



Preparatory study on professional dishwashers

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

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List of main abbreviations

BAU	Business as Usual
BAT	Best Available Techniques
BC	Base Case
BNAT	Best Not Available Techniques
BoM	Bill of Materials
DG	Directorate-General (of the European Commission)
DOC	Declaration of Conformity
DO	Design Option
DPP	Digital Product Passport
EoL	End of Life
EP	European Parliament
EPREL	European Product Database for Energy Labelling
ErP	Energy-related Products
ESPR	Ecodesign for Sustainable Products Regulation
GHG	Greenhouse Gas
ISO	International Organisation for Standardisation
JRC	Joint Research Centre (European Commission)
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LVD	Low Voltage Directive
MEErP	Methodology for Ecodesign of Energy-related Products
MEEuP	Methodology for Ecodesign of Energy-using Products
MS	Member State
OECD	Organisation for Economic Co-operation and Development
PEFCR	Product Environmental Footprint Category Rules
RoHS	Restriction of Hazardous Substances
SoC	Substances of Concern
VAT	Value Added Tax
WEE	Waste Electrical and Electronic (Equipment)
WFD	Waste Framework Directive

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 2011 methodology for ecodesign of energy-related products (MEErP) (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 ESPR entered into force on 18 July 2024. It 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.

1.2. Objectives of this preparatory study

Within this context, Directorate-General (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

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

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 is the final report after three stakeholder meetings or interactions 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

The MEErP has recently been revised and published by the Joint Research Centre (JRC) (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 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 was 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.
- A stakeholder interaction took place on 3 November 2025. Update of Task 5 and Task 6 were shortly presented, the focus of the online meeting was on Task 7, in particular on the policy options.
- A final online consultation was held between 27 October and 24 November 2025 to collect feedback on the draft version 2 of the Task 1-7 report with special focus on Task 7 (policy options and scenarios).

Furthermore, the study team had a couple of bilateral exchanges with stakeholders, particularly from July 2025 onwards regarding some aspects related to Task 7 with a focus of the discussions on potential testing methods to be applied for the different product categories.

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**.

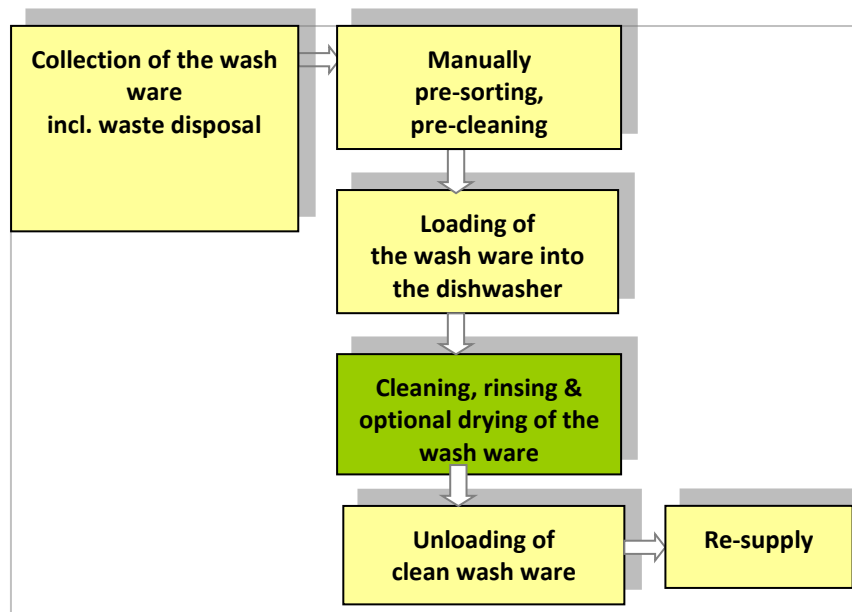


Figure 3-1: Different steps of a commercial dishwashing process.

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

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.

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

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

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

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

3.2.2. Definition of commercial dishwashers

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

3.2.2.1. Ecodesign regulation on household dishwashers

The Commission Regulation⁸ with regard to ecodesign requirements for household dishwashers provides the following definition: ‘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.

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

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

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>

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

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.

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:

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

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.

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.’

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

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

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 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.

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

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.

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.
- 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.

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.

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
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 levels possible (loading of two racks possible). The third level, the cutlery drawer, is not	Dishwashing usually on one level (two racks for undercounter models are available), in conveyor-type

Group	Domestic dishwashers	Commercial water change dishwashers	Other commercial dishwashers
		available in commercial dishwashers.	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)
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	<i>Variable dimensions depending on amount and type of items to be cleaned and spatial possibilities.</i>

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](#)

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.

[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.

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

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 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

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

Code	Description
84.22.19.00	Of other than household type
84.22.20.00	<i>Machinery for cleaning or drying bottles or other containers</i>

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

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

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

476 **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 15/00	Washing or rinsing machines for crockery or table-ware
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

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:

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

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

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

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

- 523 - Undercounter one-tank dishwasher: ‘manually loaded, programmable,
- 524 undercounter front loader with typically one detergent circulating zone and a
- 525 freshwater rinsing process’, and
- 526 - Hood-type dishwasher: ‘manually loaded, programmable, hood-type, pass-through
- 527 machine with typically one detergent-circulating zone and a freshwater rinsing
- 528 process’.

529 3.2.3.5. Labelling categories

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

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

- 534 - ‘Undercounter: A machine with an overall height 38 inches or less, in which a rack
- 535 of dishes remains stationary within the machine while being subjected to sequential
- 536 wash and rinse sprays and is designed to be installed under food preparation
- 537 workspaces. Under counter dishwashers can be either chemical or hot water
- 538 sanitizing, with an internal booster heater for the latter. For purposes of this
- 539 specification, only those machines designed for wash cycles of 10 minutes or less
- 540 can qualify for ENERGY STAR.
- 541 - Single tank, door type: A stationary rack machine designed to accept a standard 20
- 542 inch x 20 inch dish rack which requires the raising of a door to place the rack into

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

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.

- 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,

- 584 - Water efficiency, and
- 585 - Low detergent consumption.

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

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

592 While short running cycles are an important requirement for almost each commercial
 593 application, the other requirements might be very different depending on the application. These
 594 variations in the framework requirements that must be met by commercial dishwashers are the
 595 main reason for a range of different product categories on the market, compared to e.g.
 596 dishwashers for household use which are quite similar regarding the design (i.e. mainly
 597 undercounter dishwashers using fresh water for each dishwashing cycle, with a capacity of 12-
 598 14 place settings).

599 Main properties of commercial dishwashers

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

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

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

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

621 **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.

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.

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

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 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.

As part of the 2024 stakeholder consultation one stakeholder representing several manufacturers pointed out that Category 1 should be excluded from the study, as these machines are very different from all other categories in terms of specifications and technical features (e.g., number of cycles per day, number of dishes washed). However, several other stakeholders recommended keeping Category 1 in scope, as it is relevant to the commercial dishwashing sector and an integral part of the industry. Therefore, Category 1 remained in scope for this preparatory study.

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.

²⁶ Also models with two racks are available.

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 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.

799 **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

800 n.a. = not applicable

801 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.

The standard provides the following definitions for the programme time and the cycle time:

- programme time: time that is measured from the initiation of the programme (excluding any user-programmed delay) until an end of programme indicator is showing the end of the programme. Note 1 to entry: If there is no end of programme indicator, the programme time is equal to the cycle time.
- cycle time: time that is measured from the initiation of the programme (excluding any user-programmed delay) until all activity ceases (i.e. the end of the cycle)

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. However, European CLC/TC59X is working on this topic and has finalised the preparations for a rinse performance test, which is mandatory to have the full picture of the efficiency of the commercial dishwashers. The proposal is currently being developed at the IEC level within TC59A. A new edition of the standard is planned.

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 60335-2-58:2025 + A11:2025: 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,

- 912 - Machines intended for disinfection,
- 913 - Machines intended to be used on board of sea-going vessels and aircraft,
- 914 - Machines designed exclusively for industrial purposes, for example machines used
- 915 in the food industry for cleaning receptacles that serve as packaging for final
- 916 products (e.g. Bottle-cleaning machines), and machines used in manufacturing
- 917 processes,
- 918 - Separately driven transport devices not confined in the machine, and
- 919 - Machines intended to be used in locations where special conditions prevail, such as
- 920 the presence of a corrosive or explosive atmosphere (dust, vapour, or gas).

921 3.3.1.4. ASTM International Standards (USA / International)

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

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

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

- 936 - F26.01: Cleaning and Sanitation Equipment,
- 937 - F26.06: Productivity and Energy Protocol,
- 938 - F26.05: Life Cycle Cost and Sustainability.

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

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>

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

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

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

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

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

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

This specification covers multiple-tank, automatic rack less conveyor type, commercial dishwashing machines. These machines can be classified into two types: Type 1 machines shall be designed and supplied to accept the feeding of soiled tableware from the right side, when facing the front of the machine while Type II shall be designed and supplied to accept the feeding of soiled tableware from the left side, when facing the front of the machine. The dishwashing machines have three kinds of styles: Style 1 is a steam heated machine, with two classes namely Class A which uses injectors and Class B which uses heat exchange coils. Style 2 is an electrically heated dishwashing machine. Style 3 on the other hand is gas heated with two classes namely Class C which uses natural gas and Class D which uses LP gas. In addition, these dishwashing machines can be classified into three groups according to size and capacity: Group A, Group B, and Group C. Materials used in the manufacture of these machines shall consist of corrosion-resistant steel, corrosion resisting material, nickel-copper alloy, and plastics. The dishwashing machine shall be complete so that when connected to the specified source of power, water supply, heating means (steam, electric, or gas), drainage, detergent, and rinse agent feeder as applicable, the unit can be used for its intended function. Dishwashers shall be rigid, quiet in

984 operation, free from objectionable vibration, and so constructed as to prevent objectionable
985 splashing of water to the outside of the machine. Operational test, leakage test, and
986 performance profiles shall be done to determine the overall efficiency of the dishwashing
987 machine.

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

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

1000 ASTM F1021–18: Standard specification for feeders, detergent, rinse agent, and sanitizing agent
1001 for commercial dishwashing and glass washing machines

1002 This specification covers detergent feeders, rinse additive feeders, and sanitizing agent feeders
1003 intended to automatically maintain the concentration of additives in the wash, recirculated
1004 rinse, or non-recirculated rinse water of commercial spray- type dishwashing and glass washing
1005 machines. Detergent, rinse additive, and sanitizing agent feeders shall be of the following types
1006 and styles: Types I, II, III, IV, V, and VI; and Style I; II; III; IV; V; and VI. Materials used shall be free
1007 from defects that would adversely affect the performance or maintainability of individual
1008 components or of the overall assembly. The feeder shall be complete so that when connected
1009 to the specified source of power (electrical or water, or both), the unit can be used for its
1010 intended function. Feeders shall be tested in accordance with specified requirements.

1011 ASTM F1114–22: Standard specification for heat sanitizing commercial pot, pan, and utensil
1012 washing machines, stationary rack, water-driven rotary spray type

1013 This specification covers the material, design, and performance requirements pertinent to the
1014 construction of water-driven rotary spray type, stationary rack commercial pot, pan, and utensil
1015 washing machines that are manually fed yet automatically controlled to uniformly wash, rinse,
1016 and heat-sanitise food preparation utensils. Representative production models of the washers
1017 shall pass performance, operation, leakage, and energy and productivity tests, and should
1018 function satisfactorily as specified. Certification, product marking, and packaging are also
1019 considered.

1020 ASTM F1202-22: Standard specification for washing machines, heat sanitizing, commercial, pot,
1021 pan, and utensil vertically oscillating arm type

1022 This specification covers the requirements for manually fed, motor-driven vertically oscillating
1023 arm type, automatically controlled, commercial pot, pan, and utensil washing machine (also
1024 referred to as ‘the washer’). The washer is of one rack capacity (Type I) and is available in either

Style A (one door/front loading) or Style B (three door/pass-through with front load door). Heat shall be provided to the washer through steam (Style 1) by injection (Class A) or heat exchange coil (Class B) or through electric means (Style 2). The washer and its components shall be manufactured free of defects. Piping and fittings shall be manufactured from corrosion-resisting 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.

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.

1065 ASTM F1920-20: Standard test method for performance of rack conveyor, commercial
1066 dishwashing machines

1067 This test method evaluates the energy and water consumption of rack conveyor, commercial
1068 dishwashing machines, hereafter referred to as dishwashers. Dishwashers may have remote or
1069 self-contained booster heater. This procedure does not address cleaning or sanitizing
1070 performance. It is applicable to both hot water sanitizing and chemical sanitizing rack conveyor
1071 machines, which include both single tank and multiple tank machines. Rackless conveyors (i.e.
1072 flight type machines) are included. Dishwasher tank heaters are evaluated separately from the
1073 booster heater. Machines designed to be interchangeable in the field from high temperature
1074 and low temperature (i.e. Dual Sanitizing Machines) and vice versa, shall be tested at both
1075 settings. Machines should be set for factory settings. If a dishwasher includes a prewash tank
1076 heater as an option, energy should be submetered separately for the prewash tank heater. This
1077 test method may be used for dishwashers with steam coil tank or booster heat, but not
1078 dishwashers with steam injection tank or booster heat. When the test method specifies to use
1079 the data plate or manufacturer's recommendations, instructions, specifications, or
1080 requirements, the information source shall be used in the following order of preference and
1081 documented in the test report: data plate, user manual, communication with manufacturer.

1082 ASTM F2687-13: Standard practice for life cycle cost analysis of commercial food service
1083 equipment

1084 This standard practice for life cycle cost analysis of commercial food service equipment is
1085 designed for producers and end-users to utilise when forecasting and (or) evaluating the life
1086 cycle costs of equipment by accounting for tangible differences in operating and maintenance
1087 costs of commercial food service equipment. Results of the analysis detailed in this standard
1088 practice are intended for budgetary purposes. The results may also be used to compare
1089 projected life cycle cost of different models from a single manufacturer, or models
1090 manufactured by multiple suppliers, or to establish when it is cost effective to replace a specific
1091 equipment versus incurring continued maintenance expenses. Major categories included in this
1092 analysis include total purchase price, service and repair costs, preventative maintenance costs,
1093 utility operating costs and disposal costs. The results may be quantified as a yearly running total
1094 and a net present value. Inputs for this life cycle analysis will need to come from a variety of
1095 sources, including manufacturers, service agents, utility companies, and end users. Not all input
1096 variables need to be considered for effective analysis. To avoid skewing the results, sections
1097 where reliable estimates are not available should be left out of the analysis. The values stated
1098 in inch-pound units are to be regarded as standard. The values given in parentheses are
1099 mathematical conversions to SI units that are provided for information only and are not
1100 considered standard.

1101 ASTM F2916-19: Standard practice for environmental impact analysis of commercial food service
1102 equipment

1103 This practice for analysing the environmental impact of food service equipment is intended to
1104 document the performance of food service equipment using attributes that are indicators of the
1105 appliance's environmental impact. It includes, but is not limited to, cooking, ware washing,
1106 refrigeration, ventilation, and mechanical equipment that use energy or water in a typical
1107 commercial cooking application. The method assigns points for each attribute and calculates a
1108 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.

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

The standards include the following issues:

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

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

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

3.3.1.5. UL 921 (USA / Canada)

UL 921 Standard for commercial dishwashers

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

1198 Therefore, this standard is regarded to be not appropriate to cover European requirements and
1199 market trends.

1200 3.3.2.2. NSF/ANSI 29 (International / USA / Canada)

1201 NSF/ANSI 29-2021 Detergent and chemical feeders for commercial spray-type dishwashing
1202 machines

1203 This standard establishes minimum public health and sanitation requirements for chemical
1204 sanitizing feeders, detergent feeders, rinse agent feeders, and similar devices for commercial
1205 spray-type dishwashing machines that automatically maintain the concentration of additives in
1206 the prewash, wash, pumped rinse, or final rinse of commercial spray-type dishwashing
1207 machines. The requirements by this standard cover:

- 1208 - The materials used,
- 1209 - The design and construction,
- 1210 - The performance (e.g. Hydrostatic test, maintenance of solution concentration,
- 1211 reliability, chemical resistance, etc.) And
- 1212 - The installation, operation and maintenance instructions (manual, operating
- 1213 instructions).

1214 This standard established and adopted by NSF as minimum voluntary consensus standard is used
1215 internationally as well as an American National Standard (ANS).

1216 3.3.2.3. EN 17735 (European)

1217 EN 17735:2022: Commercial dishwashing machines – Hygiene requirements and testing

1218 This European standard is the first to provide a standard that defines the hygiene requirements
1219 for the operation of commercial dishwashers and the procedures for corresponding tests on the
1220 dishwashers and contains guidelines for the hygienic and proper operation, care, and
1221 maintenance of dishwashers. It has been prepared by Technical Committee CEN/TC 429 ‘Food
1222 hygiene — Commercial warewashing machines — Hygiene requirements and testing’.

1223 EN 17735 is applicable to dishwashers used in commercial environments for cleaning items in
1224 contact with food, such as plates, crockery, glassware, cutlery, reusable containers, and similar
1225 items. These can be found in cafés, restaurants, canteens, hospitals, snack bars and bars, etc.
1226 The standard is not applicable to household dishwashers, washer-disinfectors for the
1227 reprocessing of medical devices and machines for industrial use.

1228 The hygiene requirements for commercial dishwashers defined by EN 17735 include, for
1229 example, specifications for the planning and design of the various machine types (programme
1230 and conveyor dishwashers). Information is provided on hygienic and commercial operation,
1231 cleaning and disinfection of the wash ware and care and maintenance of the machines. It also
1232 describes the basic hygiene principles for the spatial arrangement of the dishwashers in the
1233 kitchen area and the organisation of the wash ware cycle.

1234 For dishwashing machines within the scope of EN IEC 63136 (see **Section 3.3.1.1**), the
1235 programme used for testing shall be the same as that used for the EN IEC 63136 performance
1236 test. As one stakeholder highlighted, this relationship (from EN 17735 to EN IEC 63136, but not
1237 vice versa) establishes a link between cleaning performance and hygiene requirements.

1238 According to stakeholder feedback, there is no European legal obligation to use EN 17735. There
1239 may be specific and varying requirements depending on the kitchen's location (country, region,
1240 or municipality). Currently, food operators have the legal obligation to comply with the
1241 provisions and requirements of food legislation, but the way they comply and demonstrate
1242 compliance is more a matter of process than of focusing on specific dishwashing machine
1243 characteristics.

1244 **3.3.2.4. DIN 10510 / 10511 / 10512 / 10522 /10544 (Germany)**

1245 This family of standards covers hygienic requirements regarding the construction, operation and
1246 maintenance of different types of commercial dishwashers.

1247 Most of the content of these German standards has been incorporated into EN 17735 (see
1248 **Section 3.3.2.3**). The previous German standards for the hygiene requirements for commercial
1249 dishwashing DIN 10510, 10511 and 10512 were withdrawn as a result. Only DIN 10522 remains.

1250 For points that are included in the previous German standards but not in EN 17735, such as type
1251 testing with glass, a residual standard is published by the responsible DIN committee in the form
1252 of DIN 10544.

1253 DIN 10522:2006 Food hygiene – Professional cleaning of reusable boxes and reusable containers
1254 for unpackaged foodstuffs – Hygiene requirements, testing

1255 This standard defines minimum hygiene requirements regarding the professional cleaning of
1256 reusable boxes and reusable containers for unpackaged foodstuffs and describes the test
1257 procedures for the hygienic operation of dishwashers used for these purposes.

1258 DIN 10522 continues to apply unchanged, as its scope of application for reusable crates and
1259 reusable containers used to store and transport unpackaged food within the commercial sector
1260 is not covered by EN 17735.

1261 DIN 10544:2024-07 Food hygiene - Commercial dishwashing machines - Additional hygiene
1262 requirements and testing

1263 This German standard is applicable to commercial dishwashers that fall within the scope of
1264 EN 17735 (see **Section 3.3.2.3**). DIN 10544 supplements the content of EN 17735 with the
1265 following points:

- 1266 - Type testing for the cleaning of drinking vessels (e.g. glasses, cups ...),
- 1267 - Extraordinary testing of dishwashers (to support the operator),
- 1268 - Inspection of the cleaning of cutlery on special wash ware carriers,
- 1269 - 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) (such as that provided by a qualified hemi-anechoic chamber), but procedures are given for

1308 applying corrections (within limits that are specified) in the case of environments that are less
1309 than ideal.

1310 Information is given on the uncertainty of the sound power levels and sound energy levels
1311 determined in accordance with ISO 3744:2010, for measurements made in limited bands of
1312 frequency and with frequency A-weighting applied. The uncertainty conforms to ISO
1313 12001:1996, accuracy grade 2 (engineering grade).

1314 3.3.3.3. ISO 3746 (International)

1315 ISO 3746:2010 Acoustics – Determination of sound power levels and sound energy levels of noise
1316 sources using sound pressure – Survey method using an enveloping measurement surface over a
1317 reflecting plane

1318 This international standard specifies methods for determining the sound power level or sound
1319 energy level of a noise source from sound pressure levels measured on a surface enveloping a
1320 noise source (machinery or equipment) in a test environment for which requirements are given.
1321 The sound power level (or, in the case of noise bursts or transient noise emission, the sound
1322 energy level) produced by the noise source with frequency A-weighting applied is calculated
1323 using those measurements. The methods specified in ISO 3746:2010 are suitable for all types of
1324 noise (steady, non-steady, fluctuating, isolated bursts of sound energy, etc.) defined in ISO
1325 12001. ISO 3746:2010 is applicable to all types and sizes of noise source (e.g. stationary or slowly
1326 moving plant, installation, machine, component, or sub-assembly), provided the conditions for
1327 the measurements can be met.

1328 The test environments that are applicable for measurements made in accordance with ISO
1329 3746:2010 can be located indoors or outdoors, with one or more sound-reflecting planes
1330 present on or near which the noise source under test is mounted.

1331 Information is given on the uncertainty of the sound power levels and sound energy levels
1332 determined in accordance with ISO 3746:2010, for measurements made with frequency A-
1333 weighting applied. The uncertainty conforms to that of ISO 12001:1996, accuracy grade 3
1334 (survey grade).

1335 3.3.3.4. ISO 4871 (International)

1336 ISO 4871:1996 Acoustics – Declaration and verification of noise emission values of machinery
1337 and equipment

1338 This international standard gives information on the declaration of noise emission values,
1339 describes acoustical information to be presented in technical documents and specifies a method
1340 for verifying the noise emission declaration.

1341 3.3.3.5. ISO 9614 (International)

1342 ISO 9614-2:1996 Acoustics – Determination of sound power levels of noise sources using sound
1343 intensity – Part 2: Measurement by scanning

1344 This international standard specifies a method for measuring the component of sound intensity
1345 normal to a measurement surface which is chosen so as to enclose the noise source(s) of which
1346 the sound power level is to be determined.

1347 3.3.3.6. ISO 11204 (International)

1348 ISO 11204:2010 Acoustics – Noise emitted by machinery and equipment – Determination of
1349 emission sound pressure levels at a work station and at other specified positions applying
1350 accurate environmental corrections

1351 This international standard specifies a method for determining the emission sound pressure
1352 levels of machinery or equipment, at a work station and at other specified positions nearby, in
1353 any environment which meets certain qualification requirements. A work station is occupied by
1354 an operator and may be located in open space, in the room where the source under test
1355 operates, in a cab fixed to the source under test, or in an enclosure remote from the source
1356 under test. One or more specified positions may be located in the vicinity of a work station, or
1357 in the vicinity of an attended or unattended machine. Such positions are sometimes referred to
1358 as bystander positions. Emission sound pressure levels are determined as A-weighted levels.
1359 Additionally, levels in frequency bands and C-weighted peak emission sound pressure levels can
1360 be determined in accordance with ISO 11204:2010, if required.

1361 A method is given for determining a local environmental correction (subject to a specified
1362 limiting maximum value) to be applied to the measured sound pressure levels to exclude the
1363 effects of reflections from reflecting surfaces other than the plane on which the source under
1364 test is placed. This correction is based upon the mean sound pressure level on a measurement
1365 surface, the sound pressure level measured at a specified position, and either an environmental
1366 correction or the equivalent absorption area of the test room.

1367 With the method specified in ISO 11204:2010, results of accuracy grade 2 (engineering grade)
1368 or accuracy grade 3 (survey grade) are obtained. Corrections are applied to background noise
1369 and as described above, to the acoustic environment. Instructions are given for the mounting
1370 and operation of the source under test and for the choice of microphone positions for the work
1371 station and for other specified positions. One purpose of the measurements is to permit
1372 comparison of the performance of different units of a given family of machines, under defined
1373 environmental conditions and standardised mounting and operating conditions.

1374 The method specified in ISO 11204:2010 is suitable for all types of noise (steady, non-steady,
1375 fluctuating, isolated bursts of sound energy, etc.) defined in ISO 12001. The method specified in
1376 ISO 11204:2010 is applicable to all types and sizes of noise sources.

1377 The type of test environment influences the accuracy of the determination of emission sound
1378 pressure levels. ISO 11204:2010 is applicable to an indoor or outdoor environment with one or
1379 more reflecting planes present, meeting specified requirements. These requirements on the
1380 room are less strict than those of ISO 11201, in particular regarding the acoustical quality of the
1381 environment. ISO 11204:2010 is applicable to work stations and other specified positions where
1382 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

1421 current of up to and including 16 A per conductor and which are intended for connection to the
1422 public low-voltage distribution network.

1423 EN 61000-3-3:2013 + A1:2019 + A2:2021 + A2:2021/AC:2022 - CSV Electromagnetic compatibility
1424 (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public
1425 low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject
1426 to conditional connection

1427 This international standard applies to the limitation of voltage fluctuations and flicker impressed
1428 on the public low-voltage system. It specifies limits of voltage changes which may be produced
1429 by an equipment tested under specified conditions and gives guidance on methods of
1430 assessment. It is applicable to electrical and electronic equipment having an input current equal
1431 to or less than 16 A per phase, intended to be connected to public low-voltage distribution
1432 systems of between 220 V and 250 V line to neutral at 50 Hz, and not subject to conditional
1433 connection. IEC 61000-3-3 has the status of a product family standard within the IEC 61000
1434 series. This third edition cancels and replaces the second edition published in 2008. This edition
1435 constitutes a technical revision which takes account of the changes made in IEC 61000-4-
1436 15:2010.

1437 3.3.4.2. EN 50366 (Europe)

1438 EN 50366:2003 Household and similar electrical appliances – Electromagnetic fields – Methods
1439 for evaluation and measurement

1440 This European standard contains several test methods by which the magnetic field emissions
1441 from products can be compared to the general public restrictions and levels over the frequency
1442 range of 10 Hz to 400 kHz.

1443 3.3.4.3. EN IEC 55014 (Europe)

1444 EN IEC 55014-1:2021 Electromagnetic compatibility - Requirements for household appliances,
1445 electric tools and similar apparatus - Part 1: Emission

1446 This standard specifies requirements for the emission of radiofrequency disturbances from
1447 household appliances, electric tools, and similar apparatus. Specifically, the standard applies to:

- 1448 - Household appliances,
- 1449 - Electric tools,
- 1450 - Similar apparatus designed for use in residential, commercial, and light industrial
- 1451 environments.

1452 It aims to ensure electromagnetic compatibility by limiting radio frequency emissions from
1453 common electrical and electronic devices used in homes and similar environments and provides
1454 manufacturers with the technical specifications needed to design and test products to meet EMC
1455 regulatory requirements.

1456 EN IEC 55014-2:2021 Electromagnetic compatibility - Requirements for household appliances,
1457 electric tools and similar apparatus - Part 2: Immunity - Product family standard

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

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

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

- Continuous electromagnetic disturbances,
- Transient electromagnetic disturbances,
- Both conducted and radiated disturbances.

3.3.5. Gas

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

3.3.5.1. UL 921 (USA / Canada)

UL 921 Standard for commercial dishwashers

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

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

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).

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.

3.4.1. 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) (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

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.

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 14 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

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.’

1600 inclusion does not weaken the environmental and health protection afforded by Regulation (EC)
1601 No 1907/2006 and if one of the following conditions is fulfilled:

1602 a) 'their elimination or substitution via design changes or materials and components which
1603 do not require any of the materials or substances listed in Annex II is scientifically or
1604 technically impracticable',

1605 b) 'the reliability of substitutes is not ensured',

1606 c) 'the total negative environmental, health and consumer safety impacts caused by
1607 substitution are likely to outweigh the total environmental, health and consumer safety
1608 benefits thereof'.

1609 Currently, there are close to 100 exemptions listed in Annex III and IV of the RoHS Directive³⁶. In
1610 Task 4 (Technical analysis of existing products) of this preparatory study, we will evaluate
1611 whether there are existing exemptions which are of importance for the scope of this study. The
1612 Directive was recently subject to a review process; however, the process has not concluded
1613 (status October 2024) and it cannot be estimated whether changes shall be introduced to RoHS
1614 or not.

1615 3.4.1.5. Waste Electrical and Electronic Equipment Directive (WEEE) 1616 2012/19/EU

1617 The Waste Electrical and Electronic Equipment Directive (WEEE Directive) was introduced as
1618 European Community Directive 2002/96/EC. Following a review, it was recast as Directive
1619 2012/19/EU (WEEE, 2012). The aim of the directive is 'protect the environment and human
1620 health by preventing or reducing the adverse impacts of the generation and management of
1621 waste from electrical and electronic equipment (WEEE)'. It contains provisions on the design,
1622 collection, treatment, recycling, and disposal of WEEE as well as on financial aspects. The
1623 responsibility for the management of waste electrical and electronic equipment is assigned to
1624 the manufacturers and partly also to the distributors.

1625 Since 15 August 2018, the Directive has applied to all electrical and electronic equipment with
1626 the exception of the appliances listed in Article 2(3) and 2(4). All electrical and electronic
1627 appliances concerned are assigned to different categories in Annex III, including the category
1628 'Large equipment (any external dimension more than 50 cm)'. According to Annex IV, this
1629 category includes 'Dish washing machines'. These are therefore within the scope of the
1630 directive.

1631 Very large and complex commercial dishwashing machines could possibly be exempted from the
1632 Directive if they can be considered as 'large-scale fixed installations'. There is no clear definition
1633 in the directive as to the size above which this is the case. There are also no clear criteria in the
1634 FAQ document for the WEEE Directive (European Commission, 2014), but reference is made to
1635 the FAQ document for the RoHS Directive (European Commission, 2012). There it is emphasised

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.

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

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

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

The purpose of the Water Framework Directive (WFD) (European Parliament und Council, 2020) is to provide a framework for the protection of inland surface waters, transitional waters, coastal

waters and groundwater. More concretely, this framework is intended to prevent further deterioration and protect the status of aquatic ecosystems as well as other related ecosystems; to promote the sustainable use of water resources; to reduce discharges, emissions and losses of priority substances and to contribute to the mitigation of floods and droughts. The water management is based on so-called 'river basins', which are defined as 'area[s] of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, lakes into the sea at a single river mouth, estuary or delta'.

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

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

It is assumed that the priority substances could be contained in the discharges of dishwashing appliances if used in the detergents applied during washing processes. In this case, the Water 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

1759 former directive many requirements remained vague in nature. These requirements affect
1760 manufacturers of packaging directly as specified in Article 15 of the regulation.

1761 3.4.1.10. Regulation (EU) 528/2012 – Biocidal Products

1762 The Biocide Directive 98/8/EC was reviewed and recast as Regulation (EU) 528/2012 (European
1763 Parliament und Council, 2012) concerning the making available on the market and use of biocidal
1764 products. This Directive concerns:

- 1765 a) the establishment at Community level of a positive list of active substances which may be
1766 used in biocidal products;
- 1767 b) the authorisation of biocidal products;
- 1768 c) the mutual recognition of authorisations within the Community;
- 1769 d) the placing on the market for use of biocidal products within one or more Member States;
1770 and
- 1771 e) the placing on the market of treated articles.

1772 A biocidal product is defined as ‘any substance or mixture, in the form in which it is supplied to
1773 the user, consisting of, containing or generating one or more active substances, with the
1774 intention of destroying, deterring, rendering harmless, preventing the action of, or otherwise
1775 exerting a controlling effect on, any harmful organism by any means other than mere physical
1776 or mechanical action’ or ‘any substance or mixture, generated from substances or mixtures
1777 which do not themselves fall under the first indent, to be used with the intention of destroying,
1778 deterring, rendering harmless, preventing the action of, or otherwise exerting a controlling
1779 effect on, any harmful organism by any means other than mere physical or mechanical action.’
1780 Treated articles that have a primary biocidal function shall be considered biocidal products as
1781 well.

1782 If such substances are used in detergents or cleaning agents in commercial dishwashers, the
1783 regulation is considered relevant for this product group. In addition, biocidal products could also
1784 be used in wooden packaging for commercial dishwashing appliances.

1785 Furthermore, the regulation also sets limits on the content of phosphates and other phosphorus
1786 compounds (as specified in Annex VIa) and contains obligations concerning information and
1787 labelling as well as specifications concerning testing methods.

1788 3.4.1.11. Regulation (EC) 517/2014 – Fluorinated GHG

1789 The former Regulation (EC) 842/2006 was repealed by Regulation (EU) 517/2014 (European
1790 Parliament and Council, 2014), which has been repealed by the Regulation (EU) 2024/573 of 7
1791 February 2024 on fluorinated greenhouse gases. The objective of this regulation is to protect
1792 the environment by reducing emissions of fluorinated greenhouse gases. To achieve this
1793 objective, it

- 1794 a) ‘Establishes rules on containment, use, recovery, and destruction of fluorinated
1795 greenhouse gases, and on related ancillary measures,

1796 b) imposes conditions on the placing on the market of specific products and equipment that
1797 contain, or whose functioning relies upon, fluorinated greenhouse gases,

1798 c) imposes conditions on specific uses of fluorinated greenhouse gases; and

1799 d) establishes quantitative limits for the placing on the market of hydrofluorocarbons.’

1800 This includes provisions concerning the labelling and disposal of products and equipment
1801 containing those gases; the reporting of information on those gases; the control of uses and the
1802 placing on the market prohibitions of the products and equipment; and the training and
1803 certification of personnel and companies involved in activities provided for by this regulation.
1804 Annex I to this regulation contains a list of the fluorinated greenhouse gases currently covered
1805 by this regulation, together with their global warming potentials.

1806 Requirements that are particularly relevant with regard to the design of devices are provisions
1807 on labelling. Article 12 specifies that ‘products and equipment that contain, or whose
1808 functioning relies upon, fluorinated greenhouse gases shall not be placed on the market unless
1809 they are labelled.’ This only applies to certain products, including heat pumps. The required
1810 labelling must contain specific information detailed in Article 12. For commercial dishwashers,
1811 this regulation applies in those cases when the appliances are equipped with heat pumps
1812 containing refrigerants.

1813 Concerning reclaimed or recycled fluorinated greenhouse gases, they ‘shall be labelled with an
1814 indication that the substance has been reclaimed or recycled, information on the batch number
1815 and the name and address of the reclamation or recycling facility’. Producers of fluorinated
1816 compounds are obliged to take all necessary precautions to limit emissions of fluorinated
1817 greenhouse gases to the greatest extent possible. This concerns production, transport, and
1818 storage.

1819 Article 11 prohibits the placing on the market of the products and equipment listed in Annex III.
1820 These include, inter alia: ‘Non-refillable containers for fluorinated greenhouse gases used to
1821 service, maintain or fill refrigeration, air-conditioning or heat-pump equipment, fire protection
1822 systems or switchgear, or for use as solvents’ (date of prohibition: 4 July 2007).³⁷ The same
1823 article specifies that ‘non-hermetically sealed equipment charged with fluorinated greenhouse
1824 gases shall only be sold to the end user where evidence is provided that the installation is to be
1825 carried out by an undertaking certified in accordance with Article 10’. Conversely, fluorinated
1826 greenhouse gases in heat pumps must be contained in hermetically sealed components if they
1827 are contained in appliances that are not installed by specialised personnel (this applies to
1828 household appliances, for example).

1829 Article 12 lays down provisions on labelling as well as on product and equipment information. It
1830 specifies that ‘products and equipment that contain, or whose functioning relies upon,
1831 fluorinated greenhouse gases shall not be placed on the market unless they are labelled.’ This

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

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 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,

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'.

1867 c) are dependent on energy input from the mains power source in order to work as intended;
1868 and

1869 d) are designed for use with a nominal voltage rating of 250 V or below, also when they are
1870 marketed for non-household or non-office use.

1871 In the original version of the Regulation, dishwashing machines were listed in Annex I and
1872 therefore fell within the scope of the Regulation. However, following the amendment by
1873 Commission Regulation (EU) 2019/2023 of 1 October 2019, dishwashing machines are no longer
1874 listed in Annex I. Therefore, commercial dishwashers would not fall into the scope of this
1875 regulation even if they fulfil criteria a) to d) (e.g. in some cases at camping grounds). Dishwashers
1876 designed for other groups than end-users are not in the scope of the regulation anyway.

1877 Regulation (EC) No 1275/2008 was repealed by Regulation (EU) 2023/826 of 17 April 2023 with
1878 effect from 9 May 2025. This new regulation, according to its Annex II, does not cover household
1879 dishwashers covered by Commission Regulation (EU) 2019/2022. Dishwashers designed for use
1880 other than in the households are not covered by the regulation anyway. Therefore, this new
1881 Regulation is also not considered relevant for the product group commercial dishwashers of this
1882 review study.

1883 3.4.1.13. Regulation (EC) 1907/2006 – REACH

1884 The REACH Regulation (EC) 1907/2006 (European Parliament and Council, 2006b) concerns the
1885 Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH). Its purpose is to
1886 ensure a high level of protection of human health and the environment, as well as the free
1887 circulation of substances on the internal market while enhancing competitiveness and
1888 innovation. It lays down provisions on certain substances as well as mixtures. The provisions
1889 shall apply ‘to the manufacture, placing on the market or use of such substances on their own,
1890 in mixtures or in articles and to the placing on the market of mixtures’. Hazardous substances
1891 that are relevant for commercial dishwashers will be analysed in MEERP Task 4 and Task 5.

1892 3.4.1.14. Regulation (EU) 2016/426 – Gas Appliances

1893 The former Gas Appliance Directive 2009/142/EC (GAD) was repealed by Regulation (EU)
1894 2016/426 on appliances burning gaseous fuels (European Parliament und Council, 2016). It
1895 regulates appliances burning gaseous fuels used for cooking, refrigeration, air-conditioning,
1896 space heating, hot water production, lighting or washing, and also forced draught burners and
1897 heating bodies to be equipped with such burners. The regulation applies to appliances as well
1898 as fittings and according to the Commission's guidance document, this includes dishwashing
1899 machines (European Commission, 2024a).

1900 The regulation obliges manufacturers to ensure that appliances or fittings that they place on the
1901 market or appliances that they use for their own purposes are designed and manufactured in
1902 accordance with the essential requirements set out in Annex I. This includes, among other
1903 things, safety requirements including a risk analysis and corresponding risk minimisation
1904 measures as well as information obligations. In addition, there are requirements regarding
1905 technical documentation and processes for the declaration of conformity, as well as for the

1906 provision of information (e.g. the affixing of a type, batch or serial number or other identification
1907 mark, manufacturer's details, instructions for use and safety information).

1908 3.4.1.15. Regulation (EU) 2024/1252 – Critical raw materials

1909 The Critical Raw Materials Act (CRM Act) is a regulation aimed 'to improve the functioning of the
1910 internal market by establishing a framework to ensure the Union's access to a secure, resilient
1911 and sustainable supply of critical raw materials, including by fostering efficiency and circularity
1912 throughout the value chain' (European Parliament und Council, 2024).

1913 To achieve this goal, the regulation sets out measures to:

- 1914 a) 'lower the risk of supply disruptions related to critical raw materials likely to distort
1915 competition and fragment the internal market,
- 1916 b) improve the Union's ability to monitor and mitigate the supply risk related to critical raw
1917 materials, and
- 1918 c) ensure the free movement of critical raw materials and products containing critical raw
1919 materials placed on the Union market while ensuring a high level of environmental
1920 protection and sustainability, including by improving their circularity.'

1921 Commercial dishwashers are affected by the regulation as they may contain critical raw
1922 materials and in particular permanent magnets which are specifically addressed by the
1923 regulation. According to Article 28, a conspicuous, clearly legible and indelible label shall indicate
1924 whether the products contain one or more permanent magnets and whether the magnets
1925 contained belong to one of the following types: (i) neodymium-iron-boron; (ii) samarium-cobalt;
1926 (iii) aluminium-nickel-cobalt; (iv) ferrite. In case one or more such are included, additional
1927 information must be provided on a data carrier present on or in the product, providing data on
1928 the responsible legal party, data on the magnet weight, type and location and instructions for
1929 its dismantling.³⁹

1930 The requirements set out in Article 28 shall apply from two years after the entry into force of
1931 the implementing act referred to in paragraph 2. If a product passport is required for a product
1932 in accordance with another Union legal act, the relevant information should be recorded
1933 therein. The information needs to be complete, up-to-date, and accurate and remain available
1934 for a period at least equal to the product's typical lifetime plus 10 years.

1935 Article 29 contains provisions on the recycled content of permanent magnets. The requirements
1936 shall apply from 24 May 2027 or two years after the still pending entry into force of the
1937 delegated act referred to in paragraph 2, whichever is the later. Article 29 obliges operators who
1938 place on the market products containing one or more permanent magnets in accordance with
1939 Article 28 (1) to publish on a on a free-access website the content of neodymium, dysprosium,
1940 praseodymium, terbium, boron, samarium, nickel and cobalt recovered from post-consumer
1941 waste that is present in the incorporated permanent magnets. The information obligation
1942 applies from a total weight of all permanent magnets contained of 0.2 kg. By 24 May 2026, the

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.

1943 Commission shall adopt rules for the calculation and verification of the share of corresponding
1944 raw materials. Furthermore, the Commission shall adopt rules as to minimum shares of the raw
1945 materials neodymium, dysprosium, praseodymium, terbium, boron, samarium, nickel, and
1946 cobalt recovered from post-consumer waste that must be present in the permanent magnet
1947 incorporated in relevant products referred.

1948 According to Article 33, the requirements of Articles 28 and 29 must be taken into account in
1949 the conformity assessment procedure and the associated required technical documentation.

1950 According to Article 24, by 24 May 2025, Member States are to identify large companies
1951 operating on their territory that use strategic raw materials to manufacture various products,
1952 including heat pumps. The companies identified in this way are obliged to carry out a specific
1953 risk assessment of their raw material supply chain for strategic raw materials at least every three
1954 years. Depending on the result, companies may be obliged to take mitigation measures. They
1955 can also be obliged by the Member States to submit a report to their board of directors. As heat
1956 pumps are contained in certain commercial dishwashing appliances, this requirement could
1957 apply in some cases.

1958 3.4.2. European ecolabelling

1959 There is no **EU Ecolabel** for household or commercial dishwashers themselves, but for industrial
1960 and institutional dishwasher detergents (European Commission, n.d.). The label's criteria for this
1961 product group relate to dosage requirements, toxicity to aquatic life, biodegradability and the
1962 sustainable sourcing of palm oil components. Furthermore, they include restricted or banned
1963 substances, packaging requirements and requirements for the fitness for use, automatic dosing
1964 systems, user information and information appearing on the EU label (EU Ecolabel, 2024).

1965 Best Environmental Management Practices for Tourism addressing dishwashing, part of the
1966 European EMAS Program

1967 Since 2016, under the European Commission EMAS programme, 'Optimised dishwashing,
1968 cleaning and food preparation' is addressed by Best Environmental Management Practices for
1969 Tourism (BEMP) (European Union, 2016). This requires EMAS-registered organisations in the
1970 tourism sector to take the relevant sectoral reference documents into account.

1971 BEMPs addressing 'Optimised dishwashing, cleaning and food preparation' are 'to select
1972 efficient washing equipment, including trigger-operated low-flow pre-rinse spray valves,
1973 efficient dishwashers and connectionless steamers, and to monitor and benchmark water
1974 consumption in kitchen/restaurant' (European Union, 2016).

1975 Furthermore, the BEMP details several performance indicators and their considered
1976 benchmark of excellence, which are shown in **Table 3-7**.

1977

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. At least 70 % of the purchase volume of chemical cleaning products (excluding oven cleaners) for dishwashing and cleaning are ecolabelled (e.g. EU Ecolabel)
Percentage of ecolabelled dishwashing and kitchen cleaning chemicals (%)	
Green procurement of efficient kitchen equipment (y/n)	

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/

2006 3.4.3.2. French Code de la Consommation (Consumption Law), Art. L. 213-4-1 2007 on planned obsolescence

2008 In France, planned obsolescence is prohibited under Article L441-2 of the ‘Code de la
2009 Consommation’⁴¹. Planned obsolescence is defined there as the use of techniques – including
2010 software – by which the person responsible for placing a product on the market deliberately
2011 seeks to shorten its lifespan. Articles L441-3 and L441-4⁴² lay down prohibitions on the use of
2012 techniques that prevent the repair of devices or that restrict the access of specialised personnel
2013 (for repair, reuse or repurpose) to spare parts, instructions, technical information, or other tools
2014 necessary for the repair of products. The Article does not specify if it is also applicable to
2015 appliances not intended for the use in households.

2016 2Article 16⁴³ of the ‘LOI n° 2020-105 du 10 février 2020 relative à la lutte contre le gaspillage et
2017 à l'économie circulaire’ imposes an obligation on manufacturers, importers, distributors, or
2018 other marketers of electrical equipment to provide a reparability index, including the
2019 parameters that made it possible to create this index. Sellers are obliged to use this index to
2020 inform customers about the reparability of products. This regulation already applies to
2021 dishwashers (Ministère de l'économie des finances et de la souveraineté industrielle et
2022 numérique, 2024). From 1 January 2024, a more general durability index should be used for
2023 certain products. It will replace the reparability index for these products and also evaluate other
2024 indicators such as the reliability and robustness of the products⁴⁴. So far, however, the durability
2025 index has only been applied to washing machines and televisions and not yet to dishwashers
2026 (Ministère de la Transition écologique et de la Cohésion des territoires, 2024). As the aim of the
2027 indexes is to inform consumers, the regulation is considered relevant only for appliances
2028 intended for household use.

2029 3.4.4. Labelling at Member State level

2030 3.4.4.1. Blue Angel (Germany)

2031 The Blue Angel also has no award criteria dishwashers per se, but for the product group
2032 ‘automatic dishwashing detergents’ (RAL gGmbH, 2022). However, the scheme is only applicable
2033 to detergents for household dishwashers and detergents for commercial use, provided that they
2034 are comparable to household dishwashers in terms of machine size and use. The label is
2035 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

3.4.4.2. Nordic Swan (Scandinavia)

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

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

3.4.4.3. Sustainable Energy Authority (Ireland)

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

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

- All equipment and/or components must be CE marked as required by the specific EU directive(s) and comply with requirements of RoHS and WEEE Directives.
- Appliances must have a certain maximum water consumption and a maximum idle energy rate as specified in **Table 3-8**.
- Appliances must incorporate a heat-recovery system to preheat rinse water to a minimum temperature of 40° C (concern only Single and Multiple Tank Rack Conveyor Dishwashers).

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

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

⁴⁷ See: (seai, n.d.).

2072 **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

2073 Source: seai (n.d.).

2074 3.4.4.4. European consumer association tests and consumer information 2075 portals

2076 There are organisations in various countries that publish test reports for household appliances
2077 (e.g., Stiftung Warentest in Germany, Que choisir in France, Altroconsumo in Italy or OCU in
2078 Spain). It is assumed that these are only aimed at private users and are therefore not relevant
2079 in the context of this study.

2080 3.4.5. Third country legislation and labelling

2081 Again, this section deals with the subjects as above, but for legislation and measures in Third
2082 Countries (extra-EU) that have been indicated by stakeholders (NGOs, industry, consumers) as
2083 being relevant for the product group.

2084 3.4.5.1. Minimum Energy Performance Standards (Australia)

2085 Concerning energy efficiency, a wide range of products are already regulated in Australia. New
2086 products are regularly being considered for regulation or other programmes as well. However,
2087 until now there were no Minimum Energy Performance Standards for commercial dishwashers.
2088 Labelling requirements exist, but only apply to household appliances (Australian Government,
2089 2024). New Greenhouse and Energy Minimum Standards for dishwashers were registered in
2090 October 2024 (Australian Government, 2024), but it is not clear if they apply to commercial
2091 appliances.

2092 3.4.5.2. Declaration of the energy and water consumption as well as the 2093 cleaning performance in accordance with the Federal Energy Efficiency 2094 Ordinance (Switzerland)

2095 In Switzerland, declaration requirements were introduced for commercial dishwashers, which
2096 came into force in 2024 (Swiss Federal Office of Energy, 2023). From then on, energy and water
2097 consumption as well as the cleaning performance must be declared in the technical
2098 documentation as well as on a freely accessible website in accordance with the European
2099 standard EN IEC 63136:2019. Switzerland is thus taking on a pioneering role, as there are no

⁴⁸ Taken exactly as written in the original source.

2100 such requirements in the EU to date. However, an energy label for commercial dishwashers does
2101 not exist (Swiss Federal Office of Energy, 2023).

2102 The declaration requirements are intended to enable the sector to better estimate operating
2103 costs and choose particularly efficient appliances. As these normally have a higher purchase
2104 price, this is particularly important in order to make overall costs more transparent. The
2105 requirements apply to new electrical appliances for commercial use. Existing appliances are
2106 exempt from the requirements. Appliances purchased abroad and directly imported must fulfil
2107 the requirements (energieschweiz, 2023).

2108 The following types of appliances are affected by the obligation (energieschweiz, 2023):

- 2109 - Single-tank undercounter dishwashers
- 2110 - Single-tank pass-through dishwashers closed by a hood

2111 Not affected types of appliances are (energieschweiz, 2023):

- 2112 - Water-changing undercounter dishwashers
- 2113 - Rack conveyor and flight type dishwashers
- 2114 - Utensil dishwashers

2115 The following product information needs to be declared (energieschweiz, 2023):

- 2116 - The indication whether the appliance has an integrated heat recovery or not
- 2117 - An explanation of how the integrated heat recovery works, if there is one
- 2118 - The test results in accordance with the European standard EN IEC 63136:2019
- 2119 concerning electric dishwashers for commercial use. These include
- 2120 - Energy consumption for initial filling x.xxx kWh (kilowatt hours)
- 2121 - Water consumption for initial filling x.x L (litres)
- 2122 - Initial filling time x s (seconds)
- 2123 - Number of plates per rack and cycle x (number)
- 2124 - Cleaning performance with the standard cleaning cycle x % (per cent)
- 2125 - Resoiling performance in particles per plate x particles/plate (particles per
- 2126 plate)
- 2127 - Energy consumption per cycle x.xxx kWh (kilowatt hours)
- 2128 - Water consumption per cycle x.x L (litres)
- 2129 - Average programme and cycle duration x s (seconds)
- 2130 - Electricity consumption of standby mode x kW (kilowatts)

2131 3.4.5.3. Energy Technology List (UK)

2132 The UK Energy Technology List (ETL) is a government-backed scheme designed to encourage the
2133 use of highly energy-efficient commercial dishwashers, including undercounter and hood-type
2134 models. Administered by the Department for Energy Security and Net Zero, the ETL provides a
2135 list of independently verified products that meet strict energy and water efficiency criteria,
2136 positioning them within the top 25% of the market in their respective categories. To be included,

dishwashers must demonstrate low energy and water consumption per cycle (e.g. ≤0.4 kWh and ≤3.4 litres for undercounter models; ≤0.6 kWh and ≤3 litres for hood-type models), limited standby power use and high cleaning performance (≥90%). Hygiene and sanitation standards must also be met.⁴⁹

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

3.4.5.4. Appliance and Equipment Standards Program (USA)

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

3.4.5.5. Energy Star Label (USA)

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

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
- Under Counter
- Glasswashing

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>.

- 2170 - Single Tank, Door Type
- 2171 - Pot, Pan, and Utensil (PPU)
- 2172 - Dump and Fill
- 2173 - Conveyor Machine
- 2174 - Single Tank Conveyor
- 2175 - Multiple Tank Conveyor
- 2176 - Flight Type Conveyor
- 2177 - Heat Recovery Machine

2178 These machine types are eligible for ENERGY STAR with the following exceptions: Only
 2179 undercounter machines designed for wash cycles of 10 minutes or less are eligible. The Version
 2180 3.0 specification only covers electric models. High temperature PPU machines and non-PPU,
 2181 dual sanitizing are eligible as well. Dishwashers intended for use in residential or laboratory
 2182 application are not eligible under this product specification as well as 'PPU and Flight Type
 2183 products which are only rated for low temperature operation, steam, gas, and other non-electric
 2184 models'.

2185 The energy and water performance requirements are listed in **Table 3-9**.

2186 **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 x 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	$GPH \leq 2.975x + 55.00$
Multiple Tank Flight Type	Reported	Reported	$GPH \leq 4.96x + 17.00$

*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) x 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; SFrack is Square Feet of rack area, same as in PPU water consumption metric.

Source: US EPA/DOE (2021).

2199 4. MEErP Task 2 – Markets

2200 4.1. Objectives of MEErP Task 2

2201 The aim of MEErP Task 2 is to provide market and cost inputs for the calculation of the EU-wide
 2202 environmental impact of the commercial dishwashers product group, to provide insight in the
 2203 latest market trends, to establish a practical data set of prices and rates to be used in a Life Cycle
 2204 Cost (LCC) calculation and to make recommendations on a potentially refined product scope in
 2205 MEErP Task 1, as well as composing indications for the development on Base Cases in MEErP
 2206 Task 5, e.g. by assessing the most relevant product categories from the economic / commercial
 2207 perspective.

2208 MEErP Task 2 shall include a description of the market trends including amongst others channels
 2209 to market, general trends in product design and product features, major players and the market
 2210 share, business models, geographical distribution of production, distribution channels (retail
 2211 versus wholesale), the number of employees, role of installation services, role of repair and
 2212 maintenance (service models), share of SMEs in production and indication of the segments of
 2213 the markets that SMEs are operating in, supplemented by information on market and logistical
 2214 support of recyclability and availability of amounts of recycled materials related to the market
 2215 size.

2216 To facilitate the potential Impact Assessment support study, data also needs to be collected on
 2217 public markets (relevant for GPP), international markets, competition issues and
 2218 competitiveness of relevant EU sectors.

2219 4.2. Generic economic data

2220 The PRODCOM database is useful for an initial analysis as it is transparent and publicly available
 2221 data provided by Member States of the EU on manufacturing and production information within
 2222 the EU.

2223 4.2.1. EU Production

2224 4.2.1.1. Unit volume

2225 In 2023, 380,000 commercial dishwashers were produced according to Prodcom data. **Table 4-1**
 2226 presents the number of units produced from 2014 to 2023, highlighting the locations of major
 2227 manufacturing centres. However, it is important to note that data for several Member States is
 2228 missing; therefore, the total should be interpreted with caution. The data is also visualised in
 2229 **Figure 4-1**, which clearly illustrates that the primary producers within the EU-27 are Italy and
 2230 Germany. This figure has been relatively stable over the past 10 years, with some larger
 2231 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.

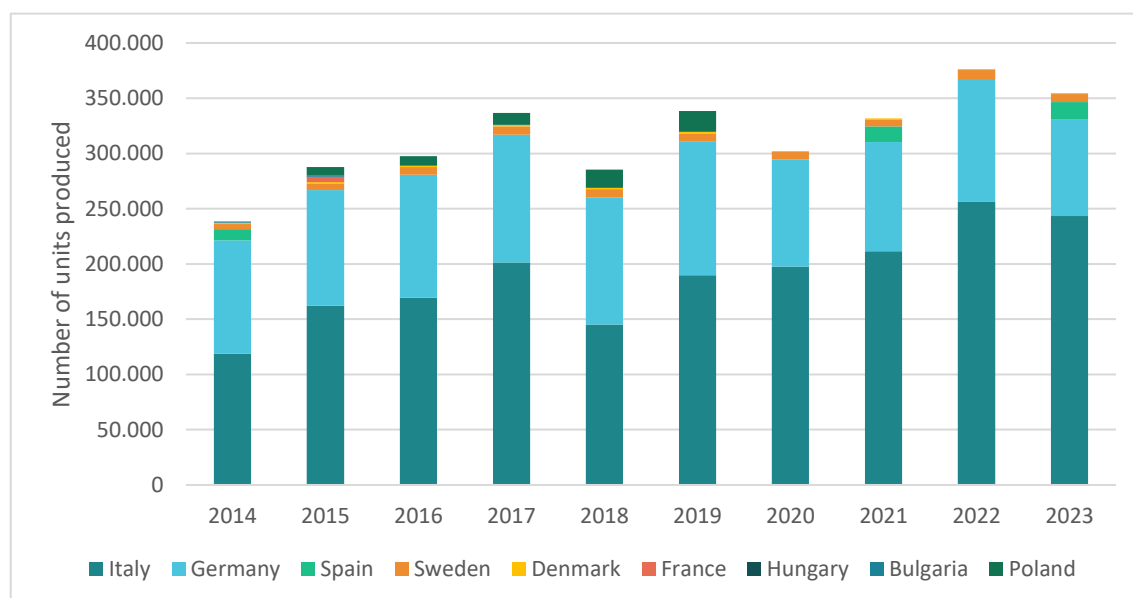


Figure 4-1: Number of units produced from 2014-2023 per country.

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.

2251 **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%

2252 ‘:’ 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
2253 period. Countries for which all recorded years report either 0 or ‘:’ values have been excluded.

2254 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.

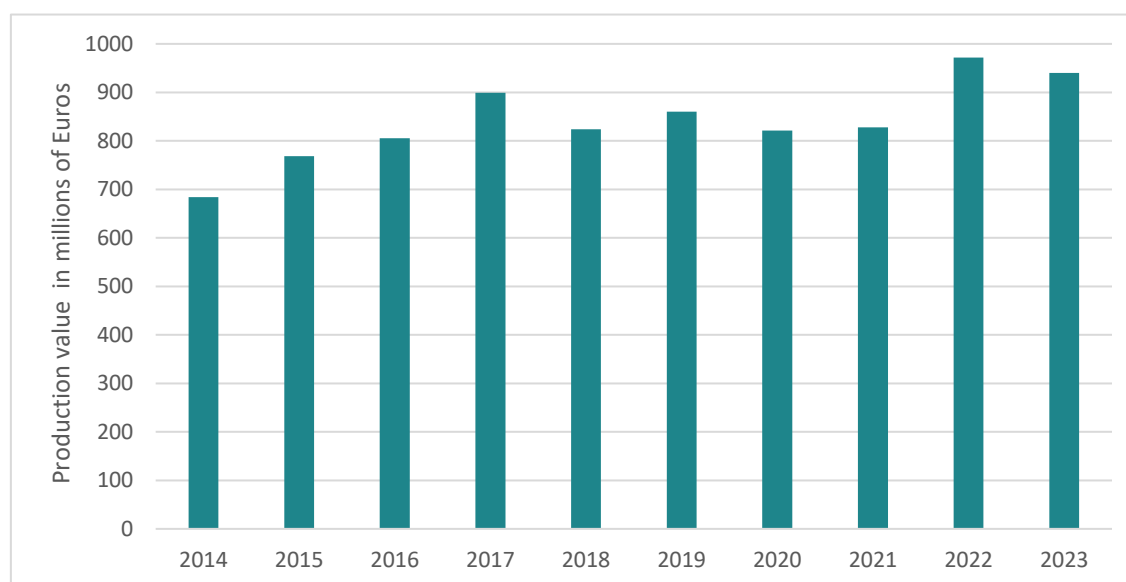


Figure 4-2: Value of EU-produced commercial dishwashers in EU-27, 2014-2023.

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 %

2271 ‘:’ signifies that the information is unavailable either because it is confidential or estimated or both. All other EU 27
2272 Member States have reported a zero production quantity over the whole period. Countries for which all recorded
2273 years report either 0 or ‘:’ values have been excluded.

2274 Source: Prodcom custom database extracted 16 October 2024

2275 4.2.1.3. Share of market represented by public sector customers

2276 No publicly available data provides information on the share of sales made to public-sector
2277 customers.

2278 The feedback obtained from stakeholders on the topic during the consultation held between
2279 September and October 2024 led to very scarce feedback:

2280 One large manufacturer stated that it sold ca. 5 % of its turnover to public sector customers.
2281 Two manufacturers in the same group provided very contrasting figures, which may indicate a
2282 sharing of the market among subsidiaries of that group:

- 2283 - One manufacturer in the group sold ca. 25 % of its turnover to public sector
2284 customers.
- 2285 - The other answering manufacturer of the same group did not sell to institutional
2286 customers.

2287 One difficulty stated by one manufacturer is that the resellers of products do not provide
2288 feedback to the manufacturers on their sales.

2289 External data is also scarce, but an estimate was made based on data regarding the global
2290 commercial dishwasher market per end-user as shown in **Table 4-3**. Among the categories,
2291 educational institutions and hospitals/healthcare facilities could partly represent the public
2292 sector. Data on the share of private versus public sector in both of these end-users is not
2293 available for 2023, so proxies were used. For hospitals and healthcare facilities an estimate was
2294 used based on a 2008/2009 OECD study, which includes the share of publicly owned hospitals
2295 per country⁵⁰. In the absence of a total EU-27 figure, the average of the available EU-27 countries
2296 was used, which was 72 %⁵¹. For educational institutions, the share of primary to tertiary

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

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

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.

2314 **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

2315 Source: Prodcem.

2316 **4.2.2. Extra-EU Trade**

2317 **Table 4-5** presents the import and export values of trade with countries outside the EU-27.
 2318 **Figure 4-3** clearly illustrates the trade balance, highlighting that the EU-27 exports significantly
 2319 more than it imports. Several countries were identified by more than one stakeholder as key
 2320 destinations for EU-27 dishwasher exports outside the EU-27. These include Australia, Israel,
 2321 Norway, Switzerland, the UK, and the USA.

2322 **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

2323 Source: Comext.

2324 **Figure 4-3** show a clear dip during the COVID-19 pandemic. A recovery surge could explain why
 2325 the values for 2022 are exceptionally high, even exceeding those of 2023. However, it remains
 2326 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.

2338 **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
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

2339 Source: Prodcorn

4.3. Market and stock data

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

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

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 Prodcom (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.

2367 **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 %

2368 Source: APPLIA Italia (2023).

2369 In **Table 4-9**, an overview is given of the estimated number of units sold per year. The stock is
 2370 based on the share of sales and the lifespan of each category.

2371 **Table 4-9: Stock in 2023 based on share of sales and lifespan (in grey) of each category.**

Year	EU-27 Total (units)	1	2	3	4	5	6
		(units)	(units)	(units)	(units)	(units)	(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

Year	EU-27 Total (units)	1	2	3	4	5	6
		(units)	(units)	(units)	(units)	(units)	(units)
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

2372 Source: Prodcam.

2373 4.3.3. Annual sales growth rate

2374 Based on the numbers on apparent consumption, the growth rate from 2022 to 2023 is -0.9 %,
2375 while the average annual growth rate from 2014 to 2023 is 3.9 % in terms of sales value.

2376 4.3.4. New & Replacement sales (derived)

2377 To determine the replacement and new sales, the number of units in year 1 (calculated as 2023
2378 – lifespan) is compared with the number of units at the end of their lifespan (2023). The lifespan
2379 varies by category, as shown in **Table 4-9**. For each category, we compare the sales in 2023 with
2380 the sales in year 1 (highlighted in grey) and sum the results across all categories. Consequently,
2381 the **total number of replacement sales in 2023 is 194,471 units**, while the **total number of new**
2382 **sales is 80,545 units**.

2383 4.4. Market trends

2384 4.4.1. General market trends

2385 Manufacturer brochures and websites were analysed to identify important product-specific
2386 developments and trends in commercial dishwashers, in order to update the information
2387 already gathered in the 2011 study.

2388 It should be noted that not all innovative features presented hereafter are easy to implement in
2389 all market segments. Indeed, some of these features induce higher upfront costs, that may be
2390 beyond the purchasing capacity of some customers, in particular those subject to intense price
2391 pressure, such as the catering and hospitality industry.

2392 4.4.1.1. Processing capacity

2393 The **Table 4-10** below provides the typical processing capacities of commercial dishwashers, per
2394 cycle and per year. Further details can be found in **Section 5.2.2.1**.

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

Product category	Number of dishes ⁵² 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)

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

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

⁵² For categories 2 and 3, dishes are specified in standard EN 63136 as “standard plates”, i.e. dinner plates with a diameter of 240 mm. Also, the categories 5 and 6 are using plates according to EN IEC 63136 as a reference. For dishwasher category 1, other dishes like cups etc. will be cleaned. Therefore, a direct comparison of capacities among different product categories is not possible.

2407 **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 ⁵³	Up to 15

2408 Source: Website of Winterhalter GmbH, accessed on 13 November 2024.

2409 4.4.1.3. Detergents

2410 Some suppliers of commercial dishwashers (mainly those targeting that market segment only)
 2411 provide their own detergent products, whereas others rely on third-party suppliers. The
 2412 detergent products supplied by manufacturers of dishwashers perform the following functions:

- 2413 - Washing,
- 2414 - Rinsing and drying aids.

2415 The rinsing and drying aids have become mainstream. They provide proper drying and good
 2416 visual appearance of the substrates.

2417 The market of detergent products evolves towards:

- 2418 - Adaptation to the water 'hardness' (= concentration in calcium carbonate),
- 2419 - Higher concentration,
- 2420 - Recyclable plastic containers,
- 2421 - Biodegradability,
- 2422 - Avoidance of chlorine, of phosphates and of EDTA (Ethylenediaminetetraacetic
 2423 acid, a chelator of calcium that is criticised for being poorly biodegradable, bio-
 2424 accumulative⁵⁴ and toxic in case of ingestion).

2425 4.4.1.4. Wastewater treatment

2426 The treatment of the wastewater after its use in the machine is in general an integral part of the
 2427 dishwasher, as it is the feature that enables the re-use of the water over several cycles (and
 2428 hence a strong overall reduction in water use). The manufacturers hence increasingly offer in
 2429 addition the filters and other equipment needed to perform this function.

⁵³ According to one stakeholder input, the savings which can be achieved with an ECO programme refer to a maximum operating cost reduction of up to 15 %, not to water savings only. Savings are based on the fresh water consumption as well as the reduction of the detergent consumption.

⁵⁴ 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>

4.4.1.5. Evolution of energy performance over time

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

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

Table 4-13: Ratio between energy consumption of new products and that of the average 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

(*) Low reliability: figures provided by technical university. According to a manufacturer's feedback, it has to be considered that there are plenty of appliances in the market which do provide several design options as their minimum state of technique since more than 10 years and thus cannot achieve these savings of about 30 %. It is assumed that only low performing machines might have these savings of approximately 30 %. Another stakeholder assumes that the savings would be about 10 % which leads to a ratio of 0.9.

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

4.4.1.6. Marketing of commercial dishwashers and technological features

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

- Functionality (speed, hygiene, cleanliness, and aspect of the washed crockery and utensils),
- Economic and environmental aspects of the use phase (i.e. costs of energy and water consumption),
- Uptime of the appliance (e.g. reliability, robustness, long lifetime, ease, and speed of maintenance operations)

- 2458 - Comfort / ergonomics for the personnel using the machine (e.g. motorised hood for
2459 Category 3 “Hood-type dishwashers”).

2460 4.4.2. Market channels and production structure

2461 The commercial dishwasher market is above all a business-to-business (B2B) market and has
2462 some key characteristics.

2463 4.4.2.1. Sales and distribution

2464 The majority of smaller manufacturers typically sell and distribute their products to catering
2465 equipment dealers/distributors who stock and sell several brands of commercial dishwashers,
2466 and usually other types of catering equipment supplies (ovens, refrigerators, plates, utensils,
2467 etc). This is particularly applicable for smaller machines such as the undercounter and hood-type
2468 machines. The catering equipment distribution and supplier network for small commercial
2469 dishwasher machines is very convoluted as several supply routes are available depending on the
2470 type of end user, the end application and the type of machine bought. Because of the
2471 competition and the saturation of the market, the choice of distribution strategies is very
2472 important which is why many different ones have been developed. Machines may be purchased
2473 directly from the manufacturers, via wholesalers, various kinds of retailers or on the second-
2474 hand market. For this reason, manufacturers of small appliances generally do not keep close
2475 track of where their products end up.

2476 Commercial dishwashers sold directly to users from the manufacturer tend to be larger
2477 dishwashers (conveyor-type) and are usually tuned to customer-specific specifications or
2478 requirements upon purchase. They indeed require more intensive support services (training,
2479 servicing).

2480 Catering equipment dealers often service and maintain the dishwasher products and can also
2481 be dedicated (affiliate) suppliers of one or a few particular dishwasher brands. They do not
2482 operate walk in shops but make site visits to the customers. Companies include mostly SMEs
2483 with large businesses as well comprising the operators. Equipment may be sold through several
2484 channels depending on the company: in dedicated retail outlets, online or as part of a full project
2485 management service.

2486 4.4.2.2. Manufacturers

2487 The B2B nature of the commercial dishwasher market makes it much less transparent than the
2488 household dishwasher market. This poses difficulties when attempting to characterise the
2489 market in terms of sales, stock, prices and even brands. As there is not a large number of
2490 commercial dishwasher manufacturers, it is considered relevant to list them for the sake of
2491 characterising the market.

2492 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 Maschinenbau GmbH & Co. KG	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
SMEG S.p.A.		IT
Wexiödisk AB		SE

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

HKI - Industrieverband Haus-, Heiz- und Küchentechnik

EFCEM Italy

Branschforeningen For Storkokksleverantörer (BFS)

FELAC

In general, these companies provide **maintenance** and **repair** services of their own products, in addition to the manufacture of new products. In addition, the company sandoro GmbH, a subsidiary of Winterhalter, has been identified as performing **refurbishment** services, i.e. the

2505 processing of used equipment to make them into fully operational equipment with an extended
2506 lifetime.

2507 4.4.2.3. Industry associations

2508 The European Federation of Catering Equipment Manufacturers (EFCEM)⁵⁵ gathers the manu-
2509 facturers of all catering equipment, which includes equipment for food preparation, cooking,
2510 refrigeration and washing of dishes and utensils. It is represented in the European policy-making
2511 field by the federation of technology industries Orgalim⁵⁶. Its national members are:

- 2512 - SYNETAM - Union des Fabricants D'Equipements et D'Ustensiles pour les Arts
2513 Culinaires des Grandes Cuisines⁵⁷ (France)
- 2514 - HKI - Industrieverband Haus-, Heiz- und Küchentechnik⁵⁸ (Germany)
- 2515 - SEEME - (Association of Catering Equipment Companies)⁵⁹ (Greece)
- 2516 - IFSA - Irish Foodservice Suppliers Alliance⁶⁰ (Ireland)
- 2517 - EFCEM Italy⁶¹ (Italy);
- 2518 - BFSN - Bransjeforening for Storkjøkkenleverandører i Norge⁶² (Norway)
- 2519 - APIRAC⁶³ (Portugal);
- 2520 - Branschforeningen For Storkøksleverantører (BFS)⁶⁴ (Sweden);
- 2521 - FELAC - Federación Española de Asociaciones de Fabricantes de Maquinaria para
2522 Hostelería, Colectividades e Industrias Afines⁶⁵ (Spain)
- 2523 - FEA - Food Service Equipment Association⁶⁶ (United Kingdom).

2524 In addition, two associations and one dedicated branch of a larger association exist in Germany
2525 to represent dishwasher manufacturers:

- 2526 - AKGGS "Arbeitskreis Gewerbliches Geschirrspülen" (Working Group Commercial
2527 Dishwashing)⁶⁷
- 2528 - Verband der Hersteller von gewerblichen Geschirrspülmaschinen e.V.⁶⁸

⁵⁵ <https://www.efcem.info/>

⁵⁶ <https://orgalim.eu/en/>

⁵⁷ <http://www.syneg.org/>

⁵⁸ <http://hki-online.de/de>

⁵⁹ <https://seeme.com.gr/>

⁶⁰ <http://www.ifsa.eu.com/>

⁶¹ <http://www.efcemitalia.it/>

⁶² <http://www.bfsn.no/>

⁶³ <http://www.apirac.pt/>

⁶⁴ <http://bfs.se/>

⁶⁵ <http://www.felac.com/>

⁶⁶ <http://www.fea.org.uk/>

⁶⁷ <https://www.akggs.de/en>

⁶⁸ <https://vgg-online.de/>

- 2529 - ZVEI Fachabteilung Gewerbliche Spültechnik (German Electro and Digital Industry
2530 Association – Technical department Division commercial dishwashing)⁶⁹

2531 4.4.3. Trends in product design / features

- 2532 The consultation of manufacturers in 2024 provided the feedback of **Table 4-15** below on the
2533 presence of resource-saving technical features of commercial dishwashers (saving of energy or
2534 of materials – along the Circular Economy paradigm).

2535 **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

⁶⁹ <https://www.zvei.org/verband/fachverbaende/fachverband-elektro-haushalt-grossgeraete/gremien>

Technical feature	Category of feature	Number of manufacturers citing the feature as present	
		in their products	in all products of the market
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	(*)	(*)

2536 Legend: (*) Absent from the consultation survey, but provided in: Arbeitskreis Gewerbliches Geschirrspülen (2021)
 2537 "Praxishandbuch Gewerbliches Geschirrspülen, <https://www.akggs.de/de/handbuch>

2538 Source: Stakeholder consultation survey n°2, performed between September and October 2024. A total of 7
 2539 manufacturers provided answers to these questions.

2540 As can be seen in this table, the features most implemented relate to energy and water saving,
 2541 which has an immediately positive impact on operating costs by the customer. Similarly, the
 2542 Circular Economy feature most implemented relates to ease of maintenance and repair, which
 2543 has a direct impact on availability of the appliance, and hence on the daily operations of the
 2544 customer. On the other hand, features having mainly an environmental impact but none on the
 2545 customer's experience or profit (e.g. use of recycled materials, recyclability) are less popular.

2546 4.4.4. Innovations

2547 The study enabled the consultant team to identify some innovative concepts in the field of
 2548 commercial dishwashing. Further BAT will be described in Task 4.

2549 4.4.4.1. Granule dishwashing

2550 The Swedish-based company Nor:disk developed **granule-based** dishwashing for the removal of
 2551 dirt from cooking utensils, which often are difficult to clean⁷⁰. The granules are used as a
 2552 complement to water and detergent, and do not replace them. The cylinder-shaped granules
 2553 have been developed to have the adequate shape, density and hardness to remove dirt, while
 2554 still preserving the surface of the utensils. They are used in conjunction with a dedicated family
 2555 of dishwashers and exist in two versions: fossil-based plastics and a 'bio' version based on
 2556 calcium salt, rapeseed oil and biodegradable polyesters that is claimed to be biodegradable in
 2557 soils.

2558 Stakeholders other than the manufacturer of these machines expressed environmental and
 2559 health concerns regarding the usage of these granules in their non-bio, plastic-based version:

⁷⁰ <https://www.nordiskclean.com/products-services/products/>

- 2560 - The plastic debris from the non-bio granules, if they remain on cooking pans after
2561 wash are suspected to cause health hazards.
- 2562 - Similarly, the plastic debris resulting from the abrasion of the plastic granules is
2563 considered to be difficult to catch by filters, and hence susceptible to generate
2564 micro-plastics pollution to the environment.

2565 4.5. Consumer expenditure base data

2566 4.5.1. Average EU end-user prices

2567 The average unit price of dishwashing equipment, based on Eurostat data, is provided in
2568 **Section 0** above. An investigation made in the online catalogues of resellers of products led to
2569 the maximum end-user prices per segment listed in **Table 4-16**.

2570 **Table 4-16: Observed end-user prices of commercial dishwashers.**

Product category	Minimum observed price (EUR exl. VAT)	Maximum observed price (EUR exl. 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)

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

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

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

4.5.2. Consumer prices of consumables

4.5.2.1. Electricity costs

The electricity rate in EU depends on the consumption and therefore will vary depending on the 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 energy⁷¹.

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 Lifecycle Costing exercise will hence need to make assumptions about the future evolution in the price of electric energy.

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

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
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

Member State	Electricity price in EUR / kWh (excluding VAT and other recoverable taxes and levies). Band IA (annual consumption below 20 MWh)	
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

2615 Source: Eurostat (2024), Electricity prices for non-household consumers - bi-annual data (from 2007 onwards).

2616 Online data code: nrg_pc_205. https://doi.org/10.2908/NRG_PC_205.

2617 Custom dataset:

2618 https://ec.europa.eu/eurostat/databrowser/view/nrg_pc_205_custom_13397870/default/table?lang=en

2619 4.5.2.2. Water costs

2620 The New International Benchmarking Network for Water and Sanitation Services (New IBNet)⁷²,
 2621 set up by the World Bank, provides an international benchmark for the price of water, by
 2622 obtaining data from utilities. **Table 4-19** below provides the average (based on population
 2623 served) and extreme prices per m³ of water, based on a consumption of 15 m³ per month, for
 2624 all EU-27 Member States (except Ireland).

2625 **Table 4-19: Average, minimum and maximum prices of water from utilities in EU Member**
 2626 **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

⁷² <https://newibnet.org/about-us-0>

EU Member State	Price per m ³ in EUR for a consumption of 15 m ³ /month		
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
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 **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)

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

From the composition of some ‘packaged deals’ offered online⁷³, it appears that ca. 6 to 7 litres of washing detergent are used for 1 litre of rinsing agent. The amount of detergent (and of rinsing agent) needed per cycle or per dish were not provided in the information collected.

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

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

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

- In appliances of Category 1 – Undercounter water-change dishwashers, the detergent is only used in the cleaning step during the entire cycle. In the other programme steps, only fresh water is used, and the rinse aid is only used in the final rinse. Therefore, the consumption of detergent can be computed easily as it is determined by the amount of detergent (resp. of rinsing agent) needed per litre of freshwater used for washing (resp. for rinsing).

⁷³ E.g. <https://www.chefook.com/fr/produits-de-lavage/>

- In tank-based dishwashers (i.e. in Categories 2 – Undercounter one-tank dishwashers, 3 – Hood-type dishwashers and 4 – Utensil / pot dishwashers) a saturated detergent solution is kept available at all times. In these cases, the computation of the amount of detergent is more complex, as it implies assumptions on the rate at which the detergent loses its washing capacity (and hence needs to be regenerated), which itself depends on the soiling status of the dishes / utensils being washed.
- In conveyor-type dishwashers (i.e. in Categories 5 – One-tank conveyor-type dishwashers and 6 – Multi-tank conveyor-type dishwashers) very large quantities of detergent / rinsing agent are used, which are delivered to the appliances via entire dosing systems, at a rate controlled by the appliance.
- In the case of Category 4 – Utensil / pot dishwashers, some types are primarily cleaned with the granules, resulting in lower detergent consumption.

4.5.3. Repair and Maintenance costs

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

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

As a preliminary estimate of the maintenance and service costs of commercial dishwashing appliances, an indication can be taken from the size of the new equipment market versus the 'spares and service' (spare parts including accessories, repairs, and maintenance) market in the UK. In total, the UK spares and service market was 44 % of the value of the new foodservice equipment market in 2006.⁷⁴ This indicates that for the entire lifetime of a foodservice product, the total **maintenance costs are 44 % of the initial purchase costs**. This value will be used to estimate the life cycle costs of dishwashing products later in the study (it is therefore assumed that the commercial dishwashers have average maintenance and repairs costs, in comparison with other foodservice equipment, including prime cooking and refrigeration equipment). Stakeholders have indicated that maintenance costs per year are inferior to 5 % of the purchasing price of the appliance. Based on a lifetime of ca. 10 years (as identified in **Section 4.3.1**), this sums up to less than 50 % of the purchase cost over the lifetime of the product, which is coherent with the estimate above.

⁷⁴ Catering Equipment Suppliers' Association (CESA) 2007, The UK Market for Foodservice Equipment – The authoritative report on the UK market

2707 Stakeholders have commented that the most common items for maintenance on commercial
2708 dishwasher products are water pumps, control panels, heating elements and doors. All of these
2709 components in commercial dishwashers are easily replaceable and generally justify
2710 maintenance rather than replacing the entire dishwasher. According to manufacturers, the most
2711 common cause for commercial dishwasher breaking is operator misuse or abuse.

2712 4.5.4. Installation costs

2713 The installation costs apply mainly to the larger equipment (categories 5 and 6: conveyor
2714 dishwashers) that is large and complex, with some on-site adaptation and customisation.
2715 However, even smaller appliances may require installation work that, dependent on the delivery
2716 contract, may add installation costs to the cost of the purchase of the equipment itself.

2717 The stakeholders provided no data in the survey regarding these installation costs.

2718 4.5.5. Disposal tariffs/ taxes (€/product)

2719 In general, most professional catering service establishments need a working dishwasher for
2720 daily operation. As a result, for all replacement sales, the old dishwasher unit is removed at the
2721 same time as the new unit is provided.

2722 Stakeholders have commented that many commercial dishwasher units can be refurbished and
2723 resold as second-hand products by dealers in a fairly buoyant second-hand market (around 5-
2724 10 % of the annual sales, according to manufacturers' estimates). These products generally are
2725 given new water pumps, control panels and heating elements, as the most common items to
2726 fail.

2727 According to stakeholders, dishwashers that are not refurbished are almost always recycled for
2728 scrap parts. A large majority of the materials in commercial dishwashers is valuable metallic
2729 parts (stainless steel, in particular for austenitic stainless steel, i.e. containing nickel) and the
2730 value for scraps is high. As a result, most dealers or manufacturers will offer to remove the old
2731 dishwashers on purchase and delivery for new dishwashers and may even provide the customer
2732 with a discount for the salvaged product.

2733 As a result, this study will assume the disposal costs for commercial dishwashers are 0 Euro per
2734 product.

4.6. Recommendations

4.6.1. Refined product scope from the economical/ commercial perspective

No market has been identified as ‘niche’ in the study. The larger the appliances (typically: categories 5 and 6 – conveyor dishwashers), the smaller their numbers. However, their processing capacity per unit and duration of operation per year result in an annual throughput that is also ca. 10 times larger (cf. **Section 4.4.1.1**). Thus, the environmental impact of the whole stock of these appliances needs to be assessed in detail further in the study to check whether they deserve being discarded from the scope of the study or not.

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

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

- Consolidating the already dominant features to ensure that they are the norm for all products present on the market:
- Wastewater heat recovery using a heat exchanger,
- Automatic dosing of detergents,
- Improved thermal insulation,
- Improved maintainability / repairability / capacity to be upgraded or refurbished (ease of dis-assembly and re-assembly, ease of access to servicing area, modular design),
- Additional warm/hot water connection, if not already provided, with adapted water temperature controls able to cope with higher temperature of externally supplied water.
- Introducing some features that would provide a clear environmental benefit, even if they still are not often present:
- Use of recycled metals, taking care of potential issues regarding hygiene,
- Improved recyclability (avoidance or clear marking of substances of concern without duplicating existing legislation such as REACH, separability of parts made of different materials).

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

5. MEErP Task 3 – Users

5.1. Objectives of MEErP Task 3

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

2823 Undercounter tank machines (category 2) are usually used in bars, bistros, small restaurants,
 2824 offices, clubhouses, hotels, conference centres, gas stations, motorway service stations, day-
 2825 care homes, bakeries, butcheries, and elderly homes. According to stakeholder feedback, it is
 2826 mandatory – and so typically stated in the documentation – that only trained, or at least
 2827 supervised persons are allowed to use the dishwasher of this category. Due to the shorter cycle
 2828 time, they have a higher capacity than commercial water-change models. They make only sense
 2829 if a certain amount of wash ware must be cleaned as the water in the tank has to be heated and
 2830 the dishwasher is kept in ‘ready to use’ mode between the dishwashing cycles.

2831 Hood-type dishwashers (category 3) are more ergonomically to handle compared to
 2832 undercounter dishwashers as the racks are put on a table next to the dishwasher and pushed
 2833 into the machine after loading. The filled (quite heavy) rack usually does not have to be carried
 2834 by the user but only the empty ones. They are used if enough space is available and usually if
 2835 more wash ware is to be cleaned compared to undercounter dishwashers. They are more
 2836 seldom used in small restaurants or bars. According to stakeholder feedback, it is mandatory –
 2837 and so typically stated in the documentation – that only trained, or at least supervised persons
 2838 are allowed to use the dishwasher of this category.

2839 Utensil/pot dishwashers (category 4) are used to clean heavily soiled pots and pans and other
 2840 large utensils. They are used by trained personnel in institutional kitchens, restaurants, bread
 2841 and bakery industries, butcheries, hypermarkets etc.

2842 Conveyor-type dishwashers with one or more tanks (categories 5 and 6) require a relatively large
 2843 number of items to be cleaned per day and a large amount of space. They are only used by
 2844 trained staff in medium and large company canteens, hospitals, caterers, and hotels.

2845 All commercial dishwasher categories 1-6 are operated by trained, instructed staff which is also
 2846 specified in the Machinery Directive and written in every instruction manual for the respective
 2847 devices. It must be noted that the personnel who operates the machine, often 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 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] ⁷⁵
No 1 Undercounter water-change	80-300 ⁷⁶ (200)	285-500 (350) ⁷⁷
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 ⁷⁸ (20 cycles/ hour)	7-30 cycles/hour (15 cycles/hour)
No 5 Conveyor-type one-tank	1,500-2,000 ⁷⁹ (1,750)	800-2,520 (1,800)
No 6 Conveyor-type multi-tank	1,700-6,000 ⁸⁰ (3,600)	900-8,000 (3,600)

⁷⁵ 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/rack, with 2 racks washed per cycle.

⁷⁶ Different throughput rates with cold water supply at 15°C or cold & hot water supply (hot water 65°C).

⁷⁷ According to stakeholder feedback, the value is based on 50 dishes per 2 racks in 1 cycle, leading to a typical standard of 350 dishes/hour (ideal condition = basic setting, i.e. most commonly used programme, 7 full cycles of 8 minutes possible within one hour, partial cycles were not considered).

⁷⁸ 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.

⁷⁹ 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.

⁸⁰ 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.

2863 Sources: left column: Task 3 report of Lot 24, 2011; right column: stakeholder consultation and review of
 2864 manufacturers' product datasheets, 2024.

2865 One stakeholder confirms that there is no, or very little performance/capacity information based
 2866 on standards or scientific publications; thus, such data are almost exclusively provided by the
 2867 dishwasher manufacturers themselves. There are sometimes different and divergent
 2868 interpretations of the basic data that are used so it appears that the term 'dishes per hour' has
 2869 been interpreted differently, which is probably why the manufacturers' specifications vary so
 2870 widely. As all categories of commercial dishwashers clean a large variety of wash ware, the
 2871 specification 'dishes per hour' is based on different items (possibly dessert plates, saucers,
 2872 coffee cups etc.) in the load.

2873 The stakeholder further informs that a 'unit' for specifying the capacity is the number of racks
 2874 to be washed per hour. As there is a wide variety of different racks, the standard rack (500 x 500
 2875 mm) made of plastic with a single plate load is usually used here. This 'standard plate load' refers
 2876 to 18 dinner plates (based on the load from EN 63136 with 'standard plates' of 240 mm
 2877 diameter). This load could be, and to some extent has been, used to provide a degree of
 2878 comparability between the categories. To ensure that this basis is clearly defined, the
 2879 stakeholder recommended that the term 'plates per hour' rather than 'dishes per hour' should
 2880 be used consistently with a standardised standard load of 18 dinner plates to compare capacities
 2881 as a 'unit' to which everything is converted. This would work for all categories except for
 2882 category 4 which focuses on pots and pans and is slightly different from the others, all of which
 2883 have the same extensive wash ware (from cutlery to porcelain and glasses). However, according
 2884 to the stakeholder, a pure plate load does not reflect the real conditions, but only approximately
 2885 20 percent of the load whereas around 80 percent is other wash ware. Although a standard
 2886 mixed load would be useful, there is currently not much further information on the real
 2887 conditions of use.

2888 Based on a review of product datasheets for category 1 (undercounter water-change), it appears
 2889 that there is no typical average capacity, but that there are rather two capacity classes; a smaller
 2890 one with approximately 285 dishes per hour (15 racks à 19 dishes per hour) and a larger one of
 2891 approximately 456 dishes per hour (24 racks à 19 dishes per hour). The load per wash cycle is
 2892 very mixed. In the other categories, each rack tends to be washed with a single type of dishes.
 2893 For the purposes of this study, it was initially assumed that the smaller category is more
 2894 prevalent in the market and is therefore taken as the typical capacity. According to 2024
 2895 stakeholder feedback, this type of machine, unlike the other categories, cleans two racks at a
 2896 time. Stakeholder feedback therefore suggested a typical standard capacity of 350 dishes per
 2897 hour under ideal conditions, i.e. a basic setting with the most commonly used programme,
 2898 where 7 full cycles of each 8 minutes would be possible within one hour (based on 50 dishes per
 2899 two racks), not considering partial cycles.

2900 For category 2, the initial values of the 2011 preparatory study were mostly confirmed by the
 2901 2024 stakeholder consultation. Depending on the product portfolio of individual manufacturers,
 2902 the capacity range has widened slightly at the lower and the upper limits. Feedback on the
 2903 typical capacity was still around 540, 550 or 600 dishes per hour with one manufacturer stating
 2904 that these figures were only theoretical and would be lower (more like 360 dishes per hour) if
 2905 loading and unloading of the machine was considered. Another manufacturer stated that in
 2906 recent years, for category 2, programmes with lower productivity (as low as 72 dishes per hour)
 2907 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:

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

These input data were used to calculate the annual number of dishes⁸¹ (category 4: cycles) cleaned per category, which served as input for the further calculations of the energy, water, and detergent consumption per dish and/or per cycle and also per year under ideal and real conditions.

⁸¹ 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.

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

Dishwasher category	Average capacity per cycle or per hour ⁸²	Number of cycles per day	Time in active mode per day ⁸³	Working days per year	Typical workload of rack/belt ⁸⁴	Number of dishes / cycles per year
No 1 Undercounter water-change	30 dishes/cycle ⁸⁵	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
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

⁸² 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).

⁸³ Calculations based on stakeholder feedback (2011) with regard to distributed usage of different programme durations.

⁸⁴ 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.

⁸⁵ 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.

according to IEC EN 63136 and is usually higher than the programme time due to rack changes and the reestablishment of working temperatures (for definitions of programme time and cycle time, see also **Section 3.3.1.1**). According to latest stakeholder feedback, it is proposed to define the ‘active mode’ as follows:

‘Active mode: Operation time of the appliance where it does provide its full working function (e.g. cleaning, washing, rinsing, drying.’

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) ⁸⁶ per cycle	Working days per year	Typical workload of rack ⁸⁷	Number of dishes or cycles per year
No 1 Undercounter water-change	7 ⁸⁸	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
Dishwasher category	Number of dishes per hour	Time in active mode per day	Working days per year	Typical workload of belt ⁸⁹	Number of dishes per year
No 5 Conveyor-type one-tank	1,800	3h 30	330	80 %	1,663,200 dishes
No 6 Conveyor-type multi-tank	3,600	4h 30	330	80 %	4,276,800 dishes

Sources: Derived from 2024 stakeholder input.

⁸⁶ For dishwasher category 1, a mixed load of wash ware is used plates, glasses, cups instead of “standard plates”; therefore, a direct comparison of capacities between the different dishwasher categories is not possible.

⁸⁷ 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.

⁸⁸ According to stakeholder feedback, the values are based on 50 dishes per 2 racks in 1 cycle, leading to a typical standard of 350 dishes per hour (ideal condition = basic setting, i.e. most commonly used programme, 7 full cycles of 8 minutes possible within one hour, partial cycles were not taken into account). The statement “7 full cycles of 8 minutes possible in one hour” refers to the theoretical capacity range per hour (dishes/hour) in Table 5-2. According to the stakeholder, the typical number of cycles per day in Table 5-4 might rather be 5 cycles per day.

⁸⁹ 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.

2974 For category 1 (undercounter water-change), calculations use the ‘typical’ capacities shown in
 2975 **Table 5-2** (50 dishes per two racks in one cycle), assuming 7 cycles per day, 200 working days
 2976 per year and 75 percent of work load.

2977 Stakeholder feedback on category 2 (undercounter one-tank) was contradictory, probably
 2978 because the number of cycles per day depends strongly on the type of foodservice operation
 2979 and the overall capacity of the dishwasher used. While few stakeholders agreed with the initial
 2980 2011 values as an average normal use, one stakeholder considered the initial 55 cycles per day
 2981 to be probably above average; also, because not always standard dishes / plates are washed but
 2982 other objects (glasses, cups, ...). On the contrary, one stakeholder suggests that even 250 cycles
 2983 per day and 5 hours per day in active mode should be considered as average. Another
 2984 stakeholder suggests 3 hours per day in active mode for chains or heavy duty, which would be
 2985 significantly higher than the 2011 data. Finally, one stakeholder suggests 40 cycles per hour
 2986 (assuming 18 dishes per cycle) and 1.5 hours per day in active mode. However, 720 dishes per
 2987 hour would be significantly higher than the typical capacity shown in **Table 5-2** (550 dishes per
 2988 hour), which is also based on stakeholder feedback. For further calculations for category 2
 2989 dishwashers, 55 cycles per day at a capacity of 18 plates per cycle, i.e. 990 plates per day are
 2990 considered, resulting in 237,600 dishes cleaned per year when considering a workload of 80 %
 2991 (same value as in 2011).

2992 For category 3 (hood-type), some stakeholders agreed with the initial values from the 2011 study
 2993 as an average for normal use. However, there was also feedback that 80 cycles per day (2011
 2994 data) was probably an underestimate, with one stakeholder suggesting that 150 cycles per day
 2995 and 3 h 50 per day in active mode should be considered. For heavy use, another stakeholder
 2996 even suggests a working time of 4.5 hours per day, resulting in 800,000 dishes to be cleaned per
 2997 year. In its product brochure, the manufacturer Hobart uses 100 cycles per day at 2,160 dishes
 2998 per hour and 312 working days per year to calculate the energy savings of its hood-type
 2999 machine⁹⁰. Another stakeholder suggests 60 cycles per hour at 18 dishes per cycle. Weighing all
 3000 the varying information, the study team decided to choose a value of 110 cycles per day⁹¹ at
 3001 18 plates per cycle, resulting in 475,200 dishes per year at a typical workload of 80%.

3002 For category 4 (utensils/pots), some stakeholders agreed with the initial values presented in the
 3003 2011 study. Another stakeholder suggested a higher number of hours in active mode (4 hours
 3004 per day). Using a typical capacity of 15 cycles per hour as shown in **Table 5-2** this would result in
 3005 60 cycles per day which was questioned by other stakeholders (see the comment above on the
 3006 challenges of using the time in active mode for the calculations).

⁹⁰ 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. Updated product specifications are available under the following link: <https://www.hobart.de/produkte/spueltechnik/geschirrspuelmaschinen/haubenmodelle-geschirrspuelmaschinen/produkt/amxt>

⁹¹ 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.

3007 One stakeholder commented for this category of commercial dishwashers that the number of
 3008 cycles per day depends very much on the typology of the end user (butchery, bakery, food lab,
 3009 or other). Therefore, due to the lack of more specified data, for this category the 2011 values,
 3010 i.e. 30 cycles per day, will be used for the further calculations.

3011 For categories 5 and 6, one stakeholder confirmed the initial data from the 2011 study, another
 3012 one sees too much variability in the applications to make a meaningful estimate. One
 3013 stakeholder considers that the time in active mode should not be considered less than 9 hours
 3014 per day. On the other hand, three stakeholders considered an active mode of no less than 9
 3015 hours per day as an average to be definitely too high, which in their opinion has definitely not
 3016 doubled since the 2011 study. Another stakeholder suggested to reduce the time in active mode
 3017 to 8 hours and the time in ready-to-use mode to be 4 to 6 hours, with a typical duration of 4.5
 3018 hours. Combined, this would be around 12 hours, which would be in line with the typical
 3019 operating times of large users of category 5 and 6 commercial dishwashers, which could be
 3020 between 10 and 18 hours (canteens, hotels, hospitals).

3021 Latest feedback from several stakeholders of August 2025 questioned draft interim data of this
 3022 preparatory study that estimated the time in active mode for categories 5 and 6 to be 8 hours
 3023 per day. They informed that a common conveyor type machine switches steadily between
 3024 active-mode and ready-to-use mode by self-detection.

3025 One stakeholder explains the typical operation of BC5 and BC6 dishwashers as follows: A
 3026 machine is switched on in the morning. Then it starts filling and heating up, until it reaches the
 3027 'ready to use mode'. Now wash ware is put on the conveyor and the machine is activated into
 3028 the 'Active Mode' as long as wash ware is inside the machine. As soon as the wash ware leaves
 3029 treatment zones the machine changes to the Ready to Use Mode (typically automatically) and
 3030 does just take the consumption to maintain this status and does not use full energy and
 3031 resources anymore (see **Section 5.4.3** on influence of low power modes). Depending on the
 3032 business application, there are usually 'dishwashing peak times' during the day. In a canteen, for
 3033 example, the first round begins during breakfast and lasts until sometime afterwards. After the
 3034 breakfast dishes and kitchen utensils have been washed, there is only a low demand until
 3035 lunchtime, followed by a high demand again until a certain time (which serves as a measure of
 3036 the machine's maximum capacity). After washing the lunch dishes and kitchen utensils, there is
 3037 again little demand – depending on the business, the machine may even be emptied and
 3038 cleaned. In a hospital or restaurant, there is another session during/after dinner. Active Mode is
 3039 therefore only used during these peak times and only when the drive is running, and the
 3040 actuators are activated.

3041 Several stakeholders therefore stated that the initial data of the former preparatory study Lot
 3042 24 are still valid and proposed that the time in active mode should be 4.5 hours instead of 8
 3043 hours for BC6 and 3.5 hours instead of 8 hours for BC5, assuming that these appliances are
 3044 operated more time in active mode than BC3 but less than BC6.

3045 One stakeholder considers the typical rack or conveyor load for these dishwasher types to be
 3046 80 % rather than 75 % and the typical capacity to be slightly lower for category 5 (1,600 dishes
 3047 per hour) and higher for category 6 (4,500 dishes per hour) compared to the 2011 values. The
 3048 stakeholder feedback further explained that there are typically two scenarios for these
 3049 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, small organisations with a lot of dishes to wash often use a smaller, undersized dishwasher. As a result, their machine always runs at full load.

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

5.2.3. Detergent consumption and consumables

Standards EN IEC 63136 and EN 17735 define ‘chemical treating agents’, e.g. definition 3.5 of EN 17735 states ‘treating agent: product used to clean and/or sanitise and/or rinse and/or descale wash ware in dishwashing machines’ with Note 1 to entry: ‘Examples of treating agents are: detergent, rinse aid and granules.’⁹²

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

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

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

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

⁹² 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.

According to the 2011 preparatory study, there are differences in water hardness across Europe and even within countries. These result in the need for different detergents products or different dosing levels to cope with the water hardness. Country differences also exist in the type of soil 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 ⁹³	litre/100 dishes	g/100 dishes
No 1 Undercounter water-change	4.3 ⁹⁴	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.

⁹³ In case of category 4, values are given per cycle.

⁹⁴ 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 ⁹⁵	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)⁹⁶.

⁹⁵ In case of category 4, values are given per cycle.

⁹⁶ 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 'standard' dishes (plates) of 240 mm diameter. In the case of a category 2 dishwasher

3197 For example, the water consumption of category 2 dishwashers was found to be between 2.0
3198 and 3.5 litres per cycle according to the analysed product datasheets. For the further
3199 calculations, a value of 3.0 litres per cycle, i.e. 16.7 litres per 100 dishes was taken which is still
3200 close to the 2011 data.

3201 Regarding the consumption of detergents and rinse aids, two stakeholders suggested a lower
3202 consumption of 40 grams and one stakeholder only 34 grams per 100 dishes for category 2
3203 dishwashers. One stakeholder points out that the detergent concentration for categories 2 and
3204 3, i.e. undercounter single-tank and hood-type dishwashers is required according to EN IEC
3205 63136 and for utensil/pot dishwashers according to ENAK (per cycle) at 3 ± 0.3 g/l (with a
3206 detergent density of 1.35 g/ml); this translates to a concentration of 2.2 ml/l. Regarding rinse
3207 aid, while the standard does not specify density, it is typically 1 g/ml, and therefore the
3208 concentration would be 0.30 g/l. However, the actual detergent and rinse aid consumption is
3209 likely to vary from these standard conditions.

3210 For category 3 (hood-type dishwashers), stakeholders suggest a slightly higher energy
3211 consumption (around 2.0 kWh per 100 dishes) compared to the 2011 data. On the other hand,
3212 the water consumption seems to be lower now, at 2.4 to 2.6 litres per cycle, i.e. approximately
3213 12 to 14 litres per 100 dishes. Finally, the detergent and rinse aid consumption are lower than
3214 in 2011, ranging from 34 to 44 grams per 100 dishes. For the further calculations, an average of
3215 13 litres per 100 dishes was considered.

3216 For category 4 (utensil/pot dishwashers), both the stakeholder inputs for energy and the water
3217 consumption appear to be slightly higher compared to the 2011 data.

3218 Finally, for categories 5 and 6, one stakeholder informs that due to the wide range of conveyor-
3219 type machines there are no data that referring to x/100 dishes but proposes to discuss a
3220 calculation approach to obtain the data in the best way according to EN 17735 as a reference.
3221 However, it has to be noted that EN 17735 focuses on hygiene and not on consumption
3222 measurements such as energy consumption, etc. Only one stakeholder suggests that the energy
3223 consumption for category 6 could be half of what was reported in 2011. As this was not
3224 confirmed by other stakeholders, the study will use the existing values for further calculations.
3225 For both categories, lower values were proposed for the water and detergent consumption
3226 compared to 2011 data. For category 6, a water consumption of 8 litres per 100 dishes appears
3227 to be closer to the actual situation.

3228 Based on the 2024 stakeholder feedback in **Section 5.2.3** above suggesting a separate rather
3229 than integrated application of detergent and rinse aid consumption, the detergent and rinse aid
3230 consumption under ideal conditions will be calculated for tank operated dishwashers (categories
3231 2 to 6) as follows:

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 will 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.

- 3232 - For the rinse aid consumption, it is assumed that the standard concentration of 0.3
 3233 g/litre is applied to the freshwater consumption of the rinse cycles that is required
 3234 to rinse the corresponding number of dishes.
- 3235 - For the detergent consumption during cycle based or continuous operation of the
 3236 dishwashers the values provided through stakeholder feedback for the integrated
 3237 detergent and rinse aid consumption per 100 dishes reduced by the rinse aid
 3238 consumption are taken. The additional detergent consumption due to the first fill
 3239 and refills of the wash tank are only considered under real-life consumptions (see
 3240 **Section 5.4.1.4**).

3241 Based on the annual number of dishes or cycles given in **Table 5-2**, which were considering a
 3242 'typical' share of partial workload, i.e., real life conditions, the following **Table 5-7** shows on the
 3243 basis of the number of dishes or cycles per year (ideal conditions without partial workload) the
 3244 updated annual consumption of energy, water and detergent (including rinse aid) for each of
 3245 the six dishwasher categories under ideal conditions in 2024.

3246 **Table 5-7: Annual energy, water, detergent and rinse aid consumption of commercial**
 3247 **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	2,079,000	41,580	249,480	75	674
No 6 Multi-tank conveyor-type	5,346,000	106,920	427,680	128	1,155

3248 Source: Calculated based on stakeholder inputs from the 2024 survey.

3249 Due to the increased ideal number of cycles or dishes cleaned per year in all dishwasher
 3250 categories (values in the 2011 study were based on 'typical use intensities' which were
 3251 considering a partial workload), there is also an increase in the consumption of energy, water
 3252 and detergent including rinse aid under assumed ideal conditions.

3253 An undercounter water-change dishwasher (category 1) cleaning about 70,000 dishes per year
 3254 will consume about 1,540 kWh energy and 24,500 litres of water during continuous operation
 3255 under ideal conditions. The numbers of cycles are connected with a detergent and rinse aid
 3256 consumption of 28 kg per year. The energy and water consumption of a multi-tank conveyor-
 3257 type dishwasher is of a different order: around 107,000 kWh of energy and 427,680 litres of
 3258 water, plus nearly 1.3 tonnes of together detergent and rinse aid, are used to wash around 5.3
 3259 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** 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 % workload⁹⁷.

However, one stakeholder of the 2024 consultation informed that appliances with comprehensive empty-space detection capabilities are extremely rare or potentially even non-

⁹⁷ 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**.

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 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.

3364 **Table 5-9: Energy, water, detergent and rinse aid consumption at partial loads (2024).**

Dishwasher category	Average work-load	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 %	1,663,200 dishes	41,580	249,480	75	674
No 6 Conveyor-type multi-tank	80 %	4,276,800 dishes	106,920	427,680	128	1,155

3365 Source: Calculated based on stakeholder input from 2024 consultation.

3366 **Table 5-10** shows the resulting effect of partial loading under real-life conditions on the specific
 3367 consumption of energy, water and detergent / rinse aid per 100 dishes.

3368 **Table 5-10: Specific energy, water, detergent, and rinse aid consumption of commercial dish-**
 3369 **washers 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 ⁹⁸	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

3370 Source: Calculated based on stakeholder input from 2024 consultation.

⁹⁸ In case of category 4, values are given per cycle.

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' programme⁹⁹, 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.

⁹⁹ 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.

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 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.

Table 5-11: Programme selection and its influence on energy, water, and detergent 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%

Type of programme		Duration of programme	Share of programme	Relative consumption of		
				Energy	Water	Detergent
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						
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%

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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:

- Category 1: +10 % of the nominal consumption of the dishwashers
- Categories 2 to 4: +5 % of the nominal consumption of the dishwashers
- Categories 5/6: +7.5 % of the nominal consumption of the dishwashers

5.4.1.4. Manual pre-rinsing of wash ware

According to the 2011 preparatory study, the *manual* pre-cleaning of the wash ware outside the machine (one stakeholder informed that pre-cleaning is available, for example, for a certain model of hood type machines) as well as the manual cleaning of the dishwashing machines after the running cycles might cause considerably further water and energy consumption in the whole washing process. The inclusion of the whole process from dirty to clean (including the manual pre-soak and pre-cleaning of the wash ware outside the machine as well as the manual machine cleaning) would be rather desirable. However, the water and energy¹⁰⁰ consumption is strongly dependent on the specific user behaviour, the soiling of the wash ware and the machines, the existing infrastructure, and other factors¹⁰¹. Further, there is no standard measurement method and at that time no reliable data to record the average consumption through external pre-cleaning of the wash ware or cleaning of the machines. Thus, the manual process steps outside the dishwashing machines were excluded from the scope and were not included in the consumption values under real-life usage conditions of the 2011 study.

¹⁰⁰ Energy consumption: due to the use of warm water for cleaning.

¹⁰¹ E.g., the use of active filter systems can reduce the dirtiness of the wash water through the separation of food residues during the washing process and transporting them out of the machine.

For the updated 2024 preparatory study, a study by Kerschgens et al. (2021) can be taken as information basis. They conducted an independent survey on commercial dishwasher usage in Germany and Denmark in 200 commercial enterprises and analysed inter alia the manual pre-rinsing of items.

The study informs that in passthrough or hood-type and conveyor dishwashers the dishes are usually rinsed in the washing rack with the help of a hand spray during pre-washing. A preliminary test was carried out to determine the water flow of a spray and the average time required to rinse a washing rack. These values were used to calculate an average consumption of 0.39 litres/rack. Based on the cleaning cycles per day, the water consumption for pre-rinsing hood-type and conveyor dishwashers (categories 3, 5, and 6) was calculated according to the following equation:

$$\text{water consumption}_{\text{hood \& conveyour type}} = 0.39 \text{ litres} * \text{rinse cycles per day}$$

In the case of commercial single-tank and water-change machines (categories 1 and 2) there is no separate technical structure for pre-rinsing. Each item to be washed is pre-rinsed individually.

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.

3575 **Table 5-12: Additional water consumption for pre-rinse.**

Dishwasher category	Additional water consumption for manual dishwashing and 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	49,896
No 6 Conveyor-type multi-tank	6	128,304

3576 Source: Own calculation (right column) based on Kerschgens et al. (2021), Table 2.

3577 **Sensitivity analysis of the water consumption for pre-rinsing after stakeholder**
3578 **feedback**

3579 Stakeholder feedback at a later time during this preparatory study raised doubts about these
3580 calculations for additional water consumption, particularly with regard to the assumption that
3581 86 litres of water are used for manual pre-rinsing in dishwasher category 2. The stakeholder
3582 explained that the flow rate of a typical modern eco hand spray is around 5 litres per minute. If
3583 customers pre-rinse six racks of 18 plates each (108 plates/items) and rinse each rack for one
3584 minute, they will need 30 litres for 108 dishes. The stakeholder expects the actual water
3585 consumption to be much lower, for example 15 litres for 100 items, assuming a 30-seconds pre-
3586 rinse for each rack. Furthermore, it was explained that pre-cleaning is not carried out at all for
3587 glass washing, with glasswashers accounting for approximately 70 % of the BC2 category.

3588 Sensitivity analysis 1: Since the 86 litres in Table 2 of the Kerschgens et al. (2021) study (see
3589 above **Table 5-12**, middle column) includes both pre-rinsing and manual dishwashing, the
3590 additional annual water consumption is calculated using the formula for pre-rinsing only (0.73
3591 litres per item). The study by Kerschgens et al. (2021) explains that each item is pre-rinsed
3592 individually as there is typically no technical installation to spray a whole rack. Therefore, the
3593 values are still considered appropriate. The revised calculation leads to an additional water
3594 consumption of 86,724 litres per year for pre-rinsing.

3595 Another stakeholder argues that the value of 0.73 litres per item is based on another study by
3596 "Richter, C.P. (2011): Usage of dishwashers: observation of consumer habits in the domestic
3597 environment" and is determined in that study for manually washed items followed by
3598 (household) machine washing. As **Section 3.2.2.5** of this study on the distinction between
3599 commercial and household dishwashers according to functional performance and technological
3600 differences states "Further, in household dishwashers, the wash ware is often not cleaned
3601 directly after the meals so that the soil is rather dried", the stakeholder argues that this fact
3602 together with potential smelling leads to unproportionate pre-rinsing behaviour in the domestic

use. In contrast, commercial dishwashing machines of BC2 are used in commercial enterprises where long drying times before the washing cycle are not an issue and water and cost savings in general have high priority in the commercial field. Therefore, the stakeholder does not see the data from Richter cited by Kerschgens et al. 2021 as representative for the commercial dishwashing sector.

Sensitivity analysis 2: It is assumed that each item will be pre-rinsed individually (with a share of 50 % of all items per year). Assuming 5 seconds for pre-rinsing per item, i.e. the water for 1.5 minutes until the rack with 18 plates will be filled, and a water flow rate of around 5 litres per minute of the hand spray, would result in 0.42 litres per item. This sensitivity analysis would lead to an additional water consumption of around 49,896 litres per year for pre-rinsing.

Concluding remarks: The overall contribution of the water consumption on the environmental impact of the use phase over the products' lifetime of the initial data based on **Table 5-12** is less than 5 % (see **Section 9.2.2.1**); even if the share of pre-rinsing will be reduced according to the above sensitivity analyses, there will be no relevant effect of the pre-rinsing in the overall assessment of impacts.

5.4.1.5. Use of other wash ware than standard plates

According to Kerschgens et al. (2021) who conducted an independent survey on commercial dishwasher usage in Germany and Denmark in 200 commercial enterprises, the share of plates in the surveyed enterprises only makes about 20 to 25 % among the distribution of the different kinds of wash ware. Other items are for example cutlery, cups, glasses, plastic dishes, and others. The businesses participating reported that 26 to 46 % of their daily items to be washed up consist of cutlery. The second largest share of the total items to be washed up, are plates (16 to 25 %). Children's day-care centres have the highest proportion of dishes made of plastic – about 14 %. Pots, chopping-boards, cooking utensils and bowls make up only a small proportion (between 1.0 % and 2.5 %) of all dishes to be washed.

The impact of wash ware different to standard items in real life user behaviour compared to ideal (standard use) could be for example a different number of dishes per cycle and year or the use of different programmes. However, as no detailed information on these effects is available, these impacts are not considered in the following calculations of the real-life consumption.

5.4.2. Influence of initial filling and heating of tanks

The consumption data for commercial dishwashing machines under ideal conditions (see **Section 5.3.2**) do not include the initial filling and heating of the wash tanks at the start of the process (applicable to all tank machines, i.e. categories 2 to 6). This amount of energy (for the heating of the water), water (**Section 5.3.2** only includes the water consumption of the freshwater rinsing) and detergent needs to be considered as it may represent a significant part of the consumption figures. Of course, the importance depends on the intensity of use of the dishwashers. The more dishwashing cycles (or hours of cleaning) performed, the lower the proportion of energy and water used for the initial filling and heating of the wash tanks.

It is also relevant whether the first filling is done with cold or hot water (see **Section 5.6.1**). In the case of hot water, according to stakeholder feedback, a minimum of additional energy is needed compared to cold water connection in order to hold the temperature. For the further calculations, however, this is assumed to be negligible and is therefore not considered.

In order to calculate the annual water and energy demand of the initial filling and heating of the wash tanks the following parameters must be specified:

- Number of working days per year, Number of working shifts per day (as the wash tanks have to be emptied and refilled each time)¹⁰²,
- Volume of the wash tanks,
- Share of the cold water and hot water connections of commercial dishwashers (see **Table 5-26**)
- Temperature of inlet water (15 °C) and operating temperature of wash tanks (60 °C), i.e. the temperature difference for heating the inlet water is 45 K. In the case of hot water load, no direct energy is required by the dishwasher itself to heat the detergent solution of the first load (the environmental impact should be calculated by considering the average upstream chains of hot water provision), however, a minimum of additional energy is needed compared to cold water connection in order to hold the temperature (considered negligible for the further calculations),
- Heat capacity of water, which is 4.19 kJ/(kg*K), and
- Efficiency of the cold-water heating process which is assumed to be 90 %, i.e. an assumed 10 % efficiency loss of the machine and boiler.

Table 5-13 shows the parameters for the different dishwasher categories with updated information from the 2024 analysis of product datasheets and stakeholder consultation.

¹⁰² 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.

Table 5-13: Input parameters for calculation of consumption through initial filling and heating of wash tanks (2024).

Dishwasher category	Number of working days per year ¹⁰³	Number of working shifts per day	Volume of wash tank(s) ¹⁰⁴ (in brackets: assumed average)	Operating temperature of wash tank(s) (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)
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)

n.a. not applicable

With these assumptions the annual energy consumption (i.e. only the direct energy demand by the dishwasher itself), water and detergent consumption of two tank loads and the initial heating of the tank water can be calculated. The total amount of tank water is split according to the shares of cold water and hot water connections referenced in **Table 5-26**, assuming that this share of available connections is comparable to the real-life usage of the hot water connection.

The column 'cold water fills' shows the direct energy demand of the dishwasher, i.e. the amount of electricity required to heat the cold water at 15 °C to a temperature of 60 °C inside the dishwasher itself. For the filling with 'hot water', no direct energy demand of the dishwasher is required as the water is heated outside of the dishwasher. The related energy consumption will be considered when calculating the total environmental impacts in Task 5.

Further, it is assumed that in addition to the detergent and rinse aid consumption under continuous operation as already calculated in **Section 5.3.2**, the tank fills at the start of a work shift also include an initial detergent load (without rinse aid) according to the detergent concentration of 3 g/l as listed in **Section 5.2.3**.

¹⁰³ cf. Table 5-3

¹⁰⁴ cf. machine characteristics as shown in **Section 6.2.2**

Table 5-14: Energy, water, and detergent consumption for two fills and heating of wash tanks (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	litres/year	kWh/ year	kg/ year
No 1 Undercounter water-change	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
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

n.a. not applicable

* hot water heating requires indirect energy demand outside of the dishwasher; the environmental impacts will be modelled in Task 5

5.4.3. Influence of low-power modes consumption

According to stakeholder feedback, the following different modes need to be distinguished for commercial dishwashers (tank dishwashers, categories 2 to 6):

- 'Active mode', i.e. when the machine is performing a wash cycle (for categories 5 and 6 this means the mode when an active cycle is running, i.e. the time when wash ware is transported conveyed through the treatment zones and wash pumps and final rinse is activated,
- A significant part of energy consumption happens between the cycles with two completely different situations:
 - o 1) The machine is heating up ('ready to use mode'), i.e. the temperature settings shall be reached before performing a washing cycle. Ready-to-use mode, where water in the tank and/or the boiler is kept warm but not currently performing a washing cycle. In this mode, a washing cycle can be started whenever needed.

3703 ○ 2) The operational temperatures are already reached, the water in the tank
 3704 and/or the boiler has not to be further kept warm and thus the energy
 3705 consumption is almost zero (only display/control circuits or a LED are active,
 3706 while loads such as heating elements are not active).

3707 - Off-mode, when the dishwasher is disconnected, i.e. not electrically supplied.

3708 Off-mode energy consumption and also the energy consumption when the machine is neither
 3709 disconnected nor in the ready to use mode are not taken into account: For the smaller
 3710 dishwashers, the off-mode consumption is negligible compared to the total energy
 3711 consumption.¹⁰⁵ According to the 2011 preparatory study, large conveyor-type dishwashers are
 3712 disconnected from the circuit by a power switch so no power is consumed in off-mode at all.
 3713 Therefore, off-mode has not been considered in the following sections and tasks. In the 2024
 3714 stakeholder consultation, all responding stakeholders confirmed that off-mode consumption is
 3715 not relevant for commercial dishwashers (less than 1 kWh per year).

3716 For household dishwashers, the aim is to reduce the standby consumption when the user does
 3717 not switch off the appliance after use by setting low standby ecodesign requirements. Usually,
 3718 this does not affect the usability of the appliance.

3719 For commercial dishwashers, under real conditions, the appliances are usually switched on at
 3720 the start of the work shift to establish the operating status. According to stakeholder feedback
 3721 this happens regardless of the fact that soiled dishes are due to be washed in the foreseeable
 3722 coming period. This means that the appliances (i.e. in this case tank dishwashers in categories 2
 3723 to 6) are in a so called 'ready to use' mode for a longer period of time (sometimes several hours
 3724 depending on the business) and are heated up which means a significant energy consumption
 3725 without the appliances being used at all. The higher consumption of the so called 'ready to use'
 3726 mode of commercial dishwashers compared to the standby consumption of household
 3727 appliances is due to the continuous heating of the tank in order to avoid long preheating times.
 3728 Due to their wash tank that has to be preheated and kept on a certain heat level, categories 2
 3729 to 6 have to be kept in a so called 'ready to use' mode between the dishwashing cycles. For
 3730 categories 2 and 3, the measurement of the power consumption of the 'ready to use' mode is
 3731 specified in EN IEC 63136 (see **Section 3.3.1.1**).

3732 Category 1 machines do not have a 'ready to use' mode; due to their water-change technology
 3733 they can be used immediately. However, they may not be switched off immediately at the end
 3734 of the programme and therefore remain in 'left-on mode' for some time. The 2024 stakeholder
 3735 consultation confirmed the category 1 values. Further, a stakeholder informed that when
 3736 loading and unloading, the device is in 'left-on-mode' and consumes around 0.004 to 0.005 kW
 3737 (half of the 0.01 kW assumed in the study). No later than 10 minutes after the user's last action,
 3738 the device goes into standby mode, which reduces energy consumption even further. Therefore,
 3739 these values were considered negligible.

¹⁰⁵ 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.

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 on¹⁰⁶.

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 shift¹⁰⁷, 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	6.5 11.5	n.a.	0.8-2.1
No 6 Multi-tank conveyor-type	10 15	5.5 10.5	n.a.	1.5-2.2

Source: Stakeholder feedback from the 2024 survey.

n.a. not applicable

According to stakeholder feedback, also dishwashers with higher capacities and more intensive use have considerable times in ready-to-use mode as the machines are not running continuously, but rather at certain peak times. 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.

¹⁰⁶ 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.

¹⁰⁷ 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.

3762 The average energy consumption of water tank machines in ready-to-use mode is estimated to
 3763 be around 2 kW. Water-change dishwashers (category 1) have very low energy consumption
 3764 values in their 'left on' mode.¹⁰⁸

3765 5.4.4. Energy, water and detergent consumption under real-life 3766 usage conditions

3767 The following **Table 5-16** summarises the different influencing parameters of the above sections
 3768 and shows the annual consumption of energy, water, detergent, and rinse aid for each of the six
 3769 dishwasher categories under real-life usage conditions. The results show that under real-life
 3770 conditions the additional consumption of energy, water, detergent, and rinse aid might be
 3771 significantly higher compared to ideal conditions. The higher water consumption values in
 3772 comparison to 2011 values can be explained by the effect of considering the manual pre-rinsing
 3773 of the wash ware (see **Section 5.4.1.4**). For the tank-type machines, the 2011 preparatory study
 3774 only considered one initial filling of the tanks per day in its calculation of the energy and water
 3775 consumption, although the data suggest two shifts per day. The one additional tank filling per
 3776 day makes a significant contribution to the total energy and water consumption. Also, the
 3777 energy consumption of tank-type machines due to their 'ready to use' mode has not been
 3778 included in the calculation of the real-life energy consumption in 2011. Finally, for some
 3779 categories the cycle times and the number of dishes washed per year have changed compared
 3780 to the 2011 values, according to stakeholder feedback.

3781 Further stakeholder feedback suggests that an increase in consumption compared to the 2011
 3782 data is also directly related to the different market segmentation post-pandemic and less trained
 3783 personnel. This picture is still consolidating.

108 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).

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	1,663,200 (1,515,900)	52,810 (37,703)	403,524 (255,686)	979 (865)	82
No 6 Multi-tank conveyor-type	4,276,800 (4,009,500)	128,257 (102,229)	763,752 (643,645)	1,765 (2,146)	141

* integrated detergent and rinse aid consumption for Category 1 Undercounter water-change machines

Source: own calculations.

The tables **Table 5-17** to **Table 5-20** below show in detail the additional energy, water (including manual pre-rinsing, see **Section 5.4.1.4**), and detergent consumption due to partial workload, use of different programmes, maloperation, first fill, and standby.

3791 **Table 5-17: Additional energy consumption (real life conditions).**

Dishwasher category	(Ideal) energy consumption, based on partial loads (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	41,580	1,039	3,119	2,765	4,307	52,810	3.18
No 6 Conveyor-type multi-tank	106,920	2,673	8,019	5,761	4,884	128,257	3.00

3792 * Categories 2 to 6: standby = consumption due to 'ready to use' mode

3793

3794 **Table 5-18: Additional water consumption (real life conditions).**

Dishwasher category	(Ideal) water consumption, based on partial loads (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 (per cycle)
No 5 Conveyor-type one-tank	249,480	6,237	18,711	79,200	49,896	n.a.	403,524	24
No 6 Conveyor-type multi-tank	427,680	10,692	32,076	165,000	128,304	n.a.	763,752	18

3795 **See **Section 5.4.1.4** for a sensitivity analysis of the additional water consumption for pre-rinsing.

3796 **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	674	17	51	238	n.a.	979	59
No 6 Conveyor-type multi-tank	1,155	29	87	495	n.a.	1,765	41

3797

3798 **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	75	2	6	n.a.	n.a.	82	5
No 6 Conveyor-type multi-tank	128	3	10	n.a.	n.a.	141	3

3799

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).

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)

Source: Stakeholder consultation 2024.

5.5.2. Maintenance and repair practice

According to the 2011 preparatory study, high-capacity commercial dishwashers are usually serviced regularly. The maintenance of the machines has a preventive function, and signs of wear and tear can be detected and remedied at an early stage. Companies with a high demand for dishwashing, and therefore a high risk in case of failure, usually have a service and inspection contract with the manufacturer or a specialised service provider. This seems to be less common for the smaller undercounter dishwashers. Due to the relatively high initial cost of commercial dishwashers, it is likely that damaged machines will be repaired rather than replaced. At some point, however, the user will replace the machine with a new one. The maintenance and repairs are almost exclusively done at the customers' premises. No additional transport of the devices is necessary. In this context, it is important that customer service can provide a qualified technician quickly when needed.

The table below shows the stakeholder feedback on estimates of the average number of maintenance operations per year per dishwasher category. The range is quite wide with manufacturers' estimates tending to be at the lower end (1 to 4 maintenance operations per year). According to one manufacturer, there are specifications for each machine regarding the scope and intervals of maintenance, but the manufacturer usually does not know whether the operator is following these specifications.

One stakeholder suggests that a reason for the wide ranges of repair and maintenance actions could be due to the lack of a definition of what is meant by 'maintenance' and 'repair'. For example, it is not clear if it only includes the manufacturer's service activities (e.g. according to the specifications for each machine regarding the scope and intervals of maintenance) or also things that the customer does on their own (such as regular cleaning of the appliance).

Therefore, it is suggested to take the median as the number of 'planned, predictive maintenance 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 <u>maintenance</u> actions (numbers <u>per year</u>) (in brackets: range)	Estimated average frequency of <u>repair</u> actions (numbers <u>during lifetime</u>) (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.¹⁰⁹ 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.

¹⁰⁹ [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)

3884 **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

3885 Source: 2024 stakeholder feedback.

3886 Stakeholders were also asked on typical upgrade and repair activities, required time and costs
3887 of the repair of commercial dishwashers. It has to be noted that the values and information
3888 provided below are only exemplary for a few repair activities performed by responding
3889 stakeholders and therefore cannot be generalised to the whole sector.

3890 **Upgrade activities**, time to carry this out and average cost of spare part:

- 3891 - Category 1: values in the same range as for categories 2 and 3
- 3892 - Categories 2 / 3: Installation of pumps for detergent; 1 hour; 200 €
- 3893 - Categories 5 / 6: Installation of pumps for detergent and rinse aid; 2 hours; 350 €

3894 **Repair activities**, time to carry this out and average cost of spare part:

- 3895 - Category 1: values in the same range as for categories 2 and 3
- 3896 - Category 2:
 - 3897 ○ Replacement of the regulation thermostat; 0.5 hour; 40 €
 - 3898 ○ Replacement of probes; 0.5 hour; 55 €
 - 3899 ○ Replacement of a component (not specified); 0,75 hour; 100 €
- 3900 - Category 3:
 - 3901 ○ Replacement of boiler safety thermostat; 0.5 hour; 54 €

- 3902 ○ Replacement of boiler pressure switch; 1 hour; 54 €
- 3903 ○ Replacement of a component (not specified); 0,75 hour; 100 €
- 3904 - Category 4:
 - 3905 ○ Replacement/Checks auxiliary pump contactor; 0.5 hour; 47 €
 - 3906 ○ Replacement of boiler pressure switch; 1 hour; 54 €
 - 3907 ○ Replacement of a component (not specified); 0,75 hour; 100 €
- 3908 - Categories 5 and 6:
 - 3909 ○ Replacement of probes; 1 hour; 24 €
 - 3910 ○ Replacement of boiler heating elements; 1 hour; 150 €

3911 When asked about the average labour rate for carrying out the upgrade and/or repair activities,
 3912 stakeholders replied that this depended heavily on the labour rates in each country. Further,
 3913 sharing exact details could probably be traced back to a single manufacturer. The range
 3914 suggested was between 60, 90 and 130 Euros per hour in Europe. One stakeholder indicated
 3915 that, as a manufacturer, their repair interventions are not very frequent and are invoiced to the
 3916 dealer, not to the end-user.

3917 5.5.3. Estimated second hand use

3918 According to the 2011 preparatory study, customers can sell the dishwasher on the second-hand
 3919 market if their dishwashing needs change over time. Disadvantage for buyers may be that they
 3920 usually do not get a warranty for the product. In some cases, manufacturers or their dealers may
 3921 act as intermediaries when one of their customers wants to trade in a working appliance and
 3922 another customer is looking for a used appliance. The 2011 study report estimates that the
 3923 market for used dishwashers is around 5 to 10 % of annual sales.

3924 However, stakeholder feedback from the 2024 survey suggests that most dishwashers do not
 3925 have a second life in this sense. They are repaired for as long as it is economically viable and
 3926 then scrapped. For example, in categories 5 and 6, heavily used dishwashers are scrapped after
 3927 8 to 10 years when they are no longer repairable. In about half of the listings, the transport
 3928 dishwashers have a service life of 15 years or more. Even for components, there does not seem
 3929 to be a trade in used spare parts, as is the case for example in the automotive sector.

3930 5.5.4. Collection rates, by fraction

3931 At the end of their use time, the commercial dishwashers become e-waste. Consequently, they
 3932 are professionally dismantled and then disposed of properly, as required by the WEEE Directive.

3933 Stakeholder feedback from the 2024 consultation suggests that refurbishment is not practiced
 3934 as refurbished equipment is not in demand for hygiene reasons. Regular maintenance leads to
 3935 a significant increase in lifetime and this approach is generally used for high-priced commercial
 3936 dishwashers. Refurbishment of used equipment is the exception and is usually only carried out
 3937 on relatively new equipment as the machines really wear out at the end of their life. One
 3938 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) ¹¹⁰	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).

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

¹¹⁰ <https://schrottpreise-aktuell.org/>, sighted on 18/11/2024

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 potable 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.

3999 **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 %

4000 Source: 2011 preparatory study for commercial dishwashers with update from 2024 stakeholder feedback.

4001 The following table gives an overview of possible options, and the share of dishwashers sold or
 4002 installed with the respective option. Both data provided in

4003 **Table 5-25** and **Table 5-26** were considered feasible according to 2024 stakeholder feedback.
 4004 One stakeholder further informed that typically, the primary difference between appliances
 4005 designed for hot water versus cold water connections is the lower tank heating element power.
 4006 Appliances with hot water connection have a standard power heating element as the base
 4007 configuration. For cold water connections, customers can request higher-power heating
 4008 elements. Based on the current description, one might assume that cold water connections are
 4009 most requested (and/or water softeners, reverse osmosis systems, or heat recovery systems are
 4010 more prevalent). However, from the stakeholder's experience this assumption is not accurate.

4011 **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	20 %	80 %	-	-
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 %

4012 Source: 2011 preparatory study for commercial dishwashers with update from 2024 stakeholder feedback

4013 Typical water inlet temperature is 15 °C (cold water). Tank temperatures are between 55 °C and
4014 65 °C (warm water) (see **Section 6.2.2**). One stakeholder informed that for categories 3, 4, 5 in
4015 the case of heat recovery, the rinse circuit is mandatory fed with cold water. Without heat
4016 recovery, however, it is up to the customer who choose in the order phase.

4017 In general, hot water connection leads to shorter programme times and lower energy
4018 consumption of the dishwasher itself. For undercounter water-change dishwashers, stakeholder
4019 feedback suggested that most of the appliances are connected to the customer's hot and cold
4020 water supply in order to benefit from these advantages. However, the overall environmental
4021 and economic advantage of the connection to hot water supply strongly depends on the
4022 customer-specific type of water heating outside the appliance and other infrastructural
4023 parameters, like length and insulation of the stub water line. Therefore, for the calculation of
4024 impacts of the water supply, hot water supply is only considered for tank machines (categories
4025 2 to 6) for the initial filling of the tanks. For category 1, it is assumed that data provided by
4026 stakeholders in terms of the specific energy consumption of the machines are still based on cold
4027 water supply and internal heating of the water within the machines. The external effect of hot
4028 water supply at the customers' premises is not included in the LCA results.

4029 5.6.2. Energy supply / water heating

4030 There are different options for heating the water inside the dishwasher. Based on stakeholder
4031 feedback from the 2024 consultation, the following table shows the proportion of dishwashers
4032 sold or installed with different types of water heating. The basic option is electric heating. Under-
4033 counter and hood-type dishwashers (categories 1, 2 and 3) are only available with electric
4034 heating. According to stakeholders, other types of heating do not make sense as they would
4035 require too much effort for little benefit, as the throughput is lower, and the necessary
4036 infrastructure is often not available.

4037 Stakeholders confirmed that the initial data from the 2011 preparatory study are still up to date
4038 for categories 1 to 3. For categories 4 and 5, the share of electricity for water heating has actually
4039 increased, in category 4 close to 100 % and in category closer to 95 % electricity and 5 % low
4040 pressure steam. Electricity is also increasingly used for water heating in category 6, with figures
4041 ranging from 80 to 90 %.

4042 Tank heating with natural gas no longer plays a role. One reason for this may be the strict
4043 building regulations regarding ambient air conditions. The stakeholder survey did not reveal any
4044 information on the use of solar energy to heat water tanks, so this approach does not seem to
4045 be used in practice yet.

4046

4047 **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)

4048 Source: Stakeholder feedback from the 2024 survey; text in red: updated data compared to 2011 values

4049 **5.6.3. Telecom**

4050 A number of commercial dishwashers are now equipped with features that allow them to be
 4051 connected and 'smart'. This allows the user to know when the machine is on, whether it is under-
 4052 or oversised, control the cycle time, operator waiting time and total working time, and
 4053 consumption values. It also allows remote diagnosis in the event of fault or breakdown.

4054 **5.6.4. Installation / Physical environment**

4055 There is no specific information available on the availability and level of knowledge or training
 4056 of installers. At least the larger dishwashers in categories 2 to 6 need to be installed by trained
 4057 personnel.

4058 Unlike commercial washing machines and tumble dryers, which can be used in shared laundries,
 4059 there appear to be no shared solutions for commercial dishwashers.

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**).

4083 **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	Black cookware and large utensils.
Category 4 Utensil/pot				Conveyor-type	n.a.
Category 5 Conveyor-type one-tank		2 and more	n.a.		
Category 6 Conveyor-type multi-tank					

4084

4085 n.a. = not applicable

4086 Source: Task 4 report of 2011 preparatory study on professional dishwashers, adapted.

4087 There are differences between each of the six categories; however, some of the categories can
 4088 be grouped together: e.g. all dishwashers of categories 2 to 6 work with a tank system, where
 4089 the detergent solution is circulated within the machine and not fully changed between the
 4090 dishwashing cycles. On the contrary, dishwashers of category 1 use fresh water for each cycle.
 4091 Similar groups of certain properties apply for other aspects, like operating principle, type of
 4092 loading, etc.

4093 Regarding the technology there is no essential difference between the dishwasher categories
 4094 under consideration. Most important components of all categories are:

- 4095 - Containment and support structure;
- 4096 - Tanks and / or boilers;
- 4097 - Heating elements;
- 4098 - Motor and pumps;
- 4099 - Spray arms;
- 4100 - Filter system;
- 4101 - Control and display, electronics and sensors, electrics, and
- 4102 - Where applicable, heat exchangers or heat pumps.

4103 Major components of a commercial dishwasher, such as the external panelling and the tank, are
 4104 made of stainless steel. According to stakeholder input, the stainless steel grades used are
 4105 mainly austenitic (304/1.4307; 1.4301) for corrosion resistance, but some ferritic stainless steel
 4106 grade are also used (like 430/1.4016), as well as molybdenum-rich austenitic grades
 4107 (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.

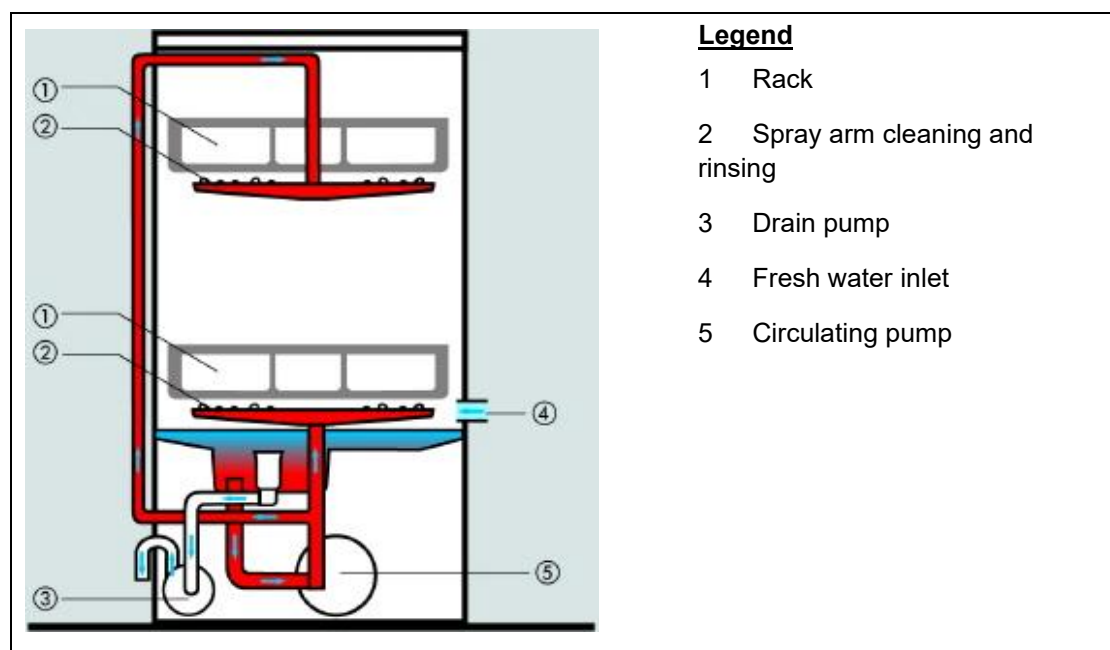


Figure 6-1: Construction of an undercounter water-change dishwasher (category 1).

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);
- Wash period: spraying with warm/hot leach;
- Final rinse period: rinsing with hot water and rinse aid;

4132 - Drying period: drying by use of fresh air or by the residual heat of the final rinse
4133 period.

4134 In general dishwashers work with the mechanical force of water jets. The water jets spray
4135 against every spot on the dish surface, separate the food-soil from the dish and wash it away.
4136 The water is circulated and again sprayed onto the dishes.

4137 Dishwashers of this category work with one set of rotating spray arms for both cleaning and
4138 rinsing (2). Sideward-pointing nozzles are placed on the spray arms to create an inclined plane
4139 of water jets to clean the dishes and rotate the spray arms through the backlash of the water.

4140 The water is drawn from the fresh water inlet (4) and heated in the wash chamber by means of
4141 heating coils. It is then pumped into the spray arms by a circulating pump (5). The drained
4142 detergent solution is collected, and large dirt and food particles are removed through a filter to
4143 avoid damage or blockage of the narrow jet nozzles. The filtered detergent solution is then
4144 pumped into the spray arms (2) again. After the wash period the detergent solution is drained
4145 by a drain pump (3). For the final rinse, fresh water is used that has to be heated using heating
4146 coils.

4147 6.2.1.2. Tank operation

4148 Commercial dishwashers with tank operation can be subdivided into batch dishwashers with
4149 one-tank (categories 2-4) and conveyor-type dishwashers (categories 5 and 6), either one- or
4150 multi-tank. Batch dishwashers need much less space than the spacious conveyor-type
4151 dishwashers. However, the latter allow continuous dishwashing of large amounts of dishes in a
4152 short time.

4153 Batch dishwashers (one-tank)

4154 The following steps can be distinguished in a dishwashing process of one-tank batch
4155 dishwashers:

- 4156 - Wash period: spraying with warm/hot leach (usually between 55°C and 65°C);
- 4157 - Final rinse period: rinsing with hot water and rinse aid (usually between 80 and 85°C; in
4158 case of special glasswashers also lower temperatures between 60 and 65°C possible);
- 4159 - Drying period: drying by use of fresh air or by the residual heat of the final rinse period;
4160 this period often takes place outside the machine; machines with internal drying cycle
4161 (using zeolite technology) are available;
- 4162 - The pre-cleaning is usually performed manually before the items are put into the
4163 dishwasher.

4164 **Figure 6-2** gives an overview of the construction and principal function of tank operated
4165 dishwashers.

4166

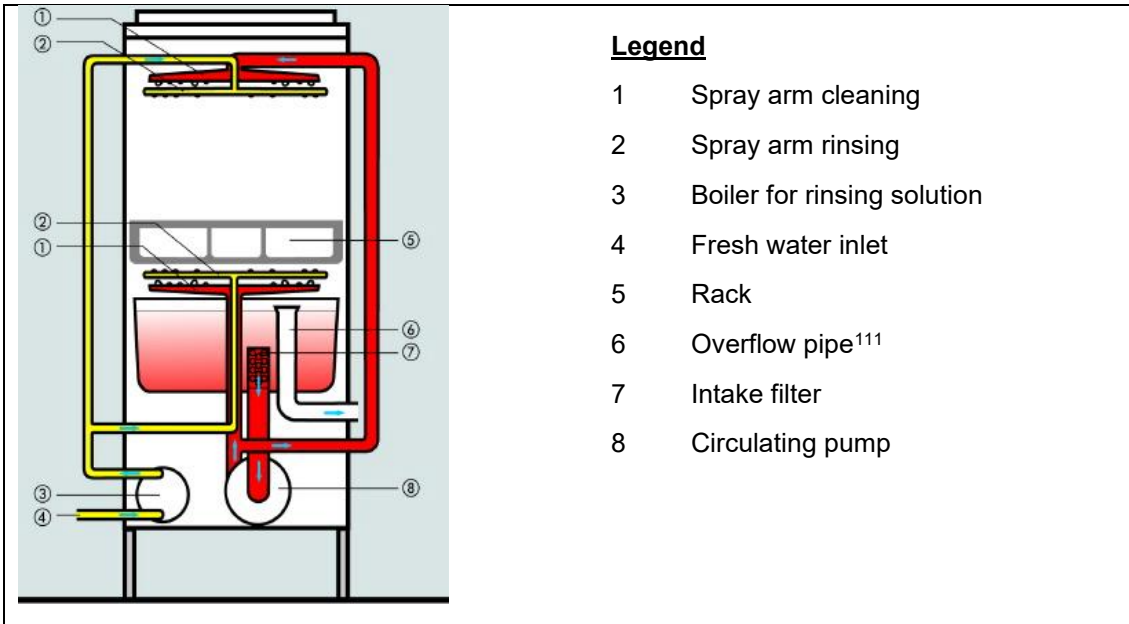


Figure 6-2: Construction of a one-tank batch dishwasher (categories 2 to 4).

Source: Task 4 report of 2011 preparatory study on professional dishwashers.

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).

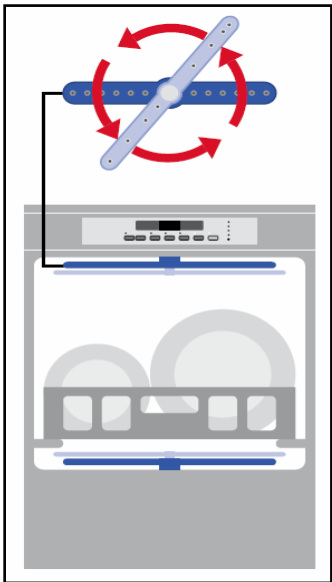


Figure 6-3: Circular movement of the spray arms in tank operated batch dishwashers (categories 2 to 4).

Source: Task 4 report of 2011 preparatory study on professional dishwashers.

¹¹¹ 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.

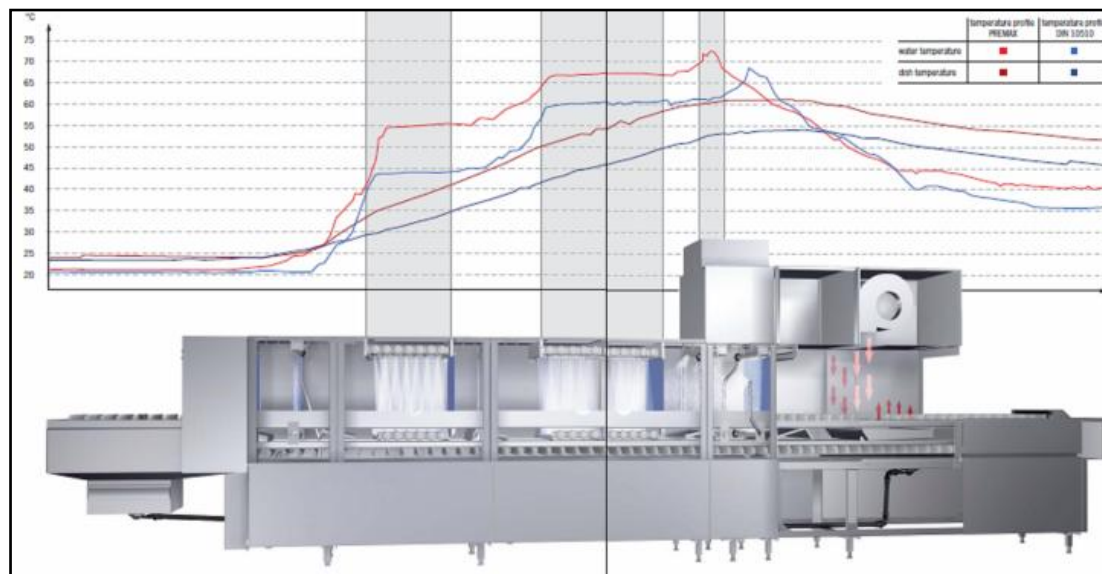


Figure 6-5: Example of a multi-tank conveyor-type dishwasher (category 6).

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**).

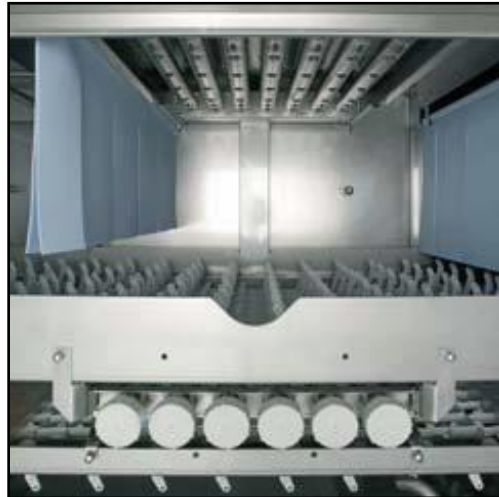


Figure 6-6: Arrangement of wash arms and nozzles.

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).

Source: Task 4 report of 2011 preparatory study on professional dishwashers.

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 overview¹¹².

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

n. a. = not available for the model; x = technology is part of the series or option

6.2.1.3. Differences between water-change and tank operated dishwashers

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).

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.

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 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.

¹¹² Note: Example by one manufacturer; other manufacturers might have different sets of optional configurations.

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.

4326 **Table 6-5: Main characteristics of a typical undercounter one-tank 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

4327 Source: Task 4 of 2011 preparatory study on professional dishwashers; updated with current stakeholder data
4328 highlighted in red colour.
4329

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 hood-type 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
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

Main characteristics	Data from 2011 preparatory study, Task 4 report	Updated data according to stakeholder input from the current study
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 utensil / pot 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 one-tank conveyor-type 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.

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		

Main criteria	Data from 2011 preparatory study, Task 4 report	Updated data according to stakeholder input from the current study
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

4444 systematic and clear distinction between equipment features that are standard design options
4445 and features that can be clearly assigned to a BAT.

4446 **Heat exchanger**

4447 According to the manufacturers, heat exchangers are used in the majority of the appliances (see
4448 chapter 4.4.3), so that an allocation to standard improvement (design) options is obvious for this
4449 option.

4450 However, from a technical point of view, 'heat exchanger' is a generic term because there are
4451 significantly different types of heat exchangers used in commercial dishwashers. Without
4452 claiming to be exhaustive, heat exchangers can be used as follows:

- 4453 - Recovery of waste heat from the wastewater flow.
- 4454 - Recovery of waste heat from the moisture-laden air inside the appliance (vapours).

4455 Heating of the cleaning and rinsing water in cases where the appliance is supplied with thermal
4456 energy in the form of low pressure steam and hot water. However, this is only the case for a
4457 small percentage of the appliances in categories 4 to 6 (see Table 5-17 in **section 5.6.2**) and the
4458 relevance is consistently rated as declining by the manufacturers.

4459 In addition, heat exchangers are technically divided into recuperators (where the two media are
4460 passed through separate spaces) and regenerators (where the hot and cold media pass
4461 alternately through the heat-storing body), as in the case of Zeolite(R) technology. Finally, heat
4462 exchangers vary in their design (from simple plate heat exchangers to so-called water-pocket
4463 heat exchangers to complex tube bundle heat exchangers) and in the way the media are directed
4464 (counterflow versus co-current flow versus cross-flow).

4465 **Improved thermal insulation**

4466 Improving the insulation of the equipment also appears to be a standard improvement option.
4467 Insulation generally has two effects: it can improve the energy efficiency of the equipment by
4468 reducing heat loss, and it can improve working conditions in the dishwashing area (scullery).

4469 Clarification is needed for the further processing of the study with regard to whether improved
4470 thermal insulation is used in all appliance categories, what specific savings can be achieved and
4471 whether recycling is hampered by, for example, composite materials that are difficult to
4472 separate.

4473 **Additional warm/hot water connection, steam-operated heating and gas-operated heating**

4474 The option of heating the operating fluids for cleaning and rinsing in commercial dishwashing
4475 machines using gas, steam or hot water is a standard improvement option. However, the data
4476 in

4477 **Table 5-27, section 5.6.2** indicate that electric heating is at a high level and continues to increase.

4478 Feedback from stakeholders (i.e. manufacturers) on the identified standard improvement
4479 options as presented above was mixed and partly contradictory, probably mainly due to the
4480 different portfolios of appliances they produce. However, the majority of the above-mentioned
4481 options were confirmed. Nevertheless, some manufacturers noted that some features, such as
4482 the hot water connection, are already standard in most of their appliances. For stationary
4483 machines, a hot water connection is always an option, as these machines only have one water
4484 connection point.

4485 Bigger machines, such as conveyor or belt transport machines, can have several water
4486 connection points to speed up the initial filling process at the start of the working day. These
4487 water connections are usually fed with hot water to speed up the filling process. One
4488 stakeholder pointed out that heat exchangers, improved thermal insulation and steam-operated
4489 heating should be considered Best Available Technology (BAT). With regard to steam-operated
4490 heating, some stakeholders raised concerns about these machines being considered as BAT,
4491 given that this technology is state of the art and does not qualify as energy-efficient. It would
4492 only make sense in areas where steam is easily available from natural sources, which is
4493 applicable only in very few areas in Europe. Gas-operated heating, on the other hand, does not
4494 have to be considered at all.

4495 Regarding the standard improvement option of an additional warm/hot water connection, the
4496 question arises as to whether using a local steam or hot water supply provides advantages over
4497 electric heating of operating fluids for cleaning and rinsing, from a holistic energy perspective.
4498 According to stakeholder feedback, this question cannot be easily answered, as it depends on
4499 the hot water and steam energy sources present at the customer site. The assessment also
4500 depends on the individual situation of the appliance operator (e.g. pipe length). Some
4501 stakeholders even doubt whether a steam (or hot water) supply for heating is realistic or
4502 advantageous. Steam production and distribution is considered to be the most expensive form
4503 of energy. In Europe, it is deemed outdated unless there is a geothermal source or a combined
4504 heat and power plant available nearby.

4505 With regard to hot water supply, it is up to the operating company whether it is willing to provide
4506 piping close to the machine, which cannot be influenced by the machine supplier. Additional
4507 product variance would make manufacturing more difficult, resulting in higher costs for the
4508 manufacturer and customer. Another stakeholder pointed out that steam or hot water
4509 generation must be particularly efficient, e.g. with the help of renewable energy or heat pumps,
4510 for this to be advantageous from a holistic energy perspective. Similar discussions have already
4511 taken place regarding a separate hot water connection for household appliances.

4512 **6.2.4. Best Available Technology (BAT)**

4513 As part of a comprehensive research, the following design features were assigned to the
4514 category of Best Available Technology (BAT).

4515 **6.2.4.1. Heat recovery (wastewater and vapours)**

4516 Generally speaking, systems for utilising waste heat are not yet among the standard options for
4517 improvement; they are usually additional options or system components for commercial
4518 dishwashers that can be selected. From a technical point of view, there are two heat sources
4519 that can be used for recovery: firstly, waste heat from wastewater and, secondly, waste heat
4520 from vapours, i.e. the warm, moisture-laden air inside the appliance. In the case of appliances
4521 in categories 5 and 6, the wastewater is already being used due to the design, as the water flow
4522 is directed against the direction of the dishes. Manufacturers apparently use different concepts
4523 for heat recovery. Specifically, systems are offered with and without heat pumps. According to
4524 the manufacturers, the controlled air flow within the appliances is of particular importance for
4525 the question of how heat recovery can be achieved.

4526 To our knowledge, specific and comparable data on effectiveness (i.e. what proportion of the
4527 waste heat is used) and efficiency (i.e. how high are the costs of heat recovery in relation to the
4528 benefits) are not yet available and will need to be clarified with the relevant manufacturers in
4529 the further course of the study. In addition, it is necessary to investigate which systems can be
4530 used in which categories of appliances.

4531 In addition, heat storage systems such as zeolite technology should be further investigated.
4532 These can be considered as a BAT for domestic dishwashers and an application of this technology
4533 for commercial category 1 appliances is conceivable.

4534 There are alternative concepts and technologies without an additional consumable like zeolite,
4535 that can also achieve good consumption values. In some cases, systems are used where the air
4536 to be dried is mixed with ambient air, or systems that enable a kind of recirculation operation.

4537 According to stakeholder feedback, heat recovery is feasible in principle for category 1
4538 dishwashers, but only for programmes with high cleaning and rinsing temperatures. A large
4539 temperature difference is required for energy recovery to be energy efficient. For all other
4540 categories, heat recovery is available for most products, at least as an option.

4541 Concerning zeolite technology, several stakeholders reject its classification as BAT because it is
4542 primarily used to improve the drying process rather than for heat recovery. Since the
4543 regeneration of zeolite requires more energy than adsorption, the entire zeolite drying process
4544 would consume additional energy. Another disadvantage of zeolite technology is that it is
4545 heavily covered by patents. Free use is therefore not considered to be possible. Furthermore,
4546 one stakeholder noted that this technology has the additional drawback of generating zeolite
4547 dust during use, which requires the use of additional equipment such as dust collectors. Also,
4548 zeolite is consumed over time and needs to be refilled or replaced.

4549 **6.2.4.2. Automatic adaptation of programme to load and to soiling level of**
4550 **dishes / utensils**

4551 Several manufacturers offer automatic detection of empty spaces on the conveyor belts or
4552 unfilled racks as an additional option for category 5 and 6 machines. The devices can reduce
4553 rinsing to the areas where the dishes are actually located. This should result in significant savings
4554 of fresh water and rinse aid. In general, further clarification is needed with stakeholders as to

4555 which automatic adjustment options in line with BAT are available for which appliance
4556 categories and what energy, water and detergent savings could be achieved as a result.

4557 Stakeholders commented in this respect that an automatic programme for recognising loads and
4558 soils is a feasible solution that would provide practical benefits. It should be noted, however,
4559 that additional sensors would be required in the devices. Automatic adjustment for category 1
4560 dishwashers is not currently available. For categories 2 and 3, automatic detection of the rack
4561 via magnetic sensors allows the correct cycle to be performed depending on the items to be
4562 washed on that rack, such as dishes, glasses or bottles. In the case of conveyor appliances, a
4563 reed sensor can detect whether each row or rack position contains items to be washed (or
4564 whether a rack is present) and activate the relevant phase when needed.

4565 The additional cost of the sensors should also be taken into account. This is why many
4566 manufacturers currently offer a wide range of programmes, enabling them to meet customer
4567 needs as closely as possible without exceeding economic limits.

4568 In this context, stakeholders also mentioned that some manufacturers produce their own
4569 cleaning and care products alongside the appliances to enable improved coordinated process
4570 technology. This system solution opens up new possibilities for dosing high-concentrate
4571 products, e.g. by integrating them into machines and adapting the process parameters. This
4572 could lead to innovative business models as part of a sustainability strategy, for example by
4573 increasing efficiency through optimised consumption and precise dosing, which reduces
4574 resource consumption.

4575 6.2.4.3. Water treatment (demineralisation and reverse osmosis)

4576 Several manufacturers of commercial dishwashers offer integrated or additional water
4577 treatment systems. Two different processes are offered:

- 4578 - the so-called demineralisation (here, all minerals are removed from the water and
4579 replaced with ions that do not form any residues on the washed items) and
- 4580 - reverse osmosis systems (here, water is passed under high pressure through a
4581 membrane that retains almost all substances).

4582 According to stakeholder feedback, water treatment is already state of the art. A built-in water
4583 softener comes as standard with category 1 appliances and is available as an optional extra with
4584 category 2 and 3 devices. Reverse osmosis is an optional extra for category 1 machinery whereas
4585 it is state of the art for the appliances of category 3, 4, 5, and 6; for category 2, the stakeholder
4586 feedback is diverse with being stated as state of the art by one stakeholder and being an optional
4587 extra feature for category 2 by another stakeholder. Another stakeholder pointed out that water
4588 treatment is important for achieving spotless cleaning results but does not improve the
4589 dishwasher's energy or water efficiency. In fact, water treatment (particularly reverse osmosis)
4590 can have a negative impact on overall water consumption (up to 50% for reverse osmosis).
4591 Therefore, water treatment, and reverse osmosis in particular, should not be considered as BAT.

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.

Additionally, one stakeholder pointed out that low-temperature cleaning cannot be considered Best Available Technology (BAT) in this study because it is a feature of the detergent rather than the dishwasher itself.

6.2.5. Best Not yet Available Technology (BNAT)

A patent research has been carried out to identify technologies or technological features that are currently under research and development or in the early stages of commercialisation. These Best Not yet Available Technologies (BNAT) are currently not widely used, but have the potential to enable significant advances in environmental performance. The research resulted in the following innovations:

6.2.5.1. Supercritical carbon dioxide cleaning

Patent number: CN105686777A

Origin: China

Year of publication: 2016

This technology for dishwashers utilises supercritical carbon dioxide as a cleaning medium, offering high cleanliness and environmental benefits. The design includes a cleaning seal chamber, ultrasonic transducers and a separation kettle for efficient cleaning.

Reference: <https://patents.google.com/patent/CN105686777A/en>

6.2.5.2. Combined ultrasonic and spray cleaning

Patent number: KR20230085690A

Origin: South Korea

4626 Year of publication: 2023

4627 This dishwasher technology integrates ultrasonic cleaning with traditional spray methods,
4628 aiming to enhance cleaning efficiency and reduce water and energy consumption.

4629 Reference: <https://patents.google.com/patent/KR20230085690A/en>

4630 6.2.5.3. Closed loop heat pump drying

4631 Patent number: EP3542114B1

4632 Origin: Europe

4633 Year of publication: 2020

4634 The core of this technology is a drying system that incorporates a heat pump assembly operating
4635 with a primary fluid, connected to multiple heat sources and sinks to improve the energy
4636 efficiency of drying processes.

4637 Reference: <https://patents.google.com/patent/EP3542114B1/en>

4638 6.2.5.4. Enzyme cleaning agents

4639 Patent number: EP3542114B1

4640 Origin: Germany

4641 Year of publication: 2014

4642 This invention relates to a detergent for dishwashers comprising enzymes, phosphorus-free
4643 complexing agents, non-ionic surfactants, propylene glycol and other components. The
4644 formulation is claimed to increase the cleaning efficiency while being environmentally friendly.

4645 Reference: <https://patents.google.com/patent/DE102012107728A1/en>

4646 With regard to the potential for significant improvements in environmental performance,
4647 stakeholders provided heterogeneous feedback. While one stakeholder confirmed relevant
4648 potentials in this respect, another considered the presented technologies to be rather
4649 unpromising. For instance, ultrasonic cleaning requires complete immersion of the washing
4650 items and, as such, a complete redesign of all appliances and operating procedures.

4651 In terms of the different technological approaches, the stakeholder provided the following
4652 detailed feedback:

- 4653 - Supercritical CO₂ cleaning: Initial investigations into possible applications are
4654 publicly available. However, it is not possible to completely remove food
4655 ingredients. Current general conditions rule out its use in areas where unskilled
4656 people handle dishwashers.

- 4657 - Combined ultrasonic and spray cleaning: Ultrasound alone is not effective in
4658 removing a wide range of soiling types, including baked-on and denatured soils.
4659 Cleaning agent ingredients (e.g. alkalis and surfactants) dissolve these soils on the
4660 surface so they can be more easily removed. This is also a highly bespoke system
4661 that can only be implemented in hood-type dishwashers. In this case, it would be
4662 a new appliance rather than an optional retrofittable feature for existing
4663 appliances.
- 4664 - Closed loop heat pump drying: This is a drying system with improved energy
4665 efficiency that is used in industrial applications, such as in the chemical, textile,
4666 food, wood and paper industries. However, it is not specifically designed for use in
4667 category 1 dishwashers and its implementation in 60 cm niche devices is limited.
4668 However, this technology is already available in category 5 and 6 dishwashers from
4669 almost all manufacturers.
- 4670 - Enzyme cleaning agents: A detergent specially developed for dishwashers. This
4671 cleaner formulation contains a particularly high proportion of enzymes. Several
4672 cleaners with similar formulations are already on the market. However, these are
4673 often still not suitable for commercial users as the dissolution time is still too short.
4674 One stakeholder informs that the positive effects are limited due to known
4675 technical barriers in the field of hygiene performance. The compliance with EN
4676 17735 is a mandatory process result of a commercial dishwashing machine. In
4677 addition, the worker safety protection can be affected negatively by the
4678 contaminated waste air.
- 4679 Concerning further BNAT candidates, stakeholders pointed out that disclosing potential
4680 innovations like BNAT could reveal sensitive information about ongoing research and
4681 development projects, which could result in a competitive disadvantage.

4682 6.3. Production, distribution, end-of-life

4683 This section covers the following aspects:

- 4684 - Product weight and Bills-of-Materials;
4685 - Energy use of manufacturing;
4686 - Primary scrap/waste produced during manufacturing;
4687 - Volume and weight of the packaged product;
4688 - Means of transport employed;
4689 - Technical product life (time-to-failure of critical parts);
4690 - Material flows and collection effort at end-of-life (secondary waste), to landfill/
4691 incineration/ recycling/ re-use.

4692 6.3.1. Product weight and Bills-of-Materials

4693 In the following, the Bill-of-Materials (BOM) for each of the commercial dishwasher categories
4694 is presented, as defined in Task 1 (see **section 3.2.3.7**).

6.3.1.1. Category 1: Undercounter water-change dishwashers

According to stakeholder input, the material composition is equivalent to that of a household dishwasher as described in the preparatory study on washing machines and dishwashers (Lot 24). Therefore, the BOM has been taken from the 2011 preparatory study on professional dishwashers, Task 4 report, see

Table 6-11.

Table 6-11: Material composition of an undercounter water-change dishwasher (category 1) - 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
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 %). 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	

4751 6.3.1.4. Category 4: Utensil / pot dishwashers

4752 The following table shows the BOM of a typical dishwasher of category 4 (without granulates¹¹³),
4753 the shares of the different materials and the category to which the materials are assigned. The
4754 dataset is again taken from the 2011 preparatory study on professional dishwashers, Task 4
4755 report, see **Table 6-17**.

4756 **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	

113 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.

4757 Similar to the previous categories, stakeholders generally confirmed the category 4 data from
 4758 the 2011 preparatory study on professional dishwashers. As no specific changes were proposed
 4759 in the 2024 online survey or in written stakeholder feedback on the draft Task 1–4 study report,
 4760 the values from the 2011 preparatory study were left unchanged.

4761 6.3.1.5. Category 5: One-tank conveyor-type dishwashers

4762 **Table 6-18** shows the BOM of a typical dishwasher of category 5, the shares of the different
 4763 materials and the category to which the materials are assigned. The dataset is again taken from
 4764 the 2011 preparatory study on professional dishwashers, Task 4 report.

4765 **Table 6-18: Material composition of a one-tank conveyor-type dishwasher (category 5) - 2011**
 4766 **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 commercial 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 ¹¹⁴
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 generated during sheet metal production is considered to be a relevant parameter for the overall environmental performance of commercial dishwashers.

In this respect, the EcoReport Tool dataset for steel sheet stamping and bending stamping and bending single route, assumes a default value of 5% loss.

However, according to stakeholder feedback, it can be assumed that the pre-consumer stainless steel scrap produced in the manufacturing process has a recycling rate close to 100 %, thanks to an effective scrap market for stainless steel.

¹¹⁴ Due to the data gap, the value of category 2 was used as an proxy value for category 1 in MEER Task 5.

6.3.4. Packaging materials

In the 2011 preparatory study on commercial dishwashers, Task 4 report, packaging materials were included in the BOM of the different dishwasher categories. For the purpose of the present report, these 2011 values have been summarised in following **Table 6-24**.

Table 6-24: Average type and weight of the packaging in the different categories of commercial 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

(Source: Based on final conclusions as presented in Tables 5, 7, 9, 12, 14, and 16 of the Task 4 report of the 2011 preparatory study on professional dishwashers).

The partially wide range of individual packaging materials reflects the differences between dishwashers from different manufacturers. Several stakeholders emphasised that the exact weights depend heavily on the individual models and options selected, the destination country and the required means of transport (e.g. ocean freight). For category 6 in particular, quantities can vary significantly depending on how many parts the appliance is split into for shipping, and the number of parts depends on the 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). Several manufacturers pointed out that they will also need to comply with the PPWR, which should be taken into consideration in order to avoid double regulation. Hence, they recommend excluding the optimisation of packaging from the impact assessment as the upcoming PPWR will focus on this aspect.

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 **Table 6-26** that once more mirrors a wide range of differences between dishwashers from various manufacturers.

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 2011 values	Average volume of the final packaged product 2024 values	Average weight of the final packaged product 2011 values	Average weight of the final packaged product 2024 values
Category 1: Undercounter water-change dishwashers	0.40 m ³	0.48 m ³	ca. 50 kg	72.5 kg

Commercial dishwasher category	Average volume of the final packaged product 2011 values	Average volume of the final packaged product 2024 values	Average weight of the final packaged product 2011 values	Average weight of the final packaged product 2024 values
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).

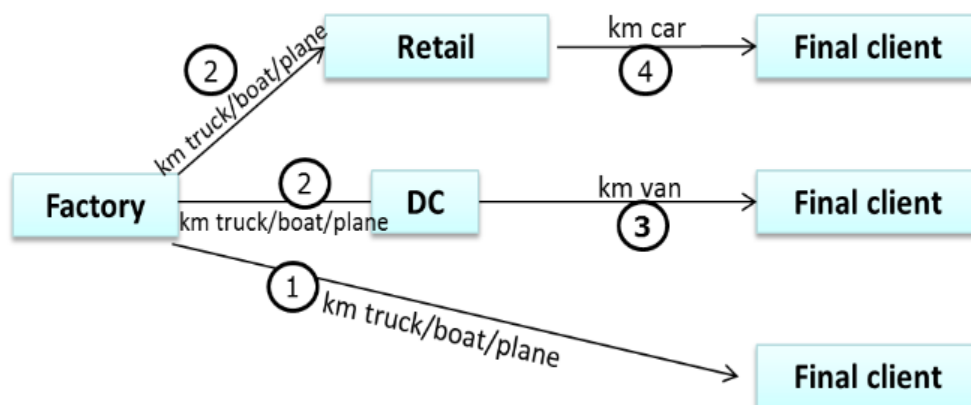


Figure 6-15: Default transport scenario according to PEFCR (European Commission, 2018a).

It is assumed that only direct delivery to the final client and delivery via a distribution centre (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 an intra-continental 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. MEER 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 MEER) 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:

- 4921 - Thermal recycling: 70 %.
- 4922 - Material (or mechanical) recycling: 29 %
- 4923 - Re-use, closed loop recycling: 1 %

4924 Printed wiring boards (PWB) are used in dishwashing machines of all categories. According to
4925 stakeholder information, these parts are easy to dismantle and are completely recycled by
4926 certified scrap dealers.

4927 If a dishwasher with an installed heat pump is dismantled, specialised technicians will extract
4928 the refrigerant from the heat pump. In this process, only a technically unavoidable, small amount
4929 of refrigerant will escape.

4930 6.4. Aspects beyond MEErP

4931 Beyond the aspects foreseen under the current methodology for energy-related products, the
4932 study team will also consider further specific aspects with relevance to the new regulatory
4933 scheme under ESPR, especially Article 5 on ecodesign requirements and on Article 8ff. on a
4934 Digital Product Passport (DPP).

4935 6.4.1. Analysis of critical raw materials and substances of concern

4936 This relates in particular to the presence of critical raw materials (CRM) and the analysis of
4937 potential substances of concern (SoC). Within this context, the following substances were
4938 covered by the desk research and the 2nd stakeholder consultation in 2024.

4939 6.4.1.1. Refrigerants

4940 Dishwashers of categories 3, 5 and 6 can be equipped with a heat pump containing refrigerants.
4941 The refrigerants used are R-134a (tetrafluorodichlorethene), R-407C (a hydrofluorocarbon blend
4942 of R-32, R-125, and R-134a), R-513a and others with an average filling of approx. 1.5 kg.
4943 According to stakeholder feedback, refrigerants are not used in the other dishwasher categories
4944 1 to 4. As the use of heat pumps is considered as BAT (Best Available Technology), this aspect
4945 will be further elaborated in Task 6.

4946 6.4.1.2. Mercury

4947 According to stakeholders, the dishwashers of all six categories do not contain mercury. All
4948 materials used within the products comply with the restrictions set out in the RoHS Directive (cf.
4949 **section 3.4.1.4**).

4950 6.4.1.3. Silver ions

4951 According to stakeholders, the dishwashers of all six categories do not contain silver ions. There
4952 is no need of silver ions in dishwashers, because there are other possibilities (temperature,
4953 chemistry, steam) to guarantee hygienic standards.

4954 6.4.1.4. Permanent magnets (containing neodymium)

4955 According to input received during the 2nd stakeholder consultation in 2024, permanent magnets
4956 containing neodymium are used in drive and fan motors, microswitches (reed contact), sensors
4957 for detecting fill levels, spray arm speeds, position detection of sieves, flaps, floats, flow meters,
4958 etc. Ferrite-based permanent magnets are also used in cutlery lifting magnets, electric pumps
4959 as well as sensors.

4960 With regard to the corresponding quantities, stakeholders reported for motors 6 magnets of
4961 11.5 g each or 4 magnets of 3.4 g each (NdFeB), for reed magnets approx. 100 g, for door locks
4962 1.5 g (NdFeB). Drain pumps contain 38.5 g (ferrite), sensors contain various ferrite magnets of
4963 approx. 1 g each, cutlery lifting magnet approx. 5-10 kg (ferrite).

4964 Regarding the advantages of permanent magnets (containing neodymium), stakeholders
4965 mentioned their effectiveness, reliability and affordability. Alternatives for motors are
4966 considered to be inferior in terms of efficiency, performance and energy consumption. For many
4967 applications, contactless signal or force transmission using permanent magnetism is seen as a
4968 solution with no known alternatives. Where mechanically activated door switches are used, the
4969 risk of malfunction due to dirt / vapour / chemicals and mechanical influences is considered to
4970 be high. In the case of reed switches, magnet-based components reduce the failure rate by
4971 operating in harsh and dirty conditions. Disadvantages of neodymium-based permanent
4972 magnets are corrosion problems. This is not the case with ferrite-based permanent magnets.

4973 6.4.1.5. Other critical raw materials

4974 Stakeholders mentioned copper, which is used in wires, as well as several other critical raw
4975 materials used in electronic boards and circuits.

4976 6.4.1.6. Other substances of concern

4977 According to stakeholder input, lead is contained in copper and brass alloys as well as in heating
4978 elements. Furthermore, boric acid, PTFE and PVDF were mentioned. This information is
4979 applicable to all dishwashing categories.

4980 Furthermore, it must be noted that many more critical raw materials (CRMs) and substances of
4981 concern (SoCs) are commonly used in dishwashing appliances. These contain generic electronic
4982 parts, among other components, and are connected to the drinking water system. Substances
4983 that should be present in almost all standard appliances include, for example, the following (CAS
4984 No):

4985 - 7439-92-1

- 4986 - 22673-19-4
- 4987 - 1317-36-8
- 4988 - 127-19-5
- 4989 - 96-45-7

4990 In addition to that, PFAS is considered to be a widespread issue and likely to be present in various
 4991 components of commercial dishwashing appliances. Currently, it is assumed by stakeholders
 4992 that producing an appliance without PFAS is technically impossible.

4993 6.4.2. Analysis of circular economy aspects

4994 Beyond these aspects foreseen under the current methodology for energy-related products, the
 4995 study team will also consider further specific aspects within the context of circular economy with
 4996 relevance to the new regulatory scheme under ESPR, especially Article 5 on ecodesign
 4997 requirements and on Article 8ff. on a Digital Product Passport, which are the following:

4998 Special focus on existing design approaches for circular economy (durability, reliability,
 4999 reparability, maintenance, refurbishment) and resource efficiency, as well as current materials,
 5000 components or technologies potentially impeding a circular approach, such as:

- 5001 - Integrated components like electronics;
- 5002 - Existing application of recycled materials;
- 5003 - Remanufacturing and recycling technologies;
- 5004 - Application of novel production technologies like 3D-printing, relevant in terms of
 5005 environmental impacts or availability of spare parts for commercial dishwashers;
- 5006 - Existing approaches of the commercial dishwasher's sector to develop Digital
 5007 Product Passports¹¹⁵.

5008 In terms of reparability, the importance of spare parts is obvious. For the possibility to estimate
 5009 the impact of maintenance and repair, the MEERP methodology foresees taking a present
 5010 percentage of the impacts of the materials as inputs to the Bill of Materials. In the 2011
 5011 preparatory study, a default value = 1 % was taken as percentage for all categories. This estimate
 5012 was confirmed by the feedback from the 2nd stakeholder consultation in 2024.

5013 In this context, a manufacturer emphasised the importance of supplying spare parts for the full
 5014 lifetime of the appliances, even after production has ceased. In many cases, these parts are
 5015 available well beyond the lifetime.

115 In parallel to this preparatory study on commercial dishwashers, the JRC was developing a methodology for the preparation of a DPP. When publishing this report, this method has not yet been published and could therefore not be used within this study for the analysis and proposal of DPP requirements and design.

6.4.3. Analysis and consideration of DPP-induced requirements

6.4.3.1. DPP-requirements

The ESPR outlines several requirements for the Digital Product Passport (DPP) in Chapter III, Articles 9 to 15:

- Article 9 Digital product passport;
- Article 10 Requirements for the digital product passport;
- Article 11 Technical design and operation of the digital product passport;
- Article 12 Unique identifier;
- Article 13 Digital product passport registry;
- Article 14 Web portal for data in the digital product passport;
- Article 15 Customs controls relating to the digital product passport.

Two exceptions are specified in the ESPR 2024/1781, Article 9, paragraph 4, regarding cases when a DPP is not required:

- '4. When setting the requirements related to the digital product passport, the Commission may exempt product groups from the requirement to have a digital product passport where:
 - technical specifications of the digital product passport are not available in relation to the essential requirements included in Articles 10 and 11; or
 - other Union law includes a system for the digital provision of information related to a product group which the Commission considers achieves the objectives referred to in paragraph 3, points (a) and (b).'

Regarding Article 9, paragraph 4, the EPREL database serves as a system under Union law for the digital provision of information. Currently, commercial dishwashers are not included in the EPREL system. However, there is potential for using the EPREL system, as the product group is similar to household dishwashers, especially considering that the revised MEErP methodology is not yet available. The EPREL system operates on a centralised database, with information accessible via a website and a QR code linking to the website's information. EPREL focuses on energy-related information, meaning that other ecodesign-related information is currently not included. Therefore, EPREL may not be sufficient for all product groups with new system or information requirements.

6.4.3.2. Options to decide for existing EPREL system or new DPP system

There are three main options to meet new (DPP and information) requirements, exemplified in the following **Table 6-27** and described below:

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 commercial 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

- Option 1: The product group already exists within the EPREL system, meaning the exemption from DPP requirements according to ESPR 2024/1781, Article 9, paragraph 4(b) applies. In this case, the EPREL system can be used, but there may be new information that is relevant. While the EPREL system is sufficient, the information it contains needs to be expanded.
 - Option 2: The product group is not yet included in EPREL, but the EPREL system and/or information might still be sufficient. In this case, the EPREL system can be extended by adding a new product category with similar information and system features (e.g., QR code).
 - Option 3: The product group is not present in EPREL, and there are requirements that EPREL cannot meet. In this situation, the requirements must be evaluated, and the DPP system and information design specified. For example, a QR code may not be 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.

6.4.3.3. Approach to define information and system requirements

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/study foresees the use of so-called 'use cases' to define the necessary DPP information and system requirements (as required by ESPR Article 9-12). DPP use cases are specific objectives such as "informed purchase decision" towards environmental or economic benefit and that can be achieved/supported with information. That means, for some use cases, a simple QR code and model-level information are sufficient, while other require more complex technical structures (e.g. NFC chip) and information (item level). The following **Table 6-28** shows the use case developed in the Battery Pass and CIRPASS projects for the electronics sector. Important to note - there is a qualitative assessment (rating) by experts in the right column.

5077 **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

5078 This use case-oriented approach will make it possible to determine whether specific use cases,
5079 such as 'more efficient recycling processes' are relevant. For example, relevance may arise when
5080 waste products contain several hazardous substances or valuable materials, such as CRMs.
5081 Providing this information to recyclers is critical to effectively sorting products within the waste
5082 stream. It is therefore important to ensure that the necessary data is included in the DPP, or
5083 another system for the digital provision of information which the Commission considers
5084 achieves the DPP objectives. The use case also includes considerations for the DPP system.

5085 All use-cases, their relevance and the entailed effort needs to be further validated by all sector-
5086 specific and relevant stakeholder, e.g. manufacturer, repairer, waste collector/recycler. The
5087 initial feedback from stakeholder:

- 5088 - Several stakeholder mention, that "usage/operating history" and "repair history"
5089 should not be mandatory required for the DPP, as producers have not always access
5090 to this data as the appliances also distributed by third party sellers.
- 5091 - "batteries" are not relevant for commercial dishwashers
- 5092 - Product identification: Manufacturers should be able to use a domain name that
5093 they own, and codify product identification (on model, batch, or item level) under
5094 their own responsibility. This choice has several advantages:
- 5095 - Product identification: the identifiers can be assigned without a central registration
5096 authority; except for the manufacturer domain name which must be registered in
5097 the DNS system
- 5098 - Product identification: no incremental cost for each created identifier is incurred.
- 5099 - Product identification: Identifiers can be implemented on a granularity level that is
5100 useful for the product under consideration: either on item level for products that

5101 bear an individual serial number, or on product model or batch level where
5102 serialisation is not applied.

5103 For the DPP system, the type of data carrier is particularly important. A QR code may be suitable
5104 for larger products that are unlikely to be exposed to dirt or wear and tear, as it ensures that the
5105 code remains readable throughout the life cycle of the product. For smaller products, where a
5106 QR code may not be practical, an RFID chip may be required.

5107 The logic for deriving use case based DPP information and DPP system aspects will need to be
5108 defined by the JRC as part of a harmonised methodology under the revised MEERp. Following
5109 this logic, use cases and associated DPP requirements will be provided in Task 5 of this
5110 Preparatory Study. The use case approach takes into account, among other factors, the
5111 relevance of the CRM content and information required for specific stakeholders, the data
5112 carrier (QR code or RFID chip) and the DPP registry. It is important to note that the harmonised
5113 approach to the analysis of DPP requirements will be introduced with the revision of the MEERp.
5114 Therefore, this analysis is qualitative and addresses DPP essentials, but will not include the full
5115 quantitative analysis of stakeholder-specific DPP requirements.

5116 The design measures developed under Task 6 of the Preparatory Study will include the
5117 information to be included into the DPP, or another system for the digital provision of
5118 information which the Commission considers achieves the DPP objectives.

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

5155 address this, BCs approximate the 'average' product and serve as a basis for extrapolating the
5156 environmental impacts across the entire market for the product category under review.

5157 7.1.1.2. Life Cycle Cost (LCC)

5158 As part of the study, the Life Cycle Costs (LCC) for each BC will be calculated using the structured
5159 methodology outlined in the MEERp. The LCC analysis encompasses key cost elements over the
5160 product's lifecycle, including product price and operational costs. Both the LCA and LCC
5161 calculations are then scaled to the EU-27 level for each BC. This broader market-based
5162 perspective allows for an evaluation of implications at scale. This dual approach ensures the
5163 study delivers actionable insights for stakeholders, facilitates robust policy development, and
5164 identifies opportunities to optimise both environmental and economic outcomes across the
5165 market.

5166 7.1.1.3. New considerations in environmental analysis and LCC

5167 This assessment incorporates updates introduced to the MEERp process based on the review
5168 and the new aspects resulting from the Ecodesign for Sustainable Products Regulation (ESPR).
5169 These updates address:

- 5170 - **Lifetime Extension:** Factors such as durability, reliability, reusability, upgradability,
5171 reparability, maintenance, and refurbishment.
- 5172 - **Material Efficiency:** Considerations such as recycled content usage.

5173 The ERT has been revised to integrate these elements, enabling more comprehensive
5174 evaluations of environmental impacts and LCCs.

5175 7.1.2. Data quality and sensitivity analysis

5176 The study is based on data extrapolated from literature and stakeholder input. While every
5177 effort has been made to ensure accuracy, variations in real-world performance introduce an
5178 element of approximation that cannot be entirely avoided. To maintain transparency, the quality
5179 and sources of each data point used are documented for the BC according to the criteria
5180 indicated in **Table 7-1: Data quality scoring**.

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 MEErP 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 Base Case 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)

5210 **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

5211 Data in the following tables (**Table 7-3** to **Table 7-8**) is derived from the Task 1-4 in this report.5212 **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)	50
Lifetime (years)	12
Average price (€)	3,148
Annual sales (units per year)	8,250
Maintenance and repair costs (€/lifetime)	1,385
Energy consumption wash (kWh/cycle)	1.26
Water consumption (litres/cycle)	31.42 (see Section 5.4.4, Table 5-18: split into 17.5 litres ideal consumption -3.0 litres due to use of other programmes +1.8 litres due to maloperation +15.2 litres due to manual pre-rinsing)

Description	Characteristic
Integrated detergent and rinse aid consumption (kg per cycle)	0.022

5213

5214 **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)	178,760
Maintenance and repair costs (€/lifetime)	2,490
Energy consumption wash (kWh/cycle)	0.42
Water consumption (litres/cycle)	9.8 (see Section 5.4.4, Table 5-18: split into 3.0 litres ideal consumption +0.2 litres due to maloperation +0.5 litres due to initial tank fillings +6.2 litres due to manual pre-rinsing)
Detergent consumption (kg per cycle)	0.011
Rinsing agent consumption (kg per cycle)	0.001

5215 **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)	66,004
Maintenance and repair costs (€/lifetime)	3,812
Energy consumption wash (kWh/cycle)	0.43
Water consumption (litres/cycle)	4.7 (see Section 5.4.4, Table 5-18: split into 2.3 litres ideal consumption +0.1 litres due to maloperation +0.7 litres due to initial tank fillings +1.5 litres due to manual pre-rinsing)
Detergent consumption (kg per cycle)	0.010
Rinsing agent consumption (kg per cycle)	0.001

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5217 **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)	13,751
Maintenance and repair costs (€/lifetime)	4,776
Energy consumption wash (kWh/cycle)	1.35
Water consumption (litres/cycle)	12.96 (see Section 5.4.4, Table 5-18: split into 6.0 litres ideal consumption +0.3 litres due to maloperation +6.7 litres due to initial tank fillings)
Detergent consumption (kg per cycle)	0.036
Rinsing agent consumption (kg per cycle)	0.002

5218

5219 **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)	891.29
Lifetime (years)	11
Average price (€)	13,394
Annual sales (units per year)	5,500
Maintenance and repair costs (€/lifetime)	5,894
Energy consumption wash (kWh/hour)	45.72 (including energy consumption electricity, energy consumption heat, and energy consumption heat for water heating of tank fills); ideal consumption plus additional energy consumption due to different programmes, mal-operation and standby.
Water consumption (litres/hour)	349.4 (see Section 5.4.4, Table 5-18: split into 215.9 litres ideal consumption +5.4 litres due to different programmes +16.2 litres due to maloperation +68.6 litres due to initial tank fillings +43.2 litres due to manual pre-rinse)
Detergent consumption (kg per hour)	0.847
Rinsing agent consumption (kg per hour)	0.071

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5222 **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)	2,750
Maintenance and repair costs (€/lifetime)	10,062
Energy consumption wash (kWh/hour)	86.37 (including energy consumption electricity, energy consumption heat, and energy consumption heat for water heating of tank fills); ideal consumption plus additional energy consumption due to different programmes, mal-operation and standby.
Water consumption (litres/hour)	514.3 (see Section 5.4.4, Table 5-18: split into 288.0 litres ideal consumption +7.2 litres due to different programmes +21.6 litres due to maloperation +111.1 litres due to initial tank fillings +86.4 litres due to manual pre-rinse)
Detergent consumption (kg per hour)	1.189
Rinsing agent consumption (kg per hour)	0.095

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7.3. Product-specific inputs

In this section, the specific inputs for the ERT are described per life cycle stage of the Base Cases. Detailed input tables per Base Case are in **Appendix 4**.

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**). For all raw material inputs, the default ERT recycled content (R1, 30% for aluminium, 0% for all other materials) 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**). For some Base Cases, no data was available. For wood, a proxy was used (**Table 7-10**).

5245 **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

5246 **7.3.3. Manufacturing & Assembly**

5247 The manufacturing of the raw materials (e.g. polypropylene granulates) into a component was
5248 modelled with a process (e.g. injection moulding for plastics) in the Manufacturing & Assembly
5249 life cycle. The datasets used are provided per Base Case in **Appendix 4**. For several raw materials
5250 however, proxy datasets were used as no specific manufacturing process was available.

5251 **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

5252 In addition, the electricity consumption for assembly of the product was included in this life
5253 cycle. The electricity consumption was derived from stakeholder data that was provided for all
5254 Base Cases except BC1. An assumption was made that the electricity consumption for the
5255 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. According to the PEF default values, a total distance of 640 km, divided between three different transport modes, was included for supplier to factory transportation and 1,200 km of truck transport for factory to client transportation. 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.

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

7.3.5. Use phase

In the use phase, energy (both electricity and heat), water and detergent use (if applicable) were modelled according to the input data derived from Task 1 to 4 in this report. Real life annual energy, water (including external pre-rising; for details, see Section 5.4.1.4) and detergent use were modelled as inputs for the LCA instead of ideal conditions, as described in Table 7-13. Detailed data input and calculations can be found in Appendix 4.

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	1,768.2	6,969.2	14,065.7	11,872.3	47,528.9	109,018.7
Heat consumption for water heating (within machine)*	kWh/year	0	0	0	242.3	5,281	19,238.6
Heat consumption for external water heating (outside the machine)**	KWh/year	0	94.1	313.5	940.5	1,655.3	3,448.5
Water consumption***	m ³ /year	43.9	163.2	154.9	116.7	403.5	763.8
Detergent consumption	kg/year	31	183	315	324	979	1,765
Rinsing agent consumption	kg/year	0	16	24	17	82	141

* this refers to heat produced within the machine, assumed to be generated from natural gas combustion; ** heat produced outside of the machine, assumed to be generated from natural gas combustion;

*** this includes the water consumption for manual pre-rinsing; for more information and sensitivity analysis, see section 5.4.1.4 and split of input data in section 7.2.

Total energy use was provided, which was subdivided into electricity and heat for internal heating of water. The shares are based on **Table 5-27** of Tasks 1-4 of the current preparatory study and provided in the input tables in **Appendix 4**. In addition, for some Base Cases, hot water supply (heated up outside the machine) was included (as indicated in **Table 5-26**). 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. This value is provided by the EcoReport Tool in case that there are no more detailed stakeholder input data.

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, 50% for electronics, 85% for aluminium and (stainless) steel, 0% for other materials) and the allocation factor (A coefficient, 20% for metals and 50% for all other materials) 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**.

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.

. 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**.

Table 7-14: Life cycle costing input data for all dishwasher 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**. 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
- Resource use, fossils, in MJ

The LCA results are reported for each impact category and each life cycle stage:

- Raw materials
- Manufacturing
- Distribution
- Packaging
- Use
- Maintenance and repair
- End-of-life (impacts and credits)

A detailed breakdown of the results is provided in **Appendix 5 – Results of LCA / LCC per Base Case**.

7.4.1. Results overview LCA

Table 7-15 and **Table 7-16** contain an overview of the impact of commercial dishwashers for the total life cycle impact and per year of use respectively. It can be observed from the tables that BC5 and BC6 have the highest energy use. As a consequence, BC5 and BC6 also have the highest impact across all impact categories, whereas Base Cases BC1 and BC2 have the lowest impact across all impact categories. This can be attributed mainly to the size of each product and the higher nominal capacity. Specifically, BC5 and BC6 are the heaviest products and BC1 and BC2 are the least heavy. Furthermore, products with higher nominal capacity (BC5 and BC6) have a higher energy, water, detergent and rinsing agent consumption, leading to higher impacts across most impact categories compared to products with a lower weight and nominal capacity (e.g. BC1 and BC2).

When observing the results per year of use (**Table 7-15** and **Table 7-16**), in general, Base Cases BC5 and BC6 still show the highest impact per year of use, while Base Cases BC1 and BC2 show the lowest impact per year of use. However, when observing the results per cleaned dish, BC5 and BC6 show the lowest impact across most impact categories, due to the large number of dishes cleaned per year (

Table 7-17). For BC4, the results are presented per cycle as no number of cleaned dishes is relevant for this type of machine.

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	2.12E+04	5.57E+04	1.13E+05	1.07E+05	5.23E+05	1.64E+06
Thermal energy	MJ	0.00E+00	2.57E+03	8.59E+03	3.65E+04	2.62E+05	1.17E+06
PEF Impact categories							
Climate change, total	kg CO ₂ eq	9.99E+03	2.65E+04	5.19E+04	5.13E+04	2.52E+05	7.93E+05
Ozone depletion	kg CFC-11 eq	1.49E-05	4.39E-05	6.41E-05	6.45E-05	2.70E-04	7.25E-04
Human toxicity, cancer	CTUh	5.87E-06	2.48E-05	4.60E-05	5.71E-05	2.33E-04	4.64E-04
Human toxicity, non-cancer	CTUh	8.13E-05	2.09E-04	3.09E-04	2.90E-04	1.34E-03	3.74E-03
Particulate matter	disease incidence	3.73E-04	1.03E-03	1.95E-03	1.92E-03	9.00E-03	2.65E-02
Ionising radiation, human health	kBq U235 eq	3.89E+03	1.02E+04	2.05E+04	1.95E+04	9.53E+04	2.97E+05
Photochemical ozone formation, human health	kg NMVOC eq	1.83E+01	4.94E+01	9.36E+01	9.13E+01	4.34E+02	1.32E+03

Environmental aspect	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Acidification	mol H+ eq	3.24E+01	8.83E+01	1.71E+02	1.67E+02	7.91E+02	2.38E+03
Eutrophication, terrestrial	mol N eq	6.76E+01	1.85E+02	3.55E+02	3.46E+02	1.64E+03	4.92E+03
Eutrophication, freshwater	kg P eq	1.44E-01	4.20E-01	5.67E-01	5.67E-01	2.39E+00	6.40E+00
Eutrophication, marine	kg N eq	7.24E+00	2.06E+01	3.80E+01	3.75E+01	1.74E+02	5.12E+02
Ecotoxicity, freshwater	CTUe	5.38E+04	1.47E+05	2.74E+05	2.67E+05	1.26E+06	3.74E+06
Land use	pt	1.66E+05	3.56E+05	5.86E+05	7.12E+05	5.02E+06	9.03E+06
Water use	m ³ water eq. of deprived water	1.23E+04	3.16E+04	3.99E+04	3.62E+04	1.63E+05	4.58E+05
Resource use, minerals and metals	kg Sb eq	4.02E-02	9.96E-02	1.61E-01	1.72E-01	9.04E-01	1.71E+00
Resource use, fossils	MJ	1.70E+05	4.49E+05	8.87E+05	8.73E+05	4.29E+06	1.35E+07

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5369 **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	1.77E+03	6.97E+03	1.41E+04	1.19E+04	4.76E+04	1.09E+05
Thermal energy	MJ	0.00E+00	3.21E+02	1.07E+03	4.05E+03	2.38E+04	7.78E+04
PEF Impact categories							
Climate change, total	kg CO ₂ eq	8.33E+02	3.32E+03	6.49E+03	5.70E+03	2.29E+04	5.29E+04
Ozone depletion	kg CFC-11 eq	1.24E-06	5.49E-06	8.01E-06	7.16E-06	2.46E-05	4.83E-05
Human toxicity, cancer	CTUh	4.90E-07	3.10E-06	5.74E-06	6.34E-06	2.12E-05	3.09E-05
Human toxicity, non-cancer	CTUh	6.78E-06	2.62E-05	3.86E-05	3.22E-05	1.22E-04	2.50E-04
Particulate matter	disease incidence	3.11E-05	1.29E-04	2.44E-04	2.13E-04	8.18E-04	1.77E-03
Ionising radiation, human health	kBq U235 eq	3.24E+02	1.28E+03	2.56E+03	2.17E+03	8.66E+03	1.98E+04

Photochemical ozone formation, human health	kg NMVOC eq	1.53E+00	6.17E+00	1.17E+01	1.01E+01	3.95E+01	8.78E+01
Acidification	mol H+ eq	2.70E+00	1.10E+01	2.13E+01	1.85E+01	7.19E+01	1.59E+02
Eutrophication, terrestrial	mol N eq	5.63E+00	2.32E+01	4.44E+01	3.85E+01	1.49E+02	3.28E+02
Eutrophication, freshwater	kg P eq	1.20E-02	5.25E-02	7.09E-02	6.30E-02	2.17E-01	4.27E-01
Eutrophication, marine	kg N eq	6.03E-01	2.58E+00	4.75E+00	4.17E+00	1.58E+01	3.42E+01
Ecotoxicity, freshwater	CTUe	4.48E+03	1.84E+04	3.42E+04	2.96E+04	1.14E+05	2.50E+05
Land use	pt	1.38E+04	4.45E+04	7.32E+04	7.91E+04	4.56E+05	6.02E+05
Water use	m ³ water eq. of deprived water	1.03E+03	3.95E+03	4.98E+03	4.02E+03	1.48E+04	3.05E+04
Resource use, minerals and metals	kg Sb eq	3.35E-03	1.25E-02	2.01E-02	1.91E-02	8.22E-02	1.14E-01
Resource use, fossils	MJ	1.41E+04	5.62E+04	1.11E+05	9.70E+04	3.90E+05	9.02E+05

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5371 **Table 7-17: Total life cycle impact per commercial dishwasher Base Case per number of**
5372 **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	237,600	475,200	9,000 (cycles per year)	1,663,200	4,276,800
Energy consumption							
Electricity	kWh	3.37E-02	2.93E-02	2.96E-02	1.32E+00	2.86E-02	2.55E-02
Thermal energy	MJ	0.00E+00	1.35E-03	2.26E-03	4.50E-01	1.43E-02	1.82E-02
PEF Impact categories							
Climate change, total	kg CO ₂ eq	1.59E-02	1.40E-02	1.37E-02	6.33E-01	1.38E-02	1.24E-02
Ozone depletion	kg CFC-11 eq	2.36E-11	2.31E-11	1.68E-11	7.96E-10	1.48E-11	1.13E-11
Human toxicity, cancer	CTUh	9.32E-12	1.30E-11	1.21E-11	7.05E-10	1.27E-11	7.23E-12
Human toxicity, non-cancer	CTUh	1.29E-10	1.10E-10	8.12E-11	3.58E-09	7.33E-11	5.84E-11

Particulate matter	disease incidence	5.92E-10	5.42E-10	5.13E-10	2.37E-08	4.92E-10	4.13E-10
Ionising radiation, human health	kBq U235 eq	6.18E-03	5.39E-03	5.39E-03	2.41E-01	5.21E-03	4.62E-03
Photochemical ozone formation, human health	kg NMVOC eq	2.91E-05	2.60E-05	2.46E-05	1.13E-03	2.37E-05	2.05E-05
Acidification	mol H ⁺ eq	5.15E-05	4.65E-05	4.49E-05	2.06E-03	4.32E-05	3.71E-05
Eutrophication, terrestrial	mol N eq	1.07E-04	9.76E-05	9.33E-05	4.28E-03	8.94E-05	7.66E-05
Eutrophication, freshwater	kg P eq	2.29E-07	2.21E-07	1.49E-07	7.00E-06	1.31E-07	9.98E-08
Eutrophication, marine	kg N eq	1.15E-05	1.08E-05	1.00E-05	4.63E-04	9.49E-06	7.99E-06
Ecotoxicity, freshwater	CTUe	8.54E-02	7.76E-02	7.21E-02	3.29E+00	6.87E-02	5.83E-02
Land use	pt	2.63E-01	1.87E-01	1.54E-01	8.79E+00	2.74E-01	1.41E-01
Water use	m ₃ water eq. of deprived water	1.95E-02	1.66E-02	1.05E-02	4.47E-01	8.89E-03	7.13E-03
Resource use, minerals and metals	kg Sb eq	6.39E-08	5.24E-08	4.23E-08	2.12E-06	4.94E-08	2.67E-08
Resource use, fossils	MJ	2.69E-01	2.36E-01	2.33E-01	1.08E+01	2.35E-01	2.11E-01

5373 7.5. Base Case Environmental Impact Assessment

5374 7.5.1. Contribution analysis per Base Case

5375 This section contains a detailed analysis on the contribution of each life cycle stage to the life
5376 cycle impact per Base Case. Furthermore, a contribution analysis is performed in the two highest
5377 contribution life cycle stages, namely use stage and raw materials production, per Base Case.

5378 7.5.1.1. BC1: Undercounter water-change dishwasher

5379 The detailed results for BC1 are presented in **Appendix 11.5.1**. In this chapter the contribution
5380 analyses of the full results and of the two highest contributing life cycle stages are presented in
5381 detail.

5382 The majority of the lifetime impact of the undercounter water-change dishwasher is derived
5383 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**).

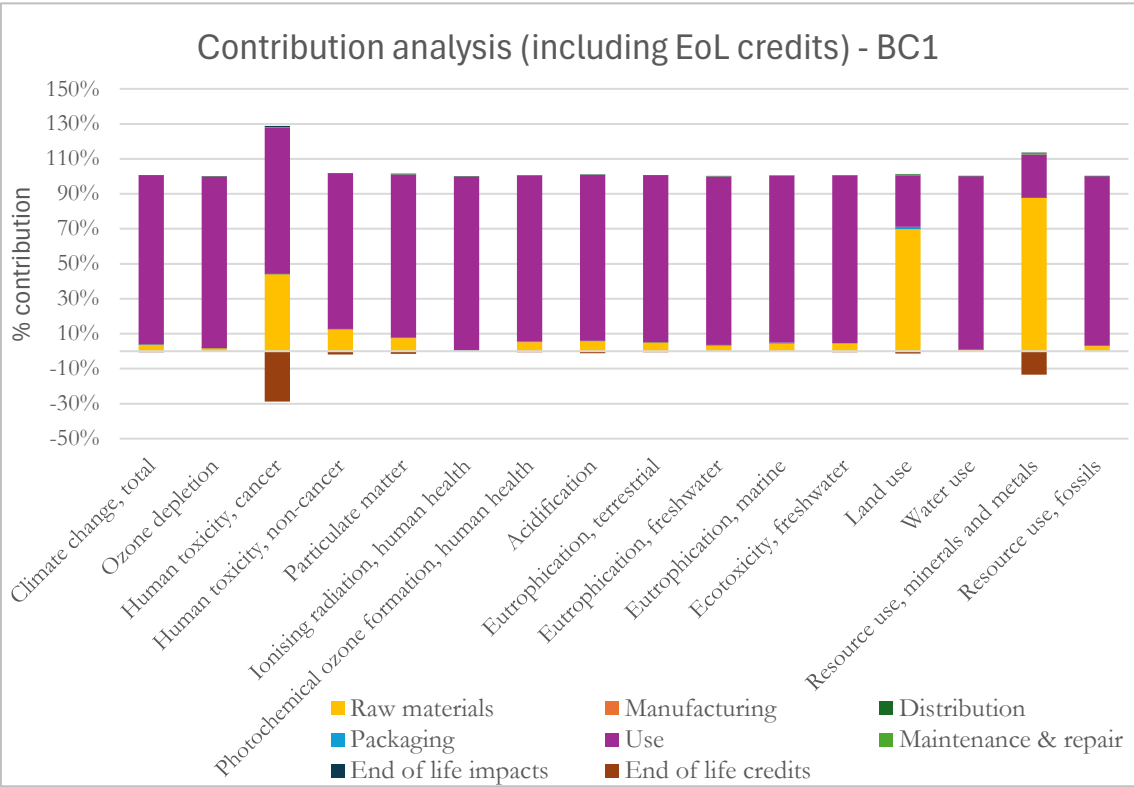


Figure 7-1: Contribution analysis (including EoL credits), BC1.

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 use¹¹⁶ of commercial dishwashers contributes the most (49 to 72 %) (**Figure 7-2**). Detergent use is highest contributor to the impact category ‘Resource use, minerals and metals’.

¹¹⁶ 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.

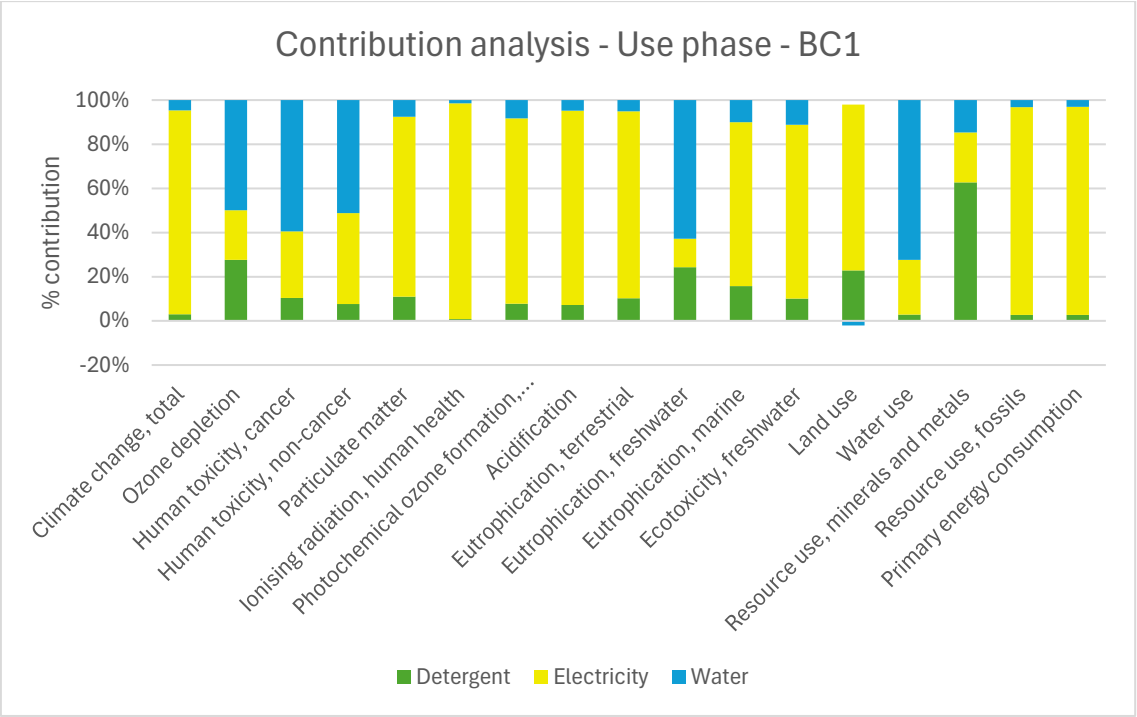


Figure 7-2: Contribution analysis – Use phase, BC1.

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.

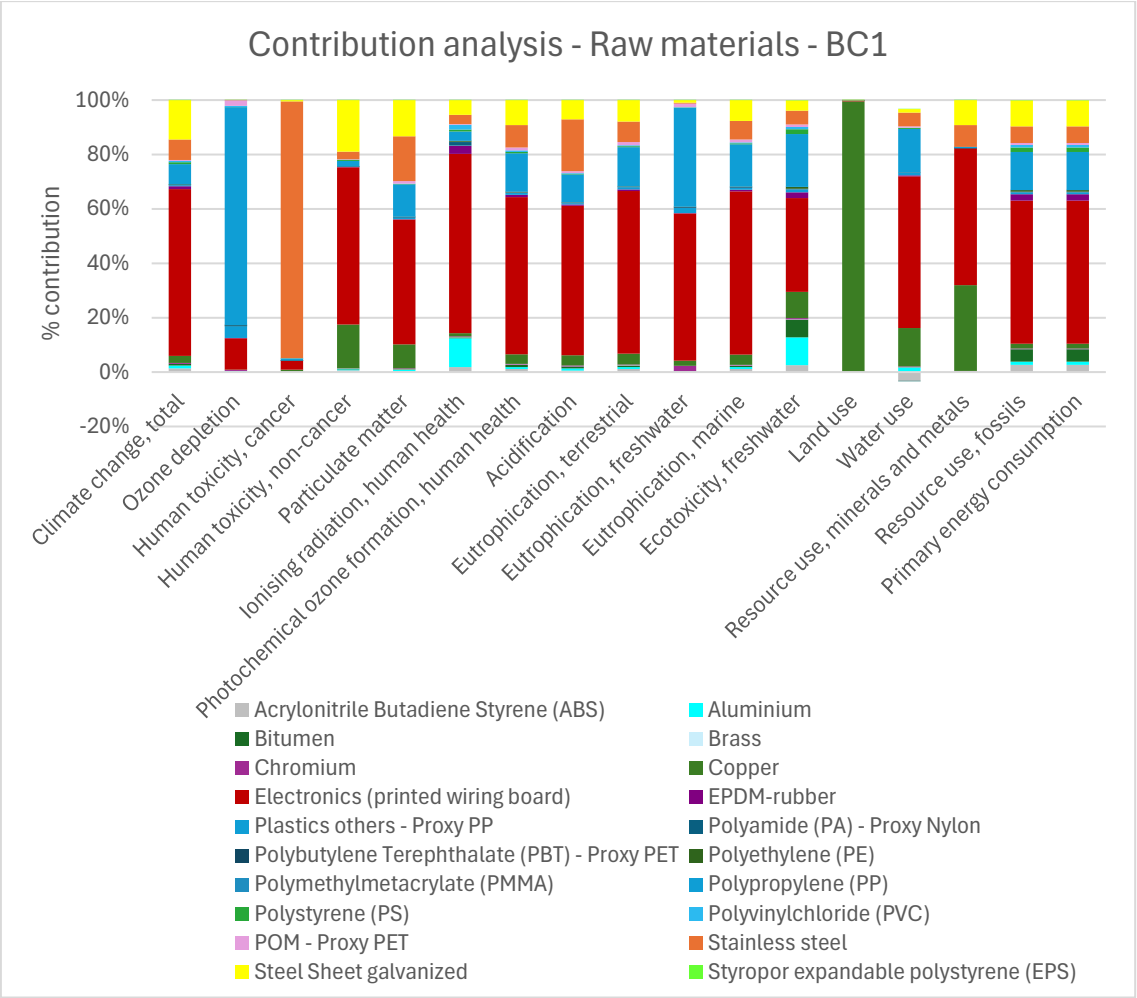


Figure 7-3: Contribution analysis – Raw materials, BC1.

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**).

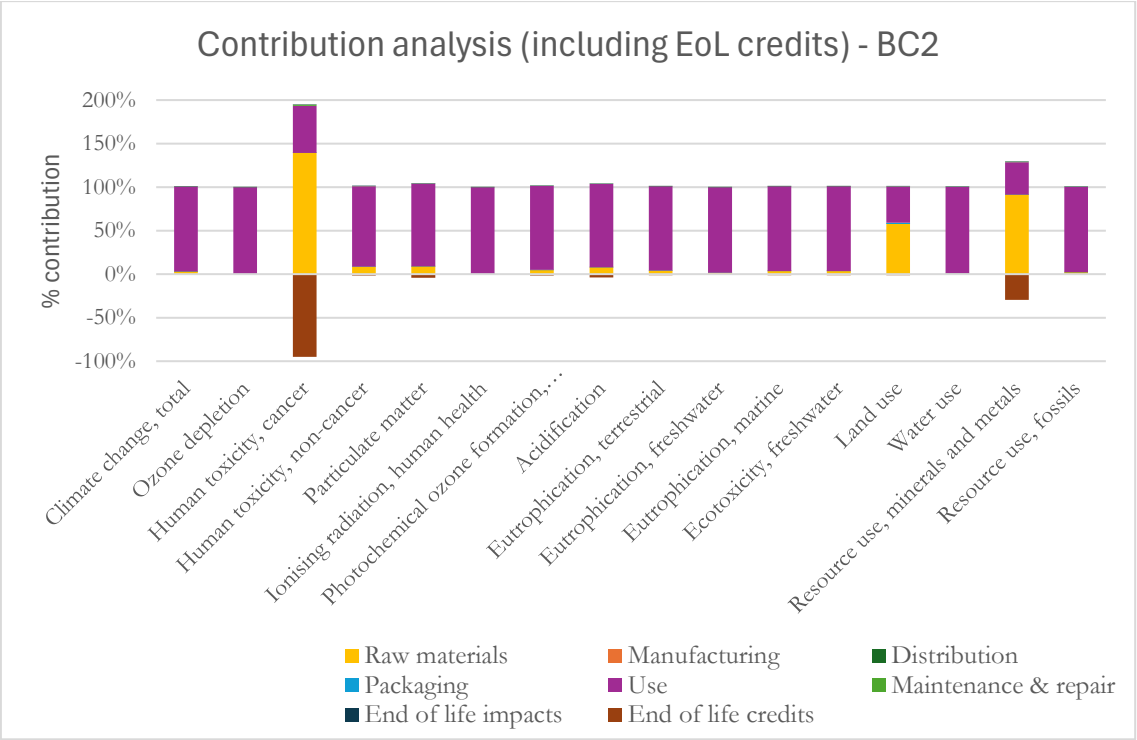
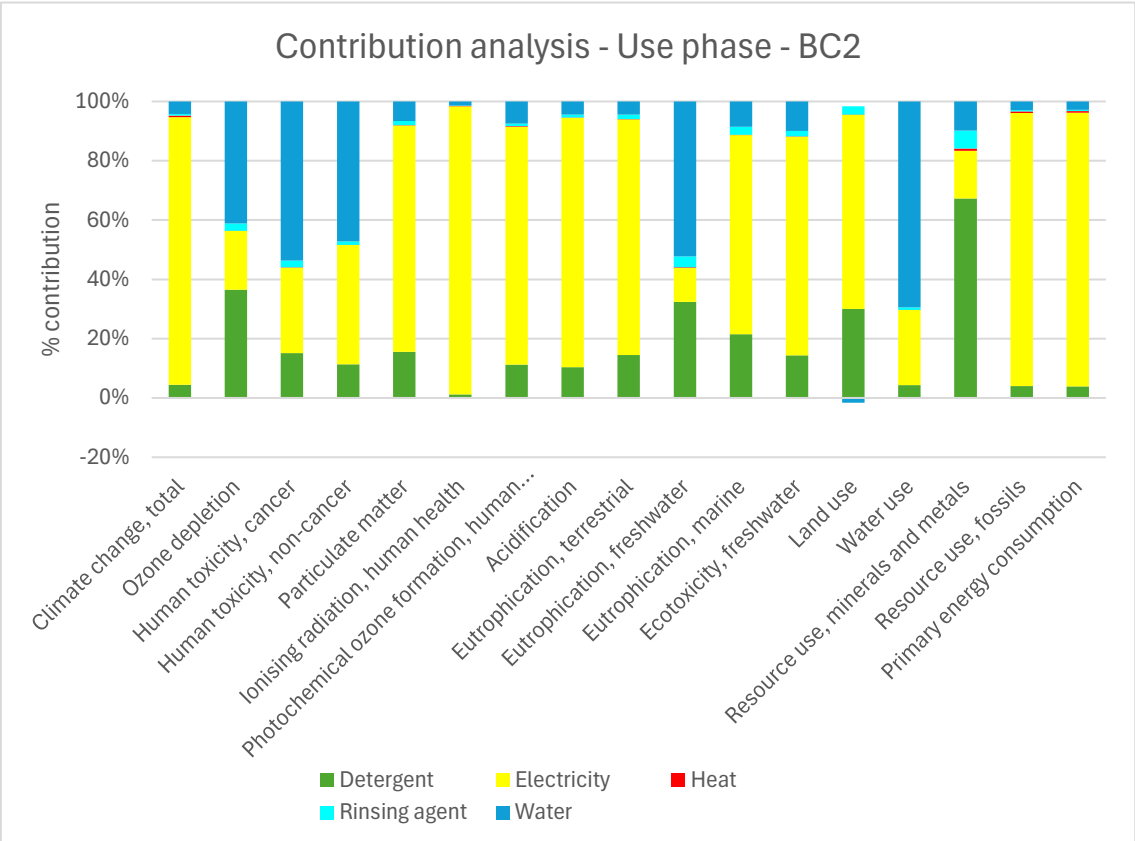


Figure 7-4: Contribution analysis (including EoL credits), BC2.

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'¹¹⁷ 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).

¹¹⁷ 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.

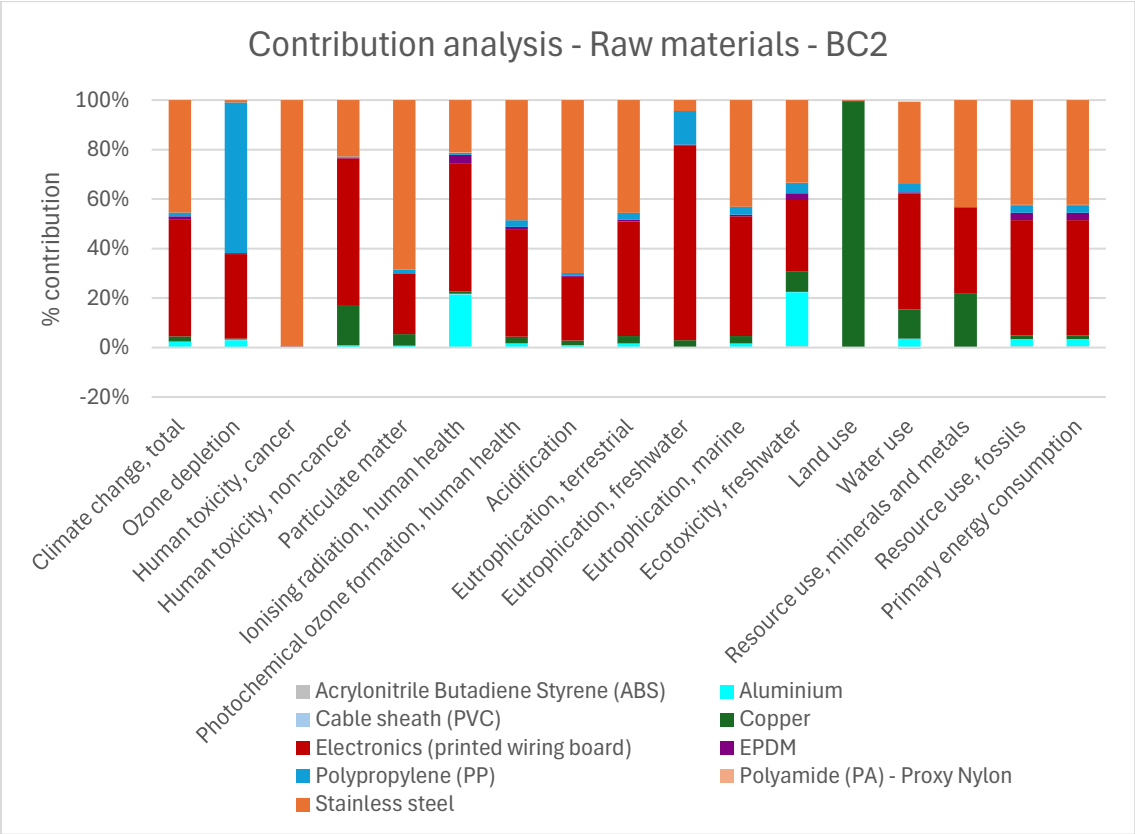


Figure 7-6: Contribution analysis – Raw materials, BC2.

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**).

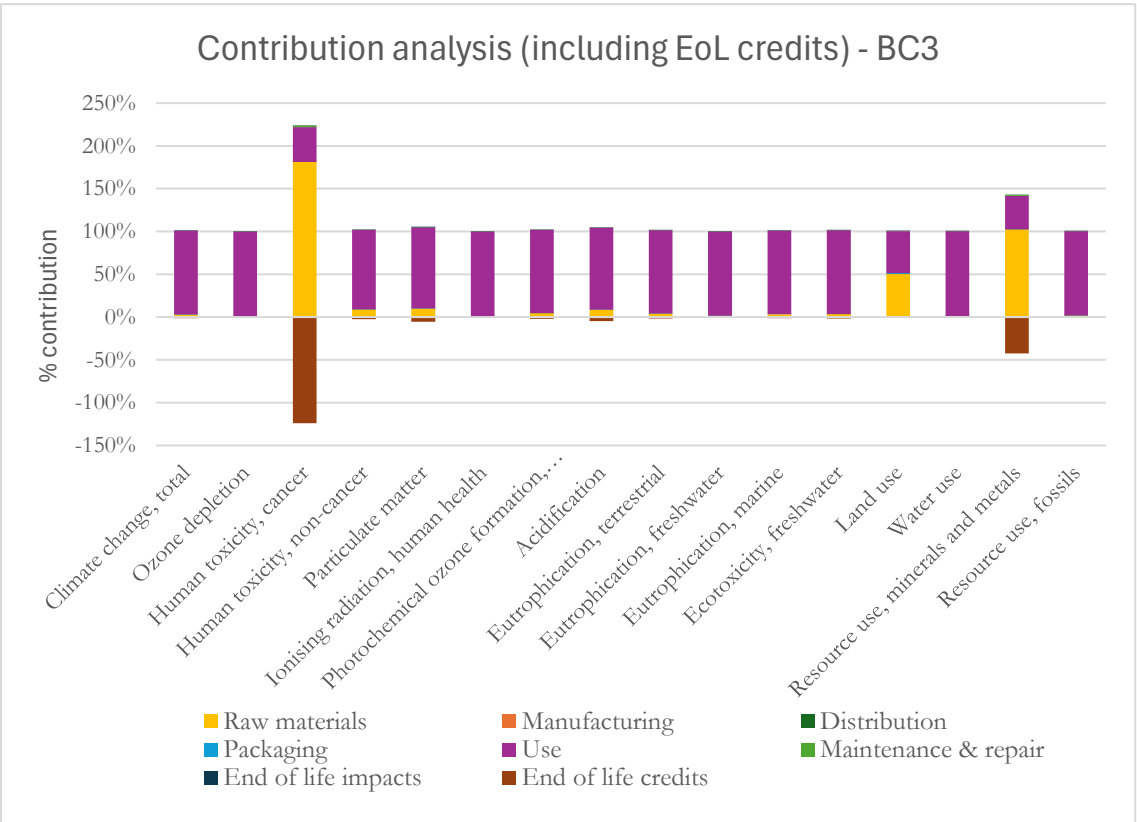


Figure 7-7: Contribution analysis (including EoL credits), BC3.

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**).

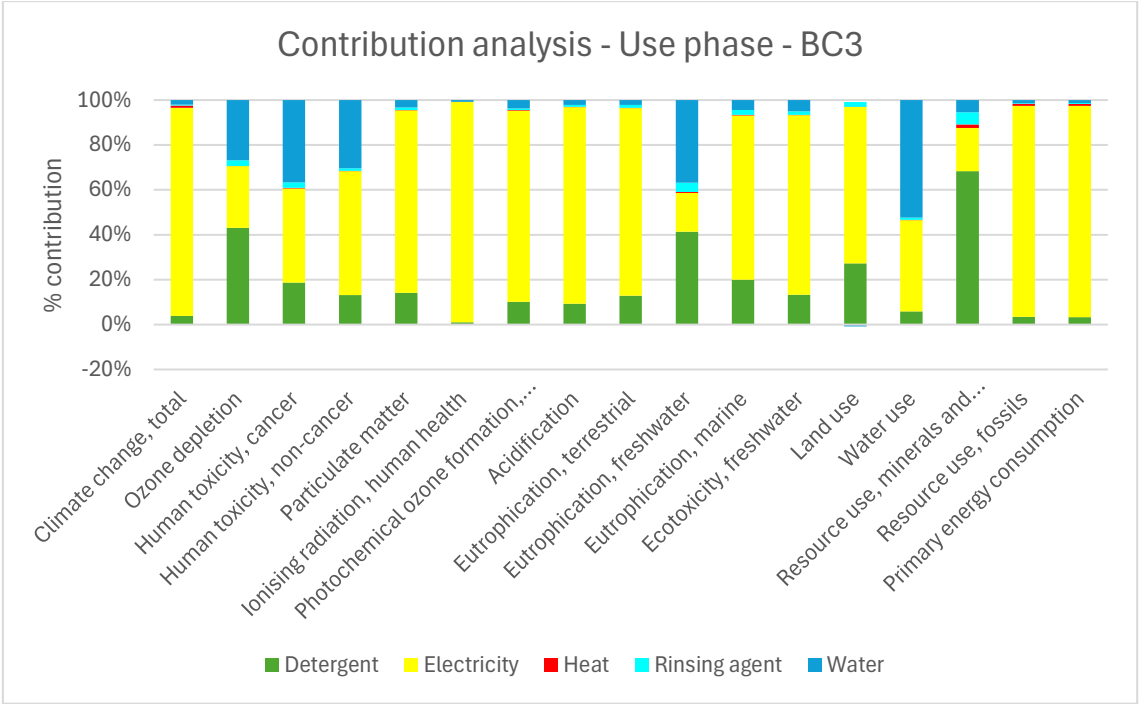


Figure 7-8: Contribution analysis – Use phase, BC3.

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.

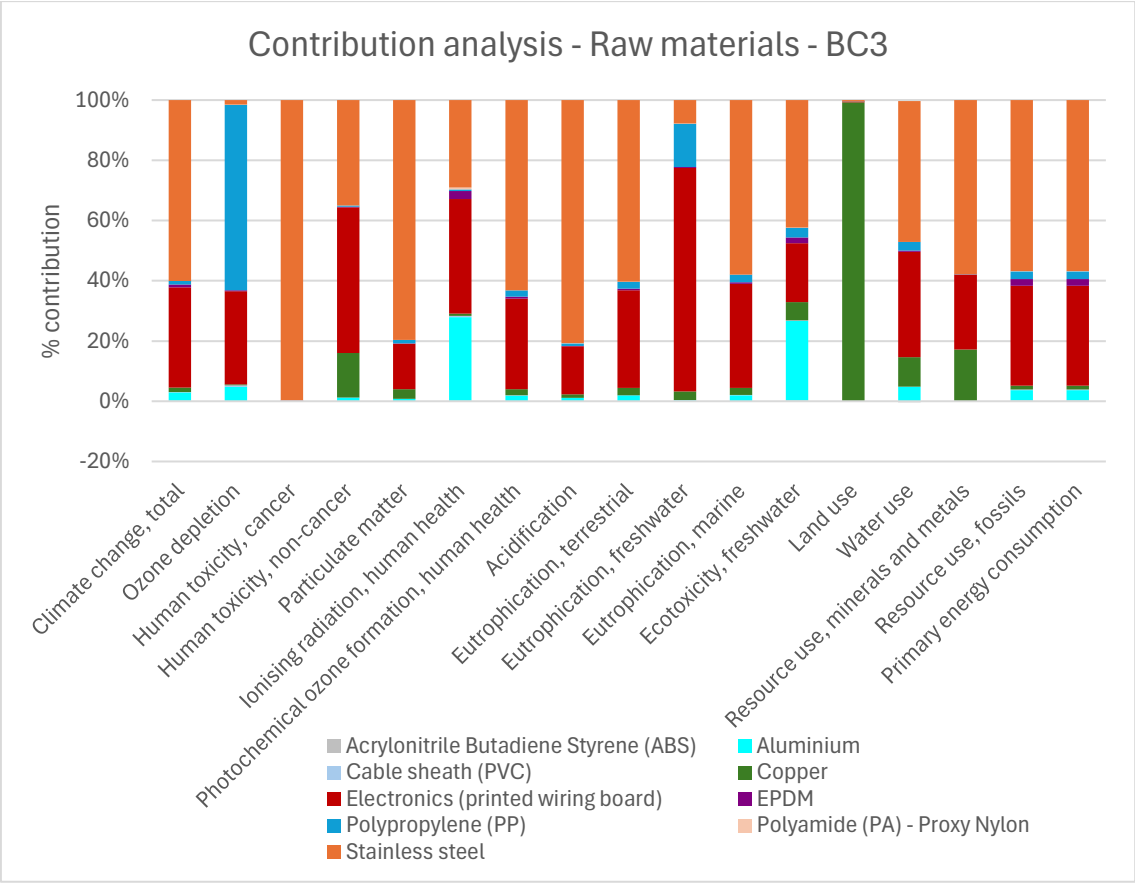


Figure 7-9: Contribution analysis – Raw materials, BC3.

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 (>94 %), 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**).

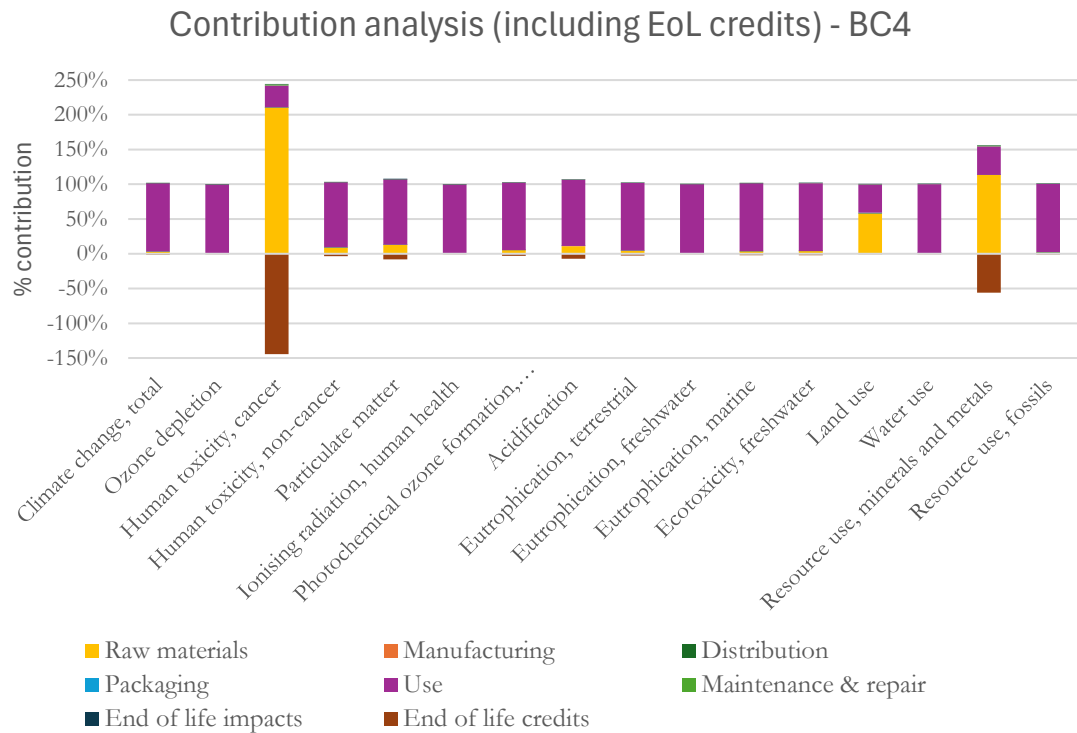


Figure 7-10: Contribution analysis (including EoL credits), BC4.

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).

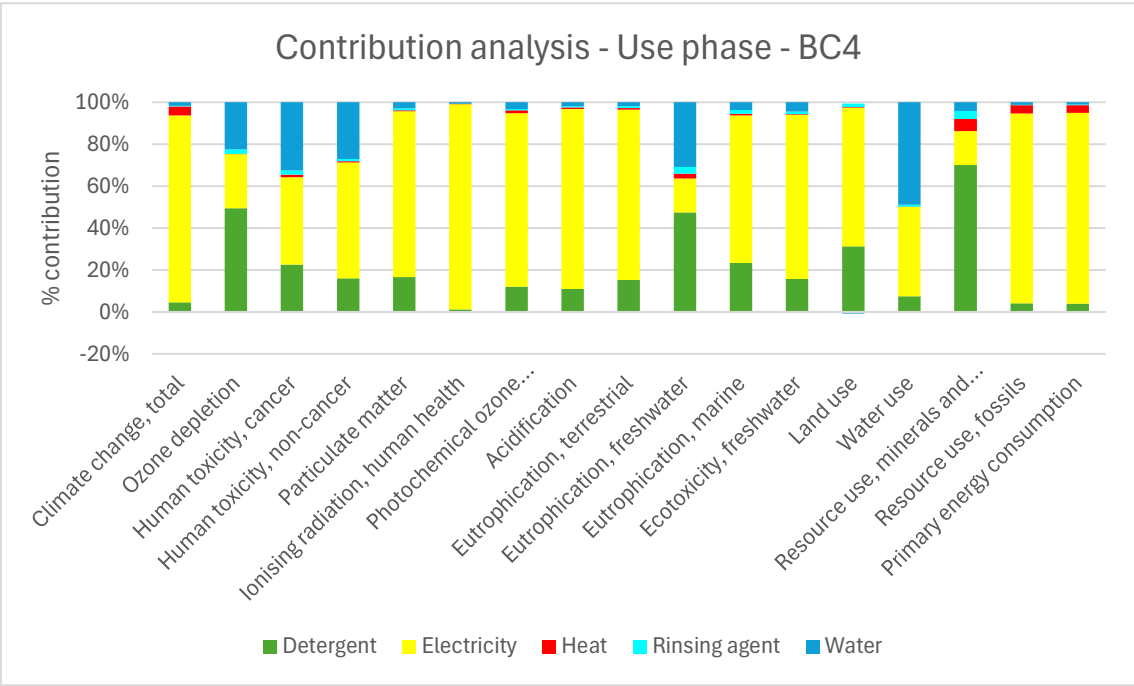


Figure 7-11: Contribution analysis – Use phase, BC4.

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.

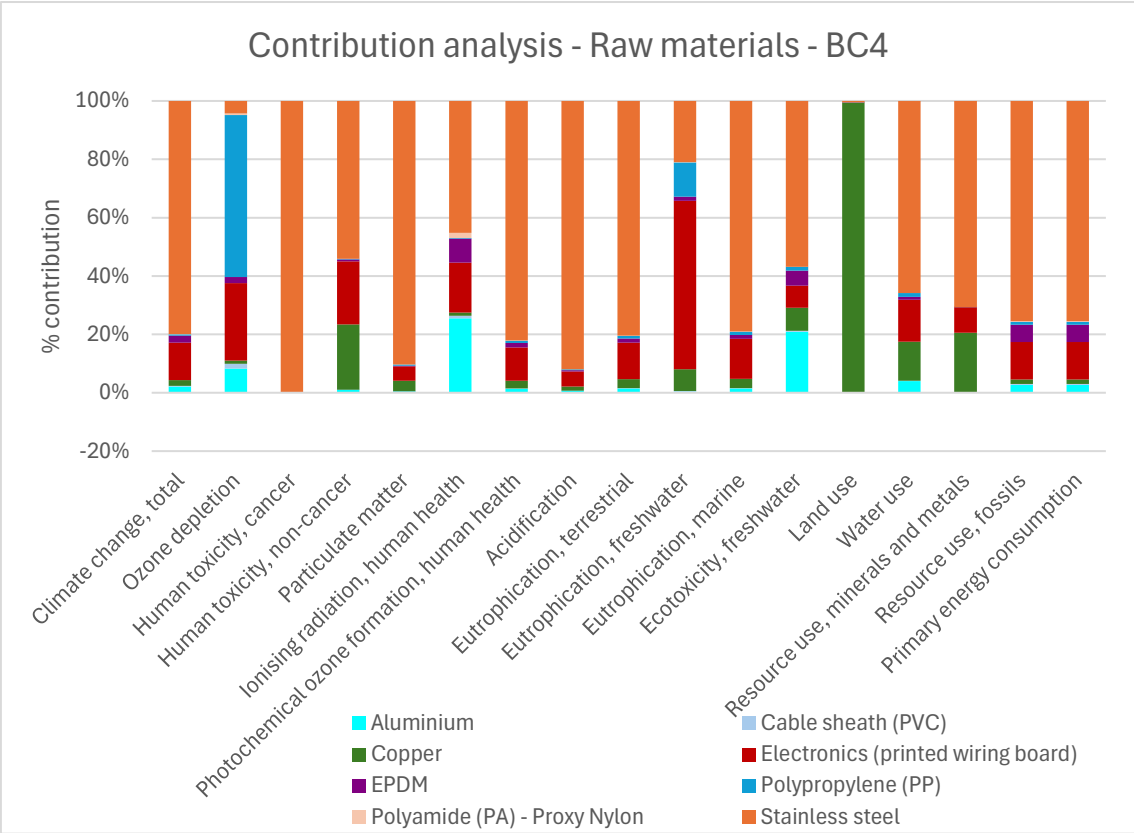


Figure 7-12: Contribution analysis – Raw materials, BC4.

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 (>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 7-13).

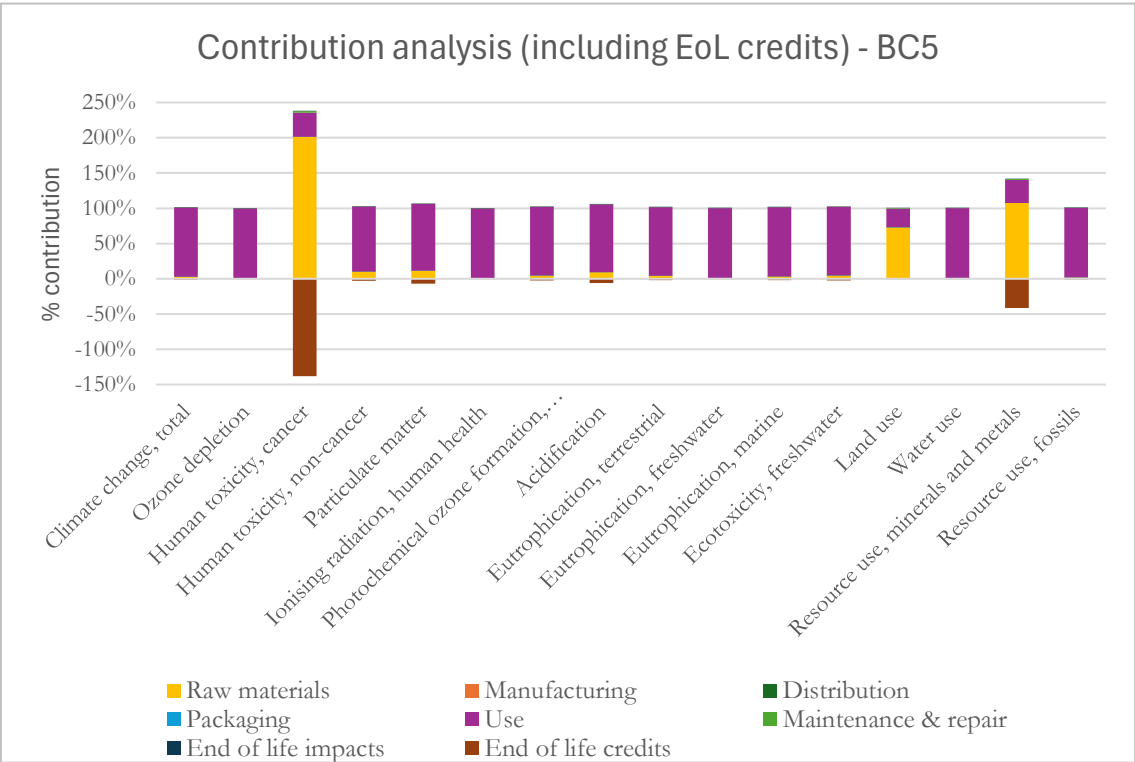


Figure 7-13: Contribution analysis (including EoL credits), BC5.

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).

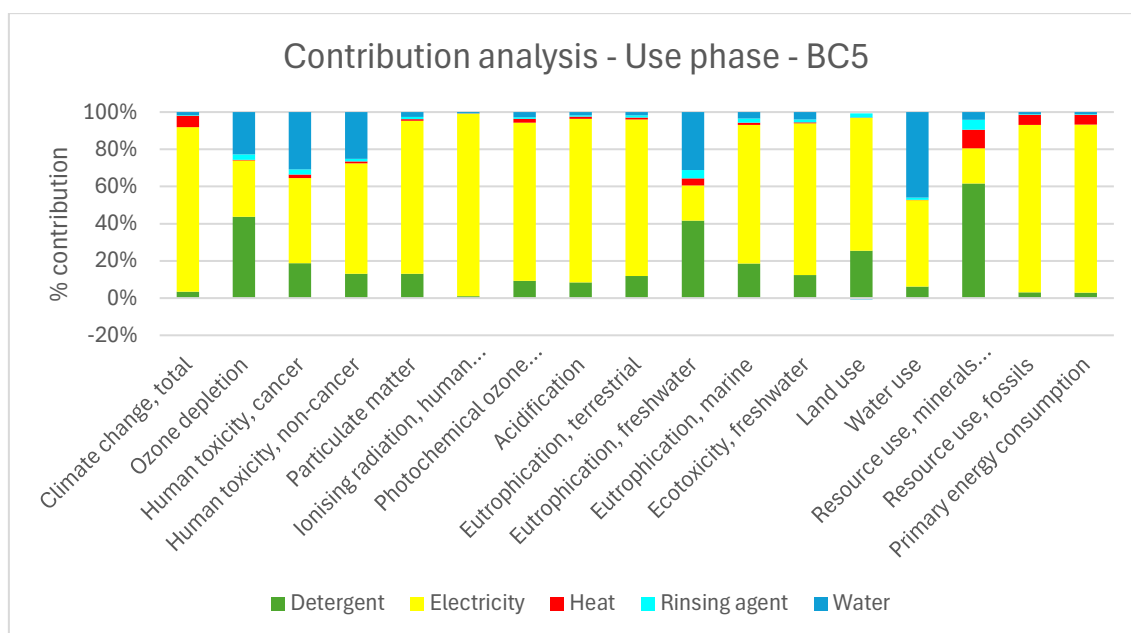


Figure 7-14: Contribution analysis – Use phase, BC5.

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.

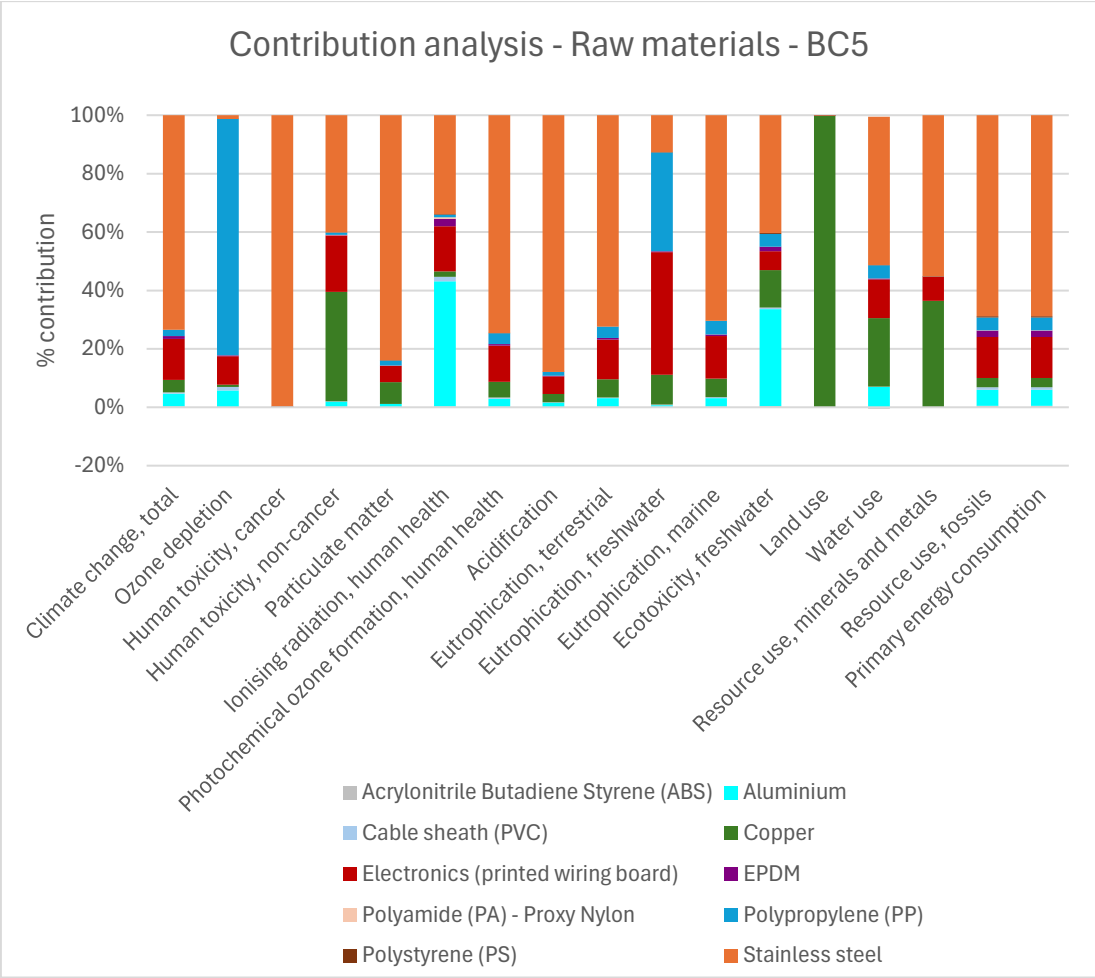


Figure 7-15: Contribution analysis – Raw materials, BC5.

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 (>96 %), 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**).

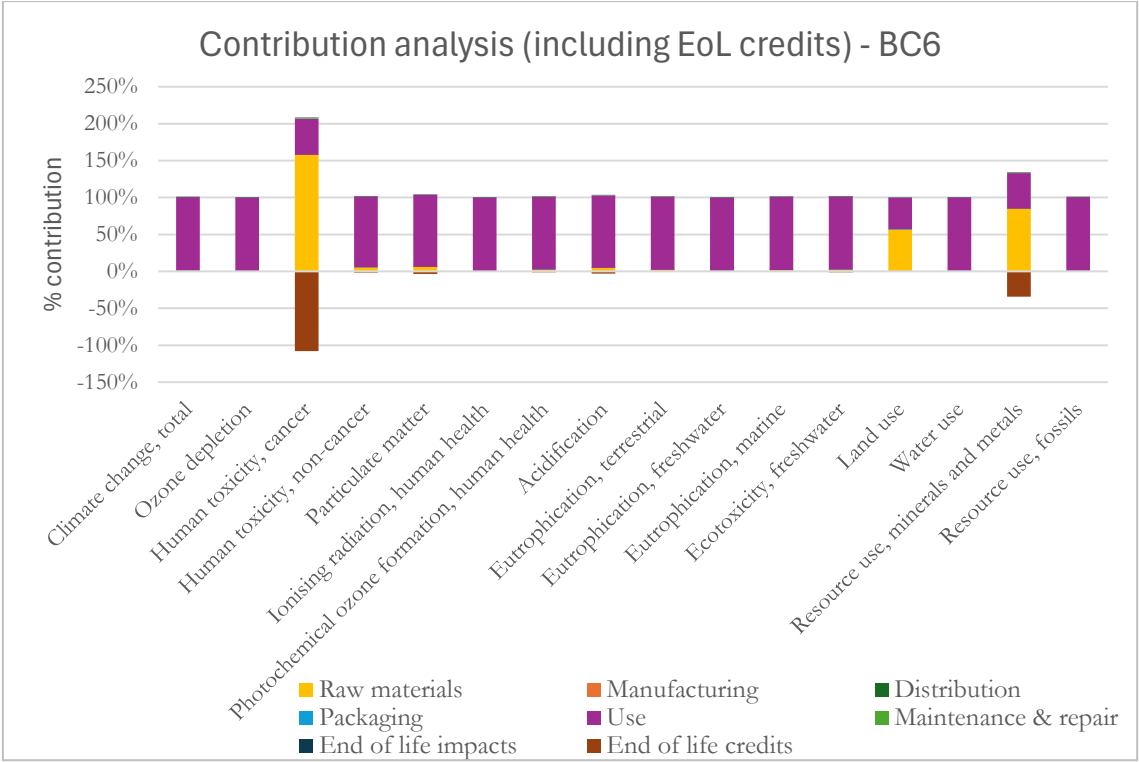


Figure 7-16: Contribution analysis (including EoL credits), BC6.

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 (38 to 54 %) (Figure 7-17).

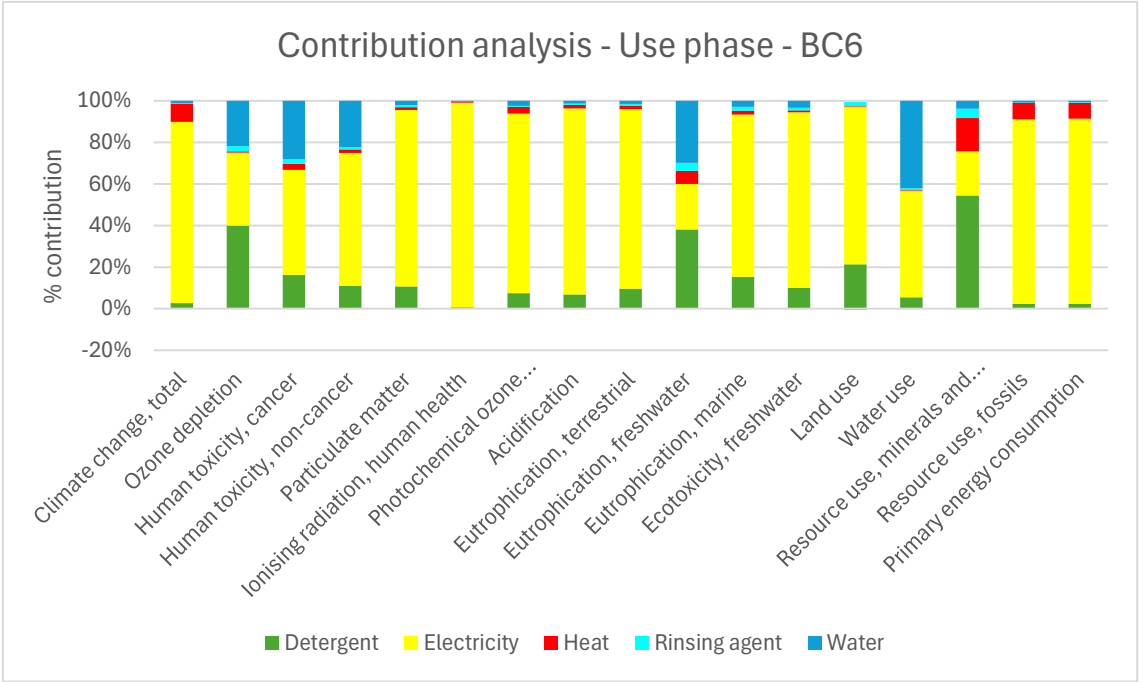


Figure 7-17: Contribution analysis – Use phase, BC6.

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 (44 %). 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.

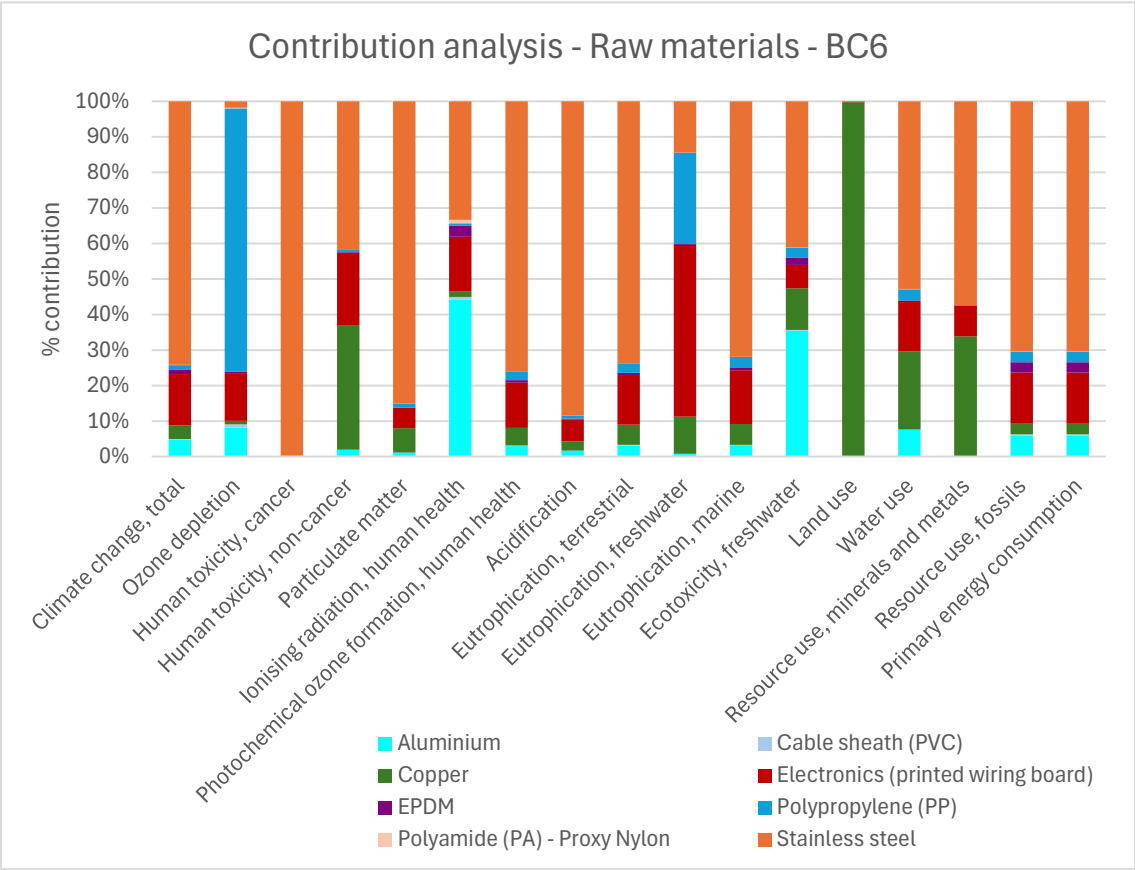


Figure 7-18: Contribution analysis – Raw materials, BC6.

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 in Appendix 5 – Results of LCA / LCC per Base Case**). 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 – 34,964 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							
Natural gas	EUR/year	0	7	23	86	500	1,593
Electricity	EUR/year	411	1,665	3,375	2,829	11,166	24,946
Water	EUR/year	76	290	277	207	705	1,299
Detergent	EUR/year	117	718	1,243	1,266	3,775	6,633
Rinsing agent	EUR/year	0	57	89	62	296	494
Repair & maintenance costs per lifetime	EUR	1,385	2,490	3,811	4,776	5,894	10,061
Total running costs	EUR/year	603	2,738	5,007	4,450	16,441	34,964
Total life cycle costs	EUR/year	981	3,756	6,566	6,187	18,195	37,160

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 (in this graph still including manual pre-rinsing) 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 € 603 per year.

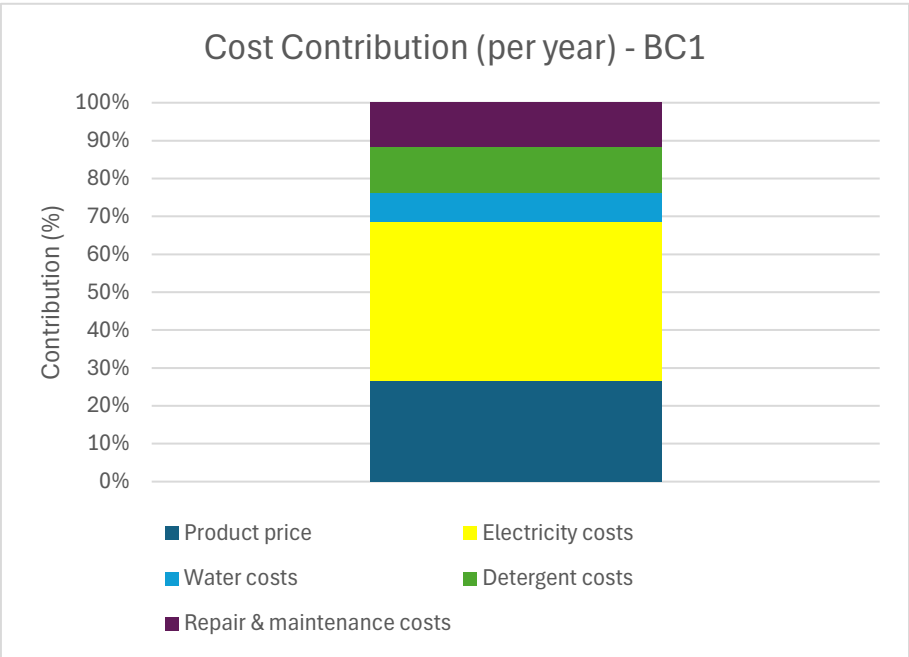


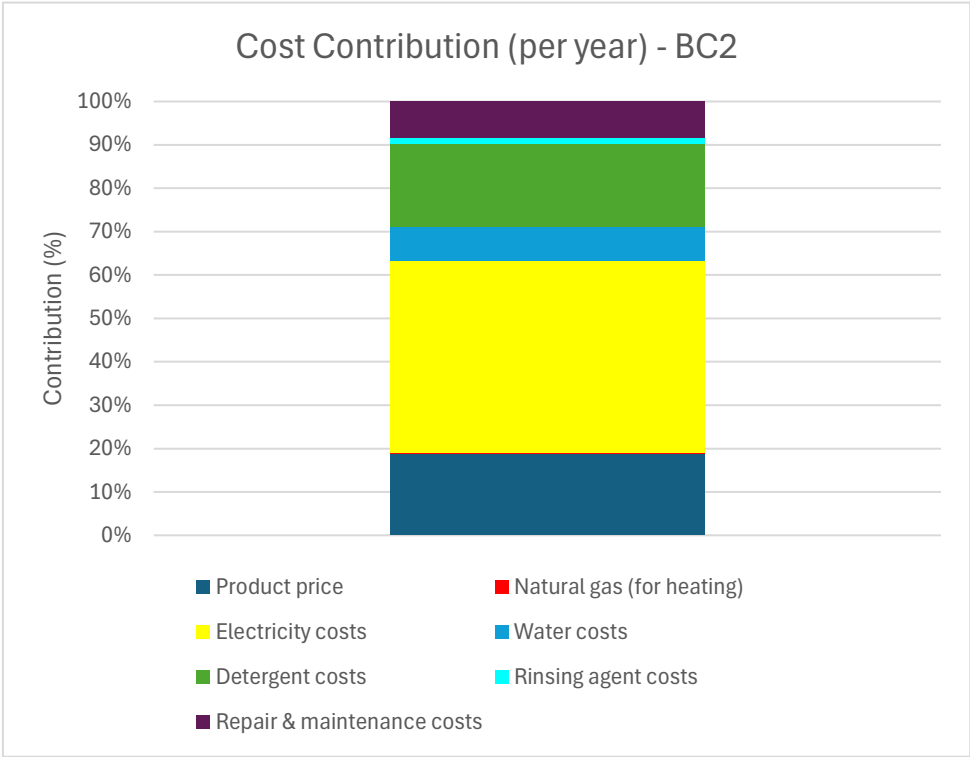
Figure 7-19: Cost contribution (per year), BC1.

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 (in this graph still including manual pre-rinsing), detergent and rinsing agent costs. In addition, repair and maintenance costs over the lifetime were included as 44 % of the purchase price.

5623 The main contribution to the costs per machine (on a yearly basis) is the costs for electricity
5624 (44 %), followed by the detergent costs and the product price (19 %) (**Figure 7-20**).

5625 Thus, each time a consumer makes a buying decision, the decision is not just on a purchase price
5626 of € 5,659, but on the total Life Cycle Costs (LCC) of the product – including running costs
5627 (electricity, natural gas for heating, water, detergent and rinsing agent costs) discounted to their
5628 net present value – which is on average € 2,738 per year.



5629

5630 **Figure 7-20: Cost contribution (per year), BC2.**

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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 (in this graph still including manual pre-rinsing), 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.

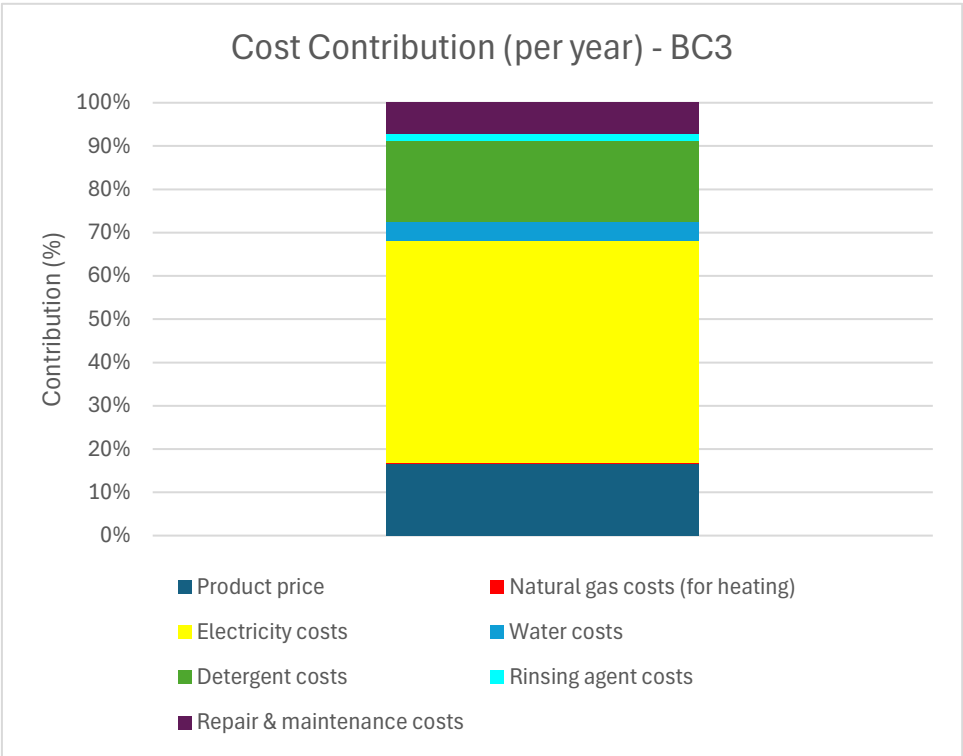


Figure 7-21: Cost contribution (per year), BC3.

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.

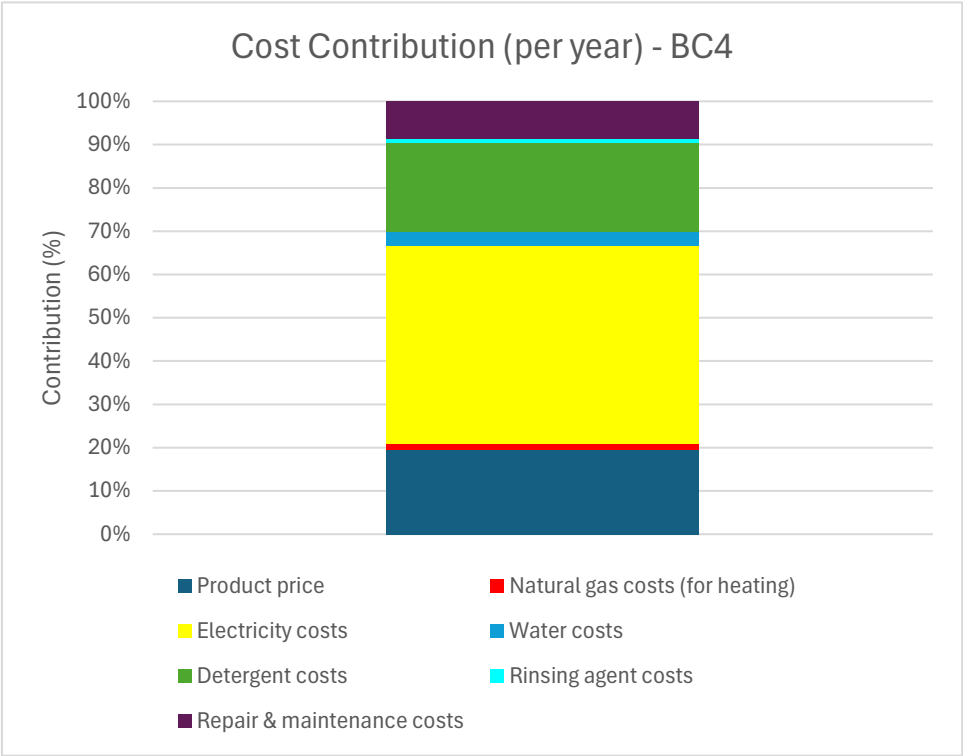


Figure 7-22: Cost contribution (per year), BC4.

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 (61 %), 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 € 16,441 per year.

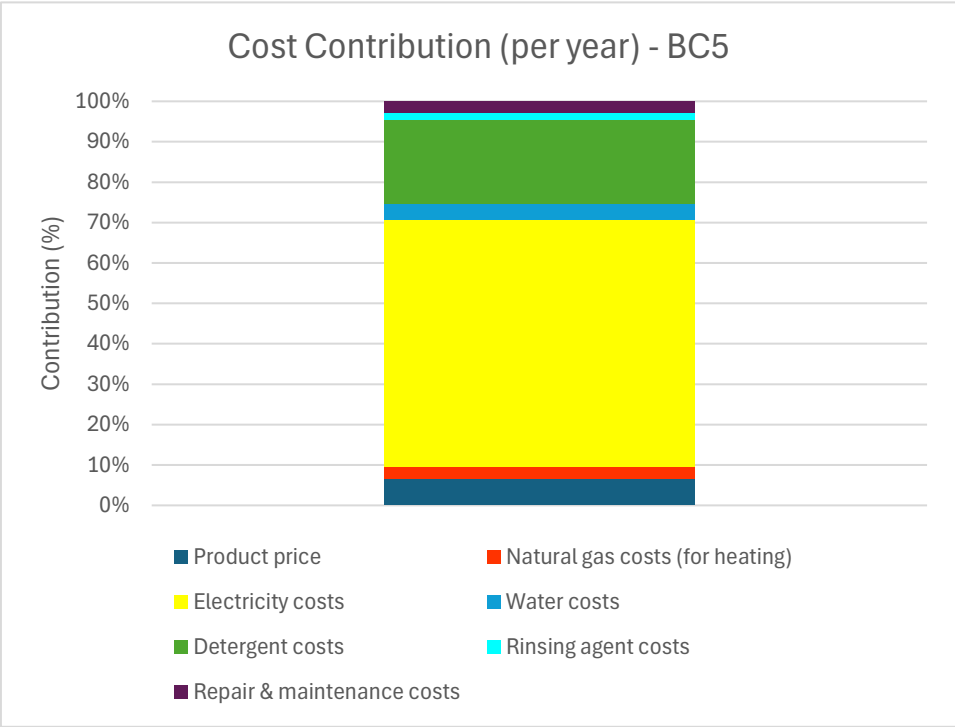


Figure 7-23: Cost contribution (per year), BC5.

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 (67 %), followed by the detergent (18 %) (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 € 34,964 per year.

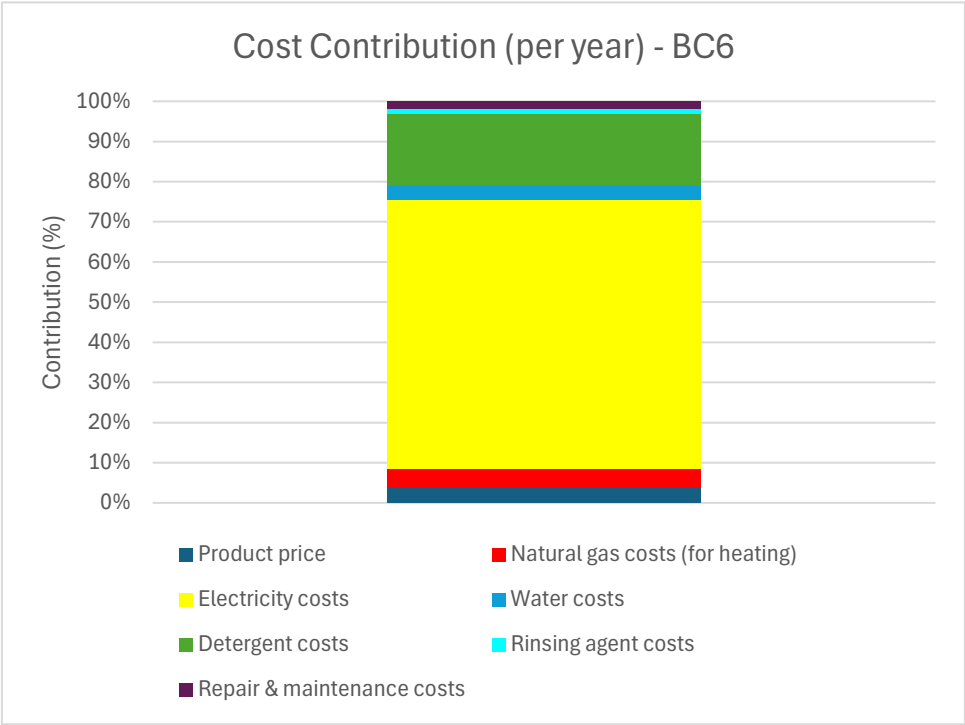


Figure 7-24: Cost contribution (per year), BC6.

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. The table provides the environmental results of the EU as a whole. The results are derived from the EcoReport tool, as described in **Section 7.4**. 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'.

5708 **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	2.53E+10	5.13E+10
Thermal energy	MJ	0.00E+00	3.06E+09	3.78E+09	3.69E+09	1.26E+10	3.66E+10
PEF Impact categories							
Climate change, total	kg CO ₂ eq	7.80E+08	3.16E+10	2.28E+10	5.19E+09	1.22E+10	2.49E+10
Ozone depletion	kg CFC-11 eq	1.16E+00	5.22E+01	2.82E+01	6.53E+00	1.30E+01	2.27E+01
Human toxicity, cancer	CTUh	4.59E-01	2.95E+01	2.02E+01	5.78E+00	1.12E+01	1.46E+01
Human toxicity, non-cancer	CTUh	6.35E+00	2.49E+02	1.36E+02	2.94E+01	6.47E+01	1.17E+02
Particulate matter	disease incidence	2.91E+01	1.23E+03	8.57E+02	1.95E+02	4.35E+02	8.31E+02
Ionising radiation, human health	kBq U235 eq	3.04E+08	1.22E+10	9.00E+09	1.98E+09	4.60E+09	9.31E+09
Photochemical ozone formation, human health	kg NMVOC eq	1.43E+06	5.88E+07	4.11E+07	9.25E+06	2.10E+07	4.13E+07
Acidification	mol H ⁺ eq	2.53E+06	1.05E+08	7.50E+07	1.69E+07	3.82E+07	7.46E+07
Eutrophication, terrestrial	mol N eq	5.28E+06	2.21E+08	1.56E+08	3.51E+07	7.90E+07	1.54E+08
Eutrophication, freshwater	kg P eq	1.13E+04	5.00E+05	2.49E+05	5.75E+04	1.15E+05	2.01E+05
Eutrophication, marine	kg N eq	5.65E+05	2.45E+07	1.67E+07	3.80E+06	8.38E+06	1.61E+07
Ecotoxicity, freshwater	CTUe	4.20E+09	1.76E+11	1.20E+11	2.70E+10	6.07E+10	1.17E+11
Land use	pt	1.30E+10	4.24E+11	2.58E+11	7.21E+10	2.42E+11	2.83E+11
Water use	m ³ water eq. of deprived water	9.62E+08	3.76E+10	1.75E+10	3.67E+09	7.85E+09	1.44E+10
Resource use, minerals and metals	kg Sb eq	3.14E+03	1.19E+05	7.06E+04	1.74E+04	4.36E+04	5.37E+04
Resource use, fossils	MJ	1.32E+10	5.35E+11	3.90E+11	8.85E+10	2.07E+11	4.24E+11

5709 **Table 7-21: Summary environmental impacts EU new product.**

Main life cycle indicators	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Energy Consumption							
Electricity	kWh	1.75E+08	9.96E+09	7.43E+09	1.47E+09	2.88E+09	4.50E+09
Thermal energy	MJ	0.00E+00	4.59E+08	5.67E+08	5.01E+08	1.44E+09	3.21E+09
PEF Impact Categories							
Climate change, total	kg CO ₂ eq	8.24E+07	4.74E+09	3.43E+09	7.05E+08	1.39E+09	2.18E+09
Ozone depletion	kg CFC-11 eq	1.23E-01	7.84E+00	4.23E+00	8.87E-01	1.49E+00	1.99E+00
Human toxicity, cancer	CTUh	4.85E-02	4.43E+00	3.03E+00	7.85E-01	1.28E+00	1.28E+00
Human toxicity, non-cancer	CTUh	6.71E-01	3.74E+01	2.04E+01	3.98E+00	7.38E+00	1.03E+01
Particulate matter	disease incidence	3.08E+00	1.84E+02	1.29E+02	2.64E+01	4.95E+01	7.28E+01
Ionising radiation, human health	kBq U235 eq	3.21E+07	1.83E+09	1.35E+09	2.69E+08	5.24E+08	8.16E+08
Photochemical ozone formation, human health	kg NMVOC eq	1.51E+05	8.83E+06	6.18E+06	1.25E+06	2.39E+06	3.62E+06
Acidification	mol H ⁺ eq	2.67E+05	1.58E+07	1.13E+07	2.29E+06	4.35E+06	6.54E+06
Eutrophication, terrestrial	mol N eq	5.57E+05	3.32E+07	2.34E+07	4.76E+06	8.99E+06	1.35E+07
Eutrophication, freshwater	kg P eq	1.19E+03	7.50E+04	3.74E+04	7.80E+03	1.32E+04	1.76E+04
Eutrophication, marine	kg N eq	5.97E+04	3.68E+06	2.51E+06	5.16E+05	9.55E+05	1.41E+06
Ecotoxicity, freshwater	CTUe	4.44E+08	2.64E+10	1.81E+10	3.67E+09	6.91E+09	1.03E+10
Land use	pt	1.37E+09	6.37E+10	3.87E+10	9.79E+09	2.76E+10	2.48E+10
Water use	m ³ water eq. of deprived water	1.02E+08	5.65E+09	2.63E+09	4.98E+08	8.95E+08	1.26E+09
Resource use, minerals and metals	kg Sb eq	3.32E+02	1.78E+04	1.06E+04	2.36E+03	4.97E+03	4.71E+03
Resource use, fossils	MJ	1.40E+09	8.03E+10	5.85E+10	1.20E+10	2.36E+10	3.72E+10

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 88 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 59 to 93 % of the total annual EU-27 expenditure. On the other hand, purchase costs entail 5 to 29 % 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	35	2,131	1,588	309	590	879
Natural gas	mln. EUR/year	0	9	11	9	26	56
Water	mln. EUR/year	7	371	130	23	37	46
Detergent	mln. EUR/year	10	919	585	138	199	234
Rinsing agent	mln. EUR/year	0	73	42	7	16	17
Repair & maintenance costs per lifetime	mln. EUR/year	10	398	224	58	28	24
Total running costs	mln. EUR/year	52	3,503	2,356	486	868	1,232
Total life cycle costs	mln. EUR/year	88	4,912	3,152	694	970	1,319

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 highest sales volume per year in the EU. Both sensitivity of results to the input data and sensitivity of some datasets was included.

7.9.1. Sensitivity analysis for BC2

To determine the sensitivity of the LCA and LCC results, for one Base Case (Undercounter one-tank dishwasher, BC2) several sensitivity analyses were performed. As the main impact of all Base Cases is derived from the use phase followed by the raw materials, the focus of these analyses was on these life cycle stages. In addition, sensitivity analyses for the product aspects as indicated in Article 5 of the ESPR Regulation (EU) 2024/1781 were included as well. An overview of the sensitivity analysis is in **Table 7-23**.

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 %
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

Scenario #	Product aspect	Life cycle stage	Modelling change
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 slightly 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. From a raw material perspective, 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 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 (REACH¹¹⁸, CLP¹¹⁹, POP¹²⁰, WFD/SCIP¹²¹, WEEE¹²², RoHS¹²³) to determine which substances in Commercial Dishwashers warrant additional scrutiny. The stakeholder consultation provided insights on the complexity of data collection, the overlap with the aforementioned regulations. Additionally, recyclers expressed concerns on the lag-time between design and recycling, the challenges of using a DPP in fast-paced waste treatment operations, and the need for harmonised methodologies for testing for the presence of SoC.

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.

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

¹¹⁸ 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)

¹¹⁹ 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

¹²⁰ Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants

¹²¹ 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

¹²² Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE)

¹²³ 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

5836 - A uniform 0.1 % w/w cutoff for Substance of Concern affecting circularity (Art.
5837 2(27)(d)), pending more granular data obtained by implementing information
5838 requirements.

5839 Because full-life-cycle Intentionally Added Substances and Non-Intentionally Added Substances
5840 data collection is time- and resource-intensive, the scope has been limited to product-specific
5841 Intentionally Added Substances present in the final product, including its components and spare
5842 parts. Three implementation scenarios are proposed for implement the information
5843 requirements in this product group:

5844 - Ambitious: covering all Art. 2(27) Substances of Concern without exemptions;
5845 - Intermediate: covering all Art. 2(27) Substances of Concern, with case-by-case
5846 exemptions for substances based on solid justification; and
5847 - Limited: tracking only Art. 2(27)(a–c) Substances of Concern would be tracked, but
5848 companies could justify broader exemptions for groups of substances, hazard
5849 classes or categories, etc, within the flexibilities offered by the legal text, coupled
5850 with a targeted study to identify additional Art. 2(27)(d) candidates for selected
5851 regulation through amending the delegative act.

5852 A five-year roll-out is recommended across all scenarios to allow for supplier engagement, data
5853 gathering, and Digital Product Passport integration. An assessment of feasibility and
5854 administrative burden should be undertaken as part of the impact assessment.

5855 Finally, performance requirements under Art. 6 of the ESPR may not be necessary at this stage,
5856 as there is currently no clear indication that the WEEE/RoHS recycling framework has issues with
5857 SoC, and stakeholder feedback has not revealed any specific performance gaps. As new research
5858 or recyclability insights emerge, revisiting performance criteria should be considered. Further
5859 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. It should be noted that this design option is only relevant and potentially impactful for appliances with a single-walled construction, which experience higher thermal losses. To provide a sound baseline in this respect, a single-walled construction is assumed in the BOM for BC1.
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 originally combined the features of all the aforementioned design options (DO-01 to DO-07). Following stakeholder feedback received in August 2025, it has been revised to comprise only DO-01, DO-03, DO-04 and DO-07 (see justification in Section 8.1.2.4).

5914 8.1.2.3. Stakeholder consultation process

5915 Based on the design options identified above, stakeholders were asked to provide feedback and
5916 input, particularly with regard to the following aspects:

- 5917 - Applicability of the different design options, especially in relation to the six
5918 dishwasher categories.

- 5919 - Combinability of design options for each dishwasher category.
- 5920 - Completeness of the proposed design options.
- 5921 - Data on the corresponding Bills of Materials (BoM), energy demand during the use
- 5922 phase as well as purchase price and initial lifetime; input was requested as relative
- 5923 changes to the Base Case values, which were normalised to 100 %.

5924 8.1.2.4. Stakeholder consultation feedback

5925 Initial stakeholder feedback revealed that all of the proposed design options were considered
 5926 to be reasonable. However, latest feedback from several stakeholders received in August 2025
 5927 questioned the feasibility of DO-05 and DO-06:

- 5928 - The feasibility of DO-05 is considered to be limited due to the demanding workload
- 5929 of commercial dishwashers in many applications. To guarantee 24/7 uptime, parts
- 5930 must be designed to be as robust as possible (e.g. using stainless steel). Additionally,
- 5931 planned PFAS restrictions are expected to reduce the availability of polymer
- 5932 alternatives to metal.
- 5933 - Regarding the feasibility of DO-06, it is argued that commercial dishwashers usually
- 5934 have electronics that cannot be reused due to their long service life of more than
- 5935 ten years. In the meantime, many of the electronic components have aged and
- 5936 reached the end of their service life, therefore preventing them from being reused.

5937 In light of these concerns, DO-05 and DO-06 will generally not be pursued further in Task 7.
 5938 Nevertheless, the initial version of the calculation of the ecological and economic analysis for
 5939 these design options is still reported in Task 6 for transparency reasons. However, these results
 5940 have not been updated in light of the comments on specific details made by stakeholders in
 5941 August 2025.

5942 Furthermore, stakeholders pointed out for the remaining design options, that not all of them
 5943 can be applied to each of the dishwasher categories. In the extreme case of category 1, the
 5944 majority of stakeholders considered DO-04 to be the only feasible option, even though most
 5945 devices are already equipped with a double-walled design. With regard to category 2, all of the
 5946 design options were considered applicable, except for DO-02. In all other categories (3–6), all of
 5947 the design options were regarded as applicable.

5948 Moreover, as a result of stakeholder consultation, the study team has added another design
 5949 option that covers heat recovery. This design option supplements the existing DO-01 by referring
 5950 to heat recovery from drain water and is described as DO-07 in **Table 8-1**. However, one
 5951 stakeholder noted in August 2025 that a properly engineered dishwashing machine would not
 5952 add enough value to justify the investment in this design option.

5953 Regarding the specific savings potential of the different design options, feedback on DO-02, DO-
 5954 03 and DO-08 was provided by several stakeholders in August 2025:

- 5955 - For DO-02, the energy savings of up to 25 % were considered to be too high, and it
- 5956 was argued that they should be set at less than 20 %. Consequently, the energy
- 5957 savings have been reduced to 15 % for all Base Cases.

5958 - Based on stakeholder feedback on DO-03, the water savings (12 %) are calculated
5959 using the real water consumption without pre-rinsing. This is deemed necessary
5960 since the reported savings potential refers solely to the machines' water
5961 consumption, excluding user-dependent processes such as manual pre-rinsing.
5962 Furthermore, one stakeholder noted that energy savings for DO-03 are expected to
5963 be lower. However, as no quantitative information was provided in this respect, the
5964 savings rate remains at 12 %.

5965 - The energy savings for DO-08 were judged to be too high in general. In practice, it
5966 would not be reasonable to combine all design options. For example, either DO-01
5967 or DO-02 can be applied, but not both at once. If DO-02 needs to be applied due to
5968 a dishwasher with lower performance, it has to be noted that the environmental
5969 impact will be significantly higher due to increased maintenance efforts and the
5970 presence of substances of concern in coolants. Reflecting all the overall feedback
5971 provided in this respect, DO-08 is now merely a combination of DO-01, DO-03, DO-
5972 04, and DO-07. For the Bill of Materials for DO-08, the additional material costs
5973 resulting from the aforementioned design options were added. The same applies
5974 to the purchase price of the system. According to stakeholder feedback, the energy
5975 savings for DO-08 were reduced to 30 % for all the relevant base cases. With regard
5976 to savings in water, detergent, and rinsing agent, the respective figures for DO-03
5977 were also applied to DO-08. With regard to the service life of the DO-08 system, the
5978 same period was assumed in all cases as for the respective Base Cases. This
5979 constitutes a conservative assumption, as a slightly longer service life can be
5980 expected due to the consideration of DO-03.

5981 For Base Cases BC4 and BC6, Acrylonitrile Butadiene Styrene (ABS) was not included in their
5982 initial Bill of Materials as well as for the design options. When asked whether ABS should be
5983 added to the BOMs of Categories 4 and 6, the vast majority of stakeholders responded that this
5984 could be disregarded given the small quantities involved (significantly less than one kilogram).
5985 Compared to household appliances, there are much smaller volumes used, so implementing it
5986 in the design option would not be a countable effort. Further detailed feedback provided by
5987 stakeholders for each of the dishwashing categories on the Bill of Materials, the energy demand
5988 during the use phase, as well as the purchase price and initial lifetime, can be found in **Section**
5989 **8.2.**

5990 8.2. Input parameters design options per Base Case

5991 In this section, the key input parameters for all six Base Cases and their design options are
5992 presented. The Bill of Materials for each Base Case and the modifications introduced by each
5993 design option are detailed, alongside consumption data for energy, water, and other resource
5994 use, as well as the adjusted LCC inputs. These parameters serve as the basis for calculating both
5995 the environmental and life cycle cost impacts of each design option in the analyses that follow.

5996 8.2.1. BC1: Undercounter water-change dishwasher

5997 8.2.1.1. Bill of Materials

5998 Below (**Table 8-2**), the Bill of Materials for BC1 is provided, with the original Base Case as 100 %
5999 and the changes per design option as percentage compared to the reference. Only one design
6000 option (DO-04) is considered for this Base Case.

6001 **Table 8-2: Changes to Bill of Material per design option for BC1.**

Material	Value	Unit	Reference	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 %
Plastics others	0.55	kg	100 %	100 %

Material	Value	Unit	Reference	DO-04: Improved thermal insulation (double-walled design)
				Percentage compared to 100 % reference
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 %	

6002 8.2.1.2. Consumption data

6003 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
 6004 to the reference.

6005

6006 **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 %

6007 **8.2.1.3. Life Cycle Costing data**

6008 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
6009 compared to the reference.

6010 **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 %

6011

6012 **8.2.2. BC2: Undercounter one-tank dishwasher**

6013 **8.2.2.1. Bill of Materials**

6014 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
 6015 the reference. Design option DO-02 was excluded from the calculations.

6016 **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 %								

*additional load sensor required for DO-03 and DO-08, which was included in the electronics (printed wiring board) increase for these design options.

Additional material 'polymeric insulation' was modelled in the ERT with the dataset '21-Polyurethane rigid foam from methylene diisocyanate (MDI) and polyols 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 5 for the original BoM.

8.2.2.2. Consumption data

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 to the reference.

6025 **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 %	70 %
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 %

6026

6027 8.2.2.3. Life Cycle Costing data

6028 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
 6029 compared to the reference.

6030 **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 %

6031

6032 **8.2.3. BC3: Hood-type dishwasher**

6033 **8.2.3.1. Bill of Materials**

6034 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
6035 the reference.

6036 **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 %

6037 *additional load sensor required for DO-03 and DO-08, which was included in the electronics (printed wiring board) increase for these design options.

6038 Additional material 'polymeric insulation' was modelled in the ERT with the dataset '21-Polyurethane rigid foam from methylene diisocyanate (MDI) and polyols
6039 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
6040 5 for the original BoM.

6041

6042 8.2.3.2. Consumption data

6043 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
 6044 to the reference.

6045 **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 %	85 %	88 %	90 %	100 %	100 %	95 %	70 %
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 %

6046 8.2.3.3. Life Cycle Costing data

6047 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
6048 compared to the reference.

6049 **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 %

6050

6051 8.2.4. BC4: Utensil/pot dishwasher

6052 8.2.4.1. Bill of Materials

6053 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
 6054 the reference.

6055 **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 %

6056 # 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%.

6057 *additional load sensor required for DO-03 and DO-08, which was included in the electronics (printed wiring board) increase for these design options.

6058

6059 Additional material 'polymeric insulation' was modelled in the ERT with the dataset '21-Polyurethane rigid foam from methylene diisocyanate (MDI) and polyols
6060 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
6061 5 for the original BoM.

6062

6063 8.2.4.2. Consumption data

6064 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
 6065 to the reference.

6066 **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 %	85 %	88 %	90 %	100 %	100 %	95 %	70 %
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 %

6067 8.2.4.3. Life Cycle Costing data

6068 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
6069 compared to the reference.

6070 **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 %

6071

6072 **8.2.5. BC5: One-tank conveyor-type dishwasher**

6073 **8.2.5.1. Bill of Materials**

6074 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
6075 the reference.

6076 **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 %								

6077

6078 Additional material 'polymeric insulation' was modelled in the ERT with the dataset '21-Polyurethane rigid foam from methylene diisocyanate (MDI) and polyols
6079 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
6080 5 for the original BoM.

6081 8.2.5.2. Consumption data

6082 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
 6083 to the reference.

6084 **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 %	85 %	88 %	90 %	100 %	100 %	90 %	70 %
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 %

6085 8.2.5.3. Life Cycle Costing data

6086 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
 6087 compared to the reference.

6088 **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 %

6089

6090 **8.2.6. BC6: Multi-tank conveyor-type dishwasher**

6091 **8.2.6.1. Bill of Materials**

6092 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
6093 the reference.

6094 **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 %								

6095 * 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 %.

6096 Additional material 'polymeric insulation' was modelled in the ERT with the dataset '21-Polyurethane rigid foam from methylene diisocyanate (MDI) and polyols
6097 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
6098 5 for the original BoM.

6099 8.2.6.2. Consumption data

6100 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
 6101 to the reference.

6102 **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 %	85 %	88 %	100 %	100 %	90 %	70 %
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 %

6103 8.2.6.3. Life Cycle Costing data

6104 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
 6105 compared to the reference.

6106 **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 %

6107

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	21,249	18,066
	% 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-04
Climate change, total	kg CO ₂ eq.	9.99E+03	8.74E+03
	% difference	0 %	-12.6 %
Ozone depletion	kg CFC-11 eq.	1.49E-05	2.94E-05
	% difference	0 %	97.4 %
Human toxicity, cancer	CTUh	5.87E-06	9.08E-06
	% difference	0 %	54.5 %
Human toxicity, non-cancer	CTUh	8.13E-05	7.76E-05
	% difference	0 %	-4.6 %
Particulate matter	disease incidence	3.73E-04	3.40E-04
	% difference	0 %	-8.7 %
Ionising radiation, human health	kBq U235 eq.	3.89E+03	3.33E+03
	% difference	0 %	-14.4 %

PEF Impact categories	Unit	Reference	DO-04
Photochemical ozone formation, human health	kg NMVOC eq.	1.83E+01	1.63E+01
	% difference	0 %	-10.7 %
Acidification	mol H+ eq.	3.24E+01	2.90E+01
	% difference	0 %	-10.6 %
Eutrophication, terrestrial	mol N eq.	6.76E+01	6.01E+01
	% difference	0 %	-11.0 %
Eutrophication, freshwater	kg P eq.	1.44E-01	1.42E-01
	% difference	0 %	-1.5 %
Eutrophication, marine	kg N eq.	7.24E+00	6.55E+00
	% difference	0 %	-9.5 %
Ecotoxicity, freshwater	CTUe	5.38E+04	4.83E+04
	% difference	0 %	-10.3 %
Land use	pt	1.66E+05	1.60E+05
	% difference	0 %	-3.3 %
Water use	m ³ water eq. of deprived water	1.23E+04	1.19E+04
	% difference	0 %	-3.5 %
Resource use, minerals and metals	kg Sb eq.	4.02E-02	4.40E-02
	% difference	0 %	9.2 %
Resource use, fossils	MJ	1.70E+05	1.48E+05
	% difference	0 %	-13.0 %

6125 8.3.1.2. LCC impact

6126 Below (Table 8-21), the Life Cycle Costs of the original Base Case (reference) and all design
6127 options are provided.

6128 **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	410	348
	% difference	0 %	-15.2 %
Water	EUR/year	76	76
	% difference	0 %	-0.2 %
Auxiliary material 1 (Detergent)	EUR/year	117	117
	% difference	0 %	-0.2 %
Auxiliary material 2 (Rinsing agent)	EUR/year	0	0
	% difference	0 %	0 %
Repair & maintenance costs	EUR	115	115
	% difference	0 %	0 %
Total	EUR/year	981	918
	% difference	0 %	-6.4 %

6130 8.3.2. BC2: Undercounter one-tank dishwasher

6131 8.3.2.1. Environmental impact

6132 Below, the resource use as well as the environmental impact of the original Base Case (reference) and all design options are provided.

6133 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	39,815
	% difference	0 %	-13.5 %	-3.5 %	-9.8 %	-26.6 %	10.1 %	-4.9 %	-29.5 %
Water (use phase)	m ³	1,305	1,305	1,369	1,305	957	1,436	1,305	1,244
	% difference	0 %	0 %	4.9 %	0 %	-26.7 %	10 %	0 %	-4.7 %
Detergent (use phase)	kg	1,464	1,464	1,409	1,464	1,073	1,610	1,464	1,288
	% difference	0 %	0 %	-3.7 %	0 %	-26.7 %	10 %	0 %	-12.0 %
Rinsing agent (use phase)	kg	125	125	120	125	91	137	125	110
	% difference	0 %	0 %	-3.7 %	0 %	-26.7 %	10 %	0 %	-12.0 %
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	1.95E+04
	% difference	0 %	-11.9%	-3.0 %	-8.6 %	-26.0 %	11.4 %	-4.3 %	-26.7 %
Ozone depletion	kg CFC-11 eq.	4.39E-05	4.27E-05	4.38E-05	4.50E-05	3.22E-05	4.83E-05	4.35E-05	4.04E-05
	% difference	0 %	-2.6%	-0.1 %	2.6 %	-26.5 %	10.1 %	-1.0 %	-7.9 %
Human toxicity, cancer	CTUh	2.48E-05	2.43E-05	2.55E-05	2.54E-05	1.95E-05	2.63E-05	2.46E-05	2.46E-05
	% difference	0 %	-2.0%	2.7 %	2.5 %	-21.5 %	6.0 %	-0.8 %	-0.8 %
Human toxicity, non-cancer	CTUh	2.09E-04	2.01E-04	2.12E-04	2.02E-04	1.58E-04	2.40E-04	2.06E-04	1.84E-04
	% difference	0 %	-4.0%	1.4 %	-3.6 %	-24.7 %	14.4 %	-1.8 %	-12.1 %
Particulate matter	disease incidence	1.03E-03	9.32E-04	1.00E-03	9.59E-04	7.67E-04	1.15E-03	9.93E-04	7.97E-04
	% difference	0 %	-9.5%	-2.4 %	-6.9 %	-25.5 %	11.8 %	-3.5 %	-22.6 %
	kBq U235 eq.	1.02E+04	8.89E+03	9.89E+03	9.26E+03	7.53E+03	1.13E+04	9.76E+03	7.27E+03

Preparatory study on professional dishwashers

Ionising radiation, human health	% difference	0 %	-13.2%	-3.5 %	-9.6 %	-26.5 %	10.2 %	-4.8 %	-29.1 %
Photochemical ozone formation, human health	kg NMVOC eq.	4.94E+01	4.42E+01	4.81E+01	4.56E+01	3.66E+01	5.52E+01	4.75E+01	3.74E+01
	% difference	0 %	-10.4%	-2.6 %	-7.6 %	-25.8 %	11.7 %	-3.8 %	-24.3 %
Acidification	mol H+ eq.	8.83E+01	7.88E+01	8.58E+01	8.14E+01	6.56E+01	9.86E+01	8.48E+01	6.64E+01
	% difference	0 %	-10.8%	-2.8 %	-7.8 %	-25.7 %	11.7 %	-3.9 %	-24.8 %
PEF Impact categories	Unit	Reference	DO-01	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Eutrophication, terrestrial	mol N eq.	1.85E+02	1.66E+02	1.80E+02	1.72E+02	1.38E+02	2.07E+02	1.78E+02	1.40E+02
	% difference	0 %	-10.3%	-2.9 %	-7.5 %	-25.9 %	11.7 %	-3.8 %	-24.5 %
Eutrophication, freshwater	kg P eq.	4.20E-01	4.14E-01	4.24E-01	4.15E-01	3.10E-01	4.66E-01	4.17E-01	3.78E-01
	% difference	0 %	-1.4%	0.9 %	-1.1 %	-26.2 %	11.0 %	-0.6 %	-9.8 %
Eutrophication, marine	kg N eq.	2.06E+01	1.88E+01	2.01E+01	1.93E+01	1.53E+01	2.30E+01	1.99E+01	1.60E+01
	% difference	0 %	-8.7%	-2.6 %	-6.4 %	-26.0 %	11.5 %	-3.2 %	-22.3 %
Ecotoxicity, freshwater	CTUe	1.47E+05	1.33E+05	1.44E+05	1.37E+05	1.09E+05	1.64E+05	1.42E+05	1.13E+05
	% difference	0 %	-9.5%	-2.4 %	-7.1 %	-26.0 %	10.9 %	-3.5 %	-23.1 %
Land use	pt	3.56E+05	4.74E+05	4.64E+05	3.46E+05	3.23E+05	3.71E+05	3.51E+05	5.94E+05
	% difference	0 %	33.1%	30.4 %	-2.8 %	-9.2 %	4.3 %	-1.4 %	66.7 %
Water use	m3 water eq. of deprived water	3.16E+04	3.05E+04	3.23E+04	3.08E+04	5.00E+00	3.49E+04	3.12E+04	2.81E+04
	% difference	0 %	-3.4%	2.3 %	-2.5 %	-26.5 %	10.3 %	-1.2 %	-11.2 %
Resource use, minerals and metals	kg Sb eq.	9.96E-02	1.12E-01	1.12E-01	1.00E-01	8.85E-02	1.34E-01	9.94E-02	1.25E-01
	% difference	0 %	12.8%	12.2 %	0.6 %	-11.2 %	34.2 %	-0.3 %	25.5 %
Resource use, fossils	MJ	4.49E+05	3.94E+05	4.35E+05	4.09E+05	3.32E+05	4.98E+05	4.29E+05	3.27E+05
	% difference	0 %	-12.3%	-3.1 %	-8.9 %	-26.2 %	11.0 %	-4.4 %	-27.3 %

6134 8.3.2.2. LCC impact

6135 Below (Table 8-23), the Life Cycle Costs of the original Base Case (reference) and all design options are provided.

6136 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	8,818
	% difference / year	0 %	15.0 %	15.9 %	3.3 %	32.9 %	-4.6 %	10.0 %	55.8 %
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 %	-0.7 %	-0.1 %	1.7 %	-0.6 %	0.0 %	-0.3 %
Electricity	EUR/year	1,665	1,436	1,448	1,499	1,695	1,656	1,583	1,165
	% difference	0 %	-13.8 %	-13.0 %	-10.0 %	1.8 %	-0.5 %	-4.9 %	-30.0 %
Water	EUR/year	290	290	275	290	295	288	290	276
	% difference	0 %	-0.1 %	-5.3 %	0 %	1.7 %	-0.6 %	0.0 %	-4.9 %
Auxiliary material 1 (Detergent)	EUR/year	718	718	624	718	731	714	718	631
	% difference	0 %	-0.1 %	-13.1 %	-0.1 %	1.7 %	-0.6 %	0.0 %	-12.2 %
Auxiliary material 2 (Rinsing agent)	EUR/year	57.0	57	50	57	58	57	57	50
	% difference	0 %	-0.1 %	-13.1 %	0 %	1.7 %	-0.7 %	-0.1 %	-12.3 %
Repair & maintenance costs	EUR	311	358	361	322	414	297	342	498
	% difference	0 %	15.0 %	15.9 %	3.3 %	33.0 %	-4.5 %	10.0 %	60.0 %
Total	EUR/year	3,756	3,679	3,584	3,623	4,140	3,694	3,775	3,728
	% difference	0 %	-2.1 %	-4.6 %	-3.5 %	10.2 %	-1.7 %	0.5 %	-0.7 %

8.3.3. BC3: Hood-type dishwasher Environmental impact

8.3.3.1. Environmental impact

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.

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	95,618	110,967	103,695	84,305	126,439	109,322	81,190
	% difference	0 %	-13.4 %	-16.8 %	-3.4 %	-9.7 %	-26.6 %	10.1 %	-4.8 %	-29.3 %
Water (use phase)	m ³	1,240	1,240	1,209	1,248	1,240	909	1,364	1,240	1,134
	% difference	0 %	0.0 %	-2.5 %	0.7 %	0.0 %	-26.7 %	10.0 %	0.0 %	-8.5 %
Detergent (use phase)	kg	2,522	2,522	2,459	2,427	2,522	1,849	2,774	2,522	2,219
	% difference	0 %	0.0 %	-2.5 %	-3.7 %	0.0 %	-26.7 %	10.0 %	0.0 %	-12.0 %
Rinsing agent (use phase)	kg	195	195	190	187	195	143	214	195	171
	% difference	0 %	0.0 %	-2.5 %	-3.7 %	0.0 %	-26.7 %	10.0 %	0.0 %	-12.0 %
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	4.38E+04	5.02E+04	4.73E+04	3.83E+04	5.76E+04	4.96E+04	3.77E+04
	% difference	0 %	-12.2 %	-15.6 %	-3.3 %	-8.9 %	-26.2 %	10.8 %	-4.5 %	-27.4 %
Ozone depletion	kg CFC-11 eq.	6.41E-05	6.17E-05	5.99E-05	6.25E-05	6.63E-05	4.71E-05	7.05E-05	6.32E-05	5.79E-05
	% difference	0 %	-3.7 %	-6.4 %	-2.5 %	3.5 %	-26.5 %	10.1 %	-1.4 %	-9.6 %
Human toxicity, cancer	CTUh	4.60E-05	4.87E-05	4.44E-05	4.69E-05	4.77E-05	3.59E-05	4.80E-05	4.56E-05	5.03E-05
	% difference	0 %	6.0 %	-3.4 %	2.0 %	3.8 %	-21.9 %	4.5 %	9.4 %	9.4 %
Human toxicity, non-cancer	CTUh	3.09E-04	2.91E-04	2.81E-04	3.06E-04	2.94E-04	2.32E-04	3.51E-04	3.01E-04	2.57E-04
	% difference	0 %	-5.8 %	-8.9 %	-1.1 %	-4.9 %	-24.9 %	13.8 %	-2.5 %	-16.7 %

PEF Impact categories	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Particulate matter	disease incidence	1.95E-03	1.76E-03	1.69E-03	1.89E-03	1.81E-03	1.45E-03	2.16E-03	1.87E-03	1.49E-03
	% difference	0 %	-9.9 %	-13.4 %	-2.9 %	-7.3 %	-25.8 %	11.0 %	-3.8 %	-23.6 %
Ionising radiation, human health	kBq U235 eq.	2.05E+04	1.77E+04	1.71E+04	1.97E+04	1.85E+04	1.50E+04	2.25E+04	1.95E+04	1.45E+04
	% difference	0 %	-13.4 %	-16.7 %	-3.6 %	-9.7 %	-26.6 %	10.1 %	-4.8 %	-29.4 %
Photochemical ozone formation, human health	kg NMVOC eq.	9.36E+01	8.33E+01	8.01E+01	9.06E+01	8.60E+01	6.92E+01	1.04E+02	8.97E+01	6.96E+01
	% difference	0 %	-11.0 %	-14.4 %	-3.2 %	-8.1 %	-26.0 %	11.1 %	-4.1 %	-25.6 %
Acidification	mol H+ eq.	1.71E+02	1.52E+02	1.46E+02	1.65E+02	1.57E+02	1.26E+02	1.89E+02	1.64E+02	1.27E+02
	% difference	0 %	-11.0 %	-14.6 %	-3.2 %	-8.1 %	-26.0 %	11.0 %	-4.2 %	-25.5 %
Eutrophication, terrestrial	mol N eq.	3.55E+02	3.16E+02	3.05E+02	3.43E+02	3.27E+02	2.62E+02	3.94E+02	3.41E+02	2.64E+02
	% difference	0 %	-10.8 %	-14.2 %	-3.3 %	-8.0 %	-26.1 %	11.1 %	-4.0 %	-25.5 %
Eutrophication, freshwater	kg P eq.	5.67E-01	5.54E-01	5.39E-01	5.56E-01	5.57E-01	4.18E-01	6.29E-01	5.62E-01	4.92E-01
	% difference	0 %	-2.2 %	-4.9 %	-1.9 %	-1.7 %	-26.2 %	11.0 %	-0.8 %	-13.3 %
Eutrophication, marine	kg N eq.	3.80E+01	3.44E+01	3.32E+01	3.68E+01	3.54E+01	2.81E+01	4.22E+01	3.67E+01	2.90E+01
	% difference	0 %	-9.6 %	-12.8 %	-3.2 %	-7.0 %	-26.1 %	11.0 %	-3.5 %	-23.8 %
Ecotoxicity, freshwater	CTUe	2.74E+05	2.45E+05	2.37E+05	2.65E+05	2.53E+05	2.02E+05	3.03E+05	2.63E+05	2.06E+05
	% difference	0 %	-10.4 %	-13.6 %	-3.1 %	-7.7 %	-26.2 %	10.5 %	-3.9 %	-24.9 %
Land use	pt	5.86E+05	7.18E+05	7.39E+05	7.53E+05	5.66E+05	5.20E+05	6.15E+05	5.76E+05	8.81E+05
	% difference	0 %	22.6 %	26.2 %	28.5 %	-3.4 %	-11.2 %	4.9 %	-1.7 %	50.4 %
Water use	m ³ water eq. of deprived water	3.99E+04	3.77E+04	3.66E+04	3.94E+04	3.83E+04	5.00E+00	4.40E+04	3.91E+04	3.31E+04
	% difference	0 %	-5.4 %	-8.3 %	-1.3 %	-4.0 %	-26.5 %	10.3 %	-2.0 %	-17.1 %
Resource use, minerals and metals	kg Sb eq.	1.61E-01	1.81E-01	1.76E-01	1.79E-01	1.62E-01	1.39E-01	2.06E-01	1.60E-01	1.99E-01
	% difference	0 %	12.5 %	9.4 %	11.6 %	1.1 %	-13.3 %	28.1 %	-0.4 %	24.1 %
Resource use, fossils	MJ	8.87E+05	7.76E+05	7.46E+05	8.57E+05	8.06E+05	6.53E+05	9.81E+05	8.46E+05	6.39E+05
	% difference	0 %	-12.5 %	-15.9 %	-3.3 %	-9.1 %	-26.3 %	10.6 %	-4.6 %	-27.9 %

6141 8.3.3.2. LCC impact

6142 Below (Table 8-25), the Life Cycle Costs of the original Base Case (reference) and all design options are provided.

6143 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	23.1	23.0	23.1	22.9	23.1	23.4	22.9	23.1	23.0	
	% difference		0 %	-0.1%	0 %	-0.6 %	-0.1 %	1.6 %	-0.6 %	0 %	-0.2 %
Electricity	EUR/year	3,375	2,909	2,871	2,936	3,037	3,431	3,356	3,207	2,358	
	% difference		0 %	-13.8%	-14.9 %	-13.0 %	-10.0 %	1.6 %	-0.6 %	-5.0 %	-30.1 %
Water	EUR/year	277	276	277	251	276	281	275	276	252	
	% difference		0 %	-0.1%	0 %	-9.1 %	0 %	1.6 %	-0.6 %	0 %	-8.7 %
Auxiliary material 1 (Detergent)	EUR/year	1,243	1,241	1,243	1,080	1,242	1,263	1,235	1,242	1,091	
	% difference		0 %	-0.1%	0 %	-13.1 %	-0.1 %	1.6 %	-0.6 %	0 %	-12.2 %
Auxiliary material 2 (Rinsing agent)	EUR/year	89.3	89.2	89.3	77.6	89.2	90.7	88.7	89.3	78.4	
	% difference		0 %	-0.1%	0 %	-13.1 %	0 %	1.6 %	-0.6 %	0 %	-12.2 %
Repair & maintenance costs	EUR	476	564	794	552	492	633	455	524	762	
	% difference		0 %	18.3 %	66.7 %	15.9 %	3.3 %	33.0 %	-4.5 %	10.0 %	60.0 %
Total	EUR/year	6,566	6,384	7,102	6,176	6,278	7,161	6,466	6,554	6,289	
	% difference	0 %	-2.8%	8.2 %	-5.9 %	-4.4 %	9.1 %	-1.5 %	-0.2 %	-4.2 %	

6144 **8.3.4. BC4: Utensil/pot dishwasher**

6145 **8.3.4.1. Environmental impact**

6146 Below (**Table 8-26**), the resource use as well as the environmental impact of the original Base Case (reference) and all design options are provided.

6147 **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
Total energy consumption	kWh	117,005	102,052	99,013	113,751	106,137	85,832	128,729	111,583	84,351
	% difference	0 %	-12.8 %	-15.4 %	-2.8 %	-9.3 %	-26.6 %	10.0 %	-4.6 %	-27.9 %
Water (use phase)	m ³	1,050	1,050	1,033	1,011	1,050	770	1,155	1,050	924
	% difference	0 %	0 %	-1.7 %	-3.7 %	0 %	-26.7 %	10.0 %	0 %	-12.0 %
Detergent (use phase)	kg	2,913	2,913	2,864	2,804	2,913	2,136	3,204	2,913	2,563
	% difference	0 %	0 %	-1.7 %	-3.7 %	0 %	-26.7 %	10.0 %	0 %	-12.0 %
Rinsing agent (use phase)	kg	153	153	151	147	153	112	168	153	135
	% difference	0 %	0 %	-1.7 %	-3.8 %	0 %	-26.7 %	10.0 %	0 %	-12.0 %
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.	5.16E+04	4.52E+04	4.38E+04	4.98E+04	4.68E+04	3.78E+04	5.65E+04	4.90E+04	3.77E+04
	% difference	0 %	-11.9 %	-14.5 %	-2.8 %	-8.7 %	-26.4 %	10.2 %	-4.4 %	-26.4 %
Ozone depletion	kg CFC-11 eq.	6.45E-05	6.22E-05	6.10E-05	6.21E-05	6.88E-05	4.73E-05	7.09E-05	6.36E-05	5.98E-05
	% difference	0 %	-3.5 %	-5.5 %	-3.7 %	6.7 %	-26.6 %	10.0 %	-1.3 %	-7.2 %
Human toxicity, cancer	CTUh	5.72E-05	6.17E-05	5.57E-05	5.84E-05	6.01E-05	4.48E-05	5.90E-05	5.67E-05	6.50E-05
	% difference	0 %	8.1 %	-2.4 %	2.3 %	5.3 %	-21.5 %	3.3 %	13.9 %	13.9 %
Human toxicity, non-cancer	CTUh	2.98E-04	2.73E-04	2.67E-04	2.88E-04	2.75E-04	2.16E-04	3.23E-04	2.82E-04	2.44E-04
	% difference	0 %	-5.7 %	-7.9 %	-0.6 %	-5.0 %	-25.3 %	11.4 %	-2.6 %	-15.9 %

PEF Impact categories	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Particulate matter	disease incidence	1.94E-03	1.74E-03	1.69E-03	1.87E-03	1.79E-03	1.42E-03	2.11E-03	1.85E-03	1.49E-03
	% difference	0 %	-9.3 %	-12.2 %	-2.5 %	-6.9 %	-25.9 %	10.1 %	-3.7 %	-22.2 %
Ionising radiation, human health	kBq U235 eq.	1.95E+04	1.69E+04	1.64E+04	1.88E+04	1.76E+04	1.43E+04	2.15E+04	1.86E+04	1.38E+04
	% difference	0 %	-13.3 %	-16.0 %	-3.6 %	-9.7 %	-26.6 %	10.0 %	-4.9 %	-29.3 %
Photochemical ozone formation, human health	kg NMVOC eq.	9.20E+01	8.15E+01	7.91E+01	8.87E+01	8.41E+01	6.73E+01	1.01E+02	8.76E+01	6.86E+01
	% difference	0 %	-10.7 %	-13.4 %	-2.8 %	-7.8 %	-26.2 %	10.3 %	-4.0 %	-24.8 %
Acidification	mol H+ eq.	1.68E+02	1.49E+02	1.44E+02	1.62E+02	1.53E+02	1.23E+02	1.83E+02	1.60E+02	1.26E+02
	% difference	0 %	-10.6 %	-13.5 %	-2.8 %	-7.8 %	-26.1 %	10.1 %	-4.1 %	-24.4 %
Eutrophication, terrestrial	mol N eq.	3.49E+02	3.10E+02	3.01E+02	3.36E+02	3.20E+02	2.55E+02	3.82E+02	3.33E+02	2.61E+02
	% difference	0 %	-10.6 %	-13.2 %	-3.0 %	-7.7 %	-26.3 %	10.3 %	-3.9 %	-24.7 %
Eutrophication, freshwater	kg P eq.	5.71E-01	5.55E-01	5.44E-01	5.50E-01	5.58E-01	4.17E-01	6.26E-01	5.62E-01	4.87E-01
	% difference	0 %	-2.2 %	-4.0 %	-3.1 %	-1.6 %	-26.4 %	10.4 %	-0.8 %	-14.1 %
Eutrophication, marine	kg N eq.	3.78E+01	3.41E+01	3.31E+01	3.64E+01	3.50E+01	2.77E+01	4.14E+01	3.62E+01	2.89E+01
	% difference	0 %	-9.2 %	-11.7 %	-3.0 %	-6.7 %	-26.3 %	10.3 %	-3.4 %	-23.1 %
Ecotoxicity, freshwater	CTUe	2.68E+05	2.40E+05	2.33E+05	2.58E+05	2.47E+05	1.97E+05	2.94E+05	2.56E+05	2.02E+05
	% difference	0 %	-10.1 %	-12.6 %	-3.1 %	-7.5 %	-26.2 %	10.1 %	-3.8 %	-24.4 %
Land use	pt	7.10E+05	9.04E+05	9.28E+05	9.33E+05	6.93E+05	6.49E+05	7.46E+05	7.02E+05	1.12E+06
	% difference	0 %	26.9 %	30.4 %	31.0 %	-2.7 %	-8.8 %	4.8 %	-1.4 %	57.4 %
Water use	m ³ water eq. of deprived water	3.63E+04	3.41E+04	3.34E+04	3.49E+04	3.47E+04	5.00E+00	3.98E+04	3.54E+04	2.93E+04
	% difference	0 %	-5.7 %	-7.8 %	-3.4 %	-4.2 %	-26.5 %	10.1 %	-2.1 %	-19.0 %
Resource use, minerals and metals	kg Sb eq.	1.94E-01	1.98E-01	1.94E-01	2.07E-01	1.75E-01	1.46E-01	1.96E-01	1.71E-01	2.34E-01
	% difference	0 %	15.3 %	12.8 %	20.6 %	1.8 %	-15.1 %	13.9 %	-0.3 %	36.3 %
Resource use, fossils	MJ	8.77E+05	7.67E+05	7.44E+05	8.47E+05	7.96E+05	6.43E+05	9.62E+05	8.34E+05	6.37E+05
	% difference	0 %	-12.2 %	-14.8 %	-3.0 %	-8.9 %	-26.4 %	10.2 %	-4.5 %	-27.0 %

6148 8.3.4.2. LCC impact

6149 Below (Table 8-27), the Life Cycle Costs of the original Base Case (reference) and all design options are provided.

6150 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
Product price	EUR	10,855	12,664	18,996	13,840	11,217	10,584	11,398	11,940	17,097
	% difference / year	0 %	16.7 %	78.0 %	15.9 %	3.3 %	33.0 %	-4.5 %	10.0 %	57.5 %
Natural gas (for heat)	EUR/year	86.4	84	83.8	83.7	84.7	88.1	85.9	85.6	81
	% difference	0 %	-2.8 %	-2.9 %	-3.1 %	-2.0 %	1.9 %	-0.5 %	-0.9 %	-6.2 %
Electricity	EUR/year	2,829	2,438	2,405	2,459	2,545	2,881	2,810	2,687	1,976
	% difference	0 %	-13.8 %	-15.0 %	-13.1 %	-10.0 %	1.8 %	-0.7 %	-5.0 %	-30.1 %
Water	EUR/year	207	207	207	180	207	210	205	207	182
	% difference	0 %	-0.1 %	0 %	-13.1 %	-0.1 %	1.8 %	-0.7 %	0 %	-12.2 %
Auxiliary material 1 (Detergent)	EUR/year	1,266	1,265	1,267	1,101	1,266	1,289	1,258	1,266	1,112
	% difference	0 %	-0.1 %	0 %	-13.1 %	-0.1 %	1.8 %	-0.7 %	0 %	-12.2 %
Auxiliary material 2 (Rinsing agent)	EUR/year	62	61.9	62	53.9	62	63.1	61.6	62	54.4
	% difference	0 %	-0.1 %	0 %	-13.1 %	-0.1 %	1.8 %	-0.7 %	0 %	-12.2 %
Repair & maintenance costs	EUR	531	619	944	615	548	706	507	584	849
	% difference	0 %	16.7 %	78.0 %	15.9 %	3.3 %	33.0 %	-4.5 %	10.0 %	60.0 %
Total	EUR/year	6,187	6,082	7,116	5,890	5,958	6,841	6,079	6,218	6,154
	% difference	0 %	-1.7 %	15.0 %	-4.8 %	-3.7 %	10.6 %	-1.7 %	0.5 %	-0.5 %

6151 **8.3.5. BC5: One-tank conveyor-type dishwasher**

6152 **8.3.5.1. Environmental impact**

6153 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.

6154 **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	595,734	509,012	500,533	575,788	537,920	436,934	655,282	537,920	422,291
	% difference	0 %	-14.6 %	-16.0 %	-3.3 %	-9.7 %	-26.7 %	10.0 %	-9.7 %	-29.1 %
Water (use phase)	m ³	4,439	4,439	4,365	4,348	4,439	3,255	4,883	4,439	3,953
	% difference	0 %	0.0 %	-1.7 %	-2.0 %	0.0 %	-26.7 %	10.0 %	0.0 %	-11.0 %
Detergent (use phase)	kg	10,764	10,764	10,585	10,360	10,764	7,894	11,841	10,764	9,472
	% difference	0 %	0.0 %	-1.7 %	-3.8 %	0.0 %	-26.7 %	10.0 %	0.0 %	-12.0 %
Rinsing agent (use phase)	kg	906	906	891	872	906	664	996	906	797
	% difference	0 %	0.0 %	-1.7 %	-3.7 %	0.0 %	-26.7 %	10.0 %	0.0 %	-12.0 %
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.	2.52E+05	2.18E+05	2.14E+05	2.44E+05	2.29E+05	1.86E+05	2.78E+05	2.29E+05	1.83E+05
	% difference	0 %	-13.6 %	-15.0 %	-3.1 %	-9.0 %	-26.4 %	10.2 %	-9.2 %	-27.5 %
Ozone depletion	kg CFC-11 eq.	2.70E-04	2.58E-04	2.54E-04	2.61E-04	2.77E-04	1.99E-04	2.97E-04	2.62E-04	2.38E-04
	% difference	0 %	-4.5 %	-6.1 %	-3.2 %	2.5 %	-26.5 %	10.0 %	-3.0 %	-11.9 %
Human toxicity, cancer	CTUh	2.33E-04	2.42E-04	2.48E-04	2.38E-04	2.44E-04	1.83E-04	2.41E-04	2.29E-04	2.54E-04
	% difference	0 %	3.9 %	6.5 %	2.2 %	4.7 %	-21.6 %	3.6 %	9.0 %	9.0 %
Human toxicity, non-cancer	CTUh	1.34E-03	1.24E-03	1.22E-03	1.33E-03	1.27E-03	1.01E-03	1.50E-03	1.27E-03	1.10E-03
	% difference	0 %	-7.5 %	-8.7 %	-1.2 %	-5.4 %	-24.9 %	11.6 %	-5.5 %	-17.8 %

PEF Impact categories	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Particulate matter	disease incidence	9.00E-03	7.99E-03	7.89E-03	8.76E-03	8.33E-03	6.67E-03	9.92E-03	8.30E-03	6.87E-03
	% difference	0 %	-11.2 %	-12.4 %	-2.7 %	-7.4 %	-25.9 %	10.2 %	-7.8 %	-23.7 %
Ionising radiation, human health	kBq U235 eq.	9.53E+04	8.13E+04	8.00E+04	9.18E+04	8.60E+04	6.99E+04	1.05E+05	8.59E+04	6.72E+04
	% difference	0 %	-14.7 %	-16.1 %	-3.7 %	-9.8 %	-26.6 %	10.0 %	-9.8 %	-29.5 %
Photochemical ozone formation, human health	kg NMVOC eq.	4.34E+02	3.80E+02	3.75E+02	4.22E+02	3.99E+02	3.21E+02	4.79E+02	3.98E+02	3.22E+02
	% difference	0 %	-12.4 %	-13.8 %	-3.0 %	-8.3 %	-26.2 %	10.3 %	-8.4 %	-25.8 %
Acidification	mol H+ eq.	7.91E+02	6.93E+02	6.83E+02	7.68E+02	7.26E+02	5.84E+02	8.72E+02	7.24E+02	5.89E+02
	% difference	0 %	-12.4 %	-13.6 %	-2.9 %	-8.2 %	-26.1 %	10.2 %	-8.5 %	-25.5 %
Eutrophication, terrestrial	mol N eq.	1.64E+03	1.44E+03	1.41E+03	1.59E+03	1.50E+03	1.21E+03	1.80E+03	1.50E+03	1.21E+03
	% difference	0 %	-12.2 %	-13.6 %	-3.1 %	-8.1 %	-26.2 %	10.3 %	-8.3 %	-25.7 %
Eutrophication, freshwater	kg P eq.	2.39E+00	2.32E+00	2.28E+00	2.33E+00	2.34E+00	1.76E+00	2.64E+00	2.34E+00	2.04E+00
	% difference	0 %	-3.2 %	-4.8 %	-2.6 %	-2.1 %	-26.3 %	10.4 %	-2.1 %	-14.8 %
Eutrophication, marine	kg N eq.	1.74E+02	1.55E+02	1.52E+02	1.68E+02	1.61E+02	1.28E+02	1.92E+02	1.61E+02	1.32E+02
	% difference	0 %	-10.9 %	-12.3 %	-3.1 %	-7.2 %	-26.3 %	10.3 %	-7.4 %	-24.2 %
Ecotoxicity, freshwater	CTUe	1.26E+06	1.11E+06	1.09E+06	1.22E+06	1.16E+06	9.29E+05	1.38E+06	1.16E+06	9.39E+05
	% difference	0 %	-11.7 %	-13.1 %	-3.2 %	-7.9 %	-26.1 %	10.1 %	-8.0 %	-25.3 %
Land use	pt	5.02E+06	5.47E+06	5.51E+06	5.12E+06	4.92E+06	4.67E+06	5.47E+06	4.92E+06	5.49E+06
	% difference	0 %	9.1 %	9.8 %	2.0 %	-1.9 %	-7.0 %	9.0 %	-1.9 %	9.5 %
Water use	m ³ water eq. of deprived water	1.63E+05	1.52E+05	1.49E+05	1.58E+05	1.55E+05	5.00E+00	1.79E+05	1.55E+05	1.31E+05
	% difference	0 %	-6.8 %	-8.3 %	-2.8 %	-4.6 %	-26.5 %	10.1 %	-4.6 %	-19.4 %
Resource use, minerals and metals	kg Sb eq.	9.04E-01	9.67E-01	9.76E-01	9.78E-01	9.13E-01	7.92E-01	1.04E+00	8.96E-01	1.04E+00
	% difference	0 %	7.0 %	8.0 %	8.2 %	1.0 %	-12.4 %	15.2 %	-0.9 %	14.6 %
Resource use, fossils	MJ	4.29E+06	3.70E+06	3.64E+06	4.16E+06	3.90E+06	3.16E+06	4.73E+06	3.90E+06	3.09E+06
	% difference	0 %	-13.8 %	-15.2 %	-3.2 %	-9.2 %	-26.4 %	10.2 %	-9.3 %	-27.9 %

6155 8.3.5.2. LCC impact

6156 Below (Table 8-29), the Life Cycle Costs of the original Base Case (reference) and all design options are provided.

6157 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	25,003
	% difference / year	0 %	16.7 %	39.8 %	36.4 %	5.0 %	33.0 %	-2.3 %	15.0 %	86.7 %
Natural gas (for heat)	EUR/year	500	443	444	449	462	511	497	462	385
	% difference	0 %	-11.4 %	-11.3 %	-10.1 %	-7.6 %	2.3 %	-0.7 %	-7.6 %	-22.9 %
Electricity	EUR/year	11,166	9,492	9,505	9,705	10,055	11,422	11,091	10,055	7,806
	% difference	0 %	-15.0 %	-14.9 %	-13.1 %	-10.0 %	2.3 %	-0.7 %	-10.0 %	-30.1 %
Water	EUR/year	704.5	704.6	705.6	623.2	704.9	720.7	699.8	704.9	626.6
	% difference	0 %	0 %	0.1 %	-11.6 %	0.1 %	2.3 %	-0.7 %	0.1 %	-11.1 %
Auxiliary material 1 (Detergent)	EUR/year	3,775	3,775	3,780	3,281	3,777	3,861	3,750	3,777	3,318
	% difference	0 %	0.0 %	0.1 %	-13.1 %	0.1 %	2.3 %	-0.7 %	0.1 %	-12.1 %
Auxiliary material 2 (Rinsing agent)	EUR/year	295.8	295.8	296.2	257.1	295.9	302.5	293.8	295.9	259.9
	% difference	0 %	0 %	0.1 %	-13.1 %	0.1 %	2.3 %	-0.7 %	0.1 %	-12.1 %
Repair & maintenance costs	EUR	536	625	749	731	563	712	524	616	938
	% difference	0 %	16.7 %	39.8 %	36.4 %	5.0 %	33.0 %	-2.3 %	15.0 %	75.0 %
Total	EUR/year	18,195	16,757	17,183	16,706	17,136	19,149	18,045	17,311	15,606
	% difference	0 %	-7.9 %	-5.6 %	-8.2 %	-5.8 %	5.2 %	-0.8 %	-4.9 %	-14.2 %

6158 **8.3.6. BC6: Multi-tank conveyor-type dishwasher**

6159 **8.3.6.1. Environmental impact**

6160 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.

6161 **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	1,959,686	1,673,164	1,645,283	1,892,979	1,720,917	1,437,183	2,155,625	1,768,670	1,386,647
	% difference	0 %	-14.6 %	-16.0 %	-3.4 %	-12.2 %	-26.7 %	10.0 %	-9.7 %	-29.2 %
Water (use phase)	m ³	11,456	11,456	11,265	11,291	11,456	8,401	12,602	11,456	10,265
	% difference	0 %	0 %	-1.7 %	-1.4 %	0 %	-26.7 %	10.0 %	0 %	-10.4 %
Detergent (use phase)	kg	26,478	26,478	26,037	25,485	26,478	19,417	29,126	26,478	23,168
	% difference	0 %	0 %	-1.7 %	-3.8 %	0 %	-26.7 %	10.0 %	0 %	-12.5 %
Rinsing agent (use phase)	kg	2,117	2,117	2,082	2,038	2,117	1,552	2,329	2,117	1,852
	% difference	0 %	0 %	-1.7 %	-3.7 %	0 %	-26.7 %	10.0 %	0 %	-12.5 %
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.	7.92E+05	6.82E+05	6.71E+05	7.67E+05	7.01E+05	5.83E+05	8.74E+05	7.19E+05	5.69E+05
	% difference	0 %	-13.9 %	-15.3 %	-3.2 %	-11.6 %	-26.4 %	10.3 %	-9.3 %	-28.2 %
Ozone depletion	kg CFC-11 eq.	7.25E-04	6.86E-04	6.75E-04	7.02E-04	7.08E-04	5.32E-04	7.98E-04	6.99E-04	6.08E-04
	% difference	0 %	-5.3 %	-6.9 %	-3.2 %	-2.3 %	-26.6 %	10.1 %	-3.5 %	-16.1 %
Human toxicity, cancer	CTUh	4.62E-04	4.68E-04	4.76E-04	4.69E-04	4.71E-04	3.59E-04	4.87E-04	4.52E-04	4.73E-04
	% difference	0 %	1.3 %	3.0 %	1.4 %	1.9 %	-22.3 %	5.3 %	2.2 %	2.2 %
Human toxicity, non-cancer	CTUh	3.74E-03	3.41E-03	3.35E-03	3.67E-03	3.46E-03	2.78E-03	4.15E-03	3.51E-03	2.96E-03
	% difference	0 %	-8.9 %	-10.3 %	-1.9 %	-7.6 %	-25.6 %	11.0 %	-6.1 %	-20.9 %

PEF Impact categories	Unit	Reference	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
Particulate matter	disease incidence	2.64E-02	2.32E-02	2.29E-02	2.56E-02	2.38E-02	1.95E-02	2.92E-02	2.43E-02	1.96E-02
	% difference	0 %	-12.1 %	-13.4 %	-3.0 %	-10.0 %	-26.1 %	10.3 %	-8.1 %	-25.7 %
Ionising radiation, human health	kBq U235 eq.	2.96E+05	2.53E+05	2.49E+05	2.86E+05	2.60E+05	2.18E+05	3.26E+05	2.67E+05	2.09E+05
	% difference	0 %	-14.7 %	-16.1 %	-3.6 %	-12.2 %	-26.6 %	10.1 %	-9.8 %	-29.6 %
Photochemical ozone formation, human health	kg NMVOC eq.	1.32E+03	1.14E+03	1.13E+03	1.27E+03	1.17E+03	9.69E+02	1.45E+03	1.20E+03	9.59E+02
	% difference	0 %	-13.0 %	-14.4 %	-3.2 %	-10.8 %	-26.4 %	10.3 %	-8.7 %	-27.1 %
Acidification	mol H+ eq.	2.38E+03	2.06E+03	2.03E+03	2.30E+03	2.12E+03	1.75E+03	2.62E+03	2.17E+03	1.73E+03
	% difference	0 %	-13.1 %	-14.4 %	-3.2 %	-10.9 %	-26.3 %	10.2 %	-8.8 %	-27.1 %
Eutrophication, terrestrial	mol N eq.	4.91E+03	4.28E+03	4.21E+03	4.75E+03	4.39E+03	3.62E+03	5.42E+03	4.49E+03	3.59E+03
	% difference	0 %	-12.8 %	-14.2 %	-3.3 %	-10.7 %	-26.4 %	10.3 %	-8.6 %	-26.9 %
Eutrophication, freshwater	kg P eq.	6.40E+00	6.14E+00	6.04E+00	6.23E+00	6.19E+00	4.71E+00	7.06E+00	6.23E+00	5.37E+00
	% difference	0 %	-4.0 %	-5.6 %	-2.6 %	-3.3 %	-26.5 %	10.3 %	-2.7 %	-16.1 %
Eutrophication, marine	kg N eq.	5.12E+02	4.52E+02	4.45E+02	4.95E+02	4.62E+02	3.77E+02	5.64E+02	4.72E+02	3.81E+02
	% difference	0 %	-11.7 %	-13.1 %	-3.3 %	-9.7 %	-26.4 %	10.3 %	-7.8 %	-25.6 %
Ecotoxicity, freshwater	CTUe	3.74E+06	3.27E+06	3.22E+06	3.61E+06	3.35E+06	2.76E+06	4.12E+06	3.43E+06	2.75E+06
	% difference	0 %	-12.4 %	-13.8 %	-3.4 %	-10.4 %	-26.3 %	10.1 %	-8.3 %	-26.6 %
Land use	pt	9.03E+06	9.19E+06	9.19E+06	9.05E+06	8.66E+06	8.01E+06	9.83E+06	8.74E+06	8.85E+06
	% difference	0 %	1.7 %	1.7 %	0.2 %	-4.1 %	-11.3 %	8.9 %	-3.3 %	-2.1 %
Water use	m ³ water eq. of deprived water	4.57E+05	4.23E+05	4.16E+05	4.45E+05	4.28E+05	5.00E+00	5.04E+05	4.34E+05	3.64E+05
	% difference	0 %	-7.6 %	-9.1 %	-2.6 %	-6.4 %	-26.5 %	10.1 %	-5.1 %	-20.3 %
Resource use, minerals and metals	kg Sb eq.	1.71E+00	1.75E+00	1.76E+00	1.81E+00	1.70E+00	1.44E+00	1.95E+00	1.68E+00	1.80E+00
	% difference	0 %	2.4 %	2.7 %	5.6 %	-0.6 %	-15.8 %	14.2 %	-1.7 %	5.2 %
Resource use, fossils	MJ	1.35E+07	1.16E+07	1.14E+07	1.31E+07	1.19E+07	9.94E+06	1.49E+07	1.22E+07	9.66E+06
	% difference	0 %	-14.1 %	-15.5 %	-3.3 %	-11.7 %	-26.5 %	10.2 %	-9.4 %	-28.5 %

6162 8.3.6.2. LCC impact

6163 Below (Table 8-31), the Life Cycle Costs of the original Base Case (reference) and all design options are provided.

6164 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	41,923
	% difference / year	0 %	15.0 %	40.7 %	36.4 %	3.3 %	29.5 %	-2.3 %	15.0 %	103.7 %
Natural gas (for heat)	EUR/year	1,593	1,390	1,393	1,411	1,424	1,641	1,578	1,458	1,186
	% difference	0 %	-12.7 %	-12.6 %	-11.4 %	-10.6 %	3.0 %	-0.9 %	-8.4 %	-25.6 %
Electricity	EUR/year	24,946	21,203	21,241	21,626	21,832	25,695	24,717	22,461	17,431
	% difference	0 %	-15.0 %	-14.9 %	-13.3 %	-12.5 %	3.0 %	-0.9 %	-10.0 %	-30.1 %
Water	EUR/year	1,299	1,299	1,301	1,153	1,299	1,338	1,287	1,299	1,162
	% difference	0 %	0.0 %	0.2 %	-11.2 %	0.0 %	3.0 %	-0.9 %	0.0 %	-10.6 %
Auxiliary material 1 (Detergent)	EUR/year	6,633	6,632	6,644	5,750	6,634	6,832	6,572	6,635	5,793
	% difference	0 %	0.0 %	0.2 %	-13.3 %	0.0 %	3.0 %	-0.9 %	0.0 %	-12.7 %
Auxiliary material 2 (Rinsing agent)	EUR/year	494	494	495	428	494	509	489	494	431
	% difference	0 %	0.0 %	0.2 %	-13.3 %	0.0 %	3.0 %	-0.9 %	0.0 %	-12.7 %
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	37,160	33,542	34,161	33,362	33,952	38,858	36,788	34,873	30,412
	% difference	0 %	-9.7 %	-8.1 %	-10.2 %	-8.6 %	4.6 %	-1.0 %	-6.2 %	-18.2 %

6165

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:

$$PEF\ single\ score = \sum_{i=1}^{16} I_i * \frac{WFi}{NFi}$$

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**.

6198 **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 %

6199 **8.4.2. PEF single score per Base Case and design option**

6200 The purpose of PEF single scores is to provide comparable weighted values across all 16 PEF
6201 impact categories, where a higher single score indicates a greater environmental impact (**Table**
6202 **8-33**). Therefore, PEF single scores were calculated for each of the six Base Cases, aggregating
6203 impacts across all life-cycle stages over the product's entire lifetime. The same scoring system
6204 was then applied to every design option within each Base Case, enabling a like-for-like
6205 comparison of overall environmental performance. Although the EcoReport tool already
6206 calculates all sixteen PEF impact categories and provides the necessary inputs for single-score
6207 calculation, it doesn't perform a full, PEF-aligned LCA study. Therefore, scores derived from the
6208 tool should be treated as an indicative guidance rather than as a comprehensive PEF assessment
6209 when comparing results. Finally, the PEF single score approach has been developed to eventually
6210 compare the impact of products to standard benchmark values for specific product categories,
6211 calculated following product specific PEF Category Rules. Thus, there is no standard scale
6212 currently for broader comparison outside this study.

6213 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	0.88	n.a.	n.a.	n.a.	0.79	n.a.	n.a.	n.a.	n.a.
	% difference	0 %	n.a.	n.a.	n.a.	-9.3 %	n.a.	n.a.	n.a.	n.a.
	Per year of use	0.073	n.a.	n.a.	n.a.	0.066	n.a.	n.a.	n.a.	n.a.
	% difference	0 %	n.a.	n.a.	n.a.	-10.4 %	n.a.	n.a.	n.a.	n.a.
BC2	Total life time	2.32	2.12	n.a.	2.30	2.16	1.74	2.61	2.24	1.85
	% difference	0 %	-8.6 %	n.a.	-1.0 %	-7.1 %	-25.0 %	12.2 %	-3.6 %	-20.2 %
	Per year of use	0.29	0.27	n.a.	0.26	0.27	0.30	0.30	0.28	0.23
	% difference	0 %	-8.6 %	n.a.	-10.0 %	-7.1 %	2.3 %	2.0 %	-3.6 %	-20.2 %
BC3	Total life time	4.30	3.88	3.74	4.21	3.97	3.21	4.79	4.13	3.33
	% difference	0 %	-9.7 %	-13.0 %	-2.0 %	-7.7 %	-25.4 %	11.4 %	-4.0 %	-22.5 %
	Per year of use	0.54	0.49	0.48	0.48	0.50	0.55	0.54	0.52	0.42
	% difference	0 %	-9.7 %	-10.8 %	-10.9 %	-7.7 %	1.7 %	1.2 %	-4.0 %	-22.5 %
BC4	Total life time	4.24	3.86	3.75	4.20	3.93	3.16	4.67	4.08	3.37
	% difference	0 %	-8.9 %	-11.6 %	-1.1 %	-7.4 %	-25.4 %	10.2 %	-3.9 %	-20.5 %
	Per year of use	0.47	0.43	0.42	0.42	0.44	0.48	0.47	0.45	0.37

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 %	-8.9 %	-10.1 %	-10.1 %	-7.4 %	1.7 %	0.1 %	-3.9 %	-20.5 %
BC5	Total life time	20.7	18.4	18.2	20.2	19.1	15.5	22.9	19.1	15.9
	% difference	0 %	-11.1 %	-12.2 %	-2.3 %	-7.7 %	-25.1 %	10.3 %	-8.0 %	-23.1 %
	Per year of use	1.88	1.67	1.68	1.67	1.74	1.92	1.89	1.73	1.45
	% difference	0 %	-11.1 %	-10.7 %	-11.2 %	-7.7 %	2.2 %	0.3 %	-8.0 %	-23.1 %
BC6	Total life time	61.7	54.0	53.2	59.9	55.2	45.7	68.0	56.4	45.8
	% difference	0 %	-12.4 %	-13.7 %	-2.8 %	-10.5 %	-25.8 %	10.3 %	-8.5 %	-25.8 %
	Per year of use	4.11	3.60	3.61	3.63	3.68	4.16	4.12	3.76	3.39
	% difference	0 %	-12.4 %	-12.3 %	-11.7 %	-10.5 %	1.2 %	0.3 %	-8.5 %	-17.5 %

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.

6221 **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	981	n.a.	n.a.	n.a.	918	n.a.	n.a.	n.a.	n.a.
	% difference	0 %	n.a.	n.a.	n.a.	-6.4 %	n.a.	n.a.	n.a.	n.a.
BC2	EUR/year	3,756	3,679	n.a.	3,584	3,623	4,140	3,694	3,775	3,728
	% difference	0 %	-2.1 %	n.a.	-4.6 %	-3.5 %	10.2 %	-1.7 %	0.5 %	-0.7 %
BC3	EUR/year	6,566	6,384	7,102	6,176	6,278	7,161	6,466	6,554	6,289
	% difference	0 %	-2.8 %	8.2 %	-5.9 %	-4.4 %	9.1 %	-1.5 %	-0.2 %	-4.2 %
BC4	EUR/year	6,187	6,082	7,116	5,890	5,958	6,841	6,079	6,218	6,154
	% difference	0 %	-1.7 %	15.0 %	-4.8 %	-3.7 %	10.6 %	-1.7 %	0.5 %	-0.5 %
BC5	EUR/year	18,195	16,757	17,183	16,706	17,136	19,149	18,045	17,311	15,606
	% difference	0 %	-7.9 %	-5.6 %	-8.2 %	-5.8 %	5.2 %	-0.8 %	-4.9 %	-14.2 %
BC6	EUR/year	37,160	33,542	34,161	33,362	33,952	38,858	36,788	34,873	30,412
	% difference	0 %	-9.7 %	-8.1 %	-10.2 %	-8.6 %	4.6 %	-1.0 %	-6.2 %	-18.2 %

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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).

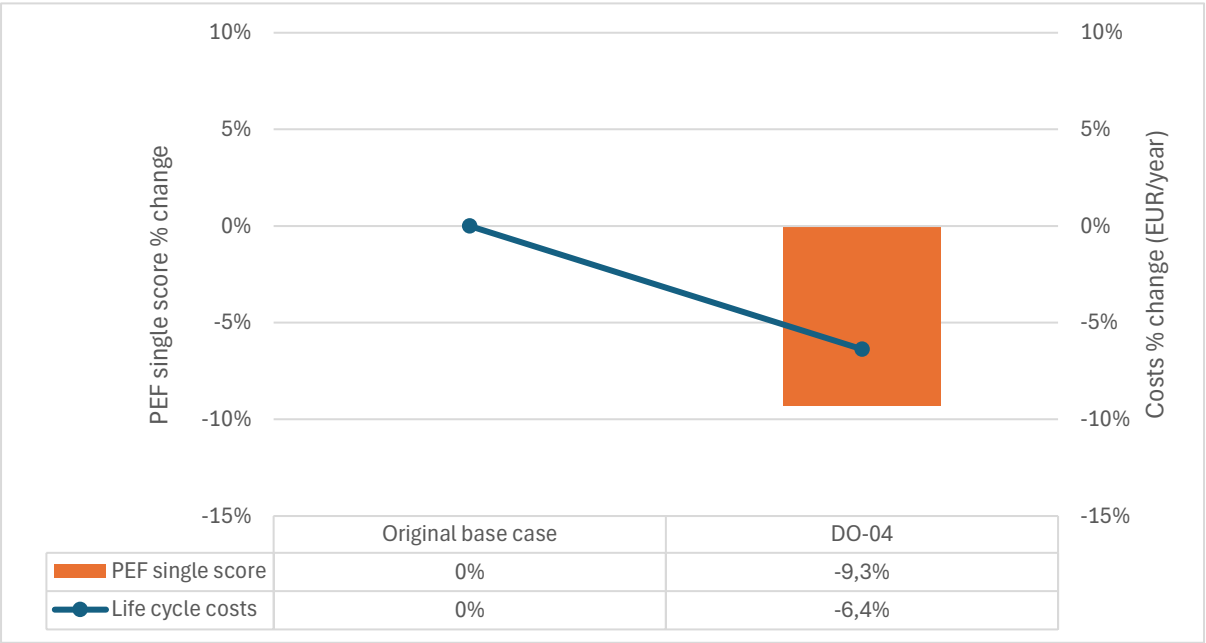


Figure 8-1: BC1 - PEF score change (in %) per design option over the full lifetime versus costs change per year (in %).

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).

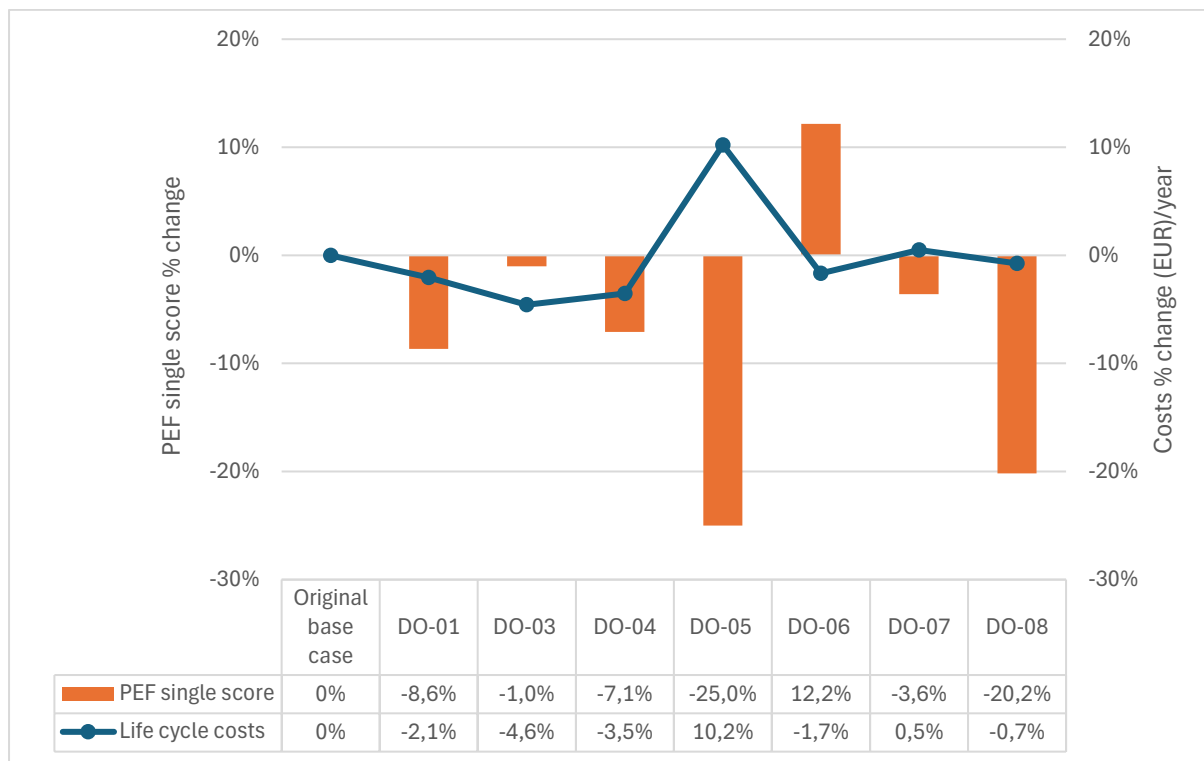


Figure 8-2: BC2 - PEF score change (in %) per design option over the full life time versus costs change per year (in %).

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.

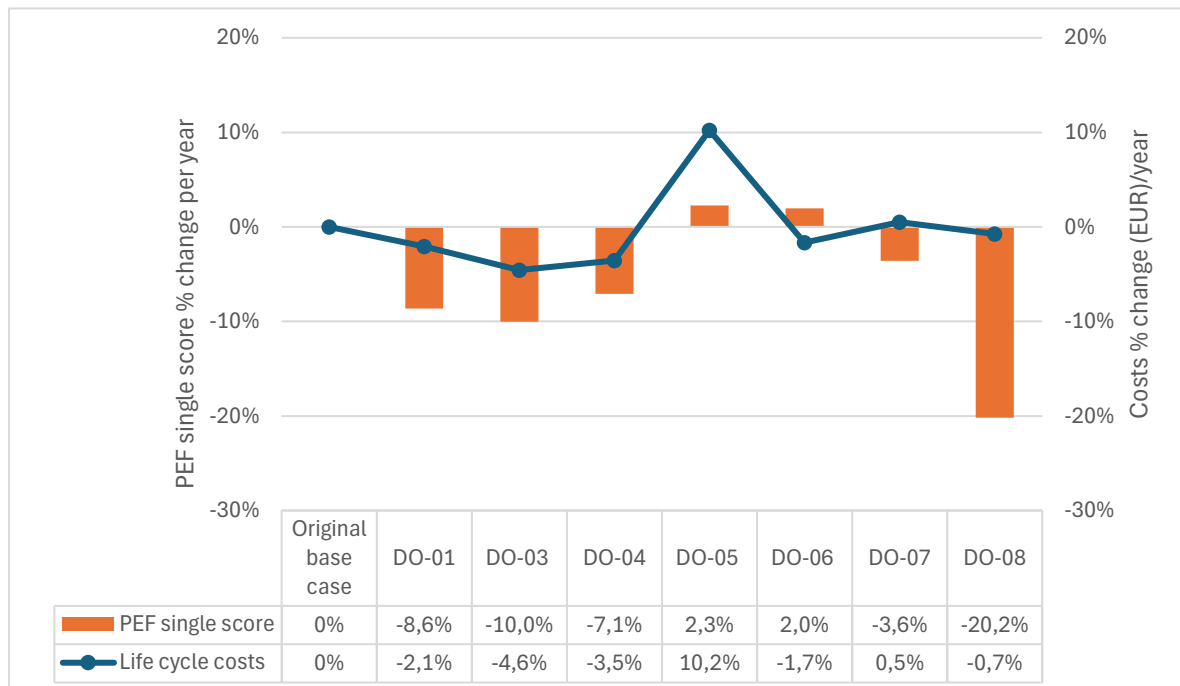


Figure 8-3: BC2 - PEF score change (in %) per design option per year of use versus costs change per year (in %).

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).

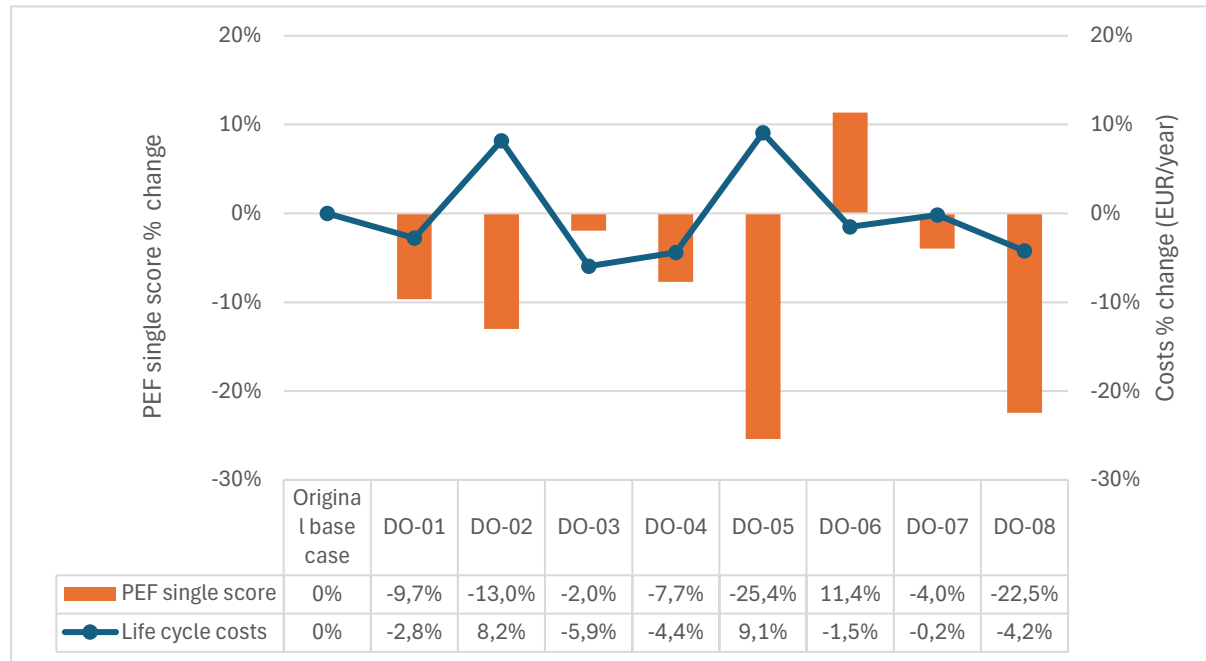


Figure 8-4: BC3 - PEF score change (in %) per design option over the full life time versus costs change per year (in %).

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.

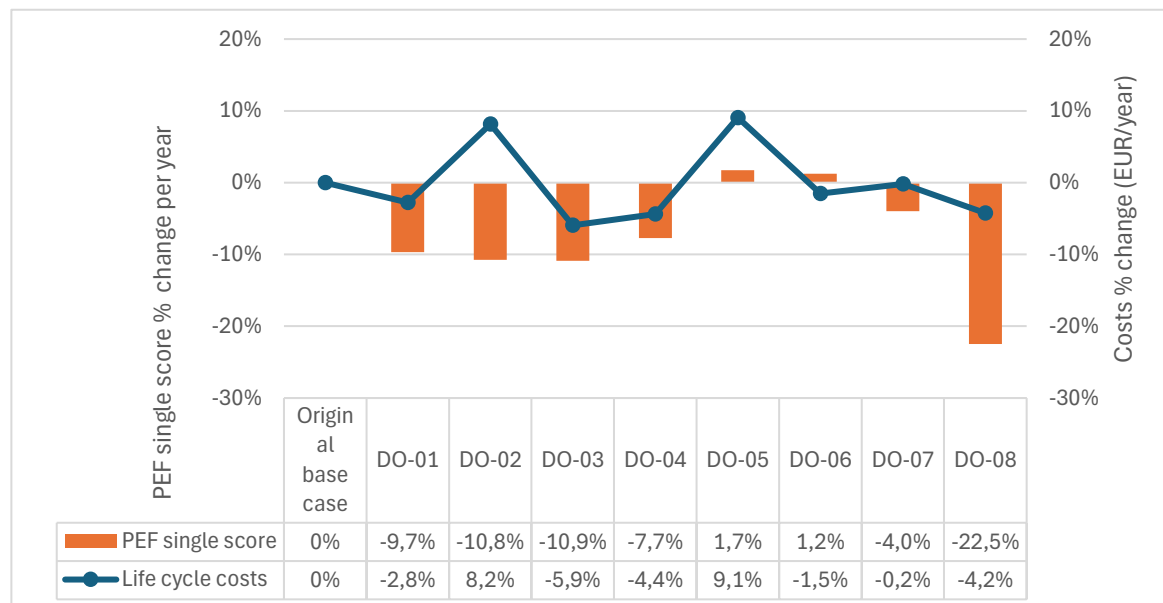


Figure 8-5: BC3 - PEF score change (in %) per design option per year of use versus costs change per year (in %).

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).

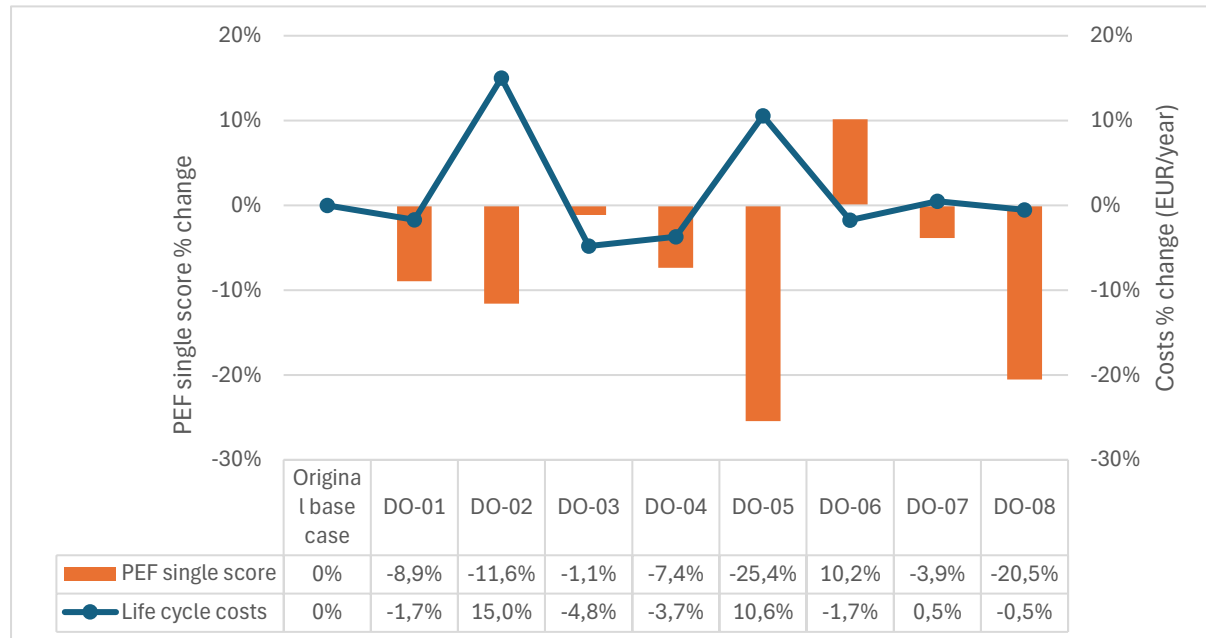


Figure 8-6: BC4 - PEF score change (in %) per design option over the full life time versus costs change per year (in %).

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.

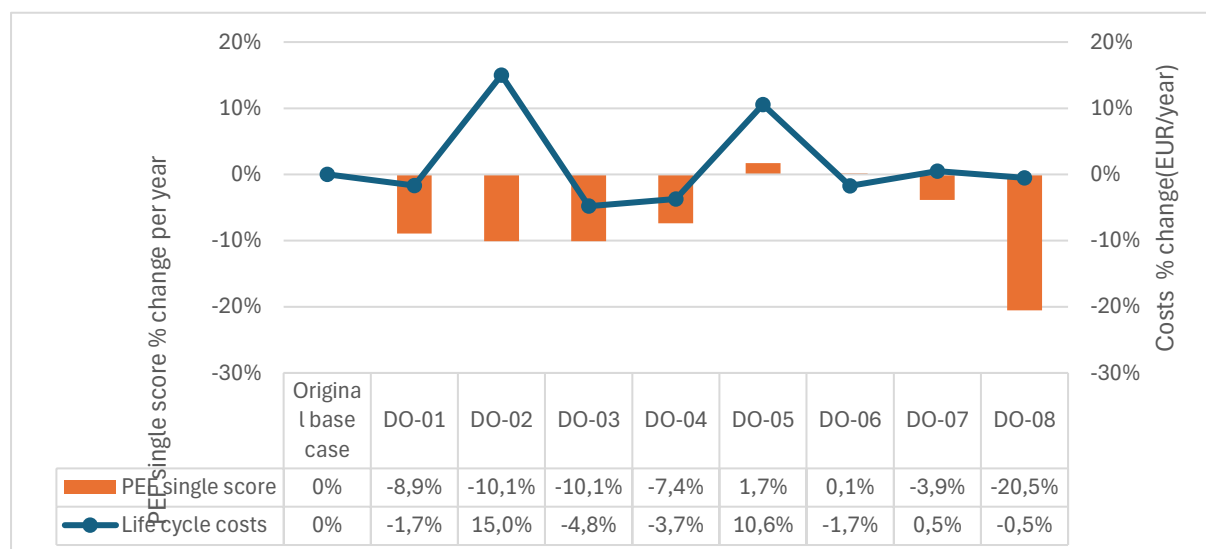


Figure 8-7: BC4 - PEF score change (in %) per design option per year of use versus costs change per year (in %).

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).

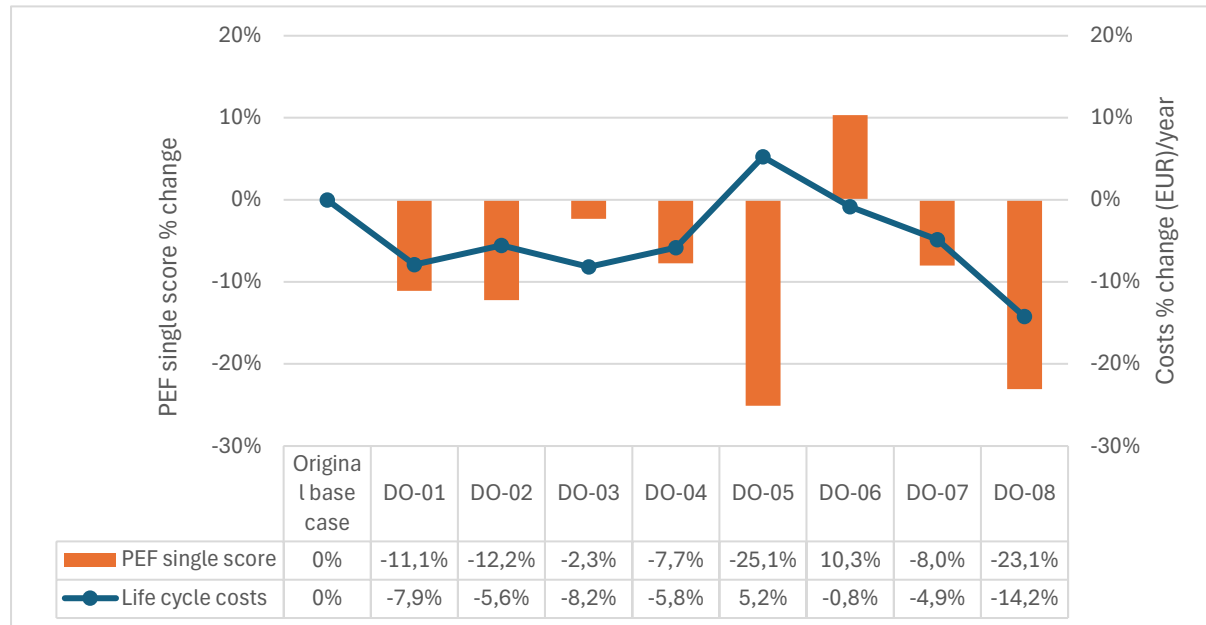


Figure 8-8: BC5 - PEF score change (in %) per design option over the full life time versus costs change per year (in %).

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.

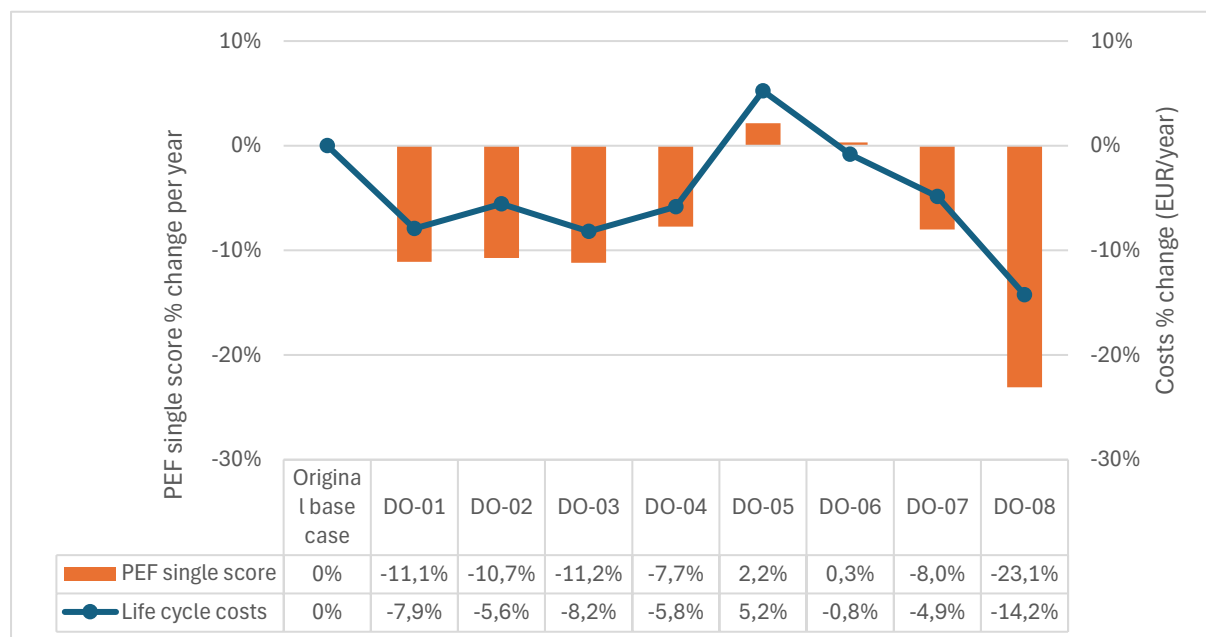


Figure 8-9: BC5 - PEF score change (in %) per design option per year of use versus costs change per year (in %).

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).

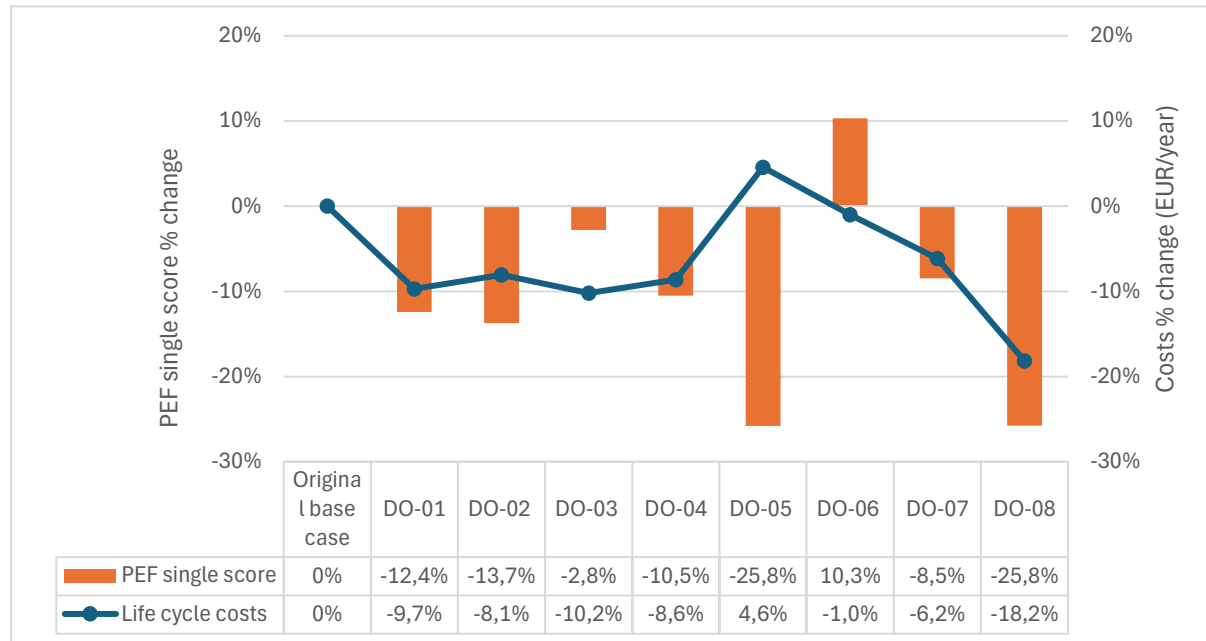


Figure 8-10: BC6 - PEF score change (in %) per design option over the full lifetime versus costs change per year (in %).

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.

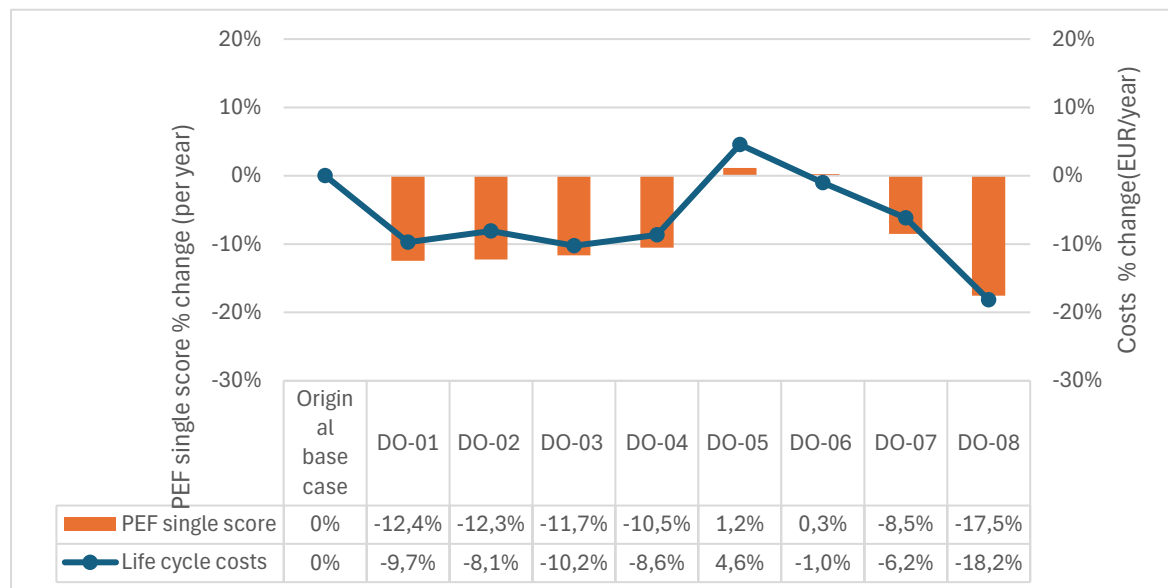


Figure 8-11: BC6 - PEF score change (in %) per design option per year of use versus costs change per year (in %).

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.

9. MEErP Task 7 – Scenarios

9.1. Introduction

9.1.1. Objectives of MEErP Task 7

This task identifies and discusses in Task 7.1 policy options aimed at reducing the impacts of commercial dishwashers on the environment as analysed in previous tasks. It provides in Task 7.2 and Task 7.3 an analysis of the impacts of future scenarios in line with policy measures that could be introduced at EU level. This is a key task as it combines the results of the previous tasks. It discusses potential ESPR requirements, and it is aimed at providing an analytical basis in support of the decision-making process within the ESPR framework as to the need to introduce ESPR legislation for this product group.

As in Task 6, only one package of combined design options was taken into account, only two scenarios are considered in Task 7:

- the Business-as-Usual (BAU) scenario; and
- the Best Available Technology (BAT) scenario, which is represented by DO4 for BC1 and a combination of DO1 (exhaust heat recovery), DO3 (automatic programme for load and soil recognition), DO4 (Improved thermal insulation (double-walled design) and DO7 (energy recovery from drain water) for all other Base Cases (see Task 6).

To this end, a stock model has been developed to estimate environmental and economic impacts according to future stocks of both scenarios.

This document describes a proposed set of policy options for commercial dishwashers within the scope as defined in Task 1. The improvement potential of the environmental impact and the key parameters to achieve this were previously discussed in Task 6, while this Task 7 discusses how the design options can potentially be converted into policy. In relation to the proposed policy options this task also analyses and models impact scenarios. This is a reviewed version elaborated after consulting a few stakeholders in bilateral meetings and collecting feedback in writing. A summary of stakeholder positions with regard to the proposed policy is included as a support to the subsequent policy making process.

9.1.2. Introduction to the evaluation of Scenarios using the MEErP

The MEErP provides a structured and comprehensive framework for assessing the environmental, economic, and technical performance of product design options. At its core, the MEErP methodology facilitates a life-cycle-based evaluation that integrates environmental impact assessments with techno-economic analysis to identify the least life-cycle cost (LLCC) and best available technologies (BAT). This ensures that design decisions not only meet regulatory requirements but also promote sustainability and cost-effectiveness.

The evaluation of Design Options within MEERP is prepared by several tasks, including the definition of product scope (Task 1), market analysis (Task 2), use-phase and technical analysis of existing products (Task 3 & 4), as well as the subsequent life-cycle assessment (LCA) and life-cycle-costing (LCC) (Task 5). The revised MEERP methodology (2024) introduces refinements to better align the framework with the EU's Green Deal objectives, emphasising aspects related to climate neutrality, circularity, and Substances of Concern (SoC) related to the product group under study. The work process for developing design options remains structured around seven core tasks, with Task 6 playing a pivotal role in identifying and evaluating improvement potentials. Design options are first mapped and evaluated, taking stakeholder input into account, and then assessed using the EcoReport tool. The latter helps to quantify the improvement potential of environmental impact against the Base Cases. This structured approach enables policymakers and stakeholders to compare alternatives objectively and select the most sustainable and economically viable solutions. Thus, the MEERP method ensures that product innovations are aligned with broader environmental goals, such as reducing greenhouse gas emissions and improving energy efficiency and the adoption of a circular economy.

Task 7 of the preparatory study encompasses the following sections:

- Policy analysis;
- Scenario analysis, including inter alia
 - o Socio-economic impact analysis;
 - o Sensitivity analysis of key parameters;
- Summary of results and main policy recommendations per product.

9.2. Policy analysis

9.2.1. Stakeholder consultation

Building on its ongoing efforts to foster collaboration and transparency, the study team has engaged since the start of the study in June 2024 with a broad range of stakeholders.

Three meetings with stakeholder took place:

- a first stakeholder meeting (hybrid) on 10 December 2024¹²⁴ covering Task 1-4, and
- a second stakeholder meeting (hybrid) on 1 July 2025¹²⁵. During the second stakeholder meeting, the results of Task 5 and Task 6 were presented, along with initial ideas for potential policy options, which were presented to the participants. Stakeholders had the opportunity to comment during the meeting (see discussion in Annex 11.8).

¹²⁴ See https://ecodesign-commdishwashers.eu/sites/ecodesigncommdishwashers/files/downloads/ESPR_SR5_1st-Stakeholder_Meeting_Presentation_20241210.pdf

¹²⁵ See https://ecodesign-commdishwashers.eu/sites/ecodesigncommdishwashers/files/downloads/ESPR_SR5_2nd-Stakeholder_Meeting_Presentation_20250701_Final.pdf

- a stakeholder interaction on 3 November 2025. Update of Task 5 and Task 6 were shortly presented, the focus of the meeting was on Task 7, in particular on the policy options.
- In addition to the stakeholder meetings, three online stakeholder consultations took place to collect:
- initial inputs on the scope (MEErP Task 1), carried out between July and September 2024
 - inputs on the markets, users, and technologies (MEErP Tasks 2, 3, 4), carried out between mid-September and mid-October 2024
 - inputs on Design Options (DO) and Substances of Concerns (SoC), carried out between mid-April and mid-May 2025
- Furthermore, the study team had bilateral exchanges with some stakeholders, particularly from July 2025 onwards regarding some aspects related to Task 7 with a focus of the discussions on a potential testing method to be applied for the different product categories.
- Accordingly, the policy proposals of this draft Task 7 report are based on the ideas presented at the 2nd stakeholder meeting, the stakeholder inputs gathered afterwards and additional research.

9.2.2. Barriers (and opportunities) for improvements

9.2.2.1. Opportunities

For most impact categories, Task 5 indicates that the use phase is the dominant stage in the product's life cycle. In terms of overall environmental impact, when assessing the PEF single score,¹²⁶ the use phase contributes to 87 % to 93 % of the lifecycle impact, the energy consumption in the use phase contributes alone to 71 % to 84 % (see **Table 9-1**).

Table 9-1: Contribution of the use phase to the LCA impact (PEF single score) over the total lifetime of the product, on product level.

Use phase	BC1	BC2	BC3	BC4	BC5	BC6
Energy consumption	73 %	71 %	77 %	75 %	77 %	84 %
Water consumption	12 %	11 %	6 %	5 %	4 %	4 %
Detergent and rinsing agent consumption	5 %	8 %	7 %	8 %	6 %	5 %
Total contribution	90 %	90 %	90 %	87 %	87 %	93 %

Accordingly, the most effective way to reduce the product's environmental impact is to reduce the energy consumption, i.e. improve the energy efficiency of the products.

¹²⁶ PEF single scores were calculated for each Base Case, aggregating impacts across all life-cycle stages over the product's entire lifetime. 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 than as a comprehensive PEF assessment when comparing results.

The LCC results likewise confirm that the use phase is the dominant cost driver for all product categories within the scope of the study. Depending on the Base Case considered, the running costs are responsible for 62 % to 94 % of the LCC. Costs related to energy consumption during the use phase contributes to 42 % to 71 % of the LCC, detergent and rinsing agent consumption alone can account for up to 22 % of the total LCC (see **Table 9-2**).

Table 9-2: Contribution of the use phase in the LCC, at product level¹²⁷.

Use phase	BC1	BC2	BC3	BC4	BC5	BC6
Energy consumption	42 %	45 %	52 %	47 %	64 %	71 %
Water consumption	8 %	8 %	4 %	3 %	4 %	3 %
Detergent and rinsing agent consumption	12 %	21 %	20 %	21 %	22 %	19 %
Total use phase	62 %	73 %	76 %	72 %	90 %	94 %

Furthermore, the Task 6 report identified significant savings potential mainly in terms of energy consumption. When coupled with extended product lifetimes, these improvements can translate into substantial annual reductions in life cycle costs (LCC/a) (see **Table 9-3**):

Table 9-3: Improvement potential, at product level¹²⁸.

Use phase	BC1	BC2	BC3	BC4	BC5	BC6
Energy consumption	-15 %	-30 %	-30 %	-30 %	-30 %	-30 %
Yearly life cycle costs	-6 %	4 %	-2 %	4 %	-32 %	-41 %
Single score	-6 %	-19 %	-20 %	-17 %	-21 %	-24 %

In addition, according to Task 2, the total market volume of commercial dishwashers in 2023 was 275,015 units/year. As orientation, an indicative threshold of 200,000 units/year was mentioned in the Ecodesign Directive 2009/125/EG, regarding the market size for the product group to be regulated.¹²⁹

Table 9-4: Improvement potential, at market level. provides an overview of each BC's contribution to reducing the overall environmental impact of the market. It takes into account both product-level improvements and the market volume. Combined, BC2 and BC3 account for nearly two-thirds of the total improvement within the product group, while BC5 and BC6 contribute approximately 30 %.

Table 9-4: Improvement potential, at market level.

	BC1	BC2	BC3	BC4	BC5	BC6	Total
Volume [1,000 units] in 2023	8.3	178.8	66.0	13.8	5.5	2.8	275.0
Improvement of the environmental impact of the market [single score]	4.67E+02	8.17E+04	6.00E+04	1.08E+04	2.48E+04	4.28E+04	2.21E+05
Contribution to the reduction of env. impact of the whole market [single score]	0.2 %	37 %	27 %	5 %	11 %	19 %	100 %

¹²⁷ Based on the sensitivity analysis carried out in Task 5

¹²⁸ Based on Task 6

¹²⁹ See 2009/125/EC Art. 15 Point 2 (a)

9.2.2.2. Barriers

The aforementioned improvement potential is significant, but difficult to realise. One key barrier is the lack of transparency in market information. Currently, customers have access to only limited data on product performance – particularly with regard to energy, water, detergent and rinsing agent consumption. However:

- The consumption figures are often derived from the individual manufacturers' own testing protocols.¹³⁰ This hinders comparability between manufacturers.
- The scarcity of data made public further limits its utility for comparison.

Under these circumstances, it is unlikely that professional customers of commercial dishwashers will be able to make objective comparisons between products based on environmental performance. The absence of harmonised and accessible data undermines informed decision-making. Furthermore, the absence of standardised performance metrics and market transparency may hinder competition and slow innovation towards more sustainable product development across the sector.

The current obstacles hindering market transformation towards sustainable products in the EU and the development of EU regulations include the following aspects:

- **Harmonised data on performance**

- **Limited number of product categories covered by a performance standard:** only BC2 and BC3 are covered (see: EN IEC 63136:2019). For other Base Cases (1, 4-6), there is still no standard (see additional information in **Section 0**).
- **Limited uptake of the existing EN standard in categories BC2 and BC3**, leading to a lack of:
 - reliable and comparable data on the energy, water, detergent and rinsing agent consumption of the *Base Cases* analysed in Task 5, as well as the improvement potential achieved through the *Design Options* in Task 6.
 - a database of products on the EU market with performance assessed according to the newly developed EN standards.¹³¹

- **Reduced competitive pressure:** Due to the lack of comparable data on energy, water, and detergent consumption across products, two key risks emerge:

- Lack of transparency for high-performing products: Manufacturers that deliver environmentally superior solutions face challenges in effectively showcasing their performance benefits. This limits their ability to differentiate in the market and reduces the impact of sustainability-driven innovation on purchasing decisions of professional customers.

¹³⁰ In particular for Base Cases BC5 and BC6 as they are not standard products and there is no test standard.

¹³¹ A better overview of the market for BC2 and BC3 products is available in Switzerland due to the Standardised Measure GG-02a and the publication of the performance of some models based on the EN standard.

6456 - Weak innovation incentives: In the absence of standardised benchmarks and transparent
6457 performance comparisons, manufacturers face limited external pressure to improve in
6458 efficiency. This undermines the business case for investing in the development of high-
6459 performance, environmentally optimised technologies.

6460 • **Inconsistent test results:** To ensure comparability between competing products, all similar
6461 products should be tested under a programme delivering a similar level of cleaning
6462 performance. This is still not the case. E.g.: two dishwashers tested according to EN 63136
6463 might have a different efficiency but show the same energy consumption if the final cleaning
6464 performance in both tests is not the same. As no cleaning performance requirement is defined
6465 in The EN standard, this should be provided in the regulation. The programme run for the
6466 declaration of the dishwasher should fulfil all requirements (incl. the cleaning requirement)
6467 and would be named “declaration programme”¹³².

6468 9.2.3. ESPR Framework

6469 ESPR¹³³ seeks to enhance the sustainability of products in the EU market by improving their circularity,
6470 energy performance, recyclability, and durability. It aims to foster a unified market for sustainable
6471 products, replacing the Ecodesign Directive 2009/125/EC by extending its scope to nearly all physical
6472 products (excluding food, feed, and medicinal products) and reinforcing ecodesign requirements. This
6473 regulation supports economic opportunities in innovation, job creation, and sustainability.

6474 The ESPR sets establishes a framework allowing the setting of ecodesign requirements for product
6475 categories, focusing on parameters that are relevant to the product in question such as:

- 6476 - Durability, reusability, upgradability, and reparability,
- 6477 - Maintenance and refurbishment potential,
- 6478 - Energy and resource efficiency,
- 6479 - Limiting substances that hinder circularity,
- 6480 - Increasing recycled content,
- 6481 - Simplifying remanufacturing and recycling,
- 6482 - Carbon and environmental footprint rules,
- 6483 - Waste reduction,
- 6484 - Information on product sustainability.

6485 ESPR enables horizontal rules for product groups with shared characteristics and introduces several
6486 new measures to enhance product sustainability.

¹³² It should be discussed whether the programme should be named “eco” or “standard”. The declaration programme is expected to be energy efficient (as subject to energy efficiency requirements) and users should be incentivised to use it.

¹³³ https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/ecodesign-sustainable-products-regulation_en



Figure 9-1: Type of requirements within the ESPR framework (source EC¹³⁴).

9.2.4. Potential Policy Options

9.2.4.1. Definition of the scope and standards

Scope

The definition of commercial dishwashers used in this study has been updated in **Section 3.2.2.6** 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).

The scope of a potential regulation would be aligned with this definition and would cover the six Base Cases analysed in Task 5 and 6:

- BC1: Undercounter water-change dishwasher
- BC2: Undercounter one-tank dishwasher
- BC3: Hood-type dishwasher
- BC4: Utensil/pot dishwasher
- BC5: One-tank conveyor-type dishwasher
- BC6: Multi-tank conveyor-type dishwasher

¹³⁴ https://environment.ec.europa.eu/events/information-session-new-ecodesign-sustainable-products-regulation-espr-2024-05-22_en

Standards

Following the mandate M/495¹³⁵ by the Commission to CENELEC and CEN to develop new performance standards for commercial dishwashers. M/495 described the standardisation needs for professional (washing machines, dryers and) dishwashers as follows (the standardisation mandate also included professional washing machines and dryers which are, however, not in scope of this preparatory study):

*„For washing machines, dryers and **dishwashers**¹³⁶, standardisation work should define:*

- Ambient temperature and humidity;
- Input water temperature;
- Input temperature for the wash ware;
- Selection of programme ('standard' washing and drying programmes) and programme duration
- Cleaning capacity;
- Type (formulation) and dosage of detergent (and rinse aid for dishwashers);
- Standard wash ware and laundry;
- Soiling of the items including dry-on time of the soiling;
- Type and dosage of detergents

Measurement methods for the following parameters should be developed:

- Cleaning and possibly rinsing results and hygienic performance;
- Energy and water consumption during continuous use or per cycle at full and partial loads; possibly consumption in other than 'standard' programme
- Energy demand in standby modes (ready-to-use, left-on, and if applicable: off mode);
- For professional washing machines: residual moisture content and spinning efficiency.

The standardisation work should aim at giving results close to real-user behaviours and include an estimate of measurement variation, which should be reduced to the minimum possible.”

However, for dishwashers only one standard was developed. The EN IEC 63136:2019 “Electric Dishwasher For Commercial Use – Test Methods For Measuring The Performance” applies to manually loaded under-counter one-tank¹³⁷ and one-tank hood-type¹³⁸ electrically heated dishwashing machines for washing plates, dishes, glassware, cutlery and similar articles. Currently, no other product category under commercial dishwashers is covered by an EN standard.

During the 2nd stakeholder meeting in the context of this preparatory study on 1st July 2025 and afterwards, the way to deal with this situation has been discussed with stakeholders.

¹³⁵ Standardisation mandate to CEN, CENELEC and ETSI under Directive 2009/125/EC relating to harmonised standards in the field of Ecodesign, M/495 EN.

¹³⁶ M/495 described the Standardisation needs for Professional washing machines, dryers and dishwashers

¹³⁷ Corresponds to Base Case 2

¹³⁸ Corresponds to Base Case 3

Furthermore, while the elaborated EN standard provides a measurement method, it doesn't provide requirements for a declaration programme¹³⁹ in terms of service delivered by the tested product. This could be provided within the regulation. Also, hygiene requirements are usually reached with the programme used for the IEC 63136, but they are not explicitly required in the standard and cannot be tested at the same time.

Test procedure for BC1

For BC1, no EN standard has been elaborated. This is due to the fact, that not enough parties volunteered for the elaboration of a new EN standard, so that the process could not start at all.

The elaboration of a test standard seems technically feasible, which is discussed later in the section. However, the situation with BC1 can be summarised as follows:

- BC1 is rather a niche market. Its improvement potential accounts for less than 1 % of the total improvement potential of the entire product group (see Table 9-4).
- In Task 6, only one Design Option was identified for BC1: DO-04 "Improved thermal insulation (double-walled design)", which is - according to stakeholder feedback - already implemented in most BC1 models available on the EU market.

Given this context, developing a dedicated test standard and setting minimum performance requirements would be disproportionate to the limited potential energy savings.

From a technical point of view: most of the stakeholders rather recommended to base the test method on EN IEC 63136 "Electric dishwashers for commercial use - Test methods for measuring the performance", and to modify some points to better reflect the typical use of BC1 appliances. A test method based on the EN 60436 "Electric dishwashers for household use - Methods for measuring the performance" would not be possible, as BC1 is a commercial fresh-water dishwasher. One stakeholder, who is manufacturing and testing BC1 products, provided details on a possible test method based on the EN 63136 standard. The key points for the proposed test approach are as follows:¹⁴⁰

¹³⁹ Declaration programme: The programme with which the service-related performance results (e.g. cleaning performance, etc.) must be met for the product declaration.

¹⁴⁰ Such a proposal would need to be discussed. In any case, development work on a standard shall be done by dedicated experts in CLC/TC 59X.

Test conditions:

- Load of the lower and upper baskets
- Wash ware¹⁴¹:
 - lower basket: dinner plates (32) and cutlery parts (24)
 - upper basket: dessert plates (11), long drink glasses (12), coffee cups (20)
- Soiling: Production of soiling in accordance with EN IEC 63136, but addition of sesame seeds
- Placement of sesame seed in the rinsing chamber

Regarding a declaration programme: Some stakeholders supported the introduction of a declaration programme to enable market comparison of products; its primary purpose is to compare products within the same BC, rather than comparing all products across the product categories covered by this study.

Key aspects of such a programme would be:

- Test programme that cleans normally soiled wash ware. The programme must also fulfil the minimum hygiene requirements (see standard EN 17735).
- Connection to cold water
- Dishwasher with integrated water softening device (water softening cannot be deactivated)
- Testing the cleaning and resoiling performance in accordance to IEC 63136
- Requirements for the declaration programmes:
 - Cleaning performance: $X_c \geq 95\%$ ¹⁴² and
 - Resoiling performance: $X_r \leq 1$

With:

$$\text{Cleaning performance: } X_c = \left(1 - \frac{T_{NRD}}{T_{NAD}}\right) \cdot 100\%$$

With:

T_{NRD} : Total number of remaining dots

T_{NAD} : Total number of applied dots

And:

$$\text{Resoiling performance: } X_r = \frac{T_{NPF}}{T_{NEP}}$$

With:

T_{NPF} : Total number of particles found

T_{NEP} : Total number of the examined plates

¹⁴¹ According to one stakeholder feedback, the capacity ("dishes") refers to different kinds of wash ware; the data for dishwasher categories 2 and 3 amounts to 18–20 plates (based on EN 63136 with "standard plates", i.e. dinner plates with a diameter of 240 mm). The information for categories 5 and 6 also refers more to "plate capacity". The information for category 1, on the other hand, refers more generally to "tableware", i.e. including glasses, cups, dessert plates etc., and not exclusively to dinner plates as in the other categories. Dinner plates can also only be cleaned on one level in machines of category 1. If these other items of tableware, such as glasses, cups and dessert plates, were also taken into account in the other dishwasher categories 2, 3, 5 and 6, the capacity specifications would be completely different.

¹⁴² Some stakeholders supported the 95 % requirements, other rather 90 %, which is also required in UK Energy Technology List (ETL).

6565 From a practical point of view: it would be easier for the standardisation body to add a specific annex
6566 for BC1 in the EN IEC 63136 than to develop a new dedicated standard. However, the aforementioned
6567 test method would need to be checked and validated.¹⁴³

6568 **Test procedure for BC2-3**

6569 EN IEC 63136 is already covering and used for BC2 and BC3 appliances. In addition to the test standard,
6570 a declaration programme for the test should be specified in the regulation. While EN IEC 63136:

- 6571 - requires the test to be carried out using the programme designed for cleaning normally
- 6572 soiled dishes,
- 6573 - requires the manufacturer to specify which programme was used for testing, and
- 6574 - specifies how to measure the cleaning and resoiling performance,

6575 it still doesn't clarify what is understood under "cleaning" (which is the energy service provided by the
6576 appliance). Therefore, the study team sees a need to define requirements to be fulfilled. Suggested
6577 requirements for such a programme are:^{144 145}

- 6578 - Cleaning performance: $X_c \geq 90 \%$
- 6579 - Resoiling performance: $X_r \leq 1$
- 6580 - The programme must also fulfil the minimum hygiene requirements (see standard EN
- 6581 17735).

6582 The proposed value for the resoiling performance requirement was generally accepted by most of the
6583 stakeholders. For the cleaning performance requirements, initially a threshold of $X_c \geq 95 \%$ was
6584 suggested and discussed. This threshold was considered as too stringent by many stakeholders (not
6585 only by manufacturers). Therefore, a cleaning performance requirement of $\geq 90 \%$ is now suggested;
6586 this level is also in line with the requirements of the Energy Technology List (ETL) in UK¹⁴⁶. In this
6587 section, for transparency, analysis with $X_c \geq 90 \%$ and with $X_c \geq 95 \%$ are shown.

6588 The figures of the Swiss product database (23 BC2 and 38 BC3 products) show that 89 % of the
6589 products have a washing performance higher than 90 %. 72 % would fulfil a cleaning performance
6590 criterion of 95 % (see **Figure 9-2**).

¹⁴³ Please note that if a test standard for BC1 is required and no harmonised standard can be developed, a fallback solution may be applied under Article 42 of the ESPR. This provision allows common specifications to be formulated in the implementing act because the conditions in points 1(a)(ii) and 1(b) are met.

¹⁴⁴ See stakeholder meeting 2.

¹⁴⁵ To enable better comparison of test results, requirements on rinsing performance (X_{rinse}) would make sense; however, this aspect is not yet addressed in the EN IEC 63136 standard (expected by end 2027)

¹⁴⁶ See also **Section 3.4.5.3**

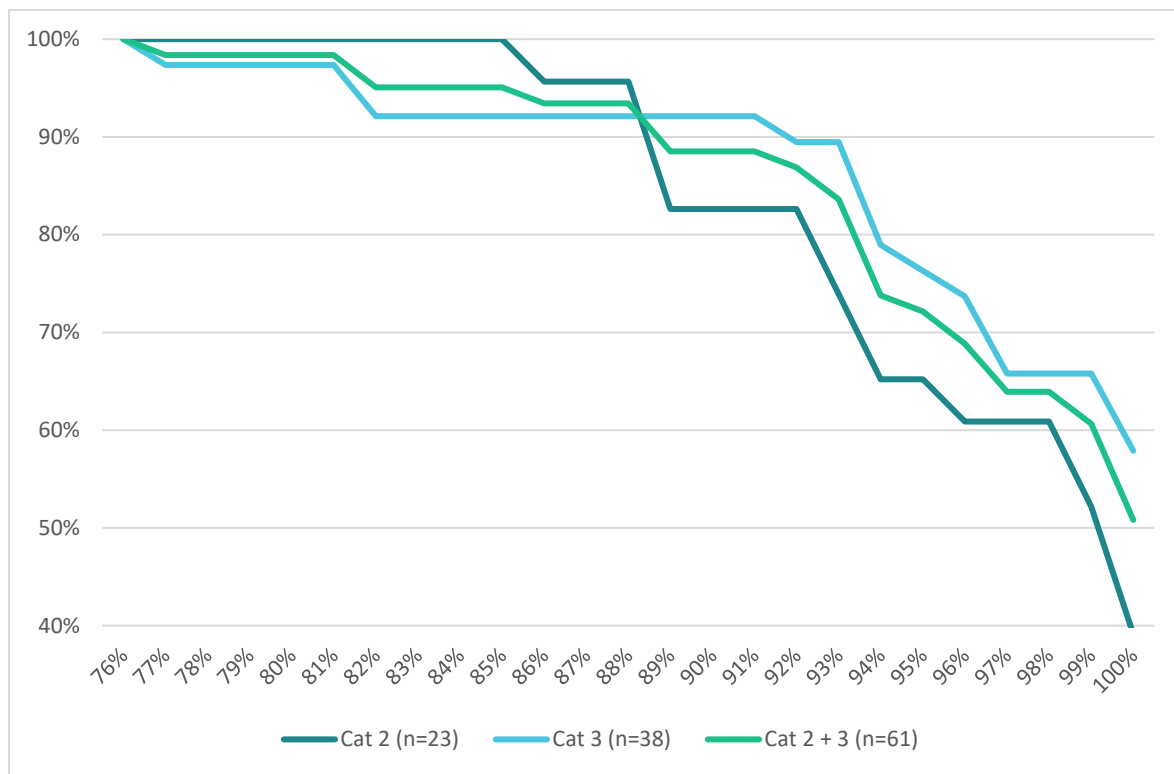


Figure 9-2: Cleaning performance with the standard cleaning cycle [%].

Test procedure for BC4

By definition, utensil/pot dishwashers are designed to clean a wide range of wash ware, such as heavily soiled black wash. These dishwashers also include a special type of dishwashers: the so-called “granulate dishwashers”. A completely new test standard (with new test dish and new test soiling) would have to be elaborated, tested and validated. Developing a test procedure for BC4 would be challenging, especially given that the market size is rather very limited. Accordingly, this BC is not seen as a priority for standardisation works.

Test procedure for BC5-6

As with BC4, BC5 and BC6 are not yet covered by any EN standards that address the performance characteristics of commercial dishwashers. In addition, BC5 and BC6 have a modular design and are customised for each order.¹⁴⁷ Nevertheless, it would be possible to develop a test procedure, although it would require considerable effort and time. However, it is not expected that such a test method could be developed and applied in time for the forthcoming regulation.

¹⁴⁷ Accordingly, individual testing is conducted in consultation with the customer

9.2.4.2. Performance requirements (ESPR Art. 6)

At this stage of the study, there is a lack of data, as the **Table 9-5** shows, which is mainly due to the lack of test standards.

Table 9-5: Data available to assess performance requirements.

BC	BC1	BC2	BC3	BC4	BC5	BC6
EN	Not available, but likely doable (see Section 9.2.4.1)	EN IEC 63136:2019	EN IEC 63136:2019	Not available and not realistic	Not available and not expected for the forthcoming regulation	Not available and not expected for the forthcoming regulation
Data	1 indicative value provided for the approach based on EN63136	Yes, from 23 products of a Swiss product database	Yes, from 38 products of a Swiss product database	Not available	Not available	Not available

To deal with this situation, the following approaches have been considered in order to elaborate performance requirements (thresholds) in a future regulation:

BC 1

As outlined in **Section 9.2.4.1**, given the current absence of a test standard, the limited improvement potential at product level, and the marginal contribution of this BC to the overall product group, no quantitative performance requirements are proposed.

The study team considered introducing qualitative requirements to ensure the implementation of DO-04. However, translating “improved thermal insulation (double-walled design)” into criteria that are enforceable and verifiable by MSAs is rather difficult. Such requirements would effectively demand new testing methods (e.g., defining a maximum U-value for the BC1 envelope or a maximum permissible temperature gradient), which is an additional burden for a DO which is already widely implemented in the EU market.

A more proportionate approach would be to address the reduction of thermal losses through an information requirement rather than a performance requirement. Manufacturers would need to declare where the “double-walled design” is applied (side, front, back, top, bottom). Such an approach would enhance transparency for customers and provide regulators with valuable information for a future review of a regulation, helping to assess whether lack of thermal insulation represents a broader market issue requiring regulatory action.

6631 **BC 2-3**

6632 **Table 9-6** shows the energy consumption of BC2 and BC3 products of the Swiss product database.¹⁴⁸
 6633 The table shows also the cumulated share of products fulfilling both types of requirements:

- 6634 - cleaning and resoiling requirements of the suggested declaration programme, and
- 6635 - the energy consumption requirements

6636 The underlying test procedure for the Swiss data includes a cleaning performance $X_c \geq 90 \%$ and a
 6637 resoiling performance $X_r \leq 1$ as suggested above.

6638 **In order to provide the full information and allow a better assessment of a suitable level of**
 6639 **requirements, as**

6640 **Table 9-7 also shows:**

- 6641 - two compliance rates:
 - 6642 ○ one taking into account the total number of products fulfilling the cleaning and
 - 6643 resoiling requirements
 - 6644 ○ one taking into account the total number of products in the database. The figures (in
 - 6645 italic) are lower, as the total number of products considered is larger than before
- 6646 - as the requirements of a declaration programme to be used in a Delegated Act for
- 6647 commercial dishwashers are still under discussion, two different levels of requirements for
- 6648 the declaration programme are also shown:
 - 6649 ○ $X_c \geq 90 \%$ and $X_r \leq 1$ (new proposal)
 - 6650 ○ $X_c \geq 95 \%$ and $X_r \leq 1$ (initial proposal)

6651 **Table 9-6: Energy consumption per test dish at $X_c \geq 90 \%$ and $X_r \leq 1$ (new proposal)**

BC	BC2 (n=23)					BC3 (n=38)				
Energy consumption per test dish [kWh/test dish]	Nr of models [-]	Share [%] (n=15)	Cumulated share [%]	Share [%] (n=23)	Cumulated share [%]	Nr of models [-]	Share [%] (n=27)	Cumulated share [%]	Share [%] (n=38)	Cumulated share [%]
0.012	1	7 %	7 %	4 %	4 %	1	4 %	4 %	3 %	3 %
0.014	3	20 %	27 %	13 %	17 %	0	0 %	4 %	0 %	3 %
0.016	6	40 %	67 %	26 %	43 %	4	15 %	19 %	11 %	13 %
0.018	3	20 %	87 %	13 %	57 %	7	26 %	44 %	18 %	32 %
0.020	1	7 %	93 %	4 %	61 %	9	33 %	78 %	24 %	55 %
0.022	0	0 %	93 %	0 %	61 %	2	7 %	85 %	5 %	61 %

¹⁴⁸ See Section 9.2.4.1

0.024	0	0 %	93 %	0 %	61 %	1	4 %	89 %	3 %	63 %
0.026	1	7 %	100 %	4 %	65 %	3	11 %	100 %	8 %	71 %
Total	15	100 %		65 %		27	100 %		71 %	

6652

6653 According to **Table 9-6**, 93 % of the BC2 and 78 % of the BC3 models in the Swiss product database
6654 that meet cleaning requirements of $X_c \geq 90$ % and resoiling requirements of $X_r \leq 1$ consume less than
6655 0.02 kWh per test dish. When considering all products of the Swiss product database, the compliance
6656 rate falls respectively to 61 % and 55 %.

6657 BC3 models consume more energy per test dish than BC2 models. Their compliance rate is significantly
6658 lower than that of BC2 at thresholds below 0.02 kWh per test dish, while the difference becomes
6659 moderate above this level. This could justify applying a less stringent energy efficiency threshold for
6660 BC3 - around 10 % lower - compared to BC2 for thresholds above 0.02 kWh per test dish.

6661 **Table 9-7** shows the compliance rate with the initial proposal for the declaration programme
6662 ($X_c \geq 95$ % and $X_r \leq 1$).

6663 **Table 9-7: Energy consumption per test dish at $X_c \geq 95$ % and $X_r \leq 1$ (initial proposal)**

BC	BC2 (n=23)					BC3 (n=38)				
	Nr of models [-]	Share [%] (n=13)	Cumulated share [%]	Share [%] (n=23)	Cumulated share [%]	Nr of models [-]	Share [%] (n=23)	Cumulated share [%]	Share [%] (n=38)	Cumulated share [%]
0.012	1	8 %	8 %	4 %	4 %	1	4 %	4 %	3 %	3 %
0.014	3	23 %	31 %	13 %	17 %	0	0 %	4 %	0 %	3 %
0.016	5	38 %	69 %	22 %	39 %	4	17 %	22 %	11 %	13 %
0.018	3	23 %	92 %	13 %	52 %	7	30 %	52 %	18 %	32 %
0.020	0	0 %	92 %	0 %	52 %	9	39 %	91 %	24 %	55 %
0.022	0	0 %	92 %	0 %	52 %	2	9 %	100 %	5 %	61 %
0.024	0	0 %	92 %	0 %	52 %	0	0 %	100 %	0 %	61 %
0.026	1	8 %	100 %	4 %	57 %	0	0 %	100 %	0 %	61 %
Total	13	100 %		57 %		23	100 %		61 %	

6664

6665

6666 Table 9-8 is similar to **Table 9-6** but considers the water instead of the energy consumption.

6667 **Table 9-8: Water consumption per test dish at $X_c \geq 90$ % and $X_r \leq 1$ (new proposal)**

BC	BC2 (n=23)					BC3 (n=38)				
Water consumption per test dish (L / test dish)	Nr of models [-]	Share [%] (n=15)	Cumulated share [%]	Share [%] (n=23)	Cumulated share [%]	Nr of models [-]	Share [%] (n=27)	Cumulated share [%]	Share [%] (n=38)	Cumulated share [%]
0.080	0	0 %	0 %	0 %	0 %	1	4 %	4 %	3 %	3 %
0.090	1	7 %	7 %	4 %	4 %	0	0 %	4 %	0 %	3 %
0.100	3	20 %	27 %	13 %	17 %	11	41 %	44 %	29 %	32 %
0.110	2	13 %	40 %	9 %	26 %	2	7 %	52 %	5 %	37 %
0.120	4	27 %	67 %	17 %	43 %	7	26 %	78 %	18 %	55 %
0.130	0	0 %	67 %	0 %	43 %	0	0 %	78 %	0 %	55 %
0.140	0	0 %	67 %	0 %	43 %	2	7 %	85 %	5 %	61 %
0.150	4	27 %	93 %	17 %	61 %	0	0 %	85 %	0 %	61 %
0.160	0	0 %	93 %	0 %	61 %	0	0 %	85 %	0 %	61 %
0.170	0	0 %	93 %	0 %	61 %	4	15 %	100 %	11 %	71 %
0.180	0	0 %	93 %	0 %	61 %	0	0 %	100 %	0 %	71 %
0.190	1	7 %	100 %	4 %	65 %	0	0 %	100 %	0 %	71 %
0.200	0	0 %	100 %	0 %	65 %	0	0 %	100 %	0 %	71 %
Total	15	100 %		65 %		27	100 %		71 %	

6668

6669 According to **Table 9-8**, 93 % of the BC2 and 85 % of the BC3 models in the Swiss product database
 6670 that meet cleaning requirements ≥ 90 % and resoiling requirements ≤ 1 consume less than 0.15 litre
 6671 per test dish. When considering all products of the Swiss product database, the compliance rate falls
 6672 to 61 %.

6673 BC2 models consume slightly more water per test dish than BC3 models. Their compliance rate is
 6674 usually lower than that of BC3. This could justify applying a less stringent water efficiency threshold
 6675 for BC2 - around 10 % weaker - compared to BC3.

6676 **Table 9-9** shows the compliance rate with the initial proposal for the declaration programme ($X_c \geq 95$
 6677 % and $X_r \leq 1$).

6678 **Table 9-9: Water consumption per test dish at $X_c \geq 95$ % and $X_r \leq 1$ (initial proposal)**

BC	BC2 (n=23)					BC3 (n=38)				
Water consumption per test dish (L / test dish)	Nr of models [-]	Share [%] (n=13)	Cumulated share [%]	Share [%] (n=23)	Cumulated share [%]	Nr of models [-]	Share [%] (n=23)	Cumulated share [%]	Share [%] (n=38)	Cumulated share [%]
0.080	0	0 %	0 %	0 %	0 %	1	4 %	4 %	3 %	3 %
0.090	1	8 %	8 %	4 %	4 %	0	0 %	4 %	0 %	3 %
0.100	3	23 %	31 %	13 %	17 %	11	48 %	52 %	29 %	32 %
0.110	2	15 %	46 %	9 %	26 %	2	9 %	61 %	5 %	37 %
0.120	4	31 %	77 %	17 %	43 %	7	30 %	91 %	18 %	55 %
0.130	0	0 %	77 %	0 %	43 %	0	0 %	91 %	0 %	55 %
0.140	0	0 %	77 %	0 %	43 %	2	9 %	100 %	5 %	61 %
0.150	2	15 %	92 %	9 %	52 %	0	0 %	100 %	0 %	61 %
0.160	0	0 %	92 %	0 %	52 %	0	0 %	100 %	0 %	61 %
0.170	0	0 %	92 %	0 %	52 %	0	0 %	100 %	0 %	61 %
0.180	0	0 %	92 %	0 %	52 %	0	0 %	100 %	0 %	61 %
0.190	1	8 %	100 %	4 %	57 %	0	0 %	100 %	0 %	61 %
0.200	0	0 %	100 %	0 %	57 %	0	0 %	100 %	0 %	61 %
Total	13	100 %		57 %		23	100 %		61 %	

6679 Based on the analysis of both single parameters (energy and water consumption), following
6680 performance requirements for a declaration programme ($X_c \geq 90$ % and $X_r \leq 1$) could be suggested for
6681 BC2 and BC3:

- 6682 - Energy consumption:
6683 ≤ 0.02 kWh/test dish (potentially +10 % for BC3: ≤ 0.022 kWh/test dish)
- 6684 - Water consumption: ≤ 0.15 l/test dish (potentially +10 % for BC2: ≤ 0.165 l/test dish)

6685 Important remark:

6686 To ensure product comparability and verification by market surveillance, the declaration programme
6687 must be clearly defined and ideally reflect real-life use, not one optimised only for ESPR purposes.
6688 Experience with household washing machines shows that overly long, low-energy test programmes
6689 are not used in practice. The same risk exists for commercial dishwashers. Therefore, the declaration
6690 programme should meet minimum performance levels, have a reasonable maximum duration (this
6691 should be further analysed).

6692 However, the proposed performance requirements should be carefully checked. On the one side, the
6693 aforementioned compliance rates:

- 6694 - are not based on the combination of all requirements at once,
6695 - don't fully reflect the EU market but only few products on the Swiss market, which might
6696 provide a better performance than the European market average.

6697 On the other side:

- 6698 - as the Swiss policy instrument does not stipulate any requirements in terms of cleaning
6699 and resoiling performance,¹⁴⁹ the products considered in the analysis have not been
6700 optimised for the proposed declaration programme and may not even have been tested
6701 using the most appropriate programme. In other words, products from the Swiss market
6702 may perform better than those shown in Table 9-6 and Table 9-8 and accordingly, the
6703 compliance rate may therefore be higher.
- 6704 - according to Task 6, BAT performance is cost efficient for each BC. Consequently, high
6705 ambitions could be considered for the ecodesign performance requirements, unless
6706 stakeholders can provide evidence (e.g. figures from test reports according to the EN
6707 63136 standard).¹⁵⁰
- 6708 - the suggested performance requirements could be implemented stepwise (e.g. with two
6709 Tiers) to ease the market transformation for the manufacturers.

6710 For information:

6711 To ease the discussion regarding:

- 6712 - the cleaning requirement Xc for the declaration programme
6713 - the level of ambition for the possible performance requirements

6714 the following tables present an overview of the compliance rate – when taking into account combined
6715 requirements on energy and water consumption – of the products from the Swiss product database.

6716

¹⁴⁹ Products have to be tested according to EN IEC 63136, which does not set Xc and Xr requirements

¹⁵⁰ However, please note that the Task 5 and Task 6 assumptions were not based on performance data according to the EN 63136 standard.

Table 9-10: Overview of the compliance rates of the products of the Swiss product database for $X_c \geq 0.9$ und $X_r \leq 1$

Requirements		BC2			BC3		
Energy	Water		Share (based on n=15)	Share (based on n=23)		Share (based on n=27)	Share (based on n=38)
kWh/test dish	l/test dish	<i>Nr of models complying</i>	Considering all products fulfilling X_c and X_r requirements	<i>Considering all products in the database</i>	<i>Nr of models complying</i>	Considering all products fulfilling X_c and X_r requirements	<i>Considering all products in the database</i>
0.02	0.15	11	73 %	48 %	12	44 %	32 %
0.022	0.15	11	73 %	48 %	21	78 %	55 %
0.02	0.165	13	87 %	57 %	12	44 %	32 %
0.022	0.165	14	93 %	61 %	21	78 %	55 %

Table 9-10 shows that setting the same requirements (≤ 0.02 kWh and ≤ 0.15 l per test dish) for BC2 and BC3 would discriminate against BC3. Consequently, it seems justified to set BC specific requirements. Considering the results of the analysis of Table 9-6 and Table 9-8, the following requirements are suggested:

Table 9-11: Suggested performance requirements (for $X_c \geq 0.9$ und $X_r \leq 1$)

Parameter	BC2	BC3
Energy consumption [kWh/test dish]	0.020	0.022
Water consumption [l/test dish]	0.165	0.150

As complementary information, **Table 9-12** shows the compliance rates of the products in the Swiss product database with the initial proposal for the declaration programme ($X_c \geq 0.95$ und $X_r \leq 1$).

Table 9-12: Overview of the compliance rates of the products of the Swiss product database for $X_c \geq 0.95$ und $X_r \leq 1$ (initial proposal).

Requirements		BC2			BC3		
Energy	Water		Share (based on n=13)	Share (based on n=23)		Share (based on n=23)	Share (based on n=38)
kWh/test dish	l/test dish	<i>Nr of models complying</i>	<i>Considering all products fulfilling X_c and X_r requirements</i>	<i>Considering all products in the database</i>	<i>Nr of models complying</i>	<i>Considering all products fulfilling X_c and X_r requirements</i>	<i>Considering all products in the database</i>
0.02	0.15	11	85 %	48 %	12	52 %	32 %
0.022	0.15	11	85 %	48 %	21	91 %	55 %
0.02	0.165	12	92 %	52 %	12	52 %	32 %
0.022	0.165	12	92 %	52 %	21	91 %	55 %

Benchmark 1: Example from Switzerland

The Swiss Federal Office of Energy (Bundesamt für Energie, BfE) mentioned a new Swiss policy instrument, under which electricity suppliers are given savings targets, to be achieved through the implementation of various measures among end consumers (including businesses and private households).¹⁵¹ Specifically, electricity suppliers must demonstrate that end consumers have taken steps to improve electricity efficiency - such as upgrading electric drives, lighting, ventilation, cooling systems, or similar equipment and devices.

The Standardised Measure “GG-02a” under this framework focuses on commercial dishwashers, which have to be replaced. Its scope covers electric dishwashers for commercial use within the scope of standard IEC 63136:2019 and energy consumption requirements per cycle have been defined, see **Table 9-13**.

¹⁵¹ Directive for Energy Efficiency Improvements by Electricity Suppliers Implementation Guide according to Articles 51a–51i of the Energy Ordinance (EnV):
<https://www.bfe.admin.ch/bfe/de/home/effizienz/energieeffizienzsteigerungen-durch-elektrizitaetslieferanten.exturl.html/aHR0cHM6Ly9wdWJkYi5iZmUuYWRTaW4uY2gvZGUvcHVibGljYX/Rpb24vZG93bmxxvYWQvMTE5NTM=.html>

Table 9-13: GG-02a requirements (V1.0)

	New system	
Energy Efficiency	The new dishwashers must not exceed the following energy consumption values, determined in accordance with standard IEC 63136:2019:	
	Undercounter dishwashers, 400x400 mm rack (glassware):	0.23 kWh/cycle
	Undercounter dishwashers, 500x500 mm rack:	0.30 kWh/cycle
	Pass-through dishwashers, hood for 1 rack:	0.40 kWh/cycle
	Pass-through dishwashers, double hood for 2 racks:	0.80 kWh/cycle

Source: BfE 2025¹⁵², translation: Fraunhofer ISI

Table 9-14 shows the requirements converted in kWh/test dish. For BC2, the performance requirement on energy consumption would be slightly stricter than the above proposed 0.02 kWh/test dish; for BC3, the requirement would be slightly less strict. However, comparing the levels of requirements has certain limitations, as the Swiss requirements are based on the IEC 63136:2019 standard, but without requirements on the programme tested.

Table 9-14: Requirements estimated in kWh/test dish.

Number of test dishes	16	18
BC2 ¹⁵³	0.019	0.017
BC3 ¹⁵⁴	0.025	0.022

Source: Fraunhofer ISI, based on BfE 2025

Benchmark 2: Example from U.K.

Section 3.4.5.3 of this preparatory study presented the criteria for the Energy Technology List (ETL) in U.K. The requirements are presented in the following table, original figures (consumption per rack) are converted (in consumption per test dish¹⁵⁵):

¹⁵² See Table 1 of GG-02a (Version 1.0 from 11.2024). Source: <https://www.bfe.admin.ch/>. Checked on 11.07.2025

¹⁵³ Considering the requirements for “undercounter dishwashers, 500x500 mm rack”

¹⁵⁴ Considering the requirements for “pass-through dishwashers, hood for 1 rack”

¹⁵⁵ Considering each 16 and 18 test dishes per rack (comparable as for the models available in the Swiss database)

Table 9-15: Energy and water requirements of the ETL programme.

	Energy consumption [kWh]				Water consumption [l]			
	ETL			Comparison to ESPR proposal	ETL			Comparison to ESPR proposal
	per rack	per test dish (assuming 16/rack)	per test dish (assuming 18/rack)	per test dish (18/rack)	per rack	per test dish (assuming 16/rack)	per test dish (assuming 18/rack)	per test dish (18/rack)
BC2 ¹⁵⁶	0.400	0.025	0.022	0.020	3.400	0.213	0.189	0.165
BC3 ¹⁵⁷	0.600	0.038	0.033	0.022	3.000	0.188	0.167	0.150

Source: Fraunhofer ISI, based on UK Energy Technology List

The proposed ESPR requirements are more stringent than the ETL ones. Nevertheless, it should be noted that 95 % of BC2 models and 85 % of BC3 models in the Swiss database that achieve $X_c > 90$ % and $X_r > 1$ comply with the ETL energy and water requirements. The compliance rate is relatively high. In addition, for BC2 and BC3, the BAT configuration contributes to reducing life-cycle costs. Consequently, requirements stricter than those of the ETL are feasible and are expected to deliver economic benefits to users, even when potential increases in acquisition costs are taken into account.

Alternative approach to define the level of requirements

The previous section presented the approach used to define energy and water consumption thresholds for a specific declaration programme. In order to provide some flexibility to the manufacturers without impacting the environmental impact of the products, an approach based on the single score (see PEF methodology) could be used. It would provide the possibility to capture the environmental impact of the aforementioned consumptions at once.

The environmental performance of a commercial dishwasher could be calculated as follows:

$$env\ performance = \frac{w_e \times E + w_h \times H + w_w \times W}{test\ dish}$$

With:

E: energy consumption in the use phase (in kWh)

H: heat consumption in the use phase (in MWh)

W: Water consumption in the use phase (in m³)

w: weighting factor

test dish: number of test dishes cleaned

¹⁵⁶ Considering the requirements for “undercounter dishwashers, 500x500 mm rack”

¹⁵⁷ Considering the requirements for “pass-through dishwashers, hood for 1 rack”

6781 The weighting factors could be derived from the environmental impact of each parameter based on
 6782 the PEF single score as suggested in **Table 9-16**.¹⁵⁸

6783 **Table 9-16: Suggested weighting factor to convert specific consumption in PEF single score.**^{159, 160}

Consumption in the use phase	Quantity	Corresponding PEF single score
Electricity	1 kWh	2.30E-01
Heat	1 MJ	2.79E-02
Water	1 m ³	4.59E-01

6784 As this approach was not supported by stakeholders, it will not be further considered.

6785 **BC 4, 5 and 6**

6786 For these three BCs, due to the lack of data, an alternative approach will have to be chosen. Article
 6787 6(2) of the ESPR mentions the following:

6788 *“The performance requirements shall be based on the relevant product parameters referred*
 6789 *to in Annex I and shall, as appropriate, include either or both of the following:*

6790 *(a) minimum or maximum levels in relation to a specific product parameter or a combination*
 6791 *thereof;*

6792 *(b) non-quantitative requirements that aim to improve performance in relation to one or*
 6793 *more of such product parameters.”*

6794 This means that, in cases where no metric or threshold can be defined for a relevant product
 6795 parameter, an alternative approach would be to **set mandatory requirements based on the analysis**
 6796 **conducted in Task 6**. For example, regarding energy efficiency: if no specific criteria or minimum
 6797 performance level can be determined, then design options identified as contributing to reduced
 6798 environmental impact and lower lifecycle costs may be set as non-quantitative requirements for new
 6799 products, impact on the increased purchase price would need to be considered as well. **Table 9-17**
 6800 shows the selected DOs to be translated as non-quantitative requirements for each BC. However,
 6801 stakeholders argued that due to the lack of standards for measuring the effect of such design options,
 6802 the formulation of non-quantitative requirements could be challenging.

¹⁵⁸ PEF single scores were calculated for each Base Case, aggregating impacts across all life-cycle stages over the product's entire lifetime. 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 than as a comprehensive PEF assessment when comparing results.

¹⁵⁹ Based on Task 6

¹⁶⁰ In case the detergent and rinsing agent consumptions would be also known, it would even be possible to include them in the calculation of the single score, with following factors: 0.434/kg detergent and 0.549/kg rinsing agent.
 EcoReport Tool Dataset 218 “detergent dish production production mix 1 kg of detergent dish”, UUID: 123dd059-035e-57ed-bb77-8d60f38ff148
 EcoReport Tool Dataset 232 “rinsing agent dish production production mix 1 kg of rinsing agent dish”, UUID: 0f961681-a96e-591e-8730-39f5f8115f25

Table 9-17: Overview of potential non-quantitative requirements based on design options applicable to the respective Base Cases.¹⁶¹

Design option no.	Short title	BC4	BC5	BC6
DO-01	Exhaust heat recovery (regenerator)	Yes	Yes	Yes
DO-02	Exhaust air heat pump	No	Yes	Yes
DO-03	Automatic programme for load and soil recognition	Yes	Yes	Yes
DO-04	Improved thermal insulation (double-walled design)	Yes	Yes	Yes
DO-07	Energy recovery from drain water	No	Yes	Yes

9.2.4.3. Information requirements (ESPR Art. 7)

As already emphasised, the lack of (harmonised) data represents one of the greatest challenges in the context of this study. Accordingly, information requirements play a crucial role. Information requirements could address several key areas.

Products should be tested according to the standards mentioned in **Section 9.2.4.2**. At least, the following information should be reported for BC2 and BC3, see **Table 9-18**.

Table 9-18: Information requirements.

Measured data	Unit
Energy consumption for initial filling [1]	kWh
Water consumption for initial filling [1]	L
Initial filling time [1]	s
Water tank temperature when ready-to-use mode reached [1], [3], [5]	°C
Number of test dishes [2] per rack and cycle	-
Cleaning performance with the standard cleaning cycle	%
Resoiling performance in particles per test dish [2]	particles / test dish
Specific energy consumption per test dish [2]	kWh / test dish
Specific water consumption per test dish [2]	l / test dish
Specific detergent consumption per test dish [2],[3]	g / test dish
Specific rinsing agent consumption per test dish [2],[3]	g / test dish
Average cycle time	s
Power left-on mode [3],[4]	kW
Power ready-to-use mode [1]	kW
[1] only applicable to product with tank	
[2] test dish = plate	
[3] currently not part of the EN IEC 63136:2019	
[4] only applicable to product without tank (Cat 1)	
[5] added to better compare products as well as the tank performance	

¹⁶¹ Some options might not be compatible (e.g. DO1 and DO2), some are not meaningful when the dishwasher is connected to hot water supply

Similar information requirements would have been desirable for the other Base Cases as well, but without an established test standard, this is not realistic.

For all products (BC 1-6), following additional information would be required:

- general information such as nominal capacity and noise level¹⁶²
- list of the DOs implemented
- SoCs: see more details in **Section 9.2.4.8**.

Remark: Please note that the information requirements complement other data points referred to in Annex III of the ESPR also included in the Digital Product Passport. See **Section 9.2.4.5** and **Table 9-15** for more details.

9.2.4.4. Labelling requirements

The former preparatory study on commercial dishwashers (2011) proposed the introduction of an EU Energy Label for dishwashers, based on the label developed for household appliances.

As highlighted by two Member States during the stakeholder consultation of the current preparatory study, it is also acknowledged that an EU Energy Label offers several benefits, in particular:

- It simplifies information and improves guidance for non-specialists.
- Information of the EU Energy Label are made public in an EU database (EPREL: EU Product Database for EU Energy Labelling).
- When an EU Energy Label is available, GPP criteria are based on the highest energy classes¹⁶³. Without EU Energy Label, performance classes have to be defined under ESPR and an implementing measure under Art. 65(3) of the ESPR regulation that contains the minimum requirements in form of technical specifications has to be adopted.

However, based on Sections 9.2.4.1 and 9.2.4.2, it is clear that currently, no EU Energy Label can be elaborated for BC1, BC4, BC5 and BC6.

For BC2 and BC3, given that commercial dishwashers are Business-to-Business (B2B) products purchased by professional customers who typically prioritise operating costs (directly linked to energy, detergent, and water consumption), it is assumed that robust information requirements on energy but also on detergent and water consumption might be sufficient to guide purchasers towards more sustainable choices. Consequently, no specific need for a label (such as an ESPR label or EU Energy Label) has been identified in this context, but this will be further explored in the Impact Assessment.

Hence, in accordance with Article 7, paragraph 2, point (b)(i), classes of performance could be defined, where appropriate, particularly for the performance parameters specified in **Section 9.2.4.2**.

¹⁶² According to EN 60335-2-58

¹⁶³ See (EU) 2023/1791 (Energy Efficiency Directive) Art. 7(4)

9.2.4.5. Digital Product Passport (DPP) (ESPR Art. 9):

This chapter evaluates potential DPP requirements for the product group of commercial dishwashers, in line with the provisions of ESPR Article 9, Annex III and referenced or related articles. Commercial dishwashers are currently not covered by EPREL (EU Product Database for Energy Labelling) established under the Energy Labelling Framework Regulation (EU) 2017/1369. Therefore, the exemption clause in ESPR Article 9(4)(b), which allows DPP exemptions for products already covered by EPREL, does not yet apply to commercial dishwashers. This reinforces the potential importance of implementing a DPP for this product group.

Commercial dishwashers represent a high-impact product group in terms of energy consumption, water usage and material durability due to their intensive use in commercial environments. This makes them subject to frequent maintenance cycles, repairs and potential second-hand use, which make them relevant for the implementation of a DPP as it potentially allows to track such individual product information (usage cycled, individual repairs and product condition). However, the benefit of item-level information should be carefully evaluated against the implementation effort for such a DPP. Beneath, starting in **Table 9-19**, the project team makes suggestions for potential mandatory and optional DPP requirements.

There is no official or harmonised approach **to elaborate on the DPP requirements**, yet; the harmonised methodology was expected to be delivered by the end of 2025 by the European Commission's Joint Research Centre (EC-JRC) under the service contract *Technical assistance in defining requirements for the inclusion of data and information in the Digital Product Passport (DPP)*. Therefore, the **approach used here**, and the elaborated requirements presented in this chapter are to be seen as preliminary and may need to be reviewed and aligned once the harmonised EC-JRC approach is made available. The **scope** covers both technical aspects (e.g. data carrier, layout, granularity, accessibility, governance, and update arrangements) and information aspects (e.g. sustainability-related data fields, access rights for different actors, and traceability requirements). Each requirement is considered in relation to its specific use-cases within the commercial dishwashers sectors, recognising that the relevance and configuration of individual DPP elements will vary depending on the actors involved and the intended purpose of the information.

From an **implementation perspective**, it may not be necessary at this stage for every individual actor who puts a product on the market to build and maintain a fully independent DPP system or to deeply engage with every regulatory detail. DPP integration in this product group could be facilitated through DPP service providers or industry associations. DPP service providers already offer DPP-compliant services that can handle data storage, validation, and access rights in line with ESPR requirements. Alternatively, a centralised DPP platform could be hosted by sectoral industry associations, which are typically familiar with regulatory obligations and have both technical and organisational capacity for data management. This centralisation can streamline compliance, especially for small and medium-sized enterprises, and enhance interoperability across actors involved in the product life cycle.

Table 9-19 shows a comprehensive overview of DPP use cases, related stakeholder group and for which use-cases a DPP is necessary (highlighted in bold). Rows highlighted in green show use-cases that are seen potentially relevant by the project team. A validation of the relevance is necessary by the involved stakeholders in order to make a final decision regarding which use cases should be prioritised for implementation. The chosen use-cases determine the associated stakeholders and

regulatory needs. To note, the right column still shows if a use case could also be realised through EPREL, extended by specific information. Due to the circumstance that commercial dishwashers are not and will not be covered by EPREL, this option is obsolete.

Table 9-19: Overview of use-cases per stakeholder and whether a DPP is necessary

Stakeholder	Use-case (CE-goal)	Information to be provided	Feasible with EPREL / DPP
Customer	Sustainable purchase	CO2 footprint, circularity indicators (e.g. reparability), recycled content	EPREL (extended with sustainability information)
Customer	Sustainable purchase	Environmental and social label	EPREL (extended with label)
Customer	Sustainable purchase	Technical specifications / documentation	EPREL
Customer	Prolong use (maintenance, DIY repair)	Use, maintenance and DIY repair instructions	EPREL (extended with manuals)
Customer	Resell & second-hand purchase	Usage history, repair history	DPP (item level information)
Customer	Proper disposal	Disposal and return options	EPREL (extended with disposal information)
Repairer	Professional (certified) repair	Dismantling instructions, spare part availability, etc.	EPREL (extended with repair information)
2 nd hand operator	Enable reuse	Usage history, repair history	DPP (item level information)
Refurbisher	Enable refurbishment	Dismantling instructions, usage & repair history	DPP (item level information)
Remanufacturer	Enable remanufacturing / repurposing	Dismantling instructions, usage & repair history	DPP (item level information)
Collection & Presorting	Preparation for reuse	Energy efficiency, Usage/repair history, purchase date, original product price	DPP (item level information)
Collection & Presorting	Component sorting	Dismantling instructions	EPREL (extended)
Collection & Presorting	Separation of products/components with prohibited substances (WEEE, RoHS, REACH, etc.)	Prohibited / hazardous substances per component (incl. Batteries)	EPREL (extended with material information)
Collection & Presorting	Separation of products/components with valuable materials	Valuable materials	EPREL (extended)
Collection & Presorting	Closed loop recycling	Application type, model	EPREL (extended)

Based on the above use cases which are evaluated as relevant, the aspects according to ESPR Art. 9 need to be determined, shown in following table. This means, that the following table shows initial suggestions and an indication of potentially relevant requirements:

Table 9-20: Overview of aspects to be determined according to ESPR Article 9.

(a) the data to be included in the digital product passport pursuant to Annex III; see Table 9-21,

(b) one or more **data carriers** to be used;

Recommended: QR code combined with optional RFID.

QR code placed on the machine exterior (service panel or control housing);

RFID tag embedded in industrial models for use by service teams. This ensures access for both end-users and professionals under typical use and service conditions.

(c) the **layout** in which the data carrier is to be presented and its positioning;

QR code must be visible without disassembly, ideally near the product name-plate;

Label should indicate it links to a DPP;

Must withstand humidity, detergents, and mechanical cleaning.

(d) whether the digital product passport is to be established at **model, batch or item level**, and the definition of such levels;

Recommended level: Model-level with optional item-level extension

- This matches industry practices where technical configurations are standardised across units;
- Batch-level data (e.g. production date ranges) can be optionally linked;
- Item-level data (e.g. individual condition, repaired parts) might be considered when individual machines have to be recognised (use-cases: repair, predictive maintenance, with high variability and presence of personalised configurations).

(e) the **manner in which the product passport is to be made accessible** to customers before they are bound by a contract for sale, hire or hire purchase, including in the event of distance selling;

The DPP must be accessible via:

- URL or QR code in online product listings;
- Scannable code on showroom displays;
- PDF or data link in downloadable brochures or sales platforms. This supports transparency and compliance with EU consumer law.

f) the actors that are to **have access to data** in the Digital Product Passport and to what data they are to have access; see next section

- Public
 - information: e.g. energy and water performance, durability, repair instructions;
- Professionals
 - Manufacturers/importers: full access and control rights.
 - Recyclers: e.g. material composition, hazardous substance & location;
- End-users/customers: to be clarified;
 - Service technicians: e.g. disassembly instructions, software versioning, spare part IDs;
- Market authorities: all information including conformity and substance declarations;

g) the actors that are to **create a Digital Product Passport or update the data** in a Digital Product Passport and what data they may introduce or update;

- Manufacturers or DPP service provider: create the initial DPP and ensure updates for revisions;
- Importers: update localisation fields where required (language, distributor info);
- Other professionals (e.g. repairers, refurbishers): add repair status, refurbishment status or updated maintenance logs, where permitted;
- Service providers: may add non-binding service logs or condition reports

h) the detailed arrangements for introducing or updating data.

- Use of central DPP platforms authorised by industry or EC-recognised bodies;
- Version-controlled updates with timestamped logs;
- Role-specific authorisation to prevent unauthorised overwrites.

6895 To note, further actors are listed in ESPR “Article 11 The technical design and operation of the digital
6896 product passport shall comply with the following essential requirements”, which might be specified
6897 in detail, depending on the decision which use-cases are relevant: “ESPR Article 11 (b) customers,
6898 manufacturers, importers, distributors, dealers, professional repairers, independent operators,
6899 refurbishers, remanufacturers, recyclers, market surveillance authorities and customs authorities, civil
6900 society organisations, trade unions and other relevant actors shall have free of charge and easy access
6901 to the digital product passport based on their respective access rights set out in the applicable
6902 delegated act adopted pursuant to Article 4;”

6903 The **validation of the proposed DPP use cases and related requirements** for commercial dishwashers
6904 is essential to ensure their practical relevance, technical feasibility, sectoral alignment and (most
6905 important) acceptance amongst all stakeholders. This validation should involve a comprehensive
6906 stakeholder engagement process, including all stakeholders that are involved in the use-cases along
6907 the product's life cycle and DPP handling (have access, can write or update data). Workshops,
6908 structured interviews, or online surveys are potential formats to gather detailed input. Due to the
6909 complexity and number of affected actors, this validation will require substantial coordination and
6910 resources.

6911 **Table 9-21: Evaluation of data / requirements related requirements according to ESPR ANNEX III**
6912 **Information requirements.**

Digital Product Passport Data Element (Annex III ESPR)	Relevant for DPP? (Yes/No)
(a) Information required under Article 7(2)(b), Article 7(5), or other Union law	See next section
(b) Unique product identifier at level indicated in delegated act	Yes - To be determined by standardisation
(c) the Global Trade Identification Number as provided for in International Organisation for Standardisation/International Electrotechnical Commission standard ISO/IEC 15459-6 or equivalent of products or their parts; or (upcoming) 18219 Unique Identifiers	Yes - To be determined by standardisation
(d) relevant commodity codes, such as a TARIC code as defined in Regulation (EEC) No 2658/87;	Yes - To be determined by standardisation
(e) Compliance documentation (e.g., declaration of conformity, technical documentation, certificates)	Yes
(f) User manuals, instructions, warnings, or safety information as required by EU law	Yes
(g) Manufacturer information (including unique operator identifier, Article 27(7) info)	Yes
(h) Unique operator identifiers (others than manufacturer)	Yes
(i) Unique facility identifiers	Yes
(j) Importer information, including Article 29(3) info (name, registered trade name or registered trademark, postal address) and EORI number	Yes
(k) Responsible EU-based economic operator info (Article 4 Reg. 2019/1020 or Article 15 Reg. 2023/988)	Yes

Digital Product Passport Data Element (Annex III ESPR)	Relevant for DPP? (Yes/No)
(I) Reference of the DPP service provider hosting the backup copy	Yes
Standards compliance (where relevant): ISO/IEC 15459-1 to -6 or (upcoming) 18219 Unique Identifiers	Yes – where relevant
Optional ecodesign-relevant data: Additional manufacturer-provided information (e.g., voluntary labels)	Yes – where relevant
– Includes indication whether an EU Ecolabel has been awarded (Reg. (EC) No 66/2010)	Yes – where relevant

6913

6914 **Table 9-22: Evaluation of data related requirements according to ESPR Article 7 Information**
6915 **requirements.**

Information Requirement (from Article 7 ESPR)	Relevant? (Yes/No)
1. General compliance: Compliance with information requirements laid down in delegated acts under Article 4	Yes
2(a). Minimum requirement: Digital product passport (Chapter III)	Yes
2(a). Minimum requirement: Information on substances of concern (Article 7.5)	Yes
2(b)(i). Performance parameters: Repairability score	(Likely) No – only if information or performance requirement are set
2(b)(i). Performance parameters: Durability score	(Likely) No – only if information or performance requirement are set
2(b)(i). Performance parameters: Carbon footprint	(Likely) No – only if information or performance requirement are set
2(b)(i). Performance parameters: Environmental footprint	Likely no
2(b)(ii). Customer instructions: Installation, use, maintenance, and repair	Yes
2(b)(ii). Customer instructions: Installation of third-party operating systems (where relevant)	Yes
2(b)(ii). Customer instructions: Collection for refurbishment or remanufacture	To be clarified
2(b)(ii). Customer instructions: Return or handling at end-of-life	Yes
2(b)(iii). Treatment instructions: Disassembly, reuse, refurbishment, recycling, disposal	Yes
2(b)(iv). Other relevant information: For sustainable product choices and end-of-life handling by third parties	Yes
2(c). Clarity Requirement: Information must be clear, understandable, and tailored to the target audience	Yes

Information Requirement (from Article 7 ESPR)	Relevant? (Yes/No)
3. Substances labelling restriction: No info on hazards for labelling purposes per Annex I(f)	To be clarified
4. Performance classes: If set, must reflect significant improvements and include minimum class level	Yes – if performance classes are set
5 (a)-(d) Substance information (SoC contained in the product)	See MEErP Task 5 (SOC)
5(a)(i). Substance identification: IUPAC name or international name	Yes
5(a)(ii). Substance identification: Other/trade names, abbreviations	Yes
5(a)(iii). Substance identification: EC number (EINECS/ELINCS/NLP/ECHA)	Yes
5(a)(iv). Substance identification: CAS name and number	Yes
5(b). Substance location: Within the product or components	Yes
5(c). Substance concentration: At product/component/spare part level	See Task 5 (SOC)
5(d). Safe use instructions: For hazardous substances	If relevant
5(e). End-of-Life info: For disassembly, reuse, recycling, environmentally sound disposal	Yes
6(a). Applicability dates: Differentiation of start dates for different substances	Yes
6(b). Exemptions: Based on technical feasibility, analytical methods, CBI protection, etc.	Yes
6(c). Alignment of information requirements with other EU laws and minimisation of admin burden	To be clarified
7. Format of availability: Information must be provided via DPP and possibly also:	
- on the product itself	Yes
- on packaging	Yes
- on a label (Art. 16)	No
- in a user manual or other docs	Yes
- on a free-access website or app	Yes
7. Data carrier requirement: Info on substances of concern must be on product or accessible via data carrier	Via data carrier
8. Language requirement: Easily understood by customers in target Member State	Yes

9.2.4.6. Green Public Procurement GPP (ESPR Art. 65)

The European Commission indicates that public procurement represents 14 % of the European Union's GDP,¹⁶⁴ highlighting its substantial impact on the economy. Commercial dishwashers are operated in or by various public entities, including schools, hospitals, and similar facilities. There is no precise statistics on public procurement of commercial dishwasher markets. However, based on available data in Task 2, the share of the public sector was estimated to be approximately 24 % of the commercial dishwasher market (see **Section 4.2.1.3**).

Accordingly, it is reasonable to assume that Green Public Procurement (GPP) could have a meaningful impact on the EU market for commercial dishwashers. Article 65 of the Ecodesign for Sustainable Products Regulation (ESPR) states that *“the minimum requirements shall be based on the two highest performance classes, the highest scores, or, when not available, on the best possible performance levels as set out in the delegated act adopted pursuant to Article 4 applicable to the product groups in question.”* This provision emphasises the need for establishing high performance standards that align with environmental sustainability objectives. Setting mandatory GPP requirements close to the Best Available Techniques (BAT) level appears to be justified, as Task 6 indicated that the BAT level reduces the yearly life cycle cost (LCC) of the products.

One stakeholder suggested establishing, as a GPP criterion, a combination of a double-walled design (DO-04) with at least one additional Design Option identified in Task 6. While this approach is pragmatic and constructive, it would only comply with Article 65 of the ESPR if the package of options corresponds to the best achievable performance levels, as defined in the Delegated Act adopted pursuant to Article 4 and applicable to the relevant product groups.

9.2.4.7. Circular economy

Spare parts

To ease repairability of the commercial dishwashers and to extend their lifetime, the following requirements on the spare-parts are suggested:

- All products shall offer access to spare parts within a maximum delivery time. Current Ecodesign regulations on household dishwashers or washing machines require 15 working days. For commercial products, it is proposed to reduce this period, given the high volume of wash ware processed by clients and the need to minimise operational downtime. It is proposed to require a timeframe of 5 working days until the handover of spare parts to an express logistics provider, rather than final delivery to the end customer.
- This availability must be guaranteed for a minimum period of ten years following the placement of the last unit of the model on the market.

Based on the analysis carried out in **Section 5.5.2**, **Table 9-23** provides an overview of the spare parts recommended for inclusion in the requirements.

¹⁶⁴ See ESPR regulation: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202401781

Table 9-23: Most important priority parts in terms of necessary repairs / spare parts to be covered by requirements.

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 Category 3 Hood-type Category 4 Utensil/Pot	Parts of the dosing system are maintenance parts. Parts related to the water circulation system e.g. circulation pump, piping, nozzles. Pumps, heating elements, chemical dispensers, printed circuit boards (PCBs), relays/contactors. Thermostats and temperature sensors, pressure sensors or 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, nozzles. Pumps, heating elements, chemical dispensers, printed circuit boards (PCBs), relays/contactors. Thermostats and temperature sensors, pressure sensors or switches.

Source: stakeholders feedback

In addition, manufacturers shall provide comprehensive repair and maintenance information to facilitate servicing by professional repairers and, where applicable, end-customers.

Important remark:

Concerns have been raised regarding motors and fans, where spare parts (after 2029¹⁶⁵ for motors falling under the scope of (EU) 2019/1781 and after 2037¹⁶⁶ for fans falling under the scope of (EU) 2024/1834) might not be subject to the same requirements as the components used in original manufacture. However, these components fall under the scope of dedicated motor and fan regulations, including their respective ongoing reviews. Therefore, they are not covered by the potential regulation for commercial dishwashers under the ESPR framework.

Critical raw materials

Dishwashers are already explicitly mentioned in the scope of Article 28 of the CRM Act Regulation (EU) 2024/1252:

- Art. 28 (Recyclability of permanent magnets)
- Art. 29 (Recycled content of permanent magnets)

*Furthermore, the CRM Act mentions in Article 29, Point 3: “After the entry into force of the delegated act adopted pursuant to paragraph 2, and in any event by 31 December 2031, the Commission shall adopt **delegated acts supplementing this Regulation by laying down minimum shares for neodymium, dysprosium, praseodymium, terbium, boron, samarium, nickel and cobalt recovered from***

¹⁶⁵ See Art. 2 point 2 (m) of (EU) 2019/1781 (ecodesign requirements for electric motors and variable speed drives). Please note, that this regulation does not cover permanent magnet motors.

¹⁶⁶ See Annex II of (EU) 2024/1834 (ecodesign requirements for fans driven by motors with an electric input power between 125 W and 500 kW)

6973 *post-consumer waste that must be present in the permanent magnet incorporated in the products*
6974 *referred to in paragraph 1.”*

6975 Consequently, no specific need to regulate additional CRM aspects under ESPR has been identified for
6976 commercial dishwashers.

6977 9.2.4.8. Substances of Concern

6978 The ESPR requires manufacturers of commercial dishwashers to adhere to information requirements
6979 for all SoCs present in their products, resulting in tracking obligations concerning their identity,
6980 location, concentration, safe-use instructions, and end-of-life treatment.¹⁶⁷ Based on the analysis
6981 carried out in Task 5, to meet these obligations with minimal duplication and maximum alignment,
6982 the following thresholds (based on draft JRC guidance) are recommended:

- 6983 - A 0.1 % w/w threshold for SVHCs (Art. 2(27)(a)) and POPs (Art. 2(27)(c)) in line with REACH
6984 Art. 33(1) "meaning an information obligation like existing in REACH for SVHC";
- 6985 - UN Globally Harmonized System (GHS) generic concentration limits (or, where absent,
6986 the lowest CLP GCLs) for hazard-classed substances under Art. 2(27)(b), supplemented by
6987 the latest endocrine-disruptor and PMT/PBT criteria; and
- 6988 - A uniform 0.1 % w/w cutoff for SoCs affecting circularity (Art. 2(27)(d)), pending more
6989 granular data.

6990 Because full-lifecycle intentionally added substances (IAS) and non-intentionally added substances
6991 (NIAS) data collection is time- and resource-intensive, the scope is limited to product-specific IAS
6992 present in the final product, including its components and spare parts. Three implementation
6993 scenarios are proposed:

- 6994 - Ambitious: covering all SoCs without exemptions;
- 6995 - Intermediate: case-by-case exemptions for substances based on solid justification; and
- 6996 - Limited: tracking only Art. 2(27)(a–c) substances with broader approach towards
6997 exemptions within the flexibilities offered by the legal text, coupled with a targeted study
6998 to identify additional Art. 2(27)(d) candidates for selected regulation through amending
6999 the delegated act.

7000 A five-year roll-out is recommended across all scenarios to allow for supplier engagement, data
7001 gathering, and Digital Product Passport integration. An assessment of feasibility and administrative
7002 burden should be undertaken as part of the impact assessment.

7003 Finally, performance requirements under Art. 6 of the ESPR need not be imposed at this stage: current
7004 WEEE/RoHS recycling frameworks are working satisfactorily, and stakeholder feedback has not
7005 identified any specific performance gaps. As new research or recyclability insights emerge, revisiting
7006 performance criteria should be considered.

¹⁶⁷ Substances of concern are in the scope of Ecodesign requirements (Art. 5) and Information requirements (Art. 7) of the ESPR regulations.

9.3. Scenario analysis

The scenario analysis is performed using a stock model calculation, comparing a business-as-usual (BAU) scenario with the best available technology (BAT) for the different base cases. Inputs are the EcoReport data for base cases (Task 5) and design options (Task 6), as well as the sales data in the reference year and projections for market trends (based on Task 2).

Section 9.3.1 starts with describing the data inputs for the scenario analysis, including inputs from previous Tasks as well as necessary assumptions such as on market development. Thereafter, **Section 9.3.2** introduces the logic behind the stock model, including its components and the granularity level. Results of the environmental assessment are presented in **Section 9.3.3**, structured according to sales and stock, use-phase electricity, gas, water and detergent consumption. After the environmental results, socio-economic impacts are presented (**Section 9.3.5**) and finally a sensitivity analysis (section 9.3.6.3.6).

9.3.1. Inputs from previous Tasks and necessary assumptions

Base cases, design options and policy timing

The analysis includes the six base cases described in Task 5 and 6. **Table 9-24** lists the Base Cases and selected input data for the BAU and BAT products variations. Following Task 6 results, the scenario calculation basis for Base Case 1 is Design Option DO4, while for all other Base Cases a combination of Design Options DO1, DO3, DO4 and DO7 is taken as the BAT. As reported in Task 2 (based on 2024 stakeholder consultation), the average estimated product lifespan is approximately 12 years, with a range extending from 8 to 15 years, and with differences between product types. **Table 9-24** provides an overview of selected input data for the scenario analysis.

7029 **Table 9-24: Selected input data from Tasks 3, 5 and 6 for BAU and BAT.**

Base cases	Lifetime [years]		Average price [Euro]		Maintenance and repair costs [Euro/lifetime]		Electricity use (on-mode & standby) [kWh/month]		Gas consumption [kWh/month]		Water consumption (use phase) [m³/month]		Detergent consumption (use phase) [kg/month]		Rinsing agent consumption (use phase) [kg/month]	
	BAU	BAT	BAU	BAT	BAU	BAT	BAU	BAT	BAU	BAT	BAU	BAT	BAU	BAT	BAU	BAT
BC1: Undercounter water-change dishwasher	12	12	3,148	3,148	1,385	1,385	147.35	125.25	-	-	3.67	3.67	2.58	2.57	-	-
BC2: Undercounter one-tank dishwasher	8	8	5,659	8,818	2,490	3,984	580.25	407.00	7.43	7.43	13.60	12.96	15.25	13.42	1.30	1.14
BC3: Hood-type dishwashers	8	8	8,662	13,788	3,811	6,098	1,171.50	820.50	24.86	24.86	12.92	11.82	26.27	23.12	2.03	1.78
BC4: Utensil/pot dishwasher	9	9	10,855	17,097	4,776	7,642	989.25	692.56	93.76	88.10	9.73	8.56	26.97	23.73	1.42	1.25
BC5: One-tank conveyor-type dishwasher	11	11	13,394	25,003	5,894	10,314	3,960.78	2,772.52	550.46	424.76	33.63	29.94	81.55	71.76	6.86	6.04
BC6: Multi-tank conveyor-type dishwasher	15	15	22,867	41,923	10,061	17,608	9,084.86	6,359.42	1,800.62	1,342.50	63.65	57.03	147.10	128.71	11.76	10.29

7030

7031 Cost rates are estimated to be the same throughout all base cases in the base year 2023 at:

- 7032 - 0.023 Euro/MJ fuel rate (gas, oil, wood)
- 7033 - 0.257 Euro/kWh electricity rate
- 7034 - 1.91 Euro/m³ water rate
- 7035 - 4.22 Euro/kg detergent price
- 7036 - 3.93 Euro/kg rinsing agent price

7037 After the base year, the specific escalation rates from **Table 11-19** are used to account for dynamic
 7038 price variations over time (2.15 % for natural gas, 1.62 % for electricity, 0.16 % for water, 1.21 % for
 7039 detergent and rinsing agent).

7040 Sales, stocks and market development for the business-as-usual (BAU)

7041 Task 2 estimated the stock data based on EU apparent consumption data (= production + import -
 7042 export). Shares of sales were based on sales data provided by the industry association APPLIA Italia,
 7043 extended by data from the 2011 study (based on the NAFEM Size and Shape of the Industry Report
 7044 2010).

7045 Sales and stock per bases case are shown in **Table 9-25**.

7046 **Table 9-25: Sales and 2023 stock of base cases (see Task 2, source: Prodcum).**

Year	EU-27 Total [units]	BC1 [units]	BC2 [units]	BC3 [units]	BC4 [units]	BC5 [units]	BC6 [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

Year	EU-27 Total [units]	BC1 [units]	BC2 [units]	BC3 [units]	BC4 [units]	BC5 [units]	BC6 [units]
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

7047 The modelling timeframe is started in 1990 to establish a continuous inflow and outflow of appliances
7048 in the stock. Before this modelling timeframe, a linear ramp up of sales is assumed, over a period
7049 corresponding to the lifetime of the respective BAU base case.

7050 Regarding market growth, the reference period from 2008 to 2023 showed strong fluctuations which
7051 make predictions or extrapolations difficult. Therefore, for the timeframe before and after the
7052 reference period, a conservative, moderate growth scenario of +1.5 % / year is assumed.

7053
$$sales(year) = sales_{reference\ year} * 1.015^{year - reference\ year}$$

7054 Moving from the BAU to the BAT scenario, the stock is expected to remain identical, as the demand
7055 for the number of commercial dishwashers and also the cycles per dishwasher category (functionality
7056 of the devices) is expected to be independent from the type of product used. Even with an identical
7057 stock, the sales will be altered, however, due to the different lifetimes of the BAT products (more or
7058 less sales are necessary to achieve the same stock).

7059 Further assumptions are needed for the electricity mix. As the energy consumption during the use
7060 phase was identified as an environmental hotspot in Task 5, it was decided to keep the respective
7061 values for global warming impacts (kg CO₂ per kWh) and costs (€ per kWh) dynamic, to reflect future
7062 changes in the analysis. More specifically the PRIMES model was used for a consistent scenario (see
7063 **Table 9-22**). This scenario depicts a consistent scenario development of carbon intensities and energy
7064 costs. The relative development in the scenarios was linked to the absolute, but static assumptions of
7065 the Task 5 environmental assessment. In Task 5, values are fixed to 0.257 €/kWh for costs and
7066 0.419 kg CO_{2eq}/kWh for greenhouse gas intensity of the electricity grid mix. These values are taken as
7067 the reference point in 2025 and are linked to the relative development of the scenarios. For the
7068 electricity price, additionally the yearly escalation rate from Task 5 is added (see below). Values for
7069 the greenhouse gas intensity of heating fuelled by natural gas are also based on Task 5 with a value of
7070 0.234 kg CO_{2eq}/kWh but are kept static throughout the modelling timeframe.

7071

Table 9-26: Data on greenhouse gas intensity of electricity production and electricity prices from the EU reference scenario and derived dynamic data for Task 7.

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Reference values										
Average Price in final demand sectors ¹⁶⁸ (€/15/kWh)	- (no value)	0.1332	0.1371	0.1487	0.1545	0.1613	0.1615	0.1628	0.1638	0.1656
Greenhouse gas intensity ¹⁶⁹ (kg CO _{2eq} /kWh)	0.45	0.40	0.37	0.26	0.19	0.12	No values	No values	No values	No values
Dynamic data for Task 7 (reference values normalised to base year 2025)										
Electricity price (€/kWh)	0.215	0.222	0.228	0.247	0.257	0.268	0.269	0.271	0.272	0.275
Greenhouse gas intensity ¹⁷⁰ (kg CO _{2eq} /kWh)	0.992	0.882	0.816	0.573	0.419	0.265	0.198	0.132	0.066	0.000

This approach can be understood as an additional layer of detail, tailored to the life cycle stage with the highest impact, and to the impact category with high relevance and highest data availability.

The technical improvement options, labelled as BAT, are set to be active from January 2030 for all Base Cases and to apply to all sales from this year onwards. Thereby it is assumed that all new products purchased from 01.01.2030 correspond to the BAT level. This scenario reflects the theoretical maximum improvement potential that could be achieved on the commercial dishwasher market. Stakeholder feedback pointed out that this improvement potential seems to be overestimated as a certain share of machines on the market has already implemented the proposed Design Options which is not yet considered in the current calculations due to a lack of such market data. It is therefore recommended that manufacturers provide more detailed data on the share of implemented Design Options on the market to further specify and refine the environmental impacts in the following Impact Assessment study.

9.3.2. Stock model description

The stock model is meant to establish scenarios according to the Design Options described in Task 6 and the policy options previously described in Task 7. The model is implemented in Microsoft Excel (several files) and comprises several components. Compared to former approaches, all data (including all impact categories and all life cycle stages) are imported from the ERTs, allowing for a very detailed analysis. As input data from previous Tasks serve especially the Task 5 assessments for the six Base Cases, respectively for BAU and BAT (in total 12 ERTs), including:

¹⁶⁸ Based on 2020 EU reference scenario (https://energy.ec.europa.eu/data-and-analysis/energy-modelling/eu-reference-scenario-2020_en)

¹⁶⁹ Based on FF55 REG scenario (https://energy.ec.europa.eu/data-and-analysis/energy-modelling/policy-scenarios-delivering-european-green-deal_en)

¹⁷⁰ Assuming that the reduction in the reference values will continue with decarbonisation by 2050

- 7093 - Purchase price, installation costs, repair costs, electricity, gas, water, detergent and
- 7094 rinsing agent costs
- 7095 - Inflation (or escalation) rates
- 7096 - Product lifetime and annual sales (basis for calculating stocks)
- 7097 - Annual resource consumption (electricity, gas, water, detergents) during the product's
- 7098 use
- 7099 - Material and energy flows of all other life phases: product weight and components,
- 7100 materials, energy and processes of manufacture, packaging, transport, repair and
- 7101 disposal

7102 The stock models serve as the core calculation modules of the model. They calculate the metrics of
 7103 Sales, Stock, and End-of-Life over time for a Base Case and the implementation of policy options at
 7104 various levels. These metrics are interdependent and fundamentally rely on the lifespan of the Base
 7105 Cases. The modelling of stocks in this framework follows the formulas outlined in the 2011 MEERP
 7106 guidelines and the revised version from 2024. The logic of the stock model depends on whether it is
 7107 driven by sales or stock.

7108 In this context, the terms **Sales**, **Stock**, and **End-of-Life** require further clarification to understand their
 7109 usage within the stock model.

- 7110 - **Stock** denotes the total inventory of each Base Case per time unit. The stock encompasses
- 7111 all active devices within their lifespan at a given time. Thus, the stock serves as the
- 7112 foundation for calculating the environmental impact during the use phase. In market data
- 7113 collection, the stock is represented by the value at the beginning of the year, specifically
- 7114 on January 1st of each year.
- 7115 - **Sales** or **Total Sales** refers to the sales per time unit, which consist of **New Sales** and
- 7116 **Replacement Sales**. A **New Sale** increases the total stock of base cases. A **Replacement**
- 7117 **Sale** refers to the replacement of a product that has reached the end of its lifespan. Both
- 7118 types of sales imply that another product has been produced; however, in the case of
- 7119 replacement sales, the total stock remains unchanged. Sales is the controlling factor,
- 7120 allowing for the accounting of all life phases prior to the usage phase.
- 7121 - **End-of-Life** describes the devices that have reached their maximum lifespan and are now
- 7122 being disposed of. This includes the calculation of emissions and/or credits associated
- 7123 with disposal and recycling.

7124 Generally, in both cases, stock is calculated as the sum of sales between the current time and the
 7125 current time minus the lifespan of the device.

7126 Here, the sales are provided as the input value (developed based on the inputs from Task 2), based on
 7127 which the stock in year y can be calculated.

$$7128 \quad stock_y = \sum_{t=y-lifetime+1}^{t=y} sales_t \quad (1)$$

We use a stock-driven approach, therefore changes in lifetime of the BAT should not impact the overall number of products in stock. First, a target stock must be calculated. Thereafter, sales figures are adjusted based on changes in lifetime to match the target stock.

Technical, environmental and economic data is imported from the environmental assessment from Task 5 and 6 for all six Base Cases, each with the BAU and the BAT. These product-level impacts are scaled-up using the calculated sales and stock data. For some parameters, dynamic changes over time are considered, namely for the carbon intensity as well as the price of the electricity consumption.

The disaggregation level is set on monthly basis, resulting in 720 timesteps for the period 1990 – 2050. For the results calculation, the relevant reference period is from 2025 to 2050.

Figure 9-3 presents a visual representation of the modelling logic and its components.

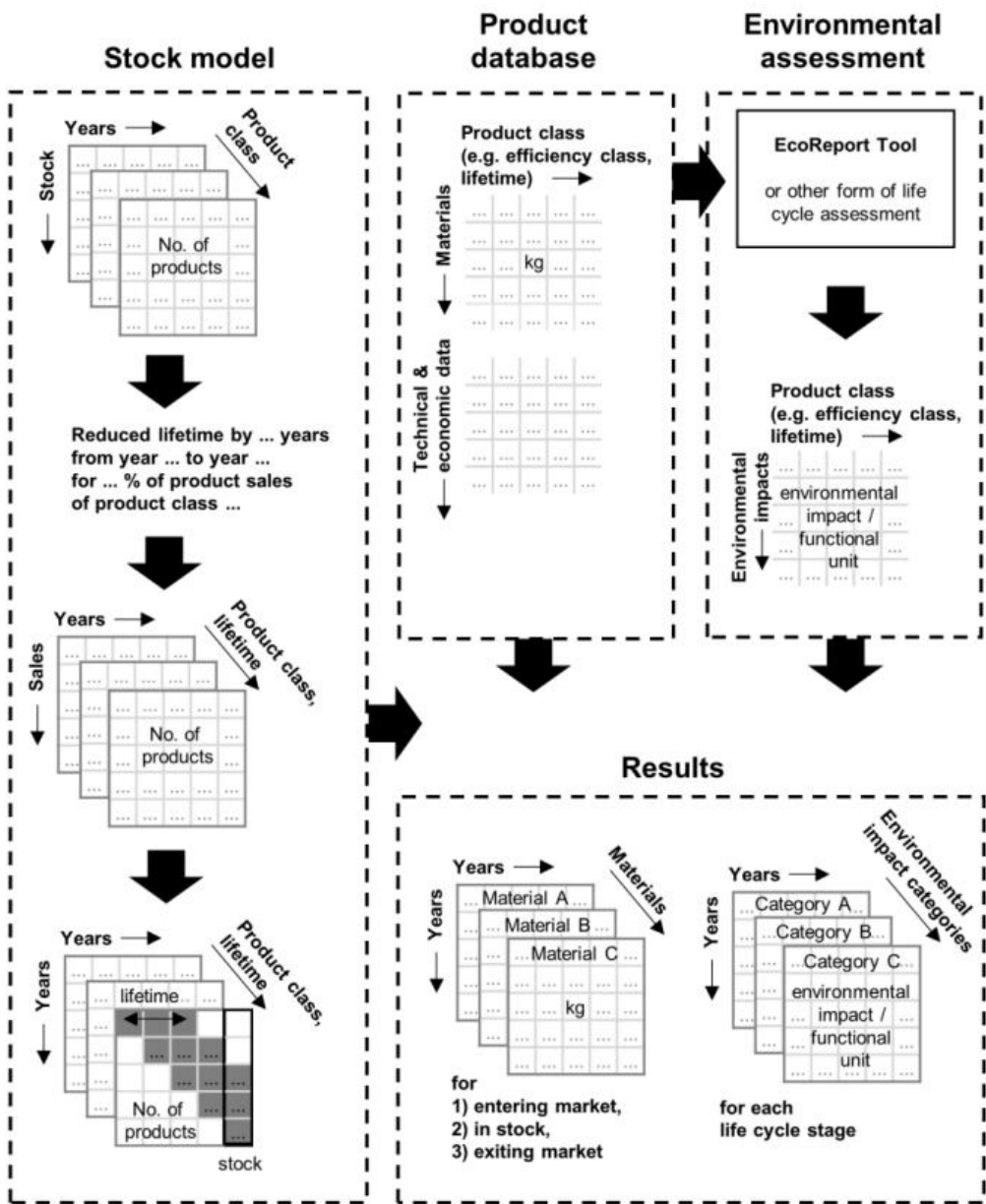


Figure 9-3: Schematic representation of the scenario analysis model (source: Fraunhofer ISI).

9.3.3. Results: Sales and stock

Based on the described sales data the stocks for the BAU can be calculated and are shown in **Figure 9-4**. In 2025, sales for the six Base Cases accumulate to 283,327 units. As can be seen from the graph, BC2 (Undercounter water-change dishwasher) and BC3 (Hood-type dishwashers) are the ones with the highest number of sales. Comparably low sales numbers are calculated for BC4 (Utensil/pot dishwasher), BC1 (Undercounter water-change dishwasher), BC5 (One-tank conveyor-type dishwasher) and BC6 (Multi-tank conveyor-type dishwasher).

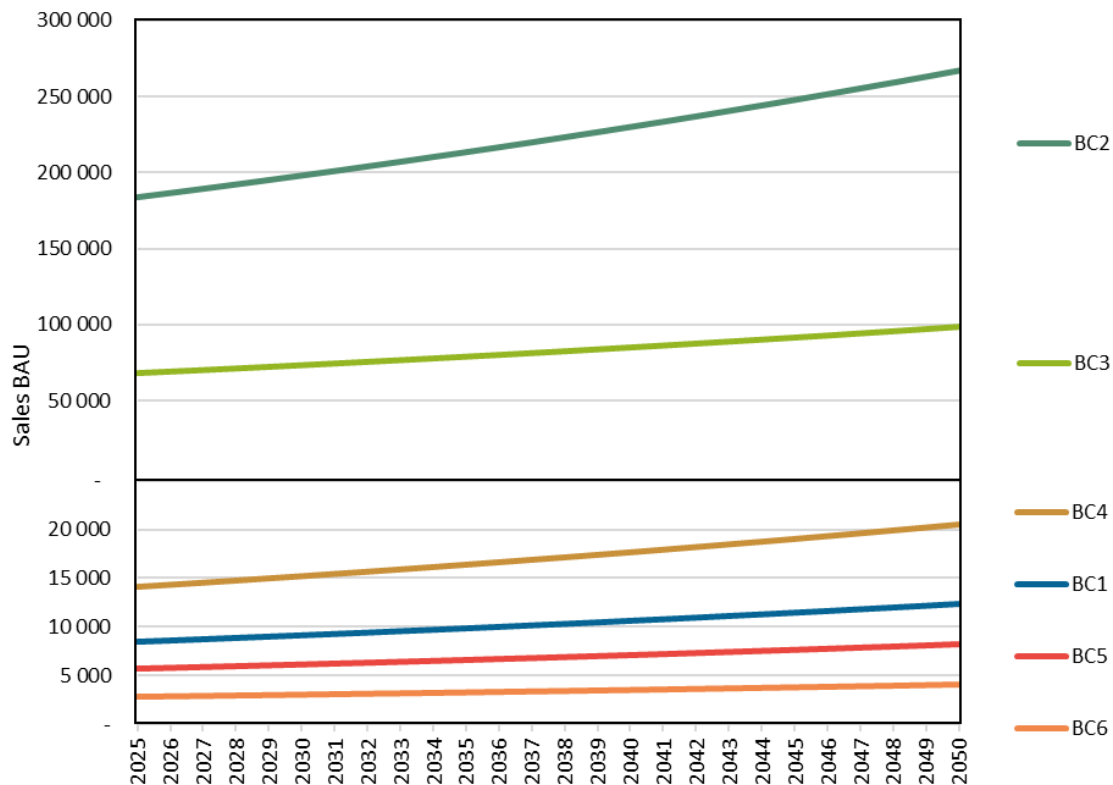


Figure 9-4: Sales in the BAU scenario for all Base Cases (sorted according to sales numbers).

The stock is shown in **Figure 9-5**. It raises from a total of 2,140,401 in 2025 to 3,208,773 in 2050.

Corresponding to the sales figures, also stock is dominated by the Base Case 2 and Base Case 3. The total stock in 2050 is made up to 86 % from Base Case 2 and Base Case 3 (BC2: 2,016,570 corresponding to 63 % of the market; BC3: 744,583 corresponding to 23 % of market).

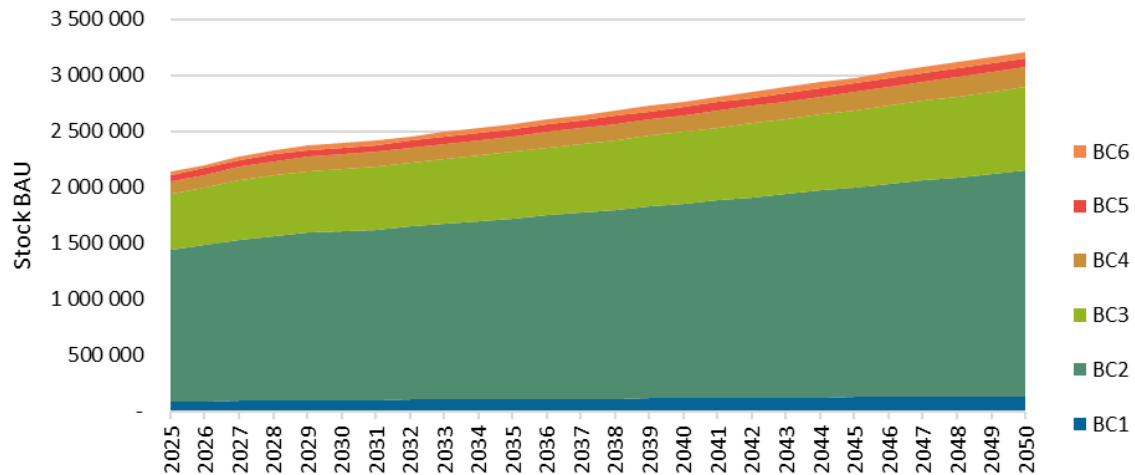


Figure 9-5 Calculated stock in the BAU scenario based on sales data assumptions and lifetimes.

The change in the stock due to the introduction of BAT products is exemplary shown in **Figure 9-6** for BC2. As the BAT products are introduced to the market, they replace BAU sales from 2030 onwards and induce a transformation in the stock that is completed in year 2038, when 100 % of the market is made up of the BAT.

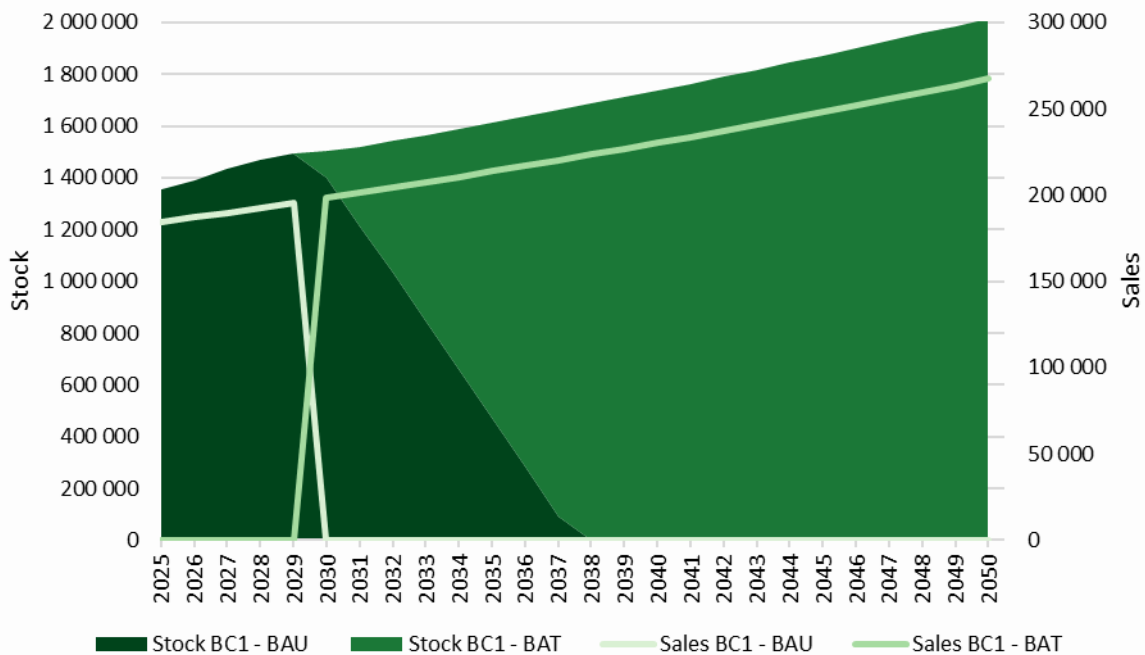


Figure 9-6: Changes in the stock of the BAT scenario for BC2 due to BAU and BAT product sales.

9.3.4. Results: Environmental Impacts

Electricity and gas consumption

The impact of the BAT scenario on the use-phase electricity consumption are shown in **Figure 9-7**, accumulated for all Base Cases. **Table 9-26** provides a deeper insight into the individual Base Cases for use-phase electricity for selected years.

For the period from 2025 to 2050 and all Base Cases accumulated, the relative savings of electricity are 20.13 %. These relative savings equal effective savings of 160.26 TWh, representing significant saving opportunities. Zooming in on the year 2050 alone, use-phase electricity savings accumulate to 10.98 TWh, representing a reduction of 30 % compared to the BAU scenario for the same year.

As informed above, stakeholder feedback pointed out that this theoretical maximum improvement potential might be overestimated as a certain share of machines on the market has already implemented the proposed Design Options which is not yet considered in the current calculations due to a lack of market data.

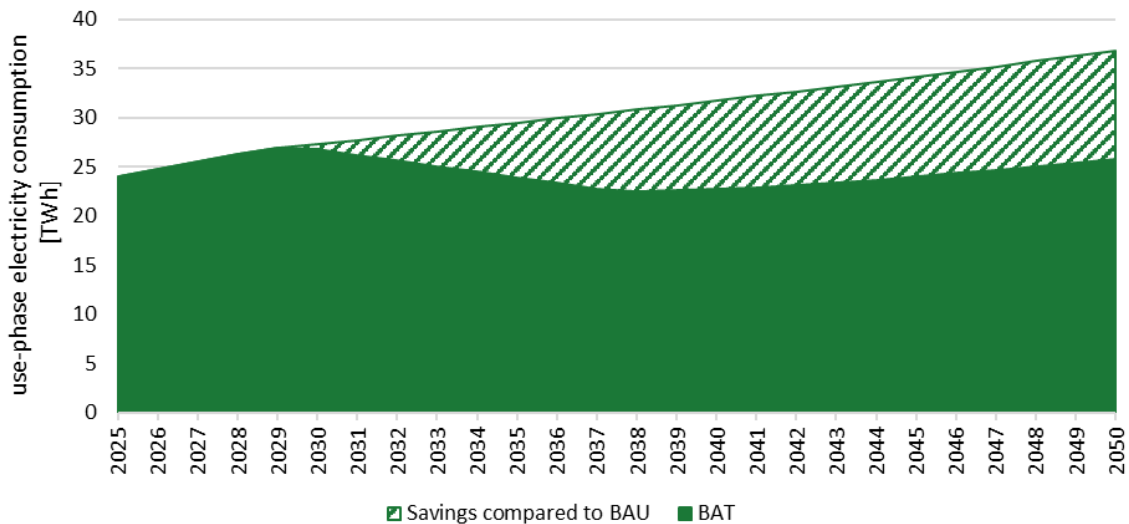


Figure 9-7: Electricity consumption of the BAT scenario and savings compared to the BAU scenario.

7173

7174

Table 9-27: Use-phase electricity and gas consumption of the BAU and the BAT scenario (the BAT scenario includes BAU products while they are phased out from the stock).

<i>all in GWh</i>		2025		2030		2035		2040		2045		2050	
		electricity	gas	electricity	gas	electricity	gas	electricity	gas	electricity	gas	electricity	gas
BC1	BAU	149	0	176	0	192	0	207	0	223	0	240	0
	BAT	149 (+0 %)	0 (+0 %)	175 (-1 %)	0 (+0 %)	178 (-7 %)	0 (+0 %)	179 (-13 %)	0 (+0 %)	189 (-15 %)	0 (+0 %)	204 (-15 %)	0 (+0 %)
BC2	BAU	9,431	121	10,479	134	11,231	144	12,099	155	13,034	167	14,041	180
	BAT	9,431 (+0 %)	121 (+0 %)	10,256 (-2 %)	134 (-0 %)	8,865 (-21 %)	144 (+0 %)	8,486 (-30 %)	155 (+0 %)	9,142 (-30 %)	167 (+0 %)	9,849 (-30 %)	180 (+0 %)
BC3	BAU	7,030	149	7,812	166	8,372	178	9,019	191	9,716	206	10,467	222
	BAT	7,030 (+0 %)	149 (+0 %)	7,645 (-2 %)	166 (-0 %)	6,603 (-21 %)	178 (-0 %)	6,317 (-30 %)	191 (+0 %)	6,805 (-30 %)	206 (-0 %)	7,331 (-30 %)	222 (+0 %)
BC4	BAU	1,377	131	1,546	147	1,645	156	1,772	168	1,909	181	2,057	195
	BAT	1,377 (+0 %)	131 (+0 %)	1,516 (-2 %)	146 (-0 %)	1,333 (-19 %)	150 (-4 %)	1,241 (-30 %)	158 (-6 %)	1,337 (-30 %)	170 (-6 %)	1,440 (-30 %)	183 (-6 %)
BC5	BAU	2,544	354	2,951	410	3,173	441	3,419	475	3,683	512	3,967	551
	BAT	2,544 (+0 %)	354 (+0 %)	2,904 (-2 %)	405 (-1 %)	2,674 (-16 %)	388 (-12 %)	2,432 (-29 %)	371 (-22 %)	2,578 (-30 %)	395 (-23 %)	2,777 (-30 %)	425 (-23 %)
BC6	BAU	3,522	698	4,345	861	4,851	961	5,194	1,030	5,596	1,109	6,028	1,195
	BAT	3,522 (+0 %)	698 (+0 %)	4,291 (-1 %)	852 (-1 %)	4,278 (-12 %)	865 (-10 %)	4,063 (-22 %)	839 (-18 %)	3,917 (-30 %)	827 (-25 %)	4,220 (-30 %)	891 (-25 %)

7175

Connected to the energy savings are reductions of greenhouse gases, shown in **Figure 9-8** for all Base Cases from 2025 to 2050 for use-phase electricity. The carbon intensity is calculated with dynamic emission factors, representing a scenario with ongoing decarbonisation of the electricity mix. Despite the growing electricity demand due to the growing stock, the decarbonisation of the electricity mix leads to a reduction in emissions, in both the BAU and BAT scenario. In the BAT scenario, due to more efficient devices, additional savings are achieved, accumulating to 16.12 Mt CO_{2eq.}, representing savings of 12.5 % compared to the BAU scenario in the period 2025 to 2050.

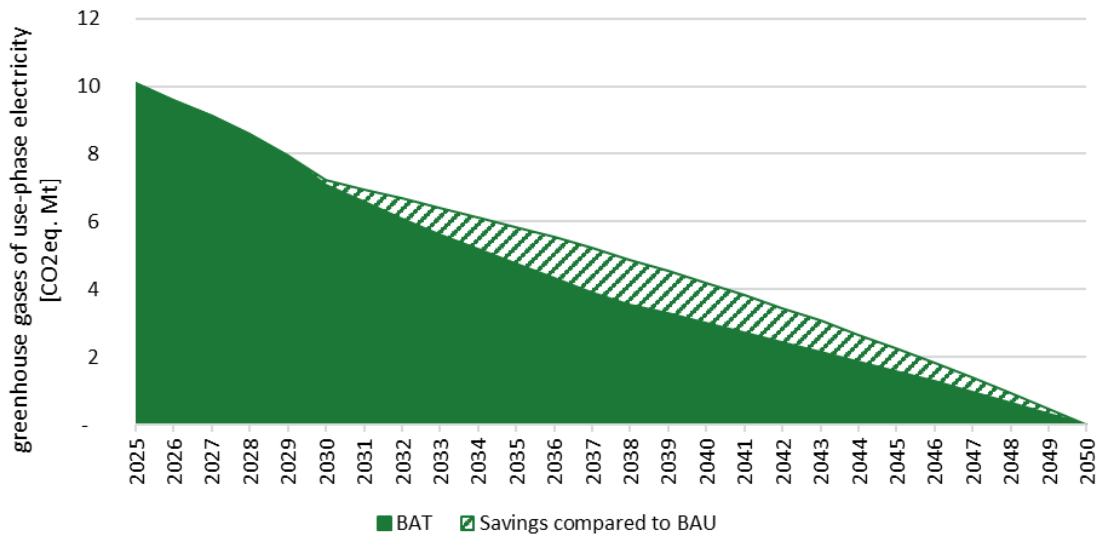


Figure 9-8: Greenhouse gases associated to use-phase electricity consumption of the BAT scenario and savings compared to the BAU scenario.

Table 9-28 lists the numerical values for selected years for the greenhouse gas emissions associated with the use-phase electricity and gas consumption. As can be seen from the data, also the savings due to the reduction in gas consumption will lead to significant savings. In 2050, the reduced gas consumption in the BAT scenario saves 0.10 Mt CO_{2eq.} compared to the BAU scenario.

7190 **Table 9-28 Greenhouse gases associated to use-phase electricity and gas consumption of the BAU and the BAT scenario (the BAT scenario includes BAU**
 7191 **products while they are phased out from the stock).**

<i>all in kt CO₂_{eq.}</i>		2025		2030		2035		2040		2045		2050	
		electricity	gas	electricity	gas	electricity	gas	electricity	gas	electricity	gas	electricity	gas
BC1	BAU	62	0	47	0	38	0	27	0	15	0	0	0
	BAT	62 (+0%)	0 (+0%)	46 (-1%)	0 (+0%)	35 (-7%)	0 (+0%)	24 (-13%)	0 (+0%)	13 (-15%)	0 (+0%)	0 (-15%)	0 (+0%)
BC2	BAU	3,950	28	2,772	31	2,228	34	1,600	36	862	39	0	42
	BAT	3,950 (+0%)	28 (+0%)	2,713 (-2%)	31 (-0%)	1,759 (-21%)	34 (+0%)	1,123 (-30%)	36 (+0%)	605 (-30%)	39 (+0%)	0 (-30%)	42 (+0%)
BC3	BAU	2,945	35	2,067	39	1,661	42	1,193	45	643	48	0	52
	BAT	2,945 (+0%)	35 (+0%)	2,023 (-2%)	39 (-0%)	1,310 (-21%)	42 (-0%)	836 (-30%)	45 (+0%)	450 (-30%)	48 (-0%)	0 (-30%)	52 (+0%)
BC4	BAU	577	31	409	34	326	36	234	39	126	42	0	46
	BAT	577 (+0%)	31 (+0%)	401 (-2%)	34 (-0%)	265 (-19%)	35 (-4%)	164 (-30%)	37 (-6%)	88 (-30%)	40 (-6%)	0 (-30%)	43 (-6%)
BC5	BAU	1,066	83	781	96	630	103	452	111	244	120	0	129
	BAT	1,066 (+0%)	83 (+0%)	768 (-2%)	95 (-1%)	531 (-16%)	91 (-12%)	322 (-29%)	87 (-22%)	171 (-30%)	92 (-23%)	0 (-30%)	100 (-23%)
BC6	BAU	1,475	163	1,150	201	962	225	687	241	370	259	0	279
	BAT	1,475 (+0%)	163 (+0%)	1,135 (-1%)	199 (-1%)	849 (-12%)	202 (-10%)	537 (-22%)	196 (-18%)	259 (-30%)	193 (-25%)	0 (-30%)	208 (-25%)

7192 BC 1: As informed above, stakeholder feedback pointed out that this improvement potential might be overestimated as a certain share of machines on the market has already implemented
 7193 the proposed Design Options which is not yet considered in the current calculations due to a lack of market data. Especially in BC1, the only applicable Design Option DO4 (double-wall
 7194 insulation) has already a rather high market share according to stakeholder feedback.

7195

7196 **Water, detergent and rinsing agent consumption**

7197 The BAT technologies also have an impact on water, detergent and rinsing agent consumption. This can be seen in **Table 9-29**, which lists the numerical values
 7198 for selected years for the use-phase water, detergent and rinsing agent consumption. Savings in 2050 account to 35.78 million m³ water, 101.17 kt detergent
 7199 and 8.11 kt rinsing agent.

7200 **Table 9-29 Use-phase water, detergent and rinsing agent consumption of the BAU and the BAT scenario.**

water in million m ³ detergent and rinsing agent in kt		water	detergent	rinsing agent	water	detergent	rinsing agent	water	detergent	rinsing agent	water	detergent	rinsing agent	water	detergent	rinsing agent	water	detergent	rinsing agent
BC1	BAU	4	3	0	4	3	0	5	3	0	5	4	0	6	4	0	6	4	0
	BAT	4 (+0%)	3 (+0%)	0 (+0%)	4 (-0%)	3 (-0%)	0 (+0%)	5 (+0%)	3 (+0%)	0 (+0%)	5 (+0%)	4 (+0%)	0 (+0%)	6 (+0%)	4 (+0%)	0 (+0%)	6 (+0%)	4 (+0%)	0 (+0%)
BC2	BAU	221	248	21	246	275	23	263	295	25	283	318	27	305	342	29	329	369	31
	BAT	221 (+0%)	248 (+0%)	21 (+0%)	245 (-0%)	273 (-1%)	23 (-1%)	254 (-3%)	270 (-8%)	23 (-8%)	270 (-5%)	280 (-12%)	24 (-12%)	291 (-5%)	301 (-12%)	26 (-12%)	314 (-5%)	325 (-12%)	28 (-12%)
BC3	BAU	78	158	12	86	175	14	92	188	14	99	202	16	107	218	17	115	235	18
	BAT	78 (+0%)	158 (+0%)	12 (+0%)	86 (-1%)	174 (-1%)	13 (-1%)	87 (-6%)	172 (-8%)	13 (-8%)	91 (-9%)	178 (-12%)	14 (-12%)	98 (-9%)	192 (-12%)	15 (-12%)	106 (-9%)	207 (-12%)	16 (-12%)
BC4	BAU	14	38	2	15	42	2	16	45	2	17	48	3	19	52	3	20	56	3
	BAT	14 (+0%)	38 (+0%)	2 (+0%)	15 (-1%)	42 (-1%)	2 (-1%)	15 (-8%)	41 (-8%)	2 (-8%)	15 (-12%)	43 (-12%)	2 (-12%)	17 (-12%)	46 (-12%)	2 (-12%)	18 (-12%)	49 (-12%)	3 (-12%)
BC5	BAU	22	52	4	25	61	5	27	65	5	29	70	6	31	76	6	34	82	7
	BAT	22 (+0%)	52 (+0%)	4 (+0%)	25 (-1%)	60 (-1%)	5 (-1%)	25 (-6%)	61 (-6%)	5 (-6%)	26 (-11%)	62 (-12%)	5 (-12%)	28 (-11%)	67 (-12%)	6 (-12%)	30 (-11%)	72 (-12%)	6 (-12%)
BC5	BAU	25	57	5	30	70	6	34	79	6	36	84	7	39	91	7	42	98	8
	BAT	25 (+0%)	57 (+0%)	5 (+0%)	30 (-0%)	70 (-1%)	6 (-1%)	33 (-4%)	75 (-5%)	6 (-5%)	34 (-8%)	76 (-9%)	6 (-9%)	35 (-10%)	79 (-13%)	6 (-12%)	38 (-10%)	85 (-13%)	7 (-12%)
BC6	BAU	4	3	0	4	3	0	5	3	0	5	4	0	6	4	0	6	4	0
	BAT	4 (+0%)	3 (+0%)	0 (+0%)	4 (-0%)	3 (-0%)	0 (+0%)	5 (+0%)	3 (+0%)	0 (+0%)	5 (+0%)	4 (+0%)	0 (+0%)	6 (+0%)	4 (+0%)	0 (+0%)	6 (+0%)	4 (+0%)	0 (+0%)

7201

9.3.5. Results: Socio-economic impact analysis

The calculated costs are considering the commodity-specific escalation or inflation rate, as well as the dynamic scenario-based development of the electricity price (see **Section 9.3.1**).

Figure 9-9 shows the costs of the electricity consumption. As could be expected, with the growth of the stock also electricity costs are rising. However, the introduction of BAT reduces energy consumption and thereby costs compared to the BAU scenario. Cost savings of use-phase electricity sum up to 57.84 billion Euro for the period 2025 to 2050, representing a reduction by 22 %.

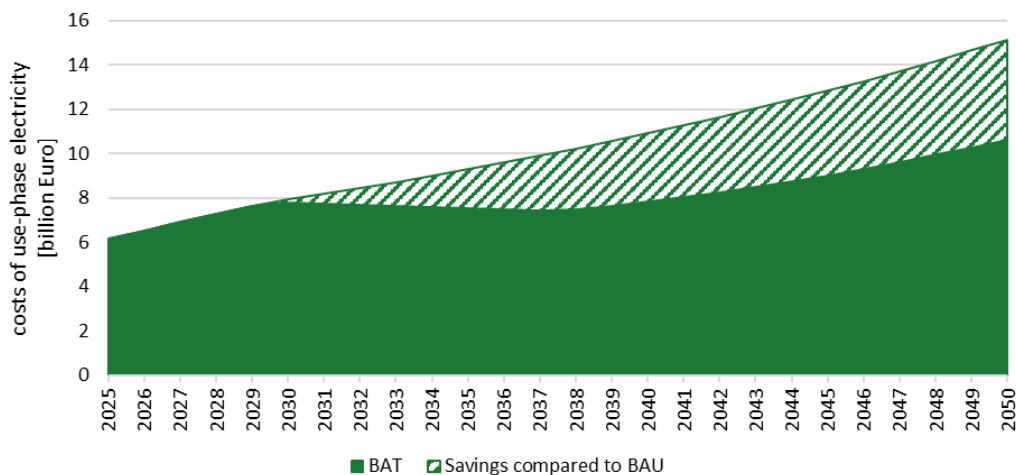


Figure 9-9 costs of use-phase electricity consumption of the BAT scenario and savings compared to the BAU scenario.

Table 9-30 provides an overview of all costs included in the scenario analysis for selected years. The table includes the additional investment cost for the industry due to purchase (product price and installation/acquisition cost) and repair. Furthermore, costs for the use-phase consumption of electricity, natural gas, water, detergents and rinsing agent are listed.

Some data points warrant clarification. While prices for use-phase electricity, gas consumption, water, detergent and rinsing agent are decreasing due to the more efficient products, purchase costs and repair of the BAT products are significantly increased for most Base Cases (see Task 6), which drive the overall prices to increase when sales of BAT start from year 2030 onward. But, as also indicated on individual product level in the previous tasks, additional costs for the purchase of more efficient products are over time offset by use-phase savings. While in 2030 and 2035, total cost increases due to pricier sales, the overall use-phase savings for the users outweigh additional costs in the years after this.

For example, in year 2050, overall savings of the BAT compared to the BAU scenario are 1.33 billion Euro, or 5 %. The highest contribution comes from the savings associated to reduction of electricity consumption with 4.52 billion Euro, followed by the reduction of the consumption of detergent (0.58 billion Euro) water (0.07 billion Euro), gas (0.06 billion Euro) and rinsing agent (0.04 billion Euro). These cost savings are higher than the additional investments for new sales (2.71 billion Euro) and repair (1.23 billion Euro).

7230 **Table 9-30 Overview of costs of the BAU and the BAT scenario for selected years.**

all in million Euro		2025										2030										2035										2040										2045										2050									
		purchase costs		repair costs		electricity costs		natural gas costs		water costs		detergent costs		Rinsing agent costs		total	purchase costs		repair costs		electricity costs		natural gas costs		water costs		detergent costs		Rinsing agent costs		total	purchase costs		repair costs		electricity costs		natural gas costs		water costs		detergent costs		Rinsing agent costs		total	purchase costs		repair costs		electricity costs		natural gas costs		water costs		detergent costs		Rinsing agent costs		total
BC1	BAU	27	12	38	0	7	11	0	95	32	14	51	0	8	14	0	119	38	17	61	0	9	16	0	140	45	20	71	0	10	18	0	164	54	24	84	0	11	21	0	192	64	28	99	0	12	24	0	226												
	BAT	27 (-0%)	12 (-0%)	38 (+0%)	0 (+0%)	7 (+0%)	11 (+0%)	0 (+0%)	95 (-0%)	32 (-0%)	14 (-0%)	51 (-0%)	0 (+0%)	8 (-0%)	14 (-0%)	0 (+0%)	119 (-0%)	38 (+0%)	17 (+0%)	56 (-7%)	0 (+0%)	9 (+0%)	16 (+0%)	0 (+0%)	136 (-3%)	45 (+0%)	20 (+0%)	62 (-13%)	0 (+0%)	10 (+0%)	18 (+0%)	0 (+0%)	155 (-6%)	54 (+0%)	24 (+0%)	71 (-15%)	0 (+0%)	11 (+0%)	21 (+0%)	0 (+0%)	180 (-7%)	64 (+0%)	28 (+0%)	84 (-15%)	0 (+0%)	12 (+0%)	24 (+0%)	0 (+0%)	211 (-7%)												
BC2	BAU	1,042	459	2,424	10	422	1,046	83	5,485	1,240	545	3,047	12	473	1,234	98	6,649	1,474	649	3,543	15	511	1,404	112	7,708	1,754	772	4,170	18	555	1,607	128	9,001	2,086	918	4,898	21	602	1,838	146	10,509	2,481	1,091	5,780	25	654	2,103	167	12,300												
	BAT	1,042 (-0%)	459 (-0%)	2,424 (+0%)	10 (+0%)	422 (+0%)	1,046 (+0%)	83 (+0%)	5,485 (-0%)	1,932 (+56%)	873 (+60%)	2,982 (-2%)	12 (-0%)	471 (-0%)	1,223 (-1%)	97 (-1%)	7,590 (+14%)	2,297 (+57%)	1,038 (+60%)	2,797 (-21%)	15 (+0%)	494 (-3%)	1,286 (-8%)	102 (-8%)	8,028 (+4%)	2,732 (+56%)	1,234 (+60%)	2,925 (-30%)	18 (+0%)	529 (-5%)	1,414 (-12%)	112 (-12%)	8,964 (-0%)	3,250 (+56%)	1,468 (+60%)	3,435 (-30%)	21 (+0%)	574 (-5%)	1,618 (-12%)	128 (-12%)	10,495 (-0%)	3,866 (+56%)	1,746 (+60%)	4,054 (-30%)	25 (+0%)	623 (-5%)	1,851 (-12%)	147 (-12%)	12,310 (+0%)												
BC3	BAU	589	259	1,807	12	148	665	48	3,528	701	308	2,271	15	166	785	56	4,303	833	367	2,641	18	179	894	64	4,996	991	436	3,108	22	195	1,022	73	5,848	1,179	519	3,651	26	211	1,170	84	6,839	1,402	617	4,309	31	229	1,338	96	8,023												
	BAT	589 (+0%)	259 (+0%)	1,807 (+0%)	12 (+0%)	148 (+0%)	665 (+0%)	48 (+0%)	3,528 (+0%)	1,115 (+59%)	493 (+60%)	2,223 (-2%)	15 (-0%)	165 (-1%)	778 (-1%)	56 (-1%)	4,845 (+13%)	1,326 (+59%)	587 (+60%)	2,083 (-21%)	18 (-0%)	168 (-6%)	818 (-8%)	59 (-8%)	5,059 (+1%)	1,578 (+59%)	698 (+60%)	2,177 (-30%)	22 (+0%)	178 (-9%)	900 (-12%)	65 (-12%)	5,616 (-4%)	1,876 (+59%)	830 (+60%)	2,557 (-30%)	26 (-0%)	193 (-9%)	1,029 (-12%)	74 (-12%)	6,586 (-4%)	2,232 (+59%)	987 (+60%)	3,018 (-30%)	31 (+0%)	210 (-9%)	1,177 (-12%)	85 (-12%)	7,740 (-4%)												
BC4	BAU	154	68	354	11	26	158	8	778	183	80	449	13	29	189	9	954	218	96	519	16	31	213	10	1,103	259	114	611	19	34	244	12	1,293	308	135	717	23	37	279	14	1,514	366	161	847	27	40	320	16	1,777												
	BAT	154 (-0%)	68 (+0%)	354 (+0%)	11 (+0%)	26 (+0%)	158 (+0%)	8 (+0%)	778 (-0%)	288 (+57%)	129 (+60%)	441 (-2%)	13 (-0%)	29 (-1%)	187 (-1%)	9 (-1%)	1,097 (+15%)	343 (+57%)	153 (+60%)	421 (-19%)	15 (-4%)	29 (-8%)	197 (-8%)	10 (-8%)	1,168 (+6%)	208 (+57%)	182 (+60%)	428 (-30%)	18 (+0%)	30	215 (-12%)	11 (-12%)	1,291 (-0%)	485 (+57%)	217 (+60%)	502 (-30%)	22 (-6%)	33 (-12%)	246 (-12%)	12 (-12%)	1,516 (+0%)	577 (-57%)	258 (+60%)	593 (-30%)	26 (-6%)	35 (-12%)	281 (-12%)	14 (-12%)	1,783 (+0%)												
BC5	BAU	76	33	654	29	41	221	17	1,072	90	40	858	38	48	272	21	1,368	107	47	1,001	45	52	311	24	1,588	128	56	1,178	54	57	356	28	1,857	152	67	1,384	65	62	407	32	2,168	181	79	1,633	78	67	466	36	2,540												
	BAT	76 (-0%)	33 (-0%)	654 (+0%)	29 (+0%)	41 (+0%)	221 (+0%)	17 (+0%)	1,072 (-0%)	169 (+87%)	70 (+75%)	844 (-2%)	37 (-1%)	48 (-1%)	271 (-1%)	21 (-1%)	1,459 (+7%)	200 (+87%)	83 (+75%)	844 (-12%)	40 (-6%)	49 (-6%)	291 (-6%)	23 (-6%)	1,530 (+8%)	228 (+87%)	98 (+75%)	838 (-29%)	42 (-22%)	51 (-11%)	315 (-12%)	25 (-12%)	1,607 (+87%)	284 (+117%)	969 (+73%)	50 (-23%)	55 (-11%)	358 (-12%)	28 (-12%)	1,860 (+14%)	337 (+87%)	139 (+75%)	1,143 (-30%)	60 (-23%)	60 (-11%)	410 (-12%)	32 (-12%)	2,181 (-14%)													
BC6	BAU	65	29	905	58	47	241	18	1,362	77	34	1,263	79	59	315	23	1,851	92	40	1,560	98	66	374	28	2,228	109	48	1,790	117	71	425	32	2,592	130	57	2,103	141	77	486	36	3,030	154	68	2,482	168	84	556	41	3,555												
	BAT	65 (+0%)	29 (+0%)	905 (+0%)	58 (+0%)	47 (+0%)	241 (+0%)	18 (+0%)	1,362 (+0%)	141 (+83%)	59 (+75%)	1,263 (-1%)	78 (-1%)	58 (-0%)	314 (-1%)	23 (-1%)	1,922 (+4%)	168 (+83%)	71 (+75%)	1,350 (-12%)	89 (-10%)	63 (-4%)	355 (-5%)	26 (-5%)	2,122 (+5%)	200 (+83%)	84 (+75%)	1,400 (-22%)	116 (-18%)	66 (-8%)	387 (-9%)	29 (-9%)	2,261 (+13%)	238 (+83%)	100 (+75%)	1,472 (-30%)	105 (-25%)	69 (-10%)	426 (-13%)	32 (-12%)	2,441 (+19%)	283 (+83%)	119 (+75%)	1,737 (-30%)	126 (-25%)	75 (-10%)	487 (-13%)	36 (-12%)	2,862 (+19%)												
total	BAU	1,952	859	6,182	120	691	2,342	174	12,321	2,322	1,022	7,940	158	783	2,809	208	15,243	2,762	1,215	9,295	193	849	3,212	238	17,764	3,285	1,445	10,928	230	921	3,672	273	20,755	3,907	1,719	12,836	276	1,000	4,201	312	24,252	4,648	2,045	15,150	330	1,086	4,807	357	28,420												
	BAT	1,952 (-0%)	859 (-0%)	6,182 (+0%)	120 (+0%)	691 (+0%)	2,342 (+0%)	174 (+0%)	12,321 (+58%)	3,676 (+58%)	1,637 (+60%)	7,789 (-2%)	157 (-1%)	780 (-0%)	2,787 (-1%)	207 (+12%)	17,033 (+4%)	2,733 (+58%)	1,948 (+60%)	7,550 (-19%)	177 (-8%)	813 (-8%)	2,963 (-8%)	220 (-8%)	18,043 (+2%)	5,201 (+58%)	2,316 (+60%)	7,829 (-28%)	195 (-15%)	863 (-6%)	3,248 (-4%)	241 (-12%)	19,894 (-4%)	4,183 (+58%)	2,755 (+60%)	9,006 (-30%)	124 (-7%)	935 (-7%)	3,697 (-12%)	274 (-12%)	23,077 (-5%)	7,358 (+58%)	3,277 (+60%)	10,629 (-30%)	268 (-19%)	1,015 (-7%)	4,230 (-12%)	314 (-12%)	27,090 (-4%)												

7231

7232 In the scenario analysis, it was not possible to examine employment effects due to a lack of necessary data.

9.3.6. Sensitivity analysis

Inputs and necessary assumptions

The aim of the sensitivity analysis is to analyse the sensitivity of the results when changing input parameters. Here the sensitivity of the electricity price will be investigated, as the input with the highest impact on overall cost savings based on the scenario results. The analysis should provide a better understanding of the robustness of the results and possible uncertainties in the underlying data assumptions.

For the sensitivity analysis the assumptions for the electricity price for the initial analysis (see **Section 9.3.1**) is defined as the medium scenario. Based on this, a low and high scenario are defined with a 20 % increase and a 20 % decrease (see **Table 9-31**). Values for the increase and decrease are linearly introduced from the original value in 2025 to 2030 and are then kept constant.

Table 9-31: Variations in the electricity price considered for the sensitivity analysis.

<i>Euro / kWh</i>	2025	2030	2035	2040	2045	2050
Low	0.234	0.195	0.196	0.198	0.198	0.201
Medium	0.234	0.244	0.245	0.247	0.248	0.251
High	0.234	0.293	0.294	0.296	0.298	0.301

Results

Results are shown in **Figure 9-10**, for the BAT scenario. As can be seen, significant changes to total electricity costs are induced by the changes in electricity prices. In 2050 costs range from 8.50 billion Euro in the low-price scenario to 12.76 billion Euro in the high price scenario.

Even in the low-price scenario, electricity costs remain the most important cost factor. In 2050, 8.50 billion Euro for electricity stand against 7.36 billion Euro purchase costs for new sales and costs of 4.23 billion Euro for detergents, 3.28 billion Euro for repair, 1.02 billion Euro for water, 0.31 for rinsing agent and 0.27 for natural gas.

Total accumulated electricity costs for the period from 2015 to 2050 range from 172.60 billion Euro for the low-price scenario to 248.91 billion Euro for the high-price scenario.

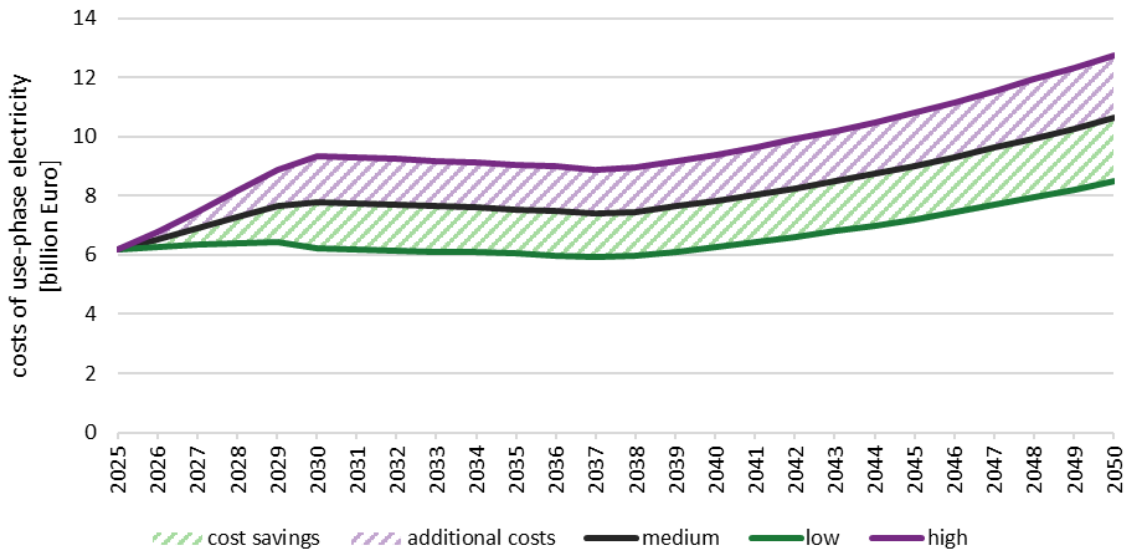


Figure 9-10: sensitivity of use-phase electricity consumption of the BAT scenario.

9.3.7. Overview of results

Table 9-32, Table 9-33, and Table 9-34 present an overview of results for the years 2025, 2035 and 2050. It includes energy consumption (electricity and gas), greenhouse gas emissions (attributed to electricity and gas consumption), consumption of auxiliary materials (water, detergent, rinsing agent) as well as costs for purchase, repair, as well as those for energy and auxiliary material consumption.

The introduction of the BAT products starts in 2030, leading to significant electricity savings of 20.13 % or 160.26 TWh until 2050. In 2050, savings are 10.98 TWh for electricity and 0.44 TWh for gas. Greenhouse gas emissions associated to electricity consumption in the use-phase are reduced by 16.12 Mt CO₂eq., representing savings of 12.5 % compared to the BAU scenario in the period 2025 to 2050. In 2050, greenhouse gas emissions are reduced by 0.10 Mt CO₂eq. for gas. Also, auxiliary materials show significant reduction potential. In 2050, the analysis yields savings of 35.78 million m³ water (7 %), 101.17 kt detergent and 8.11 kt rinsing agent (both 12 %). As informed above, stakeholder feedback pointed out that this theoretical maximum achievable improvement potential might be overestimated as a certain share of machines on the market has already implemented the proposed Design Options which is not yet considered in the current calculations due to a lack of market data.

Based on the stated assumptions, the BAT scenario leads to total electricity savings of 57.84 billion Euro for the period 2025 to 2050, representing a reduction by 22 %. Sensitivity shows that the electricity price fluctuations significantly impact the total costs, with the total accumulated electricity costs for the period from 2015 to 2050 ranging from 172.60 billion Euro for the low-price scenario to 248.91 billion Euro for the high-price scenario. The sensitivity also shows, that, even in the low-price scenario, electricity costs remain the most important cost factor. In 2050, 8.50 billion Euro for electricity stand against 7.36 billion Euro purchase costs for new sales and costs of 4.23 billion Euro for detergents, 3.28 billion Euro for repair, 1.02 billion Euro for water, 0.31 for rinsing agent and 0.27 for natural gas. Overall, transitioning to BAT products supports both environmental sustainability and economic benefits.

7284 **Table 9-32: Overview of results for 2025.**

		2025													
		energy consumption (GWh)		emissions (kt CO ₂)		auxiliary materials			costs (million Euro)						
		electricity	gas	electricity	gas	water (million m ³)	detergent (kt)	rinsing agent (kt)	Purchase costs	repair costs	electricity costs	natural gas costs	water costs	detergent costs	Rinsing agent
BC1	BAU	149	0	62	0	4	3	0	27	12	38	0	7	11	0
	BAT	149 (+0 %)	0 (+0 %)	62 (+0 %)	0 (+0 %)	4 (+0 %)	3 (+0 %)	0 (+0 %)	27 (-0 %)	12 (-0 %)	38 (+0 %)	0 (+0 %)	7 (+0 %)	11 (+0 %)	0 (+0 %)
BC2	BAU	9,431	121	3,950	28	221	248	21	1,042	459	2,424	10	422	1,046	83
	BAT	9,431 (+0 %)	121 (+0 %)	3,950 (+0 %)	28 (+0 %)	221 (+0 %)	248 (+0 %)	21 (+0 %)	1,042 (-0 %)	459 (-0 %)	2,424 (+0 %)	10 (+0 %)	422 (+0 %)	1,046 (+0 %)	83 (+0 %)
BC3	BAU	7,030	149	2,945	35	78	158	12	589	259	1,807	12	148	665	48
	BAT	7,030 (+0 %)	149 (+0 %)	2,945 (+0 %)	35 (+0 %)	78 (+0 %)	158 (+0 %)	12 (+0 %)	589 (+0 %)	259 (+0 %)	1,807 (+0 %)	12 (+0 %)	148 (+0 %)	665 (+0 %)	48 (+0 %)
BC4	BAU	1,377	131	577	31	14	38	2	154	68	354	11	26	158	8
	BAT	1,377 (+0 %)	131 (+0 %)	577 (+0 %)	31 (+0 %)	14 (+0 %)	38 (+0 %)	2 (+0 %)	154 (+0 %)	68 (+0 %)	354 (+0 %)	11 (+0 %)	26 (+0 %)	158 (+0 %)	8 (+0 %)
BC5	BAU	2,544	354	1,066	83	22	52	4	76	33	654	29	41	221	17
	BAT	2,544 (+0 %)	354 (+0 %)	1,066 (+0 %)	83 (+0 %)	22 (+0 %)	52 (+0 %)	4 (+0 %)	76 (-0 %)	33 (-0 %)	654 (+0 %)	29 (+0 %)	41 (+0 %)	221 (+0 %)	17 (+0 %)
BC6	BAU	3,522	698	1,475	163	25	57	5	65	29	905	58	47	241	18
	BAT	3,522 (+0 %)	698 (+0 %)	1,475 (+0 %)	163 (+0 %)	25 (+0 %)	57 (+0 %)	5 (+0 %)	65 (+0 %)	29 (+0 %)	905 (+0 %)	58 (+0 %)	47 (+0 %)	241 (+0 %)	18 (+0 %)
total	BAU	24,053	1,452	10,076	340	362	555	44	1,952	859	6,182	120	691	2,342	174
	BAT	24,053 (+0 %)	1,452 (+0 %)	10,076 (+0 %)	340 (+0 %)	362 (+0 %)	555 (+0 %)	44 (+0 %)	1,952 (-0 %)	859 (-0 %)	6,182 (+0 %)	120 (+0 %)	691 (+0 %)	2,342 (+0 %)	174 (+0 %)

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Table 9-33 Overview of results for 2035

		2035													
		energy consumption (GWh)		emissions (kt CO ₂)		auxiliary materials			costs (million Euro)						
		electricity	gas	electricity	gas	water (million m ³)	detergent (kt)	rinsing agent (kt)	Purchase costs	repair costs	electricity costs	natural gas costs	water costs	detergent costs	Rinsing agent
BC1	BAU	192	0	38	0	5	3	0	38	17	61	0	9	16	0
	BAT	178 (-7 %)	0 (+0 %)	35 (-7 %)	0 (+0 %)	5 (+0 %)	3 (+0 %)	0 (+0 %)	38 (+0 %)	17 (+0 %)	56 (-7 %)	0 (+0 %)	9 (+0 %)	16 (+0 %)	0 (+0 %)
BC2	BAU	11,231	144	2,228	34	263	295	25	1,474	649	3,543	15	511	1,404	112
	BAT	8,865 (-21 %)	144 (+0 %)	1,759 (-21%)	34 (+0 %)	254 (-3 %)	270 (-8 %)	23 (-8 %)	2,297 (+56 %)	1,03 8 (+60%)	2,797 (-21 %)	15 (+0 %)	494 (-3 %)	1,286 (-8 %)	102 (-8 %)
BC3	BAU	8,372	178	1,661	42	92	188	14	833	367	2,641	18	179	894	64
	BAT	6,603 (-21 %)	178 (-0 %)	1,310 (-21%)	42 (-0 %)	87 (-6 %)	172 (-8 %)	13 (-8 %)	1,326 (+59 %)	587 (+60 %)	2,083 (-21 %)	18 (-0 %)	168 (-6 %)	818 (-8 %)	59 (-8 %)
BC4	BAU	1,645	156	326	36	16	45	2	218	96	519	16	31	213	10
	BAT	1,333 (-19 %)	150 (-4 %)	265 (-19%)	35 (-4 %)	15 (-8 %)	41 (-8 %)	2 (-8 %)	343 (+57 %)	153 (+60 %)	421 (-19 %)	15 (-4 %)	29 (-8 %)	197 (-8 %)	10 (-8 %)
BC5	BAU	3,173	441	630	103	27	65	5	107	47	1,001	45	52	311	24
	BAT	2,674 (-16 %)	388 (-12 %)	531 (-16%)	91 (-12 %)	25 (-6 %)	61 (-6 %)	5 (-6 %)	200 (+87 %)	83 (+75 %)	844 (-16 %)	40 (-12 %)	49 (-6 %)	291 (-6 %)	23 (-6 %)
BC6	BAU	4,851	961	962	225	34	79	6	92	40	1,530	98	66	374	28
	BAT	4,278 (-12 %)	865 (-10 %)	849 (-12%)	202 (-10 %)	33 (-4%)	75 (-5 %)	6 (-5 %)	168 (+83 %)	71 (+75 %)	1,350 (-12 %)	89 (-10 %)	63 (-4 %)	355 (-5 %)	26 (-5 %)
total	BAU	29,464	1,880	5,846	440	437	675	54	2,762	1,215	9,295	193	849	3,212	238
	BAT	23,931 (-19 %)	1,725 (-8 %)	4,748 (-19 %)	403 (-8 %)	419 (-4 %)	623 (-8 %)	50 (-8 %)	4,373 (+58 %)	1,948 (+60 %)	7,550 (-19 %)	177 (-8 %)	813 (-4 %)	2,963 (-8 %)	220 (-8 %)

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Table 9-34 Overview of results for 2050

		2050													
		energy consumption (GWh)		emissions (kt CO ₂)		auxiliary materials			costs (million Euro)						
		electricity	gas	electricity	gas	water (million m ³)	detergent (kt)	rinsing agent (kt)	Purchase costs	repair costs	electricity costs	natural gas costs	water costs	detergent costs	Rinsing agent
BC1	BAU	240	0	0	0	6	4	0	64	28	99	0	12	24	0
	BAT	204 (-15 %)	0 (+0 %)	0 (-15 %)	0 (+0 %)	6 (+0 %)	4 (+0 %)	0 (+0 %)	64 (+0 %)	28 (+0 %)	84 (-15 %)	0 (+0 %)	12 (+0 %)	24 (+0 %)	0 (+0 %)
BC2	BAU	14,041	180	0	42	329	369	31	2,481	1,091	5,780	25	654	2,103	167
	BAT	9,849 (-30 %)	180 (+0 %)	0 (-30 %)	42 (+0 %)	314 (-5 %)	325 (-12 %)	28 (-12 %)	3,866 (+56 %)	1,746 (+60 %)	4,054 (-30 %)	25 (+0 %)	623 (-5 %)	1,851 (-12 %)	147 (-12 %)
BC3	BAU	10,467	222	0	52	115	235	18	1,402	617	4,309	31	229	1,338	96
	BAT	7,331 (-30 %)	222 (+0 %)	0 (-30 %)	52 (+0 %)	106 (-9 %)	207 (-12 %)	16 (-12 %)	2,232 (+59 %)	987 (+60 %)	3,018 (-30 %)	31 (+0 %)	210 (-9 %)	1,177 (-12 %)	85 (-12 %)
BC4	BAU	2,057	195	0	46	20	56	3	366	161	847	27	40	320	16
	BAT	1,440 (-30 %)	183 (-6 %)	0 (-30 %)	43 (-6 %)	18 (-12 %)	49 (-12 %)	3 (-12 %)	577 (+57 %)	258 (+60 %)	593 (-30 %)	26 (-6 %)	35 (-12 %)	281 (-12 %)	14 (-12 %)
BC5	BAU	3,967	551	0	129	34	82	7	181	79	1,633	78	67	466	36
	BAT	2,777 (-30 %)	425 (-23 %)	0 (-30 %)	100 (-23 %)	30 (-11 %)	72 (-12 %)	6 (-12 %)	337 (+87 %)	139 (+75 %)	1,143 (-30 %)	60 (-23 %)	60 (-11 %)	410 (-12 %)	32 (-12 %)
BC6	BAU	6,028	1,195	0	279	42	98	8	154	68	2,482	168	84	556	41
	BAT	4,220 (-30 %)	891 (-25 %)	0 (-30 %)	208 (-25 %)	38 (-10 %)	85 (-13 %)	7 (-12 %)	283 (+83 %)	119 (+75 %)	1,737 (-30 %)	126 (-25 %)	75 (-10 %)	487 (-13 %)	36 (-12 %)
total	BAU	36,801	2,343	0	548	546	843	67	4,648	2,045	15,150	330	1,086	4,807	357
	BAT	25,821 (-30 %)	1,901 (-19 %)	0 (-30 %)	445 (-19 %)	511 (-7 %)	742 (-12 %)	59 (-12 %)	7,358 (+58 %)	3,277 (+60 %)	10,629 (-30 %)	268 (-19 %)	1,015 (-7 %)	4,230 (-12 %)	314 (-12 %)

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9.4. Conclusions

In the BAU scenario for 2025, the total sales reach 283,327 units. BC2 (Undercounter water-change dishwasher) and BC3 (Hood-type dishwashers) lead in sales, with significantly lower figures for other base cases. The total stock, which starts at 2,140,401 units in 2025, is projected to increase to 3,208,773 units by 2050. By then, BC2 and BC3 will comprise 86 % of the total stock.

The introduction of BAT products begins in 2030, replacing BAU sales. This scenario represents the technical saving potential, in which over time all products on the market are replaced by the BAT. The time for this transition depends on the respective lifetime of the BAU base cases. E.g. for BC1, in 2042 the stock is entirely comprised of BAT products.

The BAT scenario leads to significant energy savings of 20.13 % in electricity consumption from 2025 to 2050, equating to 160.26 TWh. In 2050, yearly savings are 10.98 TWh for electricity and 0.44 TWh for gas. Greenhouse gas emissions associated to electricity consumption in the use-phase are reduced by 16.12 Mt CO₂eq. from 2025 to 2050, a 12.5 % decrease compared to the BAU scenario. Auxiliary materials also see strong reductions. E.g., in year 2050, savings are 35.78 million m³ for water (7 %), 101.17 kt for detergent (12 %) and 8.11 kt for rinsing agent (12 %).

It has to be noted, however, that stakeholder feedback pointed out that this theoretical maximum achievable improvement potential might be overestimated as a certain share of machines on the market has already implemented the proposed Design Options which is not yet considered in the current calculations due to a lack of market data. Therefore, it is recommended that in the subsequent Impact Assessment study, manufacturers shall be asked for more detailed market data on the share of implemented Design Options to further refine the environmental impacts and improvement potential.

The BAT scenario leads to total savings of 57.84 billion Euro in electricity costs from 2025 to 2050. Sensitivity analysis shows that electricity price fluctuations significantly impact total costs, with yearly expenses in 2050 ranging from 8.50 billion Euro in the low-price scenario to 12.76 billion Euro in the high price scenario.

Similar to electricity costs for natural gas, water and detergent are significantly reduced, while purchase and repair costs are increased (due to higher prices of BAT products), but this is outweighed over time by the aforementioned savings.

Overall, transitioning to BAT products supports both environmental sustainability and economic benefits.

One of the main issues in fostering market transformation towards more sustainable products is the lack of information. As shown in Task 1, Member States have not implemented any mandatory instruments to regulate the market (see **Section 3.4.3**); only a few incentive programmes or voluntary information requirements are in place (see **Section 3.4.4**).

7327 In this context, a market regulation at the EU level would be beneficial. Since the use phase is
 7328 responsible for 87 % to 93 % of the environmental impact and for 62 % to 94% of the life cycle
 7329 costs,¹⁷¹ the focus of the ESPR requirements should be on:

- 7330 - **Information requirements** regarding energy and water consumption (for BC2 and BC3)
- 7331 - **Performance requirements:**
 - 7332 ○ **Minimum requirements** for specific energy and water consumption for BC2 and
 - 7333 BC3.
 - 7334 ○ **Non-quantitative requirements** for BC1, BC4, BC5 and BC6.

7335 Further aspects include provisions for spare parts availability and delivery, as well as information
 7336 requirements related to SoCs. As commercial dishwashers are a typical B2B product group, the
 7337 relevance of an EU Energy Label was discussed controversial, while Green Public Procurement
 7338 (GPP) is relevant. If no EU Energy Label would be applicable, to align with the ESPR regulation, a
 7339 DPP would be necessary.

7340 To elaborate a regulation based on performance requirements, several challenges must be
 7341 addressed:

- 7342 - **For BC2 and BC3:**
 - 7343 ○ **Validation (for BC2 and BC3) of the requirements for a declaration**
 - 7344 **programme.**
 - 7345 ○ **Collection of further market-representative data**, as only models from the
 - 7346 Swiss market are available and it would be desirable to have a more
 - 7347 representative sample of models for the EU market. Based on the analysis of
 - 7348 such data, the ESPR minimum requirements will be developed/finalised.
- 7349 - For BC4, BC5 and BC6: **‘Translation’ of the relevant Design Options in non-quantitative**
- 7350 **requirements** (if possible).

¹⁷¹ Depending on the BC considered, see 9.2.2

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11. Appendices

11.1. Appendix 1 – Online questionnaire of 1st stakeholder consultation

The definition mentioned in the introduction differs slightly from the definition of commercial dishwashers given in EN IEC 63136:2019 or ENERGY STAR. In this context, which definition do you consider to be the most appropriate for a possible future product regulation?	
Would the term "non-household" be a feasible way of unambiguously delimiting professional/commercial/industrial from household dishwashers which are covered by Commission Regulations (EU) 2019/2022 and (EU) 2019/2017 on Ecodesign and Energy labelling for household dishwashers?	
How can an external party (e.g. consumers, market surveillance) clearly recognise whether a dishwasher is a household or non-household appliance (e.g. based on a specific regulation to be met or a specific technical parameter/feature)?	
Are there any technical parameters that could be used for the delimitation between professional and household use of dishwashing machines?	Type of materials and/or components used (in terms of robustness)
	Planned lifetime (e.g., in number of cycles)
	Detergent dosage (e.g. automatic detergent dosage in case of professional dishwashers)
	Connected load (e.g., three phase connection (400V) in case of professional dishwashers)
	Level of programmability
	Aspects of the warranty to the user
	Further aspects
Do you agree that the current categorisation (see below) is fit for purpose? If not, please explain why and indicate alternative categorisation parameters that in your opinion should be considered in a potential future regulation of professional dishwashers. – Category 1: Undercounter water-change dishwashers (semi-professional) – Category 2: Undercounter one-tank dishwashers – Category 3: Hood-type dishwashers – Category 4: Utensil/pot dishwashers – Category 5: One-tank conveyor-type dishwashers (belt/basket) – Category 6: Multi-tank conveyor-type dishwashers (belt/basket)	
The following table specifies qualitative functional and performance parameters for dishwashers in the different categories, as concluded in the 2011 preparatory study report. Do you consider this data to be up-to-date with the machines currently available on the market?	

	Category 1: Undercounter water-change dishwashers	Category 2: Undercounter one- tank dishwashers	Category 3: Hood-type dishwashers	Category 4: Utensil/pot dishwashers	Category 5: One-tank conveyor-type dishwashers	Category 6: Multi-tank conveyor-type dishwashers
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	program automat	program automat	program automat	program automat	conveyor-type dishwasher	conveyor-type dishwasher
Type of loading	front loading	front loading	pass through	front loading or pass through	n.a.	n.a.
Means of transport	n.a.	n.a.	n.a.	n.a.	basket transport or conveyor belt	basket transport or conveyor belt
Number of baskets to be cleaned at the same time	two of three (on two or three levels)	one (on one level)	one or two (on one level)	one (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)	electricity low pressure steam or hot water, (natural gas)
Variants	freestanding, built-under, integrated and fully integrated models	freestanding and built-under models		granulate dishwasher for black cookware		dishwasher for cleaning of reusable boxes and containers
Would it be more suitable to introduce other/further categories in light of their effect on performance (e.g. differentiating between categories based on the energy source used for heating of water/air)?						
Are there any types of professional dishwashers that in your opinion should be excluded from the scope of a possible future product regulation? If so, please explain which ones and why.						
At the time of the previous preparatory study in 2011, standards were lacking that addressed the definition of different categories of professional dishwashers as well as methods for the testing of their performance (e.g., consumption of energy, water and detergents). Since then, existing standards (e.g. ENERGY STAR and NSF/ANSI 3) have been updated and new standards (e.g. EN IEC 63136:2019) have been developed. Please indicate whether there are still any gaps or shortcomings and, if so, for which professional dishwashing categories and in what sense.						
Are you aware of any legislation particularly relevant for professional dishwashers that has been introduced at EU, Member State or third country level since 2011?						
If you have any additional comments on the scope, definitions, standards and legislation, please do not hesitate to provide them.						

7596 **11.2. Appendix 2 – Questionnaires of 2nd stakeholder**
 7597 **consultation**

7598 **11.2.1. Online questionnaire of 2nd stakeholder consultation**

7599 **MEErP Task 2 Markets: General questions related to markets of professional**
 7600 **dishwashers**

Background for the consultation on 'markets' (MEErPTask 2)

The following questions have been developed to request information relevant for MEErP Task 2 of the preparatory study on professional dishwashers. It aims to identify the key aspects of the market for the products in scope, as regards:

- (1) the numbers of units being sold per year and the number of units in use (the stock) in each segment;
- (2) the past and forecast evolutions of these numbers;
- (3) the technical evolution of products;
- (4) the economic, social and environmental costs and benefits associated with the production, the purchase, the operation and the disposal of the products.

Please note:

For additional, more detailed questions on MEErP Tasks 2, 3 and 4, the consultation consists of a **separate Excel file for download**

Please specify the number of employees (Full-Time Equivalent - FTE) of your company

Please provide a numerical answer (in FTE)

Please specify the total turnover (in million euros - MEUR) of your company in 2023 in the business units related to professional dishwashers. Please provide a numerical answer (in MEUR)

Please specify the turnover for each category of dishwashers (in million Euros - MEUR) of your company in 2023 in the business units related to professional dishwashers.

To your knowledge, which organisations are active in the field of repair / refurbishment / recycling of professional dishwashers?

- Organisations in the field of repairs of professional dishwashers: _____
- Organisations in the field of refurbishment of professional dishwashers: _____
- Organisations in the field of recycling of professional dishwashers: _____

7601 **MEErP Task 2 Markets: Questions specific to manufacturers, importers and industry**
 7602 **associations of professional dishwashers**

Please provide the share of the sales of your company in the field of professional dishwashers that is exported, i.e. manufactured in the EU and sold outside of the EU. Please provide your answer in % of your turnover bearing on professional dishwashers
What are the top 5 countries, outside the EU, to which your company exports professional dishwashers?
Estimate the share (in market prices) of the EU internal market demand of professional dishwashers that are covered by imports, i.e. manufactured outside of the EU and sold in the EU. Please provide your answer in % of the total EU demand for professional dishwashers
To your knowledge, do subsidiaries of non-EU companies manufacture professional dishwashers in the EU? yes no no answer
If answered "yes" to the former question, what are these companies, what are their countries of origin and where are their establishments of manufacturing sites in the EU located?
What is the approximate share (%) of your company's turnover made from direct or indirect sales to public clients (public procurement) in the field of professional dishwashers over the past 5 years?
Please provide an estimation of the current efficiency ratio STOCK:NEW in use phase. This is a rough indicator of the ratio between the energy consumption of the average new product and the energy consumption of the average product installed, i.e. in stock). Usually it is <1, i.e., the stock efficiency (products sold about half a product lifetime ago) is worse than efficiency of new products.
Can you specify a value for the Weibull shape parameter (beta) of your products (manufacturers usually determine this parameter to understand and predict how and when products are likely to fail).

7603

Can you specify a value for the price elasticity of your products, i.e., how responsive the quantity demanded of a product is to a change in the price assuming the following correlation between price (P) and variable costs of producing the products (CV): $\varepsilon = - \frac{P}{P - CV}$
Please select from the list below the technical features that apply to the professional dishwashers manufactured by your company and by all companies in the EU market, respectively. Heat exchanger Heat Pump Additional warm/hot water connection Gas-operated heating Steam-operated heating Wash process with lower temperature Recovering of wash water Waste water heat recovery Electronic stop controls (disconnect the machine from the mains supply a programme ending or after last user activity) Improved rinsing systems Automatic weighing system/ automatic load control Automatic dosing of detergents Automatic adaptation of programme to load and to soiling level of dishes / utensils Improved thermal insulation Improved maintainability / repairability / capacity to be upgraded or refurbished (ease of dis-assembly and re-assembly, ease of access to servicing area, modular design) Improved recyclability (avoidance or clear marking of substances of concern, separability of parts made of different materials) Use of recycled plastics Use of recycled metals Reduced wear and stress imposed on dishes / utensils Improved ergonomics of operation (load carrying, temperature, humidity, noise)

7604 **MEErP Task 2 Markets: Questions specific to customers/users/user associations in**
 7605 **the segment of professional dishwashers**

Please specify the professional dishwashers that you typically operate: Select all that apply Category 1: Undercounter water-change dishwashers (semi-professional) Category 2: Undercounter one-tank dishwashers Category 3: Hood-type dishwashers Category 4: Utensil/pot dishwashers Category 5: One-tank conveyor-type dishwashers (belt/basket) Category 6: Multi-tank conveyor-type dishwashers (belt/basket)
Please specify the total capacity in number of plates for each of the categories of professional dishwashers that you operate.
Please specify the average number of cycles per year per machine for each of the categories of the professional dishwashers that you operate.
Please specify the category of dishes / utensils being processed by the professional dishwasher(s) that you operate. Cutlery plates and saucers glasses cups, bowls saucepans frying pans oven dishes other
In your assessment of Life-Cycle Costs (if any), over what duration do you perform your calculation? Please specify for each dishwasher category, if necessary.
In your assessment of Life-Cycle Costs (if any), what discount rate (interest minus inflation) do you use (%)?
Please provide an estimation of the escalation rate (project annual growth of running costs) related to professional dishwashers (%).

7606

Please provide an estimate of each of the following sources of cost for your company in the use of the professional dishwasher(s) that you use (if operating different categories of professional dishwashers, please specify for each dishwasher category) (EUR, excl. VAT). upfront purchase installation/ commissioning energy costs per year water costs per year detergent costs per year operating labour costs per year maintenance / repair / upgrade costs per year downtime costs per year dis-installation / de-commissioning disposal of waste equipment

7607 **MEErP Task 2 Markets: Questions specific to companies providing maintenance,**
 7608 **repair or refurbishing services, and/or to End-of-Life service providers**

To your knowledge, does a second-hand market for spare parts of professional dishwashers exist in the EU? yes no no answer
If answered yes to the former question, at which scale does the second-hand market for spare parts of professional dishwashers operate? sub-Member State Member State the EU no answer
To your estimation, what is the share of the total demand for professional dishwashers that is met by each of the categories below of second-hand professional dishwashers? Please include your answers in % in each of the boxes below. Professional dishwashers that can be directly re-used: _____ Professional dishwashers that can be re-used after refurbishment / upgrade: _____
What is the (predominant) nature of your current contractual relationship to the manufacturer(s) of professional dishwashers? Exclusive right to repair, maintain or re-furbish over geographic zone Exclusive right to repair, maintain or re-furbish over range of products Non-exclusive right to repair, maintain or re-furbish over geographic zone Non-exclusive right to repair, maintain or re-furbish over range of products No contractual relationship Other: No answer

7609 **MEErP Task 3 Users: Questions on usage of professional dishwashers**

Background for the consultation on 'users' (MEErP Task 3) MEErP Task 3 of the preparatory study aims to identify the influence of user behaviour (e.g. intensity of use, application temperature, programme selection, real load size) on the consumption of consumables (energy, water, detergent). The correlation between user behaviour and the specific energy consumption due to technical reasons is also to be clarified and quantified. Moreover, the end-of-life behaviour and the environmental impacts depend on the respective local infrastructure, which is also covered by this section. Besides the most used programme in professional dishwashing appliances, other common programmes are selectable which mainly differ by their duration, temperature and the respective cleaning performance, thus also resulting in different consumption values. Please note: For additional, more detailed questions on MEErP Tasks 2, 3 and 4, the consultation consists of a separate Excel file for download

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The following concentration values for detergents and rinse aids were assumed as averages for calculations performed for all professional dishwashers in the 2011 preparatory study. Should new data not suggest otherwise, they will also be used in the current study as averages and for calculations. - Concentration of detergent: 3.00 g/litre (range of data: 2-4 g/litre) - Concentration of rinse aid: 0.35 g/litre. Do you have any comments on these values and/or data to support alterations?
If there is consumption of additional consumables besides detergents / rinse aids which needs to be taken into consideration, please specify them (and their values in respect of different professional dishwashing categories) below.
According to the previous preparatory study from 2011, off-mode consumption is not relevant for this product category (annual off-mode consumption below <1 kWh/year). Choose one of the following answers - Annual off-mode consumption of professional dishwashers has no relevance. - Annual off-mode consumption of dishwashers is of relevance. Please consider off-mode consumption values for respective sub-categories provided in the comment. - No answer
Maloperation of professional dishwashers can influence the energy, water and detergent / rinsing aid consumption. Maloperation is usually a result of choosing the wrong programme or wrong dosage of detergent and rinsing aids (too little/too much). For the purposes of the study and further calculations the following values assumed in the 2011 preparatory study will be assumed if no other data is available as to the average influence of maloperation on the ideal consumption of energy, water and detergents: - Professional dishwasher categories 1 to 4 (commercial dishwashers): +10% - Professional dishwasher categories 5 to 6 (industrial dishwashers): +5% Do you agree with these values? If not, please explain your view and provide an alternative. I agree to these values I do not agree to these values No answer

7611

7612 **MEErP Task 3 Users: Questions on maintenance, upgrades/repairs and end-of-life of**
7613 **professional dishwashers**

Please provide an estimation of average expected initial lifetime (years) per dishwasher category (do not consider extension of lifetime through refurbishment in your answers).
Please provide an estimation of average frequency of maintenance action(s) (numbers per year) per dishwasher category.
Please provide an estimation of average frequency of repair action(s) (numbers during lifetime) per dishwasher category.
Please specify most relevant priority parts in terms of necessary repairs / spare parts per dishwasher category.
Please estimate the average rate of labour for upgrade and/or repair activities (Euro/hour) related to professional dishwashers.
Please describe the typical treatment at the end of the first service life of professional dishwashers and/or their most relevant parts.
Is refurbishment practiced for professional dishwashers? If so, please specify for each professional dishwashing category by how much (years) this can extend the planned lifetime of an appliance (if relevant, specify whether there are multiple refurbishment cycles).

7614

7615 **MEErP Task 4 Technologies: Questions on technologies / composition / materials of**
 7616 **professional dishwashers**

Background for the consultation on 'technologies' (MEErP Task 4) MEErP Task 4 comprises a general technical analysis of the current products on the EU market. As part of it, the Bill of Materials and the whole life cycle analysis of the different product categories is to be identified. It is to provide first results regarding the annual energy, water and detergent consumptions of professional dishwashers over their lifetime. Furthermore, this task serves as a basis for the subsequent Tasks, especially MEErP Task 5 (definition of base cases) and for the identification of the improvement potential of professional dishwashers (MEErP Task 6). The technical analysis of the production phase is to specify the product weight and Bill-of-Materials (BOM), distinguishing the weight of different materials fractions and electronic components at the level requested by the EcoReport Unit Indicators as proposed in the MEErP report. This includes manufacturing and packaging. Please note: For additional, more detailed questions on MEErP Tasks 2, 3 and 4, the consultation consists of a separate Excel file for download
Please provide an estimation of the energy use of manufacturing/assembly (kWh) of an appliance per dishwasher category.
Refrigerants: In the 2011 preparatory study, it was concluded that professional dishwashers of categories 5 and 6 might be equipped with a heat pump containing refrigerant. The refrigerants used are R-134a (tetrafluorodichlorethene), R-407C (a hydrofluorocarbon blend of R-32, R-125, and R-134a) and others with an average filling of 3 to 4.5 kg. Do you agree that refrigerants are currently in use in professional dishwashers on the EU market? - Yes, refrigerants are used in professional dishwashers. Please specify in which dishwasher categories, in which components, which type of refrigerant(s) and the average (kg). - No, refrigerants are not used in professional dishwashers - I do not know
Mercury: In the 2011 preparatory study, based on stakeholder input, it was concluded that mercury is not contained in any of the components of professional dishwashers. Such appliances were explained to conform to the Directive 2011/65/EU (RoHS), albeit without making use of any of the RoHS Annex III exemptions still valid for the use of mercury. Do you agree that mercury is currently not in use in professional dishwashers on the EU market? - Yes, mercury is not used in professional dishwashers - No, mercury is used in lamps of professional dishwashers - No, mercury is used in other components of professional dishwashers - please specify which - I do not know
Silver is used in various applications to promote the release of silver ions under moisture conditions. These have an antibacterial activity that is useful in certain areas, e.g., water treatment, medical applications, etc. In the 2011 preparatory study, based on stakeholder input, it was concluded that silver was not applied anymore in professional dishwashers. Do you agree that silver is currently not in use in professional dishwashers on the EU market? - Yes, silver is currently not used in professional dishwashers - No, silver is used in certain components of professional dishwashers - please specify which - I do not know

7617

Permanent magnets / Critical Raw Materials: The proposal for a Critical Raw Material Act (see COM(2023) 160 final; 2023/0079(COD)) states that permanent magnets are incorporated in a wide variety of products, referring among others to "heat pumps, electric motors, industrial electric pumps, etc.". The permanent magnets commonly used in permanent magnet motors include sintered magnets and bonded magnets with the main types being aluminium-nickel-cobalt, ferrite, samarium cobalt, neodymium iron boron. Some of these contain materials which have been identified by the European Commission as critical raw materials. Are permanent magnets currently used in professional dishwashers? - Yes, permanent magnets are used in professional dishwashers - please detail in which components or auxiliary equipment - No, permanent magnets are not used in professional dishwashers - I do not know
Permanent magnets: If you answered "Yes" to the previous question, please specify the composition and typical weight of the permanent magnets applied in professional dishwashers. Please refer in your answer to the various dishwashing categories and specify if and which type of magnets are typically used in each category.
Permanent magnets: Does the use of these magnet-based components have an advantage over alternative components? Please detail such aspects. Are there any design alternatives to the magnet-based components and what would be their advantages and/or disadvantages, e.g. in terms of performance and/or environmental impacts? - Advantages of magnet-based components over alternative components - Alternative design solutions to magnet-based components and their advantages and/or disadvantages
Critical Raw Materials: Beyond the questions on permanent magnets, are there other Critical Raw Materials in professional dishwashers (e.g., in small batteries or other electronics)? Please specify the components containing CRM, the type of CRM and - if known - the typical weight of CRM contained in professional dishwashers.
Substances of Concern (SoC): Do the components or materials of professional dishwashers contain regulated or restricted substances (REACH SVHC, REACH Annex XVII substances or other regulatory programmes)? If so, which?
Spare parts: For the possibility to estimate the impact of maintenance and repair, the methodology foresees taking a present percentage of the impacts of the materials as inputs to the Bill of Materials (BoM). In the 2011 preparatory study, a default value = 1% was taken as percentage for all categories of professional dishwashers. Do you agree with the default value of 1% of the total Bill of Materials for the impacts of spare parts for all dishwasher categories? - Yes, I agree to the default value of 1% of spare parts for all dishwasher categories. - No, I do not agree to the default value of 1% of spare parts for all dishwasher categories. Please consider more specific data in the comment. - I do not know
Limescale: Hard water leads to limescale build-up on the heating element of dishwashers as well as on drums, pipes and hoses. Over time, as the limescale build up increases, this can cause heating element failure and subsequently reduces the lifetime of the dishwasher. What measures are taken in professional dishwashers to prevent limescale build up and its subsequent impacts on appliance and wash ware. How common is the use of such measures in the design of appliances and/or by their consumers? - Measures of product design to prevent limescale in professional dishwashers - Measures of maintenance to prevent limescale in professional dishwashers - Other measures to prevent limescale in professional dishwashers

7619 **11.2.2. Excel questionnaire of 2nd stakeholder consultation**

7620 **Background for MEErP Task 2**

7621 The following questionnaire has been developed to request information relevant for Task 2 of
7622 the preparatory study. MEErP Task 2 aims to identify the key aspects of the market for the
7623 products in scope, as regards:

7624 (1) the numbers of units being sold per year and the number of units in use (the stock) in each
7625 segment;

7626 (2) the past and forecast evolutions of these numbers;

7627 (3) the technical evolution of products;

7628 (4) the economic, social and environmental costs and benefits associated with the production,
7629 the purchase, the operation and the disposal of the products.

7630 **Tables for MEErP Task 2 questions**7631 **Q2-1: (For manufacturers and importers) Please complete the following tables on number of annual sales over past 30 years (Table 2-1a and Table 2-1b).**7632 **Table 2-1a: Annual number of sales over past 30 years of your company for each category of dishwashers you operate**

	Category 1: Undercounter water-change dishwashers (semi-professional)	Category 2: Undercounter one-tank dishwashers	Category 3: Hood-type dishwashers	Category 4: Utensil/pot dishwashers	Category 5: One-tank conveyor-type dishwashers (belt/basket)	Category 6: Multi-tank conveyor-type dishwashers (belt/basket)
2023						
2022						
2021						
2020						
2019						
2018						
2017						
2016						
2015						
2014						
2013						
2012						
2011						
2010						
[...]						
1998						
1997						
1996						
1995						
1994						

7633 Table 2-1b: Annual number of sales over past 30 years on whole EU market for each category of dishwashers you operate

	Category 1: Undercounter water-change dishwashers (semi-professional)	Category 2: Undercounter one-tank dishwashers	Category 3: Hood-type dishwashers	Category 4: Utensil/pot dishwashers	Category 5: One-tank conveyor-type dishwashers (belt/basket)	Category 6: Multi-tank conveyor-type dishwashers (belt/basket)
2023						
2022						
2021						
2020						
2019						
2018						
2017						
2016						
2015						
2014						
2013						
2012						
2011						
2010						
[...]						
2000						
1999						
1998						
1997						
1996						
1995						
1994						

7634

Q2-2: (For manufacturers & importers) For each category of professional dishwashers, please provide your perception regarding the importance for your customers of each of the features in Table 2-2.

Table 2-2: Features for customers per category off dishwasher

Dishwasher category	upfront purchasing price		lifetime duration (after which a new appliance needs to be paid again)		reliability (which reduces the downtime of the appliance)		energy costs		water costs		detergent costs		operating labour costs		maintenance / repair / upgrade costs		full life-cycle costs (including all the above)		Comments on individual rows
	Degree of importance	Trend in importance	Degree of importance	Trend in importance	Degree of importance	Trend in importance	Degree of importance	Trend in importance	Degree of importance	Trend in importance	Degree of importance	Trend in importance	Degree of importance	Trend in importance	Degree of importance	Trend in importance	Degree of importance	Trend in importance	
Category 1: Undercounter water-change dishwashers (semi-professional)																			
Category 2: Undercounter one-tank dishwashers																			
Category 3: Hood-type dishwashers																			
Category 4: Utensil/pot dishwashers																			
Category 5: One-tank conveyor-type dishwashers (belt/basket)																			
Category 6: Multi-tank conveyor-type dishwashers (belt/basket)																			

7635

7636

7637 **Q2-3: (For manufacturers & importers) For each category of professional dishwashers, please provide your perception regarding the importance for your**
 7638 **customers of each of the technical features presented in Table 2-3**

7639 Table 2-3: Importance of technical features for customers per category of dishwasher (degree of importance / trend of importance)

- 7640 ○ Heat exchanger
- 7641 ○ Heat Pump
- 7642 ○ Additional warm/hot water connection
- 7643 ○ Gas-operated heating
- 7644 ○ Steam-operated heating
- 7645 ○ Wash process with lower temperature
- 7646 ○ Recovering of wash water
- 7647 ○ Waste water heat recovery
- 7648 ○ Electronic stop controls (disconnect the machine from the mains supply a programme ending or after the last user activity)
- 7649 ○ Improved rinsing systems
- 7650 ○ Automatic weighting system / automatic load control
- 7651 ○ Automatic dosing of detergent
- 7652 ○ Automatic adaptation of programme to load and to soiling level of dishes / utensils
- 7653 ○ Improved thermal insulation
- 7654 ○ Improved maintainability / repairability / capacity to be upgraded or refurbished (ease of dis-assembly and re-assembly, ease of access to servicing area, modular design)
- 7655 ○ Improved recyclability (avoidance or clear marking of substances of concern, separability of parts made of different materials)
- 7656 ○ Use of recycled materials
- 7657 ○ Reduced wear and stress imposed on dishes / utensils
- 7658 ○ Improved ergonomics of operation (load carrying, temperature, humidity, noise)
- 7659

7660

7661

7662 **Q2-4: (For manufacturers & importers) For each category of professional dishwashers, please specify the lower bound and upper bound selling price (in**
 7663 **EUR, excl. VAT) of your products on the EU market to the end customer of new and re-furbished products, respectively (Table 2-4).**

7664 Table 2-4: Price to end customer, per category of dishwasher, in EUR, excl. VAT

Dishwasher category	New products		Re-furbished products		Comments on individual rows
	Lower-bound price (EUR, excl. VAT)	Upper-bound price (EUR, excl. VAT)	Lower-bound price (EUR, excl. VAT)	Upper-bound price (EUR, excl. VAT)	
Category 1: Undercounter water- change dishwashers (semi-professional)					
Category 2: Undercounter one- tank dishwashers					
Category 3: Hood- type dishwashers					
Category 4: Utensil/pot dishwashers					
Category 5: One-tank conveyor-type dishwashers (belt/basket)					
Category 6: Multi- tank conveyor-type dishwashers (belt/basket)					

7665

7666 **Q2-5: (For manufacturers & importers) For each of the following operations beyond manufacturing, how is the work shared (in %) among your company,**
 7667 **independent suppliers under contract with your company and independent suppliers with no contractual relationship to your company distributed?**

7668 Table 2-5: Distribution of work beyond manufacturing

Operations beyond manufacturing	Your company (%)	Independent suppliers under contract with your company (%)	Independent suppliers with no contractual relationship to your company (%)	Total	Comments on individual rows
sales				0,00%	
installation and commissioning				0,00%	
maintenance and repair				0,00%	
re-furbishing or upgrade of installed equipment				0,00%	
de-commissioning, dis-assembly				0,00%	
preparation of parts for re-use or for recycling				0,00%	
recycling				0,00%	

7669

7670 **Q2-6: (For customers/users/user associations) How important is for your company each of the following non-technical and technical features, in their**
 7671 **purchasing decision of a professional dishwasher?**

7672 Table 2-6: Technical and non-technical features for end-users of professional dishwashers

Features		Degree of importance	Trend in importance	Comments on individual rows
non-technical features	upfront purchasing price			
	lifetime duration (after which a new appliance needs to be paid again)			
	reliability (which reduces the downtime of the appliance)			
	energy costs			
	water costs			
	detergent costs			
	operating labour costs			
	maintenance / repair / upgrade costs			
	full life-cycle costs (including all the above)			
technical features	Heat exchanger			
	Heat Pump			
	Additional warm/hot water connection			
	Gas-operated heating			
	Steam-operated heating			
	Wash process with lower temperature			
	Recovering of wash water			
	Waste water heat recovery			

Features		Degree of importance	Trend in importance	Comments on individual rows
	Electronic stop controls (disconnect the machine from the mains supply a programme ending or after the last user activity)			
	Improved rinsing systems			
	Automatic weighting system / automatic load control			
	Automatic dosing of detergent			
	Automatic adaptation of programme to load and to soiling level of dishes / utensils			
	Improved thermal insulation			
	Improved maintainability / repairability / capacity to be upgraded or refurbished (ease of dis-assembly and re-assembly, ease of access to servicing area, modular design)			
	Improved recyclability (avoidance or clear marking of substances of concern, separability of parts made of different materials)			
	Use of recycled materials			
	Reduced wear and stress imposed on dishes / utensils			
	Improved ergonomics of operation (load carrying, temperature, humidity, noise)			

Background for MEErP Task 3

MEErP Task 3 of the preparatory study aims to identify the influence of user behaviour (e.g. intensity of use, application temperature, programme selection, real load size) on the consumption of consumables (energy, water, detergent). The correlation between user behaviour and the specific energy consumption due to technical reasons is also to be clarified and quantified. Moreover, the end-of-life behaviour and the environmental impacts depend on the respective local infrastructure, which is also covered by this section. Besides the most used programme in professional dishwashing appliances, other common programmes are selectable which mainly differ by their duration, temperature and the respective cleaning performance, thus also resulting in different consumption values.

Tables for MEErP Task 3 questions

Q3-1: Capacity ranges

The capacity ranges of the different professional dishwasher categories from the previous preparatory study of 2011 provide a first indication of a possible use intensity and the resulting consumption of energy, water and detergents. Do you agree with the assumptions made for capacity ranges of the different professional dishwasher categories in Table 3-1a below? Please specify your comments in the right-hand column (per row) or in the answer box below the table (general comments). To provide detailed input on the various parameters, please use the empty Table 3-1b on the right, allowing a comparison of your data to the initial assumptions.

Table 3-1a: Assumptions on professional dishwasher intensity of use

Professional dishwasher category	Capacity range [dishes/hour] (in brackets: typical capacity)	Comments on individual rows
Category 1: Undercounter water-change dishwashers	80-300 (200)	
Category 2: Undercounter one-tank dishwashers	300-800 (550)	
Category 3: Hood-type dishwashers	500-1 300 (860)	
Category 4: Utensil/pot dishwashers	10-30 cycles/ hour [1] (20 cycles/ hour)	
Category 5: One-tank conveyor-type dishwashers (belt/basket)	1 500 - 2 000 [2] (1 750)	
Category 6: Multi-tank conveyor-type dishwashers (belt/basket)	1 700 - 6 000 [3] (3 600)	

Source: Final conclusions as presented in Table 1 of Task 3 final report of 2011 Preparatory study

[1] 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.

[2] 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.

[3] 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.

Q3-2: Intensity of use

In the 2011 preparatory study, the annual numbers of dishes cleaned per professional dishwasher category were calculated serving as input for further assessments of energy, water and detergent consumption under ideal and real conditions. Do you agree with the assumptions made for the intensity of use of the different professional dishwasher categories in Table 3-2a below? Please specify your comments in the right-hand column (per row) or in the answer box below the table (general comments). To provide detailed input on the various parameters, please use the empty Table 3-2b on the right, allowing a comparison of your data to the initial assumptions.

Table 3-2a: Assumptions on professional dishwasher intensity of use

Professional dishwasher category	Average capacity per cycle or per hour	Number of cycles per day	Time in active mode per day [1]	Working days per year	Typical work-load of basket/belt [2]	Number of dishes / cycles per year	Comments on individual rows
Category 1: Undercounter water-change dishwashers	30 dishes/cycle	5	1h 30	200	80%	24 000 dishes	
Category 2: Undercounter one-tank dishwashers	18 dishes/cycle	55	1h 50	300	80%	237 600 dishes	
Category 3: Hood-type dishwashers	18 dishes/cycle	80	2h 40	300	80%	345 600 dishes	
Category 4: Utensil/pot dishwashers	not applicable	30	2h 08	300	60%	9 000 cycles	
Category 5: One-tank conveyor-type dishwashers (belt/basket)	1 750 dishes/hour	not applicable	3h 30	330	75%	1 515 900 dishes	
Category 6: Multi-tank conveyor-type dishwashers (belt/basket)	3 600 dishes/hour	not applicable	4h 30	330	75%	4 009 500 dishes	

Source: Final conclusions as presented in Table 2 of Task 3 final report of 2011 Preparatory study

[1] Calculations based on stakeholder feedback with regard to distributed usage of different program durations.

[2] 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 Table 3-4 (see Tab "T3_Q3-4_Partial_workload").

Q3-3: Ideal conditions

Table 3-3a provides an overview of the specific average energy, water and detergent (incl. rinsing aid) consumption of the different professional dishwasher categories based on the 2011 preparatory study final report. The consumption range given in brackets reflects the different ranges of capacity sizes and heating options within each machine category. The table shows the consumption values of professional dishwashers with an average technology (not including BAT) being offered on the market at that time.

Should this consultation not prove that the values have changed they will be used for preliminary calculations of energy, water and detergent consumption during the use phase under ideal conditions in order to give an overview of the environmental relevance of the different professional dishwasher categories and to subsequently determine the influence of specific aspects of user behaviour which are not included under ideal conditions.

Do you agree with the assumptions made for professional dishwasher categories specified in Table 3-3a below? Please specify your comments in the right hand column (per row) or in the answer box below the table (general comments). To provide detailed input on the various parameters, please use the empty Table 3-3b on the right, allowing a comparison of your data to the initial assumptions.

Table 3-3a: Specific energy, water and detergent consumption of an average current device of different professional dishwasher categories under ideal conditions

Professional dishwasher category	Energy consumption (range) kWh/100 dishes	Water consumption (range) litre/100 dishes	Detergent / rinse aid consumption g/100 dishes	Comments on individual rows
Category 1: Undercounter water-change dishwashers	4.3	80	268	
Category 2: Undercounter one-tank dishwashers	1.6 (1.2-2.0)	16 (equals 2.9 l per cycle)	54	
Category 3: Hood-type dishwashers	1.7 (1.5-2.0)	16	54	
Category 4: Utensil/pot dishwashers	0.5 kWh per cycle	5.2 litre per cycle	17 g per cycle	
Category 5: One-tank conveyor-type dishwashers (belt/basket)	2.0 (1.8-2.3)	13 (11-15)	44	
Category 6: Multi-tank conveyor-type dishwashers (belt/basket)	2.0 (1.6-2.3)	12 (11-13)	40	

Source: Final conclusions as presented in Table 3 of Task 3 final report of 2011 Preparatory study

7727 **Q3-4: Partial workload**

7728 In technical information sheets of professional dishwashers, the energy, water and detergent
 7729 consumption is usually specified under optimal conditions and full load. In real life, however, the
 7730 workload can be considerably lower. For the purposes of the study and further calculations the
 7731 values (and ranges) assumed in the final report of the 2011 preparatory study shall be used to
 7732 quantify the influence of real workload on the consumption of energy, water and detergent.

7733 Do you agree with the assumptions made for professional dishwasher categories specified in
 7734 Table 3-4a below? Please specify your comments in the right hand column (per row) or in the
 7735 answer box below the table (general comments). To provide detailed input on the various
 7736 parameters, please use the empty Table 3-4b on the right, allowing a comparison of your data
 7737 to the initial assumptions.

7738 Table 3-4a: Increase of energy, water and detergent consumption of an average current device
 7739 of different professional dishwasher categories due to partial workload

Professional dishwasher category	Average workload	Increase of ... due to partial workload			Comments on individual rows
		specific energy consumption	specific water consumption	specific detergent / rinse aid consumption	
Category 1: Undercounter water-change dishwashers	80%	15%	25%	25%	
Category 2: Undercounter one-tank dishwashers	80%	7,5%	25%	25%	
Category 3: Hood-type dishwashers	80%	7,5%	25%	25%	
Category 4: Utensil/pot dishwashers	60%	7,5%	30%	30%	
Category 5: One-tank conveyor-type dishwashers (belt/basket)	75%	10%	10%	10%	
Category 6: Multi-tank conveyor-type dishwashers (belt/basket)	75%	10%	10%	10%	

7740 Source: Final conclusions as presented in Table 5 of Task 3 final report of 2011 Preparatory study

7741 **Q3-5: Other Programmes**

7742 The selection of the dishwashing programme also influences the energy, water and detergent/rinse aid consumption. In addition to the basic setting, i.e. most
 7743 used programme, the 2011 preparatory study also covered a short and long running cycle. For the purposes of the study and further calculations the
 7744 corresponding values shall be used to quantify the influence of using other programmes on the consumption of energy, water and detergent. Do you agree with
 7745 the assumptions made for professional dishwasher categories specified in Table 3-5a below? Please specify your comments in the right-hand column (per row)
 7746 or in the answer box below the table (general comments). To provide detailed input on the various parameters, please use the empty Table 3-5b on the right,
 7747 allowing a comparison of your data to the initial assumptions.

7748 Table 3-5a: Increase of energy, water and detergent consumption of an average current device of different professional dishwasher categories due to the use
 7749 of other programmes

Type of programme	Duration of programme	Share of programme	Relative consumption of			Comments on individual rows
			Energy	Water	Detergent	
Category 1: Undercounter water-change dishwashers						
Basic Setting	16 min	80%	-	-	-	
Short running cycle	6 min	10%	-54%	-35%	0%	
Long running cycle	20 min	10%	16%	31%	0%	
Average consumption in comparison to standard consumption			96%	100%	100%	
Category 2: Undercounter one-tank dishwashers						
Basic Setting	120 sec	70%	-	-	-	
Short running cycle	60 sec	25%	-10%	0%	0%	
Long running cycle	180 sec	5%	10%	0%	0%	
Average consumption in comparison to standard consumption			98%	100%	100%	
Category 3: Hood-type dishwashers						
Basic Setting	120 sec	80%	-	-	-	

Type of programme	Duration of programme	Share of programme	Relative consumption of			Comments on individual rows
			Energy	Water	Detergent	
Short running cycle	60 sec	15%	-10%	0%	0%	
Long running cycle	180 sec	5%	10%	0%	0%	
<i>Average consumption in comparison to standard consumption</i>			99%	100%	100%	
Category 4: Utensil/pot dishwashers						
Basic Setting	150-360 sec	60%	-	-	-	
Short running cycle	90-180 sec	5%	-10%	0%	0%	
Long running cycle	300-540 sec	35%	10%	0%	0%	
<i>Average consumption in comparison to standard consumption</i>			103%	100%	100%	
Category 5: One-tank conveyor-type dishwashers (belt/basket)						
Basic Setting	120 sec ^[1]	90%	-	-	-	
Short running cycle	90 sec	10%	-25%	-25%	-25%	
Long running cycle	180 sec	0%	50%	50%	50%	
<i>Average consumption in comparison to standard consumption</i>			98%	98%	98%	
Category 6: Multi-tank conveyor-type dishwashers (belt/basket)						
Basic Setting	120 sec ^[1]	80%	-	-	-	
Short running cycle	90 sec	10%	-25%	-25%	-25%	
Long running cycle	180 sec	10%	50%	50%	50%	
<i>Average consumption in comparison to standard consumption</i>			103%	103%	103%	

Source: Final conclusions as presented in Table 6 of Task 3 final report of 2011 Preparatory study

[1] Contact time (plate in cleaning zone)

7751 **Q3-6: Stand-by**

7752 Professional dishwashers are not always switched off directly after the end of the programme
 7753 and therefore are left for a certain time in “stand-by mode”. The following table shows the
 7754 typical time and power consumption of professional dishwashers in low-power-modes. Do you
 7755 agree with the assumptions made for the different professional dishwasher categories? Please
 7756 specify your comments in the right hand column (per row) or in the answer box below the Table
 7757 3-6a (general comments). To provide detailed input on the various parameters, please use the
 7758 empty Table 3-6b on the right, allowing a comparison of your data to the initial assumptions.

7759 Table 3-6a: Typical time in low-power modes and standby consumption of professional
 7760 dishwashers

Professional dishwasher category	Average usage time (switched on) in hours per day	Time in low power modes in hours per day		Calculated Standby consumption (in kWh/h)	Comments on individual rows
		Ready-to-use-mode	Left-on-mode		
Category 1: Undercounter water-change dishwashers	4,0	n.a.	2,6	0,01	
Category 2: Undercounter one-tank dishwashers	10,0	8,4	n.a.	0,25	
Category 3: Hood-type dishwashers	10,0	7,5	n.a.	0,35	
Category 4: Utensil/pot dishwashers	10,0	7,4	n.a.	1,00	
Category 5: One-tank conveyor-type dishwashers (belt/basket)	10,0	6,5	n.a.	0,80	
Category 6: Multi-tank conveyor-type dishwashers (belt/basket)	10,0	5,5	n.a.	2,00	

7761 *Source: Final conclusions as presented in Table 9 of Task 3 final report of 2011 Preparatory study*

Q3-7: Energy infrastructure

Regarding the heating of the water inside professional dishwashers there are different options. The basic possibility is electric heating. For certain professional dishwasher categories, heating can additionally be done by low pressure steam or hot water or by direct gas heating. According to feedback given in the first stakeholder consultation of this study, direct gas heating is no longer applied. The following table shows the share of different energy carriers/sources used to heat up the water for professional dishwashers.

Do you agree with the assumptions made for the different professional dishwasher categories in Table 3-7a below? Please specify your comments in the right hand column (per row) or in the answer box below the Table 3-7a (general comments). To provide detailed input on the various parameters, please use the empty Table 3-7b on the right, allowing a comparison of your data to the initial assumptions.

Table 3-7a: Energy sources/carriers for water heating in professional dishwashers

Professional dishwasher category	Electricity in %	Low pressure steam and hot water in %	Natural gas in %	Comments on individual rows
Category 1: Undercounter water-change dishwashers	100	-	-	
Category 2: Undercounter one-tank dishwashers	100	-	-	
Category 3: Hood-type dishwashers	100	-	-	
Category 4: Utensil/pot dishwashers	90-95	5-10	0	
Category 5: One-tank conveyor-type dishwashers (belt/basket)	ca. 80	20	0-1	
Category 6: Multi-tank conveyor-type dishwashers (belt/basket)	ca. 70	30	0-1	

Source: Based on final conclusions as presented in Table 13 of Task 3 final report of 2011 Preparatory study

7777 **Q3-8: Maintenance / repairs**

7778 Regarding upgrades and repairs, please provide input on the typical kind of activities and the
 7779 related time to carry them out and costs for the related spare parts.

7780 Table 3-8: Typical upgrade and repair activities, time and costs related to professional
 7781 dishwashers

Professional dishwasher category	Typical upgrade activity	Total time to carry out the typical upgrade activity (in hours)	Average cost of spare parts for upgrade (in Euro)	Typical repair activity	Total time to carry out the typical repair activity (in hours)	Average cost of spare parts for repair (in Euro)
Category 1: Undercounter water-change dishwashers						
Category 2: Undercounter one-tank dishwashers						
Category 3: Hood-type dishwashers						
Category 4: Utensil/pot dishwashers						
Category 5: One-tank conveyor-type dishwashers (belt/basket)						
Category 6: Multi-tank conveyor-type dishwashers (belt/basket)						

7782

Q3-9: End-of-life

Regarding typical end-of-life treatment, please provide an estimation on the relative shares of refurbishment / remanufacturing for reuse, recycling, incineration or landfill treatments of professional dishwashers at the end of first service life.

Table 3-9: Typical upgrade and repair activities, time and costs related to professional dishwashers

Professional dishwasher category	Estimated market share of <u>refurbishment / remanufacturing for reuse</u> after end of first service-life (in percent of subcategory)	Estimated market share of <u>recycling</u> after end of first service-life (in percent of subcategory)	Estimated market share of <u>incineration</u> after end of first service-life (in percent of subcategory)	Estimated market share of <u>landfill</u> after end of first service-life (in percent of subcategory)	Total	Comments on individual rows
Category 1: Undercounter water-change dishwashers					0,00 %	
Category 2: Undercounter one-tank dishwashers					0,00 %	
Category 3: Hood-type dishwashers					0,00 %	
Category 4: Utensil/pot dishwashers					0,00 %	
Category 5: One-tank conveyor-type dishwashers (belt/basket)					0,00 %	
Category 6: Multi-tank conveyor-type dishwashers (belt/basket)					0,00 %	

Background for MEErP Task 4

MEErP Task 4 comprises a general technical analysis of the current products on the EU market. As part of it, the Bill of Materials and the whole life cycle analysis of the different product categories is to be identified. It is to provide first results regarding the annual energy, water and detergent consumptions of professional dishwashers over their lifetime. Furthermore, this task serves as a basis for the subsequent Tasks, especially Task 5 (definition of base cases) and for the identification of the improvement potential of professional dishwashers.

The technical analysis of the production phase is to specify the product weight and Bill-of-Materials (BOM), distinguishing the weight of different materials fractions and electronic components at the level requested by the EcoReport Unit Indicators as proposed in the MEErP report. This includes manufacturing and packaging materials.

Tables for MEErP Task 4 questions**Q4-1: Appliance characteristics**

The following Tables (4-1a through 4-6a) give an overview of the characteristics of typical appliances of each of the professional dishwashing categories. Do you agree with the data presented for each category? Please specify your comments in the right hand column (per row) or in the answer box below the table (general comments). To provide detailed input on the various parameters, please use the empty tables on the right (4-1b through 4-6b), allowing a comparison of your data to the initial assumptions.

Table 4-1a: Main characteristics of a typical undercounter water-change dishwasher (Category 1)

Main characteristics of Category 1	Data	Comments on individual rows
Programme		
Number of dishwashing programmes	10 (dishwashing process can be adjusted to task)	
Washing capacity, ideal	2-20 racks/h (depending on programme)	
Cycle time	6-27 minutes (depending on programme)	
Programme temperature	Depending on programme (between 20-60°C, rinsing temperature up to 93°C)	
Construction details		
Height/width/depth	820/600/600 mm	
Weight (without packaging)	ca. 50 kg	
Tank volume	not applicable	
Electricity and water consumption		
Voltage	normal (230 V) or high-load connection (400 Volt) possible	
Total load	9 kW	
Power of pump	0.4 kW	

Source: Final conclusions as presented in Table 4 of Task 4 final report of 2011 Preparatory study

7812 Table 4-2a: Main characteristics of a typical undercounter one-tank dishwasher (Category 2)

Main characteristics of Category 2	Data	Comments on individual rows
Programme		
Number of dishwashing programmes	3	
Washing capacity, ideal	40 racks/h (with 400 Voltage) 25 racks/h (with 230 Voltage)	
Cycle time	60-360 sec (with 400 Voltage) 140 / 180 / 360 sec (with 230 Voltage)	
Tank temperature	usually between 55°C and 65°C	
Boiler temperature	usually between 80°C and 85°C (glasswashers also 60-65°C possible)	
Construction details		
Height/width/depth	820/600/650 (glasswashers: 415-475 mm width)	
Weight (without packaging)	ca. 70 kg (glasswashers ca. 50 kg)	
Tank volume	7-20 litres, average 15 litres	
Electricity and water connection		
Voltage	230 Volt or 400 Volt	
Total load	with 400 Voltage: 7.7 W with 230 Voltage: 3.6 W	
Power of pump	0.2-0.8 kW, typical 0.6 kW	

Source: Final conclusions as presented in Table 6 of Task 4 final report of 2011 Preparatory study

7813

7814 Table 4-3a: Main characteristics of a typical hood-type dishwasher (Category 3)

Main characteristics of Category 3	Data	Comments on individual rows
Programme		
Number of dishwashing programmes	3	
Washing capacity, ideal	60 racks/h	
Cycle time	60-180 sec	
Tank temperature	usually between 55°C and 65°C	
Boiler temperature	usually between 80°C and 85°C	
Construction details		
Height/width/depth	2000/760/820 mm	
Weight (without packaging)	ca. 120 kg	
Tank volume	16-60 litres, average 40 litres	
Electricity and water connection		
Voltage	400 Volt	
Total load	7 kW	
Power of pump	0.75-1,5 kW, typical 0.9 kW	

Source: Final conclusions as presented in Table 8 of Task 4 final report of 2011 Preparatory study

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7816

7817 Table 4-4a: Main characteristics of a typical utensil / pot dishwasher (Category 4)

Main characteristics of Category 4	Data	Comments on individual rows
Programme		
Number of dishwashing programmes	3	
Washing capacity, ideal	20 racks/h	
Cycle time	90-540 sec	
Tank temperature	usually between 55°C and 65°C	
Boiler temperature	usually between 80°C and 85°C	
Construction details		
Height/width/depth	2000/876/900 mm	
Weight (without packaging)	ca. 200 kg	
Tank volume	60-130 litres, average 100 litres	
Electricity and water connection		
Voltage	400 Volt	
Total load	13.0 kW	
Power of pump	typical 1.6 kW	

Source: Final conclusions as presented in Table 10 of Task 4 final report of 2011 Preparatory study

7818

7819 Table 4-5a: Main characteristics of a typical one-tank conveyor-type dishwasher (Category 5)

Main characteristics of Category 5	Data	Comments on individual rows
Programme		
Number of dishwashing programmes	2-3	
Washing capacity, ideal	70-110 racks/h	
Cycle time	90-180 sec	
Tank temperature	usually between 55°C and 65°C	
Boiler temperature	usually between 80°C and 85°C	
Construction details		
Height/width/depth	1300/800/1420 mm (without preparing zone)	
Depth/height of passage height	500/460 mm	
Weight (without packaging)	ca. 900 kg	
Tank volume	110-130 litres (average 120 litres)	
Electricity and water connection		
Voltage	400 V	
Power of pump	typical 1.5 kW	

Source: Based on final conclusions as presented in Table 13 of Task 4 final report of 2011 Preparatory study for WM4

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7821

7822 Table 4-6a: Main characteristics of a typical multi-tank conveyor-type dishwasher (Category 6)

Main characteristics of Category 6	Data	Comments on individual rows
Programme		
Number of dishwashing programmes	3	
Washing capacity, ideal	1700-6000 dishes/h	
Cycle time	90-180 sec	
Tank temperature	usually between 55°C and 65°C	
Boiler temperature	usually between 80°C and 85°C	
Construction details		
Height/width/depth	4700-7400 mm (without preparing zone)	
Depth/height of passage height	different modules available	
Weight (without packaging)	ca. 1300 kg	
Tank volume	130-750 litres, average 230 litres	
Electricity and water connection		
Voltage	400 Volt	
Total load	39-51 kW	
Power of pump	no data available	

Source: Final conclusions as presented in Table 15 of Task 4 final report of 2011 Preparatory study

7823

7824 Q4-2: Bill-of-Materials

7825 The following Tables 4-7a through 4-12a give an overview of the Bill of Materials of typical
 7826 appliances of each of the professional dishwashing categories. Do you agree with the data
 7827 presented for each category? Please specify your comments in the right hand column (per
 7828 row) or in the answer box below the table (general comments). To provide detailed input on
 7829 the various parameters, please use the empty tables on the right (Tables 4-7b to 4-12b),
 7830 allowing a comparison of your data to the initial assumptions.

7831 Table 4-7a: Bill of Materials of an undercounter water-change dishwasher (Category 1)

Material / component	Weight in g	Weight in %	Material category	Comments on individual rows
Stainless Steel	24 560	51.0	3-Ferro	
Steel Sheet galvanized	403	0.8	3-Ferro	
Cast Iron	2 303	4.8	3-Ferro	
Polypropylen (PP)	4 980	10.3	1-BlkPlastics	
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	

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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-ferro	
CuZn38 cast	23	0.0	4-Non-ferro	
Chrom	71	0.1	4-Non-ferro	
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		

7832 Source: Final conclusions as presented in Table 5 of Task 4 final report of 2011 Preparatory study

7833 Table 4-8a: Bill of Materials of an undercounter one-tank dishwasher (Category 2)

Material / component	Weight in g	Weight in %	Material category	Comments on individual rows
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, EDPM)	300	0.4	1-BlkPlastics	
Electronics (control)	500	0.7	6-Electronics	
Gaskets (EDPM)	2 040	2.9	1-BlkPlastics	
Total net	69 935	100.0		

7834 Source: Final conclusions as presented in Table 7 of Task 4 final report of 2011 Preparatory study

7835

7836 Table 4-9a: Bill of Materials of a hood-type dishwasher (Category 3)

Material / component	Weight in g	Weight in %	Material category	Comments on individual rows
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	
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, EDPM)	500	0.4	1-BlkPlastics	
Electronics (control)	600	0.5	6-Electronics	
Gaskets (EDPM)	3 085	2.6	1-BlkPlastics	
Total net	117 655	100.0		

7837 Source: Final conclusions as presented in Table 9 of Task 4 final report of 2011 Preparatory study

7838 Table 4-10a: Bill of Materials of a utensil / pot dishwasher (Category 4)

Material / component	Weight in g	Weight in %	Material category	Comments on individual rows
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, EDPM)	1 100	0.5	1-BlkPlastics	
Electronics (control)	2 100	1.0	6-Electronics	
Gaskets, etc. (EDPM)	6 000	2.9	1-BlkPlastics	
Total net	206 000	100.0		

7839 Source: Final conclusions as presented in Table 12 of Task 4 final report of 2011 Preparatory study

7840

7841 Table 4-11a: Bill of Materials of a one-tank conveyor-type dishwasher (Category 5)

Material / component	Weight in g	Weight in %	Material category	Comments on individual rows
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	

Material / component	Weight in g	Weight in %	Material category	Comments on individual rows
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, EDPM)	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 (EDPM)	12 800	1.44	1-BlkPlastics	
Total net	891 285	100.00		

Source: Final conclusions as presented in Table 14 of Task 4 final report of 2011 Preparatory study

Table 4-12a: Bill of Materials of a multi-tank conveyor-type dishwasher (category 6)

Material / component	Weight in g	Weight in %	Material category	Comments on individual rows
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, EDPM)	8 360	0.7	1-BlkPlastics	
Electronics (control)	15 400	1.2	6-Electronics	
Gaskets, etc. (EDPM)	15 000	1.2	1-BlkPlastics	
Total net	1 285 000	100.0		

Source: Final conclusions as presented in Table 16 of Task 4 final report of 2011 Preparatory study

Q4-3: Volumes

The following Table 4-13a shows the average volume of the final packaged product for the various professional dishwasher categories. These values shall be used to calculate the environmental impacts resulting from distribution. Do you agree with the assumptions made for professional dishwasher categories specified in Table 4-13a below? Please specify your comments in the right hand column (per row) or in the answer box below the table (general comments). To provide detailed input on the various parameters, please use the empty Table 4-13b on the right, allowing a comparison of your data to the initial assumptions.

Table 4_13a: Average volume and weight of the final packaged product in the different categories of professional dishwashers

Professional dishwasher category	Average volume of the final packaged product	Average weight of the final packaged product	Comments on individual rows
Category 1: Undercounter water-change dishwashers	0.40 m ³	ca. 50 kg	
Category 2: Undercounter one-tank dishwashers	0,48 m ³	ca. 80 kg	
Category 3: Hood-type dishwashers	1.03 m ³	ca. 135 kg	
Category 4: Utensil/pot dishwashers	4.95 m ³	ca. 225 kg	
Category 5: One-tank conveyor-type dishwashers (belt/basket)	12.25 m ³	ca. 975 kg	
Category 6: Multi-tank conveyor-type dishwashers (belt/basket)	16.58 m ³	ca. 1465 kg	

Source: Based on final conclusions as presented in Table 19 of Task 4 final report of 2011 Preparatory study

Q4-4: Packaging

The following Table 4-14a shows the average types and weight of the packaging of the various professional dishwasher categories. These values shall be used to calculate the environmental impacts resulting from packaging. Do you agree with the assumptions made for professional dishwasher categories specified in Table 4-14a below? Please specify your comments in the right hand column (per row) or in the answer box below the table (general comments). To provide detailed input on the various parameters, please use the empty Table 4-14b on the right, allowing a comparison of your data to the initial assumptions.

Table 4_14a: Average type and weight of the packaging in the different categories of professional dishwashers

Professional dishwasher category	EPS (weight in g)	PE-Foil (weight in g)	Polystyrene (weight in g)	Wood (weight in g)	Cardboard (weight in g)	Comments on individual rows
Category 1: Undercounter water-change dishwashers	724	172	-	1011	635	
Category 2: Undercounter one-tank dishwashers	-	-	500	6000	2750	
Category 3: Hood-type dishwashers	-	-	500	12250	4750	
Category 4: Utensil/pot dishwashers	-	-	500	16000	3500	
Category 5: One-tank conveyor-type dishwashers (belt/basket)	-	-	2940	63500	15500	
Category 6: Multi-tank conveyor-type dishwashers (belt/basket)	-	-	5290	141180	33530	

Source: Based on final conclusions as presented in Tables 5, 7, 9, 12, 14, and 16 of Task 4 final report of 2011 Preparatory study

7874 11.3. Appendix 3 – Excel questionnaire of 3rd stakeholder 7875 consultation

7876 11.3.1. Consultation on Design Options (MEErP Task 6)

7877 **Background for MEErP Task 6**

7878 MEErP Task 6 aims to analyse the most important and appropriate (aggregated clusters of)
7879 design options for commercial dishwashers as identified and described in MEErP Task 4.

7880 The results of the life cycle assessment undertaken in the previous MEErP Task 5 indicate that
7881 the majority of the environmental impact of commercial dishwashers across all analysed base
7882 cases originates from the use phase on the one hand, and the raw material stage on the other
7883 hand. Specifically, in the use phase, electricity and water consumption are the largest
7884 contributors across most impact categories. Electronics used in the production of the controller
7885 board are the most significant contributors to overall impact categories. Additionally, stainless
7886 steel is identified as a major contributor across various impact categories, followed by
7887 polypropylene and copper. The life cycle costing assessment has identified electricity and
7888 detergent use as the highest contributors for all base cases. The aim of this consultation is to
7889 obtain information from manufacturers on whether and where the proposed design options
7890 significantly affect or change the LCA input values of the base cases, i.e. how the Bill of Materials
7891 (BoM) changes, what changes occur in consumption data (energy, water and detergent
7892 consumption) and how the design option affects the average purchase price and lifetime.
7893 Feedback is also sought on the potential for combining certain design options and the
7894 changes/impacts of a maximum combination. A description of the six proposed design options
7895 can be found in the spreadsheet "Design options". Working hypotheses on additional material
7896 requirements and potential savings for each design option are also provided. Comments on the
7897 validity of the assumptions made in the working hypotheses can be noted in the corresponding
7898 column. If additional design options should be considered, please state and specify it under "DO-
7899 07". Subsequently, please provide information for each of the design options in the
7900 spreadsheets for the individual dishwasher categories (BC1-BC6) on the following aspects:

- 7901 • Technical applicability / combinability of the proposed design options
- 7902 • Changes in the Bill of Material compared to a Base Case without design option
- 7903 • Changes in the consumption values of the use phase compared to a Base Case without design
7904 option
- 7905 • Changes in the purchase price or average expected lifetime compared to a Base Case without
7906 such option

7907 With regard to the changes in the Bill of Material as well as the consumption value of the use
7908 phase, the assumptions in the respective working hypotheses can be taken into account and
7909 substantiated or adjusted, if necessary.

7910 **Design Options**

Design option	Short title	Description of the design option	Working hypothesis on additional material demand and savings potentials
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.	The working hypothesis for this design option is that an additional material requirement of 25-50 kg (mainly stainless steel, copper and aluminium) can save approx. 15% of the total electricity demand.
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.	Integrating a heat pump into a commercial dishwasher recovers and upgrades heat from the exhaust air to preheat water. This design option can improve energy efficiency and indoor air quality by reducing water vapour emissions. However, the system increases resource use during manufacturing as it requires additional materials such as 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.	The working hypothesis for this design option is that an additional 1 kg of electronics can save 25% of the total demand for electricity, water and detergent, respectively, with an increase in purchase costs of around 20%.

Design option	Short title	Description of the design option	Working hypothesis on additional material demand and savings potentials
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.	The working hypothesis for this design option is that an additional material use of approx. 15 kg stainless steel (additional wall) and approx. 3 kg polyurethane (insulation material between the two walls) can save 15% of the total electricity demand. The additional material requirements apply to category 1 and 2 dishwashers. For larger appliances, proportionally higher values have to be assumed.
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.	As a working hypothesis for this design option, it is assumed that 10% of the metallic materials (mainly stainless steel and copper in equal proportions) can be replaced by PP.
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.	The working hypothesis for this design option is that 40% of the total electronics (i.e. mainly control boards and power supplies) can be reused and therefore do not need to be produced.
DO-07	Other relevant design option (stakeholder input)	Please insert a short title in the left cell Please provide here a brief description of the sustainability benefits and any additional effort required	

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7913 Consultation matrix to be filled out for each Base Case

Life Cycle Assessment and Life Cycle Costing input tables for Design options (MEErP Task 6)										
Please fill in the light yellow cells										
Technical applicability of proposed design options and potential for combinations										
Please indicate if / which of the proposed design options are technically applicable to this										
			Design option DO-01	Design option DO-02	Design option DO-03	Design option DO-04	Design option DO-05	Design option DO-06	Design option DO-07	
		Design option technically applicable to Base Case BC1?	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	Other relevant design option (stakeholder input)	
Exhaust heat recovery (regenerator)	DO-01		-							
Exhaust air heat pump	DO-02			-						
Automatic programme for load and soil recognition	DO-03				-					
Improved thermal insulation (double-walled design)	DO-04					-				
Further substitution of metals by polymers	DO-05						-			
Modular design and reuse of electronics	DO-06							-		
Other relevant design option (stakeholder input)	DO-07									
Your comments										

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Preparatory study on professional dishwashers

Bill of Materials - Base Case				Design option DO-01	Design option DO-02	Design option DO-03	Design option DO-04	Design option DO-05	Design option DO-06	Design option DO-07	Product including all possible design options
Please indicate for the proposed design options, if they will lead to significant changes in the BoM compared to a Base Case without such option (reference = 100%; increases: e.g. 105%; decreases: e.g. 95%)				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	Other relevant design option (stakeholder input)	
Material	Value	Unit	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	Percentage compared to 100% reference
Stainless Steel	18,50	kg	100%								
Steel Sheet galvanized	18,50	kg	100%								
Polypropylen (PP)	10,21	kg	100%								
Polyamid (PA)	0,82	kg	100%								
Polymethylmetacrylate (PMMA)	0,01	kg	100%								
Acrylonitrile Butadiene Styrene (ABS)	1,54	kg	100%								
Polystyrene (PS)	1,05	kg	100%								
Styropor expandable polystyrene (EPS)	0,08	kg	100%								
Polybutylene Terephthalate (PBT)	0,07	kg	100%								
Polyvinylchlorid (PVC)	0,83	kg	100%								
EPDM-rubber	1,07	kg	100%								
POM	0,47	kg	100%								
PE	0,38	kg	100%								
Plastics others	0,55	kg	100%								
Aluminium	0,56	kg	100%								
Cu wire	2,06	kg	100%								
CuZn38 cast	0,05	kg	100%								
Chrom	0,15	kg	100%								
Bitumen	5,00	kg	100%								
Cotton	0,93	kg	100%								
Electronics (control)	0,70	m2	100%								
	0	0,00	0	100%							
	0	0,00	0	100%							
	0	0,00	0	100%							
	0	0,00	0	100%							
	0	0,00	0	100%							
Total product weight	65,00	kg	100%								
Your comments											

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Preparatory study on professional dishwashers

Use phase data - Base Case				Design option D01	Design option D02	Design option D03	Design option D04	Design option D05	Design option D06	Design option D0-07	Product including all possible design options
Please indicate for the proposed design options, if they will lead to significant changes in the consumption values compared to a Base Case without such option (reference = 100%; increases: e.g. 105%; decreases: e.g. 95%)				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	Other relevant design option (stakeholder input)	
Consumption data (under real-life conditions) *	Value	Unit	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	Percentage compared to 100% reference
Specific energy consumption (real-life)	2,86	kWh/100 dishes	100%								
Specific water consumption (real-life)	84	litres/100 dishes	100%								
Specific detergent consumption (real-life)	59	g/100 dishes	100%								
Specific rinsing agent consumption (real-life)	integrated detergent and rinse aid	g/100 dishes	100%								
* real-life conditions include partial loads, mixed programme selection, maloperation, manual pre-rinse, initial filling and heating of wash tanks, two working shifts with two tank fills and heating of wash tanks, and low power modes				Your comments							

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Life Cycle Costing data - Base Case				Design option D01	Design option D02	Design option D03	Design option D04	Design option D05	Design option D06	Design option D0-07	Product including all possible design options
Please indicate for the proposed design options, if they will lead to significant changes in the purchase price or average expected lifetime compared to a Base Case without such option (reference = 100%; increases: e.g. 105%; decreases: e.g. 95%)				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	Other relevant design option (stakeholder input)	
LCC parameters	Value	Unit	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	Percentage compared to 100% reference
Average expected initial life time	12	years	100%								
Assumed purchase price	3148	Euro/unit	100%								
				Your comments							

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11.3.2. Consultation on Substances of Concern (SoC) under ESPR

Purpose of the stakeholder consultation

Given that the Ecodesign of Sustainable Products (ESPR) is a framework Regulation, the relevant Ecodesign requirements for individual product groups are to be set in product-specific Delegated Acts (DAs). To this end, and before a draft product-specific Delegated Act is consulted on, a specific Preparatory Study is carried out for the individual product group being studied. This form aims to collect information regarding Substances of Concern (SoC) in products for use during the Preparatory Study work for the considered product group.

The form seeks information to be subsequently used for potentially developing draft information and/or performance requirements, and to justify potential exemptions from these requirements, to then be consulted upon with stakeholders, Member States and the co-legislators via the ESPR regulatory consultation and governance process.

Background information on Substances of Concern in the ESPR legislation*

According to **Article 2(27) of the ESPR**, a ‘Substance of Concern’ means:

“A substance that:

a) meets the criteria laid down in Article 57 of Regulation (EC) No 1907/2006 and is identified in accordance with Article 59(1) of that Regulation;

b) is classified in Part 3 of Annex VI to Regulation (EC) No 1272/2008 in one of the following hazard classes or hazard categories:

(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;

- 7951 (xii) specific target organ toxicity — repeated exposure categories 1 and 2;
- 7952 (xiii) specific target organ toxicity — single exposure categories 1 and 2;
- 7953 c) is regulated under Regulation (EU) 2019/1021; or
- 7954 d) negatively affects the reuse and recycling of materials in the product in which it is present.”
- 7955 **Article 6 of the ESPR** states the possibility to set out performance requirements related to
7956 product aspects identified in Article 5. Also, ESPR Article 7(5) lays down the obligation to set out
7957 information requirements on Substances of Concern.
- 7958 **Article 5(1) of the ESPR** lists the product aspects that should be addressed by Ecodesign
7959 requirements:
- 7960 a) durability;
- 7961 b) reliability;
- 7962 c) reusability;
- 7963 d) upgradability;
- 7964 e) repairability;
- 7965 f) the possibility of maintenance and refurbishment;
- 7966 g) the presence of substances of concern;
- 7967 h) energy use and energy efficiency;
- 7968 i) water use and water efficiency;
- 7969 j) resource use and resource efficiency;
- 7970 k) recycled content;
- 7971 l) the possibility of remanufacturing;
- 7972 m) recyclability;
- 7973 n) the possibility of recovery of materials;
- 7974 o) environmental impacts, including carbon and environmental footprint;
- 7975 p) expected generation of waste.
- 7976 In particular, **Article 6(1) of the ESPR** states that “Products shall comply with performance
7977 requirements related to the product aspects”. Article 6(3) states that “Performance
7978 requirements based on the product parameter referred to in Annex I, point (f), shall not restrict,
7979 for reasons relating primarily to chemical safety, the presence of substances in products.”

Article 7(5) states that: “Unless otherwise provided for under paragraph 6, point (b), the information requirements shall make it possible to track the substances of concern, throughout the life cycle of the products concerned, unless such tracking is already possible pursuant to information requirements laid down in another delegated act adopted pursuant to Article 4 covering the products concerned, and shall include at least the following:

a) the name or numerical code of the substances of concern present in the product, as follows:

(i) name in the International Union of Pure and Applied Chemistry (IUPAC) nomenclature, or another international name when IUPAC name is not available;

(ii) other names, including usual name, trade name, abbreviation;

(iii) European Community (EC) number, as indicated in the European Inventory of Existing Commercial Chemical Substances (EINECS), the European List of Notified Chemical Substances (ELINCS) or the No Longer Polymer (NLP) list or the number assigned by the European Chemicals Agency (ECHA), if available and appropriate;

(iv) the Chemical Abstract Service (CAS) name and number, if available;

b) the location of the substances of concern within the product;

c) the concentration, maximum concentration or concentration range of the substances of concern, at the level of the product, its relevant components, or spare parts;

d) relevant instructions for the safe use of the product;

e) information relevant for disassembly, preparation for reuse, reuse, recycling and the environmentally sound management of the product at end-of-life.”

The ESPR also envisages the possibility to establish exemptions for substances of concern defined under Art. 2(27) b), c), and d) from the tracking obligation. **Article 7(6) of the ESPR** states that: “where the Commission sets out information requirements in a delegated act adopted pursuant to Article 4, it shall, where relevant: [...] (b) provide duly justified exemptions for substances of concern or information elements from such information requirements referred to in the first subparagraph of paragraph 5, based on the technical feasibility or relevance of tracking substances of concern, the existence of analytical methods to detect and quantify them, the need to protect confidential business information or in other duly justified cases; substances of concern within the meaning of Article 2(27), point (a), shall not be exempted if they are present in products, their relevant components or spare parts in a concentration above 0,1 % weight by weight”.

8012 **Explanation on questions included in this consultation**

8013 Questions 1-3: IAS and NIAS

8014 Aims to collect information on 3 different aspects related to Substances of Concern, covering:

8015 - Intentionally added substance (IAS)

8016 - Non-intentionally added substance (NIAS)

8017 Section 1) Substances of Concern present in the product group

8018 Stakeholders are requested to provide information to enable building the life cycle inventory of
8019 the product group regarding components, materials, etc. Information is also requested for both
8020 IAS and NIAS, including impurities from the production of raw materials or from recycled content
8021 (where present), remnant substances from process auxiliaries, etc.) in the product and from its
8022 entire life cycle. In particular, chemicals and materials remaining in the product group are
8023 relevant, and also those used or present throughout the product's lifecycle (e.g. associated
8024 emissions), including in the waste phase.

8025 Section 2) Information on substances connected to specific product aspects

8026 Information is sought on substances that are known or suspected of affecting the product
8027 aspects as listed in Article 5(1) of ESPR. The information can also relate to a possible relationship
8028 between a substance, or a family or a type of substances, and the relevant product aspect.

8029 3) Substances that negatively affect reuse and recycling

8030 Stakeholders are requested to provide information about Substances of Concern as per ESPR
8031 Article 2(27), point (d), subsequently referred to as "SoCs (d)", defined as a substance that
8032 "negatively affects the reuse and recycling of materials in the product in which it is present". In
8033 this regard, links related to the negative effect on reusability, use of recycled content, and to
8034 the possibility of recovery of materials should also be noted. "Substances of Concern (d)"
8035 negative effects can be related to:
8036 - Existing regulatory limitations to the placing on the market or use of substances*;
8037 - Customer-driven limitations along the supply chain**;
8038 - Technical constraints, interfering with the processes leading to reuse; preparing for reuse or
8039 recycling; or with the functionality, usefulness, value and aesthetics of the resulting recycled
8040 materials or products for reuse (as specified in Article 5(14)). These can be "process-disturbing
8041 SoCs"*** or "quality-disturbing SoCs"****.

8042 * Potential limitations to reuse or recycling may arise from product and waste legislation, as recycled or reused
8043 products may not be able to comply with existing requirements applicable to products placed on the market.

8044 ** Specific requirements from industry practice may address the presence of certain substances in products, which
8045 may not be met by reused and recycled materials. These limitations or pressures are exerted by actors of the supply
8046 chain, sometimes on behalf of the final consumer, on the waste chain actors and on the suppliers of the raw materials,
8047 and can occur even in compliance with derogations from regulatory obligations.

8048 *** "Process-disturbing SoCs", are substances that can disrupt the waste treatment process making the re-use, or
8049 recycling process more complicated, costly, environmentally impactful, or energy- or resource-demanding.

8050 **** "Quality-disturbing SoCs" are substances that reduce the (technical) quality and performance characteristics of
8051 the recyclate. These include substances that bring alterations in the mechanical, technical, chemical and physical
8052 properties of the recyclate, preventing it from achieving the desired/expected performance and therefore being taken
8053 up by the market or being able to compete with virgin alternatives.

8054 Questions 1-3_IAS

- 8055 - "Section 1. Intentionally added substance (IAS) name(s) (International Union of Pure and Applied Chemistry (IUPAC) nomenclature, or another international name when
- 8056 IUPAC name is not available)"
- 8057
- 8058
 - "Other name(s) (If relevant, including usual name, trade name, abbreviation)"
 - 8059 ○ Location of IAS in product
 - 8060 ○ Function of IAS in product
 - 8061 ○ Type of chemical identifier of IAS
 - 8062 ○ "Chemical identifier (In case other is selected before, please add identifier and
 - 8063 other relevant details)"
 - 8064 ○ Average concentration of IAS | Unit
 - 8065 ○ Maximum concentration of IAS | Unit
 - 8066 ○ Lifecycle stage where IAS is added
- 8067 - "Section 2. Product aspect impacted by IAS (product aspects as listed in Article 5 (1) of
- 8068 ESPR)"
- 8069
 - "Description of impact of IAS (Please describe how the substance affects the
 - 8070 product aspect including information/ relationship/ possible impacts, etc.)"
- 8071 - "Section 3. Negative impact of IAS on recycling or reuse of materials in product (To
- 8072 identify SoC under Article 2(27), point (d) of ESPR)"
- 8073
 - "Please describe the negative impact of IAS on recycling or reuse of materials
 - 8074 in product (If known)"
 - 8075 ○ Other relevant comments

8076 Questions 1-3_NIAS

- 8077 - "Section 1. Non-intentionally added substance (NIAS) name(s) (International Union of
- 8078 Pure and Applied Chemistry (IUPAC) nomenclature, or another international name
- 8079 when IUPAC name is not available)"
- 8080
 - "Other name(s) (If relevant, including usual name, trade name, abbreviation)"
 - 8081 ○ Location of NIAS in product
 - 8082 ○ Type of NIAS
 - 8083 ○ Type of chemical identifier of NIAS
 - 8084 ○ "Chemical identifier (In case other is selected before, please add identifier and
 - 8085 other relevant details)"
 - 8086 ○ Average concentration of NIAS | Unit
 - 8087 ○ Maximum concentration of NIAS | Unit
 - 8088 ○ Lifecycle stage where NIAS is added
- 8089 - "Section 2. Product aspect impacted by NIAS (Product aspects as listed in Article 5 (1)
- 8090 of ESPR)"
- 8091
 - "Description of impact of NIAS (Please describe how the substance affects the
 - 8092 product aspect including information/ relationship/ possible impacts, etc.)"
- 8093 - "Section 3. Negative impact of NIAS on recycling or reuse of materials in product (To
- 8094 identify SoC under Article 2(27), point (d) of ESPR)"
- 8095
 - "Please describe the negative impact of NIAS on recycling or reuse of materials
 - 8096 in product (If known)"
 - 8097 ○ Other relevant comments

8098 **Questions 4_Thresholds+Timelines**

8099 Questions on thresholds

8100 "Do you consider that generic or specific thresholds should be set for the product category,
 8101 below which information requirements on substances of concern should not apply? In your
 8102 opinion, what generic and / or specific thresholds should be set below which information
 8103 requirements on substances of concern should not apply? "

8104 "The obligation to provide information on substances of concern in products within the scope
 8105 of an ESPR Delegated Act applies by default to all substances of concern, without prejudice to
 8106 thresholds and/or specific exemptions that may be defined. Should differentiated dates be set
 8107 on the application of this obligation, for instance for different types or categories of substances
 8108 of concern, relevant to this product category? Please propose applicable dates and justify your
 8109 proposal. "

8110 **Questions 5_Exemptions**

Substance information	Substance 1
Intentionally added substance (IAS) name(s) <i>(International Union of Pure and Applied Chemistry (IUPAC) nomenclature, or another international name when IUPAC name is not available)</i>	
Other name(s) <i>(if relevant, including usual name, trade name, abbreviation)</i>	
Type of chemical identifier of substance	Select
Chemical identifier <i>(In case other is selected before, please add identifier and other relevant details)</i>	
Current EU regulatory status <i>(State the most relevant EU or international legislation regarding the substance, in particular as relevant to the product group concerned, and its consequences)</i>	
Type of substance of concern according to Article 2(27) of ESPR (i.e. (b), (c) or (d)). <i>(Please specify if the substance falls under more than one type)</i>	
If a substance of concern under Article 2(27) (b), state the harmonised classification(s) for the substance	
References to key technical / economic reports and studies relative to the substance's properties, impacts, uses and alternatives, e.g. risk assessments, analysis of alternatives, socio-economic assessments, etc. (EU or global level).	
Function of the substance in the product lifecycle <i>(if impurity, please state [impurity])</i>	
Is the substance present in the product or in its component(s)?	Select
If yes, state the location of the substance	
If not, state the life cycle stage in which the substance is used or present	
If the substance is present in the product or in its component(s), state the typical concentration in the final product and specific components <i>(concentration ranges are accepted)</i>	
Additional information with regard to possible exemptions	
Technical feasibility	
Is it possible to track the substance?	Select

If no, state the reasons (please explain thoroughly)	
Relevance of tracking	
Is it relevant to track the substance?	Select
If yes, is it possible to provide information on all or some of the elements that must be disclosed by information requirements on substances of concern? (The list of elements can be found in Art. 7(5) of ESPR)	
If no, justify lack of relevance and indicate any obstacles to tracking the substance? (Please explain thoroughly)	
Other reasons (Please explain thoroughly)	
Existence of analytical methods or data to detect and/or quantify substances of concern	
Are analytical methods to detect and quantify the substance of concern currently available at sufficient commercial scale/capacity globally? (Please explain thoroughly)	
If not, are there any obstacles to develop them or to their widespread availability? (Please explain thoroughly)	
Can information about the presence of the substance of concern, that would enable meeting the information requirement, be found in Safety Data Sheets(SDS) available for the mixture or its constituent substances? (Please explain thoroughly)	
Is it possible to calculate/estimate the final concentration of the substance in the product, its components or spare parts, based on information from actors in the supply chain? (Please explain thoroughly)	
Protection of confidential business information (CBI)	
If there is a need to protect CBI, is it related to intellectual property, business-related information, or other? (Please explain thoroughly)	
What information out of the elements that must be disclosed by information requirements on substances of concern should be omitted in the interest of protecting CBI and why? (The list of elements can be found in Art. 7(5) of ESPR) (Please include justification and explain thoroughly)	
Other duly justified reasons	
Please explain the reasons thoroughly	

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8113 11.4. Appendix 4 – Inputs for LCA / LCC per Base Case

8114 11.4.1. BC1: Undercounter water-change dishwasher

8115 11.4.1.1. Raw materials

8116 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
8117 source and quality scoring. BoM data was sourced from Tasks 1-4 of this report.

8118 **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 galvanised Sheet	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

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
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%
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,	36-Recycling plastic Acrylonitrile-butadiene-styrene (ABS), waste

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
							bulk polymerisation or combined processes production mix, at plant	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	41-Polyethylene terephthalate (PET) granulate secondary ; no metal fraction from post-consumer waste, via washing, granulation, pelletisation production mix, at

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
							petrochemical based	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
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	28-High density polyethylene (HDPE), recycled

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
							production mix, at plant 0.91- 0.96 g/cm ³ , 28 g/mol per repeating unit	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

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
								route, at plant 8.92 g/cm3
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/cm3	99-Brass, recycled, post-consumer die casting, from copper and zinc, primary production mix, at plant 8.41- 8.86 g/cm3
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
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%

Material		Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Total weight	product	50.00	kg	100%					efficiency, scrap incineration: 11.0 MJ/kg NCV

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8121 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
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/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%
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	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 percentage	Data quality assessment	Dataset used	Dataset recycling
							petrochemical based	
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
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 %					

8123 11.4.1.2. Manufacturing

8124 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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8126 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			

Material	Value	Unit	Input value ERT	Comments	Dataset used
Styropor expandable polystyrene (EPS)	0.08	kg			
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

Material	Value	Unit	Input value ERT	Comments	Dataset used
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

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8128 11.4.1.3. Distribution

8129 Below, the transport scenario input data is provided (Table 11-5). Scenarios are based on PEF defaults as no stakeholder data was available.

8130 **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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8133 11.4.1.4. Use phase

8134 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
 8135 parameters indicated in **Table 11-6** were used. For heat modelling, default efficiency values were used (105 %), incorporated in the ERT.

8136 **Table 11-6: Use phase parameters for calculation for BC1.**

Description	Value	Unit	Source	Data quality assessment	Reference
Utilities input					
Annual energy consumption (total)	1,768.24	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		

Description	Value	Unit	Source	Data quality assessment	Reference
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	
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	30.8	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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8139 **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	
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

Preparatory study on professional dishwashers

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	30.8	Kg/year		Calculations based on Table 11-6
Annual rinsing agent use	-			

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8142 11.4.1.5. Economic input data

8143 All economic input parameters are provided below (Table 11-8 and Table 11-10).

8144 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	0.008250	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

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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)	1.36%	%				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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8147 **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%	1,768.24	454.61	68%	
Water	0.16%	43,989.93	84.02	13%	
Detergent	1.21%	30.80	129.94	19%	
Weighted average Escalation rate	1.36%				

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8149 **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	

Year	Sales per year	Unit	Reference
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	
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

8151 11.4.2. BC2: Undercounter one-tank dishwasher

8152 11.4.2.1. Raw materials

8153 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
 8154 source and quality scoring. BoM data was sourced from Tasks 1-4 of this report.

8155 **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,	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
							bulk polymerisation or combined processes production mix, at plant	
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%

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
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/cm ³
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 m ² = 1.32 kg	2.95	m ²	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

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Total product weight	68.27	kg	100 %					

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8157 **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/cm3	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/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%
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%

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
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
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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8160 11.4.2.2. Manufacturing

8161 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

8162

8163 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	

Material	Value	Unit	Input value ERT	Comments	Dataset used
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			
Pumps (copper)	2.45	kg	3.65	Best dataset choice from tool options	65-Copper Wire Drawing wire drawing single route, at plant 8.92 g/cm ³
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/cm ³
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

8171 11.4.2.4. Use phase

8172 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
 8173 parameters indicated in **Table 11-16** were used. For heat modelling, default efficiency values were used (105%), incorporated in the ERT.

8174 **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		

Description	Value	Unit	Source	Data quality assessment	Reference
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	
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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8176 **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

Use phase inputs	Value	Unit	Comment	Reference
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
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

Use phase inputs	Value	Unit	Comment	Reference
Annual rinsing agent use	16	kg/year		

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8178 **11.4.2.5. Economic input data**8179 All economic input parameters are provided below (**Table 11-18** and **Table 11-19**).8180 **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						
Latest Annual sales	0.178760	Mln Units / year	Stakeholder input	High quality		Tasks 1-4

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
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

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
Repair & maintenance costs	2,489.74	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)	1.35 %	%				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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8183 **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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8185 **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	

Year	Sales per year	Unit	Reference
2018	0.128270	mln. units/year	
2017	0.173252	mln. units/year	
2016	0.131295	mln. units/year	
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

8187 **11.4.3. BC3: Hood-type dishwasher**

8188 **11.4.3.1. Raw materials**

8189 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
8190 source and quality scoring. BoM data was sourced from the Tasks 1-4 of this study.

8191 **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	35-Polypropylene, recycled, post-consumer washing, drying, shredding, pelletizing production mix, at plant

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
							petrochemical based	Erec/ErecEoL, efficiency 90%
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

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
								route, at plant 8.92 g/cm ³
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

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
								plant aluminium waste, efficiency 90%
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	37-Recycling plastic (PVC), waste management,

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
							plant 62 g/mol per repeating unit	technology mix, at plant
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
Electronics (printed wiring board) Based on ERT, 1 m2 = 1.32 kg	3.79	m2	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	195-*End of life of Populated Printed wiring board (PWB) (2-layer) Recycling of copper and precious metals (Ag, Au, Pd, Pt)

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
							plant 2-layer, 1.32 kg	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 %					

8192 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/cm3	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/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%

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
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%					

8194 11.4.3.2. Manufacturing

8195 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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8198 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	

Material	Value	Unit	Input value ERT	Comments	Dataset used
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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8201 11.4.3.3. Distribution

8202 Below (Table 11-25), the transport scenario input data is provided. Scenarios are based on PEF defaults as no stakeholder data was available.

8203 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

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8206 11.4.3.4. Use phase

8207 For the use phase, energy inputs (electricity and heat), water and detergent use were included. To calculate the exact inputs for the ERT (

8208 **Table 11-27**), the parameters indicated in **Table 11-26** were used. For heat modelling, default efficiency values were used (105%), incorporated in the ERT.

8209 **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	

Description	Value	Unit	Source	Data quality assessment	Reference
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.)
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

Description	Value	Unit	Source	Data quality assessment	Reference
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

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8211 **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

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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		

8212 11.4.3.5. Economic input data

8213 All economic input parameters are provided below (Table 11-28 and Table 11-30).

8214 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	0.066004	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)

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	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)	1.44	%				See Table 11-29

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
annual growth of running costs)						
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		

8215 **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 %	

Use phase input	Escalation rate	Annual amount used	Annual costs	Share of total annual costs	Comments
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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8217 **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	

Year	Sales per year	Unit	Reference
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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8219 **11.4.4. BC4: Utensil/pot dishwasher**8220 **11.4.4.1. Raw materials**

8221 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
 8222 source and quality scoring. BoM data was sourced from the Task 1-4 of this study.

8223 **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,	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
							bulk polymerisation or combined processes production mix, at plant	
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%

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
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/cm ³
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 m ² = 1.32 kg	1.59	m ²	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

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Total product weight	206	kg	100%					

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8225 **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%

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
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
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%					

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8227

8228 11.4.4.2. Manufacturing

8229 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

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8231

8232 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	

Material	Value	Unit	Input value ERT	Comments	Dataset used
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)	5.00	kg	7.40	Best dataset choice from tool options	65-Copper Wire Drawing wire drawing single route, at plant 8.92 g/cm ³
Cable (copper)	2.40	kg			
Pumps (Al)	5.00	kg	5.00	Best dataset choice from tool options	53-Aluminium sheet rolling primary production, aluminium deep- drawing single route, at plant 2.7 g/cm ³

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8235 11.4.4.3. Distribution

8236 Below, the transport scenario input data is provided (**Table 11-35**). Scenarios are based on PEF defaults as no stakeholder data was available.8237 **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

8238

8239 11.4.4.4. Use phase

8240 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
 8241 parameters indicated in **Table 11-36** were used. For heat modelling, default efficiency values were used (105 %), incorporated in the ERT.

8242 **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)	0.052	kWh/L water	Calculated		
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

Description	Value	Unit	Source	Data quality assessment	Reference
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

8243

8244 **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	

Use phase inputs	Value	Unit	Comment	Reference
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		

8245 11.4.4.5. Economic input data

8246 All economic input parameters are provided below (Table 11-38 and Table).

8247 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	0.013751	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)

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	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)	1.44%	%				See Table 11-39

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
growth of running costs)						
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 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		

8248

8249 **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%	

Use phase input	Escalation rate	Annual amount used	Annual costs	Share of total annual costs	Comments
Detergent	1.21%	323.64	1,365.36	29%	
Weighted average Escalation rate	1.44%				

8250

8251 **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	
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	

Year	Sales per year	Unit	Reference
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

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8253 11.4.5. BC5: One-tank conveyor-type dishwasher

8254 11.4.5.1. Raw materials

8255 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
8256 source and quality scoring. BoM data was sourced from Tasks 1-4 of this study.

8257 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
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

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
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/cm3
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/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	0.5%	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

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
								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
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)	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

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
							production mix, at plant 2-layer, 1.32 kg	recycling processes: 95- 98% efficiency, scrap incineration: 11.0 MJ/kg NCV
Total product weight	891.29	kg	100%					

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8261 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/cm3	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/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%
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	not available

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
							furnace route, from steel scrap, secondary production single route, at plant > 2,06 % carbon content	
Total packaging weight	105.49	kg	100%					

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8264 11.4.5.2. Manufacturing

8265 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

8266 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			

Material	Value	Unit	Input value ERT	Comments	Dataset used
Cable sheath (silicone, EPDM)	5.17	Kg			
Gaskets (EPDM)	12.80	kg			
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			

Material	Value	Unit	Input value ERT	Comments	Dataset used
Ventilator, fan (AL)	17.44	kg			
Drive motor (AL)	4.00	kg			

8267 11.4.5.3. Distribution

8268 Below, the transport scenario input data is provided (**Table 11-45**). Scenarios are based on PEF defaults as no stakeholder data was available.

8269 **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

Transport means	Value	Unit	Dataset used	Data Source	Data quality assessment	Comment
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

8270 11.4.5.4. Use phase

8271 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
8272 parameters indicated in **Table 11-46** were used. For heat modelling, default efficiency values were used (105 %), incorporated in the ERT.

8273 **Table 11-46: Use phase parameters for calculation for BC5.**

Description	Value	Unit	Source	Data quality assessment	Reference
Utilities input					
Annual energy consumption (total)	52,810	kWh	Stakeholder input	High quality	Tasks 1-4
Energy consumption: Electricity	90%	%	Stakeholder input	High quality	Tasks 1-4

Description	Value	Unit	Source	Data quality assessment	Reference
Energy consumption: Heat	10%	%	Stakeholder input	High quality	Tasks 1-4
Annual water consumption (total)	403,524	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		
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

Description	Value	Unit	Source	Data quality assessment	Reference
Dishes per cycle	n.a.	unit	Stakeholder input	High quality	Tasks 1-4
Time in active mode per day	3.5	hours/day	Stakeholder input	High quality	Tasks 1-4
Auxiliary materials					
Annual detergent consumption	978.6	kg/year	Stakeholder input	High quality	Tasks 1-4
Annual rinsing agent consumption	82.3	kg/year	Stakeholder input	High quality	Tasks 1-4

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8275 **Table 11-47: Use phase input data for BC5.**

Use phase inputs	Value	Unit	Comment	Reference
Electricity				
On-mode: Consumption per hour	41.151	kWh		Calculations based on Table 11-46
On-mode: No. of hours / year	1,155	#	Cycles per day* Number of working days per year	Calculations based on Table 11-46

Use phase inputs	Value	Unit	Comment	Reference
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	6.005	kWh	Including heat for water heating	Calculations based on Table 11-46
No. of hours / year	1,155	#	Cycles per day* Number of working days per year	Calculations based on Table 11-46
Avg. Heat Power Output	6.005	kW	Total energy per year/total operating time per year	Calculations based on Table 11-46
No. of hours / year	1,155	hrs.	Hours per cycle * cycles per year	Calculations based on Table 11-46
Water use				
Annual water use	403.5	m ³		Calculations based on Table 11-46
Auxiliary materials				
Annual detergent use	978.6	kg/year		Calculations based on Table 11-46

Use phase inputs	Value	Unit	Comment	Reference
Annual rinsing agent use	82.3	kg/year		

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8277 11.4.5.5. Economic input data

8278 All economic input parameters are provided below (Table 11-48 and Table).

8279 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	0.005500	Mln Units / year	Stakeholder input	High quality		Tasks 1-4

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
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)
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

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
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)	1.45%	%				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.	

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8283 **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%	6,605.98	558.32	3%	Heat (kWh) divided by 1.05 to account for efficiency of natural gas boiler (105%)
Electricity	1.62%	47,528.91	12,219.68	68%	
Water	0.16%	403,524.00	770.73	4%	
Detergent	1.21%	978.56	4,128.28	23%	
Rinsing agent	1.21%	82.33	323.28	2%	
Weighted average Escalation rate	1.45%				

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8285 **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	

Year	Sales per year	Unit	Reference
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

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8287 **11.4.6. BC6: Multi-tank conveyor-type dishwasher**8288 **11.4.6.1. Raw materials**

8289 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
8290 source and quality scoring. BoM data was sourced from the Tasks 1-4 of this study.

8291 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
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

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
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/cm ³
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/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%
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/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%
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

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
								scrap smelting and refining single route, at plant 8.92 g/cm ³
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/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%
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/cm ³
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/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%
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/cm ³
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/cm ³

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

Material	Value	Unit	Weight in %	Material category	Recycled content	Data quality assessment	Dataset material	Dataset recycling
Total product weight	1,343.40	kg	100%					

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8294 **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

Material	Value	Unit	Weight in %	Material category	Recycled content percentage	Data quality assessment	Dataset used	Dataset recycling
								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
Total packaging weight	238.63	kg	100%					

8295 11.4.6.2. Manufacturing

8296 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

8297

8298 Table 11-54: Material inputs Manufacturing for BC6.

Material	Value	Unit	Input value ERT	Comments	Dataset used
Stainless steel	980	kg	1,042.44	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	8-Injection moulding plastic injection moulding production mix, at plant for PP, HDPE and PE
Polyamide (PA)	18.66	kg		Proxy	
Ethylene Propylene Dien M-class rubber (EPDM)	12	kg			

Material	Value	Unit	Input value ERT	Comments	Dataset used
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			

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8300 11.4.6.3. Distribution

8301 Below, the transport scenario input data is provided (**Table 11-55**). Scenarios are based on PEF defaults as no stakeholder data was available.8302 **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

8303 11.4.6.4. Use phase

8304 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
 8305 parameters indicated in **Table 11-56** were used. For heat modelling, default efficiency values were used (105 %), incorporated in the ERT.

8306 **Table 11-56: Use phase parameters for calculation for BC6.**

Description	Value	Unit	Source	Data quality assessment	Reference
Utilities input					
Annual energy consumption (total)	128,257.3	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)	763,752	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

Description	Value	Unit	Source	Data quality assessment	Reference
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	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	4.5	hours/day	Stakeholder input	High quality	Tasks 1-4

Description	Value	Unit	Source	Data quality assessment	Reference
Auxiliary materials					
Annual detergent consumption	1,765	kg/year	Stakeholder input	High quality	Tasks 1-4
Annual rinsing agent consumption	141	kg/year	Stakeholder input	High quality	Tasks 1-4

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8308 **Table 11-57: Use phase input data for BC6.**

Use phase inputs	Value	Unit	Comment	Reference
Electricity				
On-mode: Consumption per hour	73.413	kWh		Calculations based on Table 11-56
On-mode: No. of hours / year	1,485	#	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	15.278	kWh	Including heat for water heating	Calculations based on Table 11-56
No. of hours / year	1,485	#	Cycles per day* Number of working days per year	Calculations based on Table 11-56
Avg. Heat Power Output	15.278	kW	Total energy per year/total operating time per year	Calculations based on Table 11-56
No. of hours / year	1,485	hrs.	Hours per cycle * cycles per year	Calculations based on Table 11-56
Water use				
Annual water use	763.75	m ³		Calculations based on Table 11-56
Auxiliary materials				
Annual detergent use	1765	Kg/year		Calculations based on Table 11-56
Annual rinsing agent use	141	Kg/year		

8309 **11.4.6.5. Economic input data**

8310 All economic input parameters are provided below (**Table 11-58** and **Table**).

8311 **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	0.002750	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	

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
					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	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)	1.49%	%				See Table 11-59

LCC parameter	Value	Unit	Source	Data quality assessment	Comments	Reference
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 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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8313 **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%	21,606.78	1,826.15	5%	Heat (kWh) divided by 1.05 to account for efficiency of natural gas boiler (105%)
Electricity	1.62%	109,018.66	28,028.7	71%	
Water	0.16%	763,752	1,458.77	4%	

Use phase input	Escalation rate	Annual amount used	Annual costs	Share of total annual costs	Comments
Detergent	1.21%	1,765.21	7,446.9	19%	
Rinsing agent	1.21%	141.13	554.19	1%	
Weighted average Escalation rate	1.49%				

8314

8315 **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	

Year	Sales per year	Unit	Reference
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_aaind__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.

8334 The final escalation rate per product is in **Table 11-62**.

8335 **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 %

8336 As per Base Case, only one escalation rate is required for the ERT, a weighted average was
8337 calculated; for this, the annual use volume for each running cost product (water, electricity,
8338 natural gas and detergent) was multiplied by the costs per unit to calculate the yearly costs for
8339 each product. For heat, the annual kWh was divided by 1.05 to compensate the natural gas
8340 volumes for the efficiency (105 %) of the natural gas boiler as modelled in the ERT. Subsequently,
8341 for each Base Case a weighted average of the escalation rate was calculated based on the share
8342 of yearly costs per product.

8343 **11.5.** **Appendix 5 – Results of LCA / LCC per Base Case**

8344 **11.5.1.** **BC1: Undercounter water-change dishwasher**

8345 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
8346 (**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

8347 **Table 11-67.**8348 **Table 11-63: Life cycle impact per product: BC1.**

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
Materials	unit							Impacts	Credits	
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	21,219	0			21,249
Thermal energy	MJ		0		0	0	0			0
PEF Impact categories										
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

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
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

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
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
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

8349 * Manufacturing materials are double counted with the raw materials column.

8350 **Table 11-64: Life cycle impact per product per year of use: BC1.**

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	g	1,423	1,424		48	0	n.a.			2,895

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
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
Total weight	g	4,089	3,493		633	44,020,800	41			44,029,055
Energy consumption										
Electricity	kWh		3		0	1,768	0			1,771
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

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
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
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

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Water use	m ³ water eq. of deprive d 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.

8353 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	Packaging	Use	Maintenan- ce & Repair	EoL		Total
Materials	unit									
Plastics	kt	1.41E-01	1.41E-01		4.71E-03	0.00E+00	n.a.			2.87E-01
Metals	kt	2.05E-01	2.05E-01		0.00E+00	0.00E+00	n.a.			4.10E-01
Electronics	kt	1.79E-02	0.00E+00		0.00E+00	0.00E+00	n.a.			1.79E-02
Others	kt	4.13E-02	0.00E+00		5.79E-02	4.36E+03	n.a.			4.36E+03
Total weight	kt	4.05E-01	3.46E-01		6.26E-02	4.36E+03	4.05E-03			4.36E+03
Energy consumption										
Electricity	kWh		2.48E+05		0	1.75E+08	0			1.75E+08
Thermal energy	MJ		0		0	0	0			0
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	2.95E+06	1.82E+05	5.27E+04	6.37E+04	7.96E+07	3.13E+04	2.27E+05	-4.79E+05	8.26E+07
Ozone depletion	kg CFC-11 eq.	2.17E-03	6.86E-05	6.05E-07	1.05E-05	1.21E-01	2.24E-05	5.24E-05	-6.96E-06	1.23E-01
Human toxicity, cancer	CTUh	2.14E-02	1.34E-05	1.40E-05	3.94E-05	4.05E-02	2.14E-04	2.89E-04	-1.39E-02	4.85E-02

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Life Cycle phases -->		Raw materials	Manu- facturing	Distri- bution	Packaging	Use	Maintenan ce & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Human toxicity, non-cancer	CTUh	8.42E-02	7.15E-04	3.40E-04	6.85E-04	5.97E-01	8.49E-04	1.15E-03	-1.30E-02	6.72E-01
Particulate matter	disease incidence	2.27E-01	7.93E-03	1.69E-03	3.12E-03	2.88E+00	2.35E-03	1.32E-02	-4.88E-02	3.08E+00
Ionising radiation, human health	kBq U235 eq.	8.65E+04	7.85E+04	9.51E+02	3.56E+03	3.20E+07	1.65E+03	6.31E+04	-1.21E+04	3.22E+07
Photochemical ozone formation, human health	kg NMVOC eq.	7.79E+03	3.30E+02	1.87E+02	3.18E+02	1.43E+05	8.12E+01	3.38E+02	-1.03E+03	1.51E+05
Acidification	mol H+ eq.	1.49E+04	5.86E+02	2.06E+02	2.58E+02	2.54E+05	1.54E+02	5.24E+02	-2.88E+03	2.68E+05
Eutrophication, terrestrial	mol N eq.	2.67E+04	1.28E+03	9.90E+02	8.00E+02	5.31E+05	2.80E+02	1.25E+03	-3.18E+03	5.59E+05
Eutrophication, freshwater	kg P eq.	4.02E+01	3.95E-01	3.17E-01	1.15E+00	1.15E+03	4.06E-01	3.27E-01	-4.00E-01	1.19E+03
Eutrophication, marine	kg N eq.	2.57E+03	1.20E+02	8.83E+01	8.34E+01	5.71E+04	2.69E+01	1.17E+02	-2.87E+02	5.98E+04
Ecotoxicity, freshwater	CTUe	1.95E+07	9.04E+05	4.87E+05	4.19E+05	4.25E+08	2.04E+05	7.47E+05	-2.69E+06	4.45E+08
Land use	pt	9.55E+08	9.88E+05	4.07E+05	1.65E+07	4.04E+08	9.56E+06	7.13E+05	-1.77E+07	1.37E+09

Life Cycle phases -->		Raw materials	Manu- facturing	Distri- bution	Packaging	Use	Maintenan- ce & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Water use	m³ water eq. of deprived water	9.00E+05	6.49E+04	4.89E+03	1.05E+04	1.01E+08	9.65E+03	5.10E+04	-5.75E+04	1.02E+08
Resource use, minerals and metals	kg Sb eq.	2.91E+02	5.75E-02	3.49E-02	2.40E-02	8.24E+01	2.91E+00	4.52E-02	-4.47E+01	3.32E+02
Resource use, fossils	MJ	3.96E+07	3.26E+06	7.57E+05	8.97E+05	1.36E+09	4.29E+05	3.61E+06	-4.74E+06	1.40E+09
Additional technical information										
Primary energy consumption	MJ	4.0E+07	3.33E+06	7.57E+05	8.97E+05	1.41E+09	4.29E+05	3.61E+06	-4.74E+06	1.45E+09

8355 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		Total
Materials	unit									
Plastics	kt	1.33E+00	1.33E+00		4.46E-02	0.00E+00	n.a.			2.71E+00
Metals	kt	1.94E+00	1.94E+00		0.00E+00	0.00E+00	n.a.			3.88E+00
Electronics	kt	1.69E-01	0.00E+00		0.00E+00	0.00E+00	n.a.			1.69E-01
Others	kt	3.91E-01	0.00E+00		5.48E-01	4.13E+04	n.a.			4.13E+04
Total weight	kt	3.83E+00	3.27E+00		5.93E-01	4.13E+04	3.83E-02			4.13E+04
Energy consumption										
Electricity	kWh		2.34E+06		0	1.66E+09	0			1.66E+09
Thermal energy	MJ		0		0	0	0			0
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	2.79E+07	1.72E+06	4.99E+05	6.03E+05	7.54E+08	2.96E+05	2.15E+06	-4.54E+06	7.82E+08
Ozone depletion	kg CFC-11 eq.	2.05E-02	6.50E-04	5.73E-06	9.92E-05	1.14E+00	2.12E-04	4.96E-04	-6.59E-05	1.16E+00
Human toxicity, cancer	CTUh	2.02E-01	1.27E-04	1.33E-04	3.73E-04	3.83E-01	2.02E-03	2.73E-03	-1.32E-01	4.59E-01

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Life Cycle phases -->		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Human toxicity, non-cancer	CTUh	7.97E-01	6.77E-03	3.22E-03	6.48E-03	5.65E+00	8.03E-03	1.09E-02	-1.23E-01	6.36E+00
Particulate matter	disease incidence	2.15E+00	7.51E-02	1.60E-02	2.95E-02	2.72E+01	2.22E-02	1.25E-01	-4.62E-01	2.92E+01
Ionising radiation, human health	kBq U235 eq.	8.19E+05	7.43E+05	9.00E+03	3.37E+04	3.03E+08	1.56E+04	5.97E+05	-1.14E+05	3.05E+08
Photochemical ozone formation, human health	kg NMVOC eq.	7.37E+04	3.12E+03	1.77E+03	3.01E+03	1.36E+06	7.68E+02	3.20E+03	-9.74E+03	1.43E+06
Acidification	mol H+ eq.	1.41E+05	5.55E+03	1.95E+03	2.45E+03	2.41E+06	1.46E+03	4.96E+03	-2.73E+04	2.54E+06
Eutrophication, terrestrial	mol N eq.	2.53E+05	1.21E+04	9.37E+03	7.57E+03	5.02E+06	2.65E+03	1.18E+04	-3.01E+04	5.29E+06
Eutrophication, freshwater	kg P eq.	3.80E+02	3.74E+00	3.00E+00	1.09E+01	1.09E+04	3.84E+00	3.09E+00	-3.79E+00	1.13E+04
Eutrophication, marine	kg N eq.	2.44E+04	1.14E+03	8.36E+02	7.90E+02	5.41E+05	2.55E+02	1.10E+03	-2.72E+03	5.67E+05
Ecotoxicity, freshwater	CTUe	1.84E+08	8.55E+06	4.61E+06	3.97E+06	4.03E+09	1.93E+06	7.08E+06	-2.54E+07	4.21E+09
Land use	pt	9.04E+09	9.36E+06	3.85E+06	1.56E+08	3.82E+09	9.05E+07	6.75E+06	-1.67E+08	1.30E+10
Water use	m ³ water eq. of	8.52E+06	6.14E+05	4.62E+04	9.96E+04	9.53E+08	9.14E+04	4.83E+05	-5.44E+05	9.62E+08

Life Cycle phases -->		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
	deprived water									
Resource use, minerals and metals	kg Sb eq.	2.76E+03	5.44E-01	3.30E-01	2.27E-01	7.81E+02	2.76E+01	4.28E-01	-4.23E+02	3.14E+03
Resource use, fossils	MJ	3.75E+08	3.08E+07	7.17E+06	8.49E+06	1.29E+10	4.06E+06	3.42E+07	-4.48E+07	1.33E+10
Additional technical information										
Primary energy consumption	MJ	3.75E+08	3.15E+07	7.17E+06	8.49E+06	1.33E+10	4.07E+06	3.42E+07	-4.48E+07	1.38E+10

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8358 **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	410	EUR/year	35	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	981	EUR/year	88	mIn. EUR/year

8359 11.5.2. BC2: Undercounter one-tank dishwasher

8360 Below, the life cycle impact is provided per product (**Table 11-68**), per year of use of the product (**Table 11-69**), total impact for the EU-27 for the new product
8361 (**Table 11-70**) and the impact of the stock of products in the EU-27 (**Table 11-71**). The life cycle costs per product and as EU-27 total are provided in

8362 Table 11-72.

8363 Table 11-68: Life cycle impact per product: BC2.

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
Materials	unit							Impacts	Credits	
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									

Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
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
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

Life Cycle phases -->		Raw materials	Manufac turing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
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
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

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* Manufacturing materials are double counted with the raw materials column.

8365 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		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

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.	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
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

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
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.

8369 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	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	1.61E+00	1.61E+00		3.73E-01	0.00E+00	n.a.			3.59E+00
Metals	kt	9.90E+00	9.90E+00		0.00E+00	0.00E+00	n.a.			1.98E+01
Electronics	kt	6.96E-01	0.00E+00		0.00E+00	0.00E+00	n.a.			6.96E-01
Others	kt	0.00E+00	0.00E+00		2.26E+00	2.34E+05	n.a.			2.34E+05
Total weight	kt	1.22E+01	1.15E+01		2.63E+00	2.34E+05	1.22E-01			2.34E+05
Energy consumption										
Electricity	kWh		5.36E+06		0	1.76E+08	0			1.76E+08
Thermal energy	MJ		0		0	0	0			0
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	1.48E+08	3.36E+06	1.65E+06	3.23E+06	4.62E+09	1.52E+06	1.10E+07	-4.91E+07	4.74E+09

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Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packaging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Ozone depletion	kg CFC-11 eq.	2.87E-02	1.31E-03	1.89E-05	3.34E-03	7.81E+00	3.00E-04	2.54E-03	-7.97E-04	7.84E+00
Human toxicity, cancer	CTUh	6.17E+00	-2.69E-04	4.38E-04	1.72E-03	2.40E+00	6.17E-02	1.40E-02	-4.22E+00	4.43E+00
Human toxicity, non-cancer	CTUh	3.19E+00	1.54E-02	1.06E-02	2.70E-02	3.46E+01	3.21E-02	5.55E-02	-5.28E-01	3.74E+01
Particulate matter	disease incidence	1.66E+01	2.08E-01	5.27E-02	1.96E-01	1.74E+02	1.68E-01	6.43E-01	-7.94E+00	1.84E+02
Ionising radiation, human health	kBq U235 eq.	4.28E+06	1.50E+06	2.97E+04	1.64E+05	1.82E+09	5.78E+04	3.06E+06	-1.29E+06	1.83E+09
Photochemical ozone formation, human health	kg NMVOC eq.	4.02E+05	6.83E+03	5.85E+03	1.73E+04	8.51E+06	4.09E+03	1.65E+04	-1.40E+05	8.83E+06
Acidification	mol H+ eq.	1.23E+06	1.17E+04	6.44E+03	1.55E+04	1.51E+07	1.24E+04	2.55E+04	-6.05E+05	1.58E+07
Eutrophication, terrestrial	mol N eq.	1.35E+06	2.73E+04	3.09E+04	4.70E+04	3.21E+07	1.37E+04	6.09E+04	-4.44E+05	3.32E+07

Life Cycle phases -->		Raw materials	Manu- facturing	Distri- bution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Eutrophication, freshwater	kg P eq.	1.08E+03	7.76E+00	9.89E+00	9.06E+01	7.39E+04	1.08E+01	1.58E+01	-3.43E+01	7.50E+04
Eutrophication, marine	kg N eq.	1.24E+05	2.56E+03	2.76E+03	4.92E+03	3.58E+06	1.27E+03	5.67E+03	-3.88E+04	3.68E+06
Ecotoxicity, freshwater	CTUe	9.01E+08	1.86E+07	1.52E+07	2.68E+07	2.57E+10	9.19E+06	3.63E+07	-3.53E+08	2.64E+10
Land use	pt	3.67E+10	2.34E+07	1.27E+07	7.87E+08	2.65E+10	3.67E+08	3.46E+07	-7.30E+08	6.37E+10
Water use	m ³ water eq. of deprived water	4.41E+07	1.30E+06	1.53E+05	7.58E+05	5.61E+09	4.54E+05	2.46E+06	-1.15E+07	5.65E+09
Resource use, minerals and metals	kg Sb eq.	1.63E+04	1.29E+00	1.09E+00	5.04E+00	6.58E+03	1.63E+02	2.20E+00	-5.25E+03	1.78E+04
Resource use, fossils	MJ	1.74E+09	6.32E+07	2.37E+07	5.24E+07	7.88E+10	1.81E+07	1.76E+08	-5.46E+08	8.03E+10
Additional technical information										
Primary energy consumption	MJ	1.74E+09	6.47E+07	2.37E+07	5.24E+07	8.15E+10	1.81E+07	1.76E+08	-5.46E+08	8.30E+10

8370 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	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	1.07E+01	1.07E+01		2.49E+00	0.00E+00	n.a.			2.39E+01
Metals	kt	6.59E+01	6.59E+01		0.00E+00	0.00E+00	n.a.			1.32E+02
Electronics	kt	4.64E+00	0.00E+00		0.00E+00	0.00E+00	n.a.			4.64E+00
Others	kt	0.00E+00	0.00E+00		1.50E+01	1.56E+06	n.a.			1.56E+06
Total weight	kt	8.13E+01	7.66E+01		1.75E+01	1.56E+06	8.13E-01			1.56E+06
Energy consumption										
Electricity	kWh		3.57E+07		0	6.63E+10	0			6.64E+10
Thermal energy	MJ		0		0	0	0			0
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	9.89E+08	2.24E+07	1.10E+07	2.15E+07	3.08E+10	1.01E+07	7.36E+07	-3.27E+08	3.16E+10
Ozone depletion	kg CFC-11 eq.	1.91E-01	8.73E-03	1.26E-04	2.23E-02	5.20E+01	2.00E-03	1.69E-02	-5.31E-03	5.22E+01
Human toxicity, cancer	CTUh	4.11E+01	-1.79E-03	2.92E-03	1.15E-02	1.60E+01	4.11E-01	9.32E-02	-2.81E+01	2.95E+01

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Life Cycle phases -->				Raw materials	Manu- facturing	Distri- bution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions										Impacts	Credits	
Human toxicity, non-cancer		CTUh		2.12E+01	1.03E-01	7.08E-02	1.80E-01	2.31E+02	2.13E-01	3.70E-01	-3.52E+00	2.49E+02
Particulate matter		disease incidence		1.10E+02	1.38E+00	3.51E-01	1.31E+00	1.16E+03	1.12E+00	4.28E+00	-5.29E+01	1.23E+03
Ionising radiation, human health		kBq U235 eq.		2.85E+07	9.98E+06	1.98E+05	1.09E+06	1.21E+10	3.85E+05	2.04E+07	-8.57E+06	1.22E+10
Photochemical ozone formation, human health		kg NMVOC eq.		2.68E+06	4.55E+04	3.89E+04	1.15E+05	5.67E+07	2.72E+04	1.10E+05	-9.35E+05	5.88E+07
Acidification		mol H+ eq.		8.21E+06	7.76E+04	4.29E+04	1.03E+05	1.00E+08	8.29E+04	1.70E+05	-4.03E+06	1.05E+08
Eutrophication, terrestrial		mol N eq.		8.97E+06	1.82E+05	2.06E+05	3.13E+05	2.14E+08	9.15E+04	4.06E+05	-2.95E+06	2.21E+08
Eutrophication, freshwater		kg P eq.		7.16E+03	5.17E+01	6.59E+01	6.04E+02	4.92E+05	7.21E+01	1.05E+02	-2.29E+02	5.00E+05
Eutrophication, marine		kg N eq.		8.28E+05	1.70E+04	1.84E+04	3.28E+04	2.39E+07	8.45E+03	3.78E+04	-2.59E+05	2.45E+07
Ecotoxicity, freshwater		CTUe		6.00E+09	1.24E+08	1.01E+08	1.78E+08	1.71E+11	6.12E+07	2.42E+08	-2.35E+09	1.76E+11
Land use		pt		2.45E+11	1.56E+08	8.46E+07	5.24E+09	1.76E+11	2.45E+09	2.30E+08	-4.86E+09	4.24E+11
Water use		m³ water eq. of deprived water		2.94E+08	8.66E+06	1.02E+06	5.05E+06	3.74E+10	3.03E+06	1.64E+07	-7.68E+07	3.76E+10

Life Cycle phases -->		Raw materials	Manu- facturing	Distri- bution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Resource use, minerals and metals	kg Sb eq.	1.09E+05	8.60E+00	7.26E+00	3.36E+01	4.38E+04	1.09E+03	1.46E+01	-3.50E+04	1.19E+05
Resource use, fossils	MJ	1.16E+10	4.21E+08	1.58E+08	3.49E+08	5.25E+11	1.20E+08	1.17E+09	-3.64E+09	5.35E+11
Additional technical information										
Primary energy consumption	MJ	1.16E+10	4.31E+08	1.58E+08	3.49E+08	5.43E+11	1.20E+08	1.17E+09	-3.64E+09	5.56E+11

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8373 **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

8374 **11.5.3. BC3: Hood-type dishwasher**

8375 Below, the life cycle impact is provided per product (**Table 11-73**), per year of use of the product (**Table 11-74**), total impact for the EU-27 for the new product
 8376 (**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-**
 8377 **77**.

8378 **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

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Life Cycle phases -->		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Thermal energy	MJ		0		0	8,591	0			8,591
PEF Impact categories	unit									
Climate change, total	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

Life Cycle phases -->		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
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
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

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* Manufacturing materials are double counted with the raw materials column.

8380 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	Maintenan- ce & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	g	1,720	1,719		243	0	n.a.			3,682
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

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenan- ce & Repair	EoL Impacts Credits		Total
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
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

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenan- ce & Repair	EoL Impacts Credits		Total
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

8381 * Manufacturing materials are double counted with the raw materials column.

8382 **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	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	9.08E-01	9.08E-01		1.28E-01	0.00E+00	n.a.			1.94E+00
Metals	kt	8.58E+00	8.13E+00		0.00E+00	0.00E+00	n.a.			1.67E+01

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Life Cycle phases -->		Raw materials	Manu- facturing	Distri- bution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Electronics	kt	3.30E-01	0.00E+00		0.00E+00	0.00E+00	n.a.			3.30E-01
Others	kt	0.00E+00	0.00E+00		1.60E+00	8.20E+04	n.a.			8.20E+04
Total weight	kt	9.81E+00	9.03E+00		1.73E+00	8.20E+04	9.81E-02			8.20E+04
Energy consumption										
Electricity	kWh		2.38E+06		0	1.76E+08	0			1.76E+08
Thermal energy	MJ		0		0	0	0			0
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	1.00E+08	1.63E+06	1.28E+06	1.81E+06	3.36E+09	1.02E+06	9.81E+06	-4.36E+07	3.43E+09
Ozone depletion	kg CFC-11 eq	1.51E-02	6.62E-04	1.47E-05	1.57E-03	4.21E+00	1.57E-04	2.26E-03	-6.79E-04	4.23E+00
Human toxicity, cancer	CTUh	5.49E+00	-4.25E-04	3.41E-04	1.09E-03	1.23E+00	5.49E-02	1.25E-02	-3.76E+00	3.03E+00
Human toxicity, non-cancer	CTUh	1.86E+00	8.97E-03	8.27E-03	1.94E-02	1.89E+01	1.86E-02	4.91E-02	-4.66E-01	2.04E+01
Particulate matter	disease incidence	1.27E+01	1.36E-01	4.10E-02	1.18E-01	1.22E+02	1.28E-01	5.73E-01	-7.05E+00	1.29E+02
Ionising radiation, human health	kBq U235 eq.	2.77E+06	7.56E+05	2.31E+04	9.61E+04	1.35E+09	3.52E+04	2.73E+06	-1.12E+06	1.35E+09

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Life Cycle phases -->			Raw materials	Manu- facturing	Distri- bution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions									Impacts	Credits	
Photochemical ozone formation, human health	kg NMVOC eq.		2.76E+05	3.77E+03	4.55E+03	9.85E+03	5.99E+06	2.80E+03	1.47E+04	-1.24E+05	6.18E+06
Acidification	mol H+ eq.		9.52E+05	6.16E+03	5.01E+03	8.74E+03	1.08E+07	9.58E+03	2.27E+04	-5.38E+05	1.13E+07
Eutrophication, terrestrial	mol N eq.		9.08E+05	1.56E+04	2.41E+04	2.63E+04	2.28E+07	9.23E+03	5.40E+04	-3.92E+05	2.34E+07
Eutrophication, freshwater	kg P eq.		5.40E+02	4.08E+00	7.70E+00	4.41E+01	3.68E+04	5.44E+00	1.41E+01	-3.03E+01	3.74E+04
Eutrophication, marine	kg N eq.		8.25E+04	1.45E+03	2.15E+03	2.71E+03	2.45E+06	8.40E+02	5.03E+03	-3.43E+04	2.51E+06
Ecotoxicity, freshwater	CTUe		6.34E+08	1.02E+07	1.18E+07	1.22E+07	1.77E+10	6.44E+06	3.24E+07	-3.08E+08	1.81E+10
Land use	pt		1.94E+10	1.44E+07	9.89E+06	4.62E+08	1.89E+10	1.95E+08	3.07E+07	-3.72E+08	3.87E+10
Water use	m³ water eq. of deprived water		2.82E+07	6.87E+05	1.19E+05	3.96E+05	2.61E+09	2.89E+05	2.19E+06	-1.02E+07	2.63E+09
Resource use, minerals and metals	kg Sb eq.		1.09E+04	7.76E-01	8.49E-01	2.61E+00	4.13E+03	1.09E+02	1.96E+00	-4.51E+03	1.06E+04
Resource use, fossils	MJ		1.16E+09	3.24E+07	1.84E+07	2.42E+07	5.76E+10	1.19E+07	1.57E+08	-4.84E+08	5.85E+10
Additional technical information											
Primary energy consumption	MJ		1.16E+09	3.31E+07	1.84E+07	2.42E+07	5.97E+10	1.19E+07	1.57E+08	-4.84E+08	6.06E+10

8383 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	6.05E+00	6.04E+00		8.55E-01	0.00E+00	n.a.			1.29E+01
Metals	kt	5.71E+01	5.41E+01		0.00E+00	0.00E+00	n.a.			1.11E+02
Electronics	kt	2.20E+00	0.00E+00		0.00E+00	0.00E+00	n.a.			2.20E+00
Others	kt	0.00E+00	0.00E+00		1.07E+01	5.46E+05	n.a.			5.46E+05
Total weight	kt	6.54E+01	6.02E+01		1.15E+01	5.46E+05	6.54E-01			5.46E+05
Energy consumption										
Electricity	kWh		1.58E+07		0	4.94E+10	0			4.95E+10
Thermal energy	MJ		0		0	0	0			0
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	6.67E+08	1.09E+07	8.53E+06	1.20E+07	2.24E+10	6.78E+06	6.53E+07	-2.90E+08	2.28E+10
Ozone depletion	kg CFC-11 eq.	1.00E-01	4.41E-03	9.80E-05	1.04E-02	2.80E+01	1.05E-03	1.51E-02	-4.52E-03	2.82E+01

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Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Human toxicity, cancer	CTUh	3.66E+01	-2.83E-03	2.27E-03	7.25E-03	8.21E+00	3.66E-01	8.31E-02	- 2.51E+01	2.02E+01
Human toxicity, non-cancer	CTUh	1.24E+01	5.97E-02	5.51E-02	1.29E-01	1.26E+02	1.24E-01	3.27E-01	- 3.10E+00	1.36E+02
Particulate matter	disease incidence	8.47E+01	9.09E-01	2.73E-01	7.87E-01	8.13E+02	8.56E-01	3.82E+00	- 4.70E+01	8.57E+02
Ionising radiation, human health	kBq U235 eq.	1.84E+07	5.03E+06	1.54E+05	6.40E+05	8.97E+09	2.35E+05	1.82E+07	- 7.43E+06	9.00E+09
Photochemical ozone formation, human health	kg NMVOC eq.	1.84E+06	2.51E+04	3.03E+04	6.56E+04	3.99E+07	1.86E+04	9.76E+04	- 8.27E+05	4.11E+07
Acidification	mol H+ eq.	6.34E+06	4.10E+04	3.34E+04	5.82E+04	7.19E+07	6.38E+04	1.51E+05	- 3.58E+06	7.50E+07
Eutrophication, terrestrial	mol N eq.	6.05E+06	1.04E+05	1.60E+05	1.75E+05	1.52E+08	6.15E+04	3.60E+05	- 2.61E+06	1.56E+08
Eutrophication, freshwater	kg P eq.	3.60E+03	2.72E+01	5.13E+01	2.94E+02	2.45E+05	3.63E+01	9.38E+01	- 2.02E+02	2.49E+05
Eutrophication, marine	kg N eq.	5.50E+05	9.66E+03	1.43E+04	1.81E+04	1.63E+07	5.59E+03	3.35E+04	- 2.28E+05	1.67E+07

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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	4.22E+09	6.78E+07	7.89E+07	8.09E+07	1.18E+11	4.29E+07	2.16E+08	- 2.05E+09	1.20E+11
Land use	pt	1.30E+11	9.58E+07	6.59E+07	3.08E+09	1.26E+11	1.30E+09	2.05E+08	- 2.48E+09	2.58E+11
Water use	m ³ water eq. of deprived water	1.88E+08	4.58E+06	7.91E+05	2.64E+06	1.74E+10	1.92E+06	1.46E+07	- 6.77E+07	1.75E+10
Resource use, minerals and metals	kg Sb eq.	7.24E+04	5.17E+00	5.65E+00	1.74E+01	2.75E+04	7.24E+02	1.30E+01	- 3.01E+04	7.06E+04
Resource use, fossils	MJ	7.73E+09	2.16E+08	1.23E+08	1.61E+08	3.84E+11	7.95E+07	1.05E+09	- 3.22E+09	3.90E+11
Additional technical information										
Primary energy consumption	MJ	7.73E+09	2.20E+08	1.23E+08	1.61E+08	3.97E+11	7.95E+07	1.05E+09	- 3.22E+09	4.06E+11

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8386 **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
Repair & maintenance costs	3,811	EUR	224	mIn. EUR/year
Total	6,566	EUR/year	3,152	mIn. EUR/year

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8389 **11.5.4. BC4: Utensil/pot dishwasher**

8390 Below, the life cycle impact is provided per product (**Table 11-78**), per year of use of the product (**Table 11-79**), total impact for the EU-27 for the new product
 8391 (**Table 11-80**) and the impact of the stock of products in the EU-27 (**Table 11-81**). The life cycle costs per product and as EU-27 total are provided in **Table 11-**
 8392 **82**.

8393 **Table 11-78: Life cycle impact per product: BC4.**

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
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	2,099	0		0	0	n.a.			2,099
Others	g	0	0		22,375	1,053,365,850	n.a.			1,053,388,225
Total weight	g	205,999	203,900		24,149	1,053,365,850	2,060			1,053,801,958
Energy consumption										
Electricity	kWh		40		0	106,839	0			106,879
Thermal energy	MJ		0		0	36,455	0			36,455

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
PEF Impact categories	unit							Impacts	Credits	
Climate change, total	kg CO ₂ eq.	1.7E+03	2.9E+01	2.6E+01	2.5E+01	5.0E+04	1.7E+01	2.1E+02	-9.3E+02	5.1E+04
Ozone depletion	kg CFC-11 eq.	1.1E-07	1.2E-08	2.9E-10	2.0E-08	6.4E-05	1.2E-09	5.0E-08	-1.0E-08	6.4E-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	2.6E-05	1.8E-07	1.7E-07	2.8E-07	2.7E-04	2.6E-07	1.1E-06	-1.0E-05	2.9E-04
Particulate matter	disease incidence	2.5E-04	2.9E-06	8.2E-07	1.7E-06	1.8E-03	2.5E-06	1.3E-05	-1.5E-04	1.9E-03
Ionising radiation, human health	kBq U235 eq.	3.9E+01	1.4E+01	4.6E-01	1.3E+00	1.9E+04	5.3E-01	6.0E+01	-1.9E+01	2.0E+04
Photochemical ozone formation, human health	kg NMVOC eq.	4.7E+00	7.1E-02	9.1E-02	1.3E-01	8.9E+01	4.7E-02	3.2E-01	-2.7E+00	9.1E+01
Acidification	mol H+ eq.	1.8E+01	1.2E-01	1.0E-01	1.2E-01	1.6E+02	1.8E-01	5.0E-01	-1.2E+01	1.7E+02

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Life Cycle phases -->		Raw materials	Manu- facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Eutrophication, terrestrial	mol N eq.	1.5E+01	3.0E-01	4.8E-01	3.6E-01	3.4E+02	1.5E-01	1.2E+00	-8.4E+00	3.5E+02
Eutrophication, freshwater	kg P eq.	4.4E-03	7.7E-05	1.5E-04	5.7E-04	5.6E-01	4.5E-05	3.1E-04	-6.5E-04	5.7E-01
Eutrophication, marine	kg N eq.	1.3E+00	2.8E-02	4.3E-02	3.7E-02	3.7E+01	1.4E-02	1.1E-01	-7.4E-01	3.8E+01
Ecotoxicity, freshwater	CTUe	1.0E+04	2.0E+02	2.4E+02	1.7E+02	2.6E+05	1.1E+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	-3.2E+03	7.1E+05
Water use	m ³ water eq. of deprived water	4.4E+02	1.3E+01	2.4E+00	5.3E+00	3.6E+04	4.5E+00	4.8E+01	-2.1E+02	3.6E+04
Resource use, minerals and metals	kg Sb eq.	2.0E-01	1.6E-05	1.7E-05	3.8E-05	7.0E-02	2.0E-03	4.3E-05	-9.6E-02	1.7E-01
Resource use, fossils	MJ	1.9E+04	6.0E+02	3.7E+02	3.3E+02	8.6E+05	2.0E+02	3.4E+03	-1.0E+04	8.7E+05
Additional technical information										
Primary energy consumption	MJ	1.9E+04	6.1E+02	3.7E+02	3.3E+02	8.9E+05	2.0E+02	3.4E+03	-1.0E+04	9.0E+05

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* Manufacturing materials are double counted with the raw materials column.

8395 Table 11-79: Life cycle impact per product per year of use: BC4.

Life Cycle phases -->		Raw materials	Manu-facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
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	233	0		0	0	n.a.			233
Others	g	0	0		2,486	117,040,650	n.a.			117,043,136
Total weight	g	22,889	22,656		2,683	117,040,650	229			117,089,106
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.	1.8E+02	3.2E+00	2.8E+00	2.8E+00	5.6E+03	1.9E+00	2.4E+01	-1.0E+02	5.7E+03

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Life Cycle phases -->		Raw materials	Manu-facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Ozone depletion	kg CFC-11 eq.	1.2E-08	1.4E-09	3.3E-11	2.3E-09	7.1E-06	1.4E-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	6.3E-06
Human toxicity, non-cancer	CTUh	2.9E-06	2.0E-08	1.8E-08	3.1E-08	3.0E-05	2.9E-08	1.2E-07	-1.1E-06	3.2E-05
Particulate matter	disease incidence	2.7E-05	3.2E-07	9.1E-08	1.9E-07	2.0E-04	2.8E-07	1.4E-06	-1.7E-05	2.1E-04
Ionising radiation, human health	kBq U235 eq.	4.3E+00	1.6E+00	5.1E-02	1.5E-01	2.2E+03	5.9E-02	6.6E+00	-2.2E+00	2.2E+03
Photochemical ozone formation, human health	kg NMVOC eq.	5.2E-01	7.9E-03	1.0E-02	1.5E-02	9.8E+00	5.2E-03	3.5E-02	-3.0E-01	1.0E+01
Acidification	mol H+ eq.	2.0E+00	1.3E-02	1.1E-02	1.3E-02	1.8E+01	2.0E-02	5.5E-02	-1.3E+00	1.9E+01
Eutrophication, terrestrial	mol N eq.	1.7E+00	3.4E-02	5.3E-02	4.0E-02	3.7E+01	1.7E-02	1.3E-01	-9.4E-01	3.8E+01
Eutrophication, freshwater	kg P eq.	4.9E-04	8.6E-06	1.7E-05	6.4E-05	6.2E-02	5.0E-06	3.4E-05	-7.2E-05	6.3E-02

Life Cycle phases -->		Raw materials	Manu-facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Eutrophication, marine	kg N eq.	1.5E-01	3.1E-03	4.8E-03	4.1E-03	4.1E+00	1.5E-03	1.2E-02	-8.2E-02	4.2E+00
Ecotoxicity, freshwater	CTUe	1.2E+03	2.2E+01	2.6E+01	1.8E+01	2.9E+04	1.2E+01	7.8E+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	-3.5E+02	7.9E+04
Water use	m³ water eq. of deprived water	4.9E+01	1.5E+00	2.6E-01	5.9E-01	4.0E+03	5.1E-01	5.3E+00	-2.4E+01	4.0E+03
Resource use, minerals and metals	kg Sb eq.	2.2E-02	1.7E-06	1.9E-06	4.3E-06	7.8E-03	2.2E-04	4.7E-06	-1.1E-02	1.9E-02
Resource use, fossils	MJ	2.1E+03	6.6E+01	4.1E+01	3.7E+01	9.5E+04	2.2E+01	3.8E+02	-1.1E+03	9.7E+04
Additional technical information										
Primary energy consumption	MJ	2.1E+03	6.8E+01	4.1E+01	3.7E+01	9.9E+04	2.2E+01	3.8E+02	-1.1E+03	1.0E+05

* Manufacturing materials are double counted with the raw materials column.

8398 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	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	2.68E-01	2.68E-01		2.44E-02	0.00E+00	n.a.			5.61E-01
Metals	kt	2.54E+00	2.54E+00		0.00E+00	0.00E+00	n.a.			5.07E+00
Electronics	kt	6.88E-02	0.00E+00		0.00E+00	0.00E+00	n.a.			6.88E-02
Others	kt	0.00E+00	0.00E+00		3.08E-01	1.45E+04	n.a.			1.45E+04
Total weight	kt	2.87E+00	2.80E+00		3.32E-01	1.45E+04	2.87E-02			1.45E+04
Energy consumption										
Electricity	kWh		5.50E+05		0	1.47E+09	0			1.47E+09
Thermal energy	MJ		0		0	5.01E+08	0			5.01E+08
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	2.3E+07	4.0E+05	3.5E+05	3.4E+05	6.9E+08	2.3E+05	2.9E+06	-1.3E+07	7.0E+08

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Life Cycle phases -->		Raw materials	Manu- facturing	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Ozone depletion	kg CFC-11 eq.	1.5E-03	1.7E-04	4.0E-06	2.8E-04	8.8E-01	1.7E-05	6.8E-04	-1.4E-04	8.9E-01
Human toxicity, cancer	CTUh	1.7E+00	-1.6E-04	9.4E-05	2.2E-04	2.5E-01	1.7E-02	3.8E-03	-1.1E+00	7.9E-01
Human toxicity, non-cancer	CTUh	3.6E-01	2.5E-03	2.3E-03	3.8E-03	3.7E+00	3.6E-03	1.5E-02	-1.4E-01	4.0E+00
Particulate matter	disease incidence	3.4E+00	4.0E-02	1.1E-02	2.3E-02	2.5E+01	3.4E-02	1.7E-01	-2.1E+00	2.6E+01
Ionising radiation, human health	kBq U235 eq.	5.4E+05	1.9E+05	6.4E+03	1.8E+04	2.7E+08	7.3E+03	8.2E+05	-2.7E+05	2.7E+08
Photochemical ozone formation, human health	kg NMVOC eq.	6.4E+04	9.8E+02	1.3E+03	1.9E+03	1.2E+06	6.5E+02	4.4E+03	-3.7E+04	1.3E+06
Acidification	mol H+ eq.	2.5E+05	1.6E+03	1.4E+03	1.7E+03	2.2E+06	2.5E+03	6.8E+03	-1.6E+05	2.3E+06
Eutrophication, terrestrial	mol N eq.	2.1E+05	4.2E+03	6.6E+03	5.0E+03	4.6E+06	2.1E+03	1.6E+04	-1.2E+05	4.8E+06
Eutrophication, freshwater	kg P eq.	6.1E+01	1.1E+00	2.1E+00	7.9E+00	7.7E+03	6.2E-01	4.2E+00	-8.9E+00	7.8E+03

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Life Cycle phases -->		Raw materials	Manu- facturing	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Eutrophication, marine	kg N eq.	1.8E+04	3.9E+02	5.9E+02	5.1E+02	5.0E+05	1.9E+02	1.5E+03	-1.0E+04	5.2E+05
Ecotoxicity, freshwater	CTUe	1.4E+08	2.7E+06	3.3E+06	2.3E+06	3.6E+09	1.5E+06	9.7E+06	-7.7E+07	3.7E+09
Land use	pt	5.7E+09	3.9E+06	2.7E+06	8.5E+07	4.0E+09	5.7E+07	9.2E+06	-4.4E+07	9.8E+09
Water use	m³ water eq. of deprived water	6.1E+06	1.8E+05	3.3E+04	7.2E+04	4.9E+08	6.3E+04	6.6E+05	-2.9E+06	5.0E+08
Resource use, minerals and metals	kg Sb eq.	2.7E+03	2.2E-01	2.3E-01	5.3E-01	9.7E+02	2.7E+01	5.9E-01	-1.3E+03	2.4E+03
Resource use, fossils	MJ	2.6E+08	8.2E+06	5.1E+06	4.5E+06	1.2E+10	2.7E+06	4.7E+07	-1.4E+08	1.2E+10
Additional technical information										
Primary energy consumption	MJ	2.63E+08	8.36E+06	5.06E+06	4.53E+06	1.22E+10	2.72E+06	4.72E+07	-1.42E+08	1.24E+10

8400 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	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	1.98E+00	1.98E+00		1.80E-01	0.00E+00	n.a.			4.13E+00
Metals	kt	1.87E+01	1.87E+01		0.00E+00	0.00E+00	n.a.			3.74E+01
Electronics	kt	5.07E-01	0.00E+00		0.00E+00	0.00E+00	n.a.			5.07E-01
Others	kt	0.00E+00	0.00E+00		2.27E+00	1.07E+05	n.a.			1.07E+05
Total weight	kt	2.12E+01	2.07E+01		2.45E+00	1.07E+05	2.12E-01			1.07E+05
Energy consumption										
Electricity	kWh		4.05E+06		0	1.08E+10	0			1.08E+10
Thermal energy	MJ		0		0	3.69E+09	0			3.69E+09
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	1.7E+08	2.9E+06	2.6E+06	2.5E+06	5.1E+09	1.7E+06	2.2E+07	-9.5E+07	5.2E+09
Ozone depletion	kg CFC-11 eq.	1.1E-02	1.2E-03	3.0E-05	2.1E-03	6.5E+00	1.3E-04	5.0E-03	-1.0E-03	6.5E+00

Life Cycle phases -->		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Human toxicity, cancer	CTUh	1.2E+01	-1.2E-03	6.9E-04	1.6E-03	1.8E+00	1.2E-01	2.8E-02	-8.4E+00	5.8E+00
Human toxicity, non-cancer	CTUh	2.7E+00	1.8E-02	1.7E-02	2.8E-02	2.8E+01	2.7E-02	1.1E-01	-1.0E+00	2.9E+01
Particulate matter	disease incidence	2.5E+01	2.9E-01	8.3E-02	1.7E-01	1.8E+02	2.5E-01	1.3E+00	-1.6E+01	1.9E+02
Ionising radiation, human health	kBq U235 eq.	3.9E+06	1.4E+06	4.7E+04	1.3E+05	2.0E+09	5.4E+04	6.1E+06	-2.0E+06	2.0E+09
Photochemical ozone formation, human health	kg NMVOC eq.	4.7E+05	7.2E+03	9.2E+03	1.4E+04	9.0E+06	4.8E+03	3.2E+04	-2.7E+05	9.2E+06
Acidification	mol H+ eq.	1.9E+06	1.2E+04	1.0E+04	1.2E+04	1.6E+07	1.9E+04	5.0E+04	-1.2E+06	1.7E+07
Eutrophication, terrestrial	mol N eq.	1.5E+06	3.1E+04	4.9E+04	3.7E+04	3.4E+07	1.5E+04	1.2E+05	-8.5E+05	3.5E+07
Eutrophication, freshwater	kg P eq.	4.5E+02	7.8E+00	1.6E+01	5.8E+01	5.7E+04	4.6E+00	3.1E+01	-6.6E+01	5.7E+04
Eutrophication, marine	kg N eq.	1.3E+05	2.8E+03	4.3E+03	3.7E+03	3.7E+06	1.4E+03	1.1E+04	-7.5E+04	3.8E+06
Ecotoxicity, freshwater	CTUe	1.1E+09	2.0E+07	2.4E+07	1.7E+07	2.6E+10	1.1E+07	7.2E+07	-5.7E+08	2.7E+10

Life Cycle phases -->		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Land use	pt	4.2E+10	2.9E+07	2.0E+07	6.3E+08	2.9E+10	4.2E+08	6.8E+07	-3.2E+08	7.2E+10
Water use	m ³ water eq. of deprived water	4.5E+07	1.3E+06	2.4E+05	5.3E+05	3.6E+09	4.6E+05	4.8E+06	-2.2E+07	3.7E+09
Resource use, minerals and metals	kg Sb eq.	2.0E+04	1.6E+00	1.7E+00	3.9E+00	7.1E+03	2.0E+02	4.3E+00	-9.7E+03	1.7E+04
Resource use, fossils	MJ	1.9E+09	6.0E+07	3.7E+07	3.3E+07	8.7E+10	2.0E+07	3.5E+08	-1.0E+09	8.8E+10
Additional technical information										
Primary energy consumption	MJ	1.94E+09	6.16E+07	3.73E+07	3.34E+07	9.01E+10	2.00E+07	3.47E+08	-1.04E+09	9.21E+10

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8403 **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
Total	6,187	EUR/year	694	mIn. EUR/year

8404 **11.5.5. BC5: One-tank conveyor-type dishwasher**

8405 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
 8406 (**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-**
 8407 **87**.

8408 **Table 11-83: Life cycle impact per product: BC5.**

Life Cycle phases -->		Raw materials	Manu-facturing*	Distri-bution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Materials	unit									
Plastics	g	102,280	102,280		5,985	0	n.a.			210,545
Metals	g	779,205	779,210		11,000	0	n.a.			1,569,415
Electronics	g	9,800	0		0	0	n.a.			9,800
Others	g	0	0		88,500	4,450,433,724	n.a.			4,450,522,224
Total weight	g	891,285	881,490		105,485	4,450,433,724	8,913			4,452,320,897
Energy consumption										
Electricity	kWh		250		0	522,823	0			523,073
Thermal energy	MJ		0		0	261,578	0			261,578

Life Cycle phases -->		Raw materials	Manu-facturing*	Distri-bution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	7.0E+03	1.8E+02	1.1E+02	1.0E+02	2.5E+05	7.2E+01	8.4E+02	-3.8E+03	2.5E+05
Ozone depletion	kg CFC-11 eq	1.4E-06	7.3E-08	1.3E-09	7.6E-09	2.7E-04	1.5E-08	1.9E-07	-7.2E-08	2.7E-04
Human toxicity, cancer	CTUh	4.7E-04	-3.3E-08	2.9E-08	6.7E-08	7.9E-05	4.7E-06	1.1E-06	-3.2E-04	2.3E-04
Human toxicity, non-cancer	CTUh	1.4E-04	9.3E-07	7.1E-07	1.3E-06	1.2E-03	1.4E-06	4.2E-06	-4.0E-05	1.3E-03
Particulate matter	disease incidence	1.0E-03	1.4E-05	3.5E-06	5.5E-06	8.5E-03	1.0E-05	4.9E-05	-6.0E-04	9.0E-03
Ionising radiation, human health	kBq U235 eq.	2.0E+02	8.3E+01	2.0E+00	9.4E+00	9.5E+04	2.9E+00	2.3E+02	-1.1E+02	9.5E+04
Photochemical ozone formation, human health	kg NMVOC eq.	2.0E+01	4.1E-01	3.9E-01	4.3E-01	4.2E+02	2.0E-01	1.3E+00	-1.1E+01	4.3E+02
Acidification	mol H ⁺ eq.	7.5E+01	6.7E-01	4.3E-01	3.6E-01	7.6E+02	7.5E-01	1.9E+00	-4.6E+01	7.9E+02

Life Cycle phases -->		Raw materials	Manu- facturing*	Distri- bution	Packaging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Eutrophication, terrestrial	mol N eq.	6.5E+01	1.6E+00	2.1E+00	1.1E+00	1.6E+03	6.6E-01	4.6E+00	-3.4E+01	1.6E+03
Eutrophication, freshwater	kg P eq.	2.8E-02	4.4E-04	6.6E-04	1.0E-03	2.4E+00	2.9E-04	1.2E-03	-2.6E-03	2.4E+00
Eutrophication, marine	kg N eq.	5.8E+00	1.5E-01	1.9E-01	1.1E-01	1.7E+02	6.0E-02	4.3E-01	-2.9E+00	1.7E+02
Ecotoxicity, freshwater	CTUe	5.7E+04	1.1E+03	1.0E+03	5.7E+02	1.2E+06	5.8E+02	2.8E+03	-3.0E+04	1.3E+06
Land use	pt	3.7E+06	1.5E+03	8.5E+02	2.0E+04	1.3E+06	3.7E+04	2.6E+03	-1.4E+04	5.0E+06
Water use	m ³ water eq. of deprived water	2.2E+03	7.4E+01	1.0E+01	1.3E+01	1.6E+05	2.3E+01	1.9E+02	-8.9E+02	1.6E+05
Resource use, minerals and metals	kg Sb eq.	9.7E-01	8.0E-05	7.3E-05	2.3E-05	3.0E-01	9.7E-03	1.7E-04	-3.7E-01	9.0E-01
Resource use, fossils	MJ	8.2E+04	3.6E+03	1.6E+03	1.4E+03	4.2E+06	8.5E+02	1.3E+04	-4.2E+04	4.3E+06
Additional technical information										
Primary energy consumption	MJ	8.2E+04	3.6E+03	1.6E+03	1.4E+03	4.4E+06	8.5E+02	1.3E+04	-4.2E+04	4.4E+06

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* Manufacturing materials are double counted with the raw materials column.

8410 Table 11-84: Life cycle impact per product per year of use: BC5.

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Materials	unit									
Plastics	g	9,298	9,298		544	0	n.a.			19,140
Metals	g	70,837	70,837		1,000	0	n.a.			142,674
Electronics	g	891	0		0	0	n.a.			891
Others	g	0	0		8,045	404,584,884	n.a.			404,592,929
Total weight	g	81,026	80,135		9,590	404,584,884	810			404,756,445
Energy consumption										
Electricity	kWh		23		0	47,529	0			47,552
Thermal energy	MJ		0		0	23,780	0			23,780
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	6.4E+02	1.7E+01	1.0E+01	9.1E+00	2.3E+04	6.5E+00	7.6E+01	-3.4E+02	2.3E+04
Ozone depletion	kg CFC-11 eq.	1.3E-07	6.6E-09	1.2E-10	6.9E-10	2.4E-05	1.4E-09	1.8E-08	-6.6E-09	2.5E-05
Human toxicity, cancer	CTUh	4.3E-05	-3.0E-09	2.7E-09	6.1E-09	7.2E-06	4.3E-07	9.7E-08	-2.9E-05	2.1E-05

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Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Human toxicity, non-cancer	CTUh	1.3E-05	8.5E-08	6.5E-08	1.2E-07	1.1E-04	1.3E-07	3.8E-07	-3.6E-06	1.2E-04
Particulate matter	disease incidence	9.4E-05	1.2E-06	3.2E-07	5.0E-07	7.7E-04	9.5E-07	4.5E-06	-5.5E-05	8.2E-04
Ionising radiation, human health	kBq U235 eq.	1.8E+01	7.6E+00	1.8E-01	8.6E-01	8.6E+03	2.6E-01	2.1E+01	-1.0E+01	8.7E+03
Photochemical ozone formation, human health	kg NMVOC eq.	1.8E+00	3.7E-02	3.6E-02	3.9E-02	3.8E+01	1.8E-02	1.1E-01	-9.7E-01	3.9E+01
Acidification	mol H+ eq.	6.8E+00	6.1E-02	3.9E-02	3.3E-02	6.9E+01	6.9E-02	1.8E-01	-4.2E+00	7.2E+01
Eutrophication, terrestrial	mol N eq.	5.9E+00	1.5E-01	1.9E-01	9.7E-02	1.4E+02	6.0E-02	4.2E-01	-3.1E+00	1.5E+02
Eutrophication, freshwater	kg P eq.	2.6E-03	4.0E-05	6.0E-05	9.4E-05	2.1E-01	2.6E-05	1.1E-04	-2.4E-04	2.2E-01
Eutrophication, marine	kg N eq.	5.3E-01	1.4E-02	1.7E-02	9.8E-03	1.5E+01	5.4E-03	3.9E-02	-2.7E-01	1.6E+01
Ecotoxicity, freshwater	CTUe	5.2E+03	9.9E+01	9.3E+01	5.2E+01	1.1E+05	5.3E+01	2.5E+02	-2.7E+03	1.1E+05
Land use	pt	3.3E+05	1.4E+02	7.8E+01	1.8E+03	1.2E+05	3.3E+03	2.4E+02	-1.3E+03	4.6E+05

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Water use	m ³ water eq. of deprived water	2.0E+02	6.7E+00	9.3E-01	1.2E+00	1.5E+04	2.1E+00	1.7E+01	-8.1E+01	1.5E+04
Resource use, minerals and metals	kg Sb eq.	8.8E-02	7.3E-06	6.7E-06	2.1E-06	2.7E-02	8.8E-04	1.5E-05	-3.4E-02	8.2E-02
Resource use, fossils	MJ	7.4E+03	3.2E+02	1.4E+02	1.2E+02	3.8E+05	7.8E+01	1.2E+03	-3.8E+03	3.9E+05
Additional technical information										
Primary energy consumption	MJ	7.4E+03	3.3E+02	1.4E+02	1.2E+02	4.0E+05	7.8E+01	1.2E+03	-3.8E+03	4.0E+05

* Manufacturing materials are double counted with the raw materials column.

8414 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*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Materials	unit									
Plastics	kt	5.63E-01	5.63E-01		3.29E-02	0.00E+00				1.16E+00
Metals	kt	4.29E+00	4.29E+00		6.05E-02	0.00E+00				8.63E+00
Electronics	kt	5.39E-02	0.00E+00		0.00E+00	0.00E+00				5.39E-02
Others	kt	0.00E+00	0.00E+00		4.87E-01	2.45E+04				2.45E+04
Total weight	kt	4.90E+00	4.85E+00		5.80E-01	2.45E+04	4.90E-02			2.45E+04
Energy consumption										
Electricity	kWh		1.38E+06		0.00E+00	2.88E+09	0.00E+00			2.88E+09
Thermal energy	MJ		0.00E+00		0.00E+00	1.44E+09	0.00E+00			1.44E+09
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	3.9E+07	1.0E+06	6.1E+05	5.5E+05	1.4E+09	4.0E+05	4.6E+06	-2.1E+07	1.4E+09

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Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Ozone depletion	kg CFC-11 eq.	7.8E-03	4.0E-04	7.0E-06	4.2E-05	1.5E+00	8.2E-05	1.1E-03	-4.0E-04	1.5E+00
Human toxicity, cancer	CTUh	2.6E+00	-1.8E-04	1.6E-04	3.7E-04	4.4E-01	2.6E-02	5.9E-03	-1.8E+00	1.3E+00
Human toxicity, non-cancer	CTUh	7.6E-01	5.1E-03	3.9E-03	7.0E-03	6.8E+00	7.6E-03	2.3E-02	-2.2E-01	7.4E+00
Particulate matter	disease incidence	5.7E+00	7.4E-02	1.9E-02	3.0E-02	4.7E+01	5.7E-02	2.7E-01	-3.3E+00	5.0E+01
Ionising radiation, human health	kBq U235 eq.	1.1E+06	4.6E+05	1.1E+04	5.2E+04	5.2E+08	1.6E+04	1.3E+06	-6.1E+05	5.2E+08
Photochemical ozone formation, human health	kg NMVOC eq.	1.1E+05	2.2E+03	2.2E+03	2.3E+03	2.3E+06	1.1E+03	6.9E+03	-5.9E+04	2.4E+06
Acidification	mol H+ eq.	4.1E+05	3.7E+03	2.4E+03	2.0E+03	4.2E+06	4.1E+03	1.1E+04	-2.5E+05	4.4E+06
Eutrophication, terrestrial	mol N eq.	3.6E+05	9.1E+03	1.1E+04	5.9E+03	8.8E+06	3.6E+03	2.5E+04	-1.8E+05	9.0E+06
Eutrophication, freshwater	kg P eq.	1.6E+02	2.4E+00	3.7E+00	5.7E+00	1.3E+04	1.6E+00	6.6E+00	-1.4E+01	1.3E+04

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Eutrophication, marine	kg N eq.	3.2E+04	8.5E+02	1.0E+03	5.9E+02	9.3E+05	3.3E+02	2.4E+03	-1.6E+04	9.5E+05
Ecotoxicity, freshwater	CTUe	3.1E+08	6.0E+06	5.6E+06	3.2E+06	6.7E+09	3.2E+06	1.5E+07	-1.6E+08	6.9E+09
Land use	pt	2.0E+10	8.2E+06	4.7E+06	1.1E+08	7.2E+09	2.0E+08	1.4E+07	-7.8E+07	2.8E+10
Water use	m³ water eq. of deprived water	1.2E+07	4.1E+05	5.6E+04	7.4E+04	8.9E+08	1.3E+05	1.0E+06	-4.9E+06	8.9E+08
Resource use, minerals and metals	kg Sb eq.	5.4E+03	4.4E-01	4.0E-01	1.2E-01	1.6E+03	5.4E+01	9.2E-01	-2.1E+03	5.0E+03
Resource use, fossils	MJ	4.5E+08	2.0E+07	8.7E+06	7.5E+06	2.3E+10	4.7E+06	7.4E+07	-2.3E+08	2.4E+10
Additional technical information										
Primary energy consumption	MJ	4.50E+08	2.00E+07	8.74E+06	7.50E+06	2.41E+10	4.70E+06	7.42E+07	-2.31E+08	2.44E+10

8416 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*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
Materials	unit							Impacts	Credits	
Plastics	kt	4.94E+00	4.94E+00		2.89E-01	0.00E+00				1.02E+01
Metals	kt	3.76E+01	3.76E+01		5.31E-01	0.00E+00				7.58E+01
Electronics	kt	4.73E-01	0.00E+00		0.00E+00	0.00E+00				4.73E-01
Others	kt	0.00E+00	0.00E+00		4.27E+00	2.15E+05				2.15E+05
Total weight	kt	4.30E+01	4.26E+01		5.09E+00	2.15E+05	4.30E-01			2.15E+05
Energy consumption										
Electricity	kWh		1.21E+07		0.00E+00	2.52E+10	0.00E+00			2.53E+10
Thermal energy	MJ		0.00E+00		0.00E+00	1.26E+10	0.00E+00			1.26E+10
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	3.4E+08	8.9E+06	5.3E+06	4.8E+06	1.2E+10	3.5E+06	4.1E+07	-1.8E+08	1.2E+10

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Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Ozone depletion	kg CFC-11 eq.	6.8E-02	3.5E-03	6.1E-05	3.7E-04	1.3E+01	7.2E-04	9.3E-03	-3.5E-03	1.3E+01
Human toxicity, cancer	CTUh	2.3E+01	-1.6E-03	1.4E-03	3.2E-03	3.8E+00	2.3E-01	5.1E-02	-1.6E+01	1.1E+01
Human toxicity, non-cancer	CTUh	6.7E+00	4.5E-02	3.4E-02	6.1E-02	6.0E+01	6.7E-02	2.0E-01	-1.9E+00	6.5E+01
Particulate matter	disease incidence	5.0E+01	6.5E-01	1.7E-01	2.7E-01	4.1E+02	5.0E-01	2.4E+00	-2.9E+01	4.3E+02
Ionising radiation, human health	kBq U235 eq.	9.8E+06	4.0E+06	9.6E+04	4.5E+05	4.6E+09	1.4E+05	1.1E+07	-5.3E+06	4.6E+09
Photochemical ozone formation, human health	kg NMVOC eq.	9.6E+05	2.0E+04	1.9E+04	2.1E+04	2.0E+07	9.8E+03	6.1E+04	-5.1E+05	2.1E+07
Acidification	mol H+ eq.	3.6E+06	3.2E+04	2.1E+04	1.8E+04	3.7E+07	3.6E+04	9.4E+04	-2.2E+06	3.8E+07
Eutrophication, terrestrial	mol N eq.	3.1E+06	8.0E+04	1.0E+05	5.2E+04	7.7E+07	3.2E+04	2.2E+05	-1.6E+06	7.9E+07
Eutrophication, freshwater	kg P eq.	1.4E+03	2.1E+01	3.2E+01	5.0E+01	1.1E+05	1.4E+01	5.8E+01	-1.3E+02	1.2E+05

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Life Cycle phases --> Resource use and emissions		Raw materials	Manu-facturing*	Distribution	Packaging	Use	Maintenance & Repair	EoL		Total
								Impacts	Credits	
Eutrophication, marine	kg N eq.	2.8E+05	7.4E+03	8.9E+03	5.2E+03	8.2E+06	2.9E+03	2.1E+04	-1.4E+05	8.4E+06
Ecotoxicity, freshwater	CTUe	2.7E+09	5.2E+07	4.9E+07	2.8E+07	5.9E+10	2.8E+07	1.3E+08	-1.4E+09	6.1E+10
Land use	pt	1.8E+11	7.2E+07	4.1E+07	9.6E+08	6.3E+10	1.8E+09	1.3E+08	-6.8E+08	2.4E+11
Water use	m ³ water eq. of deprived water	1.1E+08	3.6E+06	4.9E+05	6.5E+05	7.8E+09	1.1E+06	9.0E+06	-4.3E+07	7.9E+09
Resource use, minerals and metals	kg Sb eq.	4.7E+04	3.9E+00	3.5E+00	1.1E+00	1.4E+04	4.7E+02	8.1E+00	-1.8E+04	4.4E+04
Resource use, fossils	MJ	3.9E+09	1.7E+08	7.7E+07	6.6E+07	2.0E+11	4.1E+07	6.5E+08	-2.0E+09	2.1E+11
Additional technical information										
Primary energy consumption	MJ	3.95E+09	1.76E+08	7.67E+07	6.58E+07	2.11E+11	4.13E+07	6.52E+08	-2.03E+09	2.16E+11

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8419 **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	mln. EUR/year
Installation/ acquisition costs (if any)	0	EUR	0	mln. EUR/year
Fuel (gas, oil, wood)	500	EUR/year	26	mln. EUR/year
Electricity	11,166	EUR/year	590	mln. EUR/year
Water	705	EUR/year	37	mln. EUR/year
Auxiliary material 1: Detergent	3,775	EUR/year	199	mln. EUR/year
Auxiliary material 2	296	EUR/year	16	mln. EUR/year
Auxiliary material 3	0	EUR/year	0	mln. EUR/year
Auxiliary material 4	0	EUR/year	0	mln. EUR/year
Auxiliary material 5	0	EUR/year	0	mln. EUR/year
Repair & maintenance costs	5,894	EUR	28	mln. EUR/year
Total	18,195	EUR/year	970	mln. EUR/year

8420 **11.5.6. BC6: Multi-tank conveyor-type dishwasher**

8421 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
 8422 (**Table 11-90**) and the impact of the stock of products in the EU-27 (Table 11-91). The life cycle costs per product and as EU-27 total are provided in Table 11-
 8423 92.

8424 **Table 11-88: Life cycle impact per product: BC6.**

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packaging	Use	Maintenanc e & Repair	EoL Impacts Credits		Total
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	11,484,845,160	n.a.			11,485,059,425
Total weight	g	1,343,400	1,328,000		238,630	11,484,845,160	13,434			11,487,768,624
Energy consumption										
Electricity	kWh		300		0	1,635,275	0			1,635,575
Thermal energy	MJ		0		0	1,166,803	0			1,166,803

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing*	Distri- bution	Packaging	Use	Maintenanc e & Repair	EoL		Total
PEF Impact categories	unit							Impacts	Credits	
Climate change, total	kg CO ₂ eq.	1.1E+04	2.3E+02	1.8E+02	2.1E+02	7.9E+05	1.1E+02	1.3E+03	-5.9E+03	7.9E+05
Ozone depletion	kg CFC-11 eq.	1.6E-06	9.3E-08	2.0E-09	1.4E-08	7.2E-04	1.7E-08	3.0E-07	-1.2E-07	7.3E-04
Human toxicity, cancer	CTUh	7.3E-04	-6.0E-08	4.7E-08	1.5E-07	2.3E-04	7.3E-06	1.7E-06	-5.0E-04	4.6E-04
Human toxicity, non-cancer	CTUh	2.1E-04	1.3E-06	1.1E-06	2.9E-06	3.6E-03	2.1E-06	6.5E-06	-6.2E-05	3.7E-03
Particulate matter	disease incidence	1.6E-03	1.9E-05	5.6E-06	1.2E-05	2.6E-02	1.6E-05	7.6E-05	-9.4E-04	2.6E-02
Ionising radiation, human health	kBq U235 eq.	3.2E+02	1.1E+02	3.2E+00	1.7E+01	3.0E+05	4.3E+00	3.6E+02	-1.8E+02	3.0E+05
Photochemical ozone formation, human health	kg NMVOC eq.	3.0E+01	5.4E-01	6.2E-01	9.7E-01	1.3E+03	3.1E-01	2.0E+00	-1.7E+01	1.3E+03
Acidification	mol H+ eq.	1.2E+02	8.7E-01	6.9E-01	8.1E-01	2.3E+03	1.2E+00	3.0E+00	-7.2E+01	2.4E+03
Eutrophication, terrestrial	mol N eq.	9.9E+01	2.2E+00	3.3E+00	2.4E+00	4.9E+03	1.0E+00	7.2E+00	-5.2E+01	4.9E+03

Life Cycle phases -->		Raw materials	Manu- facturing*	Distri- bution	Packaging	Use	Maintenanc e & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Eutrophication, freshwater	kg P eq.	3.9E-02	5.7E-04	1.1E-03	2.3E-03	6.4E+00	4.0E-04	1.9E-03	-4.1E-03	6.4E+00
Eutrophication, marine	kg N eq.	8.8E+00	2.1E-01	2.9E-01	2.4E-01	5.1E+02	9.0E-02	6.7E-01	-4.6E+00	5.1E+02
Ecotoxicity, freshwater	CTUe	8.7E+04	1.4E+03	1.6E+03	1.1E+03	3.7E+06	8.8E+02	4.3E+03	-4.7E+04	3.7E+06
Land use	pt	5.1E+06	2.1E+03	1.4E+03	4.8E+04	3.8E+06	5.1E+04	4.1E+03	-2.2E+04	9.0E+06
Water use	m³ water eq. of deprived water	3.3E+03	9.6E+01	1.6E+01	2.9E+01	4.6E+05	3.4E+01	2.9E+02	-1.4E+03	4.6E+05
Resource use, minerals and metals	kg Sb eq.	1.5E+00	1.1E-04	1.2E-04	4.9E-05	8.2E-01	1.5E-02	2.6E-04	-5.8E-01	1.7E+00
Resource use, fossils	MJ	1.2E+05	4.6E+03	2.5E+03	2.6E+03	1.3E+07	1.3E+03	2.1E+04	-6.6E+04	1.4E+07
Additional technical information										
Primary energy consumption	MJ	1.2E+05	4.7E+03	2.5E+03	2.6E+03	1.4E+07	1.3E+03	2.1E+04	-6.6E+04	1.4E+07

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* Manufacturing materials are double counted with the raw materials column.

8426 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		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	765,656,344	n.a.			765,670,628
Total weight	g	89,560	88,533		15,909	765,656,344	896			765,851,242
Energy consumption										
Electricity	kWh		20		0	109,018	0			109,038
Thermal energy	MJ		0		0	77,787	0			77,787
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	7.2E+02	1.5E+01	1.2E+01	1.4E+01	5.2E+04	7.3E+00	8.7E+01	-3.9E+02	5.3E+04

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Life Cycle phases -->		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Ozone depletion	kg CFC-11 eq.	1.1E-07	6.2E-09	1.3E-10	9.3E-10	4.8E-05	1.1E-09	2.0E-08	-7.8E-09	4.8E-05
Human toxicity, cancer	CTUh	4.9E-05	-4.0E-09	3.1E-09	1.0E-08	1.5E-05	4.9E-07	1.1E-07	-3.3E-05	3.1E-05
Human toxicity, non-cancer	CTUh	1.4E-05	8.4E-08	7.6E-08	1.9E-07	2.4E-04	1.4E-07	4.3E-07	-4.2E-06	2.5E-04
Particulate matter	disease incidence	1.1E-04	1.3E-06	3.7E-07	8.0E-07	1.7E-03	1.1E-06	5.1E-06	-6.3E-05	1.8E-03
Ionising radiation, human health	kBq U235 eq.	2.1E+01	7.1E+00	2.1E-01	1.2E+00	2.0E+04	2.8E-01	2.4E+01	-1.2E+01	2.0E+04
Photochemical ozone formation, human health	kg NMVOC eq.	2.0E+00	3.6E-02	4.2E-02	6.5E-02	8.7E+01	2.1E-02	1.3E-01	-1.1E+00	8.8E+01
Acidification	mol H+ eq.	7.7E+00	5.8E-02	4.6E-02	5.4E-02	1.6E+02	7.8E-02	2.0E-01	-4.8E+00	1.6E+02
Eutrophication, terrestrial	mol N eq.	6.6E+00	1.5E-01	2.2E-01	1.6E-01	3.2E+02	6.7E-02	4.8E-01	-3.5E+00	3.3E+02
Eutrophication, freshwater	kg P eq.	2.6E-03	3.8E-05	7.0E-05	1.6E-04	4.2E-01	2.6E-05	1.2E-04	-2.7E-04	4.3E-01

Life Cycle phases -->		Raw materials	Manu- facturing*	Distri- bution	Packa- ging	Use	Maintenance & Repair	EoL		Total
Resource use and emissions								Impacts	Credits	
Eutrophication, marine	kg N eq.	5.9E-01	1.4E-02	2.0E-02	1.6E-02	3.4E+01	6.0E-03	4.5E-02	-3.1E-01	3.4E+01
Ecotoxicity, freshwater	CTUe	5.8E+03	9.6E+01	1.1E+02	7.5E+01	2.5E+05	5.9E+01	2.9E+02	-3.1E+03	2.5E+05
Land use	pt	3.4E+05	1.4E+02	9.0E+01	3.2E+03	2.6E+05	3.4E+03	2.7E+02	-1.5E+03	6.0E+05
Water use	m³ water eq. of deprived water	2.2E+02	6.4E+00	1.1E+00	1.9E+00	3.0E+04	2.3E+00	1.9E+01	-9.3E+01	3.1E+04
Resource use, minerals and metals	kg Sb eq.	9.7E-02	7.3E-06	7.7E-06	3.3E-06	5.5E-02	9.7E-04	1.7E-05	-3.9E-02	1.1E-01
Resource use, fossils	MJ	8.3E+03	3.1E+02	1.7E+02	1.8E+02	9.0E+05	8.6E+01	1.4E+03	-4.4E+03	9.0E+05
Additional technical information										
Primary energy consumption	MJ	8.3E+03	3.1E+02	1.7E+02	1.8E+02	9.3E+05	8.6E+01	1.4E+03	-4.4E+03	9.3E+05

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* Manufacturing materials are double counted with the raw materials column.

8428 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	3.40E-01	3.40E-01		2.58E-02	0.00E+00				7.05E-01
Metals	kt	3.31E+00	3.31E+00		4.13E-02	0.00E+00				6.67E+00
Electronics	kt	4.24E-02	0.00E+00		0.00E+00	0.00E+00				4.24E-02
Others	kt	0.00E+00	0.00E+00		5.89E-01	3.16E+04				3.16E+04
Total weight	kt	3.69E+00	3.65E+00		6.56E-01	3.16E+04	3.69E-02			3.16E+04
Energy consumption										
Electricity	kWh		8.25E+05		0.00E+00	4.50E+09	0.00E+00			4.50E+09
Thermal energy	MJ		0.00E+00		0.00E+00	3.21E+09	0.00E+00			3.21E+09
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	3.0E+07	6.4E+05	4.8E+05	5.9E+05	2.2E+09	3.0E+05	3.6E+06	-1.6E+07	2.2E+09
Ozone depletion	kg CFC-11 eq.	4.4E-03	2.6E-04	5.5E-06	3.8E-05	2.0E+00	4.7E-05	8.3E-04	-3.2E-04	2.0E+00

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Life Cycle phases --> Resource use and emissions		Raw materials	Manufacturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Human toxicity, cancer	CTUh	2.0E+00	-1.6E-04	1.3E-04	4.1E-04	6.2E-01	2.0E-02	4.6E-03	-1.4E+00	1.3E+00
Human toxicity, non-cancer	CTUh	5.7E-01	3.5E-03	3.1E-03	8.0E-03	9.9E+00	5.7E-03	1.8E-02	-1.7E-01	1.0E+01
Particulate matter	disease incidence	4.3E+00	5.3E-02	1.5E-02	3.3E-02	7.1E+01	4.4E-02	2.1E-01	-2.6E+00	7.3E+01
Ionising radiation, human health	kBq U235 eq.	8.8E+05	2.9E+05	8.7E+03	4.8E+04	8.1E+08	1.2E+04	1.0E+06	-4.9E+05	8.2E+08
Photochemical ozone formation, human health	kg NMVOC eq.	8.4E+04	1.5E+03	1.7E+03	2.7E+03	3.6E+06	8.5E+02	5.4E+03	-4.6E+04	3.6E+06
Acidification	mol H+ eq.	3.2E+05	2.4E+03	1.9E+03	2.2E+03	6.4E+06	3.2E+03	8.3E+03	-2.0E+05	6.5E+06
Eutrophication, terrestrial	mol N eq.	2.7E+05	6.1E+03	9.1E+03	6.6E+03	1.3E+07	2.8E+03	2.0E+04	-1.4E+05	1.4E+07
Eutrophication, freshwater	kg P eq.	1.1E+02	1.6E+00	2.9E+00	6.5E+00	1.7E+04	1.1E+00	5.1E+00	-1.1E+01	1.8E+04
Eutrophication, marine	kg N eq.	2.4E+04	5.7E+02	8.1E+02	6.7E+02	1.4E+06	2.5E+02	1.8E+03	-1.3E+04	1.4E+06
Ecotoxicity, freshwater	CTUe	2.4E+08	3.9E+06	4.5E+06	3.1E+06	1.0E+10	2.4E+06	1.2E+07	-1.3E+08	1.0E+10
Land use	pt	1.4E+10	5.7E+06	3.7E+06	1.3E+08	1.1E+10	1.4E+08	1.1E+07	-6.1E+07	2.5E+10

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	9.2E+06	2.7E+05	4.5E+04	7.9E+04	1.3E+09	9.4E+04	8.0E+05	-3.8E+06	1.3E+09
Resource use, minerals and metals	kg Sb eq.	4.0E+03	3.0E-01	3.2E-01	1.3E-01	2.3E+03	4.0E+01	7.2E-01	-1.6E+03	4.7E+03
Resource use, fossils	MJ	3.4E+08	1.3E+07	6.9E+06	7.2E+06	3.7E+10	3.6E+06	5.8E+07	-1.8E+08	3.7E+10
Additional technical information										
Primary energy consumption	MJ	3.40E+08	1.30E+07	6.90E+06	7.20E+06	3.80E+10	3.60E+06	5.80E+07	-1.80E+08	3.80E+10

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8431 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	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Materials	unit									
Plastics	kt	3.87E+00	3.87E+00		2.94E-01	0.00E+00				8.04E+00
Metals	kt	3.78E+01	3.78E+01		4.71E-01	0.00E+00				7.61E+01
Electronics	kt	4.83E-01	0.00E+00		0.00E+00	0.00E+00				4.83E-01
Others	kt	0.00E+00	0.00E+00		6.72E+00	3.60E+05				3.60E+05
Total weight	kt	4.22E+01	4.17E+01		7.49E+00	3.60E+05	4.22E-01			3.60E+05
Energy consumption										
Electricity	kWh		9.41E+06		0.00E+00	5.13E+10	0.00E+00			5.13E+10
Thermal energy	MJ		0.00E+00		0.00E+00	3.66E+10	0.00E+00			3.66E+10
PEF Impact categories	unit									
Climate change, total	kg CO ₂ eq.	3.4E+08	7.3E+06	5.5E+06	6.7E+06	2.5E+10	3.5E+06	4.1E+07	-1.8E+08	2.5E+10
Ozone depletion	kg CFC-11 eq.	5.1E-02	2.9E-03	6.3E-05	4.4E-04	2.3E+01	5.4E-04	9.4E-03	-3.7E-03	2.3E+01

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Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Human toxicity, cancer	CTUh	2.3E+01	-1.9E-03	1.5E-03	4.7E-03	7.1E+00	2.3E-01	5.2E-02	-1.6E+01	1.5E+01
Human toxicity, non-cancer	CTUh	6.5E+00	4.0E-02	3.6E-02	9.1E-02	1.1E+02	6.5E-02	2.0E-01	-2.0E+00	1.2E+02
Particulate matter	disease incidence	5.0E+01	6.0E-01	1.8E-01	3.8E-01	8.1E+02	5.0E-01	2.4E+00	-2.9E+01	8.3E+02
Ionising radiation, human health	kBq U235 eq.	1.0E+07	3.3E+06	9.9E+04	5.5E+05	9.3E+09	1.3E+05	1.1E+07	-5.5E+06	9.3E+09
Photochemical ozone formation, human health	kg NMVOC eq.	9.6E+05	1.7E+04	2.0E+04	3.0E+04	4.1E+07	9.7E+03	6.1E+04	-5.2E+05	4.1E+07
Acidification	mol H+ eq.	3.6E+06	2.7E+04	2.2E+04	2.6E+04	7.3E+07	3.6E+04	9.5E+04	-2.2E+06	7.5E+07
Eutrophication, terrestrial	mol N eq.	3.1E+06	7.0E+04	1.0E+05	7.6E+04	1.5E+08	3.2E+04	2.3E+05	-1.6E+06	1.5E+08
Eutrophication, freshwater	kg P eq.	1.2E+03	1.8E+01	3.3E+01	7.4E+01	2.0E+05	1.2E+01	5.9E+01	-1.3E+02	2.0E+05
Eutrophication, marine	kg N eq.	2.8E+05	6.5E+03	9.2E+03	7.6E+03	1.6E+07	2.8E+03	2.1E+04	-1.4E+05	1.6E+07
Ecotoxicity, freshwater	CTUe	2.7E+09	4.5E+07	5.1E+07	3.5E+07	1.2E+11	2.8E+07	1.4E+08	-1.5E+09	1.2E+11
Land use	pt	1.6E+11	6.5E+07	4.2E+07	1.5E+09	1.2E+11	1.6E+09	1.3E+08	-7.0E+08	2.8E+11

Life Cycle phases --> Resource use and emissions		Raw materials	Manu- facturing	Distribution	Packaging	Use	Maintenance & Repair	EoL Impacts Credits		Total
Water use	m ³ water eq. of deprived water	1.0E+08	3.0E+06	5.1E+05	9.0E+05	1.4E+10	1.1E+06	9.1E+06	-4.4E+07	1.4E+10
Resource use, minerals and metals	kg Sb eq.	4.6E+04	3.4E+00	3.6E+00	1.5E+00	2.6E+04	4.6E+02	8.2E+00	-1.8E+04	5.4E+04
Resource use, fossils	MJ	3.9E+09	1.4E+08	7.9E+07	8.3E+07	4.2E+11	4.1E+07	6.6E+08	-2.1E+09	4.2E+11
Additional technical information										
Primary energy consumption	MJ	3.90E+09	1.50E+08	7.90E+07	8.30E+07	4.40E+11	4.10E+07	6.60E+08	- 2.10E+0 9	4.40E+11

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8434 **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)	1,593	EUR/year	56	mIn. EUR/year
Electricity	24,946	EUR/year	879	mIn. EUR/year
Water	1,299	EUR/year	46	mIn. EUR/year
Auxiliary material 1: Detergent	6,633	EUR/year	234	mIn. EUR/year
Auxiliary material 2	494	EUR/year	17	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
Total	37,160	EUR/year	1,319	mIn. 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
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	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 %)	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)
				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 .	- 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 .	
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	Reduction of 2 %- 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)
					Total impact respectively.	
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%	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)
				(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.		
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	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)
					climate change reduction of 0.13 %.	
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

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

8475 the information they have provided and assesses whether the available data are sufficient to
8476 define information or performance requirements beyond existing obligations.

8477 11.7.1.2. End-of-life context of commercial dishwashers

8478 To contextualise this Task, the end-of-life treatment of commercial dishwashers is described.
8479 Once they are separately collected under the WEEE Directive (2012/19/EU) and sent to
8480 dedicated recycling and recovery facilities, nearly all materials are diverted from landfill through
8481 refurbishment, parts salvaging, and material recovery. Approximately 5% by weight is lost.

8482 Metals are recycled. Paper, cardboard, and most plastics undergo thermal recycling (with energy
8483 recovery) or mechanical recycling, and some plastic components may be directly reused. Non-
8484 metallic inert materials (e.g., concrete and bitumen) are landfilled. Electronic components
8485 account for only about 1% of the total weight. Printed circuit boards (PCBs) are easy to dismantle
8486 and are fully recycled by certified scrap dealers. Plastics make up less than 10% of a machine's
8487 weight. Of the recovered plastic fraction, an estimated 70% goes to thermal recycling, 29% to
8488 mechanical recycling, and 1% to closed-loop reuse.

8489 For units equipped with heat pumps, refrigerants are extracted by specialised technicians,
8490 resulting in only minimal, unavoidable losses.

8491 11.7.1.3. Reading guide

8492 The report is structured in four parts to guide the reader through identifying and assessing the
8493 SoC in the commercial dishwasher's product group. The first section covers the stakeholder
8494 consultation, which outlines how input from manufacturers, recyclers, and national
8495 representatives shaped the SoC inventory. Afterwards, the existing regulatory requirements are
8496 discussed. This section reviews REACH, CLP, Persistent Organic Pollutants (POP) Regulation,
8497 Waste Framework Directive (WFD), Waste Electrical and Electronic Equipment (WEEE) Directive,
8498 and Restriction of Hazardous Substances (RoHS) obligations so that ESPR proposals align with,
8499 rather than duplicate, current reporting duties. Next, SoC in the product group presents the
8500 identified substances and highlights any recycling challenges based on that inventory. Finally,
8501 the section on information and performance requirements translates these findings into
8502 recommendations for the product group.

8503 11.7.2. Stakeholder consultation

8504 As a jumping-off point for the SoC work, a stakeholder consultation was conducted to gather
8505 information. It aimed to support the creation of a SoC inventory and to identify specific
8506 requirements and potential exemptions for certain substances. The consultation was conducted
8507 from mid-April to mid-May 2025. A questionnaire originally developed by the JRC was modified
8508 to help identify both Intentionally Added Substances (IAS) and Non-Intentionally Added
8509 Substances (NIAS) and ask for other inputs. The consultation was made available to stakeholders
8510 registered on the platform used for previous consultations: [https://ecodesign-](https://ecodesign-commdishwashers.eu/en)
8511 [commdishwashers.eu/en](https://ecodesign-commdishwashers.eu/en). The stakeholders engaged in this consultation include manufacturers,
8512 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.

As final point, manufactures and industry representatives recommend removing SoC-specific policy conclusions from the preparatory study for now, as their inclusion can be considered premature. This should await clearer guidance from the European Commission’s on how SoC Art. 2(27)(d) “Negatively affecting recycling and reuse” should be determined within the wider ESPR legislative context, following on previous discussion during adoption of the ESPR legislation. Especially a harmonised methodology and single interpretation is important. Additionally, no other information obligations should be pursued for SoC Art. 2(27)(a), and the focus should be ‘one list, one declaration’ under REACH. At the same time SoC Art. 2(27)(b) covers an excessively broad range of substances, many of which are not inherently harmful and

can be essential for product circularity, safety, and sustainability. Imposing blanket information requirements creates disproportionate burdens. Moreover, tracking such a vast number of substances across complex product life cycles is not practically feasible. While SoC Art. 2(27)(c) already regulated under the POPs Regulation are already subject to established material compliance processes in industry. Therefore, no further information requirements are needed according to the stakeholders.

From the recyclers specific point of view additional perspectives were obtained on the following three points.

- Regulatory frameworks typically identify Substances of Concern for products being newly introduced to the market, giving manufacturers time to adapt their designs. However, recyclers encounter these products only at the end of their lifecycle (often more than a decade later). By that time, regulatory requirements may have evolved significantly, creating a disconnect between the substance restrictions applied during product design and those applicable during recycling. This regulatory lag and its changes over time complicates compliance and processing.
- The DPP, while potentially useful for tracking substances during a product's active life, has limited practical value at end-of-life. This is mainly due to the high-speed, high-volume processing typical in WEEE recycling, the poor physical condition of discarded products that often renders identifiers like QR codes or tags unreadable, and regulatory discrepancies between the time of manufacture and the time of waste processing, where different substance thresholds may apply.
- Analytical testing for presence of SoC in WEEE (or its waste fraction) is only effective if supported by a harmonised, mandatory methodology across all Member States that is also practical for ongoing use in industrial settings. Without such standardisation, recyclers face the risk of inconsistent outcomes, with varying methods leading to different results and potential competitive imbalances occurring between operators. Additionally, lengthy testing processes that delay results for days or weeks are not feasible in fast-paced recycling operations, where materials must be processed and forwarded quickly to meet operational demands.

Further perspectives from manufacturers, industry representatives, and national representatives on the draft proposals outlined in this annex were obtained after completion of Task 7. The views and perspectives listed below have not resulted in changes to these proposals, but are included for future reference:

- For Art. 2(27)(a) the candidate list and Article 33(1) REACH should serve as central list for mandatory information obligations for substances in products. An information obligation along the supply chain should be introduced for all substances entering the authorisation and/or restriction procedure in European legislation, where they are present in articles above 0.1% w/w (following the one list, one declaration principle). Expanding the Candidate List should be limited to once a year to reduce the burden, remain consistency prevent constantly updating the to the DPP.
- With regard to Art. 2(27)(b), the approach should be risk-based unless there is scientific evidence that the presence of a substance in products within a regulated product group contradicts the objectives of Art. 5(1) ESPR. For many of the Art.

- 8581 2(27)(b), substances, no risk to human health or the environment has been
8582 identified in relation to their presence in the product.
- 8583 - Consider redefining SoC switching the meaning of Art. 2(27)d from negatively
8584 affecting to impeding recycling and reuse.
 - 8585 - The manufacturer or importer should be able to choose how to obtain information
8586 for DPPs related to SoC when information requirements apply (for example,
8587 through supplier questionnaires, Safety Data Sheet reviews, material risk
8588 assessments, or analytical testing). However, analytical testing, certificates, or
8589 audits should not be mandatory, as requiring them would conflict with the principle
8590 of presumption of compliance, which assumes that products placed on the EU
8591 market comply with relevant regulations.
 - 8592 - A 5-year roll-out period for adherence to information is needed, as shorter
8593 timelines are impractical. This is because contracts with non-EU suppliers must be
8594 renegotiated to obtain the necessary SoC information for inclusion in the DPP, and
8595 new suppliers may need to be identified. However, market surveillance authorities
8596 should have the option to extend the roll-out period if the manufacturer or
8597 importer provides a justified reason. From the national representative perspective,
8598 the 5-year roll-out would be too long for the substances covered under Art. 2(27)
8599 (a-c), as these substances are known through the existing regulations included in
8600 them.

8601 11.7.3. Existing regulatory requirements on provision of SoC 8602 information

8603 In the consultation, stakeholders noted that several existing laws already require information
8604 sharing on SoC for waste treatment. This section therefore examines legislative requirements
8605 beyond the ESPR, highlighting obligations that apply to this product group and identifying any
8606 existing thresholds for communicating SoC information (if present).

8607 11.7.3.1. Relevant regulations

8608 REACH regulation

8609 Under Art. 33(1) of the REACH regulation (EC No 1907/2006), any supplier of an article
8610 containing a Candidate List SVHC at a concentration above 0.1% w/w must provide, at or before
8611 the time of supply, sufficient information (at minimum the substance's name) to allow safe use
8612 of the article by their professional recipients. Furthermore, upon request by a consumer, the
8613 supplier must supply the same information free of charge within 45 days of that request. This
8614 information requirement applies to SoC that fall under ESPR Art. 2(27)(a).

8615 Continuing from the requirements discussed above, Art. 31 also obliges any supplier of a
8616 substance or mixture to provide a SDS free of charge whenever it is classified as hazardous, is
8617 persistent, bioaccumulative or toxic (PBT/vPvB), appears on the Candidate List of SVHCs, or falls
8618 under EU workplace exposure limits. If a non-classified mixture contains hazardous substances
8619 above certain thresholds—1 % w/w for non-gaseous substances or 0.2 % v/v for gases (general

8620 hazards), and 0.1 % w/w for PBT/vPvB or Candidate List substances, the supplier must supply an
8621 SDS upon the recipient's request.

8622 **CLP Regulation**

8623 Under the CLP Regulation (EC No 1272/2008), any substance or mixture classified as hazardous
8624 must bear, before being placed on the EU market, a label showing at minimum the product
8625 identifier; supplier name, address and phone number; hazard pictograms; a signal word; hazard
8626 statements; precautionary statements; and (where applicable) supplemental information (Art.
8627 17–25). Labels must be applied and positioned in accordance with the general rules in Art. 31
8628 and 32, and specific rules for outer, inner and single packaging in Art. 33. Moreover, suppliers
8629 are required to assemble and keep available all the information used for classification and
8630 labelling for at least ten years after the substance or mixture was last supplied, and to provide
8631 it on request (Art. 49).

8632 **POPs regulations**

8633 For Persistent Organic Pollutants (POPs) placed on the EU market as articles, POPs regulation
8634 (EU 2019/1021) sets specific concentration limits in Annex I (as amended by Delegated
8635 regulation (EU 2020/784). Concentration thresholds are substances specific and articles
8636 containing POPs at or above that concentration may not be marketed and must be reported or
8637 managed in accordance with the regulation unless they are derogated. A cumulative limit on the
8638 concentration (amount of mg/kg) in mixtures or articles is set or a specific limit if it on their
8639 presence in substances. This type of restrictions is associated with SoC's that fall under ESPR Art.
8640 2(27)(c). POP Regulation does not place obligations on suppliers of articles on sharing
8641 information to downstream parties.

8642 **Waste Framework Directive**

8643 The SCIP (Substances of Concern In articles as such or in complex objects (Products)) database,
8644 established by ECHA under Art. 9(2) of the Waste Framework Directive (2008/98/EC), serves to
8645 collect and disseminate detailed information on Candidate List SVHCs present in articles and
8646 complex products throughout their entire lifecycle to drive substitution of hazardous
8647 substances, prevent the generation of contaminated waste, enhance transparency for waste
8648 operators.

8649 Establishing the SCIP database allows for transferring Art. 33(1) REACH information, that would
8650 otherwise not reach waste treatment operators. It is however noted in an evaluation of SCIP for
8651 ECHA (PWC, 2022) that: "While the reliability and quality of the information is not in question,
8652 its accessibility and practical use cases for waste operators and consumers remain limited for
8653 the moment, according to the consulted stakeholder organisations. Equally, some Companies
8654 are uncertain about the usefulness of the information they provide to SCIP for other
8655 stakeholders".

8656 **WEEE Directive**

8657 When placing new commercial dishwashers on the market, producers provide waste treatment
8658 operators with detailed information on preparation for reuse and treatment in accordance with
8659 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.

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.

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;
- WEEE compels producers to supply end-of-life guidance on components and hazardous-substance locations to recyclers (supported by the I4R platform); and
- RoHS restricts certain hazardous substances included in Annex II outright, with periodic reviews aligned with REACH to safeguard recyclability and worker safety.

11.7.4. Substance of Concern in the product group

This section will dive into the substances identified to be present in the product group to facilitate further evaluation of need for SoC information or performance requirements.

11.7.4.1. Substances of Concern inventory

The inventory of Substances of Concern (**Table 11-95**) is developed using stakeholder input for the main components of a commercial dishwasher. Only IAS-listed substances are included, since no data on other chemicals was available from stakeholders.

8696 For each component (e.g., heating elements, pumps, circuit boards), any added substances are
8697 listed with their CAS numbers. Substances that meet the ESPR Art. 2(27) criteria are flagged to
8698 serve as the basis for identifying what substances could be considered for information
8699 requirements.

8700 Where possible, the likely function of each substance within its component is inferred from
8701 stakeholder descriptions. It also indicates the life cycle stage at which each substance appears.
8702 This is limited to material and component manufacturing as no further information is obtained
8703 through the consultation. The information that is available generally comes from REACH Art.
8704 33(1) information requirements, under which suppliers must inform downstream parties if an
8705 article contains any substance of very high concern (Article 57) identified under Article 59(1) at
8706 concentrations above 0.1% w/w; at minimum, the substance name must be provided to ensure
8707 safe use.

8708 Stakeholder-supplied concentration ranges strongly suggest that this information was obtained
8709 via REACH Art. 33(1) disclosure, since several substances exceed the 0.1% w/w trigger threshold.
8710 In addition, stakeholders provided the concentrations of lead used for soldering and as an
8711 alloying element, and these levels align with the Annex III exemptions of the RoHS Directive.

8712 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
Motor	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
	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 ¹⁷²

¹⁷² 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 ¹⁷³
		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

¹⁷³ POP regulation Annex I restricts Perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds, but not PVDF

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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) 3,5 - 85% (2nd stakeholder input) (weight percentage of homogeneous material)	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	Not identified, but has REACH restriction Annex XVII, Entry 52
	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

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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

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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	Melamine	CAS RN 108-78-1	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	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

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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

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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	Not possible to determine from SH input	Boric acid	CAS RN 10043-35-3	>0,1%	>0,1%	Component manufacturing	a; b
	Not possible to determine from SH input	Flame retardant	2,2',6,6'-tetrabromo-4,4'-isopropylidenediph enol (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	Hexamethylphtalic 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

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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. piezoelectric 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	Vulcanisation 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	Plasticiser	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

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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

8713

8714 11.7.4.2. Bill of chemicals

8715 Building on the SoC inventory, this section assesses whether any identified substances could
8716 hinder the recycling process.

8717 Utilising the SoC inventory, a further assessment was conducted to identify if any substances
8718 would be hindering recycling. With the limited stakeholder perspectives obtained on this aspect,
8719 literature research and expert judgement is used to assess what is present in the identified
8720 substances that could impact recycling, based on customer requirements, regulatory limitations
8721 for the product group, or impacts on the recycling process or resulting quality of the recycling
8722 output. The outcomes are presented in **Table 11-96** and analysed afterwards.

8723 Table 11-96: Bill of Chemicals for commercial 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 limitations/ thresholds	Process disturbing	Quality disturbing	Exemptions according to stakeholders
imidazolidine-2-thione: CAS RN: 96-45-7	Function: Vulcanisation 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				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. <i>Other EEE not covered by any of the categories above.</i>		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.

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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
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. <i>Other EEE not covered by any of the categories above.</i>		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							
Octametylcyclotrasiloxane: 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								
Hexamethylphtalic anhydride : CAS RN: 25550-51-0	Function: Hardener Component: Electrical component	Component manufacturing	x	x							

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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
Diisononylphthalate (DINP): CAS RN: 228553-12-0 & 68515-48-0	Function: Barrier (Sealant), Adhesion promotor, Film former, Lubricating agent, Plasticiser Component: Pump	Material manufacturing						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)O ₃) : 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							
Boric acid: CAS RN: 10043-35-3	Function: Not possible to determine from SH input Component: Thermostat, Various/ Undefined	Component manufacturing	x	x							

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 to be present. "DINP is used as a plasticiser, 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, Entry 52) "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, even though it is unlikely that recycled plastics will be used for these purposes due to the regulatory requirements for these product groups, it can make such recycling economically less viable. However, the material is approved for use as in food contact materials (Regulation on plastic materials and articles intended to come into contact with food, Regulation (EU) 10/2011), albeit not for single-use food packaging intended for babies and small children.

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 commercial 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).

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.

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)

- 8804 • (v) endocrine disruption for the environment categories 1 and 2 (Table 4.2.2)
- 8805 • (vi) persistent, mobile and toxic or very persistent, very mobile properties (PMT or
- 8806 vPvM, Art. 4 (4)(3))
- 8807 • (vii) persistent, bioaccumulative and toxic or very persistent, very bioaccumulative
- 8808 properties (PBT or vPvB, Art. 4 (3)(3))

8809 **Art. 2(27)(c) substances**

8810 For persistent organic pollutants (POPs) covered by Article 2(27)(c), a 0.1 % w/w threshold is
 8811 likewise proposed based on the guidance, treating them as SVHCs on the REACH Candidate List.
 8812 This harmonised threshold streamlines compliance, ensures consistent notification criteria
 8813 across both SVHCs and restricted POPs.

8814 **Art. 2(27)(d) substances**

8815 A generic threshold of 0.1 % w/w is likewise proposed for SoC that fall under Article 2(27)(d),
 8816 namely those substances whose presence can negatively affect reuse and recycling. In the
 8817 absence of data identifying which substances most adversely affect circularity within this
 8818 product group, it is not feasible to establish specific limits related to substance groups of even
 8819 specific substances. Without any information requirement, future data collection on these SoCs
 8820 would remain severely constrained. Adopting the 0.1 % w/w threshold used for SVHCs and POPs
 8821 provides a clear, uniform obligation, which covers the complete bill of materials, including all
 8822 components and spare parts.

8823 **Information requirement exemptions and timelines**

8824 Currently it is not possible to determine substance specific exemptions based on the stakeholder
 8825 feedback obtained through the consultation. However, stakeholders expressed concerns about
 8826 the difficulty of gathering information for both IAS and NIAS across the full life cycle. They cited
 8827 the duration and scope of data collection, the need to adjust contractual relations, and the
 8828 challenge of identifying NIAS at different stages of the life cycle. From this perspective, one could
 8829 argue that information requirements should be limited to SoC that are present in the final
 8830 product (including components and spare parts) and its full bill of materials, while all other SoC
 8831 would be exempt.

8832 Regarding the SoC that must still be tracked under the information requirement, several
 8833 approaches are possible, each with its own level of ambition and associated administrative
 8834 burden. For example, from highest to lowest burden:

- 8835 - Highly ambitious scenario: All SoC listed in Art. 2(27)(a–d) present in the product
- 8836 would fall under the information requirement with the proposed thresholds (see
- 8837 previous chapter), with no further exemptions.
- 8838 - Intermediate scenario: All Art. 2(27)(a–d) SoC would still be tracked, but companies
- 8839 could justify substance-specific exemptions. Supporting evidence demonstrating,
- 8840 issues with technical infeasibility, lack of analytical methods to detect or quantify,
- 8841 irrelevance in the specific product, or the need to protect confidential business
- 8842 information) would be made available for audit. Where needed this should be
- 8843 supported with scientific evidence to substantiate the claims.

- 8844 - Limited scenario: All Art. 2(27)(a–c) SoC would be tracked, but companies could
8845 justify broader exemptions for groups of substances, hazard classes or categories,
8846 etc, within the flexibilities offered by the legal text. Supporting evidence
8847 demonstrating, issues with technical infeasibility, lack of analytical methods to
8848 detect or quantify, irrelevance in the specific product, or the need to protect
8849 confidential business information) would be made available for audit. Where
8850 needed this should be supported with scientific evidence to substantiate the claims.
- 8851 - For Art. 2(27)(d) SoC, a targeted follow-up study with recyclers would need to
8852 identify which substances pose recycling challenges for this product group. Any
8853 problematic SoC could then be added to the delegated act as an amended to
8854 remove their exemption. A variant of this approach could also target specific groups
8855 of substances or exempt certain hazard classes based on product characteristics
8856 and current recycling practices.

8857 Given the complexity of our products (each containing numerous subcomponents and sub-
8858 subcomponent) a five-year implementation period after adoption of the delegated act would be
8859 warranted for each of the scenarios. This timeline would allow for:

- 8860 - Year 1: Preliminary identification of substances present.
- 8861 - Years 2–3: Collection of necessary information and initiation of contractual
8862 negotiations.
- 8863 - Years 4–5: Receipt of supplier data, management of any supplier non-compliance,
8864 organisation of information in accordance with Art. 7(a) of the ESPR and sharing via
8865 a Digital Product Passport and/or existing information channels (for instance
8866 technical product information).

8867 That said, before choosing an exemption approach for the information requirements under Art.
8868 7 of the ESPR, the impacts of each scenario and the proposed timeline must be assessed further
8869 in the impact assessment.

8870 11.7.5.3. Performance requirements

8871 The consultation has not identified any substances that stand out as particularly problematic
8872 with respect to the existing information. Similarly, recycling of this product group is governed by
8873 the WEEE and RoHS Directives, and an established recycling procedure is already in place. The
8874 manufacturers have also not indicated any specific substances. Therefore, at this stage, there is
8875 no basis for imposing specific performance requirements in line with Art. 6 of ESPR. If further
8876 research is conducted beyond the scope of this preparatory study, it would be advisable to
8877 revisit this topic at a later date.

11.7.6. Conclusions

This report aims to identify and assess SoC in commercial 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 plasticiser that, even if unlikely to enter toys or childcare articles through recycled content. Nevertheless, the ESPR nonetheless requires manufacturers of commercial 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) "meaning an information obligation like existing in REACH for SVHC";
- 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 has been 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 delegative 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 may not be necessary at this stage, as there is currently no clear indication that the WEEE/RoHS recycling framework has issues with SoC, and stakeholder feedback has not revealed any specific performance gaps. As new research or recyclability insights emerge, revisiting performance criteria should be considered.

11.7.7. References of Appendix 7 - SoC

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8954

11.8. Appendix 8 – Meeting minutes of the stakeholder meetings

11.8.1. Minutes of the 1st stakeholder meeting

Meeting Minutes of the 1st stakeholder meeting of the
Preparatory Study and Impact assessment support study on Professional dishwashers

Meeting Minutes of the 1st stakeholder meeting of the Preparatory Study on Professional dishwashers

Project	Preparatory study and Impact assessment support study on professional dishwashers	
Event	1st stakeholder meeting of the Preparatory Study on Professional dishwashers	
Date & time	10 December 2024, 10:00 – 17:00	
Location	Hybrid: "Centre de Conférences Albert Borschette", 1049 Brussels & Online	
Documents	Available at https://ecodesign-commdishwashers.eu/en/stakeholder-meetings	
Participants	Partner/Institution	People
	VITO	Frank Meinke-Hubeny
	Oeko-Institut	Kathrin Graulich, Martin Möller, Carl-Otto Gensch
	Trinomics	Laurent Zibell, Lucia van den Boogaart
	Ecomatters	Marco Mense; Mieke de Jager; Maria Papavasiliou
	Fraunhofer IZM	Eduard Wagner
	European Commission	Wojciech Sitarz (ENV); Ian Hodgson (ENER)
	Ali Group	Marco Brugnolaro
	APPLIA	Mattia Merlini
	Aristarco	Claudio Lugnan
	Belgium – FPS Economy	Joachim Nells
	Bonferraro	Alberto Brunelli, Diego Ziviani
	CEFIC	Bernd Kappenberg
	Comenda	Alessandro Rigo
	Compliance & Risks	Michelle Walsh
	DIHR – Ali Group	Claudia Vezzaro
	Ecolab	Marion Zwillingenberger
	ECOS	Fernando Tartaglia
	Electrolux Professional	Fabio Sinatra
	etol	Wolfgang Gauss
	FEICA	Dimitrios Soutzoukis
	FH Muenster	Britta Rummier
	Germany – Ministry for Economic Affairs and Climate Action (BMWK)	Sascha Neuendorf
	Germany – German Environment Agency (UBA)	Gunar Gebauer; Kerim Zaidi
	Germany – Bundesanstalt für Materialforschung/-prüfung (BAM)	Andrea Harrer

Meeting Minutes of the 1st stakeholder meeting of the Preparatory Study and Impact assessment support study on Professional dishwashers

Partner/Institution	People
HKI	Andreas Helm, Sascha Delsel
Hobart	Klaus Padtberg; Verena Wiedenhöfer
ICF	Tom Lock
Malta Competition and Consumer Affairs Authority (MCCAA)	Ruth Baldacchino Scerri
Miele	Andreas Brömmelhaus; Lulse Christmann; Ralf Voßhans; Sarah Masmeler
Netherlands – NL Enterprise Agency	Hans-Paul Siderius
Sika Switzerland	Nathalie Kowalski
SMEG	Eliseo Mantovani; Matteo Rigano
Sweden – Swedish Energy Agency	Carlos Lopes
Switzerland – Federal Energy Agency (BFE)	Eva Geillinger
Topfen Switzerland	Nadja Groß
VDE	Ina Hook
VGG	Thomas Näger
Viegand Maagoe	Annette Gydesen
Wexlödsk	Magnus Ericsson
Winterhalter	Markus Gessler
ZVEI	Theresa Seitz

Agenda:

Time	Topic	Presenter	Institution
10:00	Welcoming / Opening Remarks from DG ENV	Wojciech Sitarz	DG ENV
10:15	The Ecodesign for Sustainable Products (ESPR): State of play	Wojciech Sitarz	DG ENV
10:30	Overview of the Preparatory Study	Kathrin Graulich	Oeko-Institut
10:45	Task 1: Scope and definitions	Martin Möller	Oeko-Institut
11:30	Task 2 – Market analysis:	Laurent Zibell	Trinomics
12:15	Lunch break		
14:00	Task 3 – Users	Kathrin Graulich	Oeko-Institut
14:45	Task 4 - Technologies	Martin Möller	Oeko-Institut
15:30	Coffee break		
16:00	Under discussion: (Extended) EPREL vs. DPP approach for Professional Dishwashers	Eduard Wagner	Fraunhofer IZM
16:20	Outlook: Task 5 – Base Cases	Marco Mense	Ecomatters
16:40	Next steps	Kathrin Graulich	Oeko-Institut
16:50	Closing remarks	Wojciech Sitarz	DG ENV
17:00	End of meeting		

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1. ESPR – State of the Play

- The current Member States expert group of the Consultation Forum will be a sub-group of the Ecodesign Forum set by the ESPR. There will be a permanent call for applications where stakeholders can apply to participate in the Ecodesign Forum. Further stakeholders will be called to participate in specific meetings when they are relevant.

2. Task 1 - Scope: Presentation of the study results + discussion – Martin Möller (Oeko-Institut)

Scope and categories of products

- One stakeholder confirms the main direction of the current study that the categories of the 2011 study could be kept and accepts that the term “commercial” dishwashers could be used instead of “professional”. Regarding “Industrial”: since the term “designed and specifically marketed” can be used to delimitate respective categories (the approach is also applied in other professional product categories under EU Ecodesign), the study could rely on it.
- **Industrial machines:** Distinguishment between commercial and Industrial use-cases (Industrial: e.g. bottle-cleaning): current categories 5 + 6 are commercial, not Industrial dishwashers. The application should be stated in the instructions from the manufacturers. Hence, categories 5 + 6 cannot be used for Industrial purposes because commercial machines are not allowed for Industrial usage. Both hygiene and performance standards exclude Industrial machines. For the distinction it can be referred to the declaration of the manufacturer, i.e. the instructions for use and the Declaration of Conformity (e.g. for Electromagnetic Compatibility). For example, one stakeholder points out to the COMMISSION REGULATION (EU) 2015/1095 of 5 May 2015 Implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for professional refrigerated storage cabinets, blast cabinets, condensing units and process chillers. In the definition of professional refrigerated storage cabinet ‘professional refrigerated storage cabinet’ means an insulated refrigerating appliance integrating one or more compartments accessible via one or more doors or drawers, capable of continuously maintaining the temperature of foodstuffs within prescribed limits at chilled or frozen operating temperature, using a vapour compression cycle, and *intended for the storage of foodstuffs in non-household environments* but not for the display to or access by customers; It was considered sufficient describing that are intended to be used in “non-household environments”, giving for grant that the Industrial sector is excluded. I.e., the term “non-household” was used to distinguish from household and Industrial use.
- **Professional dishwashers operated and heated by gas:** they seem to be no longer built or have not been built for several years. If it is confirmed that they are no longer manufactured, they could be excluded from the scope.

Definition of professional dishwashers / drying function

- The definition of professional dishwashers in the current study includes drying. According to feedback at the stakeholder meeting, however, it is very common that professional dishwashers do not include a drying function; for example, it was mentioned that only 30% of machines in Scandinavia have a drying function; many hood- or undercounter machines do not dry; more than 90% of batch machines do not have an active drying function; also for categories 5 and 6, the drying function is an option. For each category, the drying function is either an option or not.
- According to the stakeholders, professional dishwashers without a drying function should be included in the scope of the study and potential regulation, and not excluded due to the proposed definition.

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Detergents

- Detergents and their Impacts are part of the system to be investigated under Task 3 (Users) and Tasks 5 and 6. Detergents themselves will not be in the direct scope of a potential regulation on professional dishwashers, but the detergent consumption is dependent of the machines' design (that is subject to the potential regulation) which influences the performance (Sinner's circle principle). The performance and the hygiene standards include a specification of the detergents.

Standards

- Standard EN 50593 is not considered anymore as this standard was superseded by EN 63136.

New labelling scheme

- Feedback recently sent by a stakeholder raising the study team's awareness of the UK labelling scheme (the Energy Technology List which covers commercial dishwashers) was not yet included in the draft study report under the Third Country chapter in MEER Task 1.

3. Task 2 - Market: Presentation of the study results + discussion – Laurent Zibell (Trinomics)

Stakeholders are invited to confirm or modify the data provided in the draft report and presented during the workshop.

Market share and split of product categories

- The NAFEM source is based on the American market. According to a stakeholder, the American market is very different from the European market regarding the split between categories. For example, one of the stakeholders stated that category 5 is more common in the US. Also, the US market has different requirements in terms of features and performances.
- More European market data needs to be shared by the stakeholders; however, they have trouble to share figures on pricing or market share due to trade secrets, confidentiality issues and anti-trust rules as the group of stakeholders in this sector is so small that the data cannot be anonymised enough. The study team proposes as a way forward the same solution as what was done for professional laundry appliances, i.e. a neutral intermediary organisation such as APPLIA opens a "black box" repository for companies to provide their market data, which often is confidential. The data in this "black box" is only visible to the intermediary organisation, and is disclosed neither to the participating companies, nor to the consultant team or the European Commission. As soon as the number of companies having contributed to the "black box" exceeds a certain threshold, for example 4, the intermediary organisation released to the consultants the aggregated figures resulting from the sum of all figures received from the participating companies; the number of participating companies; the share of the total market that the participating companies represent.

Repair + maintenance costs

- A stakeholder indicated that the repair and maintenance costs are of interest but maybe only relevant to calculate the total costs. Until now there has been no product regulation where the repair and maintenance costs have been included as requirements so a rough estimate should be sufficient.
- According to the study team, repair and maintenance costs are needed for the Life-Cycle Costing that accompanies the Life-Cycle Assessment of environmental impacts. Since e.g. a longer lifetime is likely to entail more maintenance or repair but less frequent new purchases or installations, knowing these costs is relevant to assess the economic impacts of the measure.
- One stakeholder argues that the costs of maintenance differ per Member State and per product, so that the maintenance cost should be sought as an average per year.

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Refurbishment

- One stakeholder states that the report should clearly differentiate between “refurbishment” and “remanufacturing”. An operation that would lead to machines that would have an energy performance updated would technically be “remanufacturing”, where the machine needs to comply with the new requirements (at the time of the new placement on the market), whereas the “refurbished” product (= restoration of the initial product) only needs to comply with the requirements of its initial placement on the market and not with the newer requirements.

Heating, hot-water supply

- One stakeholder proposed to reconsider the use of warm/hot water connection.
- Overall, by heating directly, an improvement of the environmental impact may be possible. Hot water can be produced at a lesser energy cost than electricity, because of the low yield of the conversion of thermal energy into electricity in thermal power plants and of the transport & distribution of electricity, not to mention the possibility of solar thermal supply.
- However, another stakeholder advised not to focus much on this as it may be too complicated. It can be difficult to specify how it is produced vs. the electricity. Warm / hot water supply leads to a higher energy consumption because the water needs to be heated somewhere else. Further, it could be cumbersome to test a machine with a hot water supply.
- One stakeholder points out that you also have to consider that for instance heat recovery systems often need cold water to run.

Water savings (slide 69)

- One stakeholder pointed out that the most important feature for saving both water and energy is the number of cycles in which the water can be used. The more cycles you have, the more you can reduce the amount of water. In general: multiple tanks, with the dirtiest water closest to the drain. This principle applies to all categories. The stakeholder was asked to provide sources, but it is unclear whether this is available.

Market data on the share of the public sector

- The study teams ask if data can be provided regarding the share of public customers per category of dishwasher?
- Several stakeholders see this challenging as many services, e.g. the catering including dishwashing in public organisations like hospitals, are likely to be outsourced to private companies, so it is unclear who the end-user is (whether private/public).
- Further, it is difficult for manufacturers of professional dishwashers to know the destination of their machines, because the access to the market is organised via professional dealers.

4. Task 3 - Users: Presentation of the study results + discussion – Kathrin Graulich (Oeko-Institut)

There are some discrepancies in the numbers provided by stakeholders compared to the 2011 study. Not all manufacturers have responded yet, in some cases only one source was available, so cross-validation would be helpful; stakeholders should review the information and provide feedback.

Refurbishment

- Stakeholders mentioned that some machines are refurbished by the manufacturers (for example, sandoro gmbH is a sister company of Winterhalter specialised in online marketing), but this represents only a small number of machines that have been in use only for a short time (e.g. from exhibitions, closed restaurants etc.); i.e., the significance in the market is very low. Manufacturers have very little data regarding refurbishment; they recommend asking dealers/installers/service to gain more information.

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Active mode

- Stakeholders asked for a clear definition of the term “active mode” (also in relation to “switched on” as the current way of presenting the data in the study may lead to misunderstandings and wrong answers from stakeholders. The study team explains that “active mode” is understood as the mode where the machine operates and performs the washing, i.e. it does not include the standby mode between different batches. “Switched on” time on the contrary, means the whole time of use per the day including the standby times (“ready to use”, left-on mode, filling of the machine) on top the “cycle” times.
- The tables will be checked by the study team, perhaps the terms are based on 2011 and outdated (e.g. for categories 2 and 3, EN 63136 defines ready to use mode). There seem to be significant increases from 2011, which needs to be doublechecked by stakeholders as well.

Contact time

- Some stakeholders informed that standards defined and use the term “contact time” as it is difficult to talk of “cycle time” in conveyor-type machines. The contact time is defined by EN 17735 with separate definitions for batch and conveyor types of machines: *“time during which the detergent solution impacts the wash ware; Note 1 to entry: For conveyor-type machines the contact time commences from the centre of first prewash nozzle and extends until the centre of the first freshwater rinse nozzle. For batch type dishwashing machines, the contact time commences upon start of the detergent circulation and lasts until the start of the freshwater rinsing.”*
- However, drying would not be included in the “contact time” (e.g. if 1 or 2 drying zones are added).
- Another manufacturer stated that they usually mention the term “productivity” (depending on the speed of the conveyor and its length to compute the duration of the process) instead of the “programme time” for their technologies.

Operational day / real-life data

- In real-life use the stand-by time is dictated by the operators and not by standardised stand-by or by the standby regulation. Also real-life energy use during use phase cannot be answered by the machine manufacturer as it depends for example on the way how the hot water is heated.
- The number of cycles per day depend on the customers and might be lower in real life than indicated as theoretically possible by manufacturers (cycles per hour). One stakeholder suggested to start from the same number of dishes per cycle or year (as not more dishes will be cleaned in real-life) and then apply the real life usage parameters.
- One stakeholder suggested to present “an operational day” per category in the study report, for example in a graphic way (e.g. waiting for load, cycle, maybe another load etc.)
- Manufacturers indicated that they have very limited data on “real-world use” and suggest that rather professional end users (e.g., hotels, restaurants, institutions, etc.) should be consulted (in Germany for example represented by the association of hotels, small bars and restaurants (DEHOGA))

Programme duration / hygiene requirements (Slide 91)

- Stakeholders commented with regard to the table entry “up to 630 sec for hygiene-focused programmes” for dishwasher categories 2 and 3 that this is misleading because all cycles must meet hygiene standards. The 10 minutes programme listed refers to the thermal infection / treatment that is relevant for some customers only and is not commonly used; standard machines do not have this 10-minute cycle but still have to meet hygienic requirements. All categories, except for Category 1, are required to meet the hygiene requirements of the standard.

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5. Task 4 - Technology: Presentation of the study results + discussion – Martin Möller (Oeko-Institut)

- According to stakeholder feedback, steam is the most expensive energy; therefore, they would not place steam on the “future” technologies list.
- Enzyme detergents are already available on the market and therefore not a “future” technology. It is mainly used for the Category 1 machines and takes more time.

6. Digital Product Passport (DPP) – Eduard Wagner (Fraunhofer IZM)

- The Commission explains that if the preparatory study concludes that an energy label and hence an EPREL entry for the product category is needed, then it can be used to fulfil the DPP requirements and hence the regulator has the choice between the two solutions (EPREL or DPP). Otherwise, then only the DPP is allowed.
- One stakeholder added that if information would be needed on a unit and batch level (not at product level), then also the DPP is needed as EPREL only works at the scale of the product.

7. Outline of Tasks 5 – Life Cycle Assessment and Life Cycle Costing and 6: Ecodesign options – Marco Mense (Ecomatters)

Stakeholders are invited to confirm or modify the data provided in the draft report and presented during the workshop in order to facilitate the definition of Base Cases and subsequent steps of the study.

8. Information by consultant team on the next steps in the process – Kathrin Graulich (Oeko-Institut)

Stakeholders requested an extension of the feedback deadline of 07 January 2025 due to the Christmas holiday period, as at least 4 active weeks are needed to work on the data to be provided.

8965 11.8.2. Minutes of the 2nd stakeholder meeting

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**Meeting Minutes of the 2nd stakeholder meeting of the
Preparatory Study and Impact Assessment support study
on professional dishwashers**

Project	Preparatory study and Impact Assessment support study on professional dishwashers
Event	2nd stakeholder meeting of the Preparatory Study on professional dishwashers
Date & time	01 July 2025, 10:00 – 17:00
Location	Hybrid: “Centre de Conférences Albert Borschette”, 1049 Brussels & Online
Documents	Available at https://ecodesign-commdishwashers.eu/en/stakeholder-meetings
Participants	Partner/Institution VITO Oeko-Institut Trinomics Ecomatters Fraunhofer ISI Fraunhofer IZM European Commission (ENV) A.I.S.E. - European Detergents Association ADLER S.p.A BAM BMUV Bonferraro - Smeg CEFIC Chemische Fabrik Dr. Weigert GmbH & Co KG Comenda S.p.A Danish Energy Agency DIHR – Ali Group Efcem Italia Electrolux Professional Federal Environment Agency Germany (UBA) Federal Ministry for Economic Affairs and Energy (BMWE) FEICA

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FH Muenster

Foodservice Equipment Association (FEA)
FPS Economy, SMEs, Self-employed and
Energy
Germany – German Environment Agency
(UBA)

HKI

Hobart GmbH

ICF

iFixit GmbH / Right to Repair EU

Jestic Food Service Solutions

KEITI

MEIKO Maschinenbau GmbH & Co. KG

Miele

ONNERA GROUP S.COOP

Sika Switzerland

Silicones Europe, a sector group of Cefic

Smeg SpA

Topten Switzerland

VGG

Winterhalter Gastronom GmbH

Winterhalter UK Ltd

ZVEI e.V.

Agenda:

Time	Topic	Presenter	Institution
10:00	1. Welcome Opening Remarks ESPR: state of play	Wojciech Sitarz	DG ENV
10:15	2. Overview of the Preparatory Study	Kathrin Graulich	Oeko-Institut
10:30	3. Task 1 – Scope and definitions – Main changes after review	Martin Möller	Oeko-Institut
10:45	4. Task 2 – Market analysis – Main changes after review	Laurent Zibell	Trinomics
11:00	5. Task 3 – Users – Main changes after review	Kathrin Graulich	Oeko-Institut
11:15	6. Task 4 – Technologies – Main changes after review	Martin Möller	Oeko-Institut
12:00	Lunch break		
13:30	7. Task 5 – LCA & LCC of Base Cases	Mieke de Jager	Ecomatters
14:15	8. Task 6 – LCA & LCC of Design Options	Martin Möller Mieke de Jager	Oeko-Institut Ecomatters
15:00	Coffee break		

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Time	Topic	Presenter	Institution
15:30	9. Outlook: Task 7 – Scenarios / policy options	Antoine Durand	Fraunhofer ISI
16:15	10. Substances of Concern	Eelco van IJken	Ecomatters
16:45	11. Next steps of the study Closing remarks	Kathrin Graulich Wojciech Sitarz	Oeko-Institut DG ENV
17:00	End of meeting		

1. **Welcome | Opening Remarks | ESPR: state of play – Wojciech Sitarz (DG ENV)**
2. **Overview of the Preparatory Study – Kathrin Graulich (Oeko-Institut)**
3. **Task 1 – Scope and definitions – Main changes after review – Martin Möller (Oeko-Institut)**
 - No questions or comments during the meeting.
4. **Task 2 – Market analysis – Main changes after review – Laurent Zibell (Trinomics)**
 - One stakeholder questions the estimated lifespan of the machines and assumes that the lifespan of BC2-4 would be more than 8 years whereas 12 years for BC1 seem to be too high. Answer by study team: Task 2 (Table 4-7 in the report) is the source; the study team will check if previous stakeholder feedback on this point has been considered in the review.
5. **Task 3 – Users: Main changes after review – Kathrin Graulich (Oeko-Institut)**
 - One stakeholder questions the active mode of BC5 + BC6 being 8 hours (see table 5-4 in the report); at least for BC5 it seems to be not realistic as it's not possible that there is 8 hours non-stop operation. Answer by study team: the data is based on stakeholder feedback as detailed in the study report.
 - One stakeholder questions the additional water consumption for BC2 of 86L per 100 plates due to pre-rinsing (Table 5-12 in the report) as not being realistic and would be restricted by the flow rate of the spray (5 litres). Answer by the study team: data was derived from a scientific study, where this volume was measured/asked from professional users.
6. **Task 4 – Technology – Main changes after review – Martin Möller (Oeko-Institut)**
 - With regard to products with standard improvement design options / "Hot water connection for almost all machines" (slide #102 of presentation): one stakeholder points out to make a difference between 'ready for hot water connection' and machines that actually are connected to the hot water as most machines are technically ready for hot water connection, but are not actually connected. Answer by the study team: the actual use of hot water is based on lower values (Table 5-26 in the report) so this is reflected in the calculations. Wording in MEER Task 4 report will be updated.
 - One stakeholder informs that reverse osmosis is not only applicable to BC1 but also to BC2.
7. **Task 5 – LCA & LCC of Base Cases – Mieke de Jager (Ecomatters)**
 - One stakeholder asks where the cycle values and water volumes are taken from for the calculations in Task 5? Answer by the study team: The values are based on MEER Task 3: Cycles in Table 5-4 (page 108) and water volumes Table 5-18 (page 140)

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8. Task 6 – LCA & LCC of Design Options – Mieke de Jager (Ecomatters) & Martin Möller (Oeko-Institut)

- Upon the question if ABS should be included in the design options, and if so, at what quantity (see slide #158 of the presentation), one stakeholder informs that ABS is mostly used in small amounts for the front-end (user interface) in BC1+2; more seldom in BC3 and not in BC5+6. Manufacturers don't use ABS because of the resistance against chemicals; therefore, it is out of context (better not to include). One manufacturer informs that they use ABS in all BC2-6 for electronics casings as heat resistance against flammability, but not in a high amount. Another stakeholder confirms that ABS not important (for the design options).
- Upon the question on whether energy for hot water should be taken into account or not in the calculations of design options (see slide #158 of the presentation): one stakeholder suggests that hot water should be taken into account, but they don't know the source of the heat (if it is sustainable or not) - "we don't have the solution". Another stakeholder states that the customer can choose when ordering the machine if they want it to be connected to external hot water source or not.

9. Outlook: Task 7 – Scenarios / policy options – Antoine Durand (Fraunhofer ISI)

- Reusability (slide #162): One stakeholder asks why reusability is presented as an issue although reusability of commercial dishwashers is low according to the study report. Answer by the study team: the left column of that table summarises the ESPR article 5 requirements in one cell whereas the right column lists those issues that were identified as considerable for commercial dishwashers. Indeed, reusability is not the main hotspot (which is use phase + raw materials production); the study team will add this to the presentation.
- Measurement standard (slides #163-169, 179):
 - a. On the suggested proposal to define a reference programme and reference machine in the current standard for BC2 and BC3, the study team explains during the meeting that it would be good to have data on the resource consumption, cleaning performance etc. as it is currently not easy to make a comparison between machines. The performance of an 'average machine' might be used to provide benchmark values in the regulation.
 - b. One stakeholder points out that if a reference machine would be included, then the whole standard would have to be revised. The current standard is only aimed at measuring the consumption of appliances, but not at comparing the appliances to other appliances.
 - c. Stakeholder feedback during the meeting suggests that there is no need to add a reference machine to the standard itself; only the current measurement data on performance and energy consumption of appliances would have to be collected and would be needed to set thresholds and a label in the regulation (not in the standard).
 - d. It is further informed that the standard performance according to EN IEC 63136:2019 has to be tested together with the hygiene performance according to standard EN 17735. However, as there are different programmes for different purposes it is harder to define a 'standard programme' for commercial dishwashers; what seems more important is achieving the hygiene performance.
 - e. With the measurement standard, also the soiling can be measured. i.e. it is discussed that a requirement could be included in the regulation to measure the resource consumption and re-soiling at a certain minimum threshold for the soiling performance. A minimum requirement might be set in the regulation on the ratio between the soiling and the resource consumption.

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- f. Applicability of the EN IEC 63136:2019 to other dishwasher categories than BC2+3:
 - i. BC1: According to stakeholder feedback, the present standard for BC2+BC3 would not be applicable to BC1 (e.g. resoiling not relevant for water-change machines). It is proposed to rather check if the performance standard of household dishwashers could be applied.
 - ii. BC4: Using the standard, as proposed by the study team, with plates won't provide reasonable results as everything will be clean which would not be the case for the typical wash ware (pots, pans, utensils).
 - iii. BC5+BC6: customised machines which are very different from batch-based machines, i.e. there is no standard machine, thus it would be difficult to have a reference performance. Answer by the study team: Instead of setting requirements for the energy performance, as there is no possibility to compare the machines, a back-up solution could be to set minimum requirements on specific design aspects as proposed on slide #171 to improve the overall energy performance of these categories. Further stakeholder feedback and ideas are welcome.
- Spare parts (slide #172):
 - One stakeholder asks why the spare parts **delivery time** is set at 5 days although it is usually 15 days for other product categories regulated under EU Ecodesign.
 - Another stakeholder confirms that it is important to include a requirement on the availability of spare parts. Although this might be business as usual for high-end manufacturers, it is reasonable as back-stop for lower-end machines. A period of 5 days of delivery is supported, as users heavily rely on the appliances. For example, for smartphones the period is also 5 days.
 - Another stakeholder points out to the existing regulation on refrigerators with direct sales function as a rather comparable product category; in that regulation, a delivery time of spare parts of 15 days and the availability of 8 years after placing the last product on the market is required.
 - One stakeholder further proposes to consider reasonable repair costs, i.e. a requirement for **spare parts prices**.
 - Answer by the study team: A 15-day period is required e.g. for household dishwashers. For commercial dishwashers, a shorter delivery time is proposed as spare parts have to be delivered quickly anyway. As another example, in the product category EV chargers it turned out that the manufacturers are anyway providing spare parts services for satisfying the customers so that a short delivery time might be feasible. The Stakeholders are asked to provide feedback on their spare parts service and habits and if/why the 5 days would be too short.
- Digital Product Passport DPP (slide #177): One stakeholder asks if the results of the ongoing EC's open public consultation (OPC) on the DPP, ending that day, are taken into account when setting product specific requirements? Answer by DG ENV: The OPC is about rules for DPP service providers on the technical aspects, also for the revision of the NLF legislation. For products with an Energy label, data have to be provided in EPREL; for products without Energy label, the ESPR requires then a DPP as information system. If a DPP system for a regulated product category is not ready, requirements would only be applicable once the system is ready. Experiences from other product categories will be considered (DPP for batteries to be started from 2026).

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- Implementation date of policy measures (slide #179): The suggested timeline ('Feasibility for a regulation covering all aspects e.g. by 2029') seems to be very ambitious. Answer by the study team: The proposed date has not yet been discussed with the EC and not yet been impact assessed; starting point was estimating an implementation of a regulation in the year 2026 or 2027, with the requirements then usually starting about 2 years later. Based on the following impact assessment, the timelines for different requirements (information requirements, performance requirements) might be specified and split. Requirements being easier to implement may start from the beginning, whereas more difficult ones only later.

10. Substances of Concern – Eelco van IJken (Ecomatters)

- One stakeholder appreciates that the approach for household and commercial dishwashers and the other current product groups (household + commercial laundry appliances) is the same on this topic.
- It is asked if the suggested follow-up study with recyclers on Article 2(27)d for the limited scenario (see slide #186) will also be done in the highly ambitious and intermediate scenario? As it is not manufacturer's knowledge how to identify SoCs that affect recycling, a follow-up study for the SoCs for article 2(27)d would be helpful for all scenarios. Answer of the study team: it will be checked with the Commission if this option can be considered.

11. Next steps of the study | Closing remarks – Kathrin Graulich (Oeko-Institut) & Wojciech Sitarz (DG ENV)

- Stakeholders would rather appreciate an extension of the feedback deadline of 15 August 2025 due to the summer holiday period.

11.9. Appendix 9 – DPP use cases and derived requirements

Green colour indicates use-cases that are seen potentially relevant by the project team – to be validated by the stakeholders. To note, “item-level” and “batch-level” granularity (currently) can only be established through a DPP. Other aspects (access rights management, model-level, RFID data carrier, machine readable) could be established through EPREL.

Stakeholder	Use-case (CE-goal)	Information to be provided	Feasible with EPREL / DPP	Public data	Confidential	Granularity	Hierarchy	Data carrier	Offline available	Machine readable
Customer	Sustainable purchase	CO2 footprint, circularity indicators (e.g. reparability), recycled content	EPREL (extended with sustainability information)	Public	No	Model (/Batch)	Product	QR-code	-	-
Customer	Sustainable purchase	Environmental and social label	EPREL (extended with label)	Public	No	Model (/Batch)	Product	QR-code	-	-
Customer	Sustainable purchase	Technical specifications / documentation	EPREL	Public	No	Model (/Batch)	Product	QR-code	-	-
Customer	Prolong use (maintenance, DIY repair)	Use, maintenance and DIY repair instructions	EPREL (extended with manuals)	Public	No	Model	Component	QR-code	-	-
Customer	Resell & 2.hand purchase	Usage history, repair history	DPP (item level information)	No	Yes	Item	Product	QR-code	-	-
Customer	Proper disposal	Disposal and return options	EPREL (extended with disposal information)	Public	No	Model	Product	QR-code	-	-
Repairer	Professional (certified) repair	Dismantling instructions, spare part availability, etc.	EPREL (extended with repair information)	No	Yes	Model/item	Component	QR-code	-	-
Reuser	Enable reuse	Usage history, repair history	DPP (item level information)	No	Yes	Item	Component	QR-code	-	-
Refurbisher	Enable refurbishment	Dismantling instructions, usage & repair history	DPP (item level information)	No	Yes	Item	Component	QR-code	-	-
Remanufacturer	Enable remanufacturing / repurposing	Dismantling instructions, usage & repair history	DPP (item level information)	No	Yes	Item	Component	QR-code	-	-

Stakeholder	Use-case (CE-goal)	Information to be provided	Feasible with EPREL / DPP	Public data	Confidential	Granularity	Hierarchy	Data carrier	Offline available	Machine readable
Collection & Presorting	Preparation for reuse	Energy efficiency, Usage/repair history, purchase date, original product price	DPP (item level information)	No	Yes	Item	Component	QR-code	-	-
Collection & Presorting	Component sorting	Dismantling instructions	EPREL (extended)	No	Yes	Model	Component	RFID	x	-
Collection & Presorting	Separation of products/components with prohibited substances (WEEE, RoHS, REACH, etc.)	Prohibited / hazardous substances per component (incl. Batteries)	EPREL (extended with material information)	Public	No	Model (/Batch)	Component	RFID	x	(x)
Collection & Presorting	Separation of products/components with valuable materials	Valuable materials	EPREL (extended)	No	Yes	Model (/Batch)	Component	RFID	x	(x)
Collection & Presorting	Closed loop recycling	Application type, model	EPREL (extended)	Public	No	Model (/Batch)	Product	RFID	-	-

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Getting in touch with the EU

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In person

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All over the European Union there are hundreds of Europe Direct centres.

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You can find the address of the centre nearest you online ([european-](https://european-union.europa.eu/contact-eu/meet-us_en)

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[union.europa.eu/contact-eu/meet-us_en](https://european-union.europa.eu/contact-eu/meet-us_en)).

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On the phone or in writing

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Europe Direct is a service that answers your questions about the European Union. You can contact this service:

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- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),

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- at the following standard number: +32 22999696,

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- via the following form: european-union.europa.eu/contact-eu/write-us_en.

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Finding information about the EU

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Online

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Information about the European Union in all the official languages of the EU is available on the Europa website (european-union.europa.eu).

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EU publications

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You can view or order EU publications at op.europa.eu/en/publications.

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Multiple copies of free publications can be obtained by contacting Europe

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Direct or your local documentation centre ([european-](https://european-union.europa.eu/contact-eu/meet-us_en)

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[union.europa.eu/contact-eu/meet-us_en](https://european-union.europa.eu/contact-eu/meet-us_en)).

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EU law and related documents

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For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex (eur-lex.europa.eu).

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EU open data

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The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies. These can be downloaded and reused for free, for both commercial and non-commercial purposes. The portal also provides access to a wealth of datasets from European countries.

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