacts, however the effect depends on the impact category.

Several sensitivities were conducted for product aspects that are considered within the ESPR regulation, (S4, S6, S7). The increased R1 value (recycled content, S4) of several main materials had a limited effect on several impact categories (lower impact of maximum 3 % for climate change), whereas increasing the R2 value (material share to recycling, S7) showed a large effect on 'Human toxicity, cancer' (due to increase in stainless steel recycling), whereas for e.g.

'Climate change', the effect was almost not present. The % of spare parts (S6) mainly affected the 'Land use' and 'Resource use, minerals and metals' impact categories (~10 % higher impact when 20 % of Bill of Material is included as spare parts, instead of default 1 %).

Increasing the costs of the product and maintenance costs by 10 % had a medium effect on the total costs of the product (increase of 2.8 % in total costs/year, S8). Thus, depending on the impact category, the LCA and LCC results are limited or medium sensitivity to correct input data.

For all scenarios, the effect is the same for EU total data, as these are just the product impact multiplied with the yearly annual sales volume in EU-27.

For a dataset used for the ERT, a sensitivity analysis was performed, as indicated as S9 in **Table 7-23**. For steel recycling, two datasets were available in the ERT ('126-Secondary steel slab electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel' and '128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel'). Dataset #126 was tested as sensitivity showing a high reduction for the End-of-Life stage (between 69 to 98 %) due to lower impact for recycling with this process, although on the total impact across all life cycle stages, the effect was negligible (0.3 %), thus not altering the overall results of the product impact.

In conclusion, the sensitivity analyses showed that it depends on the data point and the impact category whether the results are hardly or highly affected. In general, climate change is most sensitive for energy data, whereas 'Human toxicity, cancer' and 'Resource use, minerals and metals' are most sensitive to changes in materials, in particular stainless steel. Nevertheless, more accurate input data from more recent years would enhance the reliability of this LCA and LCC study.

7.10. Conclusions

The life cycle environmental impact and life cycle costing assessment conducted in this study, and the results interpretation, has resulted in key conclusions.

The life cycle assessment indicates that the majority of the environmental impact across Base Cases originates from the use and raw material stages. This observation highlights a direct correlation between product utility consumption and product weight with overall environmental impact, meaning the heaviest products and those with the largest nominal capacity tend to have the highest absolute impacts. However, when the impact is calculated per cleaned dish, the Base Cases with the largest nominal capacity, are among the least impactful. Despite being the heaviest, their larger capacity allows the environmental burden to be distributed over a greater number of uses, resulting in lower per-dish impacts compared to other Base Cases with smaller nominal capacities. On an EU stock level, sales volume influences stock accumulation, meaning that the products with the highest impact are those with the highest sales.

The contribution analysis identified the most impactful contributors highlighting potential opportunities for impact reduction. Specifically, in the use phase, electricity, water and detergent consumption are the largest contributors across most impact categories. Electronics

used in the production of the controller board and stainless steel are the most significant contributors to overall impact categories. Additionally, polypropylene is identified as a major contributor across various impact categories, followed by copper and aluminium.

The life cycle costing assessment has identified electricity and detergent use as the highest contributors for all Base Cases, followed by the product price. In general, it is observed that the running costs for all Base Cases surpass the initial purchase and installation costs. This trend applies also at the EU stock level, reinforcing the importance of considering operational expenses. These insights can inform the development of impact reduction design options in the following tasks.

7.11. Substances of Concern

This section of the report describes the Substances of Concern identification Task, which is a new task running parallel with the life cycle environmental impact and life cycle costing assessment. It covered a stakeholder consultation process, and the resulting assessment of information and performance requirements.

The Substances of Concern identification task, guided by ESPR Art. 2(27)'s criteria, examined stakeholder consultation input and existing EU regulations (REACH¹¹², CLP¹¹³, POP¹¹⁴, WFD/SCIP¹¹⁵, WEEE¹¹⁶, RoHS¹¹⁷) to determine which substances in Professional Dishwashers warrant additional scrutiny. The stakeholder consultation provided perspectives on the complexity of data collection, the overlap with the aforementioned regulations. During the consultation, a limited set of Substances of Very High Concern were identified which in most cases also had hazard classification(s). No substances fell under the POPs regulation. The available information did not indicate any substances negatively affect reuse and recycling that would require performance requirements to be set.

¹¹² Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

¹¹³ Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006

¹¹⁴ Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants

¹¹⁵ SCIP is the database for information on Substances of Concern in articles as such or in complex objects (Products) established under the Waste Framework Directive (WFD) 2008/98/EC

¹¹⁶ Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE)

¹¹⁷ Directive 2011/65/EU/ of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment

Nevertheless, the ESPR requires manufacturers to adhere to information requirements (Art. 7 ESPR) for all Substances of Concern present in their products, resulting in tracking obligations concerning their identity, location, concentration, safe-use instructions, and end-of-life treatment. To meet these obligations with minimal duplication and maximum alignment, the following thresholds (based on draft JRC guidance) are recommended:

- A 0.1 % w/w threshold for Substances of Very High Concern (SVHC) (Art. 2(27)(a)) and POPs (Art. 2(27)(c)) in line with REACH Art. 33(1);
- UN Globally Harmonized System (GHS) generic concentration limits (or, where absent, the lowest CLP Annex I generic concentration limits) for hazard-classed substances under Art. 2(27)(b), supplemented by the latest endocrine-disruptor and PMT/PBT criteria from the CLP amendment (Delegated regulation (EU) 2023/707); and
- A uniform 0.1 % w/w cutoff for Substance of Concern affecting circularity (Art. 2(27)(d)), pending more granular data obtained by implementing information requirements.

Because full-life-cycle Intentionally Added Substances and Non-Intentionally Added Substances data collection is time- and resource-intensive, the scope is limited to product-specific Intentionally Added Substances present in the final product, including its components and spare parts. Three implementation scenarios are proposed for implement the information requirements in this product group:

- Ambitious: covering all Art. 2(27) Substances of Concern without exemptions;
- Intermediate: covering all Art. 2(27) Substances of Concern, with case-by-case exemptions for substances based on solid justification; and
- Limited: tracking only Art. 2(27)(a–c) Substances of Concern would be tracked, but companies could justify broader exemptions for groups of substances, hazard classes or categories, etc, within the flexibilities offered by the legal text, coupled with a targeted study to identify additional Art. 2(27)(d) candidates for selected regulation through amending the delegate act.

A five-year roll-out is recommended across all scenarios to allow for supplier engagement, data gathering, and Digital Product Passport integration. An assessment of feasibility and administrative burden should be undertaken as part of the impact assessment.

Finally, performance requirements under Art. 6 of the ESPR need not be imposed at this stage: current WEEE/RoHS recycling frameworks are working satisfactorily, and stakeholder feedback has not identified any specific performance gaps. As new research or recyclability insights emerge, revisiting performance criteria should be considered. Further information can be found in **Appendix 7 – Substances of Concern**.

8. MEErP Task 6 – Economics

8.1. Objectives of Task 6 design options

8.1.1. Introduction

The purpose of Task 6 within the MEErP process is to support decision-making on product Ecodesign options by systematically identifying and evaluating design options against the established Base Cases. Through integrating environmental and economic performance metrics, we ensure that suggested policy recommendations under the new ESPR reflect both sustainability and cost-effectiveness.

An analysis of the MEErP Task 1–5 results was conducted to determine the Technical Analysis of Best Available Technologies (BAT) for the commercial dishwasher product group. This involved surveying emerging technologies, components, and processes that could deliver measurable environmental improvements. This technical review was complemented by a targeted stakeholder consultation (with manufacturers, industry representatives, and country representatives) to validate the feasibility, market readiness, and social acceptance of each proposed design option. Using this feedback, the study team selected the final set of design options.

For each selected design option, the Bill of Materials of each Base Case was revised to reflect substitute materials or redesigned components; the operational consumption data (energy, water, and auxiliary inputs) were adjusted to capture differences, and life-cycle costs (covering production, maintenance, and end-of-life treatment) were recalculated using stakeholder input for each design option per Base Case. These input parameter updates establish a consistent, transparent foundation for comparing each option against the original Base Cases.

Building on the completed LCA and LCC studies from Task 5, the study team applied the Product Environmental Footprint (PEF) single-score methodology to convert impact results into a normalised, weighted indicator. When these PEF single scores are plotted alongside their corresponding life cycle costs, a clear cost–impact assessment accounting for trade-offs and synergies can be obtained. Design options with the lowest environmental burden and the most favourable cost profiles can then be prioritised for inclusion as policy measures under the ESPR’s Ecodesign requirements in Task 7 of the MEErP.

8.1.2. Identified design options

The following describes how the relevant design options were determined based on the aforementioned survey of emerging technologies, components, and processes, complemented by a subsequent targeted stakeholder consultation.

8.1.2.1. Identification process

The identification of design options is based directly on the results of the life cycle assessment and life cycle cost analysis for commercial dishwasher appliances, which was carried out in MEeRP Task 5 (see **Section 7.10**). Following the conclusions from these analyses, the most promising potential opportunities for reducing environmental impact can be found in the use phase, with electricity demand being the largest contributor to environmental burden. Furthermore, electronics and stainless steel used in production were identified as major contributors during the manufacturing of the appliances, which can be used as a starting point for strategic optimisation.

These findings were matched with the results of the survey on standard improvement options and Best Available Technologies (BAT), as well as Best Not Yet Available Technologies (BNAT), as documented in MEeRP Task 4 (see **Sections 6.2.3 - 6.2.5**).

8.1.2.2. Selected design options

Based on the identification process described above, six design options were initially selected and subsequently subjected to a stakeholder consultation process. **Table 8-1** provides an overview of the selected design options and the corresponding descriptions. Based on the stakeholder feedback (see **Section 8.1.2.4**) a further design option (DO-07) was selected. Moreover, the analyses in MEeRP Task 6 comprised also a combination of all design options (see DO-08).

Table 8-1: Selected design options

Design option no.	Short title	Description of the design option
DO-01	Exhaust heat recovery (regenerator)	Exhaust heat recovery captures waste heat from steam or hot exhaust gases to preheat incoming water. This design option can improve energy efficiency and kitchen air quality (through steam condensation). However, the system increases resource use during manufacturing as it requires additional materials such as a heat exchanger (recuperator), piping, and insulation.
DO-02	Exhaust air heat pump	The integration of a heat pump in a commercial dishwasher reclaims heat from exhaust air to preheat water. The design option can improve energy efficiency and enhance indoor air quality by reducing steam discharge. However, the system increases resource use during manufacturing as it requires additional materials like a compressor, evaporator, condenser, and refrigerant circuit.
DO-03	Automatic programme for load and soil recognition	An automatic load and soil detection programme adjusts water, energy and detergent use based on load size and soil level. This design option can improve energy efficiency and reduce water and detergent consumption. However, the system increases resource use during manufacturing as it requires additional materials such as sensors, control units, and software integration.

Design option no.	Short title	Description of the design option
DO-04	Improved thermal insulation (double-walled design)	Improved thermal insulation through double wall design reduces heat loss by creating an insulating air gap between the inner and outer walls. This design option can improve energy efficiency and workplace comfort by minimising external heat radiation. However, the system increases the use of resources during manufacture as it requires additional materials such as stainless-steel sheets, insulation layers and sealing components.
DO-05	Further substitution of metals by polymers	Substitution of metal components with polymers (such as PP and ABS) reduces overall weight and can improve durability by providing superior chemical and corrosion resistance in harsh environments. This substitution offers environmental benefits, including a reduced carbon footprint due to the lower environmental impact of manufacturing polymer materials (compared to metals) and a potentially longer service life of the commercial dishwasher.
DO-06	Modular design and reuse of electronics	Modular design with replaceable electronic modules (e.g. control boards, power supplies) allows for targeted upgrades and repairs without replacing the entire dishwasher. This design option can reduce raw material consumption and the carbon footprint associated with manufacturing new electronics. In addition, standardised modules can simplify repairs and maintenance and potentially extend the life of the commercial dishwasher. However, initial implementation may require additional design effort and durable connectors to ensure long-term reliability.
DO-07	Energy recovery from drain water	A commercial dishwasher equipped with a drain water heat recovery system is designed to significantly reduce energy consumption by capturing thermal energy from hot wastewater. After each wash cycle, the hot drain water—often at temperatures around 60 °C—is routed through a heat exchanger, where it transfers its heat to the incoming cold freshwater supply. This process preheats the cold water (for example, from 15 °C up to approximately 40 °C) before it enters the dishwasher's internal heating system, thereby reducing the energy required to reach the necessary rinse temperature. This design option can reduce the energy needed to reach washing temperatures, thereby also cutting water heating costs.
DO-08	Combined options	This design option combines the features of all the aforementioned design options (DO-01 to DO-07).

8.1.2.3. Stakeholder consultation process

Based on the design options identified above, stakeholders were asked to provide feedback and input, particularly with regard to the following aspects:

- Applicability of the different design options, especially in relation to the six dishwasher categories.
- Combinability of design options for each dishwasher category.
- Completeness of the proposed design options.
- Data on the corresponding Bills of Materials (BoM), energy demand during the use phase as well as purchase price and initial lifetime; input was requested as relative changes to the Base Case values, which were normalised to 100 %.

8.1.2.4. Stakeholder consultation feedback

The stakeholder feedback revealed that all of the proposed design options were considered to be reasonable.

Stakeholders pointed out, however, that not all design options can be applied to each of the dishwasher categories. In the extreme case of category 1, the majority of stakeholders considered DO-04 to be the only feasible option, even though most devices are already equipped with a double-walled design. With regard to category 2, all of the design options were considered applicable, except for DO-02. In all other categories (3–6), all of the design options were regarded as applicable.

Moreover, as a result of stakeholder consultation, the study team has added another design option that covers heat recovery. This design option supplements the existing DO-01 by referring to heat recovery from drain water and is described as DO-07 in **Table 8-1**.

The detailed feedback provided by stakeholders for each of the dishwashing categories on the Bill of Materials, the energy demand during the use phase, as well as the purchase price and initial lifetime, can be found in **Section 8.2**.

8.2. Input parameters design options per Base Case

In this section, the key input parameters for all six Base Cases and their design options are presented. The Bill of Materials for each Base Case and the modifications introduced by each design option are detailed, alongside consumption data for energy, water, and other resource use, as well as the adjusted LCC inputs. These parameters serve as the basis for calculating both the environmental and life cycle cost impacts of each design option in the analyses that follow.

8.2.1. BC1: Undercounter water-change dishwasher

8.2.1.1. Bill of Materials

Below (**Table 8-2**), the Bill of Materials for BC1 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared to the reference. Only one design option (DO-04) is considered for this Base Case.

5814 Table 8-2: Changes to Bill of Material per design option for BC1.

Material	Value	Unit	Reference	Material
DO-04: Improved thermal insulation (double-walled design)				
Percentage compared to 100 % reference				
Stainless Steel	3.5	kg	100 %	528.57 %
Steel Sheet galvanised	18.5	kg	100 %	100 %
Polypropylene (PP)	10.21	kg	100 %	100 %
Polyamid (PA)	0.82	kg	100 %	100 %
Polymethylmetacrylate (PMMA)	0.01	kg	100 %	100 %
Acrylonitrile Butadiene Styrene (ABS)	1.54	kg	100 %	100 %
Polystyrene (PS)	1.05	kg	100 %	100 %
Styropor expandable polystyrene (EPS)	0.08	kg	100 %	100 %
Polybutylene Terephthalate (PBT)	0.07	kg	100 %	100 %
Polyvinylchlorid (PVC)	0.83	kg	100 %	100 %
EPDM-rubber	1.07	kg	100 %	100 %
POM	0.47	kg	100 %	100 %
PE	0.38	kg	100 %	100 %

Material	Value	Unit	Reference	Material
Plastics others	0.55	kg	100 %	100 %
Aluminium	0.56	kg	100 %	100 %
Cu wire	2.06	kg	100 %	100 %
CuZn38 cast	0.05	kg	100 %	100 %
Chrom	0.15	kg	100 %	100 %
Bitumen	5.00	kg	100 %	100 %
Cotton	0.93	kg	100 %	100 %
Electronics (control)	1.64	m2	100 %	100 %
Total product weight (original)	50.0	kg	100 %	

8.2.1.2. Consumption data

Below (**Table 8-3**), the consumption data for BC1 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared to the reference.

5819 **Table 8-3: Changes to consumption data per design option for BC1.**

Consumption data (under real-life conditions)	Value	Unit	Reference	DO-04
				Improved thermal insulation (double-walled design)
				Percentage compared to 100 % reference
Specific energy consumption (real-life)	2.86	kWh/100 dishes	100 %	85 %
Specific water consumption (real-life)	84	litres/100 dishes	100 %	100 %
Specific detergent consumption (real-life)	59	g/100 dishes	100 %	100 %
Specific rinsing agent consumption (real-life)	integrated detergent and rinse aid	g/100 dishes	100 %	100 %

5820 **8.2.1.3. Life Cycle Costing data**

5821 Below (**Table 8-4**), the lifetime and purchase price for BC1 is provided, with the original Base Case as 100 % and the changes per design option as percentage
5822 compared to the reference.

5823 **Table 8-4: Changes to LCC data per design option for BC1.**

LCC parameters	Value	Unit	Reference	DO-04
				Improved thermal insulation (double-walled design)
				Percentage compared to 100 % reference
Average expected initial lifetime	12	years	100 %	100 %
Assumed purchase price	3,148	Euro/unit	100 %	100 %

5824

5825 8.2.2. BC2: Undercounter one-tank dishwasher

5826 8.2.2.1. Bill of Materials

5827 Below (**Table 8-5**), the Bill of Materials for BC2 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared to
 5828 the reference. Design option DO-02 was excluded from the calculations.

5829 **Table 8-5: Changes to Bill of Material per design option for BC2.**

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Stainless steel	44.53	kg	100%	100 %	100 %	105 %	110 %	83 %	100 %	100 %	85 %
Polypropylene (PP)	4.73	kg	100%	107.5 %	110 %	110 %	100 %	113 %	110 %	100 %	135 %
Polyamide (PA)	0.50	kg	100%	100 %	100 %	100 %	100 %	113 %	100 %	100 %	120 %
Acrylonitrile Butadiene Styrene (ABS)	0.64	kg	100%	100 %	100 %	100 %	100 %	105 %	200 %	100 %	100 %
Pumps (copper)	2.45	kg	100%	100 %	100 %	180 %	100 %	105 %	100 %	100 %	100 %
Pumps (stack of sheets)	2.45	kg	100%	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Pumps (stainless steel wave)	2.20	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Pumps (Al)	2.20	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Aluminium	0.35	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Cable (copper)	1.20	kg	100 %	103 %	105 %	105 %	100 %	100 %	105 %	100 %	115 %
Cable sheath (PVC)	0.30	kg	100 %	100 %	100 %	105 %	100 %	100 %	105 %	100 %	100 %
Cable sheath (silicone, EPDM)	0.15	kg	100 %	100 %	100 %	105 %	100 %	100 %	105 %	100 %	100 %
Gaskets (EPDM)	2.67	kg	100 %	102.5 %	105 %	180 %	100 %	100 %	105 %	100 %	110 %
Electronics (control)	2.95	m2	100 %	102.5 %	100 %	105 %	100 %	100 %	200 %	100 %	110 %
Compressor for heat pump (Al)	0.50	kg	0 %	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Compressor for heat pump (Cu)	0.50	kg	0 %	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Compressor for heat pump (Steel)	1.00	kg	0 %	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Copper tubes	1.50	kg	0 %	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Ventilator, fan (Al)	0.40	kg	0 %	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Ventilator, fan (Cu)	0.80	kg	0 %	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Dedicated polymeric insulation	0.40	kg	0 %	0 %	0 %	0 %	100 %	0 %	0 %	0 %	100 %
Load cell sensor*	0.03	kg	0 %	0 %	0 %	0 %*	0 %	0 %	0 %	0 %	0 %*
Total product weight (original)	68.3	kg	100 %								

5830 *additional load sensor required for DO-03 and DO-08, which was included in the electronics (printed wiring board) increase for these design options.

5831 Additional material 'polymeric insulation' was modelled in the ERT with the dataset '21-Polyurethane rigid foam from methylene diisocyanate (MDI) and polyols
5832 production mix, at plant 18- 53 kg/m³'. All other additional materials are modelled with the same datasets for aluminium, steel and copper as described in Task
5833 5 for the original BoM.

5834 8.2.2.2. Consumption data

5835 Below (**Table 8-6**), the consumption data for BC2 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared
5836 to the reference.

5837

5838 **Table 8-6: Changes to consumption data per design option for BC2.**

Consumption data (under real-life conditions)	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double- walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Specific energy consumption (real- life)	2.93	kWh/100 dishes	100 %	86 %	80 %	88 %	90 %	100 %	100 %	95 %	60 %
Specific water consumption (real- life)	69	litres/100 dishes	100 %	100 %	100 %	88 %	100 %	100 %	100 %	100 %	100 %
Specific detergent consumption (real- life)	77	g/100 dishes	100 %	100 %	100 %	88 %	100 %	100 %	100 %	100 %	100 %
Specific rinsing agent consumption (real- life)	7	g/100 dishes	100 %	100 %	100 %	88 %	100 %	100 %	100 %	100 %	100 %

5839

8.2.2.3. Life Cycle Costing data

Below (**Table 8-7**), the lifetime and purchase price for BC2 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared to the reference.

Table 8-7: Changes to LCC data per design option for BC2.

LCC parameters	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Average expected initial lifetime	8	years	100%	100 %	95 %	110 %	100 %	73 %	110 %	100 %	90 %
Assumed purchase price	5,659	Euro/unit	100%	115 %	125 %	128 %	103 %	98 %	105 %	110 %	160 %

5845 8.2.3. BC3: Hood-type dishwasher

5846 8.2.3.1. Bill of Materials

5847 Below (**Table 8-8**), the Bill of materials for BC3 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared to
 5848 the reference.

5849 **Table 8-8: Changes to Bill of Material per design option for BC3.**

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference
Stainless steel	112.05	kg	100%	115 %	100 %	105 %	110 %	80 %	100 %	100 %	85 %
Polypropylene (PP)	6.81	kg	100%	107.5 %	110 %	110 %	100 %	113 %	110 %	100 %	135 %
Polyamide (PA)	1.55	kg	100%	100 %	100 %	100 %	100 %	113 %	100 %	100 %	120 %
Acrylonitrile Butadiene Styrene (ABS)	0.64	kg	100%	100 %	100 %	100 %	100 %	105 %	200 %	100 %	100 %
Pumps (copper)	3.85	kg	100%	100 %	100 %	180 %	100 %	105 %	100 %	100 %	100 %
Pumps (stack of sheets)	3.85	kg	100%	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference
Pumps (stainless steel wave)	2.96	kg	100%	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Pumps (Al)	3.85	kg	100%	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Aluminium	2.00	kg	100%	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Cable (copper)	1.38	kg	100%	103 %	105 %	105 %	100 %	100 %	105 %	100 %	115 %
Cable sheath (PVC)	0.81	kg	100%	100 %	100 %	105 %	100 %	100 %	105 %	100 %	100 %
Cable sheath (silicone, EPDM)	0.41	kg	100%	100 %	100 %	105 %	100 %	100 %	105%	100 %	100 %
Gaskets (EPDM)	3.54	kg	100%	103 %	105 %	180 %	100 %	100 %	105 %	100 %	110 %
Electronics (control)	3.79	m2	100%	105 %	100 %	105 %	100 %	100 %	200 %	100 %	110 %
Compressor for heat pump (Al)	0.50	kg	0%	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Compressor for heat pump (Cu)	0.50	kg	0%	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Compressor for heat pump (Steel)	1.00	kg	0%	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Copper tubes	2.00	kg	0%	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Ventilator, fan (Al)	0.80	kg	0%	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Ventilator, fan (Cu)	0.80	kg	0%	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference
Dedicated polymeric insulation	0.80	kg	0%	0 %	0 %	0 %	100 %	0 %	0 %	0 %	100 %
Load cell sensor*	0.03	kg	0%	0 %	0 %	0 %*	0 %	0 %	0 %	0 %	0 %*
Total product weight (original)	148.7	kg	100%	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %

5850 *additional load sensor required for DO-03 and DO-08, which was included in the electronics (printed wiring board) increase for these design options.

5851 Additional material 'polymeric insulation' was modelled in the ERT with the dataset '21-Polyurethane rigid foam from methylene diisocyanate (MDI) and polyols
 5852 production mix, at plant 18- 53 kg/m³'. All other additional materials are modelled with the same datasets for aluminium, steel and copper as described in Task
 5853 5 for the original BoM.

5854

5855 8.2.3.2. Consumption data

5856 Below (**Table 8-9**), the consumption data for BC3 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared
 5857 to the reference.

5858 **Table 8-9: Changes to consumption data per design option for BC3.**

Consumption data (under real-life conditions)	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double- walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Specific energy consumption (real- life)	2.96	kWh/100 dishes	100 %	86 %	75 %	88 %	90 %	100 %	100 %	95 %	60 %
Specific water consumption (real-life)	33	litres/100 dishes	100 %	100 %	100 %	88 %	100 %	100 %	100 %	100 %	100 %
Specific detergent consumption (real-life)	66	g/100 dishes	100 %	100 %	100 %	88 %	100 %	100 %	100 %	100 %	100 %
Specific rinsing agent consumption (real-life)	5	g/100 dishes	100 %	100 %	100 %	88 %	100 %	100 %	100 %	100 %	100 %

8.2.3.3. Life Cycle Costing data

Below (**Table 8-10**), the lifetime and purchase price for BC3 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared to the reference.

Table 8-10: Changes to LCC data per design option for BC3.

LCC parameters	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Average expected initial lifetime	8	years	100 %	100 %	98 %	110 %	100 %	73 %	110 %	100 %	90 %
Assumed purchase price	8,662	Euro/unit	100 %	118 %	163 %	128 %	103 %	98 %	105 %	110 %	160 %

5864 8.2.4. BC4: Utensil/pot dishwasher

5865 8.2.4.1. Bill of Materials

5866 Below (**Table 8-11**), the Bill of Materials for BC4 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared to
 5867 the reference.

5868 **Table 8-11: Changes to Bill of Material per design option for BC4.**

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Stainless steel	165.00	kg	100 %	115 %	100 %	105 %	110 %	80 %	100 %	100 %	85 %
Polypropylene (PP)	3.00	kg	100 %	108 %	110 %	110 %	100 %	113 %	110 %	100 %	135 %
Polyamide (PA)	4.00	kg	100 %	100 %	100 %	100 %	100 %	113 %	100 %	100 %	120 %
Ethylene Propylene Dien M-class rubber (EPDM)	4.00	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Acrylonitrile Butadiene Styrene (ABS) [#]	0.00	kg	100 %	100 %	100 %	100 %	100 %	105 %	200 %	100 %	100 %
Pumps (copper)	5.00	kg	100 %	100 %	100 %	180 %	100 %	105 %	100 %	100 %	100 %

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Pumps (stack of sheets)	4.00	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Pumps (stainless steel wave)	3.00	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Pumps (Al)	5.00	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Cable (copper)	2.40	kg	100 %	103 %	105 %	105 %	100 %	100 %	105 %	100 %	115 %
Cable sheath (PVC)	1.40	kg	100 %	100 %	100 %	105 %	100 %	100 %	105 %	100 %	100 %
Cable sheath (silicone, EPDM)	1.10	kg	100 %	100 %	100 %	105 %	100 %	100 %	105 %	100 %	100 %
Electronics (control)	1.59	m2	100 %	103 %	105 %	180 %	100 %	100 %	200 %	100 %	110 %
Gaskets, etc. (EPDM)	6.00	kg	100 %	105 %	100 %	105 %	100 %	100 %	105 %	100 %	115 %
Compressor for heat pump (Al)	0.50	kg	0 %	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Compressor for heat pump (Cu)	0.50	kg	0 %	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Compressor for heat pump (Steel)	1.00	kg	0 %	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Copper tubes	3.00	kg	0 %	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Ventilator, fan (Al)	0.80	kg	0 %	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Ventilator, fan (Cu)	0.80	kg	0 %	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Dedicated polymeric insulation	1.20	kg	0 %	0 %	0 %	0 %	100 %	0 %	0 %	0 %	100 %
Load cell sensor*	0.03	kg	0 %	0 %	0 %	0 %*	0%	0 %	0 %	0 %	0 %*
Total product weight (original)	206.00	kg	100 %	0 %	0 %	0 %	0%	0 %	0 %	0 %	0 %

5869 # Acrylonitrile Butadiene Styrene (ABS) was not included in the original Base Case Bill of materials; for the design options, this material was also not included, despite a percentage >100%.

5870 *additional load sensor required for DO-03 and DO-08, which was included in the electronics (printed wiring board) increase for these design options.

5871

5872 Additional material 'polymeric insulation' was modelled in the ERT with the dataset '21-Polyurethane rigid foam from methylene diisocyanate (MDI) and polyols
5873 production mix, at plant 18- 53 kg/m³'. All other additional materials are modelled with the same datasets for aluminium, steel and copper as described in Task
5874 5 for the original BoM.

5875

5876 8.2.4.2. Consumption data

5877 Below (**Table 8-12**), the consumption data for BC4 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared
 5878 to the reference.

5879 **Table 8-12: Changes to consumption data per design option for BC4.**

Consumption data (under real-life conditions)	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Specific energy consumption (real-life)	1.35	kWh/cycle	100 %	86 %	75 %	88 %	90 %	100 %	100 %	95 %	60 %
Specific water consumption (real-life)	13	litres/cycle	100 %	100 %	100 %	88 %	100 %	100 %	100 %	100 %	100 %
Specific detergent consumption (real-life)	36	g/cycle	100 %	100 %	100 %	88 %	100 %	100 %	100 %	100 %	100 %
Specific rinsing agent consumption (real-life)	2	g/cycle	100 %	100 %	100 %	88 %	100 %	100 %	100 %	100 %	100 %

8.2.4.3. Life Cycle Costing data

Below (**Table 8-13**), the lifetime and purchase price for BC4 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared to the reference.

Table 8-13: Changes to LCC data per design option for BC4.

LCC parameters	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Average expected initial lifetime	9	years	100 %	100 %	98 %	110 %	100 %	73 %	110 %	100 %	90 %
Assumed purchase price	10,855	Euro/unit	100 %	117 %	175 %	128 %	103 %	98 %	105 %	110 %	160 %

5885 8.2.5. BC5: One-tank conveyor-type dishwasher

5886 8.2.5.1. Bill of Materials

5887 Below (**Table 8-14**), the Bill of Materials for BC5 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared to
 5888 the reference.

5889 **Table 8-14: Changes to Bill of Material per design option for BC5.**

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Stainless steel	642.25	kg	100 %	110 %	115 %	105 %	110 %	80 %	100 %	100 %	95 %
Polypropylene (PP)	55.50	kg	100 %	105 %	105 %	110 %	100 %	113 %	110 %	100 %	115 %
Polyamide (PA)	6.14	kg	100 %	100 %	100 %	100 %	100 %	113 %	100 %	100 %	120 %
Polyvinyl chloride (PVC)	4.60	kg	100 %	100 %	100 %	100 %	100 %	105 %	100 %	100 %	100 %

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Polystyrene (PS)	4.43	kg	100 %	100 %	100 %	100 %	100 %	105 %	100 %	100 %	100 %
Acrylonitrile Butadiene Styrene (ABS)	5.00	kg	100 %	100 %	100 %	180 %	100 %	105 %	200 %	100 %	100 %
Pumps (copper)	16.83	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Pumps (stack of sheets)	15.63	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Pumps (stainless steel wave)	12.34	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Pumps (Al)	17.47	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Condenser (AL)	4.72	kg	100 %	100 %	100 %	120 %	100 %	100 %	100 %	100 %	100 %
Condenser (Cu)	7.08	kg	100 %	100 %	100 %	120 %	100 %	100 %	100 %	100 %	100 %
Ventilator, fan (AL)	17.44	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Ventilator, fan (Cu)	10.16	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Drive motor (AL)	4.00	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Drive motor (Cu)	5.00	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Cable (copper)	16.30	kg	100 %	100 %	100 %	105 %	100 %	100 %	105 %	100 %	105 %
Cable sheath (PVC)	8.64	kg	100 %	100 %	100 %	105 %	100 %	100 %	105 %	100 %	100 %
Cable sheath (silicone, EPDM)	5.17	kg	100 %	100 %	100 %	105 %	100 %	100 %	105 %	100 %	100 %
Electric contactor (copper)	10.00	kg	100 %	105 %	105 %	105 %	100 %	100 %	150 %	100 %	105 %
Gaskets (EPDM)	12.80	kg	100 %	105 %	105 %	105 %	100 %	100 %	105 %	100 %	100 %
Electronics (control)	7.42	m2	100 %	100 %	100 %	180 %	100 %	100 %	200 %	100 %	110 %
Compressor for heat pump (Al)	0.50	kg	0 %	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Compressor for heat pump (Cu)	1.00	kg	0 %	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Compressor for heat pump (Steel)	4.00	kg	0 %	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Copper tubes	3.00	kg	0 %	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Evaporator (AL)	4.72	kg	0 %	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Evaporator (Cu)	7.08	kg	0 %	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Dedicated polymeric insulation	3.00	kg	0 %	0 %	0 %	0 %	100 %	0 %	0 %	0 %	100 %
Total product weight (original)	891.3	kg	100 %								

5890

5891 Additional material 'polymeric insulation' was modelled in the ERT with the dataset '21-Polyurethane rigid foam from methylene diisocyanate (MDI) and polyols
5892 production mix, at plant 18- 53 kg/m³'. All other additional materials are modelled with the same datasets for aluminium, steel and copper as described in Task
5893 5 for the original BoM.

5894 8.2.5.2. Consumption data

5895 Below (**Table 8-15**), the consumption data for BC5 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared
 5896 to the reference.

5897 **Table 8-15: Changes to consumption data per design option for BC5.**

Consumption data (under real-life conditions)	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference
Specific energy consumption (real-life)	2.88	kWh/cycle	100 %	85 %	80 %	88 %	90 %	100 %	100 %	90 %	45 %
Specific water consumption (real-life)	22	litres/cycle	100 %	100 %	100 %	88 %	100 %	100 %	100 %	100 %	100 %
Specific detergent consumption (real-life)	51	g/cycle	100 %	100 %	100 %	88 %	100 %	100 %	100 %	100 %	100 %
Specific rinsing agent consumption (real-life)	5	g/cycle	100 %	100 %	100 %	88 %	100 %	100 %	100 %	100 %	100 %

5898 8.2.5.3. Life Cycle Costing data

5899 Below (**Table 8-16**), the life time and purchase price for BC5 is provided, with the original Base Case as 100 % and the changes per design option as percentage
 5900 compared to the reference.

5901 **Table 8-16: Changes to LCC data per design option for BC5.**

LCC parameters	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference
Average expected initial lifetime	11	years	100 %	100%	98 %	110 %	100 %	73 %	110 %	100 %	90 %
Assumed purchase price	13,394	Euro/unit	100 %	117%	138 %	150 %	105 %	98 %	108 %	115 %	175 %

5902

5903 8.2.6. BC6: Multi-tank conveyor-type dishwasher

5904 8.2.6.1. Bill of Materials

5905 Below (**Table 8-17**), the Bill of Materials for BC6 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared to
 5906 the reference.

5907 **Table 8-17: Changes to Bill of Material per design option for BC6.**

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Stainless steel	980.00	kg	100 %	110 %	115 %	105 %	110 %	80 %	100 %	100 %	95 %
Polypropylene (PP)	58.00	kg	100 %	105 %	105 %	110 %	100 %	113 %	110 %	100 %	115 %
Polyamide (PA)	18.66	kg	100 %	100 %	100 %	100 %	100 %	113 %	100 %	100 %	120 %
Ethylene Propylene Dien M-class rubber (EPDM)	12.00	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Acrylonitrile Butadiene Styrene (ABS)*	0.00	kg	100 %	100 %	100 %	180 %	100 %	105 %	200 %	100 %	100 %
Pumps (copper)	39.02	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Pumps (stack of sheets)	37.07	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Pumps (stainless steel wave)	25.37	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Pumps (Al)	44.88	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Condenser (AL)	4.72	kg	100 %	100 %	100 %	120 %	100 %	100 %	100 %	100 %	100 %
Condenser (Cu)	7.08	kg	100 %	100 %	100 %	120 %	100 %	100 %	100 %	100 %	100 %
Ventilator, fan (AL)	17.44	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Ventilator, fan (Cu)	10.16	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Drive motor (AL)	4.00	kg	100 %	100 %	100 %	100 %	100 %	100 %	103 %	100 %	105 %
Drive motor (Cu)	5.00	kg	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
Cable (copper)	19.80	kg	100 %	100 %	100 %	105 %	100 %	100 %	113 %	100 %	120 %
Cable sheath (PVC)	11.44	kg	100 %	100 %	103 %	105 %	100 %	100 %	105 %	100 %	105 %
Cable sheath (silicone, EPDM)	8.36	kg	100 %	100 %	100 %	105 %	100 %	100 %	108 %	100 %	110 %
Electric contactor (copper)	10.00	kg	100 %	105 %	105 %	105 %	100 %	100 %	150 %	100 %	100 %
Gaskets, etc. (EPDM)	15.00	kg	100 %	105 %	105 %	105 %	100 %	100 %	105 %	100 %	100 %

Material	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Electronics (control)	11.67	m2	100 %	100 %	100 %	180 %	100 %	100 %	200 %	100 %	120 %
compressor for heat pump (Al)	0.50	kg	0 %	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
compressor for heat pump (Cu)	1.00	kg	0 %	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
compressor for heat pump (Steel)	4.00	kg	0 %	0 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
copper tubes	3.00	kg	0 %	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Evaporator (AL)	4.72	kg	0 %	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Evaporator (Cu)	7.08	kg	0 %	100 %	100 %	0 %	0 %	0 %	0 %	0 %	100 %
Dedicated polymeric insulation	3.00	kg	0 %	0 %	0 %	0 %	100 %	0 %	0 %	0 %	100 %
Total product weight (original)	1343.4	kg	100 %								

* Acrylonitrile Butadiene Styrene (ABS) was not included in the original Base Case Bill of materials; for the Design options, this material was also not included, despite a percentage >100 %.

5910 Additional material 'polymeric insulation' was modelled in the ERT with the dataset '21-Polyurethane rigid foam from methylene diisocyanate (MDI) and polyols
5911 production mix, at plant 18- 53 kg/m³'. All other additional materials are modelled with the same datasets for aluminium, steel and copper as described in Task
5912 5 for the original BoM.

5913 8.2.6.2. Consumption data

5914 Below (**Table 8-18**), the consumption data for BC6 is provided, with the original Base Case as 100 % and the changes per design option as percentage compared
5915 to the reference.

5916 **Table 8-18: Changes to consumption data per design option for BC6.**

Consumption data (under real-life conditions)	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double- walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference	Percentage compared to 100 % reference
Specific energy consumption (real- life)	2.86	kWh/100 dishes	100 %	85 %	77 %	88 %	88 %	100 %	100 %	90 %	40 %
Specific water consumption (real- life)	16	litres/100 dishes	100 %	100 %	100 %	88 %	100 %	100 %	100 %	100 %	100 %
Specific detergent consumption (real- life)	36	g/100 dishes	100 %	100 %	100 %	88 %	100 %	100 %	100 %	100 %	100 %

Specific rinsing agent consumption (real-life)	3	g/100 dishes	100%	100%	100%	88 %	100 %	100 %	100 %	100 %	100 %

5917 8.2.6.3. Life Cycle Costing data

5918 Below (**Table 8-19**), the lifetime and purchase price for BC6 is provided, with the original Base Case as 100 % and the changes per design option as percentage
5919 compared to the reference.

5920 **Table 8-19: Changes to LCC data per design option for BC6.**

LCC parameters	Value	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
				Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
				Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference	Percentage compared to 100% reference
Average expected initial lifetime	15	years	100 %	100 %	98 %	110 %	100 %	73 %	110 %	100 %	90 %
Assumed purchase price	22,867	Euro/unit	100 %	115 %	138 %	150 %	103 %	95 %	108 %	115 %	175 %

5921

8.3. Environmental & Life cycle costing impact of design options per Base Case

This section covers the calculated environmental benefits and impacts of the previously identified design options (and their combination into DO-08) for each Base Case. All relevant changes to input parameters per option are examined using the EcoReport tool to assess how each option affects the output values across all PEF impact categories. Additionally, the Life Cycle Costing changes for each design option are considered. The quantification will include all LCC cost categories in the tool: product price, natural gas (for heat), electricity, water, detergent and rinsing agent cost, as well as costs for repair & maintenance. By comparing the results for the design options against the previously calculated results in Task 5, the environmental impact and costs of each option can be assessed. This comparison will help to identify trade-offs that should be considered moving forward with each design option.

8.3.1. BC1: Undercounter water-change dishwasher

8.3.1.1. Environmental impact

Below (**Table 8-20**), the resource use as well as the environmental impact of the original Base Case (reference) and the design option are provided.

Table 8-20: Consumption data and environmental impact per design option compared to BC1.

Consumption	Unit	Reference	DO-04
Total energy consumption	kWh	18128	15423
	% difference	0 %	-15 %
Water (use phase)	m ³	528	528
	% difference	0 %	0 %
Detergent (use phase)	kg	370	370
	% difference	0 %	0 %
Rinsing agent (use phase)	kg	0	0
	% difference	0 %	0 %
PEF Impact categories	Unit	Reference	DO-01
Climate change, total	kg CO ₂ eq.	8.74E+03	7.61E+03
	% difference	0 %	-13 %
Ozone depletion	kg CFC-11 eq.	1.44E-05	1.40E-05
	% difference	0 %	-2.9 %
Human toxicity, cancer	CTUh	9.07E-06	8.88E-06

	% difference	0 %	-2.1 %
Human toxicity, non-cancer	CTUh	7.75E-05	7.37E-05
	% difference	0 %	-4.9 %
Particulate matter	disease incidence	3.39E-04	3.03E-04
	% difference	0 %	-10.7 %
Ionising radiation, human health	kBq U235 eq.	3.34E+03	2.86E+03
	% difference	0 %	-14.4 %
Photochemical ozone formation, human health	kg NMVOC eq.	1.63E+01	1.45E+01
	% difference	0 %	-11.4 %
Acidification	mol H+ eq.	2.90E+01	2.55E+01
	% difference	0 %	-11.9 %
Eutrophication, terrestrial	mol N eq.	6.01E+01	5.31E+01
	% difference	0 %	-11.5 %
Eutrophication, freshwater	kg P eq.	1.42E-01	1.40E-01
	% difference	0 %	-1.6 %
Eutrophication, marine	kg N eq.	6.53E+00	5.87E+00
	% difference	0 %	-10 %
Ecotoxicity, freshwater	CTUe	4.81E+04	4.30E+04
	% difference	0 %	-10.7 %
Land use	pt	1.60E+05	1.56E+05
	% difference	0 %	-3 %
Water use	m3 water eq. of deprived water	1.19E+04	1.15E+04
	% difference	0 %	-3.3 %
Resource use, minerals and metals	kg Sb eq.	4.38E-02	4.35E-02
	% difference	0 %	-0.7 %
Resource use, fossils	MJ	1.48E+05	1.28E+05
	% difference	0 %	-13.4 %

5939 8.3.1.2. LCC impact

5940 Below (**Table 8-21**), the Life Cycle Costs of the original Base Case (reference) and all design
5941 options are provided.

5942

5943 **Table 8-21: Life Cycle Costing impact per design option compared to BC1.**

Cost category	Unit	Reference	DO-04
Product price	EUR	3,148	3,148
	% difference	0 %	0 %
Natural gas (for heat)	EUR/year	0	0
	% difference	0 %	0 %
Electricity	EUR/year	348	296
	% difference	0 %	-14.9 %
Water	EUR/year	76	76
	% difference	0 %	0 %
Auxiliary material 1 (Detergent)	EUR/year	117	117
	% difference	0 %	0 %
Auxiliary material 2 (Rinsing agent)	EUR/year	0	0
	% difference	0 %	0 %
Repair & maintenance costs	EUR	115	115
	% difference	0 %	0 %
Total	EUR/year	918	866
	% difference	0 %	-5.7 %

5944 **8.3.2. BC2: Undercounter one-tank dishwasher**5945 **8.3.2.1. Environmental impact**

5946 Below (**Table 8-22**), the resource use as well as the environmental impact of the original Base
5947 Case (reference) and all design options are provided.

5948 **Table 8-22: Consumption data and environmental impact per design option compared to BC2.**

Consumption	Unit	Reference	DO-01	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Total energy consumption	kWh	56,447	48,831	54,477	50,921	41,439	62,143	53,709	56,274
	% difference	0 %	-13.5 %	-3.5 %	-9.8 %	-26.6 %	10.1 %	-4.9 %	0 %
Water (use phase)	m ³	1,305	1,305	1,256	1,305	957	1,436	1,305	1,305
	% difference	0 %	0.0 %	-3.7 %	0.0 %	-26.7 %	10.0 %	0.0 %	0 %
Detergent (use phase)	kg	1,464	1,464	1,409	1,464	1,073	1,610	1,464	1,464
	% difference	0 %	0.0 %	-3.7 %	0.0 %	-26.7 %	10.0 %	0.0 %	0 %
Rinsing agent (use phase)	kg	125	125	120	125	92	137	125	125
	% difference	0 %	0.0 %	-3.8 %	0.0 %	-26.7 %	10.0 %	0.0 %	0 %
PEF Impact categories	Unit	Reference	DO-01	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Climate change, total	kg CO ₂ eq.	2.65E+04	2.34E+04	2.57E+04	2.42E+04	1.96E+04	2.95E+04	2.54E+04	1.56E+04
	% difference	0 %	-11.92 %	-3.31 %	-8.65 %	-26.03 %	11.35 %	-4.32 %	-41.20 %
Ozone depletion	kg CFC-11 eq.	4.39E-05	4.27E-05	4.23E-05	4.50E-05	3.22E-05	4.83E-05	4.35E-05	3.84E-05
	% difference	0 %	-2.61 %	-3.68 %	2.60 %	-26.51 %	10.13 %	-0.97 %	-12.41 %
Human toxicity, cancer	CTUh	2.48E-05	2.43E-05	2.48E-05	2.54E-05	1.95E-05	2.63E-05	2.46E-05	2.06E-05
	% difference	0 %	-2.00 %	0.15 %	2.54 %	-21.55 %	6.05 %	-16.95 %	-16.95 %
Human toxicity, non-cancer	CTUh	2.09E-04	2.01E-04	2.05E-04	2.02E-04	1.58E-04	2.40E-04	2.06E-04	1.65E-04
	% difference	0 %	-4.03 %	-2.33 %	-3.61 %	-24.71 %	14.42 %	-1.83 %	-21.05 %
Particulate matter	disease incidence	1.03E-03	9.32E-04	9.99E-04	9.59E-04	7.67E-04	1.15E-03	9.93E-04	6.69E-04
	% difference	0 %	-9.49 %	-2.99 %	-6.91 %	-25.53 %	11.76 %	-3.55 %	-35.07 %
	kBq U235 eq.	1.02E+04	8.89E+03	9.87E+03	9.26E+03	7.53E+03	1.13E+04	9.76E+03	5.66E+03

Ionising radiation, human health	% difference	0 %	-13.22 %	-3.62 %	-9.58 %	-26.52 %	10.19 %	-4.76 %	-44.75 %
Photochemical ozone formation, human health	kg NMVOC eq.	4.94E+01	4.42E+01	4.78E+01	4.56E+01	3.66E+01	5.52E+01	4.75E+01	3.10E+01
	% difference	0 %	-10.41 %	-3.26 %	-7.57 %	-25.80 %	11.75 %	-3.80 %	-37.20 %
Acidification	mol H+ eq.	8.83E+01	7.88E+01	8.55E+01	8.14E+01	6.56E+01	9.86E+01	8.48E+01	5.45E+01
	% difference	0 %	-10.81 %	-3.20 %	-7.78 %	-25.72 %	11.68 %	-3.95 %	-38.33 %
Eutrophication, terrestrial	mol N eq.	1.85E+02	1.66E+02	1.79E+02	1.72E+02	1.38E+02	2.07E+02	1.78E+02	1.17E+02
	% difference	0 %	-10.34 %	-3.30 %	-7.54 %	-25.86 %	11.67 %	-3.78 %	-37.08 %
Eutrophication, freshwater	kg P eq.	4.20E-01	4.14E-01	4.05E-01	4.15E-01	3.10E-01	4.66E-01	4.17E-01	3.62E-01
	% difference	0 %	-1.38 %	-3.55 %	-1.10 %	-26.22 %	11.02 %	-0.56 %	-13.69 %
Eutrophication, marine	kg N eq.	2.06E+01	1.88E+01	1.99E+01	1.93E+01	1.53E+01	2.30E+01	1.99E+01	1.38E+01
	% difference	0 %	-8.74 %	-3.37 %	-6.39 %	-25.97 %	11.45 %	-3.21 %	-32.97 %
Ecotoxicity, freshwater	CTUe	1.47E+05	1.33E+05	1.43E+05	1.37E+05	1.09E+05	1.64E+05	1.42E+05	9.55E+04
	% difference	0 %	-9.55 %	-3.26 %	-7.07 %	-26.01 %	10.87 %	-3.54 %	-35.23 %
Land use	pt	3.56E+05	4.74E+05	4.64E+05	3.46E+05	3.23E+05	3.71E+05	3.51E+05	4.73E+05
	% difference	0 %	33.06 %	30.40 %	-2.83 %	-9.18 %	4.26 %	-1.43 %	32.83 %
Water use	m3 water eq. of deprived water	3.16E+04	3.05E+04	3.05E+04	3.08E+04	5.00E+00	3.49E+04	3.12E+04	2.56E+04
	% difference	0 %	-3.35 %	-3.62 %	-2.48 %	-26.48 %	10.34 %	-1.24 %	-18.88 %
Resource use, minerals and metals	kg Sb eq.	9.96E-02	1.12E-01	1.11E-01	1.00E-01	8.85E-02	1.34E-01	9.94E-02	1.11E-01
	% difference	0 %	12.83 %	11.87 %	0.62 %	-11.16 %	34.21 %	-0.26 %	11.88 %
Resource use, fossils	MJ	4.49E+05	3.94E+05	4.34E+05	4.09E+05	3.32E+05	4.98E+05	4.29E+05	2.60E+05
	% difference	0 %	-12.28 %	-3.37 %	-8.90 %	-26.17 %	10.95 %	-4.44 %	-42.16 %

5949 8.3.2.2. LCC impact

5950 Below (Table 8-23), the Life Cycle Costs of the original Base Case (reference) and all design options are provided.

5951 Table 8-23: Life Cycle Costing impact per design option compared to BC2.

Cost category	Unit	Reference	DO-01	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Product price	EUR	5,659	6,507	7,215	5,847	5,517	5,941	6,224	9,054
	% difference / year	0 %	15.0 %	15.90 %	3.32 %	32.94 %	-4.6 %	10.0 %	77.8 %
Natural gas (for heat)	EUR/year	6.9	6.9	6.8	6.9	7.0	6.8	6.9	6.9
	% difference	0 %	0 %	-1 %	0 %	2 %	-1 %	0 %	0 %
Electricity	EUR/year	1,665	1,436	1,449	1,499	1,695	1,656	1,583	1,003
	% difference	0 %	-14 %	-13 %	-10 %	2 %	-1 %	-5 %	-40 %
Water	EUR/year	290	290	252	290	295	288	290	291
	% difference	0 %	0 %	-13 %	0 %	2 %	-1 %	0 %	0 %
Auxiliary material 1 (Detergent)	EUR/year	718	718	625	718	731	714	718	721
	% difference	0 %	0 %	-13 %	0 %	2 %	-1 %	0 %	0 %
Auxiliary material 2 (Rinsing agent)	EUR/year	57.0	57.0	49.6	57.0	58.0	56.7	57.0	57.2
	% difference	0 %	0 %	-13 %	0 %	2 %	-1 %	0 %	0 %
Repair & maintenance costs	EUR	311	358	361	322	414	297	342	553
	% difference	0 %	15 %	16 %	3 %	33 %	-5 %	10 %	78 %
Total	EUR/year	3,756	3,679	3,563	3,623	4,140	3,694	3,775	3,889
	% difference	0 %	-2.1 %	-5.14 %	-3.55 %	10.22 %	-1.7 %	0.5 %	3.5 %

5952 **8.3.3. BC3: Hood-type dishwasher Environmental impact**

5953 **8.3.3.1. Environmental impact**

5954 Below (**Table 8-24**), the resource use as well as the environmental impact of the original Base Case (reference) and all design options are provided.

5955 **Table 8-24: Consumption data and environmental impact per design option compared to BC3.**

Consumption and environmental impact										
Consumption	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Total energy consumption	kWh	114,308	99,476	84,647	110,967	103,695	84,305	126,439	109,322	62,947
	% difference	0 %	-13.4 %	-26.3 %	-3.4 %	-9.7 %	-26.6 %	10.1 %	-4.8 %	-39.1 %
Water (use phase)	m ³	1,240	1,240	1,209	1,193	1,240	909	1,364	1,240	1,116
	% difference	0 %	0.0 %	-2.5 %	-3.8 %	0.0 %	-26.7 %	10.0 %	0.0 %	-10.0 %
Detergent (use phase)	kg	2,522	2,522	2,459	2,427	2,522	1,849	2,774	2,522	2,270
	% difference	0 %	0.0 %	-2.5 %	-3.7 %	0.0 %	-26.7 %	10.0 %	0.0 %	-10.0 %
Rinsing agent (use phase)	kg	195	195	190	187	195	143	214	195	175
	% difference	0 %	0.0 %	-2.5 %	-3.7 %	0.0 %	-26.7 %	10.0 %	0.0 %	-10.0 %
PEF Impact categories	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Climate change, total	kg CO ₂ eq.	5.19E+04	4.56E+04	3.92E+04	5.02E+04	4.73E+04	3.83E+04	5.76E+04	4.96E+04	s
	% difference	0 %	-12.2 %	-24.5 %	-3.3 %	-8.9 %	-26.2 %	10.8 %	-4.5 %	-42.4 %
Ozone depletion	kg CFC-11 eq.	6.41E-05	6.17E-05	5.82E-05	6.17E-05	6.63E-05	4.71E-05	7.05E-05	6.32E-05	5.54E-05
	% difference	0 %	-3.7 %	-9.1 %	-3.7 %	3.5 %	-26.5 %	10.1 %	-1.4 %	-13.5 %
Human toxicity, cancer	CTUh	4.60E-05	4.87E-05	4.36E-05	4.66E-05	4.77E-05	3.59E-05	4.80E-05	4.56E-05	3.75E-05
	% difference	0 %	6.0 %	-5.1 %	1.4 %	3.8 %	-21.9 %	4.5 %	-15.0 %	-18.4 %

Human toxicity, non-cancer	CTUh	3.09E-04	2.91E-04	2.66E-04	3.02E-04	2.94E-04	2.32E-04	3.51E-04	3.01E-04	2.27E-04
	% difference	0 %	-5.8 %	-13.8 %	-2.3 %	-4.9 %	-24.9 %	13.8 %	-2.5 %	-26.4 %
Particulate matter	disease incidence	1.95E-03	1.76E-03	1.54E-03	1.89E-03	1.81E-03	1.45E-03	2.16E-03	1.87E-03	1.22E-03
	% difference	0 %	-9.9 %	-20.9 %	-3.1 %	-7.3 %	-25.8 %	11.0 %	-3.8 %	-37.2 %
Ionising radiation, human health	kBq U235 eq.	2.05E+04	1.77E+04	1.51E+04	1.97E+04	1.85E+04	1.50E+04	2.25E+04	1.95E+04	1.12E+04
	% difference	0 %	-13.4 %	-26.3 %	-3.7 %	-9.7 %	-26.6 %	10.1 %	-4.8 %	-45.1 %
Photochemical ozone formation, human health	kg NMVOC eq.	9.36E+01	8.33E+01	7.26E+01	9.04E+01	8.60E+01	6.92E+01	1.04E+02	8.97E+01	5.68E+01
	% difference	0 %	-11.0 %	-22.4 %	-3.3 %	-8.1 %	-26.0 %	11.1 %	-4.1 %	-39.3 %
Acidification	mol H+ eq.	1.71E+02	1.52E+02	1.32E+02	1.65E+02	1.57E+02	1.26E+02	1.89E+02	1.64E+02	1.03E+02
	% difference	0 %	-11.0 %	-22.8 %	-3.3 %	-8.1 %	-26.0 %	11.0 %	-4.2 %	-39.9 %
Eutrophication, terrestrial	mol N eq.	3.55E+02	3.16E+02	2.76E+02	3.43E+02	3.27E+02	2.62E+02	3.94E+02	3.41E+02	2.17E+02
	% difference	0 %	-10.8 %	-22.1 %	-3.4 %	-8.0 %	-26.1 %	11.1 %	-4.0 %	-38.8 %
Eutrophication, freshwater	kg P eq.	5.67E-01	5.54E-01	5.30E-01	5.47E-01	5.57E-01	4.18E-01	6.29E-01	5.62E-01	4.78E-01
	% difference	0 %	-2.2 %	-6.5 %	-3.5 %	-1.7 %	-26.2 %	11.0 %	-0.8 %	-15.7 %
Eutrophication, marine	kg N eq.	3.80E+01	3.44E+01	3.05E+01	3.67E+01	3.54E+01	2.81E+01	4.22E+01	3.67E+01	2.46E+01
	% difference	0 %	-9.6 %	-19.8 %	-3.4 %	-7.0 %	-26.1 %	11.0 %	-3.5 %	-35.4 %
Ecotoxicity, freshwater	CTUe	2.74E+05	2.45E+05	2.16E+05	2.65E+05	2.53E+05	2.02E+05	3.03E+05	2.63E+05	1.71E+05
	% difference	0 %	-10.4 %	-21.3 %	-3.3 %	-7.7 %	-26.2 %	10.5 %	-3.9 %	-37.7 %
Land use	pt	5.86E+05	7.18E+05	7.20E+05	7.53E+05	5.66E+05	5.20E+05	6.15E+05	5.76E+05	6.82E+05
	% difference	0 %	22.6 %	22.8 %	28.5 %	-3.4 %	-11.2 %	4.9 %	-1.7 %	16.4 %
Water use	m3 water eq. of deprived water	3.99E+04	3.77E+04	3.50E+04	3.84E+04	3.83E+04	5.00E+00	4.40E+04	3.91E+04	3.02E+04
	% difference	0 %	-5.4 %	-12.2 %	-3.6 %	-4.0 %	-26.5 %	10.3 %	-2.0 %	-24.3 %
Resource use, minerals and metals	kg Sb eq.	1.61E-01	1.81E-01	1.75E-01	1.79E-01	1.62E-01	1.39E-01	2.06E-01	1.60E-01	1.69E-01
	% difference	0 %	12.5 %	8.7 %	11.5 %	1.1 %	-13.3 %	28.1 %	-0.4 %	5.1 %

Resource use, fossils	MJ	8.87E+05	7.76E+05	6.66E+05	8.57E+05	8.06E+05	6.53E+05	9.81E+05	8.46E+05	5.05E+05
	% difference	0 %	-12.5 %	-24.9 %	-3.4 %	-9.1 %	-26.3 %	10.6 %	-4.6 %	-43.0 %

5956 8.3.3.2. LCC impact

5957 Below (Table 8-25), the Life Cycle Costs of the original Base Case (reference) and all design options are provided.

5958 Table 8-25: Life Cycle Costing impact per design option compared to BC3.

Cost category	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Product price	EUR	8,662	10,251	14,076	11,045	8,951	8,446	9,096	9,529	13,860
	% difference / year	0 %	18.3 %	66.7 %	15.9 %	3.3 %	33.0 %	-4.5 %	10.0 %	77.8 %
Natural gas (for heat)	EUR/year	23	23	24	23	24	24	23	24	24
	% difference	0 %	-0.1 %	2.0 %	1.4 %	2.0 %	3.7 %	1.4 %	2.0 %	2.4 %
Electricity	EUR/year	3,375	2,909	2,533	2,938	3,038	3,432	3,357	3,208	2,033
	% difference	0 %	-13.8 %	-25.0 %	-13.0 %	-10.0 %	1.7 %	-0.5 %	-4.9 %	-39.8 %
Water	EUR/year	277	276	276	240	276	281	275	276	277
	% difference	0 %	0 %	0.0 %	-13.1 %	0 %	1.6 %	-0.6 %	0.0 %	0.3 %
Auxiliary material 1 (Detergent)	EUR/year	1,243	1,241	1,242	1,080	1,241	1,262	1,235	1,242	1,246
	% difference	0 %	-0.1 %	-0.1 %	-13.1 %	-0.1 %	1.6 %	-0.7 %	-0.1 %	0.3 %
Auxiliary material 2 (Rinsing agent)	EUR/year	89	89	89	78	89	91	89	89	89
	% difference	0 %	-0.1 %	-0.1 %	-13.1 %	0 %	1.5 %	-0.7 %	-0.1 %	0.2 %
Repair & maintenance costs	EUR	476	564	794	552	492	633	455	524	847

	% difference	0 %	18.3 %	66.7 %	15.9 %	3.3 %	33.0 %	-4.5 %	10.0 %	77.8 %
Total	EUR/year	6,566	6,384	6,762	6,167	6,279	7,163	6,467	6,555	6,442
	% difference	0 %	-2.8 %	3.0 %	-6.1 %	-4.4 %	9.1 %	-1.5 %	-0.2 %	-1.9 %

5959 8.3.4. BC4: Utensil/pot dishwasher

5960 8.3.4.1. Environmental impact

5961 Below, the resource use as well as the environmental impact of the original Base Case (reference) and all design options are provided.

5962 In addition, a sensitivity analysis has been performed on DO-08 (all design options combined), where the energy reduction of 40 % was also applied to the
 5963 external hot water that enters the machine. The results show some small changes compared to DO-08 (only 40 % energy reduction on energy from within the
 5964 machine) with a maximum difference of 2.5 % points for energy use (over the full life time) and maximum 1.2 % points (climate change) on the PEF impact
 5965 categories (see **Table 8-26**).

5966 **Table 8-26: Consumption data and environmental impact per design option compared to BC4.**

Consumption and environmental impact											
Consumption	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08	DO-08 Sensitivity
Total energy consumption	kWh	117,005	102,052	88,302	113,751	106,137	85,832	128,729	111,583	66,117	63,214
	% difference	0 %	-12.8 %	-24.5 %	-2.8 %	-9.3 %	-26.6 %	10.0 %	-4.6 %	-43.5 %	-46.0 %
Water (use phase)	m3	1050	1050	1033	1011	1050	770	1155	1050	945	945
	% difference	0 %	0.0 %	-1.7 %	-3.7 %	0.0 %	-26.7 %	10.0 %	0.0 %	-10.0 %	-10.0 %
	kg	2913	2913	2864	2804	2913	2136	3204	2913	2621	2621

Detergent (use phase)	% difference	0 %	0.0 %	-1.7 %	-3.7 %	0.0 %	-26.7 %	10.0 %	0.0 %	-10.0 %	-10.0 %
Rinsing agent (use phase)	kg	153	153	151	147	153	112	168	153	138	138
	% difference	0 %	0.0 %	-1.7 %	-3.8 %	0.0 %	-26.7 %	10.0 %	0.0 %	-10.0 %	-10.0 %
PEF Impact categories	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08	DO-08 Sensitivity
Climate change, total	kg CO ₂ eq.	5.16E+04	4.52E+04	3.94E+04	4.98E+04	4.68E+04	3.78E+04	5.65E+04	4.90E+04	2.99E+04	2.93E+04
	% difference	0 %	-12.4 %	-23.7 %	-3.3 %	-9.2 %	-26.8 %	9.6 %	-4.9 %	-41.9 %	-43.1 %
Ozone depletion	kg CFC-11 eq.	6.45E-05	6.22E-05	5.93E-05	6.21E-05	6.88E-05	4.73E-05	7.09E-05	6.36E-05	5.81E-05	5.80E-05
	% difference	0 %	-3.6 %	-8.0 %	-3.7 %	6.7 %	-26.6 %	10.0 %	-1.4 %	-10.0 %	-10.0 %
Human toxicity, cancer	CTUh	5.72E-05	6.17E-05	5.50E-05	5.84E-05	6.01E-05	4.48E-05	5.90E-05	5.67E-05	4.71E-05	4.70E-05
	% difference	0 %	7.9 %	-3.8 %	2.1 %	5.1 %	-21.6 %	3.1 %	-17.7 %	-17.7 %	-17.8 %
Human toxicity, non-cancer	CTUh	2.98E-04	2.73E-04	2.52E-04	2.88E-04	2.75E-04	2.16E-04	3.23E-04	2.82E-04	2.12E-04	2.12E-04
	% difference	0 %	-8.2 %	-15.3 %	-3.3 %	-7.5 %	-27.3 %	8.4 %	-5.2 %	-28.7 %	-28.9 %
Particulate matter	disease incidence	1.94E-03	1.74E-03	1.55E-03	1.87E-03	1.79E-03	1.42E-03	2.11E-03	1.85E-03	1.22E-03	1.22E-03
	% difference	0 %	-10.1 %	-20.2 %	-3.3 %	-7.8 %	-26.6 %	9.1 %	-4.5 %	-37.0 %	-37.1 %
Ionising radiation, human health	kBq U235 eq.	1.95E+04	1.69E+04	1.45E+04	1.88E+04	1.76E+04	1.43E+04	2.15E+04	1.86E+04	1.07E+04	1.07E+04
	% difference	0 %	-13.4 %	-25.6 %	-3.7 %	-9.7 %	-26.6 %	10.0 %	-4.9 %	-45.1 %	-45.1 %
Photochemical ozone	kg NMVOC eq.	9.20E+01	8.15E+01	7.18E+01	8.87E+01	8.41E+01	6.73E+01	1.01E+02	8.76E+01	5.59E+01	5.55E+01

formation, human health	% difference	0 %	-11.4 %	-21.9 %	-3.6 %	-8.6 %	-26.8 %	9.4 %	-4.8 %	-39.2 %	-39.6 %
Acidification	mol H+ eq.	1.68E+02	1.49E+02	1.31E+02	1.62E+02	1.53E+02	1.23E+02	1.83E+02	1.60E+02	1.01E+02	1.01E+02
	% difference	0 %	-11.3 %	-22.2 %	-3.5 %	-8.5 %	-26.7 %	9.3 %	-4.8 %	-39.8 %	-40.0 %
Eutrophication, terrestrial	mol N eq.	3.49E+02	3.10E+02	2.74E+02	3.36E+02	3.20E+02	2.55E+02	3.82E+02	3.33E+02	2.14E+02	2.13E+02
	% difference	0 %	-11.2 %	-21.5 %	-3.7 %	-8.4 %	-26.8 %	9.5 %	-4.7 %	-38.7 %	-38.9 %
Eutrophication, freshwater	kg P eq.	5.71E-01	5.55E-01	5.35E-01	5.50E-01	5.58E-01	4.17E-01	6.26E-01	5.62E-01	4.78E-01	4.74E-01
	% difference	0 %	-2.8 %	-6.2 %	-3.7 %	-2.2 %	-26.9 %	9.7 %	-1.4 %	-16.3 %	-16.9 %
Eutrophication, marine	kg N eq.	3.78E+01	3.41E+01	3.06E+01	3.64E+01	3.50E+01	2.77E+01	4.14E+01	3.62E+01	2.45E+01	2.45E+01
	% difference	0 %	-9.8 %	-19.0 %	-3.7 %	-7.3 %	-26.8 %	9.6 %	-4.1 %	-35.0 %	-35.3 %
Ecotoxicity, freshwater	CTUe	2.68E+05	2.40E+05	2.13E+05	2.58E+05	2.47E+05	1.97E+05	2.94E+05	2.56E+05	1.68E+05	1.67E+05
	% difference	0 %	-10.5 %	-20.5 %	-3.5 %	-7.9 %	-26.5 %	9.6 %	-4.2 %	-37.3 %	-37.5 %
Land use	pt	7.10E+05	9.04E+05	9.09E+05	9.33E+05	6.93E+05	6.49E+05	7.46E+05	7.02E+05	8.77E+05	8.76E+05
	% difference	0 %	27.3 %	28.1 %	31.4 %	-2.4 %	-8.5 %	5.1 %	-1.0 %	23.5 %	23.5 %
Water use	m ³ water eq. of deprived water	3.63E+04	3.41E+04	3.19E+04	3.49E+04	3.47E+04	5.00E+00	3.98E+04	3.54E+04	2.71E+04	2.71E+04
	% difference	0 %	-5.9 %	-12.1 %	-3.7 %	-4.4 %	-26.7 %	9.8 %	-2.3 %	-25.2 %	-25.2 %
Resource use, minerals and metals	kg Sb eq.	1.94E-01	1.98E-01	1.93E-01	2.07E-01	1.75E-01	1.46E-01	1.96E-01	1.71E-01	1.81E-01	1.80E-01
	% difference	0 %	2.0 %	-0.8 %	6.8 %	-9.9 %	-24.9 %	0.8 %	-11.8 %	-6.7 %	-7.3 %
	MJ	8.77E+05	7.67E+05	6.66E+05	8.47E+05	7.96E+05	6.43E+05	9.62E+05	8.34E+05	5.04E+05	4.95E+05

Resource use, fossils	% difference	0 %	-12.5 %	-24.0 %	-3.3 %	-9.2 %	-26.7 %	9.7 %	-4.9 %	-42.5 %	-43.5 %

5967 8.3.4.2. LCC impact

5968 Below (**Table 8-27**), the Life Cycle Costs of the original Base Case (reference) and all design options are provided.

5969 In addition, a sensitivity analysis has been performed on DO-08 (all design options combined), where the energy reduction of 40 % was also applied to the
 5970 external hot water that enters the machine. The results show some small changes compared to DO-08 (only 40 % energy reduction on energy from within the
 5971 machine) with large difference for cost reduction for natural gas due to additional savings, however, on the total costs per year, the difference between DO-08
 5972 and the sensitivity is very limited with a difference of 0.4 % points.

5973 **Table 8-27: Life Cycle Costing impact per design option compared to BC4.**

Cost category	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08	DO-08 Sensitivity
Product price	EUR	10,855	12,664	18,996	13,840	11,217	10,584	11,398	11,940	17,368	17,368
	% difference / year	0 %	16.7 %	78.0 %	15.9 %	3.3 %	33.0 %	-4.5 %	10.0 %	77.8 %	77.8 %
Natural gas (for heat)	EUR/year	86	84	82	84	85	88	86	86	80	52
	% difference	0 %	-2.8 %	-5.1 %	-3.1 %	-2.0 %	1.9 %	-0.5 %	-0.9 %	-7.7 %	-39.7 %
Electricity	EUR/year	2,829	2,438	2,121	2,459	2,545	2,881	2,810	2,687	1,704	1,704
	% difference	0 %	-13.8 %	-25.0 %	-13.1 %	-10.0 %	1.8 %	-0.7 %	-5.0 %	-39.8 %	-39.8 %
Water	EUR/year	207	207	207	180	207	210	205	207	208	207
	% difference	0 %	-0.1 %	-0.1 %	-13.1 %	-0.1 %	1.8 %	-0.7 %	0.0 %	0.4 %	0.4 %
Auxiliary material 1 (Detergent)	EUR/year	1,266	1,265	1,266	1,101	1,266	1,289	1,258	1,266	1,271	1,271
	% difference	0 %	-0.1 %	-0.1 %	-13.1 %	-0.1 %	1.8 %	-0.7 %	0.0 %	0.4 %	0.4 %
Auxiliary material 2 (Rinsing agent)	EUR/year	62	62	62	54	62	63	62	62	62	62
	% difference	0 %	-0.1 %	-0.1 %	-13.1 %	-0.1 %	1.8 %	-0.7 %	0.0 %	0.4 %	0.4 %

Repair & maintenance costs	EUR	531	619	944	615	548	706	507	584	943	943
	% difference	0 %	16.7 %	78.0 %	15.9 %	3.3 %	33.0 %	-4.5 %	10.0 %	77.8 %	77.8 %
Total	EUR/year	6,187	6,082	6,828	5,890	5,958	6,841	6,079	6,218	6,413	6,384
	% difference	0 %	-1.7 %	10.4 %	-4.8 %	-3.7 %	10.6 %	-1.7 %	0.5 %	3.6 %	3.2 %

5974 8.3.5. BC5: One-tank conveyor-type dishwasher

5975 8.3.5.1. Environmental impact

5976 Below (Table 8-28), the resource use as well as the environmental impact of the original Base Case (reference) and all design options are provided.

5977 Table 8-28: Consumption data and environmental impact per design option compared to BC5.

Consumption and environmental impact										
Consumption	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Total energy consumption	kWh	1,215,943	1,036,193	960,008	1,172,742	1,096,111	891,761	1,337,516	1,096,111	501,191
	% difference	0 %	-14.8 %	-21.0 %	-3.6 %	-9.9 %	-26.7 %	10.0 %	-9.9 %	-58.8 %
Water (use phase)	m ³	9,026	9,026	8,875	8,687	9,026	6,619	9,928	9,026	8,123
	% difference	0 %	0.0 %	-1.7 %	-3.7 %	0.0 %	-26.7 %	10.0 %	0.0 %	-10.0 %
Detergent (use phase)	kg	21,243	21,243	20,889	20,447	21,243	15,578	23,368	21,243	19,119
	% difference	0 %	0.0 %	-1.7 %	-3.7 %	0.0 %	-26.7 %	10.0 %	0.0 %	-10.0 %
Rinsing agent (use phase)	kg	2,070	2,070	2,035	1,992	2,070	1,518	2,277	2,070	1,863
	% difference	0 %	0.0 %	-1.7 %	-3.8 %	0.0 %	-26.7 %	10.0 %	0.0 %	-10.0 %
PEF Impact categories	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08

Climate change, total	kg CO ₂ eq.	5.13E+05	4.41E+05	4.11E+05	4.95E+05	4.65E+05	3.77E+05	5.65E+05	4.65E+05	2.25E+05
	% difference	0 %	-13.9 %	-19.9 %	-3.4 %	-9.3 %	-26.5 %	10.1 %	-9.3 %	-56.0 %
Ozone depletion	kg CFC-11 eq.	5.46E-04	5.20E-04	5.03E-04	5.25E-04	5.44E-04	4.02E-04	6.01E-04	5.30E-04	4.22E-04
	% difference	0 %	-4.7 %	-7.8 %	-3.7 %	-0.4 %	-26.4 %	10.2 %	-2.9 %	-22.6 %
Human toxicity, cancer	CTUh	3.16E-04	3.19E-04	3.20E-04	3.17E-04	3.22E-04	2.43E-04	3.32E-04	3.08E-04	2.54E-04
	% difference	0 %	1.0 %	1.3 %	0.5 %	2.2 %	-22.9 %	5.3 %	-19.6 %	-19.6 %
Human toxicity, non-cancer	CTUh	2.64E-03	2.42E-03	2.30E-03	2.57E-03	2.49E-03	1.96E-03	2.92E-03	2.48E-03	1.63E-03
	% difference	0 %	-8.3 %	-12.6 %	-2.6 %	-5.8 %	-25.7 %	10.8 %	-5.8 %	-38.0 %
Particulate matter	disease incidence	1.80E-02	1.58E-02	1.49E-02	1.74E-02	1.66E-02	1.33E-02	1.98E-02	1.65E-02	9.03E-03
	% difference	0 %	-11.9 %	-17.2 %	-3.3 %	-7.9 %	-26.2 %	10.1 %	-8.1 %	-49.8 %
Ionising radiation, human health	kBq U235 eq.	1.97E+05	1.68E+05	1.56E+05	1.90E+05	1.78E+05	1.44E+05	2.17E+05	1.77E+05	8.15E+04
	% difference	0 %	-14.7 %	-21.0 %	-3.7 %	-9.8 %	-26.6 %	10.0 %	-9.8 %	-58.6 %
Photochemical ozone formation, human health	kg NMVOC eq.	8.82E+02	7.69E+02	7.19E+02	8.52E+02	8.06E+02	6.49E+02	9.71E+02	8.06E+02	4.20E+02
	% difference	0 %	-12.8 %	-18.4 %	-3.4 %	-8.5 %	-26.4 %	10.2 %	-8.6 %	-52.4 %
Acidification	mol H ⁺ eq.	1.60E+03	1.39E+03	1.30E+03	1.54E+03	1.46E+03	1.18E+03	1.76E+03	1.46E+03	7.50E+02
	% difference	0 %	-12.9 %	-18.6 %	-3.3 %	-8.6 %	-26.4 %	10.1 %	-8.7 %	-53.0 %
Eutrophication, terrestrial	mol N eq.	3.33E+03	2.91E+03	2.72E+03	3.21E+03	3.05E+03	2.45E+03	3.66E+03	3.04E+03	1.61E+03
	% difference	0 %	-12.6 %	-18.1 %	-3.4 %	-8.4 %	-26.4 %	10.2 %	-8.4 %	-51.6 %
Eutrophication, freshwater	kg P eq.	4.80E+00	4.64E+00	4.51E+00	4.63E+00	4.69E+00	3.53E+00	5.29E+00	4.69E+00	3.80E+00
	% difference	0 %	-3.3 %	-6.0 %	-3.4 %	-2.2 %	-26.5 %	10.2 %	-2.2 %	-20.9 %
Eutrophication, marine	kg N eq.	3.53E+02	3.13E+02	2.95E+02	3.41E+02	3.26E+02	2.59E+02	3.89E+02	3.26E+02	1.87E+02
	% difference	0 %	-11.2 %	-16.3 %	-3.5 %	-7.5 %	-26.5 %	10.2 %	-7.5 %	-47.1 %
Ecotoxicity, freshwater	CTUe	2.55E+06	2.25E+06	2.11E+06	2.46E+06	2.35E+06	1.88E+06	2.81E+06	2.35E+06	1.28E+06
	% difference	0 %	-12.1 %	-17.5 %	-3.5 %	-8.1 %	-26.4 %	10.1 %	-8.1 %	-50.0 %

Land use	pt	6.39E+06	6.69E+06	6.61E+06	6.44E+06	6.19E+06	5.67E+06	6.98E+06	6.19E+06	5.85E+06
	% difference	0 %	4.8 %	3.5 %	0.8 %	-3.1 %	-11.2 %	9.2 %	-3.1 %	-8.4 %
Water use	m ³ water eq. of deprived water	3.32E+05	3.09E+05	2.96E+05	3.20E+05	3.16E+05	5.00E+00	3.65E+05	3.16E+05	2.22E+05
	% difference	0 %	-7.0 %	-10.8 %	-3.6 %	-4.7 %	-26.6 %	10.1 %	-4.7 %	-33.1 %
Resource use, minerals and metals	kg Sb eq.	1.20E+00	1.25E+00	1.24E+00	1.26E+00	1.20E+00	1.01E+00	1.36E+00	1.18E+00	1.13E+00
	% difference	0 %	4.2 %	3.9 %	5.2 %	0.0 %	-15.9 %	13.9 %	-1.3 %	-6.0 %
Resource use, fossils	MJ	8.76E+06	7.53E+06	7.00E+06	8.46E+06	7.94E+06	6.44E+06	9.65E+06	7.94E+06	3.80E+06
	% difference	0 %	-14.1 %	-20.1 %	-3.5 %	-9.4 %	-26.5 %	10.1 %	-9.4 %	-56.6 %

5978 8.3.5.2. LCC impact

5979 Below (**Table 8-29**), the Life Cycle Costs of the original Base Case (reference) and all design options are provided.

5980 **Table 8-29: Life Cycle Costing impact per design option compared to BC5.**

Cost category	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Product price	EUR	13,394	15,627	18,417	20,092	14,064	13,060	14,399	15,404	23,440
	% difference / year	0 %	16.7 %	39.8 %	36.4 %	5.0 %	33.0 %	-2.3 %	15.0 %	94.5 %
Natural gas (for heat)	EUR/year	910	790	752	804	830	929	902	830	476
	% difference	0 %	-13.2 %	-17.4 %	-11.6 %	-8.8 %	2.1 %	-0.8 %	-8.8 %	-47.7 %
Electricity	EUR/year	23,184	19,676	18,544	20,117	20,842	23,676	22,991	20,842	10,454
	% difference	0 %	-15.1 %	-20.0 %	-13.2 %	-10.1 %	2.1 %	-0.8 %	-10.1 %	-54.9 %
Water	EUR/year	1,435	1,433	1,435	1,245	1,433	1,465	1,423	1,433	1,438
	% difference	0 %	-0.2 %	0.0 %	-13.2 %	-0.1 %	2.1 %	-0.8 %	-0.1 %	0.2 %
Auxiliary material 1 (Detergent)	EUR/year	7,462	7,451	7,461	6,475	7,454	7,621	7,400	7,454	7,478

Auxiliary material 2 (Rinsing agent)	% difference	0 %	-0.2 %	0.0 %	-13.2 %	-0.1 %	2.1 %	-0.8 %	-0.1 %	0.2 %
	EUR/year	677	676	677	588	676	692	672	676	679
Repair & maintenance costs	% difference	0 %	-0.2 %	0.0 %	-13.2 %	-0.1 %	2.1 %	-0.8 %	-0.1 %	0.2 %
	EUR	536	625	749	731	563	712	524	616	1,042
Total	% difference	0 %	16.7 %	39.8 %	36.4 %	5.0 %	33.0 %	-2.3 %	15.0 %	94.4 %
	EUR/year	35,422	32,072	31,320	31,621	33,077	36,714	35,102	33,253	23,934
	% difference	0 %	-9.5 %	-11.6 %	-10.7 %	-6.6 %	3.6 %	-0.9 %	-6.1 %	-32.4 %

5981 8.3.6. BC6: Multi-tank conveyor-type dishwasher

5982 8.3.6.1. Environmental impact

5983 Below (Table 8-30), the resource use as well as the environmental impact of the original Base Case (reference) and all design options are provided.

5984 **Table 8-30: Consumption data and environmental impact per design option compared to BC6.**

Consumption and environmental impact										
Consumption	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Total energy consumption	kWh	3,290,191	2,804,103	2,491,821	3,173,601	2,885,119	2,412,892	3,619,188	2,966,135	1,211,266
	% difference	0 %	-14.8 %	-24.3 %	-3.5 %	-12.3 %	-26.7 %	10.0 %	-9.8 %	-63.2 %
Water (use phase)	m ³	18,442	18,442	18,134	17,750	18,442	13,524	20,286	18,442	16,598
	% difference	0 %	0.0 %	-1.7 %	-3.8 %	0.0 %	-26.7 %	10.0 %	0.0 %	-10.0 %
Detergent (use phase)	kg	41,297	41,297	40,609	39,749	41,297	30,285	45,427	41,297	37,168
	% difference	0 %	0.0 %	-1.7 %	-3.8 %	0.0 %	-26.7 %	10.0 %	0.0 %	-10.0 %

Rinsing agent (use phase)	kg	3,764	3,764	3,701	3,622	3,764	2,760	4,140	3,764	3,387
	% difference	0 %	0.0 %	-1.7 %	-3.8 %	0.0 %	-26.7 %	10.0 %	0.0 %	-10.0 %
PEF Impact categories	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Climate change, total	kg CO ₂ eq.	1.33E+06	1.14E+06	1.02E+06	1.28E+06	1.17E+06	9.77E+05	1.46E+06	1.20E+06	5.17E+05
	% difference	0 %	-14.1 %	-23.3 %	-3.4 %	-11.8 %	-26.5 %	10.2 %	-9.4 %	-61.1 %
Ozone depletion	kg CFC-11 eq.	1.18E-03	1.11E-03	1.06E-03	1.13E-03	1.14E-03	8.63E-04	1.29E-03	1.13E-03	8.38E-04
	% difference	0 %	-5.6 %	-10.2 %	-3.7 %	-3.4 %	-26.6 %	10.0 %	-3.7 %	-28.8 %
Human toxicity, cancer	CTUh	6.08E-04	6.02E-04	5.91E-04	6.08E-04	6.07E-04	4.66E-04	6.48E-04	5.90E-04	4.53E-04
	% difference	0 %	-1.1 %	-2.9 %	-0.1 %	-0.2 %	-23.3 %	6.5 %	-25.6 %	-25.6 %
Human toxicity, non-cancer	CTUh	6.11E-03	5.53E-03	5.12E-03	5.93E-03	5.62E-03	4.52E-03	6.76E-03	5.72E-03	3.39E-03
	% difference	0 %	-9.5 %	-16.2 %	-2.9 %	-8.0 %	-26.0 %	10.6 %	-6.4 %	-44.5 %
Particulate matter	disease incidence	4.39E-02	3.84E-02	3.47E-02	4.24E-02	3.93E-02	3.23E-02	4.84E-02	4.02E-02	1.94E-02
	% difference	0 %	-12.5 %	-20.9 %	-3.3 %	-10.4 %	-26.3 %	10.2 %	-8.4 %	-55.8 %
Ionising radiation, human health	kBq U235 eq.	5.02E+05	4.28E+05	3.80E+05	4.84E+05	4.40E+05	3.68E+05	5.53E+05	4.53E+05	1.85E+05
	% difference	0 %	-14.7 %	-24.2 %	-3.7 %	-12.3 %	-26.6 %	10.1 %	-9.8 %	-63.2 %
Photochemical ozone formation, human health	kg NMVOC eq.	2.20E+03	1.91E+03	1.72E+03	2.12E+03	1.96E+03	1.62E+03	2.42E+03	2.00E+03	9.24E+02
	% difference	0 %	-13.3 %	-22.0 %	-3.5 %	-11.0 %	-26.5 %	10.2 %	-8.9 %	-58.0 %
Acidification	mol H ⁺ eq.	3.97E+03	3.44E+03	3.09E+03	3.83E+03	3.53E+03	2.92E+03	4.37E+03	3.61E+03	1.64E+03
	% difference	0 %	-13.4 %	-22.2 %	-3.4 %	-11.2 %	-26.5 %	10.1 %	-9.0 %	-58.6 %
Eutrophication, terrestrial	mol N eq.	8.22E+03	7.14E+03	6.43E+03	7.93E+03	7.32E+03	6.04E+03	9.05E+03	7.50E+03	3.51E+03
	% difference	0 %	-13.1 %	-21.7 %	-3.5 %	-10.9 %	-26.5 %	10.2 %	-8.7 %	-57.3 %
	kg P eq.	1.03E+01	9.88E+00	9.47E+00	9.95E+00	9.95E+00	7.58E+00	1.14E+01	1.00E+01	7.71E+00

Eutrophication, freshwater	% difference	0 %	-4.2 %	-8.2 %	-3.5 %	-3.5 %	-26.5 %	10.2 %	-2.8 %	-25.3 %
Eutrophication, marine	kg N eq.	8.53E+02	7.51E+02	6.82E+02	8.23E+02	7.68E+02	6.27E+02	9.39E+02	7.85E+02	3.99E+02
	% difference	0 %	-11.9 %	-20.0 %	-3.5 %	-9.9 %	-26.5 %	10.2 %	-8.0 %	-53.2 %
Ecotoxicity, freshwater	CTUe	6.25E+06	5.46E+06	4.93E+06	6.03E+06	5.59E+06	4.60E+06	6.88E+06	5.72E+06	2.75E+06
	% difference	0 %	-12.7 %	-21.1 %	-3.6 %	-10.6 %	-26.5 %	10.1 %	-8.5 %	-55.9 %
Land use	pt	1.16E+07	1.14E+07	1.10E+07	1.15E+07	1.10E+07	9.89E+06	1.27E+07	1.11E+07	9.09E+06
	% difference	0 %	-1.3 %	-5.2 %	-0.7 %	-5.4 %	-14.7 %	9.1 %	-4.3 %	-21.6 %
Water use	m ³ water eq. of deprived water	7.55E+05	6.96E+05	6.51E+05	7.27E+05	7.05E+05	5.00E+00	8.31E+05	7.15E+05	4.65E+05
	% difference	0 %	-7.9 %	-13.7 %	-3.7 %	-6.6 %	-26.6 %	10.1 %	-5.2 %	-38.4 %
Resource use, minerals and metals	kg Sb eq.	2.21E+00	2.22E+00	2.18E+00	2.29E+00	2.18E+00	1.81E+00	2.50E+00	2.16E+00	1.91E+00
	% difference	0 %	0.5 %	-1.4 %	3.5 %	-1.6 %	-18.2 %	13.2 %	-2.2 %	-13.6 %
Resource use, fossils	MJ	2.27E+07	1.95E+07	1.74E+07	2.19E+07	2.00E+07	1.67E+07	2.50E+07	2.06E+07	8.73E+06
	% difference	0 %	-14.3 %	-23.5 %	-3.5 %	-11.9 %	-26.5 %	10.1 %	-9.5 %	-61.6 %

5985 8.3.6.2. LCC impact

5986 Below (**Table 8-31**), the Life Cycle Costs of the original Base Case (reference) and all design options are provided.

5987 **Table 8-31: Life Cycle Costing impact per design option compared to BC6.**

Cost category	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Product price	EUR	22,867	26,297	31,633	34,300	23,629	21,724	24,582	26,297	40,017
	% difference / year	0 %	15.0 %	40.7 %	36.4 %	3.3 %	29.5 %	-2.3 %	15.0 %	94.4 %

Natural gas (for heat)	EUR/year	2,540	2,191	2,002	2,228	2,249	2,611	2,512	2,307	1,164
	% difference	0 %	-13.7 %	-21.2 %	-12.3 %	-11.5 %	2.8 %	-1.1 %	-9.2 %	-54.2 %
Electricity	EUR/year	42,419	35,987	32,487	36,709	37,055	43,606	41,952	38,122	17,001
	% difference	0 %	-15.2 %	-23.4 %	-13.5 %	-12.6 %	2.8 %	-1.1 %	-10.1 %	-59.9 %
Water	EUR/year	2,096	2,092	2,093	1,813	2,092	2,154	2,072	2,093	2,100
	% difference	0 %	-0.2 %	-0.1 %	-13.5 %	-0.2 %	2.8 %	-1.1 %	-0.1 %	0.2 %
Auxiliary material 1 (Detergent)	EUR/year	10,368	10,348	10,357	8,972	10,351	10,658	10,254	10,353	10,388
	% difference	0 %	-0.2 %	-0.1 %	-13.5 %	-0.2 %	2.8 %	-1.1 %	-0.1 %	0.2 %
Auxiliary material 2 (Rinsing agent)	EUR/year	880	878	879	762	878	905	870	879	882
	% difference	0 %	-0.2 %	-0.1 %	-13.5 %	-0.2 %	2.8 %	-1.1 %	-0.1 %	0.2 %
Repair & maintenance costs	EUR	671	771	944	915	693	869	656	771	1,304
	% difference	0 %	15.0 %	40.7 %	36.4 %	3.3 %	29.5 %	-2.3 %	15.0 %	94.4 %
Total	EUR/year	60,498	54,020	50,907	53,478	54,893	62,778	59,805	56,278	35,803
	% difference	0 %	-10.7 %	-15.9 %	-11.6 %	-9.3 %	3.8 %	-1.1 %	-7.0 %	-40.8 %

8.4. Analysis of design options per Base Case

In this section, both environmental impacts and LCC results are analysed to determine which design options could be advanced as policy measures. Since these options address the product aspects outlined in Article 5(1) of the ESPR, the full range of environmental impacts must be evaluated to ensure a balanced assessment. Incorporation of multiple aspects into the framework makes it possible for a design option to perform significantly better in one impact category while underperforming in others. A narrow focus on one or two categories would introduce bias into the comparison and overlook trade-offs across the remaining impact categories.

To address this, the Product Environmental Footprint (PEF) single-score methodology is applied, transforming the impact category results (as previously shown) into a single, normalised, weighted indicator. By aggregating climate change, toxicity, eutrophication, land use, and other life cycle impacts into one score, design alternatives can be ranked according to their overall environmental performance.

When these PEF single scores are plotted alongside their corresponding life-cycle costs, a clear comparison against the Base Case is revealed. Design options exhibiting the lowest PEF single scores and the most favourable cost profiles may then be prioritised for inclusion in the new ESPR Ecodesign requirements. Prior to presenting the analysis, the single-score method will be explained and the scores for the Base Case and each design option will be reported.

8.4.1. Calculation method PEF single score

The PEF single score is calculated as follows:

$$PEF \text{ single score} = \sum_{i=1}^{16} I_i * \frac{WFi}{NFi}$$

I = calculated impact for PEF impact category (e.g. climate change, acidification, etc).

WF = Weighing factor for PEF impact category

NF = Normalisation factor PEF impact category

The weighing factor reflects the relative importance of the impact category, and the normalisation factor anchors each impact to a per-capita baseline. The most recent set of weighing and normalisation factors was released in 2023 by the Joint Research Centre (Andreasi Bassi et al., 2023), which builds on the original factors in Annex I of the Commission Recommendation (EU) 2021/2279 (European Commission, 2021). The factors used for calculating the single score is included in **Table 8-32**.

Table 8-32: PEF Single score normalisation factor and weighing factor per PEF impact category.

Impact categories	Unit	NF	WF
Climate change	kg CO ₂ eq./person	7.55E+03	21.06 %
Ozone depletion	kg CFC-11 eq./person	5.23E-02	6.31 %
Human toxicity, cancer	CTUh/person	1.73E-05	2.13 %
Human toxicity, non-cancer	CTUh/person	1.29E-04	1.84 %
Particulate matter	disease incidences/person	5.95E-04	8.96 %
Ionising radiation	kBq U-235 eq./person	4.22E+03	5.01 %
Photochemical ozone formation	kg NMVOC eq./person	4.09E+01	4.78 %
Acidification	mol H ⁺ eq./person	5.56E+01	6.20 %
Eutrophication, terrestrial	mol N eq./person	1.77E+02	3.71 %
Eutrophication, freshwater	kg P eq./person	1.61E+00	2.80 %
Eutrophication, marine	kg N eq./person	1.95E+01	2.96 %
Ecotoxicity, freshwater	CTUe/person	5.67E+04	1.92 %
Land use	pt/person	8.19E+05	7.94 %
Water use	m ³ water eq. of deprived water/person	1.15E+04	8.51 %
Resource use, minerals and metals	kg Sb eq./person	6.36E-02	7.55 %
Resource use, fossils	MJ/person	6.50E+04	8.32 %

8.4.2. PEF single score per Base Case and design option

The purpose of PEF single scores is to provide comparable weighted values across all 16 PEF impact categories, where a higher single score indicates a greater environmental impact (**Table 8-33**). Therefore, PEF single scores were calculated for each of the six Base Cases, aggregating impacts across all life-cycle stages over the product's entire lifetime. The same scoring system was then applied to every design option within each Base Case, enabling a like-for-like comparison of overall environmental performance. Although the EcoReport tool already calculates all sixteen PEF impact categories and provides the necessary inputs for single-score calculation, it doesn't perform a full, PEF-aligned LCA study. Therefore, scores derived from the tool should be treated as an indicative guidance rather than as a comprehensive PEF assessment when comparing results. Finally, the PEF single score approach has been developed to eventually compare the impact of products to standard benchmark values for specific product categories, calculated following product specific PEF Category Rules. Thus, there is no standard scale currently for broader comparison outside this study.

6036 Table 8-33: PEF Single score per design option for each Base Case.

BC	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
		Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
BC1	Total life time	0.8	n.a.	n.a.	n.a.	0.7	n.a.	n.a.	n.a.
	% difference	0.0 %	n.a.	n.a.	n.a.	-10.4 %	n.a.	n.a.	n.a.
	Per year of use	0.07	n.a.	n.a.	n.a.	0.06	n.a.	n.a.	n.a.
	% difference	0.0 %	n.a.	n.a.	n.a.	-10.4 %	n.a.	n.a.	n.a.
BC2	Total life time	2.32	2.12	n.a.	2.28	2.16	1.74	2.61	2.24
	% difference	0.0 %	-8.6 %	n.a.	-2.0 %	-7.1 %	-25.0 %	12.2 %	-3.6 %
	Per year of use	0.29	0.27	n.a.	0.26	0.27	0.30	0.30	0.28
	% difference	0.0 %	-8.6 %	n.a.	-10.9 %	-7.1 %	2.3 %	2.0 %	-3.6 %
BC3	Total life time	4.30	3.88	3.40	4.20	3.97	3.21	4.79	4.13
	% difference	0.0 %	-9.7 %	-20.8 %	-2.2 %	-7.7 %	-25.4 %	11.4 %	-4.0 %
	Per year of use	0.54	0.49	0.44	0.48	0.50	0.55	0.54	0.52
	% difference	0.0 %	-9.7 %	-18.8 %	-11.1 %	-7.7 %	1.7 %	1.2 %	-4.0 %
BC4	Total life time	4.29	3.86	3.43	4.20	3.93	3.16	4.67	4.08
	% difference	0.0 %	-9.9 %	-20.1 %	-2.2 %	-8.4 %	-26.2 %	9.0 %	-4.9 %
	Per year of use	0.48	0.43	0.39	0.42	0.44	0.48	0.47	0.45

BC		Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
			Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
	% difference	0.0 %	-9.9 %	-18.8 %	-11.1 %	-8.4 %	0.6 %	-0.9 %	-4.9 %	-29.9 %
BC5	Total life time	40.8	35.9	33.6	39.6	37.4	30.3	45.0	37.4	20.0
	% difference	0.0 %	-12.2 %	-17.6 %	-3.1 %	-8.3 %	-25.9 %	10.2 %	-8.4 %	-51.0 %
	Per year of use	3.71	3.26	3.11	3.27	3.40	3.75	3.72	3.40	2.02
	% difference	0.0 %	-12.2 %	-16.2 %	-11.9 %	-8.3 %	1.1 %	0.2 %	-8.4 %	-45.5 %
BC6	Total life time	102.0	88.8	80.0	98.7	90.9	75.3	112.4	93.0	43.7
	% difference	0.0 %	-13.0 %	-21.5 %	-3.2 %	-10.9 %	-26.1 %	10.2 %	-8.8 %	-57.2 %
	Per year of use	6.80	5.92	5.42	5.98	6.06	6.85	6.81	6.20	3.23
	% difference	0.0 %	-13.0 %	-20.2 %	-12.0 %	-10.9 %	0.7 %	0.2 %	-8.8 %	-52.4 %

8.4.3. Total yearly cost per Base Case and design option

Annualised life-cycle costs are summarised here for convenience from the data previously presented in this report, as discount rates and present-worth calculations are applied internally by the EcoReport tool. The total yearly costs are presented for every design option within each Base Case (**Table 8-34**), enabling a like-for-like comparison of annualised life-cycle costs. Because discounting and present-worth conversion occur within the tool, only the total yearly cost figures are reported, as they offer the most accurate representation of life-cycle cost in the present. Consequently, design alternatives can be ranked and prioritised based on these annualised cost values.

6044 **Table 8-34: Total yearly costs in EUR per design option for each Base Case.**

BC		Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
			Exhaust heat recovery (regenerator)	Exhaust air heat pump	Automatic programme for load and soil recognition	Improved thermal insulation (double-walled design)	Further substitution of metals by polymers	Modular design and reuse of electronics	Energy recovery from drain water	Product including all possible design options
BC1	EUR/year	918	n.a.	n.a.	n.a.	866	n.a.	n.a.	n.a.	n.a.
	% difference	0.0 %	n.a.	n.a.	n.a.	0.0 %	n.a.	n.a.	n.a.	n.a.
BC2	EUR/year	3,756	3,679	n.a.	3,563	3,623	4,140	3,694	3,775	3,889
	% difference	0.0 %	-2.1 %	-100.00 %	-5.14 %	-3.55 %	10.22 %	-1.7 %	0.5 %	3.5 %
BC3	EUR/year	6,566	6,384	6,762	6,167	6,279	7,163	6,467	6,555	6,442
	% difference	0.0 %	-2.8 %	3.0 %	-6.1 %	-4.4 %	9.1 %	-1.5 %	-0.2 %	-1.9 %
BC4	EUR/year	6,187	6,082	6,828	5,890	5,958	6,841	6,079	6,218	6,413
	% difference	0.0 %	-1.7 %	10.4 %	-4.8 %	-3.7 %	10.6 %	-1.7 %	0.5 %	3.6 %
BC5	EUR/year	35,422	32,072	31,320	31,621	33,077	36,714	35,102	33,253	23,934
	% difference	0.0 %	-9.5 %	-11.6 %	-10.7 %	-6.6 %	3.6 %	-0.9 %	-6.1 %	-32.4 %
BC6	EUR/year	60,498	54,020	50,907	53,478	54,893	62,778	59,805	56,278	35,803
	% difference	0.0 %	-10.7 %	-15.9 %	-11.6 %	-9.3 %	3.8 %	-1.1 %	-7.0 %	-40.8 %

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8.4.4. Evaluation of selected design options per Base Case

8.4.4.1. BC1: Undercounter water-change dishwasher

Below (**Figure 8-1**), the change in PEF single score over the full life time of the Base Case is shown (left y-axis), together with the % change in costs per year (right y-axis). The same results are obtained when the PEF score is calculated per year of use of BC1 (not shown).

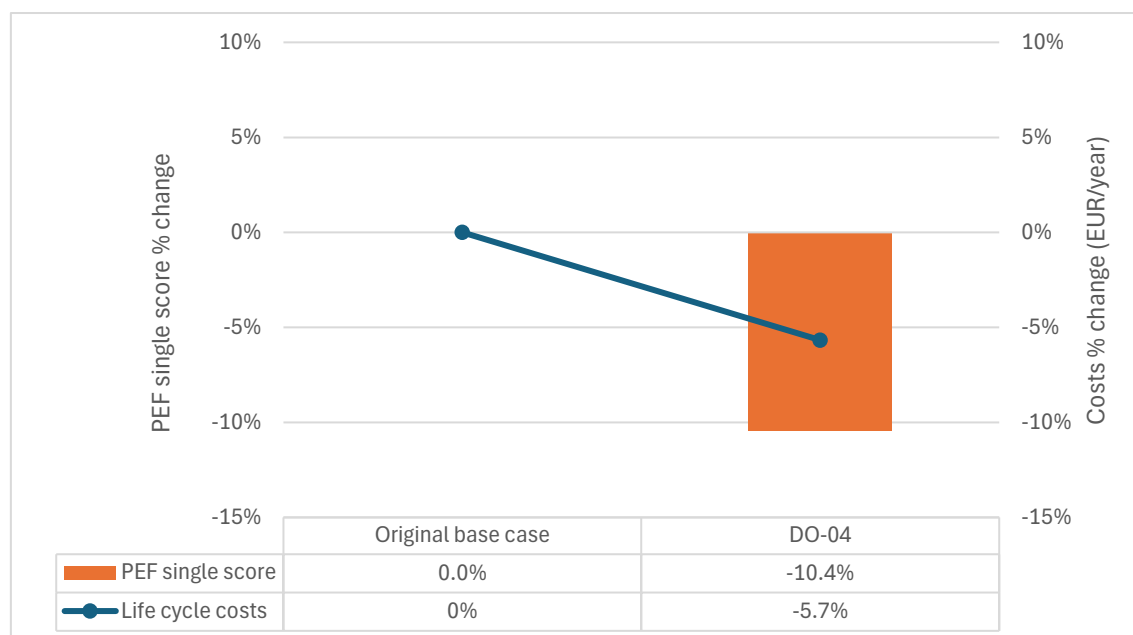


Figure 8-1: PEF score change (in %) per design option over the full life time versus costs change per year (in %).

8.4.4.2. BC2: Undercounter one-tank dishwasher

Below (**Figure 8-2**), the change in PEF single score over the full life time of the Base Case is shown (left y-axis), together with the % change in costs per year (right y-axis).

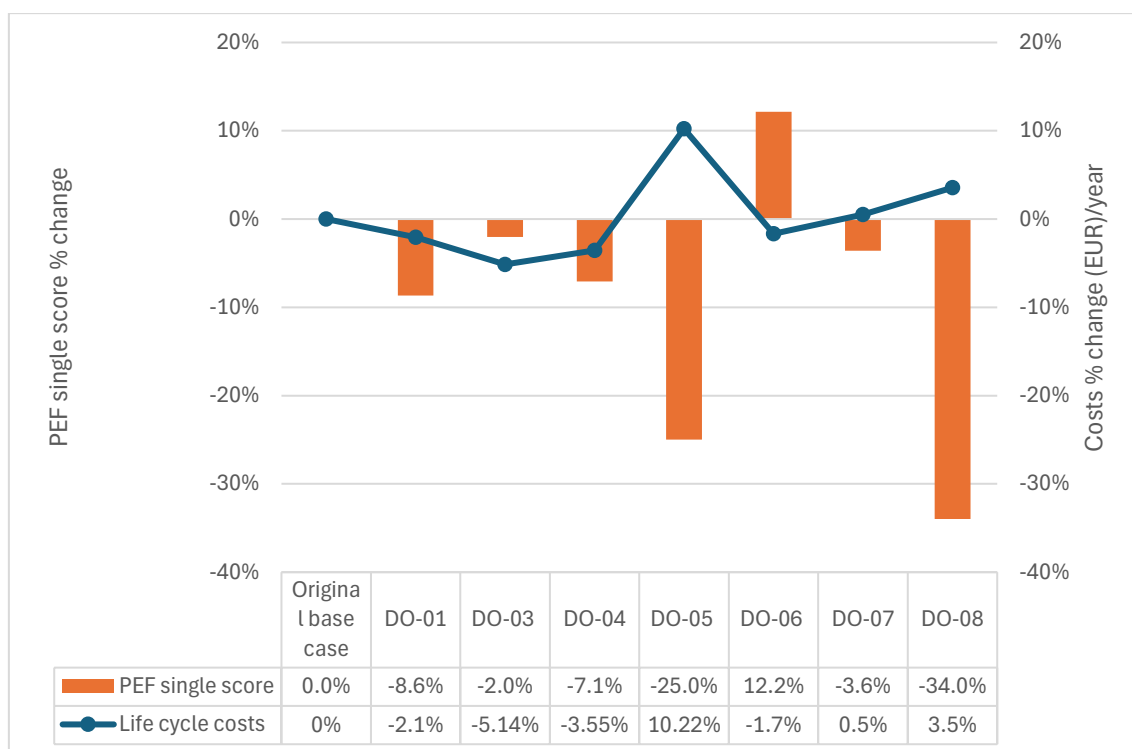


Figure 8-2: PEF score change (in %) per design option over the full life time versus costs change per year (in %).

To take into account the potential lifetime extension (DO-03, DO-06) or shortening (DO-05, DO-08), the PEF score change per design option is also reflected per year of use (see **Figure 8-3**) and combined with the cost change per year.

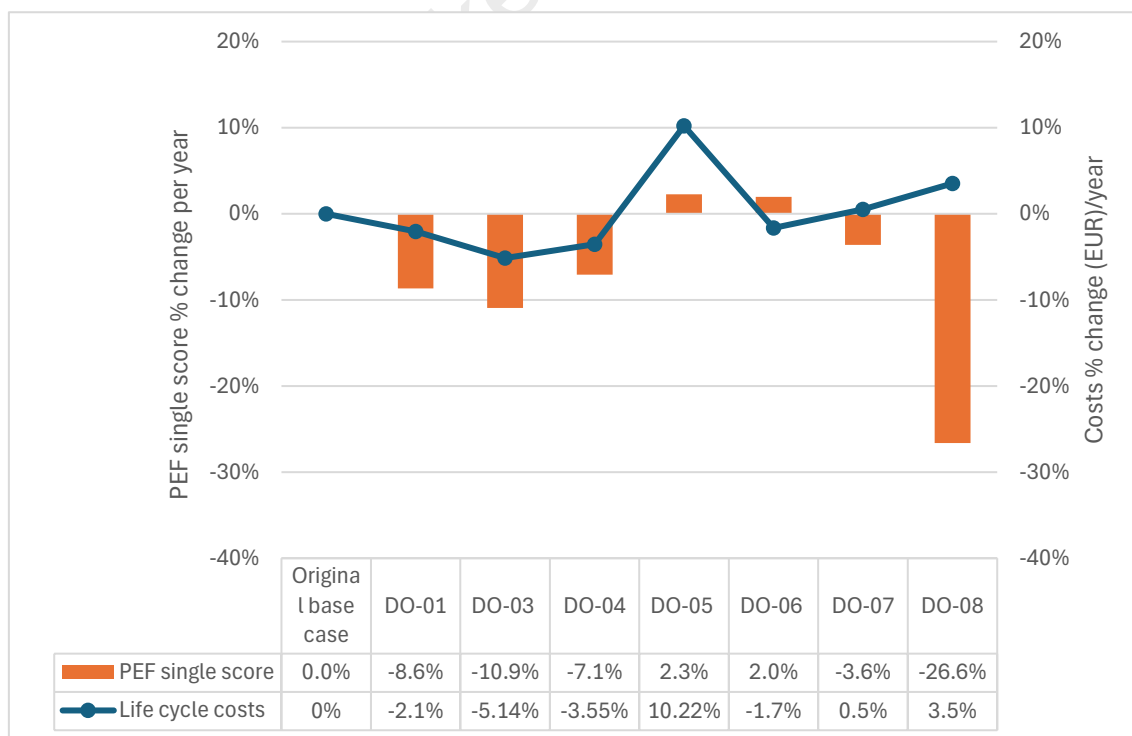


Figure 8-3: PEF score change (in %) per design option per year of use versus costs change per year (in %).

8.4.4.3. BC3: Hood-type dishwasher Environmental impact

Below (Figure 8-4), the change in PEF single score over the full life time of the Base Case is shown (left y-axis), together with the % change in costs per year (right y-axis).

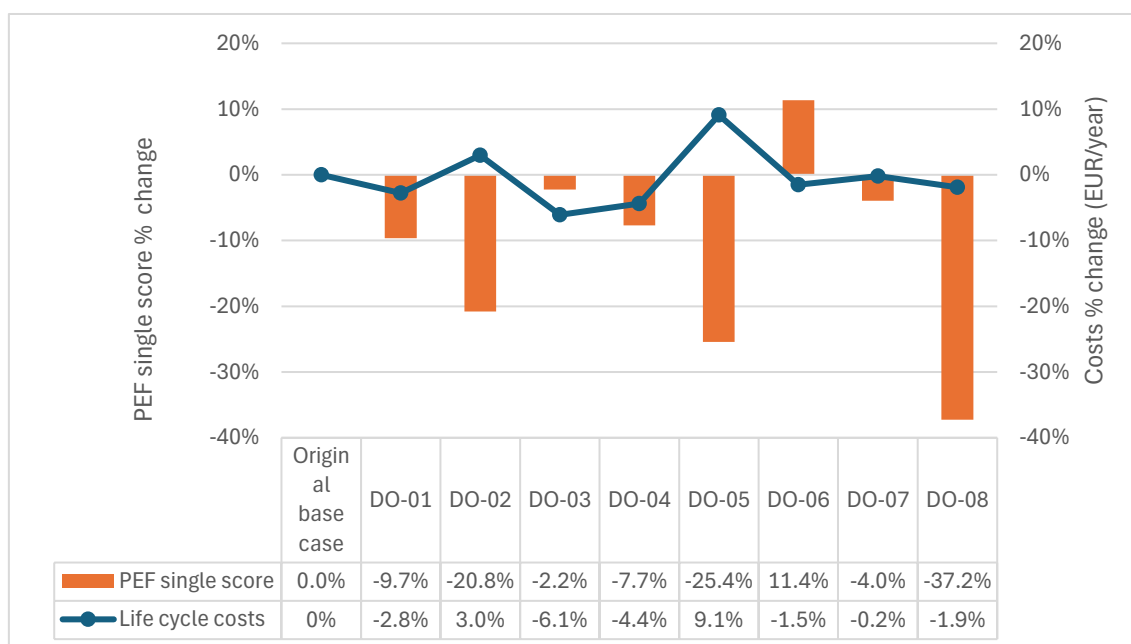


Figure 8-4: PEF score change (in %) per design option over the full life time versus costs change per year (in %).

To take into account the potential life time extension (DO-02- DO-03, DO-06) or shortening (DO-05, DO-08), the PEF score change per design option is also reflected per year of use (Figure 8-5) and combined with the cost change per year.

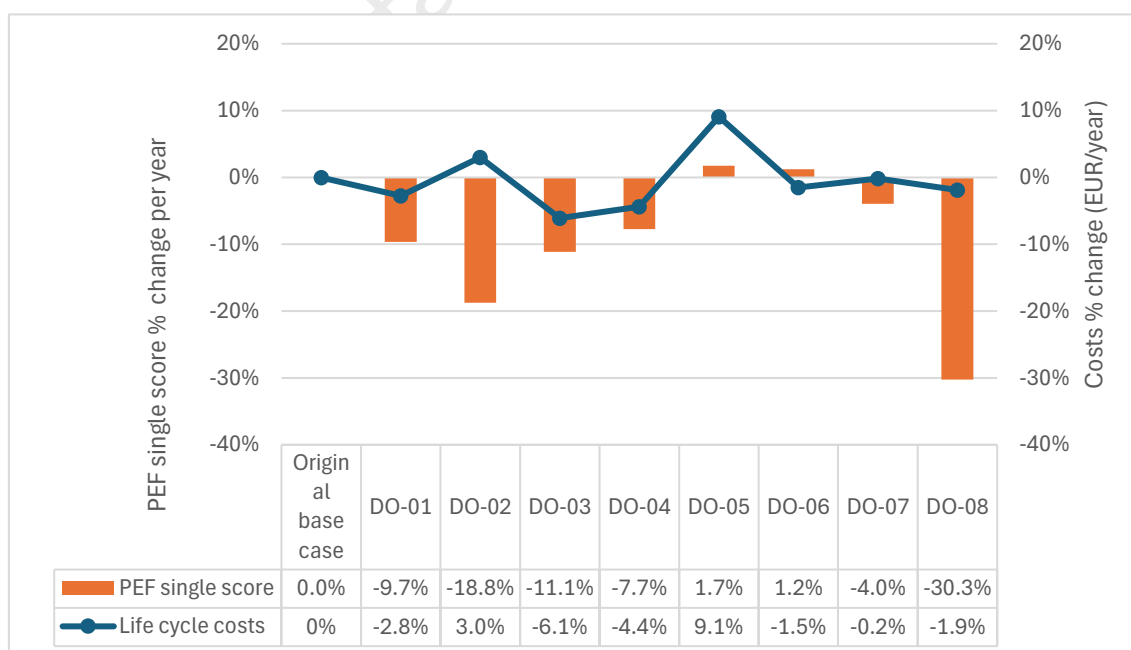


Figure 8-5: PEF score change (in %) per design option per year of use versus costs change per year (in %).

8.4.4.4. BC4: Utensil/pot dishwasher

Below (Figure 8-6), the change in PEF single score over the full life time of the Base Case is shown (left y-axis), together with the % change in costs per year (right y-axis).

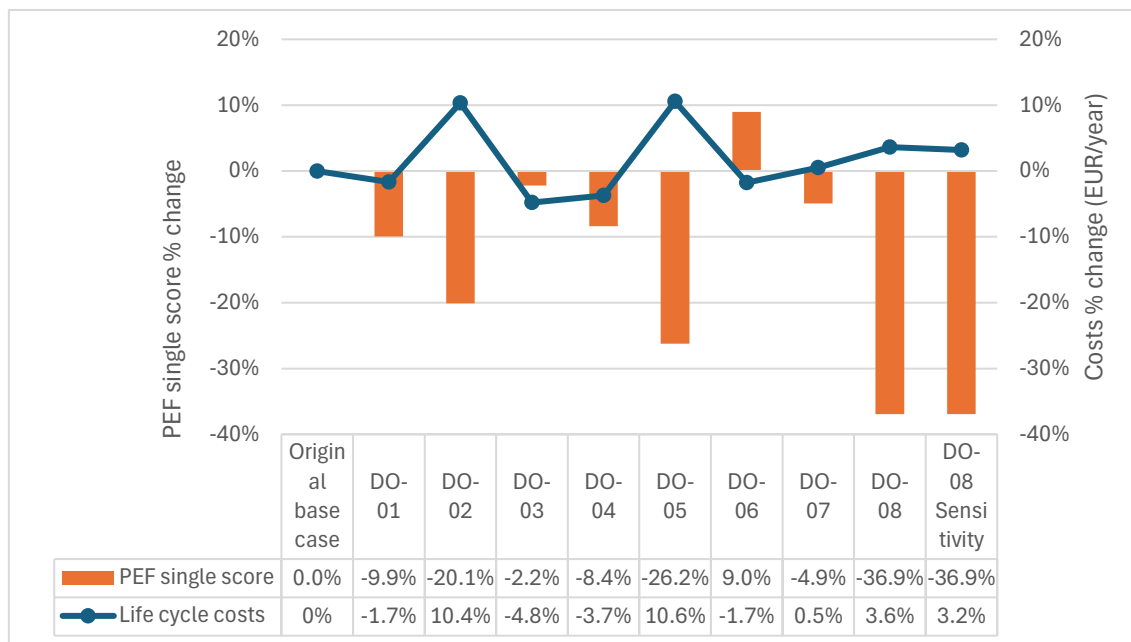


Figure 8-6: PEF score change (in %) per design option over the full life time versus costs change per year (in %).

To take into account the potential life time extension (DO-02- DO-03, DO-06) or shortening (DO-05, DO-08), the PEF score change per design option is also reflected per year of use (see Figure 8-7) and combined with the cost change per year.

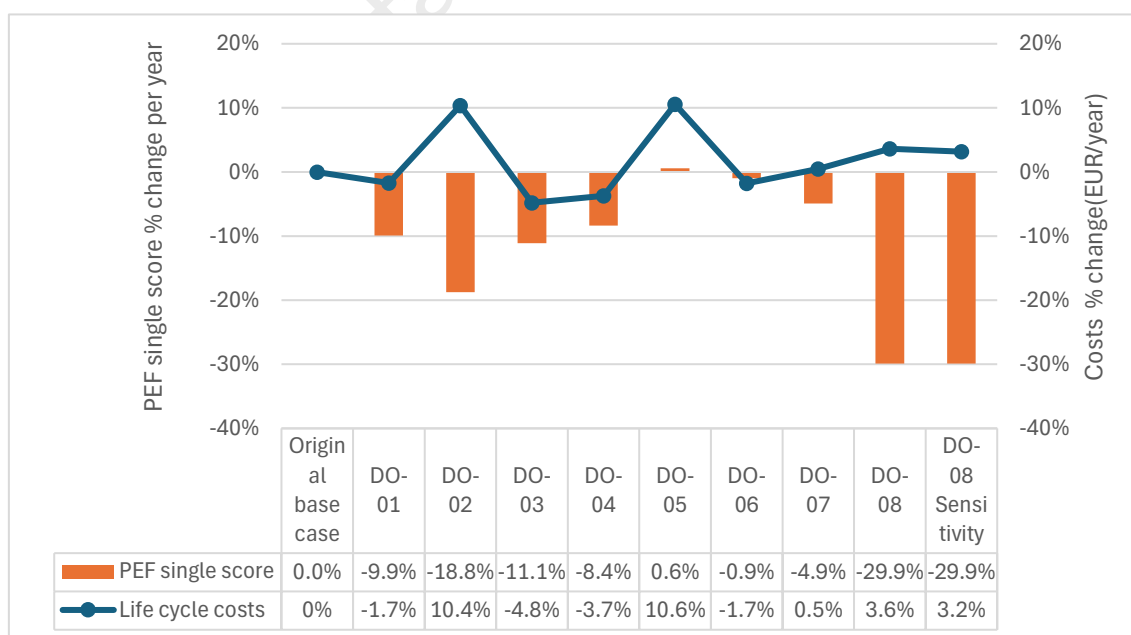


Figure 8-7: PEF score change (in %) per design option per year of use versus costs change per year (in %).

8.4.4.5. BC5: One-tank conveyor-type dishwasher

Below (Figure 8-8), the change in PEF single score over the full life time of the Base Case is shown (left y-axis), together with the % change in costs per year (right y-axis).

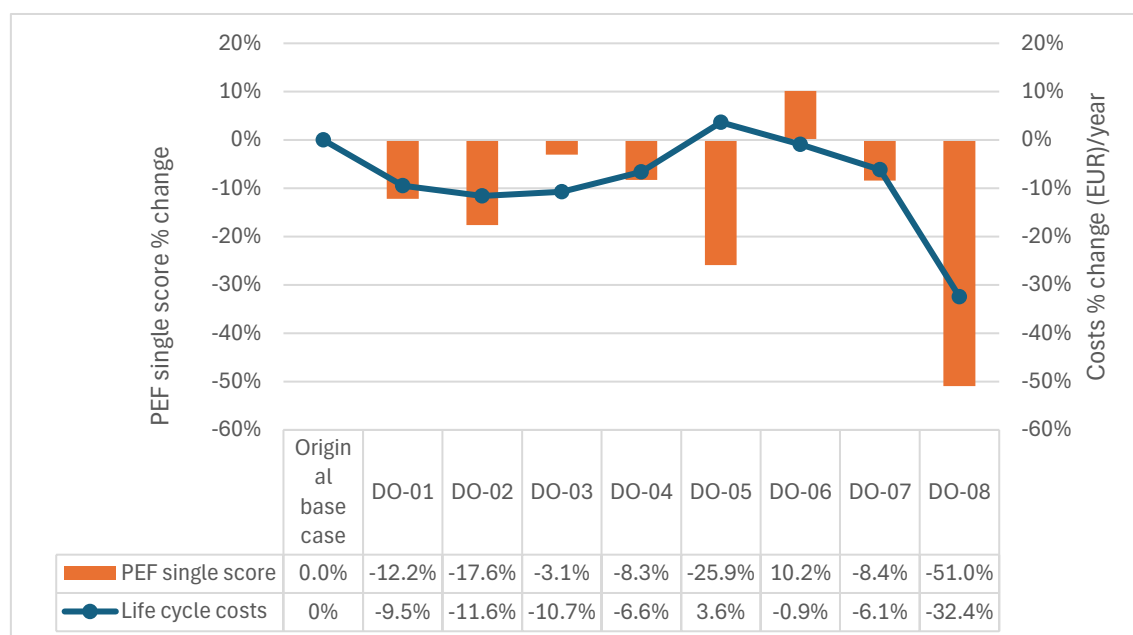


Figure 8-8: PEF score change (in %) per design option over the full life time versus costs change per year (in %).

To take into account the potential life time extension (DO-02- DO-03, DO-06) or shortening (DO-05, DO-08), the PEF score change per design option is also reflected per year of use (see Figure 8-9) and combined with the cost change per year.

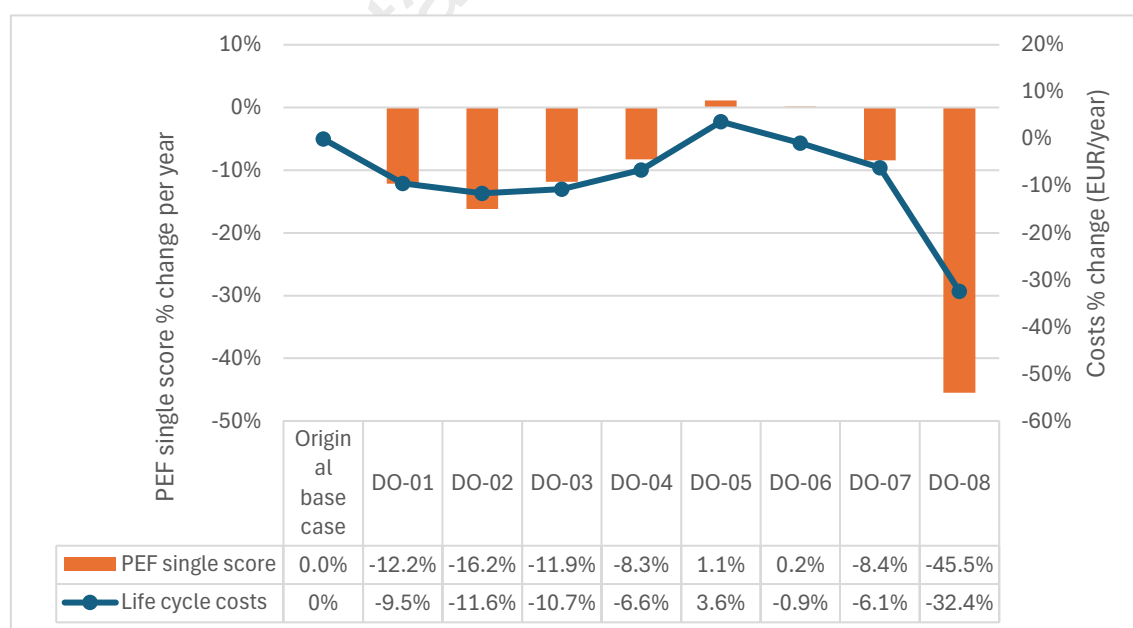


Figure 8-9: PEF score change (in %) per design option per year of use versus costs change per year (in %).

8.4.4.6. BC6: Multi-tank conveyor-type dishwasher

Below (Figure 8-10), the change in PEF single score over the full life time of the Base Case is shown (left y-axis), together with the % change in costs per year (right y-axis).

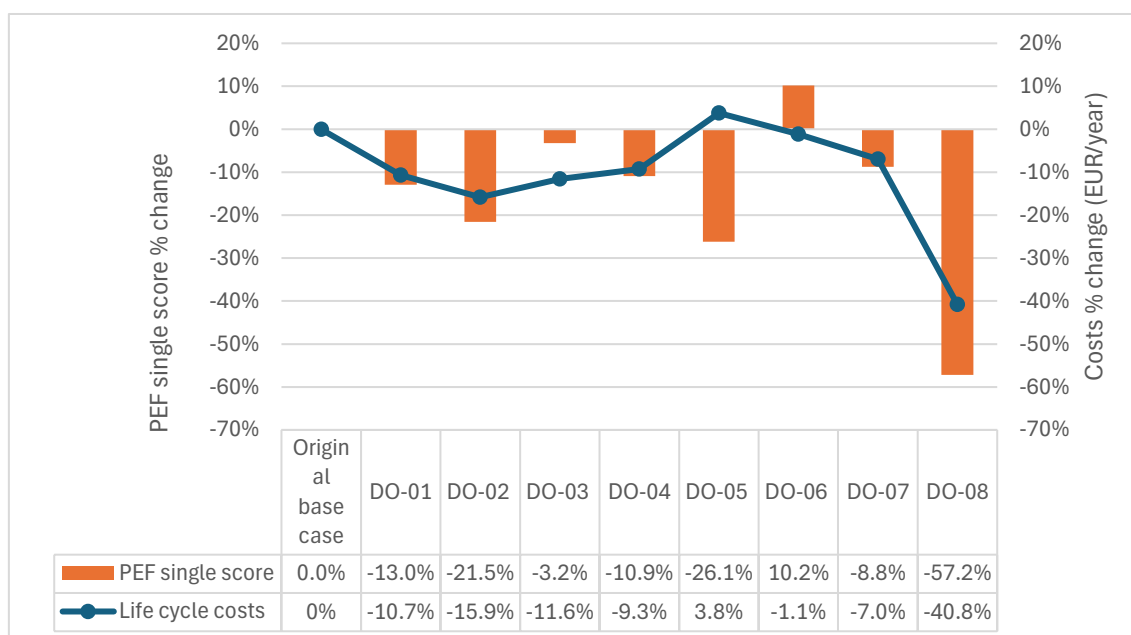


Figure 8-10: PEF score change (in %) per design option over the full lifetime versus costs change per year (in %).

To take into account the potential lifetime extension (DO-02- DO-03, DO-06) or shortening (DO-05, DO-08), the PEF score change per DO is also reflected per year of use (see Figure 8-11) and combined with the cost change per year.

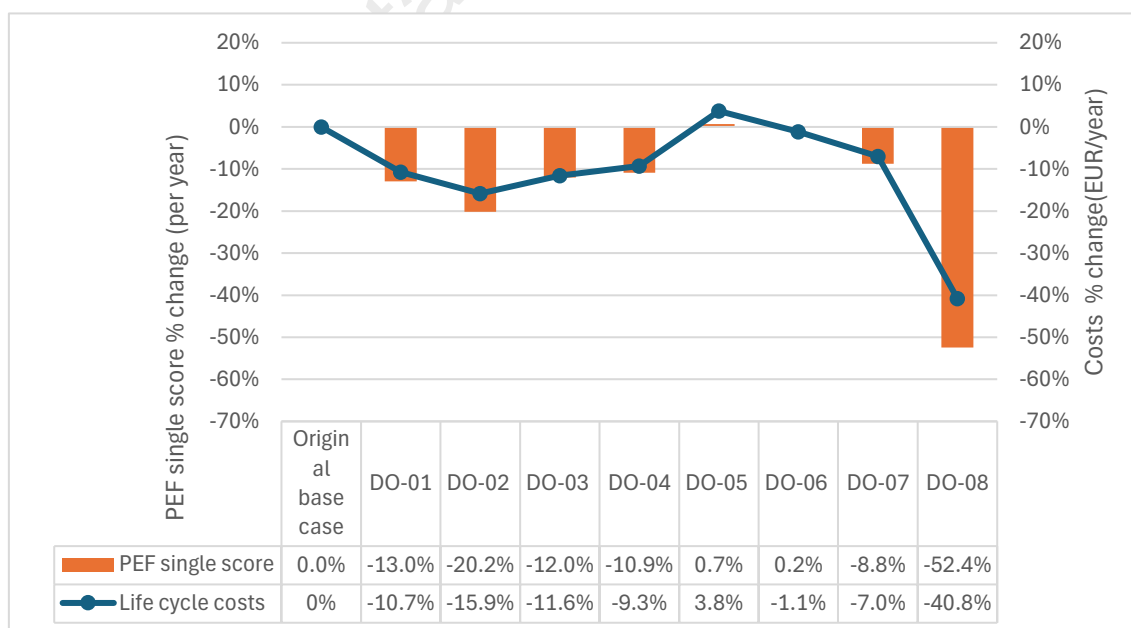


Figure 8-11: PEF score change (in %) per design option per year of use versus costs change per year (in %).

8.5. Conclusions

The evaluation of selected design options presented in the previous section allows to draw several major conclusions:

- In most cases, the examined design options have the potential to generate environmental benefits, which often go hand in hand with cost savings.
- DO-02 (Exhaust air heat pump) proves to be the most promising design option in terms of environmental benefits in the applicable dishwashing categories (BC3 to BC6), with a decrease in PEF score change ranging from 16 to 20 %. However, in the two largest dishwasher categories (BC5 and BC6) only, this design option also enables cost savings of 11 to 16 %. In the dishwasher categories BC3 and BC4, an increase in life cycle costs of 3 to 10 % has to be noted.
- DO-01 (Exhaust heat recovery (regenerator)) combines environmental benefits (9 to 13 %) with cost savings (2 to 11 %) in all applicable dishwashing categories (BC2 to BC6). However, the environmental benefits are significantly smaller than in the case of DO-02.
- The same applies to DO-03 (Automatic programme for load and soil recognition), DO-04 (Improved thermal insulation (double-walled design)) and DO-07 (Energy recovery from drain water), although the environmental benefits and cost savings are even lower, and in some cases below the significance threshold. For DO-07, there may even be slight cost increases in the dishwasher categories BC2 to BC4.
- The combined design option DO-08 offers the highest environmental relief potential, which can reach a decrease in PEF score from 27 to 52 % depending on the dishwasher category. However, significant savings in life cycle costs are only to be expected for the dishwasher categories BC5 and BC6, while for the dishwasher categories BC2 to BC4 there may even be slight cost increases.

8.6. Questions to stakeholders

Questions regarding input parameters for design options

- In general, confirmation/adaptation of the input data for each design option / Base Case would be appreciated.
- For all design options, the energy consumption reduction was modelled. This reduction was only applied to the energy consumption of the machine used directly by the machine (electricity, low pressure steam). However, for some Base Cases, additional hot water, heated up outside of the machine, was included as well. Should the energy for this hot water production also be included in the energy reduction potential of the design options?
- Is design option DO-07 relevant for Base Case BC1?

- 6150 - For Base Cases BC4 and BC6, Acrylonitrile Butadiene Styrene (ABS) was not included
6151 in the original Bill of materials; for the design options, this material was also not
6152 included, despite a percentage change compared to the original data of >100%.
6153 Should ABS be included in the design options, and if so, at what quantity?

Draft for stakeholder meeting 2

9. MEErP Task 7 – Scenarios

At the time of the editorial deadline for this version of the report, work on MEErP Task 7 had only just begun and is currently in full progress. Consequently, the current status of the work is not included in the report but will be presented at the stakeholder meeting.

9.1. Stock model

9.2. Design Option Incremental Costs

9.3. Product Life

9.4. Revenues

9.5. Consumer expenditure

9.6. Employment

9.7. Sensitivity analysis: Societal life cycle costs

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6401 **11.** **Appendices**

6402 **11.1.** **Appendix 1 – Online questionnaire of 1st stakeholder**
6403 **consultation**

6404 **11.2.** **Appendix 2 – Online questionnaire of 2nd stakeholder**
6405 **consultation**

6406 **11.3.** **Appendix 3 – Excel questionnaire of 2nd stakeholder**
6407 **consultation**

6408

Draft for stakeholder meeting 2

6409 11.4. Appendix 4 – Inputs for LCA / LCC per Base Case

6410 11.4.1. BC1: Undercounter water-change dishwasher

6411 11.4.1.1. Raw materials

6412 Below, the Bill of Materials (BoM) followed by the packaging used is provided for Base Case BC1 (**Table 11-1**) including recycled content, dataset used, data
6413 source and quality scoring. BoM data was sourced from Tasks 1-4 of this report.

6414 **Table 11-1: Bill of Materials for BC1.**

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Stainless Steel	3.50	kg	7.0 %	3-Ferro	Default	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Steel Sheet galvanised	18.50	kg	37.0 %	3-Ferro	Default	Medium quality	89-Steel hot dip galvanised steel sheet hot dip galvanisation single route, at plant 1.5 mm sheet thickness, 0.02 mm zinc thickness	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Polypropylene (PP)	10.21	kg	20.4 %	1-BlkPlastics	Default	Medium quality	16-Polypropylene (PP), petrochemical based polymerisation of bio-fossil propylene production mix, at plant petrochemical based	35-Polypropylene, recycled, post-consumer washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 90%

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Polyamid (PA)	0.82	kg	1.6 %	2-TecPlastics	Default	Medium quality	11-Nylon 6 fiber extrusion into fiber production mix, at plant 5% loss, 3,5 MJ electricity	31-Nylon fibre, recycled, mechanical, post-consumer washing, drying, shredding, drum rotating spinning production mix, at plant Erec/ErecEoL, efficiency 90%
Polymethylmetacrylate (PMMA)	0.01	kg	0.0 %	2-TecPlastics	Default	Medium quality	13-Polymethyl methacrylate (PMMA) granulate bulk polymerisation, from methyl methacrylate production mix, at plant 1.18 g/cm3	40-Recycling of post-consumer waste polypropylene (PP) collection, sorting, transport, washing, granulation, pelletisation production mix, at plant 48,9% recycling rate
Acrylonitrile Butadiene Styrene (ABS)	1.54	kg	3.1 %	1-BlkPlastics	Default	Medium quality	1-Acrylonitrile Butadiene Styrene (ABS) emulsion polymerisation, bulk polymerisation or combined processes production mix, at plant	36-Recycling plastic Acrylonitrile-butadiene-styrene (ABS), waste management, technology mix
Polystyrene (PS)	1.05	kg	2.1 %	1-BlkPlastics	Default	Medium quality	17-Polystyrene production, high impact polymerisation of styrene production mix, at plant 1.05 g/cm3	40-Recycling of post-consumer waste polypropylene (PP) collection, sorting, transport, washing, granulation, pelletisation production mix, at plant 48,9% recycling rate
Styropor expandable polystyrene (EPS)	0.08	kg	0.2 %	1-BlkPlastics	Default	Medium quality	5-EPS Beads from styrene polymerisation and foaming production mix, at plant 0.96- 1.04 g/cm3	not available
Polybutylene Terephthalate (PBT)	0.07	kg	0.1 %	1-BlkPlastics	Default	Medium quality	12-Polyethylene terephthalate (PET), petrochemical based polymerisation of ethylene glycol and terephthalic acid production mix, at plant petrochemical based	41-Polyethylene terephthalate (PET) granulate secondary ; no metal fraction from post-consumer waste, via washing, granulation, pelletisation production mix, at plant 90% recycling rate
Polyvinylchlorid (PVC)	0.83	kg	1.7 %	1-BlkPlastics	Default	Medium quality	22-PVC granulates, low density polymerisation of vinyl chloride production mix, at plant 62 g/mol per repeating unit	37-Recycling plastic (PVC), waste management, technology mix, at plant

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
EPDM-rubber	1.07	kg	2.1 %	1-BlkPlastics	Default	Medium quality	6-Ethylene propylene dien elastomer (EPDM) copolymerisation of ethylene and propylene production mix, at plant 69% ethylene, 38% propylene	39-Recycling of post-industrial waste EPDM rubber
POM	0.47	kg	0.9 %	1-BlkPlastics	Default	Medium quality	12-Polyethylene terephthalate (PET), petrochemical based polymerisation of ethylene glycol and terephthalic acid production mix, at plant petrochemical based	41-Polyethylene terephthalate (PET) granulate secondary ; no metal fraction from post-consumer waste, via washing, granulation, pelletisation production mix, at plant 90% recycling rate
PE	0.38	kg	0.8 %	1-BlkPlastics	Default	Medium quality	7-HDPE granulates Polymerisation of ethylene production mix, at plant 0.91- 0.96 g/cm ³ , 28 g/mol per repeating unit	28-High density polyethylene (HDPE), recycled washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 98%
Plastics others	0.55	kg	1.1 %	1-BlkPlastics	Default	Medium quality	16-Polypropylene (PP), petrochemical based polymerisation of bio-fossil propylene production mix, at plant petrochemical based	35-Polypropylene, recycled, post-consumer washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 90%
Aluminium	0.56	kg	1.1 %	4-Non-ferro	Default	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm ³ , >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%
Cu wire	2.06	kg	4.1 %	4-Non-ferro	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm ³
CuZn38 cast	0.05	kg	0.1 %	4-Non-ferro	Default	Medium quality	55-Brass anode furnace and casting, from copper and zinc, primary production single route, at plant 8.41- 8.86 g/cm ³	99-Brass, recycled, post-consumer die casting, from copper and zinc, primary production mix, at plant 8.41- 8.86 g/cm ³
Chrome	0.15	kg	0.3 %	4-Non-ferro	Default	Medium quality	278-Chromium oxide production; technology mix; production mix, at plant; 100% active substance	not available

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Bitumen	5.00	kg	10.0 %	7-Misc.	Default	Medium quality	214-Bitumen at refinery from crude oil production mix, at refinery 38.7 MJ/kg net calorific value	not available
Cotton	0.93	kg	1.9 %	7-Misc.	Default	Medium quality	Cut-off	Cut-off
Electronics (printed wiring board) Based on ERT, 1 m2 = 1.32 kg	1.64	m2	4.3 %	6-Electronics	Default	Medium quality	164-Printed wiring board (PWB) (2-layer) via the subtractive method (as opposed to additive method) production mix, at plant 2-layer, 1.32 kg	195-*End of life of Populated Printed wiring board (PWB) (2-layer) Recycling of copper and precious metals (Ag, Au, Pd, Pt) from electronics production mix, at plant recycling processes: 95- 98% efficiency, scrap incineration: 11.0 MJ/kg NCV
Total product weight	65.00	kg	100%					

6415

6416 **Table 11-2: Packaging used for BC1.**

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
EPS	0.518	kg	6.82 %	1-BlkPlastics	Default	Medium quality	5-EPS Beads from styrene polymerisation and foaming production mix, at plant 0.96-1.04 g/cm3	not available

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
PE-Foil	0.008	kg	0.11 %	1-BlkPlastics	Default	Medium quality	7-HDPE granulates Polymerisation of ethylene production mix, at plant 0.91-0.96 g/cm ³ , 28 g/mol per repeating unit	28-High density polyethylene (HDPE), recycled washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 98%
PP (pastic strips)	0.045	kg	0.59 %	1-BlkPlastics	Default	Medium quality	16-Polypropylene (PP), petrochemical based polymerisation of bio-fossil propylene production mix, at plant petrochemical based	35-Polypropylene, recycled, post-consumer washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 90%
Wood	4.5	kg	59.28 %	7-Misc.	Default	Medium quality	284-Plywood box; attaching veneer layers; production mix, at plant; 5% moisture	not available

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
Cardboard	2.52	kg	33.20 %	7-Misc.	Default	Medium quality	217-Corrugated board, uncoated "virgin" Kraft Pulping Process, pulp pressing and drying production mix, at plant flute thickness 0.8- 2.8 mm, R1=0%	238-Recycling paper and cardboard, waste management, technology mix, at plant collection, sorting, transport, recycling production mix, at plant paper waste, efficiency 90,9 %
Total packaging weight	7.59	kg	100 %					

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6418 11.4.1.2. Manufacturing

6419 Table 11-3: Energy inputs Manufacturing for BC1

Energy	Value	Unit	Source	Data quality assessment	Dataset used	Reference
Electricity	30	kWh	Stakeholder input	High quality	243-Electricity grid mix 1kV-60kV technology mix consumption mix, to consumer 1kV - 60kV	Proxy based on stakeholder feedback

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6421 Table 11-4: Material inputs Manufacturing for BC1

Material	Value	Unit	Input value ERT	Comments	Dataset used
Stainless Steel	18.50	kg	22.00	Best dataset choice from tool options	91-Steel sheet stamping and bending stamping and bending single route, at plant 5% loss
Steel Sheet galvanised	18.50	kg			
Polypropylen (PP)	10.21	kg	16.04	Best dataset choice from tool options	8-Injection moulding plastic injection moulding production mix, at plant for PP, HDPE and PE
Polyamid (PA)	0.82	kg		Proxy	
Polymethylmetacrylate (PMMA)	0.01	kg			
Acrylonitrile Butadiene Styrene (ABS)	1.54	kg			
Styropor expandable polystyrene (EPS)	0.08	kg			

Material	Value	Unit	Input value ERT	Comments	Dataset used
Polybutylene Terephthalate (PBT)	0.07	kg			
Polyvinylchlorid (PVC)	0.83	kg			
EPDM-rubber	1.07	kg			
POM	0.47	kg			
PE	0.38	kg			
Plastics others	0.55	kg			
Polystyrene (PS)	1.05	kg	1.05	Proxy	3-Blow moulding blow moulding production mix, at plant PET, HDPE and PP
Aluminium	0.56	kg	0.56	Best dataset choice from tool options	53-Aluminium sheet rolling primary production, aluminium deep- drawing single route, at plant 2.7 g/cm3
Cu wire	2.06	kg	2.06	Best dataset choice from tool options	65-Copper Wire Drawing wire drawing single route, at plant 8.92 g/cm3
CuZn38 cast	0.05	kg	0.05	Best dataset choice from tool options	57-Brass fittings casting single route, at plant containing copper and zinc
Chromium	0.15	kg	0.15	Best dataset choice from tool options	95-Tin plated chromium steel sheet steel sheet tin plating single route, at plant chromium steel
Bitumen	5.00	kg	-	Exclude	No relevant dataset
Cotton	0.93	kg	-	Cut-off	No relevant dataset

6423 11.4.1.3. Distribution

6424 Below, the transport scenario input data is provided (Table 11-5). Scenarios are based on PEF defaults as no stakeholder data was available.

6425 **Table 11-5: Distribution input for BC1**

Transport means	Value	Unit	Dataset used	Data Source	Data quality assessment	Comment
Transported weight (all modes of transport)	0.058	Ton	N/A			Based on total weight (BoM + Packaging)
Truck distance	1,330	Km	263-Articulated lorry transport, Euro 5, Total weight 28-32 t diesel driven, Euro 5, cargo consumption mix, to consumer 28 - 32t gross weight / 22t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory + from factory to final client
Train distance	240	Km	268-Freight train, electricity traction electricity driven, cargo consumption mix, to consumer average train, gross tonne weight 1000t / 726t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory
Ship distance	270	Km	265-Barge technology mix, diesel driven, cargo consumption mix, to consumer 1500 t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory

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6428 11.4.1.4. Use phase

6429 For the use phase, energy inputs (electricity and heat), water and detergent use were included. To calculate the exact inputs for the ERT (**Table 11-7**), the
 6430 parameters indicated in **Table 11-6** were used. For heat modelling, default efficiency values were used (105 %), incorporated in the ERT.

6431 **Table 11-6: Use phase parameters for calculation for BC1**

Description	Value	Unit	Source	Data quality assessment	Reference
Utilities input					
Annual energy consumption (total)	1,768	kWh	Stakeholder input	High quality	Tasks 1-4
Energy consumption: Electricity	100%	%	Stakeholder input	High quality	
Energy consumption: Heat	0%	%	Stakeholder input	High quality	
Annual water consumption (cold water)	43,990	litres/year	Stakeholder input	High quality	
Annual water consumption (hot water)	n.a.	litres/year	Stakeholder input	High quality	
Specific heat for water (1° C increase)	4.18	kJ/kg water	Scientific literature	High quality	(ThermExcel, n.d.).
Specific heat for water (increase from 15° C to 60 °C)	0.052	kWh/L water	Calculated		
Energy consumption: Heat for water heating	0	kWh/year	Calculated		
Operational information					
Cycles per day	7	cycles/day	Stakeholder input	High quality	Tasks 1-4
Number of working days per year	200	days/year	Stakeholder input	High quality	

Description	Value	Unit	Source	Data quality assessment	Reference
Dishes per cycle	50	unit	Stakeholder input	High quality	
Time in active mode per day	4	hours/day	Stakeholder input	High quality	
Auxiliary materials					
Annual detergent consumption	31	kg/year	Stakeholder input	High quality	Tasks 1-4
Annual rinsing agent consumption	integrated detergent and rinse aid	kg/year	Stakeholder input	High quality	

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6433 **Table 11-7: Use phase input data for BC1.**

Use phase inputs	Value	Unit	Comment	Reference
Electricity				
On-mode: Consumption per cycle	1.263	kWh		Calculations based on Table 11-6
On-mode: No. of cycles / year	1,400	#	Cycles per day* Number of working days per year	Calculations based on Table 11-6
Standby-mode: Consumption per hour	0	kWh	Included in real life electricity consumption	
Standby-mode: No. of hours / year	0	#		
Off-mode: Consumption per hour	-	kWh	N/A	
Off-mode: No. of hours / year	-	#	N/A	

Use phase inputs	Value	Unit	Comment	Reference
Heat				
Consumption of heat per cycle	0	kWh	Including heat for water heating	Calculations based on Table 11-6
No. of cycles / year	1,400	#	Cycles per day* Number of working days per year	Calculations based on Table 11-6
Avg. Heat Power Output	0	kW	Total energy per year/total operating time per year	Calculations based on Table 11-6
No. of hours / year	800	hrs.	Hours per cycle * cycles per year	Calculations based on Table 11-6
Water use				
Annual water use	43.99	m ³		Calculations based on Table 11-6
Auxiliary materials				
Annual detergent use	31	Kg/year		Calculations based on Table 11-6
Annual rinsing agent use	-			

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6436 11.4.1.5. Economic input data

6437 All economic input parameters are provided below (Table 11-8 and Table 11-10).

6438 Table 11-8: Economic inputs for BC1.

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Lifetime						
Average expected initial lifetime	12	years	Stakeholder input	High quality	Median number	Tasks 1-4
Weibull shape parameter (b)	1.6	-	Literature	Medium quality		Gama Caldas et al., 2024
Economic life cycle data						
Latest Annual sales	0.02340	Mln Units / year	Stakeholder input	High quality		Tasks 1-4
Assumed purchase price	3,148	Euro/unit	Expert judgement	Medium quality	Average price, extrapolation of 2011 data	Tasks 1-4
Number of priority parts for repair and upgrade	15	-	Literature	Medium quality	Priority parts should be identified by the Study-Team: identified based on JRC publication	(Cordella et al., 2019)

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Installation/acquisition costs (if any)	0	Euro/ unit			"No data in current study. 2011 study: "The installation of the dishwashers is taken into account in the product price so that there are no separate installation costs."	
Fuel rate (gas, oil, wood)	0.023	Euro/MJ	Literature	Medium quality	Eurostat data: average price between 2 different consumption bands, average price in EU-27, semester 1 2024.	(Eurostat, 2024)
Electricity rate	0.257	Euro/kWh	Literature	Medium quality	Average price between 2 different consumption bands (I1 and I2), average price in EU-27, semester 1 2024.	Tasks 1-4
Water rate	1.91	Euro/m ³	Literature	Medium quality	Statistics, average prices of water from EU members	Tasks 1-4
Repair & maintenance costs	1,385.1	Euro/ unit	Literature	Medium quality	Maintenance costs are 44% of the initial purchase costs	Tasks 1-4
Discount rate (interest minus inflation)	3	%	Literature	Medium quality	MEErP Review	Gama Caldas et al., 2024

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Escalation rate (project annual growth of running costs)	1.36%	%				See Table 11-9
Ratio efficiency STOCK: efficiency NEW, in Use Phase	0.9	-	Stakeholder input	High quality		Tasks 1-4
Price of auxiliary material 1: Detergent	4.22	Euro/kg detergent	Literature	Medium quality	Average taken between different minimum and maximum prices (different resellers) and average taken between the average minimum and average maximum price.	Tasks 1-4
Price of auxiliary material 2: Rinsing agent	3.93	Euro/kg detergent	Literature	Medium quality		

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6440 **Table 11-9: Escalation rate parameters for BC1.**

Use phase input	Escalation rate	Annual amount used	Annual costs	Share of total annual costs	Comments
Natural gas	2.15%	0.00	0.00	0%	Heat (kWh) divided by 1.05 to account for efficiency of natural gas boiler (105%)
Electricity	1.62%	1503.00	386.42	64%	
Water	0.16%	43989.93	84.02	14%	
Detergent	1.21%	30.80	129.94	22%	

Use phase input	Escalation rate	Annual amount used	Annual costs	Share of total annual costs	Comments
Weighted average Escalation rate	1.33%				

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6442 Table 11-10: Annual sales values for BC1.

Year	Sales per year	Unit	Reference
2023	0.008250	mln. units/year	Task 2
2022	0.008909	mln. units/year	
2021	0.008369	mln. units/year	
2020	0.007134	mln. units/year	
2019	0.007286	mln. units/year	
2018	0.005920	mln. units/year	
2017	0.007996	mln. units/year	
2016	0.006060	mln. units/year	
2015	0.005515	mln. units/year	
2014	0.004077	mln. units/year	
2013	0.003348	mln. units/year	
2012	0.001291	mln. units/year	
2011	0.006631	mln. units/year	

Year	Sales per year	Unit	Reference
2010	0.006887	mln. units/year	
2009	0.005945	mln. units/year	
2008	0.008556	mln. units/year	
2007 - 1993	0.006386	mln. units/year	Average of sales for years 2008-2023

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6444 **11.4.2. BC2: Undercounter one-tank dishwasher**6445 **11.4.2.1. Raw materials**

6446 Below, the Bill of Materials (BoM) followed by the packaging used is provided for Base Case BC2 (**Table 11-11**) including recycled content, dataset used, data
 6447 source and quality scoring. BoM data was sourced from Tasks 1-4 of this report.

6448 **Table 11-11: Bill of Materials for BC2.**

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Stainless steel	44.53	kg	65.2 %	3-Ferrous	Default	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Polypropylene (PP)	4.73	kg	6.9 %	1-BlkPlastics	Default	Medium quality	16-Polypropylene (PP), petrochemical based polymerisation of bio-fossil propylene production mix, at plant petrochemical based	35-Polypropylene, recycled, post-consumer washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 90%
Polyamide (PA)	0.50	kg	0.7 %	2-TecPlastics	Default	Medium quality	11-Nylon 6 fiber extrusion into fiber production mix, at plant 5% loss, 3,5 MJ electricity	31-Nylon fibre, recycled, mechanical, post-consumer washing, drying, shredding, drum rotating spinning production mix, at plant Erec/ErecEoL, efficiency 90%
Acrylonitrile Butadiene Styrene (ABS)	0.64	kg	0.9 %	1-BlkPlastics	Default	Medium quality	1-Acrylonitrile Butadiene Styrene (ABS) emulsion polymerisation, bulk polymerisation or combined processes production mix, at plant	36-Recycling plastic Acrylonitrile-butadiene-styrene (ABS), waste management, technology mix

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Pumps (copper)	2.45	kg	3.6 %	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm3
Pumps (stack of sheets)	2.45	kg	3.6 %	3-Ferrous	Default	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Pumps (stainless steel wave)	2.20	kg	3.2 %	3-Ferrous	Default	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Pumps (Al)	2.20	kg	3.2 %	4-Non-ferrous	Default	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm3, >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%
Aluminium	0.35	kg	0.5 %	4-Non-ferro	Default	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm3, >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%
Cable (copper)	1.20	kg	1.8 %	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm3

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Cable sheath (PVC)	0.30	kg	0.4 %	1-BlkPlastics	Default	Medium quality	22-PVC granulates, low density polymerisation of vinyl chloride production mix, at plant 62 g/mol per repeating unit	37-Recycling plastic (PVC), waste management, technology mix, at plant
Cable sheath (silicone, EPDM)	0.15	kg	0.2 %	1-BlkPlastics	Default	Medium quality	6-Ethylene propylene dien elastomer (EPDM) copolymerisation of ethylene and propylene production mix, at plant 69% ethylene, 38% propylene	39-Recycling of post-industrial waste EPDM rubber
Gaskets (EPDM)	2.67	kg	3.9 %	1-BlkPlastics	Default	Medium quality	6-Ethylene propylene dien elastomer (EPDM) copolymerisation of ethylene and propylene production mix, at plant 69% ethylene, 38% propylene	39-Recycling of post-industrial waste EPDM rubber
Electronics (printed wiring board) Based on ERT, 1 m2 = 1.32 kg	2.95	m2	5.7 %	6-Electronics	Default	Medium quality	164-Printed wiring board (PWB) (2-layer) via the subtractive method (as opposed to additive method) production mix, at plant 2-layer, 1.32 kg	195-*End of life of Populated Printed wiring board (PWB) (2-layer) Recycling of copper and precious metals (Ag, Au, Pd, Pt) from electronics production mix, at plant recycling processes: 95- 98% efficiency, scrap incineration: 11.0 MJ/kg NCV
Total product weight	68.27	kg	100 %					

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6451 Table 11-12: Packaging used for BC2.

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
EPS	0.81	kg	5.50%	1-BlkPlastics	Default	Medium quality	5-EPS Beads from styrene polymerisation and foaming production mix, at plant 0.96- 1.04 g/cm ³	not available
PE-Foil	0.25	kg	1.70%	1-BlkPlastics	Default	Medium quality	7-HDPE granulates Polymerisation of ethylene production mix, at plant 0.91- 0.96 g/cm ³ , 28 g/mol per repeating unit	28-High density polyethylene (HDPE), recycled washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 98%
PP (pastic strips)	0.654	kg	4.44%	1-BlkPlastics	Default	Medium quality	16-Polypropylene (PP), petrochemical based polymerisation of bio-fossil propylene production mix, at plant petrochemical based	35-Polypropylene, recycled, post-consumer washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 90%
PET	0.375	kg	2.55%	1-BlkPlastics	Default	Medium quality	12-Polyethylene terephthalate (PET), petrochemical based polymerisation of ethylene glycol and terephthalic acid production mix, at plant petrochemical based	41-Polyethylene terephthalate (PET) granulate secondary ; no metal fraction from post-consumer waste, via washing, granulation, pelletisation production mix, at plant 90% recycling rate
Wood	4.5	kg	30.58%	7-Misc.	Default	Medium quality	284-Plywood box; attaching veneer layers; production mix, at plant; 5% moisture	not available

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
Cardboard	8.125	kg	55.22%	7-Misc.	Default	Medium quality	217-Corrugated board, uncoated "virgin" Kraft Pulping Process, pulp pressing and drying production mix, at plant flute thickness 0.8- 2.8 mm, R1=0%	238-Recycling paper and cardboard, waste management, technology mix, at plant collection, sorting, transport, recycling production mix, at plant paper waste, efficiency 90,9%
Total packaging weight	14.71	kg	100%					

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11.4.2.2. Manufacturing

6454 **Table 11-13: Energy inputs Manufacturing for BC2.**

Energy	Value	Unit	Source	Data quality assessment	Dataset used	Reference
Electricity	30	kWh	Stakeholder input	High quality	243-Electricity grid mix 1kV-60kV technology mix consumption mix, to consumer 1kV - 60kV	Proxy based on stakeholder feedback

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6457 **Table 11-14: Material inputs Manufacturing for BC2.**

Material	Value	Unit	Input value ERT	Comments	Dataset used
Stainless steel	44.53	kg	49.18	Best dataset choice from tool options	91-Steel sheet stamping and bending stamping and bending single route, at plant 5% loss
Pumps (stack of sheets)	2.45	kg			
Pumps (stainless steel wave)	2.20	kg			
Polypropylene (PP)	4.73	kg	8.99	Best dataset choice from tool options	8-Injection moulding plastic injection moulding production mix, at plant for PP, HDPE and PE
Polyamide (PA)	0.50	kg		Proxy	
Acrylonitrile Butadiene Styrene (ABS)	0.64	kg			
Cable sheath (PVC)	0.30	kg			
Cable sheath (silicone, EPDM)	0.15	kg			
Gaskets (EPDM)	2.67	kg	3.65	Best dataset choice from tool options	65-Copper Wire Drawing wire drawing single route, at plant 8.92 g/cm3
Pumps (copper)	2.45	kg			
Cable (copper)	1.20	kg			
Pumps (Al)	2.20	kg	2.55	Best dataset choice from tool options	53-Aluminium sheet rolling primary production, aluminium deep- drawing single route, at plant 2.7 g/cm3
Aluminium	0.35	kg			

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11.4.2.3. Distribution

Below, the transport scenario input data is provided (Table 11-5). Scenarios are based on PEF defaults as no stakeholder data was available.

Table 11-15: Distribution input for BC2.

Transport means	Value	Unit	Dataset used	Data Source	Data quality assessment	Comment
Transported weight (all modes of transport)	0.083	ton	N/A			Based on total weight (BoM + Packaging)
Truck distance	1,330	km	263-Articulated lorry transport, Euro 5, Total weight 28-32 t diesel driven, Euro 5, cargo consumption mix, to consumer 28 - 32t gross weight / 22t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory + from factory to final client
Train distance	240	km	268-Freight train, electricity traction electricity driven, cargo consumption mix, to consumer average train, gross tonne weight 1000t / 726t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory
Ship distance	270	km	265-Barge technology mix, diesel driven, cargo consumption mix, to consumer 1500 t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory

6464 11.4.2.4. Use phase

6465 For the use phase, energy inputs (electricity and heat), water and detergent use were included. To calculate the exact inputs for the ERT (**Table 11-17**), the
 6466 parameters indicated in **Table 11-16** were used. For heat modelling, default efficiency values were used (105%), incorporated in the ERT.

6467 **Table 11-16: Use phase parameters for calculation for BC2.**

Description	Value	Unit	Source	Data quality assessment	Reference
Utilities input					
Annual energy consumption (total)	6,969	kWh	Stakeholder input	High quality	Tasks 1-4
Energy consumption: Electricity	100%	%	Stakeholder input	High quality	
Energy consumption: Heat	0%	%	Stakeholder input	High quality	
Annual water consumption (total)	163,153	litres/year	Stakeholder input	High quality	
Annual water consumption (hot water)	1,800	litres/year	Stakeholder input	High quality	
Specific heat for water (1° C increase)	4.18	kJ/kg water	Scientific literature	High quality	(ThermExcel, n.d.)
Specific heat for water (increase from 15° C to 60 ° C)	0.052	kWh/L water	Calculated		
Energy consumption: Heat for water heating	94	kWh/year	Calculated		
Operational information					
Cycles per day	55	cycles/day	Stakeholder input	High quality	Tasks 1-4
Number of working days per year	300	days/year	Stakeholder input	High quality	
Dishes per cycle	18	unit	Stakeholder input	High quality	
Time in active mode per day	12	hours/day	Stakeholder input	High quality	

Description	Value	Unit	Source	Data quality assessment	Reference
Auxiliary materials					
Annual detergent consumption	183	kg/year	Stakeholder input	High quality	Tasks 1-4
Annual rinsing agent consumption	16	kg/year	Stakeholder input	High quality	

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6469 **Table 11-17: Use phase input data for BC2.**

Use phase inputs	Value	Unit	Comment	Reference
Electricity				
On-mode: Consumption per cycle	0.422	kWh		Calculations based on Table 11-16
On-mode: No. of cycles / year	16,500	#	Cycles per day* Number of working days per year	Calculations based on Table 11-16
Standby-mode: Consumption per hour	0	kWh	Included in real life electricity consumption	
Standby-mode: No. of hours / year	0	#		
Off-mode: Consumption per hour	-	kWh	N/A	
Off-mode: No. of hours / year	-	#	N/A	
Heat				
Consumption of heat per cycle	0.006	kWh	Including heat for water heating	Calculations based on Table 11-16
No. of cycles / year	16,500	#	Cycles per day* Number of working days per year	Calculations based on Table 11-16
Avg. Heat Power Output	0.026	kW	Total energy per year/total operating time per year	Calculations based on Table 11-16

Use phase inputs	Value	Unit	Comment	Reference
No. of hours / year	3600	hrs.	Hours per cycle * cycles per year	Calculations based on Table 11-16
Water use				
Annual water use	163.15	m ³		Calculations based on Table 11-16
Auxiliary materials				
Annual detergent use	183	kg/year		Calculations based on Table 11-16
Annual rinsing agent use	16	kg/year		

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6471 **11.4.2.5. Economic input data**6472 All economic input parameters are provided below (**Table 11-18** and **Table 11-19**).6473 **Table 11-18: Economic inputs for BC2.**

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Lifetime						
Average expected initial lifetime	8	years	Stakeholder input	High quality	Median number	Tasks 1-4
Weibull shape parameter (b)	1.6	-	Literature	Medium quality		Gama Caldas et al., 2024
Economic life cycle data						

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Latest Annual sales	0.162012	Mln Units / year	Stakeholder input	High quality		Tasks 1-4
Assumed purchase price	5,659	Euro/unit	Expert judgement	Medium quality	Average price, extrapolation of 2011 data	Tasks 1-4
Number of priority parts for repair and upgrade	15	-	Literature	Medium quality	Priority parts should be identified by the Study-Team: identified based on JRC publication	(Cordella et al., 2019)
Installation/acquisition costs (if any)	0	Euro/ unit			"No data in current study. 2011 study: "The installation of the dishwashers is taken into account in the product price so that there are no separate installation costs."	
Fuel rate (gas, oil, wood)	0.023	Euro/MJ	Literature	Medium quality	Average price between 2 different consumption bands (I1 and I2), average price in EU-27, semester 1 2024.	(Eurostat, 2024)
Electricity rate	0.257	Euro/kWh	Literature	Medium quality	Average price between 2 different consumption bands, average price in EU-27, semester 1 2024.	Tasks 1-4
Water rate	1.91	Euro/m ³	Literature	Medium quality	Statistics, average prices of water from EU members	Tasks 1-4
Repair & maintenance costs	2,489.74	Euro/ unit	Literature	Medium quality	Maintenance costs are 44% of the initial purchase costs	Tasks 1-4

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Discount rate (interest minus inflation)	3	%	Literature	Medium quality	MEErP Review	Gama Caldas et al., 2024
Escalation rate (project annual growth of running costs)	1.35 %	%				See Table 11-19
Ratio efficiency STOCK: efficiency NEW, in Use Phase	1	-	Stakeholder input	High quality		Tasks 1-4
Price of auxiliary material 1: Detergent	4.22	Euro/kg detergent	Literature	Medium quality	Average taken between different minimum and maximum prices (different resellers) and average taken between the average minimum and average maximum price.	Tasks 1-4
Price of auxiliary material 2: Rinsing agent	3.93	Euro/kg detergent	Literature	Medium quality		

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6476 **Table 11-19: Escalation rate parameters for BC2.**

Use phase input	Escalation rate	Annual amount used	Annual costs	Share of total annual costs	Comments
Natural gas	2.15 %	89.57	7.57	0 %	Heat (kWh) divided by 1.05 to account for efficiency of natural gas boiler (105%)
Electricity	1.62 %	6969.20	1791.78	62 %	
Water	0.16 %	163153.40	311.62	11 %	
Detergent	1.21 %	182.96	771.85	27 %	
Weighted average Escalation rate	1.35 %				

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6478 **Table 11-20: Annual sales values for BC2.**

Year	Sales per year	Unit	Reference
2023	0.178760	mln. units/year	Task 2
2022	0.193026	mln. units/year	
2021	0.181322	mln. units/year	
2020	0.154560	mln. units/year	
2019	0.157874	mln. units/year	
2018	0.128270	mln. units/year	
2017	0.173252	mln. units/year	
2016	0.131295	mln. units/year	

Year	Sales per year	Unit	Reference
2015	0.119502	mln. units/year	
2014	0.088336	mln. units/year	
2013	0.072540	mln. units/year	
2012	0.027968	mln. units/year	
2011	0.143664	mln. units/year	
2010	0.149208	mln. units/year	
2009	0.128805	mln. units/year	
2008	0.185375	mln. units/year	
2007 - 1993	0.138360	mln. units/year	Average of sales for years 2008-2023

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6480 11.4.3. BC3: Hood-type dishwasher

6481 11.4.3.1. Raw materials

6482 Below, the Bill of Materials (BoM) followed by the packaging used is provided for Base Case BC3 (**Table 11-21**) including recycled content, dataset used, data
 6483 source and quality scoring. BoM data was sourced from the Tasks 1-4 of this study.

6484 **Table 11-21: Bill of Materials for BC3.**

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Stainless steel	112.05	kg	75.4 %	3-Ferrous	Stainless steel	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Polypropylene (PP)	6.81	kg	4.6 %	1-BlkPlastics	Polypropylene (PP)	Medium quality	16-Polypropylene (PP), petrochemical based polymerisation of bio-fossil propylene production mix, at plant petrochemical based	35-Polypropylene, recycled, post-consumer washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 90%

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Polyamide (PA)	1.55	kg	1.0 %	2-TecPlastics	Polyamide (PA)	Medium quality	11-Nylon 6 fiber extrusion into fiber production mix, at plant 5% loss, 3,5 MJ electricity	31-Nylon fibre, recycled, mechanical, post-consumer washing, drying, shredding, drum rotating spinning production mix, at plant Erec/ErecEoL, efficiency 90%
Acrylonitrile Butadiene Styrene (ABS)	0.64	kg	0.4 %	1-BlkPlastics	Acrylonitrile Butadiene Styrene (ABS)	Medium quality	1-Acrylonitrile Butadiene Styrene (ABS) emulsion polymerisation, bulk polymerisation or combined processes production mix, at plant	36-Recycling plastic Acrylonitrile-butadiene-styrene (ABS), waste management, technology mix
Pumps (copper)	3.85	kg	2.6 %	4-Non-ferrous	Pumps (copper)	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm3

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Pumps (stack of sheets)	3.85	kg	2.6 %	3-Ferrous	Pumps (stack of sheets)	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Pumps (stainless steel wave)	2.96	kg	2.0 %	3-Ferrous	Pumps (stainless steel wave)	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Pumps (Al)	3.85	kg	2.6 %	4-Non-ferrous	Pumps (Al)	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm ³ , >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Aluminium	2.00	kg	1.3 %	4-Non-ferro	Aluminium	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm ³ , >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%
Cable (copper)	1.38	kg	0.9 %	4-Non-ferrous	Cable (copper)	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm ³
Cable sheath (PVC)	0.81	kg	0.5 %	1-BlkPlastics	Cable sheath (PVC)	Medium quality	22-PVC granulates, low density polymerisation of vinyl chloride production mix, at plant 62 g/mol per repeating unit	37-Recycling plastic (PVC), waste management, technology mix, at plant

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Cable sheath (silicone, EPDM)	0.41	kg	0.3 %	1-BlkPlastics	Cable sheath (silicone, EPDM)	Medium quality	6-Ethylene propylene dien elastomer (EPDM) copolymerisation of ethylene and propylene production mix, at plant 69% ethylene, 38% propylene	39-Recycling of post-industrial waste EPDM rubber
Gaskets (EPDM)	3.54	kg	2.4 %	1-BlkPlastics	Gaskets (EPDM)	Medium quality	6-Ethylene propylene dien elastomer (EPDM) copolymerisation of ethylene and propylene production mix, at plant 69% ethylene, 38% propylene	39-Recycling of post-industrial waste EPDM rubber

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Electronics (printed wiring board) Based on ERT, 1 m ² = 1.32 kg	3.79	m ²	3.4 %	6-Electronics	Electronics (control)	Medium quality	164-Printed wiring board (PWB) (2-layer) via the subtractive method (as opposed to additive method) production mix, at plant 2-layer, 1.32 kg	195-*End of life of Populated Printed wiring board (PWB) (2-layer) Recycling of copper and precious metals (Ag, Au, Pd, Pt) from electronics production mix, at plant recycling processes: 95-98% efficiency, scrap incineration: 11.0 MJ/kg NCV
Total product weight	148.68	kg	100 %					

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6487 Table 11-22: Packaging used for BC3.

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
EPS	0.594	kg	2.27 %	1-BlkPlastics	Default	Medium quality	5-EPS Beads from styrene polymerisation and foaming production mix, at plant 0.96- 1.04 g/cm ³	not available
PE-Foil	0	kg	0.00 %	1-BlkPlastics	Default	Medium quality	7-HDPE granulates Polymerisation of ethylene production mix, at plant 0.91- 0.96 g/cm ³ , 28 g/mol per repeating unit	28-High density polyethylene (HDPE), recycled washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 98%
PP (plastic strips)	0.75	kg	2.86 %	1-BlkPlastics	Default	Medium quality	16-Polypropylene (PP), petrochemical based polymerisation of bio-fossil propylene production mix, at plant petrochemical based	35-Polypropylene, recycled, post-consumer washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 90%
PET	0.6	kg	4.08 %	1-BlkPlastics	Default	Medium quality	12-Polyethylene terephthalate (PET), petrochemical based polymerisation of ethylene glycol and terephthalic acid production mix, at plant petrochemical based	41-Polyethylene terephthalate (PET) granulate secondary ; no metal fraction from post-consumer waste, via washing, granulation, pelletisation production mix, at plant 90% recycling rate
Wood	15.125	kg	57.74 %	7-Misc.	Default	Medium quality	284-Plywood box; attaching veneer layers; production mix, at plant; 5% moisture	not available

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
Cardboard	9.125	kg	34.84%	7-Misc.	Default	Medium quality	217-Corrugated board, uncoated "virgin" Kraft Pulping Process, pulp pressing and drying production mix, at plant flute thickness 0.8- 2.8 mm, R1=0%	238-Recycling paper and cardboard, waste management, technology mix, at plant collection, sorting, transport, recycling production mix, at plant paper waste, efficiency 90,9%
Total packaging weight	26.19	kg	100%					

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11.4.3.2. Manufacturing

6490 **Table 11-23: Energy inputs Manufacturing for BC3.**

Energy	Value	Unit	Source	Data quality assessment	Dataset used	Reference
Electricity	36	kWh	Stakeholder input	High quality	243-Electricity grid mix 1kV-60kV technology mix consumption mix, to consumer 1kV - 60kV	Proxy based on stakeholder feedback

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6493 **Table 11-24: Material inputs Manufacturing for BC3.**

Material	Value	Unit	Input value ERT	Comments	Dataset used
Stainless steel	112.05	kg	118.85	Best dataset choice from tool options	91-Steel sheet stamping and bending stamping and bending single route, at plant 5% loss
Pumps (stack of sheets)	3.85	kg			
Pumps (stainless steel wave)	2.96	kg			
Polypropylene (PP)	6.81	kg	13.75	Best dataset choice from tool options	8-Injection moulding plastic injection moulding production mix, at plant for PP, HDPE and PE
Polyamide (PA)	1.55	kg		Proxy	
Acrylonitrile Butadiene Styrene (ABS)	0.64	kg			
Cable sheath (PVC)	0.81	kg			
Cable sheath (silicone, EPDM)	0.41	kg			
Gaskets (EPDM)	3.54	kg			
Pumps (copper)	3.85	kg	5.23	Best dataset choice from tool options	65-Copper Wire Drawing wire drawing single route, at plant 8.92 g/cm3
Cable (copper)	1.38	kg			
Pumps (Al)	3.85	kg	5.85	Best dataset choice from tool options	53-Aluminium sheet rolling primary production, aluminium deep- drawing single route, at plant 2.7 g/cm3
Aluminium	2.00	kg			

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11.4.3.3. Distribution

Below (Table 11-25), the transport scenario input data is provided. Scenarios are based on PEF defaults as no stakeholder data was available.

Table 11-25: Distribution input for BC3.

Transport means	Value	Unit	Dataset used	Data Source	Data quality assessment	Comment
Transported weight (all modes of transport)	0.175	ton	N/A			Based on total weight (BoM + Packaging)
Truck distance	1330	km	263-Articulated lorry transport, Euro 5, Total weight 28-32 t diesel driven, Euro 5, cargo consumption mix, to consumer 28 - 32t gross weight / 22t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory + from factory to final client
Train distance	240	km	268-Freight train, electricity traction electricity driven, cargo consumption mix, to consumer average train, gross tonne weight 1000t / 726t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory
Ship distance	270	km	265-Barge technology mix, diesel driven, cargo consumption mix, to consumer 1500 t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory

6501 11.4.3.4. Use phase

6502 For the use phase, energy inputs (electricity and heat), water and detergent use were included. To calculate the exact inputs for the ERT (**Table 11-27**), the
 6503 parameters indicated in **Table 11-26** were used. For heat modelling, default efficiency values were used (105%), incorporated in the ERT.

6504 **Table 11-26: Use phase parameters for calculation for BC3.**

Description	Value	Unit	Source	Data quality assessment	Reference
Utilities input					
Annual energy consumption (total)	14,066	kWh	Stakeholder input	High quality	Tasks 1-4
Energy consumption: Electricity	100%	%	Stakeholder input	High quality	
Energy consumption: Heat	0%	%	Stakeholder input	High quality	
Annual water consumption (total)	154,977	litres/year	Stakeholder input	High quality	
Annual water consumption (hot water)	6,000	litres/year	Stakeholder input	High quality	
Specific heat for water (1° C increase)	4.18	kJ/kg water	Scientific literature	High quality	(ThermExcel, n.d.)

Description	Value	Unit	Source	Data quality assessment	Reference
Specific heat for water (increase from 15° C to 60 ° C)	0.052	kWh/L water	Calculated		
Energy consumption: Heat for water heating	314	kWh/year	Calculated		
Operational information					
Cycles per day	110	cycles/day	Stakeholder input	High quality	Tasks 1-4
Number of working days per year	300	days/year	Stakeholder input	High quality	Tasks 1-4
Dishes per cycle	18	unit	Stakeholder input	High quality	Tasks 1-4
Time in active mode per day	12	hours/day	Stakeholder input	High quality	Tasks 1-4
Auxiliary materials					
Annual detergent consumption	315	kg/year	Stakeholder input	High quality	Tasks 1-4
Annual rinsing agent consumption	24	kg/year	Stakeholder input	High quality	Tasks 1-4

6505 Table 11-27: Use phase input data for BC3.

Use phase inputs	Value	Unit	Comment	Reference
Electricity				
On-mode: Consumption per cycle	0.426	kWh		Calculations based on Table 11-26
On-mode: No. of cycles / year	33,000	#	Cycles per day* Number of working days per year	Calculations based on Table 11-26
Standby-mode: Consumption per hour	0	kWh	Included in real life electricity consumption	
Standby-mode: No. of hours / year	0	#		
Off-mode: Consumption per hour	-	kWh	N/A	
Off-mode: No. of hours / year	-	#	N/A	
Heat				
Consumption of heat per cycle	0.010	kWh	Including heat for water heating	Calculations based on Table 11-26
No. of cycles / year	33,000	#	Cycles per day* Number of working days per year	Calculations based on Table 11-26
Avg. Heat Power Output	0.087	kW	Total energy per year/total operating time per year	Calculations based on Table 11-26
No. of hours / year	3,600	hrs.	Hours per cycle * cycles per year	Calculations based on Table 11-26
Water use				
Annual water use	154.98	m ³		Calculations based on Table 11-26
Auxiliary materials				
Annual detergent use	315	kg/year		Calculations based on Table 11-26
Annual rinsing agent use	24	kg/year		

6506 11.4.3.5. Economic input data

6507 All economic input parameters are provided below (Table 11-28 and Table 11-30).

6508 Table 11-28: Economic inputs for BC3.

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Lifetime						
Average expected initial lifetime	8	years	Stakeholder input	High quality	Median number	Tasks 1-4
Weibull shape parameter (b)	1.6	-	Literature	Medium quality		Gama Caldas et al., 2024
Economic life cycle data						
Latest Annual sales	0.077252	Mln Units / year	Stakeholder input	High quality		Tasks 1-4
Assumed purchase price	8,662	Euro/unit	Expert judgement	Medium quality	Average price, extrapolation of 2011 data	Tasks 1-4
Number of priority parts for repair and upgrade	15	-	Literature	Medium quality	Priority parts should be identified by the Study-Team: identified based on JRC publication	(Cordella et al., 2019)
Installation/acquisition costs (if any)	0	Euro/unit			"No data in current study. 2011 study: "The installation of the dishwashers is taken into account in the product price so that there are no separate installation costs."	

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Fuel rate (gas, oil, wood)	0.023	Euro/MJ	Literature	Medium quality	Average price between 2 different consumption bands (I1 and I2), average price in EU-27, semester 1 2024.	(Eurostat, 2024)
Electricity rate	0.257	Euro/kWh	Literature	Medium quality	Average price between 2 different consumption bands, average price in EU-27, semester 1 2024.	Tasks 1-4
Water rate	1.91	Euro/m ³	Literature	Medium quality	Statistics, average prices of water from EU members	Tasks 1-4
Repair & maintenance costs	3,811.46	Euro/unit	Literature	Medium quality	Maintenance costs are 44% of the initial purchase costs	Tasks 1-4
Discount rate (interest minus inflation)	3	%	Literature	Medium quality	MEErP Review	European Commission/JRC, 2024
Escalation rate (project annual growth of running costs)	1.44	%				See Table 11-29
Ratio efficiency STOCK: efficiency NEW, in Use Phase	1	-	Stakeholder input	High quality		Tasks 1-4
Price of auxiliary material 1: Detergent	4.22	Euro/kg detergent	Literature	Medium quality	Average taken between different minimum and maximum prices (different resellers) and average taken	Tasks 1-4

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Price of auxiliary material 2: Rinsing agent	3.93	Euro/kg detergent	Literature	Medium quality	between the average minimum and average maximum price.	

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6510 **Table 11-29: Escalation rate parameters for BC3.**

Use phase input	Escalation rate	Annual amount used	Annual costs	Share of total annual costs	Comments
Natural gas	2.15 %	298.57	25.23	0 %	Heat (kWh) divided by 1.05 to account for efficiency of natural gas boiler (105%)
Electricity	1.62 %	14065.70	3616.29	69 %	
Water	0.16 %	154977.00	296.01	6 %	
Detergent	1.21 %	315.24	1329.93	25 %	
Weighted average Escalation rate	1.44 %				

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6513 **Table 11-30: Annual sales values for BC3.**

Year	Sales per year	Unit	Reference
2023	0.066004	mln. units/year	Task 2
2022	0.071271	mln. units/year	
2021	0.066950	mln. units/year	
2020	0.057068	mln. units/year	
2019	0.058292	mln. units/year	
2018	0.047361	mln. units/year	
2017	0.063970	mln. units/year	
2016	0.048478	mln. units/year	
2015	0.044124	mln. units/year	
2014	0.032616	mln. units/year	
2013	0.026784	mln. units/year	
2012	0.010326	mln. units/year	
2011	0.053045	mln. units/year	
2010	0.055092	mln. units/year	
2009	0.047559	mln. units/year	
2008	0.068446	mln. units/year	
2007 - 1993	0.051087	mln. units/year	Average of sales for years 2008-2023

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6515 **11.4.4. BC4: Utensil/pot dishwasher**

6516 **11.4.4.1. Raw materials**

6517 Below, the Bill of Materials (BoM) followed by the packaging used is provided for Base Case BC4 (**Table 11-31**) including recycled content, dataset used, data
6518 source and quality scoring. BoM data was sourced from the Task 1-4 of this study.

6519 **Table 11-31: Bill of Materials for BC4.**

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Stainless steel	165.00	kg	80.1%	3-Ferrous	Default	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Polypropylene (PP)	3.00	kg	1.5%	1-BlkPlastics	Default	Medium quality	16-Polypropylene (PP), petrochemical based polymerisation of bio-fossil propylene production mix, at plant petrochemical based	35-Polypropylene, recycled, post-consumer washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 90%
Polyamide (PA)	4.00	kg	1.9%	2-TecPlastics	Default	Medium quality	11-Nylon 6 fiber extrusion into fiber production mix, at plant 5% loss, 3,5 MJ electricity	31-Nylon fibre, recycled, mechanical, post-consumer washing, drying, shredding, drum rotating spinning production mix, at plant Erec/ErecEoL, efficiency 90%
Ethylene Propylene Dien M-class rubber (EPDM)	4.00	kg	1.9%	1-BlkPlastics	Default	Medium quality	1-Acrylonitrile Butadiene Styrene (ABS) emulsion polymerisation, bulk polymerisation or combined processes production mix, at plant	36-Recycling plastic Acrylonitrile-butadiene-styrene (ABS), waste management, technology mix

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Acrylonitrile Butadiene Styrene (ABS)	0.00	kg	0.0%	1-BlkPlastics	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm3
Pumps (copper)	5.00	kg	2.4%	4-Non-ferrous	Default	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Pumps (stack of sheets)	4.00	kg	1.9%	3-Ferrous	Default	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Pumps (stainless steel wave)	3.00	kg	1.5%	3-Ferrous	Default	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm3, >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%
Pumps (Al)	5.00	kg	2.4%	4-Non-ferrous	Default	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm3, >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%
Cable (copper)	2.40	kg	1.2%	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm3

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Cable sheath (PVC)	1.40	kg	0.7%	1-BlkPlastics	Default	Medium quality	22-PVC granulates, low density polymerisation of vinyl chloride production mix, at plant 62 g/mol per repeating unit	37-Recycling plastic (PVC), waste management, technology mix, at plant
Cable sheath (silicone, EPDM)	1.10	kg	0.5%	1-BlkPlastics	Default	Medium quality	6-Ethylene propylene dien elastomer (EPDM) copolymerisation of ethylene and propylene production mix, at plant 69% ethylene, 38% propylene	39-Recycling of post-industrial waste EPDM rubber
Gaskets, etc. (EPDM)	6.00	kg	2.9%	1-BlkPlastics	Default	Medium quality	6-Ethylene propylene dien elastomer (EPDM) copolymerisation of ethylene and propylene production mix, at plant 69% ethylene, 38% propylene	39-Recycling of post-industrial waste EPDM rubber
Electronics (printed wiring board) Based on ERT, 1 m2 = 1.32 kg	1.59	m2	1.0%	6-Electronics	Default	Medium quality	164-Printed wiring board (PWB) (2-layer) via the subtractive method (as opposed to additive method) production mix, at plant 2-layer, 1.32 kg	195-*End of life of Populated Printed wiring board (PWB) (2-layer) Recycling of copper and precious metals (Ag, Au, Pd, Pt) from electronics production mix, at plant recycling processes: 95- 98% efficiency, scrap incineration: 11.0 MJ/kg NCV
Total product weight	206	kg	100%					

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6522 Table 11-32: Packaging used for BC4.

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
EPS	0.55	kg	2%	1-BlkPlastics	Default	Medium quality	5-EPS Beads from styrene polymerisation and foaming production mix, at plant 0.96- 1.04 g/cm3	not available
PE-Foil	0	kg	0%	1-BlkPlastics	Default	Medium quality	7-HDPE granulates Polymerisation of ethylene production mix, at plant 0.91- 0.96 g/cm3, 28 g/mol per repeating unit	28-High density polyethylene (HDPE), recycled washing, drying, shredding, pelletising production mix, at plant Erec/ErecEoL, efficiency 98%
PP (plastic strips)	0.5385	kg	2%	1-BlkPlastics	Default	Medium quality	16-Polypropylene (PP), petrochemical based polymerisation of bio-fossil propylene production mix, at plant petrochemical based	35-Polypropylene, recycled, post-consumer washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 90%
PET	0.6855	kg	5%	1-BlkPlastics	Default	Medium quality	12-Polyethylene terephthalate (PET), petrochemical based polymerisation of ethylene glycol and terephthalic acid production mix, at plant petrochemical based	41-Polyethylene terephthalate (PET) granulate secondary ; no metal fraction from post-consumer waste, via washing, granulation, pelletisation production mix, at plant 90% recycling rate
Wood	15.75	kg	64%	7-Misc.	Default	Medium quality	284-Plywood box; attaching veneer layers; production mix, at plant; 5% moisture	not available

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
Cardboard	7.25	kg	29%	7-Misc.	Default	Medium quality	217-Corrugated board, uncoated "virgin" Kraft Pulping Process, pulp pressing and drying production mix, at plant flute thickness 0.8- 2.8 mm, R1=0%	238-Recycling paper and cardboard, waste management, technology mix, at plant collection, sorting, transport, recycling production mix, at plant paper waste, efficiency 90,9%
Total packaging weight	24.77	kg	100%					

11.4.4.2. Manufacturing

Table 11-33: Energy inputs Manufacturing for BC4.

Energy	Value	Unit	Source	Data quality assessment	Dataset used	Reference
Electricity	40	kWh	Stakeholder input	High quality	243-Electricity grid mix 1kV-60kV technology mix consumption mix, to consumer 1kV - 60kV	Proxy based on stakeholder feedback

6528 **Table 11-34: Material inputs Manufacturing for BC4.**

Material	Value	Unit	Input value ERT	Comments	Dataset used
Stainless steel	165.00	kg	174.00	Best dataset choice from tool options	91-Steel sheet stamping and bending stamping and bending single route, at plant 5% loss
Pumps (stainless steel wave)	5.00	kg			
Pumps (stack of sheets)	4.00	kg			
Polypropylene (PP)	3.00	kg	19.50	Best dataset choice from tool options	8-Injection moulding plastic injection moulding production mix, at plant for PP, HDPE and PE
Polyamide (PA)	4.00	kg		Proxy	
Ethylene Propylene Dien M-class rubber (EPDM)	4.00	kg			
Cable sheath (PVC)	1.40	kg			
Cable sheath (silicone, EPDM)	1.10	kg			
Gaskets, etc. (EPDM)	6.00	kg			
Pumps (copper)	0.00	kg	2.40	Best dataset choice from tool options	65-Copper Wire Drawing wire drawing single route, at plant 8.92 g/cm3
Cable (copper)	2.40	kg			
Pumps (Al)	3.00	kg	3.00	Best dataset choice from tool options	53-Aluminium sheet rolling primary production, aluminium deep- drawing single route, at plant 2.7 g/cm3

6529

6530 11.4.4.3. Distribution

6531 Below, the transport scenario input data is provided (**Table 11-35**). Scenarios are based on PEF defaults as no stakeholder data was available.

6532 **Table 11-35: Distribution input for BC4.**

Transport means	Value	Unit	Dataset used	Data Source	Data quality assessment	Comment
Transported weight (all modes of transport)	0.231	ton	N/A			Based on total weight (BoM + Packaging)
Truck distance	1,330	km	263-Articulated lorry transport, Euro 5, Total weight 28-32 t diesel driven, Euro 5, cargo consumption mix, to consumer 28 - 32t gross weight / 22t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory + from factory to final client
Train distance	240	km	268-Freight train, electricity traction electricity driven, cargo consumption mix, to consumer average train, gross tonne weight 1000t / 726t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory
Ship distance	270	km	265-Barge technology mix, diesel driven, cargo consumption mix, to consumer 1500 t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory

6533

6534 11.4.4.4. Use phase

6535 For the use phase, energy inputs (electricity and heat), water and detergent use were included. To calculate the exact inputs for the ERT (**Table 11-37**), the
 6536 parameters indicated in **Table 11-36** were used. For heat modelling, default efficiency values were used (105 %), incorporated in the ERT.

6537 Table 11-36: Use phase parameters for calculation for BC4.

Description	Value	Unit	Source	Data quality assessment	Reference
Utilities input					
Annual energy consumption (total)	12,115	kWh	Stakeholder input	High quality	Tasks 1-4
Energy consumption: Electricity	98%	%	Stakeholder input	High quality	Tasks 1-4
Energy consumption: Heat	2%	%	Stakeholder input	High quality	Tasks 1-4
Annual water consumption (total)	116,700	litres/year	Stakeholder input	High quality	Tasks 1-4
Annual water consumption (hot water)	18,000	litres/year	Stakeholder input	High quality	Tasks 1-4
Specific heat for water (1° C increase)	4.18	kJ/kg water	Scientific literature	High quality	(ThermExcel, n.d.)
Specific heat for water (increase from 15° C to 60° C)	188.1	kWh/L water	Calculated		

Description	Value	Unit	Source	Data quality assessment	Reference
Energy consumption: Heat for water heating	941	kWh/year	Calculated		
Operational information					
Cycles per day	30	cycles/day	Stakeholder input	High quality	Tasks 1-4
Number of working days per year	300	days/year	Stakeholder input	High quality	Tasks 1-4
Dishes per cycle	n.a.	unit	Stakeholder input	High quality	Tasks 1-4
Time in active mode per day	11	hours/day	Stakeholder input	High quality	Tasks 1-4
Auxiliary materials					
Annual detergent consumption	324	kg/year	Stakeholder input	High quality	Tasks 1-4
Annual rinsing agent consumption	17	kg/year	Stakeholder input	High quality	Tasks 1-4

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6539

6540 Table 11-37: Use phase input data for BC4.

Use phase inputs	Value	Unit	Comment	Reference
Electricity				
On-mode: Consumption per cycle	1.319	kWh		Calculations based on Table 11-36
On-mode: No. of cycles / year	9,000	#	Cycles per day* Number of working days per year	Calculations based on Table 11-36
Standby-mode: Consumption per hour	0	kWh	Included in real life electricity consumption	
Standby-mode: No. of hours / year	0	#		
Off-mode: Consumption per hour	-	kWh	N/A	
Off-mode: No. of hours / year	-	#	N/A	
Heat				
Consumption of heat per cycle	0.131	kWh	Including heat for water heating	Calculations based on Table 11-36
No. of cycles / year	9,000	#	Cycles per day* Number of working days per year	Calculations based on Table 11-36
Avg. Heat Power Output	0.358	kW	Total energy per year/total operating time per year	Calculations based on Table 11-36
No. of hours / year	3,300	hrs.	Hours per cycle * cycles per year	Calculations based on Table 11-36
Water use				
Annual water use	116.70	m ³		Calculations based on Table 11-36
Auxiliary materials				
Annual detergent use	324	kg/year		Calculations based on Table 11-36
Annual rinsing agent use	17	kg/year		

6541 11.4.4.5. Economic input data

6542 All economic input parameters are provided below (Table 11-38 and Table).

6543 Table 11-38: Economic inputs for BC4.

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Lifetime						
Average expected initial lifetime	9	years	Stakeholder input	High quality	Median number	Tasks 1-4
Weibull shape parameter (b)	1.6	-	Literature	Medium quality		(Gama Caldas et al., 2024)
Economic life cycle data						
Latest Annual sales	0.00308	Mln Units / year	Stakeholder input	High quality		Tasks 1-4
Assumed purchase price	10,855	Euro/unit	Expert judgement	Medium quality	Average price, extrapolation of 2011 data	Tasks 1-4
Number of priority parts for repair and upgrade	15	-	Literature	Medium quality	Priority parts should be identified by the Study-Team: identified based on JRC publication	(Cordella et al., 2019)
Installation/acquisition costs (if any)	0	Euro/unit			"No data in current study. 2011 study: "The installation of the dishwashers is taken into account in the product price so that there are no separate installation costs."	

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Fuel rate (gas, oil, wood)	0.023	Euro/MJ	Literature	Medium quality	Average price between 2 different consumption bands (I1 and I2), average price in EU-27, semester 1 2024.	(Eurostat, 2024)
Electricity rate	0.257	Euro/kWh	Literature	Medium quality	Average price between 2 different consumption bands, average price in EU-27, semester 1 2024.	Tasks 1-4
Water rate	1.91	Euro/m ³	Literature	Medium quality	Statistics, average prices of water from EU members	Tasks 1-4
Repair & maintenance costs	4,776.2	Euro/unit	Literature	Medium quality	Maintenance costs are 44% of the initial purchase costs	Tasks 1-4
Discount rate (interest minus inflation)	3	%	Literature	Medium quality	MEErP Review	(Gama Caldas et al., 2024)
Escalation rate (project annual growth of running costs)	1.44%	%				See Table 11-39
Ratio efficiency STOCK: efficiency NEW, in Use Phase	0.95	-	Stakeholder input	High quality		Tasks 1-4
Price of auxiliary material 1: Detergent	4.22	Euro/kg detergent	Literature	Medium quality	Average taken between different minimum and maximum prices (different resellers) and average taken	Tasks 1-4

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Price of auxiliary material 2: Rinsing agent	3.93	Euro/kg detergent	Literature	Medium quality	between the average minimum and average maximum price.	

6544 **Table 11-39: Escalation rate parameters for BC4.**

Use phase input	Escalation rate	Annual amount used	Annual costs	Share of total annual costs	Comments
Natural gas	2.15%	1,126.48	95.21	2%	Heat (kWh) divided by 1.05 to account for efficiency of natural gas boiler (105%)
Electricity	1.62%	11,872.37	3,052.39	64%	
Water	0.16%	116,700.00	222.90	5%	
Detergent	1.21%	323.64	1,365.36	29%	
Weighted average Escalation rate	1.44%				

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6546 **Table 11-40: Annual sales values for BC4.**

Year	Sales per year	Unit	Reference
2023	0.013751	mln. units/year	Task 2
2022	0.014848	mln. units/year	
2021	0.013948	mln. units/year	

Year	Sales per year	Unit	Reference
2020	0.011889	mln. units/year	
2019	0.012144	mln. units/year	
2018	0.009867	mln. units/year	
2017	0.013327	mln. units/year	
2016	0.010100	mln. units/year	
2015	0.009192	mln. units/year	
2014	0.006795	mln. units/year	
2013	0.005580	mln. units/year	
2012	0.002151	mln. units/year	
2011	0.011051	mln. units/year	
2010	0.011478	mln. units/year	
2009	0.009908	mln. units/year	
2008	0.014260	mln. units/year	
2007 - 1993	0.010643	mln. units/year	
			Average of sales for years 2008-2023

6548 11.4.5. BC5: One-tank conveyor-type dishwasher

6549 11.4.5.1. Raw materials

6550 Below, the Bill of Materials (BoM) followed by the packaging used is provided for Base Case BC5 (**Table 11-41**) including recycled content, dataset used, data
 6551 source and quality scoring. BoM data was sourced from Tasks 1-4 of this study.

6552 **Table 11-41: Bill of Materials for BC5.**

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Stainless steel	642.25	kg	72.1%	3-Ferrous	Default	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Polypropylene (PP)	55.50	kg	6.2%	1-BlkPlastics	Default	Medium quality	16-Polypropylene (PP), petrochemical based polymerisation of bio-fossil propylene production mix, at plant petrochemical based	35-Polypropylene, recycled, post-consumer washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 90%
Polyamide (PA)	6.14	kg	0.7%	2-TecPlastics	Default	Medium quality	11-Nylon 6 fibre extrusion into fibre production mix, at plant 5% loss, 3,5 MJ electricity	31-Nylon fibre, recycled, mechanical, post-consumer washing, drying, shredding, drum rotating spinning production mix, at plant Erec/ErecEoL, efficiency 90%
Polyvinyl chloride (PVC)	4.60	kg	0.5%	1-BlkPlastics	Default	Medium quality	22-PVC granulates, low density polymerisation of vinyl chloride production mix, at plant 62 g/mol per repeating unit	37-Recycling plastic (PVC), waste management, technology mix, at plant

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Polystyrene (PS)	4.43	kg	0.5%	1-BlkPlastics	Default	Medium quality	17-Polystyrene production, high impact polymerisation of styrene production mix, at plant 1.05 g/cm ³	40-Recycling of post-consumer waste polypropylene (PP) collection, sorting, transport, washing, granulation, pelletisation production mix, at plant 48,9% recycling rate
Acrylonitrile Butadiene Styrene (ABS)	5.00	kg	0.6%	1-BlkPlastics	Default	Medium quality	1-Acrylonitrile Butadiene Styrene (ABS) emulsion polymerisation, bulk polymerisation or combined processes production mix, at plant	36-Recycling plastic Acrylonitrile-butadiene-styrene (ABS), waste management, technology mix
Pumps (copper)	16.83	kg	1.9%	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm ³
Pumps (stack of sheets)	15.63	kg	1.8%	3-Ferrous	Default	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Pumps (stainless steel wave)	12.34	kg	1.4%	3-Ferrous	Default	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Pumps (Al)	17.47	kg	2.0%	4-Non-ferrous	Default	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm ³ , >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Condenser (AL)	4.72	kg	0.5%	4-Non-ferrous	Default	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm3, >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%
Condenser (Cu)	7.08	kg	0.8%	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm3
Ventilator, fan (AL)	17.44	kg	2.0%	4-Non-ferrous	Default	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm3, >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%
Ventilator, fan (Cu)	10.16	kg	1.1%	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm3
Drive motor (AL)	4.00	kg	0.4%	4-Non-ferrous	Default	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm3, >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%
Drive motor (Cu)	5.00	kg	0.6%	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm3

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Cable (copper)	16.30	kg	1.8%	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm ³
Cable sheath (PVC)	8.64	kg	1.0%	1-BlkPlastics	Default	Medium quality	22-PVC granulates, low density polymerisation of vinyl chloride production mix, at plant 62 g/mol per repeating unit	37-Recycling plastic (PVC), waste management, technology mix, at plant
Cable sheath (silicone, EPDM)	5.17	kg	0.6%	1-BlkPlastics	Default	Medium quality	6-Ethylene propylene dien elastomer (EPDM) copolymerisation of ethylene and propylene production mix, at plant 69% ethylene, 38% propylene	39-Recycling of post-industrial waste EPDM rubber
Electric contactor (copper)	10.00	kg	1.1%	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm ³
Gaskets (EPDM)	12.80	kg	1.4%	1-BlkPlastics	Default	Medium quality	6-Ethylene propylene dien elastomer (EPDM) copolymerisation of ethylene and propylene production mix, at plant 69% ethylene, 38% propylene	39-Recycling of post-industrial waste EPDM rubber

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Electronics (printed wiring board) Based on ERT, 1 m ² = 1.32 kg	7.42	m ²	1.1%	6-Electronics	Default	Medium quality	164-Printed wiring board (PWB) (2-layer) via the subtractive method (as opposed to additive method) production mix, at plant 2-layer, 1.32 kg	195-*End of life of Populated Printed wiring board (PWB) (2-layer) Recycling of copper and precious metals (Ag, Au, Pd, Pt) from electronics production mix, at plant recycling processes: 95- 98% efficiency, scrap incineration: 11.0 MJ/kg NCV
Total product weight	891.29	kg	100%					

6553

6554 **Table 11-42: Packaging used for BC5.**

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
EPS	2.94	kg	2.79%	1-BlkPlastics	Default	Medium quality	5-EPS Beads from styrene polymerisation and foaming production mix, at plant 0.96- 1.04 g/cm ³	not available
PE-Foil	3.045	kg	2.89%	1-BlkPlastics	Default	Medium quality	7-HDPE granulates Polymerisation of ethylene production mix, at plant 0.91- 0.96 g/cm ³ , 28 g/mol per repeating unit	28-High density polyethylene (HDPE), recycled washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 98%

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
PP (plastic strips)	0	kg	0.00%	1-BlkPlastics	Default	Medium quality	16-Polypropylene (PP), petrochemical based polymerisation of bio-fossil propylene production mix, at plant petrochemical based	35-Polypropylene, recycled, post-consumer washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 90%
Wood	80.75	kg	76.55%	7-Misc.	Default	Medium quality	284-Plywood box; attaching veneer layers; production mix, at plant; 5% moisture	not available
Cardboard	7.75	kg	7.35%	7-Misc.	Default	Medium quality	217-Corrugated board, uncoated "virgin" Kraft Pulping Process, pulp pressing and drying production mix, at plant flute thickness 0.8- 2.8 mm, R1=0%	238-Recycling paper and cardboard, waste management, technology mix, at plant collection, sorting, transport, recycling production mix, at plant paper waste, efficiency 90,9%
Cast iron	11	kg	10.43%	3-Ferro	Default	Medium quality	Manually added, but same environmental impacts as dataset #58 in the ERT- 300-Cast iron electric arc furnace route, from steel scrap, secondary production single route, at plant > 2,06 % carbon content	not available
Total packaging weight	105.49	kg	100%					

6556 11.4.5.2. Manufacturing

6557 Table 11-43: Energy inputs Manufacturing for BC5.

Energy	Value	Unit	Source	Data quality assessment	Dataset used	Reference
Electricity	250	kWh	Stakeholder input	High quality	243-Electricity grid mix 1kV-60kV technology mix consumption mix, to consumer 1kV - 60kV	Proxy based on stakeholder feedback

6558

6559 Table 11-44: Material inputs Manufacturing for BC5.

Material	Value	Unit	Input value ERT	Comments	Dataset used
Stainless steel	642.25	kg	670.21	Best dataset choice from tool options	91-Steel sheet stamping and bending stamping and bending single route, at plant 5% loss
Pumps (stack of sheets)	15.63	kg			
Pumps (stainless steel wave)	12.34	kg			
Polypropylene (PP)	55.50	kg	97.85	Best dataset choice from tool options	8-Injection moulding plastic injection moulding production mix, at plant for PP, HDPE and PE
Polyamide (PA)	6.14	kg		Proxy	
Polyvinyl chloride (PVC)	4.60	kg			
Cable sheath (PVC)	8.64	kg			
Cable sheath (silicone, EPDM)	5.17	Kg			
Gaskets (EPDM)	12.80	kg			

Material	Value	Unit	Input value ERT	Comments	Dataset used
Acrylonitrile Butadiene Styrene (ABS)	5.00	kg			
Polystyrene (PS)	4.43	kg	4.43	Proxy	3-Blow moulding blow moulding production mix, at plant PET, HDPE and PP
Pumps (copper)	16.83	kg	65.37	Best dataset choice from tool options	65-Copper Wire Drawing wire drawing single route, at plant 8.92 g/cm3
Condenser (Cu)	7.08	kg			
Ventilator, fan (Cu)	10.16	kg			
Drive motor (Cu)	5.00	kg			
Cable (copper)	16.30	kg			
Electric contactor (copper)	10.00	kg			
Pumps (Al)	17.47	kg	43.63	Best dataset choice from tool options	53-Aluminium sheet rolling primary production, aluminium deep- drawing single route, at plant 2.7 g/cm3
Condenser (AL)	4.72	kg			
Ventilator, fan (AL)	17.44	kg			
Drive motor (AL)	4.00	kg			

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11.4.5.3. Distribution

Below, the transport scenario input data is provided (**Table 11-45**). Scenarios are based on PEF defaults as no stakeholder data was available.

Table 11-45: Distribution input for BC5.

Transport means	Value	Unit	Dataset used	Data Source	Data quality assessment	Comment
Transported weight (all modes of transport)	0.997	ton	N/A			Based on total weight (BoM + Packaging)
Truck distance	1,330	km	263-Articulated lorry transport, Euro 5, Total weight 28-32 t diesel driven, Euro 5, cargo consumption mix, to consumer 28 - 32t gross weight / 22t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory + from factory to final client
Train distance	240	km	268-Freight train, electricity traction electricity driven, cargo consumption mix, to consumer average train, gross tonne weight 1000t / 726t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory
Ship distance	270	km	265-Barge technology mix, diesel driven, cargo consumption mix, to consumer 1500 t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory

11.4.5.4. Use phase

For the use phase, energy inputs (electricity and heat), water and detergent use were included. To calculate the exact inputs for the ERT (**Table 11-47**), the parameters indicated in **Table 11-46** were used. For heat modelling, default efficiency values were used (105 %), incorporated in the ERT.

6568 Table 11-46: Use phase parameters for calculation for BC5.

Description	Value	Unit	Source	Data quality assessment	Reference
Utilities input					
Annual energy consumption (total)	109,463	kWh	Stakeholder input	High quality	Tasks 1-4
Energy consumption: Electricity	90%	%	Stakeholder input	High quality	Tasks 1-4
Energy consumption: Heat	10%	%	Stakeholder input	High quality	Tasks 1-4
Annual water consumption (total)	820,512	litres/year	Stakeholder input	High quality	Tasks 1-4
Annual water consumption (hot water)	31,680	litres/year	Stakeholder input	High quality	Tasks 1-4
Specific heat for water (1° C increase)	4.18	kJ/kg water	Scientific literature	High quality	(ThermExcel, n.d.)
Specific heat for water (increase from 15° C to 60° C)	188.1	kWh/L water	Calculated		
Energy consumption: Heat for water heating	1,655	kWh/year	Calculated		

Description	Value	Unit	Source	Data quality assessment	Reference
Operational information					
Cycles per day	1,800	Dishes/hour	Stakeholder input	High quality	Tasks 1-4
Number of working days per year	330	days/year	Stakeholder input	High quality	Tasks 1-4
Dishes per cycle	n.a.	unit	Stakeholder input	High quality	Tasks 1-4
Time in active mode per day	8	hours/day	Stakeholder input	High quality	Tasks 1-4
Auxiliary materials					
Annual detergent consumption	1,931	kg/year	Stakeholder input	High quality	Tasks 1-4
Annual rinsing agent consumption	188	kg/year	Stakeholder input	High quality	Tasks 1-4

6569

6570 **Table 11-47: Use phase input data for BC5.**

Use phase inputs	Value	Unit	Comment	Reference
Electricity				
On-mode: Consumption per hour	37.317	kWh		Calculations based on Table 11-46

Use phase inputs	Value	Unit	Comment	Reference
On-mode: No. of hours / year	2,640	#	Cycles per day* Number of working days per year	Calculations based on Table 11-46
Standby-mode: Consumption per hour	0	kWh	Included in real life electricity consumption	
Standby-mode: No. of hours / year	0	#		
Off-mode: Consumption per hour	-	kWh	N/A	
Off-mode: No. of hours / year	-	#	N/A	
Heat				
Consumption of heat per hour	4.773	kWh	Including heat for water heating	Calculations based on Table 11-46
No. of hours / year	2,640	#	Cycles per day* Number of working days per year	Calculations based on Table 11-46
Avg. Heat Power Output	4.773	kW	Total energy per year/total operating time per year	Calculations based on Table 11-46
No. of hours / year	2,640	hrs.	Hours per cycle * cycles per year	Calculations based on Table 11-46
Water use				
Annual water use	820.51	m ³		Calculations based on Table 11-46
Auxiliary materials				
Annual detergent use	1,931	kg/year		Calculations based on Table 11-46
Annual rinsing agent use	188	kg/year		

6571

6572 **11.4.5.5. Economic input data**6573 All economic input parameters are provided below (**Table 11-48** and **Table**).

6574 Table 11-48: Economic inputs for BC5

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Lifetime						
Average expected initial lifetime	11	years	Stakeholder input	High quality	Median number	Tasks 1-4
Weibull shape parameter (b)	1.6	-	Literature	Medium quality		(Gama Caldas et al., 2024)
Economic life cycle data						
Latest Annual sales	0.007728	Mln Units / year	Stakeholder input	High quality		Tasks 1-4
Assumed purchase price	13,394	Euro/unit	Expert judgement	Medium quality	Average price, extrapolation of 2011 data	Tasks 1-4
Number of priority parts for repair and upgrade	15	-	Literature	Medium quality	Priority parts should be identified by the Study-Team: identified based on JRC publication	(Cordella et al., 2019)
Installation/acquisition costs (if any)	0	Euro/unit			"No data in current study. 2011 study: "The installation of the dishwashers is taken into account in the product price so that there are no separate installation costs."	
Fuel rate (gas, oil, wood)	0.023	Euro/MJ	Literature	Medium quality	Average price between 2 different consumption bands (I1 and I2), average price in EU-27, semester 1 2024.	(Eurostat, 2024)

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Electricity rate	0.257	Euro/kW h	Literature	Medium quality	Average price between 2 different consumption bands, average price in EU-27, semester 1 2024.	Tasks 1-4
Water rate	1.91	Euro/m ³	Literature	Medium quality	Statistics, average prices of water from EU members	Tasks 1-4
Repair & maintenance costs	5,893.58	Euro/unit	Literature	Medium quality	Maintenance costs are 44% of the initial purchase costs	Tasks 1-4
Discount rate (interest minus inflation)	3	%	Literature	Medium quality	MEErP Review	(Gama Caldas et al., 2024)
Escalation rate (project annual growth of running costs)	1.48%	%				See Table 11-49
Ratio efficiency STOCK: efficiency NEW, in Use Phase	0.7	-	Stakeholder input	High quality		Tasks 1-4
Price of auxiliary material 1: Detergent	4.22	Euro/kg detergent	Literature	Medium quality	Average taken between different minimum and maximum prices (different resellers) and average taken	Tasks 1-4

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Price of auxiliary material 2: Rinsing agent	3.93	Euro/kg detergent	Literature	Medium quality	between the average minimum and average maximum price.	

6575

6576 Table 11-49: Escalation rate parameters for BC5.

Use phase input	Escalation rate	Annual amount used	Annual costs	Share of total annual costs	Comments
Natural gas	2.15%	12,001.48	1,014.34	3%	Heat (kWh) divided by 1.05 to account for efficiency of natural gas boiler (105%)
Electricity	1.62%	98,516.39	25,328.56	70%	
Water	0.16%	820,512.00	1,567.18	4%	
Detergent	1.21%	1,931.21	8,147.30	23%	
Weighted average Escalation rate	1.48%				

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6578

6579 **Table 11-50: Annual sales values for BC5.**

Year	Sales per year	Unit	Reference
2023	0.005500	mln. units/year	Task 2
2022	0.005939	mln. units/year	
2021	0.005579	mln. units/year	
2020	0.004756	mln. units/year	
2019	0.004858	mln. units/year	
2018	0.003947	mln. units/year	
2017	0.005331	mln. units/year	
2016	0.004040	mln. units/year	
2015	0.003677	mln. units/year	
2014	0.002718	mln. units/year	
2013	0.002232	mln. units/year	
2012	0.000861	mln. units/year	
2011	0.004420	mln. units/year	
2010	0.004591	mln. units/year	
2009	0.003963	mln. units/year	
2008	0.005704	mln. units/year	
2007 - 1993	0.004257	mln. units/year	Average of sales for years 2008-2023

6580

6581 11.4.6. BC6: Multi-tank conveyor-type dishwasher

6582 11.4.6.1. Raw materials

6583 Below, the Bill of Materials (BoM) followed by the packaging used is provided for Base Case BC6 (**Table 11-51**) including recycled content, dataset used, data
 6584 source and quality scoring. BoM data was sourced from the Tasks 1-4 of this study.

6585 **Table 11-51: Bill of Materials for BC6.**

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Stainless steel	980.00	kg	72.9%	3-Ferrous	Default	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Polypropylene (PP)	58.00	kg	4.3%	1-BlkPlastics	Default	Medium quality	16-Polypropylene (PP), petrochemical based polymerisation of bio-fossil propylene production mix, at plant petrochemical based	35-Polypropylene, recycled, post-consumer washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 90%
Polyamide (PA)	18.66	kg	1.4%	2-TecPlastics	Default	Medium quality	11-Nylon 6 fibre extrusion into fibre production mix, at plant 5% loss, 3,5 MJ electricity	31-Nylon fibre, recycled, mechanical, post-consumer washing, drying, shredding, drum rotating spinning production mix, at plant Erec/ErecEoL, efficiency 90%
Ethylene Propylene Dien M-class rubber (EPDM)	12.00	kg	0.9%	1-BlkPlastics	Default	Medium quality	6-Ethylene propylene dien elastomer (EPDM) copolymerisation of ethylene and propylene production mix, at plant 69% ethylene, 38% propylene	39-Recycling of post-industrial waste EPDM rubber

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Acrylonitrile Butadiene Styrene (ABS)	0.00	kg	0.0%	1-BlkPlastics	Default	Medium quality	1-Acrylonitrile Butadiene Styrene (ABS) emulsion polymerisation, bulk polymerisation or combined processes production mix, at plant	36-Recycling plastic Acrylonitrile-butadiene-styrene (ABS), waste management, technology mix
Pumps (copper)	39.02	kg	2.9%	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm3
Pumps (stack of sheets)	37.07	kg	2.8%	3-Ferrous	Default	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Pumps (stainless steel wave)	25.37	kg	1.9%	3-Ferrous	Default	Medium quality	85-Stainless steel cold rolled hot rolling production mix, at plant stainless steel	128-Steel cast part alloyed electric arc furnace route, from steel scrap, secondary production single route, at plant carbon steel
Pumps (Al)	44.88	kg	3.3%	4-Non-ferrous	Default	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm3, >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%
Condenser (AL)	4.72	kg	0.4%	4-Non-ferrous	Default	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm3, >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Condenser (Cu)	7.08	kg	0.5%	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm3
Ventilator, fan (AL)	17.44	kg	1.3%	4-Non-ferrous	Default	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm3, >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%
Ventilator, fan (Cu)	10.16	kg	0.8%	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm3
Drive motor (AL)	4.00	kg	0.3%	4-Non-ferrous	Default	Medium quality	52-Aluminium ingot mix (high purity) primary production, aluminium casting single route, at plant 2.7 g/cm3, >99% Al	123-Recycling of aluminium into aluminium ingot - from post-consumer collection, transport, pretreatment, remelting production mix, at plant aluminium waste, efficiency 90%
Drive motor (Cu)	5.00	kg	0.4%	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm3
Cable (copper)	19.80	kg	1.5%	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm3

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Cable sheath (PVC)	11.44	kg	0.9%	1-BlkPlastics	Default	Medium quality	22-PVC granulates, low density polymerisation of vinyl chloride production mix, at plant 62 g/mol per repeating unit	37-Recycling plastic (PVC), waste management, technology mix, at plant
Cable sheath (silicone, EPDM)	8.36	kg	0.6%	1-BlkPlastics	Default	Medium quality	6-Ethylene propylene dien elastomer (EPDM) copolymerisation of ethylene and propylene production mix, at plant 69% ethylene, 38% propylene	39-Recycling of post-industrial waste EPDM rubber
Electric contactor (copper)	10.00	kg	0.7%	4-Non-ferrous	Default	Medium quality	61-Copper Cathode, production mix	124-Secondary Copper Cathode (including scrap LCI input) copper scrap smelting and refining single route, at plant 8.92 g/cm3
Gaskets, etc. (EPDM)	15.00	kg	1.1%	1-BlkPlastics	Default	Medium quality	6-Ethylene propylene dien elastomer (EPDM) copolymerisation of ethylene and propylene production mix, at plant 69% ethylene, 38% propylene	39-Recycling of post-industrial waste EPDM rubber
Electronics (printed wiring board) Based on ERT, 1 m2 = 1.32 kg	11.67	m2	1.1%	6-Electronics	Default	Medium quality	164-Printed wiring board (PWB) (2-layer) via the subtractive method (as opposed to additive method) production mix, at plant 2-layer, 1.32 kg	195-*End of life of Populated Printed wiring board (PWB) (2-layer) Recycling of copper and precious metals (Ag, Au, Pd, Pt) from electronics production mix, at plant recycling processes: 95- 98% efficiency, scrap incineration: 11.0 MJ/kg NCV
Total product weight	1,343.40	kg	100%					

6587 Table 11-52: Packaging used for BC6.

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
EPS	5.29	kg	2.22%	1-BlkPlastics	Default	Medium quality	5-EPS Beads from styrene polymerisation and foaming production mix, at plant 0.96- 1.04 g/cm3	not available
PE-Foil	4.075	kg	1.71%	1-BlkPlastics	Default	Medium quality	7-HDPE granulates Polymerisation of ethylene production mix, at plant 0.91- 0.96 g/cm3, 28 g/mol per repeating unit	28-High density polyethylene (HDPE), recycled washing, drying, shredding, pelletizing production mix, at plant Erec/ErecEoL, efficiency 98%
Wood	197.5	kg	82.76%	7-Misc.	Default	Medium quality	284-Plywood box; attaching veneer layers; production mix, at plant; 5% moisture	41-Polyethylene terephthalate (PET) granulate secondary ; no metal fraction from post-consumer waste, via washing, granulation, pelletisation production mix, at plant 90% recycling rate
Cardboard	16.765	kg	7.03%	7-Misc.	Default	Medium quality	217-Corrugated board, uncoated "virgin" Kraft Pulping Process, pulp pressing and drying production mix, at plant flute thickness 0.8- 2.8 mm, R1=0%	238-Recycling paper and cardboard, waste management, technology mix, at plant collection, sorting, transport, recycling production mix, at plant paper waste, efficiency 90,9%
Cast iron	15	kg	6.29%	3-Ferro	Default	Medium quality	Manually added, but same environmental impacts as dataset #58 in the ERT - 300-Cast iron electric arc furnace route, from steel scrap, secondary production single route, at plant > 2,06 % carbon content	not available

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
Total packaging weight	238.63	kg	100%					

6588 11.4.6.2. Manufacturing

6589 **Table 11-53: Energy inputs Manufacturing for BC6.**

Energy	Value	Unit	Source	Data quality assessment	Dataset used	Reference
Electricity	300	kWh	Stakeholder input	High quality	243-Electricity grid mix 1kV-60kV technology mix consumption mix, to consumer 1kV - 60kV	Proxy based on stakeholder feedback

6590

6591 **Table 11-54: Material inputs Manufacturing for BC6.**

Material	Value	Unit	Input value ERT	Comments	Dataset used
Stainless steel	980	kg	1042.44	Best dataset choice from tool options	91-Steel sheet stamping and bending stamping and bending single route, at plant 5% loss
Pumps (stack of sheets)	37.07	kg			
Pumps (stainless steel wave)	25.37	kg			
Polypropylene (PP)	58	kg	123.46	Best dataset choice from tool options	

Material	Value	Unit	Input value ERT	Comments	Dataset used
Polyamide (PA)	18.66	kg		Proxy	8-Injection moulding plastic injection moulding production mix, at plant for PP, HDPE and PE
Ethylene Propylene Dien M-class rubber (EPDM)	12	kg			
Acrylonitrile Butadiene Styrene (ABS)	0	kg			
Cable sheath (PVC)	11.44	kg			
Cable sheath (silicone, EPDM)	8.36	kg			
Gaskets, etc. (EPDM)	15	kg			
Condenser (Cu)	7.08	kg	91.06	Best dataset choice from tool options	65-Copper Wire Drawing wire drawing single route, at plant 8.92 g/cm ³
Ventilator, fan (Cu)	10.16	kg			
Drive motor (Cu)	5	kg			
Cable (copper)	19.8	kg			
Electric contactor (copper)	10	kg			
Pumps (copper)	39.02	kg			
Pumps (Al)	44.88	kg	71.04	Best dataset choice from tool options	53-Aluminium sheet rolling primary production, aluminium deep- drawing single route, at plant 2.7 g/cm ³
Condenser (AL)	4.72	kg			
Ventilator, fan (AL)	17.44	kg			
Drive motor (AL)	4	kg			

11.4.6.3. Distribution

Below, the transport scenario input data is provided (**Table 11-55**). Scenarios are based on PEF defaults as no stakeholder data was available.

Table 11-55: Distribution input for BC6

Transport means	Value	Unit	Dataset used	Data Source	Data quality assessment	Comment
Transported weight (all modes of transport)	1.582	ton	N/A			Based on total weight (BoM + Packaging)
Truck distance	1,330	km	263-Articulated lorry transport, Euro 5, Total weight 28-32 t diesel driven, Euro 5, cargo consumption mix, to consumer 28 - 32t gross weight / 22t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory + from factory to final client
Train distance	240	km	268-Freight train, electricity traction electricity driven, cargo consumption mix, to consumer average train, gross tonne weight 1000t / 726t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory
Ship distance	270	km	265-Barge technology mix, diesel driven, cargo consumption mix, to consumer 1500 t payload capacity	Scientific literature	High quality	Distribution distance from supplier to factory

6596 11.4.6.4. Use phase

6597 For the use phase, energy inputs (electricity and heat), water and detergent use were included. To calculate the exact inputs for the ERT (**Table 11-57**), the
 6598 parameters indicated in **Table 11-56** were used. For heat modelling, default efficiency values were used (105 %), incorporated in the ERT.

6599 **Table 11-56: Use phase parameters for calculation for BC6.**

Description	Value	Unit	Source	Data quality assessment	Reference
Utilities input					
Annual energy consumption (total)	217,597	kWh	Stakeholder input	High quality	Tasks 1-4
Energy consumption: Electricity	85%	%	Stakeholder input	High quality	Tasks 1-4
Energy consumption: Heat	15%	%	Stakeholder input	High quality	Tasks 1-4
Annual water consumption (total)	1,229,448	litres/year	Stakeholder input	High quality	Tasks 1-4
Annual water consumption (hot water)	66,000	litres/year	Stakeholder input	High quality	Tasks 1-4
Specific heat for water (1° C increase)	4.18	kJ/kg water	Scientific literature	High quality	(ThermExcel, n.d.)

Description	Value	Unit	Source	Data quality assessment	Reference
Specific heat for water (increase from 15° C to 60 ° C)	188.1	kWh/L water	Calculated		
Energy consumption: Heat for water heating	3,449	kWh/year	Calculated		
Operational information					
Cycles per day	3,600	Dishes/hour	Stakeholder input	High quality	Tasks 1-4
Number of working days per year	330	days/year	Stakeholder input	High quality	Tasks 1-4
Dishes per cycle	n.a.	unit	Stakeholder input	High quality	Tasks 1-4
Time in active mode per day	8	hours/day	Stakeholder input	High quality	Tasks 1-4
Auxiliary materials					
Annual detergent consumption	2,753	kg/year	Stakeholder input	High quality	Tasks 1-4
Annual rinsing agent consumption	251	kg/year	Stakeholder input	High quality	Tasks 1-4

6601 Table 11-57: Use phase input data for BC6.

Use phase inputs	Value	Unit	Comment	Reference
Electricity				
On-mode: Consumption per hour	70.059	kWh		Calculations based on Table 11-56
On-mode: No. of hours / year	2,640	#	Cycles per day* Number of working days per year	Calculations based on Table 11-56
Standby-mode: Consumption per hour	0	kWh	Included in real life electricity consumption	
Standby-mode: No. of hours / year	0	#		
Off-mode: Consumption per hour	-	kWh	N/A	
Off-mode: No. of hours / year	-	#	N/A	
Heat				
Consumption of heat per hour	13.670	kWh	Including heat for water heating	Calculations based on Table 11-56
No. of hours / year	2,640	#	Cycles per day* Number of working days per year	Calculations based on Table 11-56
Avg. Heat Power Output	13.670	kW	Total energy per year/total operating time per year	Calculations based on Table 11-56
No. of hours / year	2,640	hrs.	Hours per cycle * cycles per year	Calculations based on Table 11-56
Water use				
Annual water use	1,229.45	m ³		Calculations based on Table 11-56
Auxiliary materials				
Annual detergent use	2,753	Kg/year		Calculations based on Table 11-56
Annual rinsing agent use	251	Kg/year		

6602 11.4.6.5. Economic input data

6603 All economic input parameters are provided below (Table 11-58 and Table).

6604 Table 11-58: Economic inputs for BC6.

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Lifetime						
Average expected initial lifetime	15	years	Stakeholder input	High quality	Median number	Tasks 1-4
Weibull shape parameter (b)	1.6	-	Literature	Medium quality		(Gama Caldas et al., 2024)
Economic life cycle data						
Latest Annual sales	0.00154	Mln Units / year	Stakeholder input	High quality		Tasks 1-4
Assumed purchase price	22,867	Euro/unit	Expert judgement	Medium quality	Average price, extrapolation of 2011 data	Tasks 1-4
Number of priority parts for repair and upgrade	15	-	Literature	Medium quality	Priority parts should be identified by the Study-Team: identified based on JRC publication	(Cordella et al., 2019)
Installation/acquisition costs (if any)	0	Euro/unit			"No data in current study. 2011 study: "The installation of the dishwashers is taken into account in the product price so that there are no separate installation costs."	

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Fuel rate (gas, oil, wood)	0.023	Euro/MJ	Literature	Medium quality	Average price between 2 different consumption bands (I1 and I2), average price in EU-27, semester 1 2024.	(Eurostat, 2024)
Electricity rate	0.257	Euro/kWh	Literature	Medium quality	Average price between 2 different consumption bands, average price in EU-27, semester 1 2024.	Tasks 1-4
Water rate	1.91	Euro/m ³	Literature	Medium quality	Statistics, average prices of water from EU members	Tasks 1-4
Repair & maintenance costs	10,061.48	Euro/unit	Literature	Medium quality	Maintenance costs are 44% of the initial purchase costs	Tasks 1-4
Discount rate (interest minus inflation)	3	%	Literature	Medium quality	MEErP Review	
Escalation rate (project annual growth of running costs)	1.52%	%				See Table 11-59
Ratio efficiency STOCK: efficiency NEW, in Use Phase	0.7	-	Stakeholder input	High quality		Tasks 1-4
Price of auxiliary material 1: Detergent	4.22	Euro/kg detergent	Literature	Medium quality	Average taken between different minimum and maximum prices (different resellers) and average taken	Tasks 1-4

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Price of auxiliary material 2: Rinsing agent	3.93	Euro/kg detergent	Literature	Medium quality	between the average minimum and average maximum price.	

6605 **Table 11-59: Escalation rate parameters for BC6.**

Use phase input	Escalation rate	Annual amount used	Annual costs	Share of total annual costs	Comments
Natural gas	2.15%	34,369.53	2,904.83	5%	Heat (kWh) divided by 1.05 to account for efficiency of natural gas boiler (105%)
Electricity	1.62%	184,957.03	47,552.45	74%	
Water	0.16%	1,229,448.00	2,348.25	4%	
Detergent	1.21%	2,753.15	11,614.85	18%	
Weighted average Escalation rate	1.52%				

6606

6607 **Table 11-60: Annual sales values for BC6.**

Year	Sales per year	Unit	Reference
2023	0.002750	mln. units/year	Task 2
2022	0.002970	mln. units/year	
2021	0.002790	mln. units/year	
2020	0.002378	mln. units/year	
2019	0.002429	mln. units/year	
2018	0.001973	mln. units/year	
2017	0.002665	mln. units/year	
2016	0.002020	mln. units/year	
2015	0.001838	mln. units/year	
2014	0.001359	mln. units/year	
2013	0.001116	mln. units/year	
2012	0.000430	mln. units/year	
2011	0.002210	mln. units/year	
2010	0.002296	mln. units/year	
2009	0.001982	mln. units/year	
2008	0.002852	mln. units/year	
2007 - 1993	0.002129	mln. units/year	Average of sales for years 2008-2023

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11.4.7. Calculation of escalation rate

The escalation rate was calculated based on the data in **Table 11-61**. Below is the explanation of how the escalation rate was calculated.

Table 11-61: Overview of Eurostat datasets.

Parameter	Dataset
General inflation (HICP) and water	HICP - annual data (average index and rate of change) [prc_hicp_aind__custom_15078220]; Statistics Eurostat
Electricity	Electricity prices for non-household consumers - bi-annual data (from 2007 onwards) [nrg_pc_205__custom_15077362]; Statistics Eurostat Three band widths were included: Consumption less than 20 MWh - band IA, Consumption from 20 MWh to 499 MWh - band IB, Consumption from 500 MWh to 1 999 MWh - band IC
Natural gas (for heat)	Gas prices for non-household consumers - bi-annual data (from 2007 onwards) [nrg_pc_203__custom_15349990]; Statistics Eurostat Consumption less than 1 000 GJ - band I1
Detergent	Sold production, exports and imports [ds-056120__custom_15078125]; Statistics Eurostat

For commercial detergent, both total volume (PRODQNT) and total value (PRODVAL) of manufacturing were available, from which the price per kg of detergent was calculated (PRODVAL divided by PRODQNT).

Per product (water, electricity, natural gas and detergent), the % increase in 2024 versus 2014 was calculated according to Formula 1.

$$\text{Increase (\%)} = \left(\frac{2024 \text{ price}^{\frac{1}{10}}}{2014 \text{ price}} - 1 \right) \times 100\%$$

Formula 1: Calculation of % increase

Subsequently, the escalation rate was calculated by Formula 2.

$$\text{Escalation rate (\%)} = \left(\frac{1 + \% \text{ increase product}}{1 + \% \text{ increase HICP}} - 1 \right) \times 100\%$$

Formula 2: Calculation of % increase

For electricity, the three escalation rates for each band were averaged to obtain one escalation rate for electricity.

The final escalation rate per product is in **Table 11-62** and per Base Case in **Appendix 4 – Inputs for LCA / LCC per Base Case**.

6629 **Table 11-62: Escalation rate per product.**

Parameter	Escalation rate
Water	0.16 %
Electricity	1.62 %
Natural gas (for heat)	2.15 %
Detergent	1.21

6630 As per Base Case, only one escalation rate is required for the ERT, a weighted average was
6631 calculated; for this, the annual use volume for each running cost product (water, electricity,
6632 natural gas and detergent) was multiplied by the costs per unit to calculate the yearly costs for
6633 each product. For heat, the annual kWh were divided by 1.05 to compensate the natural gas
6634 volumes for the efficiency (105 %) of the natural gas boiler as modelled in the ERT. Subsequently,
6635 for each Base Case a weighted average of the escalation rate was calculated based on the share
6636 of yearly costs per product.

6637 11.5. Appendix 5 – Results of LCA / LCC per Base Case

6638 11.5.1. BC1: Undercounter water-change dishwasher

6639 Below, the life cycle impact is provided per product (**Table 11-63**), per year of use of the product (**Table 11-64**), total impact for the EU-27 for the new product
 6640 (**Table 11-65**) and the impact of the stock of products in the EU-27 (**Table 11-66**). The life cycle costs per product and as EU-27 total are provided in **Table 11-67**.

6641 **Table 11-63: Life cycle impact per product: BC1.**

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	g	17,080	17,090		571	0	n.a.			34,741
Metals	g	24,820	24,820		0	0	n.a.			49,640
Electronics	g	2,167	0		0	0	n.a.			2,167
Others	g	5,000	0		7,020	528,249,600	n.a.			528,261,620
Total weight	g	49,067	41,910		7,591	528,249,600	491			528,348,659
Energy consumption										
Electricity	kWh		30		0	21,281	0			21,311
Thermal energy	MJ		0		0	0	0			0

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
PEF Impact categories	unit									
Climate change, total	kg CO2 eq.	3.6E+02	2.2E+01	6.4E+00	7.7E+00	9.7E+03	3.8E+00	2.7E+01	-5.8E+01	1.0E+04
Ozone depletion	kg CFC-11 eq.	2.6E-07	8.3E-09	7.3E-11	1.3E-09	1.5E-05	2.7E-09	6.3E-09	-8.4E-10	1.5E-05
Human toxicity, cancer	CTUh	2.6E-06	1.6E-09	1.7E-09	4.8E-09	4.9E-06	2.6E-08	3.5E-08	-1.7E-06	5.9E-06
Human toxicity, non-cancer	CTUh	1.0E-05	8.7E-08	4.1E-08	8.3E-08	7.2E-05	1.0E-07	1.4E-07	-1.6E-06	8.1E-05
Particulate matter	disease incidence	2.7E-05	9.6E-07	2.0E-07	3.8E-07	3.5E-04	2.8E-07	1.6E-06	-5.9E-06	3.7E-04
Ionising radiation, human health	kBq U235 eq.	1.0E+01	9.5E+00	1.2E-01	4.3E-01	3.9E+03	2.0E-01	7.6E+00	-1.5E+00	3.9E+03
Photochemical ozone formation, human health	kg NMVOC eq.	9.4E-01	4.0E-02	2.3E-02	3.9E-02	1.7E+01	9.8E-03	4.1E-02	-1.2E-01	1.8E+01
Acidification	mol H+ eq.	1.8E+00	7.1E-02	2.5E-02	3.1E-02	3.1E+01	1.9E-02	6.4E-02	-3.5E-01	3.2E+01
Eutrophication, terrestrial	mol N eq.	3.2E+00	1.6E-01	1.2E-01	9.7E-02	6.4E+01	3.4E-02	1.5E-01	-3.9E-01	6.8E+01
Eutrophication, freshwater	kg P eq.	4.9E-03	4.8E-05	3.8E-05	1.4E-04	1.4E-01	4.9E-05	4.0E-05	-4.9E-05	1.4E-01
Eutrophication, marine	kg N eq.	3.1E-01	1.5E-02	1.1E-02	1.0E-02	6.9E+00	3.3E-03	1.4E-02	-3.5E-02	7.3E+00
Ecotoxicity, freshwater	CTUe	2.4E+03	1.1E+02	5.9E+01	5.1E+01	5.2E+04	2.5E+01	9.1E+01	-3.3E+02	5.4E+04
Land use	pt	1.2E+05	1.2E+02	4.9E+01	2.0E+03	4.9E+04	1.2E+03	8.6E+01	-2.1E+03	1.7E+05
Water use	m ³ water eq. of deprived water	1.1E+02	7.9E+00	5.9E-01	1.3E+00	1.2E+04	1.2E+00	6.2E+00	-7.0E+00	1.2E+04

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Resource use, minerals and metals	kg Sb eq.	3.5E-02	7.0E-06	4.2E-06	2.9E-06	1.0E-02	3.5E-04	5.5E-06	-5.4E-03	4.0E-02
Resource use, fossils	MJ	4.8E+03	3.9E+02	9.2E+01	1.1E+02	1.6E+05	5.2E+01	4.4E+02	-5.7E+02	1.7E+05
Additional technical information										
Primary energy consumption	MJ	4.8E+03	4.0E+02	9.2E+01	1.1E+02	1.7E+05	5.2E+01	4.4E+02	-5.7E+02	1.8E+05

* Manufacturing materials are double counted with the raw materials column.

Table 11-64: Life cycle impact per product per year of use: BC1.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	g	1,423	1,424		48	0	n.a.			2,895
Metals	g	2,068	2,068		0	0	n.a.			4,137
Electronics	g	181	0		0	0	n.a.			181
Others	g	417	0		585	44,020,800	n.a.			44,021,802

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Total weight	g	4,089	3,493		633	44,020,800	41			44,029,055
Energy consumption										
Electricity	kWh		3		0	1,773	0			1,776
Thermal energy	MJ		0		0	0	0			0
PEF Impact categories		unit								
Climate change, total	kg CO ₂ eq.	3.0E+01	1.8E+00	5.3E-01	6.4E-01	8.0E+02	3.2E-01	2.3E+00	-4.8E+00	8.3E+02
Ozone depletion	kg CFC-11 eq.	2.2E-08	6.9E-10	6.1E-12	1.1E-10	1.2E-06	2.3E-10	5.3E-10	-7.0E-11	1.2E-06
Human toxicity, cancer	CTUh	2.2E-07	1.4E-10	1.4E-10	4.0E-10	4.1E-07	2.2E-09	2.9E-09	-1.4E-07	4.9E-07
Human toxicity, non-cancer	CTUh	8.5E-07	7.2E-09	3.4E-09	6.9E-09	6.0E-06	8.6E-09	1.2E-08	-1.3E-07	6.8E-06
Particulate matter	disease incidence	2.3E-06	8.0E-08	1.7E-08	3.1E-08	2.9E-05	2.4E-08	1.3E-07	-4.9E-07	3.1E-05
Ionising radiation, human health	kBq U235 eq.	8.7E-01	7.9E-01	9.6E-03	3.6E-02	3.2E+02	1.7E-02	6.4E-01	-1.2E-01	3.3E+02
Photochemical ozone formation, human health	kg NMVOC eq.	7.9E-02	3.3E-03	1.9E-03	3.2E-03	1.4E+00	8.2E-04	3.4E-03	-1.0E-02	1.5E+00
Acidification	mol H+ eq.	1.5E-01	5.9E-03	2.1E-03	2.6E-03	2.6E+00	1.6E-03	5.3E-03	-2.9E-02	2.7E+00
Eutrophication, terrestrial	mol N eq.	2.7E-01	1.3E-02	1.0E-02	8.1E-03	5.4E+00	2.8E-03	1.3E-02	-3.2E-02	5.6E+00

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Eutrophication, freshwater	kg P eq.	4.1E-04	4.0E-06	3.2E-06	1.2E-05	1.2E-02	4.1E-06	3.3E-06	-4.0E-06	1.2E-02
Eutrophication, marine	kg N eq.	2.6E-02	1.2E-03	8.9E-04	8.4E-04	5.8E-01	2.7E-04	1.2E-03	-2.9E-03	6.0E-01
Ecotoxicity, freshwater	CTUe	2.0E+02	9.1E+00	4.9E+00	4.2E+00	4.3E+03	2.1E+00	7.5E+00	-2.7E+01	4.5E+03
Land use	pt	9.6E+03	1.0E+01	4.1E+00	1.7E+02	4.1E+03	9.7E+01	7.2E+00	-1.8E+02	1.4E+04
Water use	m ³ water eq. of deprived water	9.1E+00	6.6E-01	4.9E-02	1.1E-01	1.0E+03	9.8E-02	5.2E-01	-5.8E-01	1.0E+03
Resource use, minerals and metals	kg Sb eq.	2.9E-03	5.8E-07	3.5E-07	2.4E-07	8.3E-04	2.9E-05	4.6E-07	-4.5E-04	3.4E-03
Resource use, fossils	MJ	4.0E+02	3.3E+01	7.7E+00	9.1E+00	1.4E+04	4.3E+00	3.6E+01	-4.8E+01	1.4E+04
Additional technical information										
Primary energy consumption	MJ	4.0E+02	3.4E+01	7.7E+00	9.1E+00	1.4E+04	4.3E+00	3.6E+01	-4.8E+01	1.5E+04

* Manufacturing materials are double counted with the raw materials column.

6646 Table 11-65: EU total impact of new products sold in the year of study: BC1.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenan- ce & Repair	EoL Impacts Credits	Total	
Materials	unit									
Plastics	kt	0	0		0	0	n.a.		0	
Metals	kt	0	0		0	0	n.a.		0	
Electronics	kt	0	0		0	0	n.a.		0	
Others	kt	0	0		0	0	n.a.		0	
Total weight	kt	0	0		0	0	0		0	
Energy consumption										
Electricity	kWh		0		0	176	0		176	
Thermal energy	MJ		0		0	0	0		0	
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	2.9E+00	1.8E-01	5.3E-02	6.4E-02	8.0E+01	3.1E-02	2.3E-01	-4.8E-01	8.3E+01
Ozone depletion	kg CFC-11 eq.	2.2E-09	6.9E-11	6.1E-13	1.0E-11	1.2E-07	2.2E-11	5.2E-11	-7.0E-12	1.2E-07
Human toxicity, cancer	CTUh	2.1E-08	1.3E-11	1.4E-11	3.9E-11	4.0E-08	2.1E-10	2.9E-10	-1.4E-08	4.9E-08
Human toxicity, non-cancer	CTUh	8.4E-08	7.1E-10	3.4E-10	6.8E-10	6.0E-07	8.5E-10	1.1E-09	-1.3E-08	6.7E-07
Particulate matter	disease incidence	2.3E-07	7.9E-09	1.7E-09	3.1E-09	2.9E-06	2.3E-09	1.3E-08	-4.9E-08	3.1E-06
Ionising radiation, human health	kBq U235 eq.	8.6E-02	7.9E-02	9.5E-04	3.6E-03	3.2E+01	1.6E-03	6.3E-02	-1.2E-02	3.2E+01

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenan- ce & Repair	EoL Impacts Credits	Total	
Photochemical ozone formation, human health	kg NMVOC eq.	7.8E-03	3.3E-04	1.9E-04	3.2E-04	1.4E-01	8.1E-05	3.4E-04	-1.0E-03	1.5E-01
Acidification	mol H+ eq.	1.5E-02	5.9E-04	2.1E-04	2.6E-04	2.5E-01	1.5E-04	5.2E-04	-2.9E-03	2.7E-01
Eutrophication, terrestrial	mol N eq.	2.7E-02	1.3E-03	9.9E-04	8.0E-04	5.3E-01	2.8E-04	1.3E-03	-3.2E-03	5.6E-01
Eutrophication, freshwater	kg P eq.	4.0E-05	4.0E-07	3.2E-07	1.1E-06	1.2E-03	4.1E-07	3.3E-07	-4.0E-07	1.2E-03
Eutrophication, marine	kg N eq.	2.6E-03	1.2E-04	8.8E-05	8.3E-05	5.7E-02	2.7E-05	1.2E-04	-2.9E-04	6.0E-02
Ecotoxicity, freshwater	CTUe	1.9E+01	9.0E-01	4.9E-01	4.2E-01	4.3E+02	2.0E-01	7.5E-01	-2.7E+00	4.4E+02
Land use	pt	9.6E+02	9.9E-01	4.1E-01	1.6E+01	4.0E+02	9.6E+00	7.1E-01	-1.8E+01	1.4E+03
Water use	m³ water eq. of deprived water	9.0E-01	6.5E-02	4.9E-03	1.1E-02	1.0E+02	9.7E-03	5.1E-02	-5.7E-02	1.0E+02
Resource use, minerals and metals	kg Sb eq.	2.9E-04	5.8E-08	3.5E-08	2.4E-08	8.2E-05	2.9E-06	4.5E-08	-4.5E-05	3.3E-04
Resource use, fossils	MJ	4.0E+01	3.3E+00	7.6E-01	9.0E-01	1.4E+03	4.3E-01	3.6E+00	-4.7E+00	1.4E+03
Additional technical information										
Primary energy consumption	MJ	4.0E+01	3.3E+00	7.6E-01	9.0E-01	1.4E+03	4.3E-01	3.6E+00	-4.7E+00	1.5E+03

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6649 Table 11-66: EU total impact of Stock of products in the year of study: BC1

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Metals	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Electronics	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Others	kt	0.000	0.000		0.000	0.041	n.a.			0.041
Total weight	kt	0.000	0.000		0.000	0.041	0.000			0.041
Energy consumption										
Electricity	kWh		2		0	1,662	0			1,664
Thermal energy	MJ		0		0	0	0			0
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	2.8E+01	1.7E+00	5.0E-01	6.0E-01	7.5E+02	3.0E-01	2.1E+00	-4.5E+00	7.8E+02
Ozone depletion	kg CFC-11 eq.	2.1E-08	6.5E-10	5.7E-12	9.9E-11	1.1E-06	2.1E-10	5.0E-10	-6.6E-11	1.2E-06
Human toxicity, cancer	CTUh	2.0E-07	1.3E-10	1.3E-10	3.7E-10	3.8E-07	2.0E-09	2.7E-09	-1.3E-07	4.6E-07
Human toxicity, non-cancer	CTUh	8.0E-07	6.8E-09	3.2E-09	6.5E-09	5.6E-06	8.0E-09	1.1E-08	-1.2E-07	6.4E-06
Particulate matter	disease incidence	2.1E-06	7.5E-08	1.6E-08	2.9E-08	2.7E-05	2.2E-08	1.3E-07	-4.6E-07	2.9E-05
Ionising radiation, human health	kBq U235 eq.	8.2E-01	7.4E-01	9.0E-03	3.4E-02	3.0E+02	1.6E-02	6.0E-01	-1.1E-01	3.0E+02

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Photochemical ozone formation, human health	kg NMVOC eq.	7.4E-02	3.1E-03	1.8E-03	3.0E-03	1.4E+00	7.7E-04	3.2E-03	-9.7E-03	1.4E+00
Acidification	mol H+ eq.	1.4E-01	5.6E-03	2.0E-03	2.4E-03	2.4E+00	1.5E-03	5.0E-03	-2.7E-02	2.5E+00
Eutrophication, terrestrial	mol N eq.	2.5E-01	1.2E-02	9.4E-03	7.6E-03	5.0E+00	2.7E-03	1.2E-02	-3.0E-02	5.3E+00
Eutrophication, freshwater	kg P eq.	3.8E-04	3.7E-06	3.0E-06	1.1E-05	1.1E-02	3.8E-06	3.1E-06	-3.8E-06	1.1E-02
Eutrophication, marine	kg N eq.	2.4E-02	1.1E-03	8.4E-04	7.9E-04	5.4E-01	2.5E-04	1.1E-03	-2.7E-03	5.7E-01
Ecotoxicity, freshwater	CTUe	1.8E+02	8.6E+00	4.6E+00	4.0E+00	4.0E+03	1.9E+00	7.1E+00	-2.5E+01	4.2E+03
Land use	pt	9.0E+03	9.4E+00	3.9E+00	1.6E+02	3.8E+03	9.1E+01	6.7E+00	-1.7E+02	1.3E+04
Water use	m ³ water eq. of deprived water	8.5E+00	6.1E-01	4.6E-02	1.0E-01	9.5E+02	9.1E-02	4.8E-01	-5.4E-01	9.6E+02
Resource use, minerals and metals	kg Sb eq.	2.8E-03	5.4E-07	3.3E-07	2.3E-07	7.8E-04	2.8E-05	4.3E-07	-4.2E-04	3.1E-03
Resource use, fossils	MJ	3.8E+02	3.1E+01	7.2E+00	8.5E+00	1.3E+04	4.1E+00	3.4E+01	-4.5E+01	1.3E+04
Additional technical information										
Primary energy consumption	MJ	3.8E+02	3.1E+01	7.2E+00	8.5E+00	1.3E+04	4.1E+00	3.4E+01	-4.5E+01	1.4E+04

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6651 Table 11-67: Life cycle costs per product and total EU expenditure: BC1

Product items	LCC new product		Total annual consumer expenditure in EU27	
	Value	Unit	Value	Unit
Product price	3,148	EUR	26	mIn. EUR/year
Installation/ acquisition costs (if any)	0	EUR	0	mIn. EUR/year
Fuel (gas, oil, wood)	0	EUR/year	0	mIn. EUR/year
Electricity	411	EUR/year	36	mIn. EUR/year
Water	76	EUR/year	7	mIn. EUR/year
Auxiliary material 1: Detergent	117	EUR/year	10	mIn. EUR/year
Auxiliary material 2	0	EUR/year	0	mIn. EUR/year
Auxiliary material 3	0	EUR/year	0	mIn. EUR/year
Auxiliary material 4	0	EUR/year	0	mIn. EUR/year
Auxiliary material 5	0	EUR/year	0	mIn. EUR/year
Repair & maintenance costs	1,385	EUR	10	mIn. EUR/year
Total	982	EUR/year	88	mIn. EUR/year

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6654 11.5.2. BC2: Undercounter one-tank dishwasher

6655 Below, the life cycle impact is provided per product (**Table 11-68**), per year of use of the product (

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6656 **Table 11-69)**, total impact for the EU-27 for the new product (**Table 11-70**) and the impact of the stock of products in the EU-27 (

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6658 Table 11-71). The life cycle costs per product and as EU-27 total are provided in **Table 11-72**

6659 **Table 11-68: Life cycle impact per product: BC2.**

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Materials	unit									
Plastics	g	8,990	8,990		2,089	0	n.a.			20,069
Metals	g	55,380	55,380		0	0	n.a.			110,760
Electronics	g	3,894	0		0	0	n.a.			3,894
Others	g	0	0		12,625	1,306,788,448	n.a.			1,306,801,073
Total weight	g	68,264	64,370		14,714	1,306,788,448	683			1,306,936,479
Energy consumption										
Electricity	kWh		30		0	55,704	0			55,734
Thermal energy	MJ		0		0	2,567	0			2,567
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	8.3E+02	1.9E+01	9.2E+00	1.8E+01	2.6E+04	8.5E+00	6.2E+01	-2.7E+02	2.7E+04

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Ozone depletion	kg CFC-11 eq.	1.6E-07	7.3E-09	1.1E-10	1.9E-08	4.4E-05	1.7E-09	1.4E-08	-4.5E-09	4.4E-05
Human toxicity, cancer	CTUh	3.5E-05	-1.5E-09	2.4E-09	9.6E-09	1.3E-05	3.5E-07	7.8E-08	-2.4E-05	2.5E-05
Human toxicity, non-cancer	CTUh	1.8E-05	8.6E-08	5.9E-08	1.5E-07	1.9E-04	1.8E-07	3.1E-07	-3.0E-06	2.1E-04
Particulate matter	disease incidence	9.3E-05	1.2E-06	2.9E-07	1.1E-06	9.7E-04	9.4E-07	3.6E-06	-4.4E-05	1.0E-03
Ionising radiation, human health	kBq U235 eq.	2.4E+01	8.4E+00	1.7E-01	9.2E-01	1.0E+04	3.2E-01	1.7E+01	-7.2E+00	1.0E+04
Photochemical ozone formation, human health	kg NMVOC eq.	2.3E+00	3.8E-02	3.3E-02	9.7E-02	4.8E+01	2.3E-02	9.2E-02	-7.9E-01	4.9E+01
Acidification	mol H+ eq.	6.9E+00	6.5E-02	3.6E-02	8.7E-02	8.4E+01	7.0E-02	1.4E-01	-3.4E+00	8.8E+01
Eutrophication, terrestrial	mol N eq.	7.5E+00	1.5E-01	1.7E-01	2.6E-01	1.8E+02	7.7E-02	3.4E-01	-2.5E+00	1.9E+02
Eutrophication, freshwater	kg P eq.	6.0E-03	4.3E-05	5.5E-05	5.1E-04	4.1E-01	6.1E-05	8.9E-05	-1.9E-04	4.2E-01
Eutrophication, marine	kg N eq.	7.0E-01	1.4E-02	1.5E-02	2.8E-02	2.0E+01	7.1E-03	3.2E-02	-2.2E-01	2.1E+01
Ecotoxicity, freshwater	CTUe	5.0E+03	1.0E+02	8.5E+01	1.5E+02	1.4E+05	5.1E+01	2.0E+02	-2.0E+03	1.5E+05
Land use	pt	2.1E+05	1.3E+02	7.1E+01	4.4E+03	1.5E+05	2.1E+03	1.9E+02	-4.1E+03	3.6E+05

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Water use	m³ water eq. of deprived water	2.5E+02	7.3E+00	8.5E-01	4.2E+00	3.1E+04	2.5E+00	1.4E+01	-6.4E+01	3.2E+04
Resource use, minerals and metals	kg Sb eq.	9.1E-02	7.2E-06	6.1E-06	2.8E-05	3.7E-02	9.1E-04	1.2E-05	-2.9E-02	1.0E-01
Resource use, fossils	MJ	9.8E+03	3.5E+02	1.3E+02	2.9E+02	4.4E+05	1.0E+02	9.9E+02	-3.1E+03	4.5E+05
Additional technical information										
Primary energy consumption	MJ	9.8E+03	3.6E+02	1.3E+02	2.9E+02	4.6E+05	1.0E+02	9.9E+02	-3.1E+03	4.6E+05

* Manufacturing materials are double counted with the raw materials column.

6662 Table 11-69: Life cycle impact per product per year of use: BC2.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	g	1,124	1,124		261	0	n.a.			2,509
Metals	g	6,923	6,923		0	0	n.a.			13,845
Electronics	g	487	0		0	0	n.a.			487
Others	g	0	0		1,578	163,348,556	n.a.			163,350,134
Total weight	g	8,533	8,046		1,839	163,348,556	85			163,367,060
Energy consumption										
Electricity	kWh		4		0	6,963	0			6,967
Thermal energy	MJ		0		0	321	0			321
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	1.0E+02	2.3E+00	1.2E+00	2.3E+00	3.2E+03	1.1E+00	7.7E+00	-3.4E+01	3.3E+03
Ozone depletion	kg CFC-11 eq.	2.0E-08	9.2E-10	1.3E-11	2.3E-09	5.5E-06	2.1E-10	1.8E-09	-5.6E-10	5.5E-06
Human toxicity, cancer	CTUh	4.3E-06	-1.9E-10	3.1E-10	1.2E-09	1.7E-06	4.3E-08	9.8E-09	-2.9E-06	3.1E-06
Human toxicity, non-cancer	CTUh	2.2E-06	1.1E-08	7.4E-09	1.9E-08	2.4E-05	2.2E-08	3.9E-08	-3.7E-07	2.6E-05
Particulate matter	disease incidence	1.2E-05	1.5E-07	3.7E-08	1.4E-07	1.2E-04	1.2E-07	4.5E-07	-5.6E-06	1.3E-04

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Ionising radiation, human health	kBq U235 eq.	3.0E+00	1.0E+00	2.1E-02	1.1E-01	1.3E+03	4.0E-02	2.1E+00	-9.0E-01	1.3E+03
Photochemical ozone formation, human health	kg NMVOC eq.	2.8E-01	4.8E-03	4.1E-03	1.2E-02	6.0E+00	2.9E-03	1.2E-02	-9.8E-02	6.2E+00
Acidification	mol H+ eq.	8.6E-01	8.2E-03	4.5E-03	1.1E-02	1.1E+01	8.7E-03	1.8E-02	-4.2E-01	1.1E+01
Eutrophication, terrestrial	mol N eq.	9.4E-01	1.9E-02	2.2E-02	3.3E-02	2.2E+01	9.6E-03	4.3E-02	-3.1E-01	2.3E+01
Eutrophication, freshwater	kg P eq.	7.5E-04	5.4E-06	6.9E-06	6.3E-05	5.2E-02	7.6E-06	1.1E-05	-2.4E-05	5.2E-02
Eutrophication, marine	kg N eq.	8.7E-02	1.8E-03	1.9E-03	3.4E-03	2.5E+00	8.9E-04	4.0E-03	-2.7E-02	2.6E+00
Ecotoxicity, freshwater	CTUe	6.3E+02	1.3E+01	1.1E+01	1.9E+01	1.8E+04	6.4E+00	2.5E+01	-2.5E+02	1.8E+04
Land use	pt	2.6E+04	1.6E+01	8.9E+00	5.5E+02	1.8E+04	2.6E+02	2.4E+01	-5.1E+02	4.5E+04
Water use	m ³ water eq. of deprived water	3.1E+01	9.1E-01	1.1E-01	5.3E-01	3.9E+03	3.2E-01	1.7E+00	-8.1E+00	4.0E+03
Resource use, minerals and metals	kg Sb eq.	1.1E-02	9.0E-07	7.6E-07	3.5E-06	4.6E-03	1.1E-04	1.5E-06	-3.7E-03	1.2E-02
Resource use, fossils	MJ	1.2E+03	4.4E+01	1.7E+01	3.7E+01	5.5E+04	1.3E+01	1.2E+02	-3.8E+02	5.6E+04
Additional technical information										
Primary energy consumption	MJ	1.2E+03	4.5E+01	1.7E+01	3.7E+01	5.7E+04	1.3E+01	1.2E+02	-3.8E+02	5.8E+04

* Manufacturing materials are currently double counting the raw materials column.

6665 Table 11-70: EU total impact of new products sold in the year of study: BC2.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	0	0		0	0	n.a.			0
Metals	kt	0	0		0	0	n.a.			0
Electronics	kt	0	0		0	0	n.a.			0
Others	kt	0	0		0	0	n.a.			0
Total weight	kt	0	0		0	0	0			0
Energy consumption										
Electricity	kWh		5		0	9,958	0			9,963
Thermal energy	MJ		0		0	459	0			459
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	1.5E+02	3.4E+00	1.6E+00	3.2E+00	4.6E+03	1.5E+00	1.1E+01	-4.9E+01	4.7E+03
Ozone depletion	kg CFC-11 eq.	2.9E-08	1.3E-09	1.9E-11	3.3E-09	7.8E-06	3.0E-10	2.5E-09	-8.0E-10	7.8E-06
Human toxicity, cancer	CTUh	6.2E-06	-2.7E-10	4.4E-10	1.7E-09	2.4E-06	6.2E-08	1.4E-08	-4.2E-06	4.4E-06
Human toxicity, non-cancer	CTUh	3.2E-06	1.5E-08	1.1E-08	2.7E-08	3.5E-05	3.2E-08	5.6E-08	-5.3E-07	3.7E-05
Particulate matter	disease incidence	1.7E-05	2.1E-07	5.3E-08	2.0E-07	1.7E-04	1.7E-07	6.4E-07	-7.9E-06	1.8E-04
Ionising radiation, human health	kBq U235 eq.	4.3E+00	1.5E+00	3.0E-02	1.6E-01	1.8E+03	5.8E-02	3.1E+00	-1.3E+00	1.8E+03

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Photochemical ozone formation, human health	kg NMVOC eq.	4.0E-01	6.8E-03	5.8E-03	1.7E-02	8.5E+00	4.1E-03	1.6E-02	-1.4E-01	8.8E+00
Acidification	mol H+ eq.	1.2E+00	1.2E-02	6.4E-03	1.6E-02	1.5E+01	1.2E-02	2.6E-02	-6.1E-01	1.6E+01
Eutrophication, terrestrial	mol N eq.	1.3E+00	2.7E-02	3.1E-02	4.7E-02	3.2E+01	1.4E-02	6.1E-02	-4.4E-01	3.3E+01
Eutrophication, freshwater	kg P eq.	1.1E-03	7.8E-06	9.9E-06	9.1E-05	7.4E-02	1.1E-05	1.6E-05	-3.4E-05	7.5E-02
Eutrophication, marine	kg N eq.	1.2E-01	2.6E-03	2.8E-03	4.9E-03	3.6E+00	1.3E-03	5.7E-03	-3.9E-02	3.7E+00
Ecotoxicity, freshwater	CTUe	9.0E+02	1.9E+01	1.5E+01	2.7E+01	2.6E+04	9.2E+00	3.6E+01	-3.5E+02	2.6E+04
Land use	pt	3.7E+04	2.3E+01	1.3E+01	7.9E+02	2.6E+04	3.7E+02	3.5E+01	-7.3E+02	6.4E+04
Water use	m ³ water eq. of deprived water	4.4E+01	1.3E+00	1.5E-01	7.6E-01	5.6E+03	4.5E-01	2.5E+00	-1.2E+01	5.6E+03
Resource use, minerals and metals	kg Sb eq.	1.6E-02	1.3E-06	1.1E-06	5.0E-06	6.6E-03	1.6E-04	2.2E-06	-5.2E-03	1.8E-02
Resource use, fossils	MJ	1.7E+03	6.3E+01	2.4E+01	5.2E+01	7.9E+04	1.8E+01	1.8E+02	-5.5E+02	8.0E+04
Additional technical information										
Primary energy consumption	MJ	1.7E+03	6.5E+01	2.4E+01	5.2E+01	8.2E+04	1.8E+01	1.8E+02	-5.5E+02	8.3E+04

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6669 Table 11-71: EU total impact of Stock of products in the year of study: BC2.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Metals	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Electronics	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Others	kt	0.000	0.000		0.000	1.556	n.a.			1.556
Total weight	kt	0.000	0.000		0.000	1.556	0.000			1.556
Energy consumption										
Electricity	kWh		36		0	66,322	0			66,357
Thermal energy	MJ		0		0	3,057	0			3,057
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	9.9E+02	2.2E+01	1.1E+01	2.2E+01	3.1E+04	1.0E+01	7.4E+01	-3.3E+02	3.2E+04
Ozone depletion	kg CFC-11 eq.	1.9E-07	8.7E-09	1.3E-10	2.2E-08	5.2E-05	2.0E-09	1.7E-08	-5.3E-09	5.2E-05
Human toxicity, cancer	CTUh	4.1E-05	-1.8E-09	2.9E-09	1.1E-08	1.6E-05	4.1E-07	9.3E-08	-2.8E-05	3.0E-05
Human toxicity, non-cancer	CTUh	2.1E-05	1.0E-07	7.1E-08	1.8E-07	2.3E-04	2.1E-07	3.7E-07	-3.5E-06	2.5E-04
Particulate matter	disease incidence	1.1E-04	1.4E-06	3.5E-07	1.3E-06	1.2E-03	1.1E-06	4.3E-06	-5.3E-05	1.2E-03
Ionising radiation, human health	kBq U235 eq.	2.8E+01	1.0E+01	2.0E-01	1.1E+00	1.2E+04	3.8E-01	2.0E+01	-8.6E+00	1.2E+04

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Photochemical ozone formation, human health	kg NMVOC eq.	2.7E+00	4.6E-02	3.9E-02	1.2E-01	5.7E+01	2.7E-02	1.1E-01	-9.3E-01	5.9E+01
Acidification	mol H+ eq.	8.2E+00	7.8E-02	4.3E-02	1.0E-01	1.0E+02	8.3E-02	1.7E-01	-4.0E+00	1.1E+02
Eutrophication, terrestrial	mol N eq.	9.0E+00	1.8E-01	2.1E-01	3.1E-01	2.1E+02	9.2E-02	4.1E-01	-3.0E+00	2.2E+02
Eutrophication, freshwater	kg P eq.	7.2E-03	5.2E-05	6.6E-05	6.0E-04	4.9E-01	7.2E-05	1.1E-04	-2.3E-04	5.0E-01
Eutrophication, marine	kg N eq.	8.3E-01	1.7E-02	1.8E-02	3.3E-02	2.4E+01	8.5E-03	3.8E-02	-2.6E-01	2.5E+01
Ecotoxicity, freshwater	CTUe	6.0E+03	1.2E+02	1.0E+02	1.8E+02	1.7E+05	6.1E+01	2.4E+02	-2.3E+03	1.8E+05
Land use	pt	2.4E+05	1.6E+02	8.5E+01	5.2E+03	1.8E+05	2.4E+03	2.3E+02	-4.9E+03	4.2E+05
Water use	m ³ water eq. of deprived water	2.9E+02	8.7E+00	1.0E+00	5.1E+00	3.7E+04	3.0E+00	1.6E+01	-7.7E+01	3.8E+04
Resource use, minerals and metals	kg Sb eq.	1.1E-01	8.6E-06	7.3E-06	3.4E-05	4.4E-02	1.1E-03	1.5E-05	-3.5E-02	1.2E-01
Resource use, fossils	MJ	1.2E+04	4.2E+02	1.6E+02	3.5E+02	5.2E+05	1.2E+02	1.2E+03	-3.6E+03	5.3E+05
Additional technical information										
Primary energy consumption	MJ	1.2E+04	4.3E+02	1.6E+02	3.5E+02	5.4E+05	1.2E+02	1.2E+03	-3.6E+03	5.6E+05

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6673 **Table 11-72: Life cycle costs per product and total EU expenditure: BC2.**

Product items	LCC new product		Total annual consumer expenditure in EU27	
	Value	Unit	Value	Unit
Product price	5,659	EUR	1,012	mIn. EUR/year
Installation/ acquisition costs (if any)	0	EUR	0	mIn. EUR/year
Fuel (gas, oil, wood)	7	EUR/year	9	mIn. EUR/year
Electricity	1,665	EUR/year	2,131	mIn. EUR/year
Water	290	EUR/year	371	mIn. EUR/year
Auxiliary material 1: Detergent	718	EUR/year	919	mIn. EUR/year
Auxiliary material 2	57	EUR/year	73	mIn. EUR/year
Auxiliary material 3	0	EUR/year	0	mIn. EUR/year
Auxiliary material 4	0	EUR/year	0	mIn. EUR/year
Auxiliary material 5	0	EUR/year	0	mIn. EUR/year
Repair & maintenance costs	2,490	EUR	398	mIn. EUR/year
Total	3,756	EUR/year	4,912	mIn. EUR/year

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6676 **11.5.3. BC3: Hood-type dishwasher**

6677 Below, the life cycle impact is provided per product (**Table 11-73**), per year of use of the product (* **Manufacturing** materials are double counted with the raw
6678 materials column.

6679 Table 11-74), total impact for the EU-27 for the new product (

6680 **Table 11-75**) and the impact of the stock of products in the EU-27 (**Table 11-76**). The life cycle costs per product and as EU-27 total are provided in **Table 11-77**.

6681 **Table 11-73: Life cycle impact per product: BC3.**

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	g	13,760	13,750		1,944	0	n.a.			29,454
Metals	g	129,940	123,130		0	0	n.a.			253,070
Electronics	g	5,000	0		0	0	n.a.			5,000
Others	g	0	0		24,250	1,242,556,538	n.a.			1,242,580,788
Total weight	g	148,700	136,880		26,194	1,242,556,538	1,487			1,242,869,799
Energy consumption										
Electricity	kWh		36		0	112,464	0			112,500
Thermal energy	MJ		0		0	8,591	0			8,591

Life Cycle phases --> Resource use and emissions			Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
PEF categories	Impact	unit							Impacts	Credits	
Climate total	change,	kg CO ₂ eq.	1.5E+03	2.5E+01	1.9E+01	2.7E+01	5.1E+04	1.5E+01	1.5E+02	-6.6E+02	5.2E+04
Ozone depletion		kg CFC-11 eq.	2.3E-07	1.0E-08	2.2E-10	2.4E-08	6.4E-05	2.4E-09	3.4E-08	-1.0E-08	6.4E-05
Human toxicity, cancer		CTUh	8.3E-05	-6.4E-09	5.2E-09	1.6E-08	1.9E-05	8.3E-07	1.9E-07	-5.7E-05	4.6E-05
Human toxicity, non-cancer		CTUh	2.8E-05	1.4E-07	1.3E-07	2.9E-07	2.9E-04	2.8E-07	7.4E-07	-7.1E-06	3.1E-04
Particulate matter	disease incidence		1.9E-04	2.1E-06	6.2E-07	1.8E-06	1.8E-03	1.9E-06	8.7E-06	-1.1E-04	1.9E-03
Ionising radiation, human health		kBq U235 eq.	4.2E+01	1.1E+01	3.5E-01	1.5E+00	2.0E+04	5.3E-01	4.1E+01	-1.7E+01	2.0E+04
Photochemical ozone formation, human health		kg NMVOC eq.	4.2E+00	5.7E-02	6.9E-02	1.5E-01	9.1E+01	4.2E-02	2.2E-01	-1.9E+00	9.4E+01
Acidification		mol H+ eq.	1.4E+01	9.3E-02	7.6E-02	1.3E-01	1.6E+02	1.5E-01	3.4E-01	-8.1E+00	1.7E+02
Eutrophication, terrestrial		mol N eq.	1.4E+01	2.4E-01	3.6E-01	4.0E-01	3.5E+02	1.4E-01	8.2E-01	-5.9E+00	3.5E+02
Eutrophication, freshwater		kg P eq.	8.2E-03	6.2E-05	1.2E-04	6.7E-04	5.6E-01	8.2E-05	2.1E-04	-4.6E-04	5.7E-01
Eutrophication, marine		kg N eq.	1.3E+00	2.2E-02	3.3E-02	4.1E-02	3.7E+01	1.3E-02	7.6E-02	-5.2E-01	3.8E+01

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Ecotoxicity, freshwater	CTUe	9.6E+03	1.5E+02	1.8E+02	1.8E+02	2.7E+05	9.8E+01	4.9E+02	-4.7E+03	2.7E+05
Land use	pt	2.9E+05	2.2E+02	1.5E+02	7.0E+03	2.9E+05	2.9E+03	4.7E+02	-5.6E+03	5.9E+05
Water use	m³ water eq. of deprived water	4.3E+02	1.0E+01	1.8E+00	6.0E+00	4.0E+04	4.4E+00	3.3E+01	-1.5E+02	4.0E+04
Resource use, minerals and metals	kg Sb eq.	1.6E-01	1.2E-05	1.3E-05	4.0E-05	6.2E-02	1.6E-03	3.0E-05	-6.8E-02	1.6E-01
Resource use, fossils	MJ	1.8E+04	4.9E+02	2.8E+02	3.7E+02	8.7E+05	1.8E+02	2.4E+03	-7.3E+03	8.9E+05
Additional technical information										
Primary energy consumption	MJ	1.8E+04	5.0E+02	2.8E+02	3.7E+02	9.0E+05	1.8E+02	2.4E+03	-7.3E+03	9.2E+05

* Manufacturing materials are double counted with the raw materials column.

Table 11-74: Life cycle impact per product per year of use: BC3.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Materials	unit									
Plastics	g	1,720	1,719		243	0	n.a.			3,682

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Metals	g	16,243	15,391		0	0	n.a.			31,634
Electronics	g	625	0		0	0	n.a.			625
Others	g	0	0		3,031	155,319,567	n.a.			155,322,599
Total weight	g	18,588	17,110		3,274	155,319,567	186			155,358,725
Energy consumption										
Electricity	kWh		5		0	14,058	0			14,063
Thermal energy	MJ		0		0	1,074	0			1,074
PEF Impact categories		unit								
Climate change, total	kg CO ₂ eq.	1.9E+02	3.1E+00	2.4E+00	3.4E+00	6.4E+03	1.9E+00	1.9E+01	-8.2E+01	6.5E+03
Ozone depletion	kg CFC-11 eq.	2.9E-08	1.3E-09	2.8E-11	3.0E-09	8.0E-06	3.0E-10	4.3E-09	-1.3E-09	8.0E-06
Human toxicity, cancer	CTUh	1.0E-05	-8.0E-10	6.5E-10	2.1E-09	2.3E-06	1.0E-07	2.4E-08	-7.1E-06	5.7E-06
Human toxicity, non-cancer	CTUh	3.5E-06	1.7E-08	1.6E-08	3.7E-08	3.6E-05	3.5E-08	9.3E-08	-8.8E-07	3.9E-05
Particulate matter	disease incidence	2.4E-05	2.6E-07	7.8E-08	2.2E-07	2.3E-04	2.4E-07	1.1E-06	-1.3E-05	2.4E-04
Ionising radiation, human health	kBq U235 eq.	5.2E+00	1.4E+00	4.4E-02	1.8E-01	2.5E+03	6.7E-02	5.2E+00	-2.1E+00	2.6E+03
Photochemical ozone formation, human health	kg NMVOC eq.	5.2E-01	7.1E-03	8.6E-03	1.9E-02	1.1E+01	5.3E-03	2.8E-02	-2.4E-01	1.2E+01

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Acidification	mol H+ eq.	1.8E+00	1.2E-02	9.5E-03	1.7E-02	2.0E+01	1.8E-02	4.3E-02	-1.0E+00	2.1E+01
Eutrophication, terrestrial	mol N eq.	1.7E+00	2.9E-02	4.6E-02	5.0E-02	4.3E+01	1.7E-02	1.0E-01	-7.4E-01	4.4E+01
Eutrophication, freshwater	kg P eq.	1.0E-03	7.7E-06	1.5E-05	8.4E-05	7.0E-02	1.0E-05	2.7E-05	-5.7E-05	7.1E-02
Eutrophication, marine	kg N eq.	1.6E-01	2.7E-03	4.1E-03	5.1E-03	4.6E+00	1.6E-03	9.5E-03	-6.5E-02	4.8E+00
Ecotoxicity, freshwater	CTUe	1.2E+03	1.9E+01	2.2E+01	2.3E+01	3.3E+04	1.2E+01	6.1E+01	-5.8E+02	3.4E+04
Land use	pt	3.7E+04	2.7E+01	1.9E+01	8.8E+02	3.6E+04	3.7E+02	5.8E+01	-7.0E+02	7.3E+04
Water use	m ³ water eq. of deprived water	5.3E+01	1.3E+00	2.2E-01	7.5E-01	4.9E+03	5.5E-01	4.1E+00	-1.9E+01	5.0E+03
Resource use, minerals and metals	kg Sb eq.	2.1E-02	1.5E-06	1.6E-06	4.9E-06	7.8E-03	2.1E-04	3.7E-06	-8.5E-03	2.0E-02
Resource use, fossils	MJ	2.2E+03	6.1E+01	3.5E+01	4.6E+01	1.1E+05	2.3E+01	3.0E+02	-9.2E+02	1.1E+05
Additional technical information										
Primary energy consumption	MJ	2.2E+03	6.3E+01	3.5E+01	4.6E+01	1.1E+05	2.3E+01	3.0E+02	-9.2E+02	1.1E+05

* Manufacturing materials are double counted with the raw materials column.

6687 Table 11-75: EU total impact of new products sold in the year of study: BC3.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	0	0		0	0	n.a.			0
Metals	kt	0	0		0	0	n.a.			0
Electronics	kt	0	0		0	0	n.a.			0
Others	kt	0	0		0	0	n.a.			0
Total weight	kt	0	0		0	0	0			0
Energy consumption										
Electricity	kWh		2		0	7,423	0			7,425
Thermal energy	MJ		0		0	567	0			567
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	1.0E+02	1.6E+00	1.3E+00	1.8E+00	3.4E+03	1.0E+00	9.8E+00	-4.4E+01	3.4E+03
Ozone depletion	kg CFC-11 eq	1.5E-08	6.6E-10	1.5E-11	1.6E-09	4.2E-06	1.6E-10	2.3E-09	-6.8E-10	4.2E-06
Human toxicity, cancer	CTUh	5.5E-06	-4.2E-10	3.4E-10	1.1E-09	1.2E-06	5.5E-08	1.2E-08	-3.8E-06	3.0E-06
Human toxicity, non-cancer	CTUh	1.9E-06	9.0E-09	8.3E-09	1.9E-08	1.9E-05	1.9E-08	4.9E-08	-4.7E-07	2.0E-05
Particulate matter	disease incidence	1.3E-05	1.4E-07	4.1E-08	1.2E-07	1.2E-04	1.3E-07	5.7E-07	-7.1E-06	1.3E-04

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Ionising radiation, human health	kBq U235 eq.	2.8E+00	7.6E-01	2.3E-02	9.6E-02	1.3E+03	3.5E-02	2.7E+00	-1.1E+00	1.4E+03
Photochemical ozone formation, human health	kg NMVOC eq.	2.8E-01	3.8E-03	4.6E-03	9.9E-03	6.0E+00	2.8E-03	1.5E-02	-1.2E-01	6.2E+00
Acidification	mol H+ eq.	9.5E-01	6.2E-03	5.0E-03	8.7E-03	1.1E+01	9.6E-03	2.3E-02	-5.4E-01	1.1E+01
Eutrophication, terrestrial	mol N eq.	9.1E-01	1.6E-02	2.4E-02	2.6E-02	2.3E+01	9.2E-03	5.4E-02	-3.9E-01	2.3E+01
Eutrophication, freshwater	kg P eq.	5.4E-04	4.1E-06	7.7E-06	4.4E-05	3.7E-02	5.4E-06	1.4E-05	-3.0E-05	3.7E-02
Eutrophication, marine	kg N eq.	8.3E-02	1.5E-03	2.1E-03	2.7E-03	2.5E+00	8.4E-04	5.0E-03	-3.4E-02	2.5E+00
Ecotoxicity, freshwater	CTUe	6.3E+02	1.0E+01	1.2E+01	1.2E+01	1.8E+04	6.4E+00	3.2E+01	-3.1E+02	1.8E+04
Land use	pt	1.9E+04	1.4E+01	9.9E+00	4.6E+02	1.9E+04	1.9E+02	3.1E+01	-3.7E+02	3.9E+04
Water use	m ³ water eq. of deprived water	2.8E+01	6.9E-01	1.2E-01	4.0E-01	2.6E+03	2.9E-01	2.2E+00	-1.0E+01	2.6E+03
Resource use, minerals and metals	kg Sb eq.	1.1E-02	7.8E-07	8.5E-07	2.6E-06	4.1E-03	1.1E-04	2.0E-06	-4.5E-03	1.1E-02
Resource use, fossils	MJ	1.2E+03	3.2E+01	1.8E+01	2.4E+01	5.8E+04	1.2E+01	1.6E+02	-4.8E+02	5.9E+04
Additional technical information										
Primary energy consumption	MJ	1.2E+03	3.3E+01	1.8E+01	2.4E+01	6.0E+04	1.2E+01	1.6E+02	-4.8E+02	6.1E+04

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6689 **Table 11-76: EU total impact of Stock of products in the year of study: BC3.**

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Metals	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Electronics	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Others	kt	0.000	0.000		0.000	0.546	n.a.			0.546
Total weight	kt	0.000	0.000		0.000	0.546	0.000			0.546
Energy consumption										
Electricity	kWh		16		0	49,440	0			49,456
Thermal energy	MJ		0		0	3,777	0			3,777
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	6.7E+02	1.1E+01	8.5E+00	1.2E+01	2.2E+04	6.8E+00	6.5E+01	-2.9E+02	2.3E+04
Ozone depletion	kg CFC-11 eq.	1.0E-07	4.4E-09	9.8E-11	1.0E-08	2.8E-05	1.0E-09	1.5E-08	-4.5E-09	2.8E-05
Human toxicity, cancer	CTUh	3.7E-05	-2.8E-09	2.3E-09	7.2E-09	8.2E-06	3.7E-07	8.3E-08	-2.5E-05	2.0E-05
Human toxicity, non-cancer	CTUh	1.2E-05	6.0E-08	5.5E-08	1.3E-07	1.3E-04	1.2E-07	3.3E-07	-3.1E-06	1.4E-04

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Particulate matter	disease incidence	8.5E-05	9.1E-07	2.7E-07	7.9E-07	8.1E-04	8.6E-07	3.8E-06	-4.7E-05	8.6E-04
Ionising radiation, human health	kBq U235 eq.	1.8E+01	5.0E+00	1.5E-01	6.4E-01	9.0E+03	2.3E-01	1.8E+01	-7.4E+00	9.0E+03
Photochemical ozone formation, human health	kg NMVOC eq.	1.8E+00	2.5E-02	3.0E-02	6.6E-02	4.0E+01	1.9E-02	9.8E-02	-8.3E-01	4.1E+01
Acidification	mol H+ eq.	6.3E+00	4.1E-02	3.3E-02	5.8E-02	7.2E+01	6.4E-02	1.5E-01	-3.6E+00	7.5E+01
Eutrophication, terrestrial	mol N eq.	6.0E+00	1.0E-01	1.6E-01	1.7E-01	1.5E+02	6.1E-02	3.6E-01	-2.6E+00	1.6E+02
Eutrophication, freshwater	kg P eq.	3.6E-03	2.7E-05	5.1E-05	2.9E-04	2.5E-01	3.6E-05	9.4E-05	-2.0E-04	2.5E-01
Eutrophication, marine	kg N eq.	5.5E-01	9.7E-03	1.4E-02	1.8E-02	1.6E+01	5.6E-03	3.4E-02	-2.3E-01	1.7E+01
Ecotoxicity, freshwater	CTUe	4.2E+03	6.8E+01	7.9E+01	8.1E+01	1.2E+05	4.3E+01	2.2E+02	-2.0E+03	1.2E+05
Land use	pt	1.3E+05	9.6E+01	6.6E+01	3.1E+03	1.3E+05	1.3E+03	2.0E+02	-2.5E+03	2.6E+05
Water use	m ³ water eq. of deprived water	1.9E+02	4.6E+00	7.9E-01	2.6E+00	1.7E+04	1.9E+00	1.5E+01	-6.8E+01	1.8E+04
Resource use, minerals and metals	kg Sb eq.	7.2E-02	5.2E-06	5.7E-06	1.7E-05	2.7E-02	7.2E-04	1.3E-05	-3.0E-02	7.1E-02
Resource use, fossils	MJ	7.7E+03	2.2E+02	1.2E+02	1.6E+02	3.8E+05	7.9E+01	1.0E+03	-3.2E+03	3.9E+05

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Additional technical information										
Primary energy consumption	MJ	7.7E+03	2.2E+02	1.2E+02	1.6E+02	4.0E+05	8.0E+01	1.0E+03	- 3.2E+03	4.1E+05

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6691 **Table 11-77: Life cycle costs per product and total EU expenditure: BC3.**

Product items	LCC new product		Total annual consumer expenditure in EU27	
	Value	Unit	Value	Unit
Product price	8,662	EUR	572	mIn. EUR/year
Installation/ acquisition costs (if any)	0	EUR	0	mIn. EUR/year
Fuel (gas, oil, wood)	23	EUR/year	11	mIn. EUR/year
Electricity	3,375	EUR/year	1,588	mIn. EUR/year
Water	277	EUR/year	130	mIn. EUR/year
Auxiliary material 1: Detergent	1,243	EUR/year	585	mIn. EUR/year
Auxiliary material 2	89	EUR/year	42	mIn. EUR/year
Auxiliary material 3	0	EUR/year	0	mIn. EUR/year
Auxiliary material 4	0	EUR/year	0	mIn. EUR/year
Auxiliary material 5	0	EUR/year	0	mIn. EUR/year

Product items	LCC new product		Total annual consumer expenditure in EU27	
	Value	Unit	Value	Unit
Repair & maintenance costs	3,811	EUR	224	mIn. EUR/year
Total	6,566	EUR/year	3,152	mIn. EUR/year

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6694 **11.5.4. BC4: Utensil/pot dishwasher**

6695 Below, the life cycle impact is provided per product (**Table 11-78**), per year of use of the product (
6696 **Table 11-79**), total impact for the EU-27 for the new product (**Table 11-80**) and the impact of the stock of products in the EU-27 (**Table 11-81**). The life cycle
6697 costs per product and as EU-27 total are provided in **Table 11-82**.

6698 **Table 11-78: Life cycle impact per product: BC4.**

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Materials	unit									
Plastics	g	19,500	19,500		1,774	0	n.a.			40,774
Metals	g	184,400	184,400		0	0	n.a.			368,800
Electronics	g	5,000	0		0	0	n.a.			5,000
Others	g	0	0		22,375	1,053,365,850	n.a.			1,053,388,225
Total weight	g	208,900	203,900		24,149	1,053,365,850	2,089			1,053,804,888
Energy consumption										
Electricity	kWh		40		0	106,839	0			106,879
Thermal energy	MJ		0		0	36,455	0			36,455
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	1.9E+03	2.9E+01	2.6E+01	2.5E+01	5.0E+04	2.0E+01	2.1E+02	-9.4E+02	5.2E+04

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Ozone depletion	kg CFC-11 eq.	1.5E-07	1.2E-08	2.9E-10	2.0E-08	6.4E-05	1.6E-09	5.0E-08	-1.0E-08	6.5E-05
Human toxicity, cancer	CTUh	1.2E-04	-1.1E-08	6.8E-09	1.6E-08	1.8E-05	1.2E-06	2.7E-07	-8.2E-05	5.7E-05
Human toxicity, non-cancer	CTUh	3.4E-05	1.8E-07	1.7E-07	2.8E-07	2.7E-04	3.4E-07	1.1E-06	-1.0E-05	3.0E-04
Particulate matter	disease incidence	2.6E-04	2.9E-06	8.2E-07	1.7E-06	1.8E-03	2.7E-06	1.3E-05	-1.5E-04	1.9E-03
Ionising radiation, human health	kBq U235 eq.	4.8E+01	1.4E+01	4.6E-01	1.3E+00	1.9E+04	6.2E-01	6.0E+01	-1.9E+01	2.0E+04
Photochemical ozone formation, human health	kg NMVOC eq.	5.4E+00	7.1E-02	9.1E-02	1.3E-01	8.9E+01	5.5E-02	3.2E-01	-2.7E+00	9.2E+01
Acidification	mol H+ eq.	2.0E+01	1.2E-01	1.0E-01	1.2E-01	1.6E+02	2.0E-01	5.0E-01	-1.2E+01	1.7E+02
Eutrophication, terrestrial	mol N eq.	1.8E+01	3.0E-01	4.8E-01	3.6E-01	3.4E+02	1.8E-01	1.2E+00	-8.5E+00	3.5E+02
Eutrophication, freshwater	kg P eq.	7.9E-03	7.7E-05	1.5E-04	5.7E-04	5.6E-01	8.0E-05	3.1E-04	-6.5E-04	5.7E-01
Eutrophication, marine	kg N eq.	1.6E+00	2.8E-02	4.3E-02	3.7E-02	3.7E+01	1.6E-02	1.1E-01	-7.4E-01	3.8E+01
Ecotoxicity, freshwater	CTUe	1.1E+04	2.0E+02	2.4E+02	1.7E+02	2.6E+05	1.2E+02	7.1E+02	-5.6E+03	2.7E+05
Land use	pt	4.2E+05	2.9E+02	2.0E+02	6.2E+03	2.9E+05	4.2E+03	6.7E+02	-6.0E+03	7.1E+05

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Water use	m ³ water eq. of deprived water	5.3E+02	1.3E+01	2.4E+00	5.3E+00	3.6E+04	5.4E+00	4.8E+01	-2.1E+02	3.6E+04
Resource use, minerals and metals	kg Sb eq.	2.2E-01	1.6E-05	1.7E-05	3.8E-05	7.0E-02	2.2E-03	4.3E-05	-9.8E-02	1.9E-01
Resource use, fossils	MJ	2.3E+04	6.0E+02	3.7E+02	3.3E+02	8.6E+05	2.3E+02	3.4E+03	-1.0E+04	8.8E+05
Additional technical information										
Primary energy consumption	MJ	2.3E+04	6.1E+02	3.7E+02	3.3E+02	8.9E+05	2.3E+02	3.4E+03	-1.0E+04	9.1E+05

* Manufacturing materials are double counted with the raw materials column.

Table 11-79: Life cycle impact per product per year of use: BC4.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	g	2,167	2,167		197	0	n.a.			4,530
Metals	g	20,489	20,489		0	0	n.a.			40,978
Electronics	g	556	0		0	0	n.a.			556

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Others	g	0	0		2,486	117,040,650	n.a.			117,043,136
Total weight	g	23,211	22,656		2,683	117,040,650	232			117,089,432
Energy consumption										
Electricity	kWh		4		0	11,871	0			11,875
Thermal energy	MJ		0		0	4,051	0			4,051
PEF Impact categories		unit								
Climate change, total	kg CO ₂ eq.	2.2E+02	3.2E+00	2.8E+00	2.8E+00	5.6E+03	2.2E+00	2.4E+01	-1.0E+02	5.7E+03
Ozone depletion	kg CFC-11 eq.	1.7E-08	1.4E-09	3.3E-11	2.3E-09	7.1E-06	1.8E-10	5.5E-09	-1.1E-09	7.2E-06
Human toxicity, cancer	CTUh	1.3E-05	-1.3E-09	7.6E-10	1.7E-09	2.0E-06	1.3E-07	3.0E-08	-9.2E-06	6.4E-06
Human toxicity, non-cancer	CTUh	3.8E-06	2.0E-08	1.8E-08	3.1E-08	3.0E-05	3.8E-08	1.2E-07	-1.1E-06	3.3E-05
Particulate matter	disease incidence	2.9E-05	3.2E-07	9.1E-08	1.9E-07	2.0E-04	3.0E-07	1.4E-06	-1.7E-05	2.2E-04
Ionising radiation, human health	kBq U235 eq.	5.4E+00	1.6E+00	5.1E-02	1.5E-01	2.2E+03	6.9E-02	6.6E+00	-2.2E+00	2.2E+03
Photochemical ozone formation, human health	kg NMVOC eq.	6.0E-01	7.9E-03	1.0E-02	1.5E-02	9.8E+00	6.1E-03	3.5E-02	-3.0E-01	1.0E+01
Acidification	mol H+ eq.	2.2E+00	1.3E-02	1.1E-02	1.3E-02	1.8E+01	2.2E-02	5.5E-02	-1.3E+00	1.9E+01

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Eutrophication, terrestrial	mol N eq.	1.9E+00	3.4E-02	5.3E-02	4.0E-02	3.7E+01	2.0E-02	1.3E-01	-9.4E-01	3.9E+01
Eutrophication, freshwater	kg P eq.	8.8E-04	8.6E-06	1.7E-05	6.4E-05	6.2E-02	8.9E-06	3.4E-05	-7.3E-05	6.3E-02
Eutrophication, marine	kg N eq.	1.8E-01	3.1E-03	4.8E-03	4.1E-03	4.1E+00	1.8E-03	1.2E-02	-8.2E-02	4.2E+00
Ecotoxicity, freshwater	CTUe	1.3E+03	2.2E+01	2.6E+01	1.8E+01	2.9E+04	1.3E+01	7.9E+01	-6.3E+02	3.0E+04
Land use	pt	4.6E+04	3.2E+01	2.2E+01	6.9E+02	3.2E+04	4.6E+02	7.5E+01	-6.6E+02	7.9E+04
Water use	m ³ water eq. of deprived water	5.9E+01	1.5E+00	2.6E-01	5.9E-01	4.0E+03	6.0E-01	5.3E+00	-2.4E+01	4.0E+03
Resource use, minerals and metals	kg Sb eq.	2.4E-02	1.7E-06	1.9E-06	4.3E-06	7.8E-03	2.4E-04	4.7E-06	-1.1E-02	2.2E-02
Resource use, fossils	MJ	2.5E+03	6.6E+01	4.1E+01	3.7E+01	9.5E+04	2.6E+01	3.8E+02	-1.1E+03	9.7E+04
Additional technical information										
Primary energy consumption	MJ	2.5E+03	6.8E+01	4.1E+01	3.7E+01	9.9E+04	2.6E+01	3.8E+02	-1.1E+03	1.0E+05

* Manufacturing materials are double counted with the raw materials column.

6704 Table 11-80: EU total impact of new products sold in the year of study: BC4.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	0	0		0	0	n.a.			0
Metals	kt	0	0		0	0	n.a.			0
Electronics	kt	0	0		0	0	n.a.			0
Others	kt	0	0		0	0	n.a.			0
Total weight	kt	0	0		0	0	0			0
Energy consumption										
Electricity	kWh		1		0	1,469	0			1,470
Thermal energy	MJ		0		0	501	0			501
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	2.7E+01	4.0E-01	3.5E-01	3.4E-01	6.9E+02	2.7E-01	2.9E+00	-1.3E+01	7.1E+02
Ozone depletion	kg CFC-11 eq.	2.1E-09	1.7E-10	4.0E-12	2.8E-10	8.8E-07	2.3E-11	6.8E-10	-1.4E-10	8.9E-07
Human toxicity, cancer	CTUh	1.7E-06	-1.6E-10	9.4E-11	2.2E-10	2.5E-07	1.7E-08	3.8E-09	-1.1E-06	7.9E-07
Human toxicity, non-cancer	CTUh	4.7E-07	2.5E-09	2.3E-09	3.8E-09	3.7E-06	4.7E-09	1.5E-08	-1.4E-07	4.1E-06
Particulate matter	disease incidence	3.6E-06	4.0E-08	1.1E-08	2.3E-08	2.5E-05	3.7E-08	1.7E-07	-2.1E-06	2.7E-05

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Ionising radiation, human health	kBq U235 eq.	6.6E-01	1.9E-01	6.4E-03	1.8E-02	2.7E+02	8.6E-03	8.2E-01	-2.7E-01	2.7E+02
Photochemical ozone formation, human health	kg NMVOC eq.	7.4E-02	9.8E-04	1.3E-03	1.9E-03	1.2E+00	7.5E-04	4.4E-03	-3.7E-02	1.3E+00
Acidification	mol H+ eq.	2.7E-01	1.6E-03	1.4E-03	1.7E-03	2.2E+00	2.7E-03	6.8E-03	-1.6E-01	2.3E+00
Eutrophication, terrestrial	mol N eq.	2.4E-01	4.2E-03	6.6E-03	5.0E-03	4.6E+00	2.4E-03	1.6E-02	-1.2E-01	4.8E+00
Eutrophication, freshwater	kg P eq.	1.1E-04	1.1E-06	2.1E-06	7.9E-06	7.7E-03	1.1E-06	4.2E-06	-9.0E-06	7.8E-03
Eutrophication, marine	kg N eq.	2.2E-02	3.9E-04	5.9E-04	5.1E-04	5.0E-01	2.2E-04	1.5E-03	-1.0E-02	5.2E-01
Ecotoxicity, freshwater	CTUe	1.6E+02	2.7E+00	3.3E+00	2.3E+00	3.6E+03	1.6E+00	9.7E+00	-7.8E+01	3.7E+03
Land use	pt	5.7E+03	3.9E+00	2.7E+00	8.5E+01	4.0E+03	5.7E+01	9.2E+00	-8.2E+01	9.8E+03
Water use	m ³ water eq. of deprived water	7.3E+00	1.8E-01	3.3E-02	7.2E-02	4.9E+02	7.5E-02	6.6E-01	-2.9E+00	5.0E+02
Resource use, minerals and metals	kg Sb eq.	3.0E-03	2.2E-07	2.3E-07	5.3E-07	9.7E-04	3.0E-05	5.9E-07	-1.3E-03	2.7E-03
Resource use, fossils	MJ	3.1E+02	8.2E+00	5.1E+00	4.5E+00	1.2E+04	3.2E+00	4.7E+01	-1.4E+02	1.2E+04
Additional technical information										
Primary energy consumption	MJ	3.1E+02	8.4E+00	5.1E+00	4.5E+00	1.2E+04	3.2E+00	4.7E+01	-1.4E+02	1.2E+04

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6706 Table 11-81: EU total impact of Stock of products in the year of study: BC4.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Metals	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Electronics	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Others	kt	0.000	0.000		0.000	0.107	n.a.			0.107
Total weight	kt	0.000	0.000		0.000	0.107	0.000			0.107
Energy consumption										
Electricity	kWh		4		0	10,826	0			10,830
Thermal energy	MJ		0		0	3,694	0			3,694
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	2.0E+02	2.9E+00	2.6E+00	2.5E+00	5.1E+03	2.0E+00	2.2E+01	-9.5E+01	5.2E+03
Ozone depletion	kg CFC-11 eq.	1.5E-08	1.2E-09	3.0E-11	2.1E-09	6.5E-06	1.7E-10	5.0E-09	-1.0E-09	6.5E-06
Human toxicity, cancer	CTUh	1.2E-05	-1.2E-09	6.9E-10	1.6E-09	1.8E-06	1.2E-07	2.8E-08	-8.4E-06	5.8E-06
Human toxicity, non-cancer	CTUh	3.5E-06	1.8E-08	1.7E-08	2.8E-08	2.8E-05	3.5E-08	1.1E-07	-1.0E-06	3.0E-05

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Particulate matter	disease incidence	2.7E-05	2.9E-07	8.3E-08	1.7E-07	1.8E-04	2.7E-07	1.3E-06	-1.6E-05	2.0E-04
Ionising radiation, human health	kBq U235 eq.	4.9E+00	1.4E+00	4.7E-02	1.3E-01	2.0E+03	6.3E-02	6.1E+00	-2.0E+00	2.0E+03
Photochemical ozone formation, human health	kg NMVOC eq.	5.5E-01	7.2E-03	9.2E-03	1.4E-02	9.0E+00	5.5E-03	3.2E-02	-2.7E-01	9.3E+00
Acidification	mol H+ eq.	2.0E+00	1.2E-02	1.0E-02	1.2E-02	1.6E+01	2.0E-02	5.0E-02	-1.2E+00	1.7E+01
Eutrophication, terrestrial	mol N eq.	1.8E+00	3.1E-02	4.9E-02	3.7E-02	3.4E+01	1.8E-02	1.2E-01	-8.6E-01	3.5E+01
Eutrophication, freshwater	kg P eq.	8.1E-04	7.8E-06	1.6E-05	5.8E-05	5.7E-02	8.1E-06	3.1E-05	-6.6E-05	5.8E-02
Eutrophication, marine	kg N eq.	1.6E-01	2.8E-03	4.3E-03	3.7E-03	3.7E+00	1.6E-03	1.1E-02	-7.5E-02	3.8E+00
Ecotoxicity, freshwater	CTUe	1.2E+03	2.0E+01	2.4E+01	1.7E+01	2.6E+04	1.2E+01	7.2E+01	-5.7E+02	2.7E+04
Land use	pt	4.2E+04	2.9E+01	2.0E+01	6.3E+02	2.9E+04	4.2E+02	6.8E+01	-6.1E+02	7.2E+04
Water use	m ³ water eq. of deprived water	5.4E+01	1.3E+00	2.4E-01	5.3E-01	3.6E+03	5.5E-01	4.8E+00	-2.2E+01	3.7E+03
Resource use, minerals and metals	kg Sb eq.	2.2E-02	1.6E-06	1.7E-06	3.9E-06	7.1E-03	2.2E-04	4.3E-06	-9.9E-03	2.0E-02
Resource use, fossils	MJ	2.3E+03	6.0E+01	3.7E+01	3.3E+01	8.7E+04	2.3E+01	3.5E+02	-1.0E+03	8.9E+04
Additional technical information										

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Primary energy consumption	MJ	2.3E+03	6.2E+01	3.7E+01	3.3E+01	9.0E+04	2.3E+01	3.5E+02	-1.0E+03	9.2E+04

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6708 Table 11-82: Life cycle costs per product and total EU expenditure: BC4.

Product items	LCC new product		Total annual consumer expenditure in EU27	
	Value	Unit	Value	Unit
Product price	10,855	EUR	149	mIn. EUR/year
Installation/ acquisition costs (if any)	0	EUR	0	mIn. EUR/year
Fuel (gas, oil, wood)	86	EUR/year	9	mIn. EUR/year
Electricity	2,829	EUR/year	309	mIn. EUR/year
Water	207	EUR/year	23	mIn. EUR/year
Auxiliary material 1: Detergent	1,266	EUR/year	138	mIn. EUR/year
Auxiliary material 2	62	EUR/year	7	mIn. EUR/year
Auxiliary material 3	0	EUR/year	0	mIn. EUR/year
Auxiliary material 4	0	EUR/year	0	mIn. EUR/year
Auxiliary material 5	0	EUR/year	0	mIn. EUR/year
Repair & maintenance costs	4,776	EUR	58	mIn. EUR/year

Product items	LCC new product		Total annual consumer expenditure in EU27	
Total	6,187	EUR/year	694	mln. EUR/year

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6710 **11.5.5. BC5: One-tank conveyor-type dishwasher**

6711 Below, the life cycle impact is provided per product (**Table 11-83**), per year of use of the product (**Table 11-84**), total impact for the EU-27 for the new product
6712 (**Table 11-85**) and the impact of the stock of products in the EU-27 (**Table 11-86**). The life cycle costs per product and as EU-27 total are provided in **Table 11-87**.

6713 **Table 11-83: Life cycle impact per product: BC5.**

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	g	102,280	102,280		5,985	0	n.a.			210,545
Metals	g	779,220	779,210		11,000	0	n.a.			1,569,430
Electronics	g	9,800	0		0	0	n.a.			9,800
Others	g	0	0		88,000	9,048,923,312	n.a.			9,049,011,312
Total weight	g	891,300	881,490		104,985	9,048,923,312	8,913			9,050,810,000
Energy consumption										
Electricity	kWh		250		0	1,083,686	0			1,083,936

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
PEF categories	Impact categories	unit						Impacts	Credits	
Thermal energy	MJ		0		0	475,227	0			475,227
Climate change, total	kg CO ₂ eq.	7.0E+03	1.8E+02	1.1E+02	9.9E+01	5.1E+05	7.2E+01	8.4E+02	-3.8E+03	5.1E+05
Ozone depletion	kg CFC-11 eq.	1.4E-06	7.3E-08	1.3E-09	7.6E-09	5.4E-04	1.5E-08	1.9E-07	-7.2E-08	5.5E-04
Human toxicity, cancer	CTUh	4.7E-04	-3.3E-08	2.9E-08	6.7E-08	1.6E-04	4.7E-06	1.1E-06	-3.2E-04	3.2E-04
Human toxicity, non-cancer	CTUh	1.4E-04	9.3E-07	7.1E-07	1.3E-06	2.5E-03	1.4E-06	4.2E-06	-4.0E-05	2.6E-03
Particulate matter	disease incidence	1.0E-03	1.4E-05	3.5E-06	5.5E-06	1.7E-02	1.0E-05	4.9E-05	-6.0E-04	1.8E-02
Ionising radiation, human health	kBq U235 eq.	2.0E+02	8.3E+01	2.0E+00	9.4E+00	2.0E+05	2.9E+00	2.3E+02	-1.1E+02	2.0E+05
Photochemical ozone formation, human health	kg NMVOC eq.	2.0E+01	4.1E-01	3.9E-01	4.2E-01	8.7E+02	2.0E-01	1.3E+00	-1.1E+01	8.8E+02
Acidification	mol H ⁺ eq.	7.5E+01	6.7E-01	4.3E-01	3.6E-01	1.6E+03	7.5E-01	1.9E+00	-4.6E+01	1.6E+03
Eutrophication, terrestrial	mol N eq.	6.5E+01	1.6E+00	2.1E+00	1.1E+00	3.3E+03	6.6E-01	4.6E+00	-3.4E+01	3.3E+03
Eutrophication, freshwater	kg P eq.	2.8E-02	4.4E-04	6.6E-04	1.0E-03	4.8E+00	2.9E-04	1.2E-03	-2.6E-03	4.8E+00
Eutrophication, marine	kg N eq.	5.8E+00	1.5E-01	1.9E-01	1.1E-01	3.5E+02	6.0E-02	4.3E-01	-2.9E+00	3.5E+02

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Ecotoxicity, freshwater	CTUe	5.7E+04	1.1E+03	1.0E+03	5.7E+02	2.5E+06	5.8E+02	2.8E+03	-3.0E+04	2.6E+06
Land use	pt	3.7E+06	1.5E+03	8.5E+02	2.0E+04	2.7E+06	3.7E+04	2.6E+03	-1.4E+04	6.4E+06
Water use	m ³ water eq. of deprived water	2.2E+03	7.4E+01	1.0E+01	1.3E+01	3.3E+05	2.3E+01	1.9E+02	-8.9E+02	3.3E+05
Resource use, minerals and metals	kg Sb eq.	9.7E-01	8.0E-05	7.3E-05	2.2E-05	5.9E-01	9.7E-03	1.7E-04	-3.7E-01	1.2E+00
Resource use, fossils	MJ	8.2E+04	3.6E+03	1.6E+03	1.4E+03	8.7E+06	8.5E+02	1.3E+04	-4.2E+04	8.8E+06
Additional technical information										
Primary energy consumption	MJ	8.2E+04	3.6E+03	1.6E+03	1.4E+03	9.0E+06	8.5E+02	1.3E+04	-4.2E+04	9.1E+06

* Manufacturing materials are double counted with the raw materials column.

Table 11-84: Life cycle impact per product per year of use: BC5.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	g	9,298	9,298		544	0	n.a.			19,140

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Metals	g	70,838	70,837		1,000	0	n.a.			142,675
Electronics	g	891	0		0	0	n.a.			891
Others	g	0	0		8,000	822,629,392	n.a.			822,637,392
Total weight	g	81,027	80,135		9,544	822,629,392	810			822,800,909
Energy consumption										
Electricity	kWh		23		0	98,517	0			98,540
Thermal energy	MJ		0		0	43,202	0			43,202
PEF Impact categories		unit								
Climate change, total	kg CO ₂ eq.	6.4E+02	1.7E+01	1.0E+01	9.0E+00	4.6E+04	6.5E+00	7.6E+01	-3.4E+02	4.7E+04
Ozone depletion	kg CFC-11 eq.	1.3E-07	6.6E-09	1.2E-10	6.9E-10	4.9E-05	1.4E-09	1.8E-08	-6.6E-09	5.0E-05
Human toxicity, cancer	CTUh	4.3E-05	-3.0E-09	2.7E-09	6.1E-09	1.5E-05	4.3E-07	9.7E-08	-2.9E-05	2.9E-05
Human toxicity, non-cancer	CTUh	1.3E-05	8.5E-08	6.5E-08	1.1E-07	2.3E-04	1.3E-07	3.8E-07	-3.6E-06	2.4E-04
Particulate matter	disease incidence	9.4E-05	1.2E-06	3.2E-07	5.0E-07	1.6E-03	9.5E-07	4.5E-06	-5.5E-05	1.6E-03
Ionising radiation, human health	kBq U235 eq.	1.8E+01	7.6E+00	1.8E-01	8.5E-01	1.8E+04	2.6E-01	2.1E+01	-1.0E+01	1.8E+04
Photochemical ozone formation, human health	kg NMVOC eq.	1.8E+00	3.7E-02	3.6E-02	3.8E-02	7.9E+01	1.8E-02	1.1E-01	-9.7E-01	8.0E+01

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Acidification	mol H+ eq.	6.8E+00	6.1E-02	3.9E-02	3.3E-02	1.4E+02	6.9E-02	1.8E-01	-4.2E+00	1.5E+02
Eutrophication, terrestrial	mol N eq.	5.9E+00	1.5E-01	1.9E-01	9.6E-02	3.0E+02	6.0E-02	4.2E-01	-3.1E+00	3.0E+02
Eutrophication, freshwater	kg P eq.	2.6E-03	4.0E-05	6.0E-05	9.3E-05	4.3E-01	2.6E-05	1.1E-04	-2.4E-04	4.4E-01
Eutrophication, marine	kg N eq.	5.3E-01	1.4E-02	1.7E-02	9.7E-03	3.2E+01	5.4E-03	3.9E-02	-2.7E-01	3.2E+01
Ecotoxicity, freshwater	CTUe	5.2E+03	9.9E+01	9.3E+01	5.2E+01	2.3E+05	5.3E+01	2.5E+02	-2.7E+03	2.3E+05
Land use	pt	3.3E+05	1.4E+02	7.8E+01	1.8E+03	2.4E+05	3.3E+03	2.4E+02	-1.3E+03	5.8E+05
Water use	m ³ water eq. of deprived water	2.0E+02	6.7E+00	9.3E-01	1.2E+00	3.0E+04	2.1E+00	1.7E+01	-8.1E+01	3.0E+04
Resource use, minerals and metals	kg Sb eq.	8.8E-02	7.3E-06	6.7E-06	2.0E-06	5.4E-02	8.8E-04	1.5E-05	-3.4E-02	1.1E-01
Resource use, fossils	MJ	7.4E+03	3.2E+02	1.4E+02	1.2E+02	7.9E+05	7.8E+01	1.2E+03	-3.8E+03	8.0E+05
Additional technical information										
Primary energy consumption	MJ	7.4E+03	3.3E+02	1.4E+02	1.2E+02	8.2E+05	7.8E+01	1.2E+03	-3.8E+03	8.2E+05

* Manufacturing materials are double counted with the raw materials column.

6720 Table 11-85: EU total impact of new products sold in the year of study: BC5.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	0	0		0	0	n.a.			0
Metals	kt	0	0		0	0	n.a.			0
Electronics	kt	0	0		0	0	n.a.			0
Others	kt	0	0		0	0	n.a.			0
Total weight	kt	0	0		0	0	0			0
Energy consumption										
Electricity	kWh		1		0	5,960	0			5,962
Thermal energy	MJ		0		0	2,614	0			2,614
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	3.9E+01	1.0E+00	6.1E-01	5.5E-01	2.8E+03	4.0E-01	4.6E+00	-2.1E+01	2.8E+03
Ozone depletion	kg CFC-11 eq.	7.8E-09	4.0E-10	7.0E-12	4.2E-11	3.0E-06	8.2E-11	1.1E-09	-4.0E-10	3.0E-06
Human toxicity, cancer	CTUh	2.6E-06	-1.8E-10	1.6E-10	3.7E-10	8.9E-07	2.6E-08	5.9E-09	-1.8E-06	1.7E-06
Human toxicity, non-cancer	CTUh	7.6E-07	5.1E-09	3.9E-09	6.9E-09	1.4E-05	7.7E-09	2.3E-08	-2.2E-07	1.5E-05
Particulate matter	disease incidence	5.7E-06	7.4E-08	1.9E-08	3.0E-08	9.6E-05	5.7E-08	2.7E-07	-3.3E-06	9.9E-05

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Ionising radiation, human health	kBq U235 eq.	1.1E+00	4.6E-01	1.1E-02	5.2E-02	1.1E+03	1.6E-02	1.3E+00	-6.1E-01	1.1E+03
Photochemical ozone formation, human health	kg NMVOC eq.	1.1E-01	2.2E-03	2.2E-03	2.3E-03	4.8E+00	1.1E-03	6.9E-03	-5.9E-02	4.8E+00
Acidification	mol H+ eq.	4.1E-01	3.7E-03	2.4E-03	2.0E-03	8.6E+00	4.1E-03	1.1E-02	-2.5E-01	8.8E+00
Eutrophication, terrestrial	mol N eq.	3.6E-01	9.1E-03	1.1E-02	5.8E-03	1.8E+01	3.6E-03	2.5E-02	-1.8E-01	1.8E+01
Eutrophication, freshwater	kg P eq.	1.6E-04	2.4E-06	3.7E-06	5.6E-06	2.6E-02	1.6E-06	6.6E-06	-1.4E-05	2.6E-02
Eutrophication, marine	kg N eq.	3.2E-02	8.5E-04	1.0E-03	5.9E-04	1.9E+00	3.3E-04	2.4E-03	-1.6E-02	1.9E+00
Ecotoxicity, freshwater	CTUe	3.1E+02	6.0E+00	5.6E+00	3.1E+00	1.4E+04	3.2E+00	1.5E+01	-1.6E+02	1.4E+04
Land use	pt	2.0E+04	8.2E+00	4.7E+00	1.1E+02	1.5E+04	2.0E+02	1.4E+01	-7.8E+01	3.5E+04
Water use	m ³ water eq. of deprived water	1.2E+01	4.1E-01	5.6E-02	7.3E-02	1.8E+03	1.3E-01	1.0E+00	-4.9E+00	1.8E+03
Resource use, minerals and metals	kg Sb eq.	5.4E-03	4.4E-07	4.0E-07	1.2E-07	3.2E-03	5.4E-05	9.2E-07	-2.1E-03	6.6E-03
Resource use, fossils	MJ	4.5E+02	2.0E+01	8.7E+00	7.5E+00	4.8E+04	4.7E+00	7.4E+01	-2.3E+02	4.8E+04
Additional technical information										
Primary energy consumption	MJ	4.5E+02	2.0E+01	8.7E+00	7.5E+00	5.0E+04	4.7E+00	7.4E+01	-2.3E+02	5.0E+04

6721 Table 11-86: EU total impact of Stock of products in the year of study: BC5.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Metals	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Electronics	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Others	kt	0.000	0.000		0.000	0.437	n.a.			0.437
Total weight	kt	0.000	0.000		0.000	0.437	0.000			0.437
Energy consumption										
Electricity	kWh		12		0	52,318	0			52,330
Thermal energy	MJ		0		0	22,943	0			22,943
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	3.4E+02	8.9E+00	5.3E+00	4.8E+00	2.5E+04	3.5E+00	4.1E+01	-1.8E+02	2.5E+04
Ozone depletion	kg CFC-11 eq.	6.8E-08	3.5E-09	6.1E-11	3.7E-10	2.6E-05	7.2E-10	9.3E-09	-3.5E-09	2.6E-05
Human toxicity, cancer	CTUh	2.3E-05	-1.6E-09	1.4E-09	3.2E-09	7.8E-06	2.3E-07	5.1E-08	-1.6E-05	1.5E-05
Human toxicity, non-cancer	CTUh	6.7E-06	4.5E-08	3.4E-08	6.1E-08	1.2E-04	6.7E-08	2.0E-07	-1.9E-06	1.3E-04
Particulate matter	disease incidence	5.0E-05	6.5E-07	1.7E-07	2.6E-07	8.4E-04	5.0E-07	2.4E-06	-2.9E-05	8.7E-04

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Ionising radiation, human health	kBq U235 eq.	9.8E+00	4.0E+00	9.6E-02	4.5E-01	9.5E+03	1.4E-01	1.1E+01	-5.3E+00	9.5E+03
Photochemical ozone formation, human health	kg NMVOC eq.	9.6E-01	2.0E-02	1.9E-02	2.0E-02	4.2E+01	9.8E-03	6.1E-02	-5.1E-01	4.3E+01
Acidification	mol H+ eq.	3.6E+00	3.2E-02	2.1E-02	1.7E-02	7.5E+01	3.6E-02	9.4E-02	-2.2E+00	7.7E+01
Eutrophication, terrestrial	mol N eq.	3.1E+00	8.0E-02	1.0E-01	5.1E-02	1.6E+02	3.2E-02	2.2E-01	-1.6E+00	1.6E+02
Eutrophication, freshwater	kg P eq.	1.4E-03	2.1E-05	3.2E-05	4.9E-05	2.3E-01	1.4E-05	5.8E-05	-1.3E-04	2.3E-01
Eutrophication, marine	kg N eq.	2.8E-01	7.4E-03	8.9E-03	5.1E-03	1.7E+01	2.9E-03	2.1E-02	-1.4E-01	1.7E+01
Ecotoxicity, freshwater	CTUe	2.7E+03	5.2E+01	4.9E+01	2.8E+01	1.2E+05	2.8E+01	1.3E+02	-1.4E+03	1.2E+05
Land use	pt	1.8E+05	7.2E+01	4.1E+01	9.5E+02	1.3E+05	1.8E+03	1.3E+02	-6.8E+02	3.1E+05
Water use	m ³ water eq. of deprived water	1.1E+02	3.6E+00	4.9E-01	6.4E-01	1.6E+04	1.1E+00	9.0E+00	-4.3E+01	1.6E+04
Resource use, minerals and metals	kg Sb eq.	4.7E-02	3.9E-06	3.5E-06	1.1E-06	2.8E-02	4.7E-04	8.1E-06	-1.8E-02	5.8E-02
Resource use, fossils	MJ	3.9E+03	1.7E+02	7.7E+01	6.5E+01	4.2E+05	4.1E+01	6.5E+02	-2.0E+03	4.2E+05
Additional technical information										

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Primary energy consumption	MJ	3.9E+03	1.8E+02	7.7E+01	6.5E+01	4.3E+05	4.1E+01	6.5E+02	-2.0E+03	4.4E+05

6722 Table 11-87: Life cycle costs per product and total EU expenditure: BC5

Product items	LCC new product		Total annual consumer expenditure in EU27	
	Value	Unit	Value	Unit
Product price	13,394	EUR	74	mIn. EUR/year
Installation/ acquisition costs (if any)	0	EUR	0	mIn. EUR/year
Fuel (gas, oil, wood)	910	EUR/year	48	mIn. EUR/year
Electricity	23,184	EUR/year	1,222	mIn. EUR/year
Water	1,435	EUR/year	76	mIn. EUR/year
Auxiliary material 1: Detergent	7,462	EUR/year	393	mIn. EUR/year
Auxiliary material 2	677	EUR/year	36	mIn. EUR/year
Auxiliary material 3	0	EUR/year	0	mIn. EUR/year
Auxiliary material 4	0	EUR/year	0	mIn. EUR/year
Auxiliary material 5	0	EUR/year	0	mIn. EUR/year
Repair & maintenance costs	5,894	EUR	28	mIn. EUR/year
Total	35,422	EUR/year	1,877	mIn. EUR/year

6723 11.5.6. BC6: Multi-tank conveyor-type dishwasher

6724 Below, the life cycle impact is provided per product (Table 11-88), per year of use of the product (Table 11-89), total impact for the EU-27 for the new product
 6725 (Table 11-90) and the impact of the stock of products in the EU-27 (

6726 Table 11-91). The life cycle costs per product and as EU-27 total are provided in Table 11-92.

6727 Table 11-88: Life cycle impact per product: BC6.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Materials	unit									
Plastics	g	123,460	123,460		9,365	0	n.a.			256,285
Metals	g	1,204,540	1,204,540		15,000	0	n.a.			2,424,080
Electronics	g	15,400	0		0	0	n.a.			15,400
Others	g	0	0		214,265	18,486,810,840	n.a.			#####
Total weight	g	1,343,400	1,328,000		238,630	18,486,810,840	13,434			#####
Energy consumption										
Electricity	kWh		300		0	2,774,336	0			2,774,636
Thermal energy	MJ		0		0	1,855,995	0			1,855,995
PEF categories	Impact unit									

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Climate change, total	kg CO ₂ eq.	1.1E+04	2.3E+02	1.8E+02	2.1E+02	1.3E+06	1.1E+02	3.2E+02	-5.9E+03	1.3E+06
Ozone depletion	kg CFC-11 eq.	1.6E-06	9.3E-08	2.0E-09	1.4E-08	1.2E-03	1.7E-08	7.2E-08	-1.2E-07	1.2E-03
Human toxicity, cancer	CTUh	7.3E-04	-6.0E-08	4.7E-08	1.5E-07	3.7E-04	7.3E-06	1.4E-07	-5.0E-04	6.1E-04
Human toxicity, non-cancer	CTUh	2.1E-04	1.3E-06	1.1E-06	2.9E-06	6.0E-03	2.1E-06	1.4E-06	-6.2E-05	6.1E-03
Particulate matter	disease incidence	1.6E-03	1.9E-05	5.6E-06	1.2E-05	4.3E-02	1.6E-05	1.5E-05	-9.4E-04	4.4E-02
Ionising radiation, human health	kBq U235 eq.	3.2E+02	1.1E+02	3.2E+00	1.7E+01	5.0E+05	4.3E+00	8.6E+01	-1.8E+02	5.0E+05
Photochemical ozone formation, human health	kg NMVOC eq.	3.0E+01	5.4E-01	6.2E-01	9.7E-01	2.2E+03	3.1E-01	6.7E-01	-1.7E+01	2.2E+03
Acidification	mol H+ eq.	1.2E+02	8.7E-01	6.9E-01	8.1E-01	3.9E+03	1.2E+00	1.0E+00	-7.2E+01	4.0E+03
Eutrophication, terrestrial	mol N eq.	9.9E+01	2.2E+00	3.3E+00	2.4E+00	8.2E+03	1.0E+00	2.3E+00	-5.2E+01	8.2E+03
Eutrophication, freshwater	kg P eq.	3.9E-02	5.7E-04	1.1E-03	2.3E-03	1.0E+01	4.0E-04	5.4E-04	-4.1E-03	1.0E+01
Eutrophication, marine	kg N eq.	8.8E+00	2.1E-01	2.9E-01	2.4E-01	8.5E+02	9.0E-02	2.1E-01	-4.6E+00	8.5E+02
Ecotoxicity, freshwater	CTUe	8.7E+04	1.4E+03	1.6E+03	1.1E+03	6.2E+06	8.8E+02	1.2E+03	-4.7E+04	6.3E+06
Land use	pt	5.1E+06	2.1E+03	1.4E+03	4.8E+04	6.4E+06	5.1E+04	1.2E+03	-2.2E+04	1.2E+07

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Water use	m ³ water eq. of deprived water	3.3E+03	9.6E+01	1.6E+01	2.9E+01	7.5E+05	3.4E+01	9.3E+01	-1.4E+03	7.5E+05
Resource use, minerals and metals	kg Sb eq.	1.5E+00	1.1E-04	1.2E-04	4.9E-05	1.3E+00	1.5E-02	8.5E-05	-5.8E-01	2.2E+00
Resource use, fossils	MJ	1.2E+05	4.6E+03	2.5E+03	2.6E+03	2.3E+07	1.3E+03	5.4E+03	-6.6E+04	2.3E+07
Additional technical information										
Primary energy consumption	MJ	1.2E+05	4.7E+03	2.5E+03	2.6E+03	2.3E+07	1.3E+03	5.4E+03	-6.6E+04	2.3E+07

6728 * Manufacturing materials are double counted with the raw materials column.

6729 **Table 11-89: Life cycle impact per product per year of use: BC6.**

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	g	8,231	8,231		624	0	n.a.			17,086
Metals	g	80,303	80,303		1,000	0	n.a.			161,605
Electronics	g	1,027	0		0	0	n.a.			1,027
Others	g	0	0		14,284	1,232,454,056	n.a.			1,232,468,340

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Total weight	g	89,560	88,533		15,909	1,232,454,056	896			1,232,648,954
Energy consumption										
Electricity	kWh		20		0	184,956	0			184,976
Thermal energy	MJ		0		0	123,733	0			123,733
PEF Impact categories		unit								
Climate change, total	kg CO ₂ eq.	7.2E+02	1.5E+01	1.2E+01	1.4E+01	8.8E+04	7.3E+00	2.2E+01	-3.9E+02	8.9E+04
Ozone depletion	kg CFC-11 eq.	1.1E-07	6.2E-09	1.3E-10	9.3E-10	7.8E-05	1.1E-09	4.8E-09	-7.8E-09	7.8E-05
Human toxicity, cancer	CTUh	4.9E-05	-4.0E-09	3.1E-09	1.0E-08	2.5E-05	4.9E-07	9.1E-09	-3.3E-05	4.1E-05
Human toxicity, non-cancer	CTUh	1.4E-05	8.4E-08	7.6E-08	1.9E-07	4.0E-04	1.4E-07	9.3E-08	-4.2E-06	4.1E-04
Particulate matter	disease incidence	1.1E-04	1.3E-06	3.7E-07	8.0E-07	2.9E-03	1.1E-06	1.0E-06	-6.3E-05	2.9E-03
Ionising radiation, human health	kBq U235 eq.	2.1E+01	7.1E+00	2.1E-01	1.2E+00	3.3E+04	2.8E-01	5.7E+00	-1.2E+01	3.3E+04
Photochemical ozone formation, human health	kg NMVOC eq.	2.0E+00	3.6E-02	4.2E-02	6.5E-02	1.5E+02	2.1E-02	4.4E-02	-1.1E+00	1.5E+02
Acidification	mol H+ eq.	7.7E+00	5.8E-02	4.6E-02	5.4E-02	2.6E+02	7.8E-02	6.8E-02	-4.8E+00	2.6E+02

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Eutrophication, terrestrial	mol N eq.	6.6E+00	1.5E-01	2.2E-01	1.6E-01	5.4E+02	6.7E-02	1.5E-01	-3.5E+00	5.5E+02
Eutrophication, freshwater	kg P eq.	2.6E-03	3.8E-05	7.0E-05	1.6E-04	6.8E-01	2.6E-05	3.6E-05	-2.7E-04	6.9E-01
Eutrophication, marine	kg N eq.	5.9E-01	1.4E-02	2.0E-02	1.6E-02	5.6E+01	6.0E-03	1.4E-02	-3.1E-01	5.7E+01
Ecotoxicity, freshwater	CTUe	5.8E+03	9.6E+01	1.1E+02	7.5E+01	4.1E+05	5.9E+01	7.8E+01	-3.1E+03	4.2E+05
Land use	pt	3.4E+05	1.4E+02	9.0E+01	3.2E+03	4.3E+05	3.4E+03	8.1E+01	-1.5E+03	7.7E+05
Water use	m ³ water eq. of deprived water	2.2E+02	6.4E+00	1.1E+00	1.9E+00	5.0E+04	2.3E+00	6.2E+00	-9.3E+01	5.0E+04
Resource use, minerals and metals	kg Sb eq.	9.7E-02	7.3E-06	7.7E-06	3.3E-06	8.8E-02	9.7E-04	5.6E-06	-3.9E-02	1.5E-01
Resource use, fossils	MJ	8.3E+03	3.1E+02	1.7E+02	1.8E+02	1.5E+06	8.6E+01	3.6E+02	-4.4E+03	1.5E+06
Additional technical information										
Primary energy consumption	MJ	8.3E+03	3.1E+02	1.7E+02	1.8E+02	1.6E+06	8.6E+01	3.6E+02	-4.4E+03	1.6E+06

* Manufacturing materials are double counted with the raw materials column.

Table 11-90: EU total impact of new products sold in the year of study: BC6.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	0	0		0	0	n.a.			0
Metals	kt	0	0		0	0	n.a.			0
Electronics	kt	0	0		0	0	n.a.			0
Others	kt	0	0		0	0	n.a.			0
Total weight	kt	0	0		0	0	0			0
Energy consumption										
Electricity	kWh		1		0	7,629	0			7,630
Thermal energy	MJ		0		0	5,104	0			5,104
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	3.0E+01	6.4E-01	4.8E-01	5.9E-01	3.6E+03	3.0E-01	8.9E-01	-1.6E+01	3.7E+03
Ozone depletion	kg CFC-11 eq.	4.4E-09	2.6E-10	5.5E-12	3.8E-11	3.2E-06	4.7E-11	2.0E-10	-3.2E-10	3.2E-06
Human toxicity, cancer	CTUh	2.0E-06	-1.6E-10	1.3E-10	4.1E-10	1.0E-06	2.0E-08	3.8E-10	-1.4E-06	1.7E-06
Human toxicity, non-cancer	CTUh	5.7E-07	3.5E-09	3.1E-09	8.0E-09	1.6E-05	5.7E-09	3.8E-09	-1.7E-07	1.7E-05
Particulate matter	disease incidence	4.3E-06	5.3E-08	1.5E-08	3.3E-08	1.2E-04	4.4E-08	4.1E-08	-2.6E-06	1.2E-04
Ionising radiation, human health	kBq U235 eq.	8.8E-01	2.9E-01	8.7E-03	4.8E-02	1.4E+03	1.2E-02	2.4E-01	-4.9E-01	1.4E+03

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Photochemical ozone formation, human health	kg NMVOC eq.	8.4E-02	1.5E-03	1.7E-03	2.7E-03	6.0E+00	8.5E-04	1.8E-03	-4.6E-02	6.0E+00
Acidification	mol H+ eq.	3.2E-01	2.4E-03	1.9E-03	2.2E-03	1.1E+01	3.2E-03	2.8E-03	-2.0E-01	1.1E+01
Eutrophication, terrestrial	mol N eq.	2.7E-01	6.1E-03	9.1E-03	6.6E-03	2.2E+01	2.8E-03	6.3E-03	-1.4E-01	2.3E+01
Eutrophication, freshwater	kg P eq.	1.1E-04	1.6E-06	2.9E-06	6.5E-06	2.8E-02	1.1E-06	1.5E-06	-1.1E-05	2.8E-02
Eutrophication, marine	kg N eq.	2.4E-02	5.7E-04	8.1E-04	6.7E-04	2.3E+00	2.5E-04	5.8E-04	-1.3E-02	2.3E+00
Ecotoxicity, freshwater	CTUe	2.4E+02	3.9E+00	4.5E+00	3.1E+00	1.7E+04	2.4E+00	3.2E+00	-1.3E+02	1.7E+04
Land use	pt	1.4E+04	5.7E+00	3.7E+00	1.3E+02	1.8E+04	1.4E+02	3.4E+00	-6.1E+01	3.2E+04
Water use	m ³ water eq. of deprived water	9.2E+00	2.7E-01	4.5E-02	7.9E-02	2.1E+03	9.4E-02	2.6E-01	-3.8E+00	2.1E+03
Resource use, minerals and metals	kg Sb eq.	4.0E-03	3.0E-07	3.2E-07	1.3E-07	3.6E-03	4.0E-05	2.3E-07	-1.6E-03	6.1E-03
Resource use, fossils	MJ	3.4E+02	1.3E+01	6.9E+00	7.2E+00	6.2E+04	3.6E+00	1.5E+01	-1.8E+02	6.2E+04
Additional technical information										
Primary energy consumption	MJ	3.4E+02	1.3E+01	6.9E+00	7.2E+00	6.4E+04	3.6E+00	1.5E+01	-1.8E+02	6.5E+04

6733 Table 11-91: EU total impact of Stock of products in the year of study: BC6

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Metals	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Electronics	kt	0.000	0.000		0.000	0.000	n.a.			0.000
Others	kt	0.000	0.000		0.000	0.580	n.a.			0.580
Total weight	kt	0.000	0.000		0.000	0.580	0.000			0.580
Energy consumption										
Electricity	kWh		9		0	87,047	0			87,057
Thermal energy	MJ		0		0	58,233	0			58,233
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	3.4E+02	7.3E+00	5.5E+00	6.7E+00	4.2E+04	3.5E+00	1.0E+01	-1.8E+02	4.2E+04
Ozone depletion	kg CFC-11 eq.	5.1E-08	2.9E-09	6.3E-11	4.4E-10	3.7E-05	5.4E-10	2.3E-09	-3.7E-09	3.7E-05
Human toxicity, cancer	CTUh	2.3E-05	-1.9E-09	1.5E-09	4.7E-09	1.2E-05	2.3E-07	4.3E-09	-1.6E-05	1.9E-05
Human toxicity, non-cancer	CTUh	6.5E-06	4.0E-08	3.6E-08	9.1E-08	1.9E-04	6.5E-08	4.4E-08	-2.0E-06	1.9E-04
Particulate matter	disease incidence	5.0E-05	6.0E-07	1.8E-07	3.8E-07	1.4E-03	5.0E-07	4.7E-07	-2.9E-05	1.4E-03

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Ionising radiation, human health	kBq U235 eq.	1.0E+01	3.3E+00	9.9E-02	5.5E-01	1.6E+04	1.3E-01	2.7E+00	-5.5E+00	1.6E+04
Photochemical ozone formation, human health	kg NMVOC eq.	9.6E-01	1.7E-02	2.0E-02	3.0E-02	6.8E+01	9.7E-03	2.1E-02	-5.2E-01	6.9E+01
Acidification	mol H+ eq.	3.6E+00	2.7E-02	2.2E-02	2.6E-02	1.2E+02	3.6E-02	3.2E-02	-2.2E+00	1.2E+02
Eutrophication, terrestrial	mol N eq.	3.1E+00	7.0E-02	1.0E-01	7.6E-02	2.6E+02	3.2E-02	7.2E-02	-1.6E+00	2.6E+02
Eutrophication, freshwater	kg P eq.	1.2E-03	1.8E-05	3.3E-05	7.4E-05	3.2E-01	1.2E-05	1.7E-05	-1.3E-04	3.2E-01
Eutrophication, marine	kg N eq.	2.8E-01	6.5E-03	9.2E-03	7.6E-03	2.7E+01	2.8E-03	6.7E-03	-1.4E-01	2.7E+01
Ecotoxicity, freshwater	CTUe	2.7E+03	4.5E+01	5.1E+01	3.5E+01	1.9E+05	2.8E+01	3.7E+01	-1.5E+03	2.0E+05
Land use	pt	1.6E+05	6.5E+01	4.2E+01	1.5E+03	2.0E+05	1.6E+03	3.8E+01	-7.0E+02	3.6E+05
Water use	m ³ water eq. of deprived water	1.0E+02	3.0E+00	5.1E-01	9.0E-01	2.4E+04	1.1E+00	2.9E+00	-4.4E+01	2.4E+04
Resource use, minerals and metals	kg Sb eq.	4.6E-02	3.4E-06	3.6E-06	1.5E-06	4.1E-02	4.6E-04	2.7E-06	-1.8E-02	6.9E-02
Resource use, fossils	MJ	3.9E+03	1.4E+02	7.9E+01	8.3E+01	7.1E+05	4.1E+01	1.7E+02	-2.1E+03	7.1E+05
Additional technical information										

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Primary energy consumption	MJ	3.9E+03	1.5E+02	7.9E+01	8.3E+01	7.3E+05	4.1E+01	1.7E+02	- 2.1E+03	7.4E+05

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6735 **Table 11-92: Life cycle costs per product and total EU expenditure: BC6.**

Product items	LCC new product		Total annual consumer expenditure in EU27	
	Value	Unit	Value	Unit
Product price	22,867	EUR	63	mIn. EUR/year
Installation/ acquisition costs (if any)	0	EUR	0	mIn. EUR/year
Fuel (gas, oil, wood)	2,540	EUR/year	89	mIn. EUR/year
Electricity	42,419	EUR/year	1,491	mIn. EUR/year
Water	2,096	EUR/year	74	mIn. EUR/year
Auxiliary material 1: Detergent	10,368	EUR/year	365	mIn. EUR/year
Auxiliary material 2	880	EUR/year	31	mIn. EUR/year
Auxiliary material 3	0	EUR/year	0	mIn. EUR/year
Auxiliary material 4	0	EUR/year	0	mIn. EUR/year
Auxiliary material 5	0	EUR/year	0	mIn. EUR/year
Repair & maintenance costs	10,061	EUR	24	mIn. EUR/year

Product items	LCC new product		Total annual consumer expenditure in EU27	
	Value	Unit	Value	Unit
Total	61,128	EUR/year		mln. EUR/year

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11.6. Appendix 6 – Results sensitivity analysis BC2

Table 11-93: Results of the sensitivity analysis: BC2.

Scenario #	Product aspect + Life cycle stage	Modelling change	Effect on LCA (per product)	Effect on LCA (per product per year of use)	Effect on LCC (product)	Effect on LCC (EU-27 total)
S1	Energy reduction	Use phase	-10 % energy use (same division between electricity and heat as in original data)	Per impact category: - Use phase: reduction between 1.1 % (Eutrophication, freshwater) and 9.7 % (Ionizing radiation, human health) - Total impact for all life cycles: reduction between 0.6 % (Resource use, minerals and metals) and 9.7 % (Ionising radiation, human health) - Reduction for climate change of 9.1 % / 8.8 for Use phase and Total impact respectively.	Per impact category: - Use phase: reduction between 1.1 % (Eutrophication, freshwater) and 9.7 % (Ionizing radiation, human health) - Total impact for all life cycles: reduction between 0.6 % (Resource use, minerals and metals) and 9.7 % (Ionising radiation, human health) - Reduction for climate change of 9.1 % / 8.8 for Use phase and Total impact respectively.	4.4 % reduction of total costs / year

Scenario #	Product aspect + Life cycle stage	Modelling change	Effect on LCA (per product)	Effect on LCA (per product per year of use)	Effect on LCC (product)	Effect on LCC (EU-27 total)
S2	Water reduction	Use phase	-10 % water use	Per impact category: - Use phase: reduction between 0.14 % (Ionising radiation, human health) and 6.9 % (Water use); increased impact for Land use (+0.25 %) - Total impact for all life cycles: reduction between 0.14 % (Ionising radiation, human health) and 6.9 % (Water use); increased impact for Land use (+0.1 %) - Reduction for climate change of 0.4 % for Use phase and Total impact .	Per impact category: - Use phase: reduction between 0.14 % (Ionising radiation, human health) and 6.9 % (Water use); increased impact for Land use (+0.25 %) - Total impact for all life cycles: reduction between 0.14 % (Ionising radiation, human health) and 6.9 % (Water use); increased impact for Land use (+0.1 %) - Reduction for climate change of 0.4 % for Use phase and Total impact .	0.7 % reduction of total costs / year

Scenario #	Product aspect + Life cycle stage	Modelling change	Effect on LCA (per product)	Effect on LCA (per product per year of use)	Effect on LCC (product)	Effect on LCC (EU-27 total)
S3	Detergent/Rinsing agent reduction	Use phase	-10 % detergent + rinsing agent use	Per impact category: - Use phase: Reduction between 0.13 % (Ionising radiation, human health) and 7.2 % (Resource use, minerals and metals) in the across all impact categories. - Total impact for all life cycles: Reduction between 0.13 % (Ionising radiation, human health) and 3.8 % (Ozone depletion) across all impact categories. - Reduction for climate change of 0.48 % / 0.47 % Use phase and Total impact respectively.	Per impact category: - Use phase: Reduction between 0.13 % (Ionising radiation, human health) and 7.2 % (Resource use, minerals and metals) in the across all impact categories. - Total impact for all life cycles: Reduction between 0.13 % (Ionising radiation, human health) and 3.8 % (Ozone depletion) across all impact categories. - Reduction for climate change of 0.48 % / 0.47 % Use phase and Total impact respectively.	Reduction of 2 %- of total costs / year

S4	Resource use and resource efficiency + Recycled content	Manufacturing + EoL	R1 at: - Polypropylene: 10 % - Stainless steel: 10 % - Electronics: 10 % - Copper: 10 % - Aluminium: 40 % (is already at 30 % default) Materials that contribute >10 % for at least 2 impact categories in Raw Materials life cycle (dishwasher components combined)	Raw materials impact: - Reduction of the impact of electronics of ~ 5 % across all impact categories - Reduction of the impact of polypropylene ~4.5 % across all impact categories; increase of impact of 10 % for Land use (recycling of PP has higher impact on Land use than virgin PP production in the ERT dataset). - Reduction of the impact of stainless steel ~ 1.6 %. Increased of impact for Ionizing radiation (7.9 %) and 28.1 % (Ozone depletion), see sensitivity analysis S9 - Reduction of impact of aluminium ~ 2 % across all impact categories - Increase (max 3%) or decrease (max 0.3%) of copper across all impact categories; increase due to higher impact of recycling process in ERT dataset. Per impact category: - Reduction between 0.3 % (Land use) and 4.6 % (Eutrophication, freshwater) in Raw Materials & Maintenance and Repair phases - Total impact for all life cycles: Reduction between 0.05 % (Ozone depletion) and 2.4 % / 2.8 % (Resource use, minerals and metals / Human toxicity, cancer) - Reduction for climate change of 3.2 % / 0.09 % for Raw Materials & Maintenance and Repair phases / Total impact respectively.	Per impact category: - Reduction between 0.3 % (Land use) and 4.6 % (Eutrophication, freshwater) in Raw Materials & Maintenance and Repair phases - Total impact for all life cycles: Reduction between 0.05 % (Ozone depletion) and 2.4 % / 2.8 % (Resource use, minerals and metals / Human toxicity, cancer) - Reduction for climate change of 3.2 % / 0.09 % for Raw Materials & Maintenance and Repair phases / Total impact respectively.	No change in costs

Scenario #	Product aspect + Life cycle stage	Modelling change	Effect on LCA (per product)	Effect on LCA (per product per year of use)	Effect on LCC (product)	Effect on LCC (EU-27 total)
S5	Resource use and resource efficiency (Lighter product)	Manufacturing + EoL	10 % less weight for all BoM inputs and Manufacturing (except for electricity in assembly)	Per impact category: - Reduction in all impact categories of 10 % for life cycles Raw Materials, End-of-life impacts, End-of-life credits, 8.3-10 % reduction for Maintenance and Repair; reduction ~ 4.5 for all impact categories, with 24% reduction for Human toxicity, cancer in for Manufacturing & Assembly stage '- Total reduction for all life cycles: between 0.03 % (Ozone depletion) and 6.2 % (Resource use, minerals and metals); 0.2 % reduction for climate change.	Per impact category: - Reduction in all impact categories of 10% for life cycles Raw Materials, End-of-life impacts, End-of-life credits, 8.3-10 % reduction for Maintenance and Repair; reduction ~ 4.5 for all impact categories, with 24 % reduction for Human toxicity, cancer in for Manufacturing & Assembly stage '- Total reduction for all life cycles: between 0.03 % (Ozone depletion) and 6.2 % (Resource use, minerals and metals); 0.2 % reduction for climate change.	No change in costs

Scenario #	Product aspect + Life cycle stage	Modelling change	Effect on LCA (per product)	Effect on LCA (per product per year of use)	Effect on LCC (product)	Effect on LCC (EU-27 total)
S6	Repairability	Maintenance and Repair	% of spare parts at 20 %	Per impact category: - Increase of 1900 % for Maintenance & Repair, 18.8 %-11 increase of End-of-life (impacts and credits); - Total impact for all life cycles increased between 0.08 % (Ionising radiation, human health) and 10-11 % (Land use & Resource use, minerals and metals) across impact categories; increase of 0.5 % for climate change	Per impact category: - Increase of 1900 % for Maintenance & Repair, 18.8 %-11 increase of End-of-life (impacts and credits); - Total impact for all life cycles increased between 0.08% (Ionising radiation, human health) and 10-11 % (Land use & Resource use, minerals and metals) across impact categories; increase of 0.5 % for climate change	No change in costs
S7	Recyclability	EoL	R2 at: - Stainless steel: 100 % - Polypropylene: 15 % - Electronics: 65 % - Copper: 15 % - Aluminium: 100 % Materials that contribute >10 % for at least 2 impact categories to the Raw Materials life cycle; increase by 15 % points	Per impact category: - Increase of End-of-life impacts and credits to different degrees depending on the impact category - Total impact for all life cycles: maximum reduction of 6 % for Resource use, minerals and metals and 17 % (Human toxicity, cancer) due to increased recycling of stainless steel; total climate change reduction of 0.13 %.	Per impact category: - Increase of End-of-life impacts and credits to different degrees depending on the impact category - Total impact for all life cycles: maximum reduction of 6 % for Resource use, minerals and metals and 17 % (Human toxicity, cancer) due to increased recycling of stainless steel; total climate change reduction of 0.13 %.	No change in costs

Scenario #	Product aspect + Life cycle stage	Modelling change	Effect on LCA (per product)	Effect on LCA (per product per year of use)	Effect on LCC (product)	Effect on LCC (EU-27 total)
S8	Costs	LCC	Increase product price and maintenance costs by 10%	Per impact category: - No changes	Per impact category: - No changes	Increase of 2.8 % in costs / year
S9	Dataset stainless steel recycling	EoL	Different secondary stainless steel dataset (2 options, quite a different environmental impact)	Per impact category: - Reduction in End-of-Life impacts between 69 % (Photochemical ozone formation) and 97.6 % (Human toxicity, cancer) across all impact categories - Total impact for all life cycles: maximum reduction of 0.28 % (Human toxicity, cancer); decrease of 0.18 % on climate change.	Per impact category: - Reduction in End-of-Life impacts between 69 % (Photochemical ozone formation) and 97.6 % (Human toxicity, cancer) across all impact categories - Total impact for all life cycles: maximum reduction of 0.28 % (Human toxicity, cancer); decrease of 0.18 % on climate change.	No change in costs

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11.7. Appendix 7 – Substances of Concern

11.7.1. Introduction

11.7.1.1. Objectives

This part of the Professional Dishwashers preparatory study focuses on identifying ‘Substances of Concern’ (SoC). These substances identified in accordance with Article 2(27) (a–d) of the ESPR, namely any substance that:

- a) Appears in the Regulation on the registration, evaluation, authorisation and restriction of chemicals (REACH) (EC No 1907/2006) Annex XIV (Substances of Very High Concern, SVHC) Candidate List.
- b) Falls under one or more hazard classes in Annex VI of the Classification, Labelling and Packaging of chemicals (CLP) Regulation (EC No 1272/2008):
 - (i) carcinogenicity categories 1 and 2;
 - (ii) germ cell mutagenicity categories 1 and 2;
 - (iii) reproductive toxicity categories 1 and 2;
 - (iv) endocrine disruption for human health categories 1 and 2;
 - (v) endocrine disruption for the environment categories 1 and 2;
 - (vi) persistent, mobile and toxic or very persistent, very mobile properties;
 - (vii) persistent, bioaccumulative and toxic or very persistent, very bioaccumulative properties;
 - (viii) respiratory sensitisation category 1;
 - (ix) skin sensitisation category 1;
 - (x) hazardous to the aquatic environment — categories chronic 1 to 4;
 - (xi) hazardous to the ozone layer;
 - (xii) specific target organ toxicity — repeated exposure categories 1 and 2;
 - (xiii) specific target organ toxicity — single exposure categories 1 and 2.
- c) Is regulated as a Persistent Organic Pollutant (EU 2019/1021).
- d) Negatively affects the reuse or recycling of materials in the product.

When such substances are present, information requirements are by default imposed (Art. 7(5) of ESPR legislation) and can require reporting of substance identity, location, concentration, safe-use instructions, and end-of-life guidance. For substances meeting criterion (d), performance requirements, such as maximum concentration limits or bans, may also be needed to safeguard circularity. Exemptions on information requirements could be justifiable in case there is solid evidence for issues around technical feasibility or relevance of tracking substances of concern, the existence of analytical methods to detect and quantify them, and/or the need to protect confidential business information. This report examines stakeholder perspectives and the information they have provided and assesses whether the available data are sufficient to define information or performance requirements beyond existing obligations.

11.7.1.2. End-of-life context of professional dishwashers

To contextualise this Task, the end-of-life treatment of professional dishwashers is described. Once they are separately collected under the WEEE Directive (2012/19/EU) and sent to dedicated recycling and recovery facilities, nearly all materials are diverted from landfill through refurbishment, parts salvaging, and material recovery. Approximately 5% by weight is lost.

Metals are recycled. Paper, cardboard, and most plastics undergo thermal recycling (with energy recovery) or mechanical recycling, and some plastic components may be directly reused. Non-metallic inert materials (e.g., concrete and bitumen) are landfilled. Electronic components account for only about 1% of the total weight. Printed circuit boards (PCBs) are easy to dismantle and are fully recycled by certified scrap dealers. Plastics make up less than 10% of a machine's weight. Of the recovered plastic fraction, an estimated 70% goes to thermal recycling, 29% to mechanical recycling, and 1% to closed-loop reuse.

For units equipped with heat pumps, refrigerants are extracted by specialised technicians, resulting in only minimal, unavoidable losses.

11.7.1.3. Reading guide

The report is structured in four parts to guide the reader through identifying and assessing the SoC in the professional dishwasher's product group. The first section covers the stakeholder consultation, which outlines how input from manufacturers, recyclers, and national representatives shaped the SoC inventory. Afterwards, the existing regulatory requirements are discussed. This section reviews REACH, CLP, Persistent Organic Pollutants (POP) Regulation, Waste Framework Directive (WFD), Waste Electrical and Electronic Equipment (WEEE) Directive, and Restriction of Hazardous Substances (RoHS) obligations so that ESPR proposals align with, rather than duplicate, current reporting duties. Next, SoC in the product group presents the identified substances and highlights any recycling challenges based on that inventory. Finally, the section on information and performance requirements translates these findings into recommendations for the product group.

11.7.2. Stakeholder consultation

As a jumping-off point for the SoC work, a stakeholder consultation was conducted to gather information. It aimed to support the creation of a SoC inventory and to identify specific requirements and potential exemptions for certain substances. The consultation was conducted from mid-April to mid-May 2025. A questionnaire originally developed by the JRC was modified to help identify both Intentionally Added Substances (IAS) and Non-Intentionally Added Substances (NIAS) and ask for other inputs. The consultation was made available to stakeholders registered on the platform used for previous consultations: <https://ecodesign-commdishwashers.eu/en>. The stakeholders engaged in this consultation include manufacturers, industry organisations for both manufacturing and recycling, as well as national representatives.

11.7.2.1. Stakeholder perspectives and feedback

The consultation provided information on the substances present in the product group and stakeholders perspectives, specifically from industry representatives and manufacturers. These perspectives covered some shared points as highlighted in Table 11-94.

Table 11-94: Shared perspective across stakeholders.

Topic	Stakeholder feedback
Leverage existing REACH thresholds	Keep the above 0.1% w/w substance concentration threshold in articles from REACH Art. 33(1) as the single trigger for any ESPR reporting.
Risk-based, practicable scope	New obligations should apply only where real circular-economy risks exist and must not duplicate what REACH, RoHS, CLP, POP or WEEE already cover.
IAS vs. NIAS	Declaring intentionally added substances (IAS) occurs via existing regulated channels; non-intentionally added substances (NIAS) should not be required unless they are on an established list and detectable with accepted analytical methods.
Supply-chain data limits	Manufacturers rarely receive detailed sub-0.1% composition data from upstream suppliers; full "100% declarations" are technically and contractually out of reach.
Need for longer timelines	The four-week consultation window is not sufficient for gathering the depth of information requested; gathering required data will take months or years, and most likely contract renegotiations across the supply chain.
Alignment & "One Substance, One Assessment"	Call for tight coordination with REACH, RoHS, WEEE, etc. to avoid double work and conflicting duties.
Exemptions mechanism	Article 2(27) exemption mechanism is welcome, provided it incorporates REACH-style socio-economic evaluation.

Beyond the shared perspective there are other relevant aspects to highlight. One submission advocates a cross-sectoral strategy for waste electrical and electronic equipment, calling for early identification of recycling-hindering substances by grouping products according to waste-stream categories rather than individual studies, involving recyclers directly to ensure end-of-life data usefulness. It is also suggested to not duplicate the existing I4R platform and the Substances of Concern In articles as such or in complex objects (Products) (SCIP) database. Another that no screening list exists for Art. 2(27)(d) substances and that Safety Data Sheet (SDS) cover only substances and mixtures, but not articles. Furthermore, it was noted that safe use instructions are already shared in the supply chain and that present SoC in this product group do not pose a risk to humans or the environment.

11.7.3. Existing regulatory requirements on provision of SoC information

In the consultation, stakeholders noted that several existing laws already require information sharing on SoC for waste treatment. This section therefore examines legislative requirements beyond the ESPR, highlighting obligations that apply to this product group and identifying any existing thresholds for communicating SoC information (if present).

11.7.3.1. Relevant regulations

11.7.3.1.1. REACH regulation

Under Art. 33(1) of the REACH regulation (EC No 1907/2006), any supplier of an article containing a Candidate List SVHC at a concentration above 0.1% w/w must provide, at or before the time of supply, sufficient information (at minimum the substance's name) to allow safe use of the article by their professional recipients. Furthermore, upon request by a consumer, the supplier must supply the same information free of charge within 45 days of that request. This information requirement applies to SoC that fall under ESPR Art. 2(27)(a).

Continuing from the requirements discussed above, Art. 31 also obliges any supplier of a substance or mixture to provide a SDS free of charge whenever it is classified as hazardous, is persistent, bioaccumulative or toxic (PBT/vPvB), appears on the Candidate List of SVHCs, or falls under EU workplace exposure limits. If a non-classified mixture contains hazardous substances above certain thresholds—1 % w/w for non-gaseous substances or 0.2 % v/v for gases (general hazards), and 0.1 % w/w for PBT/vPvB or Candidate List substances, the supplier must supply an SDS upon the recipient's request.

11.7.3.1.2. CLP Regulation

Under the CLP Regulation (EC No 1272/2008), any substance or mixture classified as hazardous must bear, before being placed on the EU market, a label showing at minimum the product identifier; supplier name, address and phone number; hazard pictograms; a signal word; hazard statements; precautionary statements; and (where applicable) supplemental information (Art. 17–25). Labels must be applied and positioned in accordance with the general rules in Art. 31 and 32, and specific rules for outer, inner and single packaging in Art. 33. Moreover, suppliers are required to assemble and keep available all the information used for classification and labelling for at least ten years after the substance or mixture was last supplied, and to provide it on request (Art. 49).

11.7.3.1.3. POPs regulations

For Persistent Organic Pollutants (POPs) placed on the EU market as articles, POPs regulation (EU 2019/1021) sets specific concentration limits in Annex I (as amended by Delegated regulation (EU 2020/784). Concentration thresholds are substances specific and articles containing POPs at or above that concentration may not be marketed and must be reported or managed in accordance with the regulation unless they are derogated. A cumulative limit on the concentration (amount of mg/kg) in mixtures or articles is set or a specific limit if it on their presence in substances. This type of restrictions is associated with SoC's that fall under ESPR Art. 2(27)(c). POP Regulation does not place obligations on suppliers of articles on sharing information to downstream parties.

11.7.3.1.4. Waste Framework Directive

The SCIP (Substances of Concern In articles as such or in complex objects (Products)) database, established by ECHA under Art. 9(2) of the Waste Framework Directive (2008/98/EC), serves to collect and disseminate detailed information on Candidate List SVHCs present in articles and complex products throughout their entire lifecycle to drive substitution of hazardous

substances, prevent the generation of contaminated waste, enhance transparency for waste operators.

Establishing the SCIP database allows for transferring Art. 33(1) REACH information, that would otherwise not reach waste treatment operators. It is however noted in an evaluation of SCIP for ECHA (PWC, 2022) that: “While the reliability and quality of the information is not in question, its accessibility and practical use cases for waste operators and consumers remain limited for the moment, according to the consulted stakeholder organisations. Equally, some Companies are uncertain about the usefulness of the information they provide to SCIP for other stakeholders”.

11.7.3.1.5. WEEE Directive

When placing new professional dishwashers on the market, producers provide waste treatment operators with detailed information on preparation for reuse and treatment in accordance with Article 15(1) of the WEEE Directive (2012/19/EU). This information shall identify each component and material and indicate the location of any hazardous substances, to the extent necessary for reuse, treatment, and recycling. Thereby enabling proper preparation for reuse and environmentally sound treatment of WEEE. To support this process, the I4R platform has been established. No specific threshold for sharing information is mentioned in the directive.

11.7.3.1.6. RoHS Directive

The RoHS Directive (2011/65/EU) aims to restrict the use of hazardous substances in electrical and electronic equipment (EEE) in order to protect human health and the environment, including ensuring the environmentally sound recovery and disposal of waste EEE. In support of these objectives Art. 6 requires the Commission to review and, if necessary, amend the list of restricted substances. This review process must align with other chemicals legislation, particularly REACH (and its Annexes XIV and XVII). When evaluating substances (including those with very small or nanoscale structures), the Commission must consider whether they could negatively affect EEE waste management (such as by impeding reuse or recycling) or give rise to uncontrolled releases or hazardous by-products during waste treatment. Furthermore, the assessment must take into account potential risks to workers handling EEE waste and identify whether alternative substances or technologies with fewer adverse effects are feasible.

11.7.3.1.7. Summary existing regulatory

The following existing information requirements are present in legislation:

- REACH requires suppliers to disclose any Candidate List SVHCs (Annex XIV) above 0.1% w/w and provide Safety Data Sheets for hazardous or PBT/vPvB substances;
- CLP requires clear hazard labelling and record-keeping for classification data;
- POPs above specific limits are banned, though POP rules don't mandate downstream information sharing;
- the Waste Framework Directive's SCIP database collects SVHC data to aid waste operators;

- 6913 • WEEE compels producers to supply end-of-life guidance on components and hazardous-
6914 substance locations to recyclers (supported by the I4R platform); and
- 6915 • RoHS restricts certain hazardous substances included in Annex II outright, with periodic
6916 reviews aligned with REACH to safeguard recyclability and worker safety.

6917 11.7.4. Substance of Concern in the product group

6918 This section will dive into the substances identified to be present in the product group to
6919 facilitate further evaluation of need for SoC information or performance requirements.

6920 11.7.4.1. Substances of Concern inventory

6921 The inventory of Substances of Concern (**Table 11-95**) is developed using stakeholder input for
6922 the main components of a professional dishwasher. Only IAS-listed substances are included,
6923 since no data on other chemicals was available from stakeholders.

6924 For each component (e.g., heating elements, pumps, circuit boards), any added substances are
6925 listed with their CAS numbers. Substances that meet the ESPR Art. 2(27) criteria are flagged to
6926 serve as the basis for identifying what substances could be considered for information
6927 requirements.

6928 Where possible, the likely function of each substance within its component is inferred from
6929 stakeholder descriptions. It also indicates the life cycle stage at which each substance appears.
6930 This is limited to material and component manufacturing as no further information is obtained
6931 through the consultation. The information that is available generally comes from REACH Art.
6932 33(1) information requirements, under which suppliers must inform downstream parties if an
6933 article contains any substance of very high concern (Article 57) identified under Article 59(1) at
6934 concentrations above 0.1% w/w; at minimum, the substance name must be provided to ensure
6935 safe use.

6936 Stakeholder-supplied concentration ranges strongly suggest that this information was obtained
6937 via REACH Art. 33(1) disclosure, since several substances exceed the 0.1% w/w trigger threshold.
6938 In addition, stakeholders provided the concentrations of lead used for soldering and as an
6939 alloying element, and these levels align with the Annex III exemptions of the RoHS Directive.

6940 Table 11-95: Substances of Concern Inventory.

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Life cycle process	Identified as SoC under art 2(27)
Heating elements	Lead	Not possible to determine from SH input	Lead	CAS RN 7439-92-1	<100% (weight percentage of homogeneous material)	Thresholds according 2011/65/EU (RoHS) exemptions in Annex III e.g. 6(c) for lead in copper alloys or 7(a) for lead in high melting temperature type solders or e.g. 6(a) or 6(a)-1 for lead as an alloying element in steel for machining purposes /in batch hot dip galvanised steel components with different thresholds for lead by weight (1st stakeholder input) 3,5 - 85% (2nd stakeholder input) (weight percentage of homogeneous material)	Component manufacturing	a; b; d
	Silicones or polysiloxanes (incl. copolymers)	Adhesion promotor, Film former	Octametylcyclotrasiloxane	CAS RN 556-67-2	Not possible to determine from SH input	Not possible to determine from SH input	Material manufacturing	a; b
		Adhesion promotor, Film former	Decametylcyclopentasiloxane	CAS RN 541-02-6	Not possible to determine from SH input	Not possible to determine from SH input	Material manufacturing	a
	Not possible to determine from SH input	Heat transferring agent	Diboron-trioxide (boric oxide)	CAS RN 1303-86-2	Not possible to determine from SH input	Not possible to determine from SH input	Material manufacturing	a; b
Motor	Fluoropolymer	Other or No technical function	Polytetrafluoroethylene (PTFE) (D5)	CAS RN 9002-84-0	Not possible to determine from SH input	Not possible to determine from SH input	Component manufacturing	Not identified ¹¹⁸

¹¹⁸ POP regulation Annex I restricts Perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds, but not PTFE

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Life cycle process	Identified as SoC under art 2(27)
Pump	Lead	Other or no technical function	Polyvinylidene fluoride (PVDF) (D4)	CAS RN 24937-79-9	Not possible to determine from SH input	Not possible to determine from SH input	Component manufacturing	Not identified ¹¹⁹
		Not possible to determine from SH input	Lead	CAS RN 7439-92-1	<100% (weight percentage of homogeneous material)	Thresholds according 2011/65/EU (RoHS) exemptions in Annex III e.g. 6(c) for lead in copper alloys or 7(a) for lead in high melting temperature type solders or e.g. 6(a) or 6(a)-1 for lead as an alloying element in steel for machining purposes /in batch hot dip galvanised steel components with different thresholds for lead by weight (1st stakeholder input) 3,5 - 85% (2nd stakeholder input) (weight percentage of homogeneous material)	Component manufacturing	a; b; d
	Fluoropolymer	Other or no technical function	Polytetrafluoroethylene (PTFE) (D5)	CAS RN 9002-84-0	Not possible to determine from SH input	Not possible to determine from SH input	Component manufacturing	Not identified
		Other or no technical function	Polyvinylidene fluoride (PVDF) (D4)	CAS RN 24937-79-9	Not possible to determine from SH input	Not possible to determine from SH input	Component manufacturing	Not identified

¹¹⁹ POP regulation Annex I restricts Perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds, but not PVDF

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Life cycle process	Identified as SoC under art 2(27)
PCB	Lead	Not possible to determine from SH input	Lead	CAS RN 7439-92-1	<100% (weight percentage of homogeneous material)	Threshold according 2011/65/EU (RoHS) exemptions in Annex III e.g. 6(c) for lead in copper alloys or 7(a) for lead in high melting temperature type solders or e.g. 6(a) or 6(a)-1 for lead as an alloying element in steel for machining purposes /in batch hot dip galvanised steel components with different threshold for lead by weight (1st stakeholder input)	Component manufacturing	a; b; d
	Not possible to determine from SH input	Barrier (Sealant), Adhesion promotor, Film former, Lubricating agent, Plasticizer	Diisononylphthalate (DINP)	CAS RN 228553-12-0 & 68515-48-0	Not possible to determine from SH input	Not possible to determine from SH input	Material manufacturing	d
	Not possible to determine from SH input	Stabiliser	6,6'-di-tert-butyl-2,2'-methylenedi-p-cresol	CAS RN 119-47-1	Not possible to determine from SH input	Not possible to determine from SH input	Material manufacturing	a; b
	Not possible to determine from SH input	Flame retardant	2,2',6,6'-tetrabromo-4,4'-isopropylidenediphenol (TBBP-A)	CAS RN 79-94-7	Not possible to determine from SH input	Not possible to determine from SH input	Material manufacturing	a; b; d

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Life cycle process	Identified as SoC under art 2(27)
	Lead	Not possible to determine from SH input	Lead	CAS RN 7439-92-1	<100% (weight percentage of homogeneous material)	Thresholds according 2011/65/EU (RoHS) exemptions in Annex III e.g. 6(c) for lead in copper alloys or 7(a) for lead in high melting temperature type solders or e.g. 6(a) or 6(a)-1 for lead as an alloying element in steel for machining purposes /in batch hot dip galvanised steel components with different thresholds for lead by weight (1st stakeholder input) 3,5 - 85% (2nd stakeholder input) (weight percentage of homogeneous material)	Component manufacturing	a; b; d
	Not possible to determine from SH input	Not possible to determine from SH input	Lead monoxide (PbO)	CAS RN 1317-36-8	<100% (weight percentage of homogeneous material)	Thresholds according 2011/65/EU (RoHS) exemptions in Annex III 7(a) / 7(c)-I for lead in high melting temperature type solders / electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound (weight percentage of homogeneous material)	Component manufacturing	a; b
	Not possible to determine from SH input	Not possible to determine from SH input	Lead titanium zirconium oxide (Pb(Ti,Zr)O ₃)	CAS RN 12626-81-2	<100% (weight percentage of homogeneous material)	Thresholds according 2011/65/EU (RoHS) exemptions in Annex III 7(a) / 7(c)-I for lead in high melting temperature type solders / electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound (weight percentage of homogeneous material)	Component manufacturing	a; b
	Not possible to determine from SH input	Not possible to determine from SH input	Melamine	CAS RN 108-78-1	Not possible to determine from SH input	Not possible to determine from SH input	Material manufacturing	a; b

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Life cycle process	Identified as SoC under art 2(27)
Display	Not possible to determine from SH input	Not possible to determine from SH input	Lead titanium zirconium oxide (Pb(Ti,Zr)O ₃)	CAS RN 12626-81-2	<100% (weight percentage of homogeneous material)	Thresholds according 2011/65/EU (RoHS) exemptions in Annex III 7(a) / 7(c)-I for lead in high melting temperature type solders / electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound (weight percentage of homogeneous material)	Component manufacturing	a; b
Control unit	Lead	Not possible to determine from SH input	Lead	CAS RN 7439-92-1	<100% (weight percentage of homogeneous material)	Thresholds according 2011/65/EU (RoHS) exemptions in Annex III e.g. 6(c) for lead in copper alloys or 7(a) for lead in high melting temperature type solders or e.g. 6(a) or 6(a)-1 for lead as an alloying element in steel for machining purposes /in batch hot dip galvanised steel components with different thresholds for lead by weight (1st stakeholder input) 3,5 - 85% (2nd stakeholder input) (weight percentage of homogeneous material)	Component manufacturing	a; b; d
	Not possible to determine from SH input	Not possible to determine from SH input	Melamine	CAS RN 108-78-1	Not possible to determine from SH input	Not possible to determine from SH input	Material manufacturing	a; b

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Life cycle process	Identified as SoC under art 2(27)
Power unit	Lead	Not possible to determine from SH input	Lead	CAS RN 7439-92-1	<100% (weight percentage of homogeneous material)	Thresholds according 2011/65/EU (RoHS) exemptions in Annex III e.g. 6(c) for lead in copper alloys or 7(a) for lead in high melting temperature type solders or e.g. 6(a) or 6(a)-1 for lead as an alloying element in steel for machining purposes /in batch hot dip galvanised steel components with different thresholds for lead by weight (1st stakeholder input) 3,5 - 85% (2nd stakeholder input) (weight percentage of homogeneous material)	Component manufacturing	a; b; d
Seals or seal rings	Fluoropolymer	Other or no technical function	Polytetrafluoroethylene (PTFE) (D5)	CAS RN 9002-84-0	Not possible to determine from SH input	Not possible to determine from SH input	Component manufacturing	Not identified
		Other or no technical function	Polyvinylidene fluoride (PVDF) (D4)	CAS RN 24937-79-9	Not possible to determine from SH input	Not possible to determine from SH input	Component manufacturing	Not identified
Thermostat	Lead	Not possible to determine from SH input	Lead	CAS RN 7439-92-1	<100% (weight percentage of homogeneous material)	Thresholds according 2011/65/EU (RoHS) exemptions in Annex III e.g. 6(c) for lead in copper alloys or 7(a) for lead in high melting temperature type solders or e.g. 6(a) or 6(a)-1 for lead as an alloying element in steel for machining purposes /in batch hot dip galvanised steel components with different thresholds for lead by weight (1st stakeholder input) 3,5 - 85% (2nd stakeholder input) (weight percentage of homogeneous material)	Component manufacturing	a; b; d
	Not possible to determine from SH input	Not possible to determine from SH input	Boric acid	CAS RN 10043-35-3	>0,1%	>0,1%	Component manufacturing	a; b

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Life cycle process	Identified as SoC under art 2(27)
Electrical component	Not possible to determine from SH input	Flame retardant	2,2',6,6'-tetrabromo-4,4'-isopropylidenediphenol (TBBP-A)	CAS RN 79-94-7	Not possible to determine from SH input	Not possible to determine from SH input	Material manufacturing	a; b; d
	Lead	Not possible to determine from SH input	Lead	CAS RN 7439-92-1	<100% (weight percentage of homogeneous material)	Thresholds according 2011/65/EU (RoHS) exemptions in Annex III e.g. 6(c) for lead in copper alloys or 7(a) for lead in high melting temperature type solders or e.g. 6(a) or 6(a)-1 for lead as an alloying element in steel for machining purposes /in batch hot dip galvanised steel components with different thresholds for lead by weight (1st stakeholder input) 3,5 - 85% (2nd stakeholder input) (weight percentage of homogeneous material)	Component manufacturing	a; b; d
	Not possible to determine from SH input	Hardener	Hexamethylphthalic anhydride	CAS RN 25550-51-0	Not possible to determine from SH input	Not possible to determine from SH input	Component manufacturing	a; b
	Not possible to determine from SH input	Not possible to determine from SH input	Lead monoxide (PbO)	CAS RN 1317-36-8	<100% (weight percentage of homogeneous material)	Thresholds according 2011/65/EU (RoHS) exemptions in Annex III 7(a) / 7(c)-I for lead in high melting temperature type solders / electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound (weight percentage of homogeneous material)	Component manufacturing	a; b

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Life cycle process	Identified as SoC under art 2(27)
Mechanical component	Not possible to determine from SH input	Not possible to determine from SH input	Lead titanium zirconium oxide (Pb(Ti,Zr)O ₃)	CAS RN 12626-81-2	<100% (weight percentage of homogeneous material)	Thresholds according 2011/65/EU (RoHS) exemptions in Annex III 7(a) / 7(c)-I for lead in high melting temperature type solders / electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound (weight percentage of homogeneous material)	Component manufacturing	a; b
	Fluoropolymer	Other or No technical function	Polytetrafluoroethylene (PTFE) (D5)	CAS RN 9002-84-0	Not possible to determine from SH input	Not possible to determine from SH input	Component manufacturing	Not identified
	Fluoropolymer	Other or No technical function	Polyvinylidene fluoride (PVDF) (D4)	CAS RN 24937-79-9	Not possible to determine from SH input	Not possible to determine from SH input	Component manufacturing	Not identified
Plastic component	Not possible to determine from SH input	Not possible to determine from SH input	Melamine	CAS RN 108-78-1	Not possible to determine from SH input	Not possible to determine from SH input	Material manufacturing	a; b
Various/ Undefined	Not possible to determine from SH input	Vulcanization enhancer in rubber	imidazolidine-2-thione	CAS RN 96-45-7	>0,1%	>0,1%	Component manufacturing	a; b
	Not possible to determine from SH input	Plasticizer	4-[2-(4-hydroxyphenyl)propan-2-yl]phenol (BPA/ Bisphenol A)	CAS RN 80-05-7	>0,1%	>0,1%	Component manufacturing	a; b
	Brass or copper alloys	Lubricating agent	Lead	CAS RN 7439-92-1	<4% (weight percentage of homogeneous material)	4% threshold according 2011/65/EU (RoHS) exemption 6(c) in Annex III Copper alloy containing up to 4 % lead by weight % (weight percentage of homogeneous material)	Material manufacturing	a; b; d
	Not possible to determine from SH input	Not possible to determine from SH input	2-methyl-1-[4-(methylsulfanyl)phenyl]-2-(morpholin-4-yl)propan-1-one	CAS RN 71868-10-5	>0,1%	>0,1%	Component manufacturing	a; b

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Life cycle process	Identified as SoC under art 2(27)
	Not possible to determine from SH input	Barrier (Sealant) or Adhesion promotor	Dibutylbis(pentane-2,4-dionato-O,O')tin	CAS RN 22673-19-4	>0,1%	>0,1%	Component manufacturing	a; b
	Not possible to determine from SH input	Not possible to determine from SH input	N,N-dimethylacetamide (DMAc)	CAS RN 127-19-5	>0,1%	>0,1%	Component manufacturing	a; b
	Not possible to determine from SH input	Not possible to determine from SH input	Boric acid	CAS RN 10043-35-3	>0,1%	>0,1%	Component manufacturing	a; b

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6942 **11.7.4.2. Bill of chemicals**

6943 Building on the SoC inventory, this section assesses whether any identified substances could
6944 hinder the recycling process.

6945 Utilising the SoC inventory, a further assessment was conducted to identify if any substances
6946 would be hindering recycling. With the limited stakeholder perspectives obtained on this aspect,
6947 literature research and expert judgement is used to assess what is present in the identified
6948 substances that could impact recycling, based on customer requirements, regulatory limitations
6949 for the product group, or impacts on the recycling process or resulting quality of the recycling
6950 output. The outcomes are presented in **Table 11-96** and analysed afterwards.

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6951 Table 11-96: Bill of Chemicals for professional dishwashers.

Substance	Function and component	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory thresholds limitations/	Process disturbing	Quality disturbing	Exemptions according to stakeholders
imidazolidine-2-thione: CAS RN: 96-45-7	Function: Vulcanization enhancer in rubber Component: Various/ Undefined	Component manufacturing	x	x							
4-[2-(4-hydroxyphenyl)propan-2-yl]phenol (BPA/ Bisphenol A): CAS RN: 80-05-7	Function: Plasticizer Component: Various/ Undefined	Component manufacturing	x	x							
2,2',6,6'-tetrabromo-4,4'-isopropylidenediphenol (TBBP-A): CAS RN: 79-94-7	Function: Flame retardant Component: PCB, Electrical component	Material manufacturing	x	x		x		Separate plastic containing brominated flame retardants during recycling: Article 8 and Annex VII of WEEE Directive 2012/19/EU			
Lead: CAS RN: 7439-92-1	Function: Lubricating agent Component: Various/ Undefined	Material manufacturing	x	x		x		RoHS Directive 2011/65/EU Art. 4(1) Member States shall ensure that EEE placed on the market, including cables and spare parts for its repair, its reuse, updating of its functionalities or upgrading of its capacity, does not contain the substances listed in Annex II. Annex II Restricted substances referred to in Article 4(1) and maximum concentration values tolerated by weight in homogeneous materials: Lead ($\leq 0,1\%$), unless exemption is in place for 11. Other EEE not		Lower purity of remelted copper obtained from recycling with higher lead concentrations.	Exemption: 4%, threshold according 2011/65/EU (RoHS) exemption 6(c) in Annex III Copper alloy containing up to 4 % lead by weight until 21 July 2024.

Substance	Function and component	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory limitations/thresholds	Process disturbing	Quality disturbing	Exemptions according to stakeholders
								covered by any of the categories above.			
Lead: CAS RN: 7439-92-1	Function: Not possible to determine from SH input Component: Heating elements, Motor, Pump, PCB, Control unit, Power unit, Thermostat, Electrical component	Component manufacturing	x	x		x		RoHS Directive 2011/65/EU Art. 4(1) Member States shall ensure that EEE placed on the market, including cables and spare parts for its repair, its reuse, updating of its functionalities or upgrading of its capacity, does not contain the substances listed in Annex II. Annex II Restricted substances referred to in Article 4(1) and maximum concentration values tolerated by weight in homogeneous materials: Lead ($\leq 0,1\%$), unless exemption is in place for 11. Other EEE not covered by any of the categories above.		Lower purity of remelted copper obtained from recycling with higher lead concentrations.	Exemption thresholds according 2011/65/EU (RoHS) exemptions in Annex III e.g. 6(a) Lead as an alloying element in steel for machining purposes and in galvanised steel containing up to 0,35% lead by weight until 21 July 2024; 6(c) Copper alloy containing up to 4% lead by weight until 21 July 2024; 7(a) Lead in high melting temperature type solders (i.e. lead-based alloys containing 85% by weight or more lead) until 21 July 2024.
2-methyl-1-[4-(methylsulfanyl)phenyl]-2-(morpholin-4-yl)propan-1-one: CAS RN: 71868-10-5	Function: Not possible to determine from SH input Component: Various/ Undefined	Component manufacturing	x	x							
Octametylcyclotetrasiloxane: CAS RN: 556-67-2	Function: Adhesion promotor, Film former Component: Heating elements	Material manufacturing	x	x							
Decametylcyclopentasiloxane: CAS RN: 541-02-6	Function: Adhesion promotor, Film former Component: Heating elements	Material manufacturing	x								

Substance	Function and component	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory thresholds	limitations/	Process disturbing	Quality disturbing	Exemptions according to stakeholders
Hexamethylphthalic anhydride : CAS RN: 25550-51-0	Function: Hardener Component: Electrical component	Component manufacturing	x	x								
Diisononylphthalate (DINP): CAS RN: 228553-12-0 & 68515-48-0	Function: Barrier (Sealant), Adhesion promotor, Film former, Lubricating agent, Plasticizer Component: Pump	Material manufacturing				x		On Annex XVII of REACH for partial restriction related to use of DINP in toys and childcare items which can be placed in the mouth by children				
Dibutylbis(pentane-2,4-dionato-O,O')tin: CAS RN: 22673-19-4	Function: Barrier (Sealant) or Adhesion promotor Component: Various/ Undefined	Component manufacturing	x	x								
Lead monoxide (PbO): CAS RN: 1317-36-8	Function: Not possible to determine from SH input Component: PCB, Electrical component	Component manufacturing	x	x								
Diboron-trioxide (boric oxide) : CAS RN: 1303-86-2	Function: Heat transferring agent Component: Heating elements	Material manufacturing	x	x								
N,N-dimethylacetamide (DMAc): CAS RN: 127-19-5	Function: Not possible to determine from SH input Component: Various/ Undefined	Component manufacturing	x	x								
Lead titanium zirconium oxide (Pb(Ti,Zr)O3) : CAS RN: 12626-81-2	Function: Not possible to determine from SH input Component: PCB, Display, Electrical component	Component manufacturing	x	x								
6,6'-di-tert-butyl-2,2'-methylenedi-p-cresol: CAS RN: 119-47-1	Function: Stabiliser Component: Pump	Material manufacturing	x	x								
Melamine: CAS RN: 108-78-1	Function: Not possible to determine from SH input Component: PCB, Control unit, Plastic component	Material manufacturing	x	x								

Substance	Function and component	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory thresholds limitations/	Process disturbing	Quality disturbing	Exemptions according to stakeholders
Boric acid: CAS RN: 10043-35-3	Function: Not possible to determine from SH input Component: Thermostat, Various/ Undefined	Component manufacturing	x	x							

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11.7.4.2.1. Assessment based on Bill of chemicals from a recycling perspective

The overall majority of the identified substances can be classified as Art 2(27)a SVHCs, these substances also are covered by the CLP hazard classification covered in Art 2(27)b. No POP regulated substances were identified. When considering the Art 2(27) substances the stakeholders indicated that lead (CAS RN: 7439-92-1), present in brass and copper alloys, can be challenging to recycle. This is corroborated by research in recycling of copper, which indicates that: "Until now, large amounts of these lead-containing alloys were remelted into new products. If the allowed lead content for new products is significantly lower than lead content in EoL products, the material either has to be strongly diluted in the direct melt route or be sent to the much more energy-intensive smelting and refining route" (Antonia Loibl et. al., 2021). Based on this, it can be determined that lead influences recycling quality, but a common practice already exists to mitigate its presence. Additionally, a 4% threshold exemption was present in RoHS Annex III related to 6(c) (copper alloy containing up to 4% lead by weight) until 21 July 2024. This exemption is no longer present, so new copper or brass should contain lower lead levels in the future. Similar exemptions for other uses of lead in RoHS have also expired. Similar exemptions for other uses of lead in RoHS have also lapsed. Additionally, for lead monoxide (CAS RN 1317-36-8) recyclers are also expected to dilute these substances in the recycling stream to manage their impact.

With TBBP-A (CAS RN: 79-94-7) there is a brominated flame-retardant present in the PCBs and other electrical components. Most likely this is part of the plastics present in these components. "According to Article 8 and Annex VII of Directive 2012/19/EU (the WEEE Directive), plastic components containing brominated flame retardants—such as TBBP-A in ABS housings and shredded polymer flakes recovered via manual or mechanical dismantling, crushing, sieving, magnetic/electrostatic, gravimetric and air separation—must be removed from separately collected WEEE for appropriate disposal, whereas non-flame-retardant ABS may be recycled, and printed wiring boards are sent to smelters where TBBP-A is co-incinerated and bromine captured as a salt for landfill disposal (Oeko institute, 2019). From this perspective it is clear that there is a regulatory guiderail and a system to deal with the presence of this type of brominated flame-retardant.

Additionally, DINP (CAS RN: 228553-12-0 & 68515-48-0) is also identified. "DINP is used as a plasticizer, especially in the production of polyvinyl chloride (PVC). It is not bound to the PVC plastic and is released over time into the environment" (Chemical for Office of Environmental, 2009). This substance is on the REACH restriction list (Annex XVII) "Shall not be used as substances or in mixtures, in concentrations greater than 0,1% by weight of the plasticised material, in toys and childcare articles which can be placed in the mouth by children" ECHA, 2016). Recycling materials that include DINP could impact the use of derived recycled content, but it is unlikely that recycled plastics will be used for these purposes due to the regulatory requirements for these product groups, making such recycling economically less viable.

11.7.5. Considerations on information and performance requirements

11.7.5.1. Information requirements

Article 7 of the ESPR mandates that any product containing a Substance of Concern must be accompanied by standardised information covering: the exact name or numerical identifier of each substance; its precise location within the product; the concentration (or concentration range/maximum value) at the product, component, or spare-part level; clear instructions for safe use; and guidance on environmentally sound end-of-life treatment. Drawing on stakeholder consultations, literature, and draft JRC guidance, this section explores the specific concentration thresholds, exemptions, and implementation timeline to be applied to information requirements for professional dishwashers.

11.7.5.2. Threshold for information requirements

The tracking thresholds proposed in the section are based on draft JRC guidance and trigger the information requirement obligation. If a SoC falls into multiple categories (for example, Article 2(27)(a) and 2(27)(b)), the most conservative (i.e. lowest) threshold should be applied. All included thresholds for tracking in this section apply to the IAS in the final product (including components and spare parts).

11.7.5.2.1. Art. 2(27)(a) substances

The largest share of SoCs identified in the consultation for this product group fall under Annex XIV candidate list SVHCs. Therefore the 0.1% w/w threshold and REACH Art. 33(1) disclosure requirements should guide threshold-setting. Based on the provided data, most SoC identified for this product group meet these criteria on a component level. Similarly, stakeholders expressed a desire to minimise duplication and ensure alignment with existing legislation. Since their component producers should be able to access Safety Data Sheets that flag any substances or mixtures above the 0.1% w/w threshold, this information could be made available at the component level to the manufacturers.

11.7.5.2.2. Art. 2(27)(b) substances

For substances of concern (SoCs) falling under Article 2(27)(b) in products classified as articles, a generic concentration threshold equal to the cut-off values in Table 1.5.1 of Section 1.5.3 ("General guidance for compiling safety data sheets") of the Globally Harmonized System (GHS) is recommended. These cut-offs define the minimum concentration at which a hazardous constituent must be disclosed in any GHS-compliant Safety Data Sheet worldwide. Where a relevant hazard class or category is absent from Table 1.5.1 but appears in Annex I of the CLP Regulation with a generic concentration limit (GCL) for mixtures, the lowest GCL that would classify the mixture into the most severe category of that hazard class should be adopted as a conservative proxy. Additionally, for the following hazard classes (introduced in 2022) the GCLs from the Delegated regulation (EU) 2023/707 are suggested:

- (iv) endocrine disruption for human health categories 1 and 2 (Table 3.11.2)

- (v) endocrine disruption for the environment categories 1 and 2 (Table 4.2.2)
- (vi) persistent, mobile and toxic or very persistent, very mobile properties (PMT or vPvM, Art. 4 (4)(3))
- (vii) persistent, bioaccumulative and toxic or very persistent, very bioaccumulative properties (PBT or vPvB, Art. 4 (3)(3))

11.7.5.2.3. Art. 2(27)(c) substances

For persistent organic pollutants (POPs) covered by Article 2(27)(c), a 0.1 % w/w threshold is likewise proposed based on the guidance, treating them as SVHCs on the REACH Candidate List. This harmonized threshold streamlines compliance, ensures consistent notification criteria across both SVHCs and restricted POPs.

11.7.5.2.4. Art. 2(27)(d) substances

A generic threshold of 0.1 % w/w is likewise proposed for SoC that fall under Article 2(27)(d), namely those substances whose presence can negatively affect reuse and recycling. In the absence of data identifying which substances most adversely affect circularity within this product group, it is not feasible to establish specific limits related to substance groups of even specific substances. Without any information requirement, future data collection on these SoCs would remain severely constrained. Adopting the 0.1 % w/w threshold used for SVHCs and POPs provides a clear, uniform obligation, which covers the complete bill of materials, including all components and spare parts.

11.7.5.2.5. Information requirement exemptions and timelines

Currently it is not possible to determine substance specific exemptions based on the stakeholder feedback obtained through the consultation. However, stakeholders expressed concerns about the difficulty of gathering information for both IAS and NIAS across the full life cycle. They cited the duration and scope of data collection, the need to adjust contractual relations, and the challenge of identifying NIAS at different stages of the life cycle. From this perspective, one could argue that information requirements should be limited to SoC that are present in the final product (including components and spare parts) and its full bill of materials, while all other SoC would be exempt.

Regarding the SoC that must still be tracked under the information requirement, several approaches are possible, each with its own level of ambition and associated administrative burden. For example, from highest to lowest burden:

- Highly ambitious scenario: All SoC listed in Art. 2(27)(a–d) present in the product would fall under the information requirement with the proposed thresholds (see previous chapter), with no further exemptions.
- Intermediate scenario: All Art. 2(27)(a–d) SoC would still be tracked, but companies could justify substance-specific exemptions. Supporting evidence demonstrating, issues with technical infeasibility, lack of analytical methods to detect or quantify, irrelevance in the specific product, or the need to protect confidential business information) would

be made available for audit. Where needed this should be supported with scientific evidence to substantiate the claims.

- Limited scenario: All Art. 2(27)(a–c) SoC would be tracked, but companies could justify broader exemptions for groups of substances, hazard classes or categories, etc, within the flexibilities offered by the legal text. Supporting evidence demonstrating, issues with technical infeasibility, lack of analytical methods to detect or quantify, irrelevance in the specific product, or the need to protect confidential business information) would be made available for audit. Where needed this should be supported with scientific evidence to substantiate the claims.

For Art. 2(27)(d) SoC, a targeted follow-up study with recyclers would need to identify which substances pose recycling challenges for this product group. Any problematic SoC could then be added to the delegated act as an amended to remove their exemption. A variant of this approach could also target specific groups of substances or exempt certain hazard classes based on product characteristics and current recycling practices.

Given the complexity of our products (each containing numerous subcomponents and sub-subcomponent) a five-year implementation period after adoption of the delegated act would be warranted for each of the scenarios. This timeline would allow for:

- Year 1: Preliminary identification of substances present.
- Years 2–3: Collection of necessary information and initiation of contractual negotiations.
- Years 4–5: Receipt of supplier data, management of any supplier non-compliance, organization of information in accordance with Art. 7(a) of the ESPR and sharing via a Digital Product Passport and/or existing information channels (for instance technical product information).

That said, before choosing an exemption approach for the information requirements under Art. 7 of the ESPR, the impacts of each scenario and the proposed timeline must be assessed further in the impact assessment.

11.7.5.3. Performance requirements

The consultation has not identified any substances that stand out as particularly problematic with respect to the existing information. Similarly, recycling of this product group is governed by the WEEE and RoHS Directives, and an established recycling procedure is already in place. The manufacturers have also not indicated any specific substances. Therefore, at this stage, there is no basis for imposing specific performance requirements in line with Art. 6 of ESPR. If further research is conducted beyond the scope of this preparatory study, it would be advisable to revisit this topic at a later date.

11.7.6. Conclusions

This report aims to identify and assess SoC in professional dishwashers under the ESPR. A stakeholder consultation (April–May 2025) confirmed that most intentionally added chemicals in these appliances are already SVHCs under REACH and exceed the 0.1% w/w threshold, triggering existing disclosure requirements. No POPs were found, though lead compounds remain subject to evolving restrictions.

Recycling considerations centred on lead in brass and copper alloys, historically managed by dilution or more energy-intensive refining suggest no need for further information. With the exemptions in the RoHS Directive passing the concentrations will reduce further. Additionally, for the brominated flame retardants in PCBs there is already a requirement to be separated under the WEEE rules. DINP was highlighted as a restricted plasticizer that, even if unlikely to enter toys or childcare articles through recycled content.

Nevertheless, the ESPR nonetheless requires manufacturers of professional dishwashers to adhere to information requirements for all SoCs present in their products, resulting in tracking obligations concerning their identity, location, concentration, safe-use instructions, and end-of-life treatment. To meet these obligations with minimal duplication and maximum alignment, the following thresholds (based on draft JRC guidance) are recommended:

- A 0.1 % w/w threshold for SVHCs (Art. 2(27)(a)) and POPs (Art. 2(27)(c)) in line with REACH Art. 33(1);
- UN Globally Harmonized System (GHS) generic concentration limits (or, where absent, the lowest CLP GCLs) for hazard-classed substances under Art. 2(27)(b), supplemented by the latest endocrine-disruptor and PMT/PBT criteria; and
- A uniform 0.1 % w/w cutoff for SoCs affecting circularity (Art. 2(27)(d)), pending more granular data.

Because full-life-cycle IAS and NIAS data collection is time- and resource-intensive, the scope is limited to product-specific IAS present in the final product, including its components and spare parts. Three implementation scenarios are proposed:

- Ambitious: covering all SoCs without exemptions;
- Intermediate: case-by-case exemptions for substances based on solid justification; and
- Limited: tracking only Art. 2(27)(a–c) substances with broader approach towards exemptions within the flexibilities offered by the legal text, coupled with a targeted study to identify additional Art. 2(27)(d) candidates for selected regulation through amending the delegate act.

A five-year roll-out is recommended across all scenarios to allow for supplier engagement, data gathering, and Digital Product Passport integration. An assessment of feasibility and administrative burden should be undertaken as part of the impact assessment.

Finally, performance requirements under Art. 6 of the ESPR need not be imposed at this stage: current WEEE/RoHS recycling frameworks are working satisfactorily, and stakeholder feedback

has not identified any specific performance gaps. As new research or recyclability insights emerge, revisiting performance criteria should be considered.

11.7.7. References of Appendix 3 - SoC

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