FWC ESPR – SR5 Professional Dishwashers

2nd Stakeholder Meeting – 1 July 2025

Oeko-Institut, Trinomics, Ecomatters, Fraunhofer IZM, Fraunhofer ISI, and VITO

Welcome &
Ecodesign for Sustainable Products Regulation (ESPR)

Professional Dishwashers

1 July 2025

Wojtek SITARZ
DG ENV B4
Sustainable Products

ESPR: timeline & milestones

25 April 2024
EP Plenary voted on final ESPR text

May 2024
Final Council endorsement

June 2024
Publication of ESPR in the OJ

18 July 2024
ESPR **entry into force**

October 2024
Establishment of Ecodesign Forum; calls for membership

February 2025
First meeting of the **Ecodesign Forum**

16 April 2025
Adoption of the 1st ESPR **Working Plan** (9m after entry into force)

Mid 2025
Acts on **unsold goods** destruction ban & exemptions (12m after entry into force)

2025/2026
Acts on DPP registry, service providers, data carriers, digital credentials

2026/2027
Adoption of the **first ESPR measures** (e.g. textiles/steel)

2027/2028
First product **requirements** start to apply.

New Final products included

Product/Measure	JRC ranking	Stakeholders' opinion	Market size (EU)	Estimated timeline for adoption
Final products				
Textiles/Apparel	1st	High support	175 billion EUR (with footwear, 2021)	2027
Furniture	2nd	Support	140 billion EUR (2021)	2028
Tyres	3rd	High support	45 billion EUR (2021)	2027
Mattresses	4th	High support	10 billion EUR (2022)	2029

Note: Information and Communication Technologies (ICT) are not in the list but they are considered covered through horizontal requirements and some energy-related products.

Intermediate products included

Product/Measure	JRC ranking	Stakeholders' opinion	Market size (EU)	Estimated timeline for adoption
Final products				
Iron & Steel	1st	High support	152 billion EUR (2023)	2026
Aluminium	4th	Support	40 billion EUR (2019)	2028

Horizontal measures included

Product/Measure	JRC ranking	Stakeholders' opinion	Market size (EU)	Estimated timeline for adoption
Horizontal requirements				
Repairability (including scoring)	N/A	High support	N/A	2027
Recycled content and recyclability of electrical and electronic equipment	N/A	Support	N/A	2029

Energy-related products included

Energy-related products	Ecodesign requirements	Energy label	Indicative timeline
Low temperature emitters	No	Yes	Adoption: 2026
Displays	Yes	Yes	Adoption: 2027
EV chargers	tbd	tbd	Adoption: 2028
Household dishwashers	Yes	Yes	Adoption: 2026
Household washing machines and household washer-dryers	Yes	Yes	Adoption: 2026
Professional laundry	Yes	tbd	Adoption: 2026
Professional dishwashers	Yes	tbd	Adoption: 2026
Electric motors and variable speed drives	Yes	No	Adoption: 2028
Refrigerating appliances (including Household fridges and freezers)	Yes	Yes	Adoption: 2028
Refrigerating appliances with a sales function	Yes	Yes	Adoption: 2028
Light sources and (only for ecodesign) separate control gears	Yes	Yes	Adoption: 2029

Energy-related products (ctd.)

Energy-related products	**Ecodesign requirements**	**Energy label**	**Indicative timeline**
Welding equipment	Yes	No	Adoption: end 2030
Mobile phones and tablets	Yes	Yes	Adoption: end 2030
Local space heaters	Yes	Yes	**Energy label**: adoption in 2026 **Ecodesign requirement**s: Adoption mid 2030
Tumble dryers	Yes	Yes	Adoption: end 2030
Standby and off mode consumption	Yes	No	Adoption: end 2030

Transition regime (ESPR Article 79) – to be finalised under the Ecodesign Directive

external power supplies, photovoltaic panels, space and combination heaters, water heaters, solid fuel local space heaters, air conditioners including air-to-air heat pumps and comfort fans, solid fuel boilers, air heating and cooling products, ventilation units, vacuum cleaners, cooking appliances, water pumps, circulators, computers, servers and data storage products, power transformers, professional refrigeration equipment, imaging equipment.

Thank you!
Questions?

Agenda

Agenda – morning

10:00 – 10:15	**Welcome | Opening Remarks | ESPR: state of play** *Wojtek Sitarz – Policy officer – ENV B.4*
10:15 – 10:30	**Overview of the Preparatory Study** *Kathrin Graulich – Senior Researcher – Oeko-Institut*
10:30 – 10:45	**Task 1: Scope and definitions – Main changes after review** *Martin Möller – Senior Researcher – Oeko-Institut*
10:45 – 11:00	**Task 2 – Market analysis – Main changes after review** *Laurent Zibell – Senior Consultant – Trinomics*
11:00 – 11:15	**Task 3 – Users – Main changes after review** *Kathrin Graulich – Senior Researcher – Oeko-Institut*
11:15 – 11:30	**Task 4 – Technologies – Main changes after review** *Martin Möller – Senior Researcher – Oeko-Institut*
11:30 – 12:00	**Q&A – Revised Tasks 1-4**

12:00 – 13:30 Lunch break outside the building!

Agenda – afternoon

13:30 – 14:00	**Task 5 – LCA & LCC of Base Cases** *Mieke de Jager – Consultant – Ecomatters*
14:00 – 14:15	**Q&A – Task 5**
14:15 – 14:45	**Task 6 – LCA & LCC of Design Options** *Martin Möller – Senior Researcher – Oeko-Institut* *Mieke de Jager – Consultant – Ecomatters*
14:45 – 15:00	**Q&A – Task 6**
15:00 – 15:30	Coffee break
15:30 – 16:00	**Outlook: Task 7 – Scenarios / policy options** *Antoine Durand – Senior Researcher – Fraunhofer ISI*
16:00 – 16:15	**Q&A – Task 7**
16:15 – 16:30	**Substances of Concern** *Eelco van Ijken – Senior Consultant – Ecomatters*
16:30 – 16:45	**Q&A – Substances of Concern**
16:45 – 17:00	**Next steps of the study | Closing remarks | End of the meeting** *Kathrin Graulich – Senior Researcher – Oeko-Institut* *Wojtek Sitarz – Policy officer – ENV B.4*

Overview of the Preparatory Study

Kathrin Graulich – Oeko-Institut

Professional dishwashers – the “history” of Ecodesign

The **initial preparatory study on professional dishwashers (“Lot 24”)** was completed in 2011 (by Oeko-Institut) and the products were found eligible in 2014 as the energy, carbon and water saving potential was reasonable.

However**, robust test standards were lacking** at that time. Following a standardisation mandate to the ESOs, test standards were developed for some of the dishwasher categories.

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 category in the Ecodesign and Energy Labelling Working Plan 2022-2024.

Ecodesign (for professional dishwashers) under ESPR

ESPR Article 5 setting of a wide range of ecodesign requirements, including:

- product durability, reusability, upgradability and reparability
- the possibility of maintenance and refurbishment
- presence of substances that inhibit circularity
- energy and resource use and efficiency
- recycled content
- remanufacturing and recycling
- carbon and environmental footprints
- information requirements, including a Digital Product Passport

MEErP methodology: revised for the purposes of the ESPR

- Revised methodological guideline for Preparatory Studies under ESPR has been published recently (September 2024): https://op.europa.eu/en/publication-detail/-/publication/03ac5f5a-eb3b-11ee-bf53-01aa75ed71a1

- MEErP phase 1 (Tasks 1 – 4): No methodological changes

- **MEErP phase 2 (Tasks 5 – 7):**
  Some changes of the methodology

  - Task 5: Environmental assessment … rules and indicators
  - Task 6: Life cycle costs assessment
  - Task 7: Scenarios

Study schedule

Overall project duration: 04.06.2024 – 03.12.2026

Short introduction of the study team

Tour de Table

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

- Founded in 1977, > 200 employees, based in Germany
- Research on sustainable products & material flows, resources, Circular Economy & global value chains, energy & climate, chemicals, environmental law & governance, ...
- Lead of 2011 Ecodesign preparatory study on Professional Dishwashers
- Methodological experts (MEErP/ERT, PEF/PEFCR, LCA/LCC, evaluations, impact assessments, Substances of Concern)

OEKO:
Technical project lead
Lead of Preparatory Study;
responsible for MEErP Tasks
1 (scope), 3 (users), 4 (technologies),
6 (design options) and
Working documents

Kathrin Graulich
SR5 Project Manager & Researcher – Senior expert

Martin Möller
Researcher – Senior expert

Carl-Otto Gensch
Researcher – Senior expert

Tour de Table

Trinomics

- Founded 2012, ca. 60 employees
- HQ in the Netherlands (Rotterdam), offices in Brussels + Paris
- Circular Economy, environment, climate and energy consultancy
- >95% of turnover with public entities or non-profit foundations
- Extensive track record of policy support to European Commission (ENV, CLIMA, ENER, GROW, REFORM) and EEA: Evaluations, IAs, studies
- Led IA study for Ecodesign for Sustainable Products Regulation (ESPR)

Trinomics:

Lead of Impact Assessment support Study; responsible for MEErP Task 2 (markets)

Dr. Laurent Zibell
Senior expert

Lucia van den Boogaart
Junior expert

Tour de Table

ecomatters

- Sustainability consultancy with 15-years of experience in LCA
- 20 team members and located in Utrecht, the Netherlands
- Specialised in LCA, applying PEF method & PEFCR development, EPD development, corporate reporting (incl. CSRD), and carbon calculations using GHG-protocol
- Our expertise on LCA and PEF is supported by work on chemical safety covering REACH, SVHC, Restriction of Microplastics, WFD, and SCIP.

Ecomatters:

Responsible for MEErP
Task 5 (Environment, SoC)
Task 6 LCA&LCC design options

Mieke de Jager
Expert

Maria Papavasileiou
Expert

Eelco van IJken
Expert

Tour de Table

Fraunhofer ISI

- Fraunhofer ISI (Institute for Systems and Innovation Research)
- Belongs to the Fraunhofer-Gesellschaft (world's leading applied research organization)
- Founded in 1972, > 300 employees, based in Karlsruhe (Germany)
- Research on energy/climate/innovation policies, sustainability & material flows, resources, Circular Economy & global value chains...
- Methodological experts (MEErP/ERT, LCA/LCC, evaluations, IA, scenarios/modelling)

Fraunhofer ISI:

Responsible for
MEErP Task 7 (Scenarios)

Antoine Durand
Researcher – Senior expert

Tour de Table

Fraunhofer Institute for Reliability and Microintegration IZM

- Fraunhofer IZM (Institute for Reliability and Microintegration) / Department Environmental and Reliability Engineering
- Belongs to the Fraunhofer-Gesellschaft (world's leading applied research organization)
- Fraunhofer IZM has been involved in various ecodesign related studies, including preparatory and impact assessments studies.
- In recent years Fraunhofer IZM takes a leading role in the development of the digital product passport for the European Commission.

Fraunhofer IZM:

Responsible for DPP aspects

Eduard Wagner
Senior expert

Theresa Aigner
Junior expert

Tour de Table

- Flemish Institute for Technological Research
- > 1000 employees
- HQ in Belgium
- Energy research embedded in the EnergyVille research collaboration
- Coordinated several Ecodesign FWC for DG ENER and DG GROW

VITO:
Coordinator of the Ecodesign FWC under which the study has been contracted

Gabriela Espadas Aldana
Researcher – Quality Assurance, Expert

Nele Kelchtermans
Researcher – Junior expert

Frank Meinke-Hubeny
Programme Manager: Sustainability & Circularity Assessment

MEErP Task 1
Scope and definitions

Main updates after review

Martin Möller - Oeko-Institut

vito

The objective of MEErP Task 1

Defining the **product category** and the **system boundaries** of the ‘playing field’ for ecodesign and ESPR Legislation

- Definition of the **functional unit** of the product group and **scope** of a potential regulation
- Determination of **definitions** and **categories**
- **Delimitation** of the scope of appliances covered versus household dishwashers
- Provide an overview of **relevant standards** and **legislation**

Definition for commercial dishwashing machines

'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).*

- Industrial appliances are explicitly excluded
- Declaration of Conformity relates to intended use / Machinery Directive

Adjustments to terminology according to stakeholder feedback

- Basket ➡ rack
- Basket transport ➡ rack conveyor
- Belt conveyor dishwasher ➡ flight type dishwasher
- Programme automats ➡ batch dishwashers
- ‘Semi-professional’ dishwasher: term also deleted in Table 3-1 ➡ commercial water-change dishwasher

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

Group	Domestic dishwashers	Commercial water change dishwashers	Other commercial dishwashers

Categorisation of commercial dishwashers

Commercial dishwashing machines:

- 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)

Stakeholder input on classification

- High level of **approval for categorisation** from Lot 24 Task 1 report
- Categorisation generally **appropriate** for the Tasks of the present study
- Partly divergent comments on **category 1**
  - Most stakeholders: integral part of the product group, should be kept in the scope
  - One stakeholder: should be excluded from the study as they are very different from all other categories in terms of their specifications and technical features
- Mixed comments on **categories 4-6**
  - Some stakeholders: should be excluded from the scope of potential *policy measures* at this point due to low market relevance and lack of standards
  - Other stakeholders: should be kept within scope, as their processing capacity and operating duration are much larger than smaller machines; information and material efficiency requirements could be set without a performance standard

Finalisation of functional and performance parameters according to stakeholder input

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

n.a. = not applicable

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

Adjustments to the results of the standardisation screening according to stakeholder feedback

International, European and MS level, see section 3.3 of the Task 1 report

- **Section 3.3.1:** Performance → Performance and safety
- **Section 3.3.1.4** has been moved up to become **3.3.1.3**, as it is also used in conjunction with EN 60335-1 and its amendments, which supplement or modify the corresponding clauses.
- Consistent **reference** to published **European versions** of the standards
  - EN IEC 63136:2019/AC:2021-04
  - EN 60335-1:2012 and its amendments
  - EN 60335-2-58:2005 + A1:2008 + A11:2010 + A2:2015 + A12:2016
  - Same as for noise and EMC standards
  - Deleted ‘DIN’ before EN 17735
- **Reference** to the **latest version of NSF/ANSI**
- **Correction** of some **typos** as well as several **minor adjustments**
- **No relevant standards missing** in the Task 1 report

Adjustments to the results of the legislation screening according to stakeholder feedback

International, European, MS and third country level, see section 3.4 of the Task 1 report

- Inclusion of the **Energy Technology List** (UK), see section 3.4.5.3
  - Government-backed voluntary scheme
  - Applicable to undercounter and hood-type dishwashers
  - Energy and water efficiency criteria per cycle (e.g. ≤0.4 kWh and ≤3.4 litres for undercounter models; ≤0.6 kWh and ≤3 litres for hood-type models)
  - Tested to recognised standards (such as EN IEC 63136 and EN 17735)

- **Update of latest legislation**
  - Packaging Directive repealed by Packaging and Packaging Waste Regulation (EU) 2025/40
  - Critical Raw Materials Regulation (EU) 2024/1252

- **Correction** of some **typos** as well as **update** with several **minor amendments**

MEErP Task 2
Markets

Main updates after review

Laurent Zibell - Trinomics

Adjusted numbers

MEErP Task 2 - Market

Share of sales per category

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

- The share of sales is now based on EU-wide sales data for Italian manufacturers, as provided by APPLiA Italia, due to the unavailability of other data sources.
- Category 1 is not produced by Italian manufacturers, so an estimate was made using the same proportions as in the 2011 study.

Adjusted numbers

MEErP Task 2 - Market

Official PRODCOM data – Estimated installed base ('stock'), estimated new sales & estimated replacement sales

- Actual numbers are unknown
- Estimation based on **lifespan** and **share of sales** per **category**
- Lifespan based on average expected initial lifetime as indicated by stakeholders
- Share of sales based on APPLIA Italia
- Estimated **stock** in in de EU27 in 2023 is **2,040,759 units**
- Estimated **total sales** in 2023: **275,016 units**
  - Estimated **replacement sales** in 2023: **194,471 units**
  - Estimated **new sales** in 2023: **80,545 units**

Category	Product type	Estimated lifespan in years (2024)	Share of sales
Category 1	Undercounter water-change	12	3 %
Category 2	Undercounter one-tank	8	65 %
Category 3	Hood-type	8	24 %
Category 4	Utensil/Pot	9	5 %
Category 5	Conveyor-type one-tank	11	2 %
Category 6	Conveyor-type multi-tank	15	1 %

MEErP Task 3
Users

Main updates after review

Kathrin Graulich - Oeko-Institut

The objective of MEErP Task 3 (Users):

Objectives:

- Overview of the analysis of data on user behaviour during the use phase of commercial dishwashers.
- Attempt to quantify relevant user-parameters that influence the environmental impact of a product throughout its lifetime
- Identify obstacles to possible ecodesign measures, that relate to consumer behaviour, social, cultural or infrastructural factors.

Adjusted numbers

MEErP Task 3 - Users

Capacity range and typical capacities (2011 and 2024 data)

Dishwasher category	Capacity range (in brackets: typical capacity); values 2011 [dishes/hour]	Capacity range (in brackets: typical capacity); updated values 2024 [dishes/hour]
No 1 Undercounter water-change	80-300 (200)	285-500 (350)
No 2 Undercounter one-tank	300-800 (550)	220-850 (550)
No 3 Hood-type	500-1,300 (860)	180-2,510 (720)
No 4 Utensil/Pot	10-30 cycles/ hour (20 cycles/ hour)	7-30 cycles/hour (15 cycles/hour)
No 5 Conveyor-type one-tank	1,500-2,000 (1,750)	800-2,520 (1,800)
No 6 Conveyor-type multi-tank	1,700-6,000 (3,600)	900-8,000 (3,600)

Adjusted numbers

MEErP Task 3 - Users

Annual number of dishes washed

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

Adjusted numbers

MEErP Task 3 - Users

Concentration of detergents and rinse aids

- For the purposes of this study and the subsequent calculations, the following concentration values for detergents and rise aids, have been used according to stakeholder feedback:
    - Category 1: 16 g/cycle (tablet) or 20 g/cycle (powder)
    - Category 2 to 6: Concentration of detergent: 3.00 g/litre,
    - Category 2 to 6: Concentration of rinse aid: 0.30 g/litre

    - ~~=> integrated detergent and rinse aid concentration of **3.30 g/litre** (2011: 3.35 g/litres)~~

Adjusted numbers

MEErP Task 3 – Users

Energy, water and detergent consumption under ideal conditions

- **Specific** energy, water and detergent consumption of an average device to clean 100 dishes under **ideal conditions**

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	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

Adjusted numbers

MEErP Task 3 - Users

Energy, water and detergent consumption under ideal conditions

- **Annual** energy, water and detergent consumption of an average device under **ideal conditions**

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

Adjusted numbers

MEErP Task 3 - Users

User behaviour in real life practice (i.e. not "ideal")

- **Increase of specific energy, water and detergent consumption due to partial workload**

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 %

Initial calculation failure in Lot 24 and previous draft version => double counting of partial workload effect: the percentages of increase only relate to specific consumption, not necessarily to the absolute consumption at partial load.

Adjusted numbers

Data confirmed for BC3-BC6

MEErP Task 3 - Users

User behaviour in real life practice (i.e. not "ideal")

- **Influence of programme selection on** energy, water and detergent consumption

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%*

New aspect

MEErP Task 3 - Users

Other parameters in real life practice (i.e. not "ideal")

- **Influence of manual pre-rinsing of wash ware**

Dishwasher category	Additional water consumption for pre-rinse (litres per 100 items)	Additional water consumption for pre-rinse (litres per year)
No 1 Undercounter water-change	81	21,263
No 2 Undercounter one-tank	86	102,168
No 3 Hood-type	21	49,896
No 4 Utensil/Pot	no information	no information
No 5 Conveyor-type one-tank	6	114,048
No 6 Conveyor-type multi-tank	6	228,096

Data confirmed

MEErP Task 3 - Users

Other parameters in real life practice (i.e. not "ideal")

- **Influence of initial filling and heating of wash tanks**

Dishwasher category	Number of working days per year[85]	Number of working shifts per day	Volume of wash tank(s)[86] (in brackets: assumed average)	Operating temperature of wash tank(s)[82] (in brackets: assumed average)
No 1 Undercounter water-change	200	n.a.	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

Adjusted numbers

MEErP Task 3 - Users

Other parameters in real life practice (i.e. not "ideal")

- **Influence of low power modes consumption**

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	n.a.	2.6	0.01
No 2 Undercounter one-tank	10 | 14	6 | 12	n.a.	0.1-0.3
No 3 Hood-type	10 | 14	7 | 10	n.a.	0.2-0.45
No 4 Utensil / Pot	10 | 12	7 | 11	n.a.	0.1-1.00
No 5 One-tank conveyor-type	10 | 15	4 | 6	n.a.	0.8-2.1
No 6 Multi-tank conveyor-type	10 | 15	4 | 6	n.a.	1.5-2.2

Adjusted numbers

MEErP Task 3 - Users

Summary: **Annual consumption parameters** per appliance under **real-life use** conditions (brackets: 2011 data)

Dishwasher categories	Number of dishes or cycles per year	Annual energy consumption per appliance (kWh)	Annual water consumption per appliance (litres)	Annual detergent consumption per appliance (kg)	Annual rinse aid consumption per appliance (kg)
No 1 Undercounter water-change	52,500 (24,000)	1,503 (1,254)	43,990 (25,920)	31* (87)	
No 2 Undercounter one-tank	237,600 (237,600)	6,969 (5,253)	163,153 (55,822)	183 (188)	16
No 3 Hood-type	475,200 (345,600)	14,066 (8,258)	154,977 (86,650)	315 (292)	24
No 4 Utensil / Pot	9,000 cycles (9,000) cycles	12,115 (8,913)	116,700 (89,520)	324 (294)	17
No 5 One-tank conveyor-type	3,801,600 (1,515,900)	109,463 (37,703)	820,512 (255,686)	1,931 (865)	188
No 6 Multi-tank conveyor-type	7,603,200 (4,009,500)	217,597 (102,229)	1,229,448 (643,645)	2,753 (2,146)	251

Adjusted numbers

MEErP Task 3 - Users

Maintenance and repair practice

Category	Estimated average frequency of maintenance actions (numbers per year) (in brackets: range)	Estimated average frequency of repair actions (numbers during lifetime) (in brackets: range)
Category 1 Undercounter water-change	1.5 (1-10)	12 (1-15)
Category 2 Undercounter one-tank	2 (1-15)	16 (1-60)
Category 3 Hood-type	2 (1-15)	16 (1-60)
Category 4 Utensil/Pot	2 (1-18)	4 (1-50)
Category 5 Conveyor-type one-tank	3 (1-30)	4 (1-75)
Category 6 Conveyor-type multi-tank	3 (1-30)	4 (1-75)

MEErP Task 3 - Users

Summary of main changes after stakeholder meeting in December 2024

- Revision of a couple of data due to stakeholder feedback and further input
- Split detergent and rinse aid use instead of integrated use due to different process steps; for BC1 different detergent type (tab or powder)
- New: Consideration of additional water consumption for manual pre-rinse under real-life conditions
- Revision of the initial calculation failure for the impacts of partial loads that led to double counting
- Resulting changes in overall annual energy, water, detergent and rinse aid consumption both under ideal conditions and under real-life conditions
- The full report includes further background information and explanations according to more detailed stakeholder feedback.

MEErP Task 4
Technologies

Main updates after review

Martin Möller - Oeko-Institut

The objective of MEErP Task 4 (Technology)

Objectives:

- Task 4 deals with the technical analysis of **existing products** as well as **Best Available Technologies (BAT)** and **Best Not yet Available Technologies (BNAT)**
- The aim is to provide general inputs for the **definition of the base cases** for the Tasks 5 and 6
- Moreover, collection of **inventory data** for the Task 5 (Life Cycle Assessment)

Approach to data collection:

- Based on data established in the 2011 preparatory study
- Stakeholder consultation (September / October 2024, further written feedback from stakeholders on the draft Task 1–4 study report)
- Phone interviews and video calls with various stakeholders

Adjusted numbers

Existing products - main characteristics (1)

Category 1: Undercounter water-change dishwashers

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

- The **average weight** (without packaging) was adjusted to 65 kg according to stakeholder feedback.
- However, this weight already includes double-walled design (see Task 6, DO-04).
- Without double-walled design, a total average weight of **50 kg** is assumed.

Adjusted numbers

Existing products - main characteristics (2)

Category 2: Undercounter one-tank dishwashers

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

- According to stakeholder input, the **maximum capacity** 40 racks/h is only theoretical.
In **real life** a maximum of **20-30 racks/h** is possible.

Adjusted numbers

Existing products - main characteristics (3)

Category 3: Hood-type dishwashers

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
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

- According to stakeholder input, the maximum capacity **60-80 racks/h** is only theoretical.
  In real life a maximum of 20-40 racks/h (or more) is possible.

Adjusted numbers

Existing products - main characteristics (4)

Category 4: Utensil / pot dishwashers

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

Adjusted numbers

Existing products - main characteristics (5)

Category 4: Utensil / 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

Adjusted numbers

Existing products - main characteristics (6)

Category 5: One-tank conveyor-type dishwashers

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)
Electricity and water connection		
Voltage	400 V	400 V
Power of pump	typical 1.5 kW	typical 1.2-1.7 kW

Adjusted numbers

Existing products - main characteristics (7)

Category 6: Multi-tank conveyor-type dishwashers

Main criteria	Data from 2011 preparatory study, Task 4 report	Updated data according to stakeholder input from the current study
Programme		
Number of dishwashing programmes	3	3-10
Washing capacity	1,700–6,000 dishes/h	1,700–6,000 dishes/h
Cycle time -> Programme time	90–180 sec.	18–180 sec.
Tank temperature	usually between 55°C and 65°C	usually between 55°C and 65°C
Boiler temperature	usually between 80°C and 85°C	usually between 80°C and 85°C
Construction details		
Width (without packaging)	4,700–7,400 mm (without preparing zone)	3,500–7,400 mm (without preparing zone), the dimensions can also be beyond that range since the variety of options is very high
Depth/height of passage height	Different modules available	530-720/450-490 mm, different modules available
Weight	ca. 1,300 kg	660-1,300 kg
Tank volume	130-750 litres, average 230 litres	130-750 litres, average 100-400 litres per single tank, a machine can have multiple tanks
Electricity and water connection		
Voltage	400 Volt	230-400 Volt
Total load	39–51 kW	33–51 kW, depending on models and options
Power of pump	no data available	0.3-3.0 kW, a machine can have multiple pumps

Existing products - main characteristics (7)

Overarching aspects according to stakeholder feedback

- The **number of programmes** has **increased** in recent years, particularly within the high-end segment of electronically controlled machines.
  - Manufacturers have **confirmed** this trend.
  - As part of the **diversification 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 in practice**, as it is not possible to constantly change programmes during business operations

- The reported **washing capacities** are measured according to **EN IEC 63136**
  - Using the **standard programme** used for normally soiled wash ware
  - Only applicable for **categories 2 and 3**

Products with standard improvement (design) options

Stakeholder feedback on the results

- **Different types of heat exchangers**
  - Heating of cleaning and rinsing water / recovery of waste heat from the wastewater flow / vapours
  - Recuperators / regenerators (zeolite technology?)
  - Simple plate heat exchangers / water-pocket heat exchangers / tube bundle heat exchangers
  - Counterflow / co-current flow / cross-flow
- **Improved thermal insulation**
  - Better energy efficiency by reducing heat losses
  - Better working conditions in the dishwashing area (scullery)
- **Alternatives for electric heating of operating fluids for cleaning and rinsing**
  - Additional warm/hot water connection
  - Steam-operated heating
  - ~~(Gas-operated heating)~~

- Stakeholder feedback was mixed and partly contradictory; however, the **majority** of the mentioned options were **confirmed**.
- Some manufacturers noted that **hot water connection**, is already **standard** in most of their appliances.
- One stakeholder pointed out that **heat exchangers, improved thermal insulation and steam-operated heating** should be considered as **BAT**.
- **Gas-operated heating** should **not** be **considered**, as it is no longer available.
- **Energy savings** due to the use of heat exchangers and improved thermal insulation are covered in **MEErP Task 6**.
- Advantages of a **steam or hot water supply** over electric heating depend on the **local energy sources** available, as well as the **individual circumstances** (e.g. pipe length) at the customer's premises.

Best Available Technology (BAT)

Stakeholder feedback on the results

- **Heat recovery**
  - Waste heat from wastewater
  - Waste heat from vapours
  - Systems with and without heat pumps
  - Systems with (?) and without zeolite technology
- **Automatic adaptation of programme to load and to soiling level of dishes / utensils**
- ~~**Water treatment**~~
  - ~~Demineralisation~~
  - ~~Reverse osmosis systems~~
- ~~**Cleaning at lower temperature**~~

- According to stakeholder feedback, **heat recovery** is **available for most appliances**, at least as an option; for category 1 dishwashers, it is only applicable for programmes with high cleaning and rinsing temperatures.
- **Zeolite** technology is heavily covered by patents making **free use impossible**; additional drawback is the generation of **dust** and **need for replacement.**
- **Automatic programmes** for recognising loads and soils are considered to be **feasible**; however, additional (magnetic or reed) sensors are required in the devices; currently not available for category 1 dishwashers.
- **Water treatment** is regarded to be **already state of the art**; built-in water softener comes as standard with category 1 and is available as an optional extra with category 2 and 3 devices; reverse osmosis is an optional extra for category 1.
- **Low-temperature cleaning** is perceived not to be a reasonable option due to environmental concerns (e.g. by using active chlorine or other bleaching agents in detergents) and hygiene requirements.
- **Energy savings** due to the use of heat recovery and automatic load and soiling recognition as well as their cost-effectiveness are covered in **MEErP Task 6**.

Best Not yet Available Technology (BNAT)

Stakeholder feedback on the results of a patent screening

- **Supercritical carbon dioxide cleaning (China /2016)**
  - Supercritical carbon dioxide as a cleaning medium
  - High cleanliness and environmental benefits
- **Combined ultrasonic and spray cleaning (South Korea / 2023)**
  - Integration of ultrasonic cleaning in traditional spray methods
  - Enhances cleaning efficiency and reduce water and energy consumption
- **Closed loop heat pump drying (Europe / 2023)**
  - Drying system with heat pump assembly operating with a primary fluid
  - Connected to multiple heat sources and sinks
  - Improves the energy efficiency of drying processes
- **Enzyme cleaning agents (Germany / 2014)**
  - Detergent for dishwashers comprising enzymes, phosphorus-free complexing agents, non-ionic surfactants, propylene glycol and other components
  - Increases cleaning efficiency while being environmentally friendly

- Initial investigations of **supercritical CO_2 cleaning** into possible applications are **publicly available**; however, **complete remove of food** ingredients appears to be **difficult**.
- **Combined ultrasonic and spray cleaning** is considered to be **not effective** in removing a wide range of soiling types; only applicable to category 3.
- Implementation pf **closed loop heat pump drying** is already available in **category 5 and 6** dishwashers from almost all manufacturers; applicability to **undercounter devices** is considered to be **limited**.
- **Enzyme cleaning agents** are still regarded **not** to be **suitable** for commercial users as the dissolution time is still too short.
- **No further BNAT candidates** provided by stakeholders.

Adjusted numbers

Product weight and Bills-of-Materials

Category 1: Undercounter water-change dishwashers

Material / component	weight in g	weight in ratio %	Material category
Stainless Steel	3,500	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	**50,000**	**100.0**	

- Based on stakeholder feedback, the **total weight** ranges from 57 kg (U-unit, without racks) to 79 kg (free-standing unit, with racks). On average, 65 kg can be assumed (including double-walled design) and **50 kg** (without double-walled design).
- 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** (including double-walled design).
- The **'ferrous' material category** was **increased** to better reflect the actual weight distribution (with a proposed range of 54 % to approximately 60 %).
- Furthermore, it was **confirmed** that **bitumen** (5 kg) and **small amounts of cotton** (less than 1 kg) are used in the devices.

Adjusted numbers

Product weight and Bills-of-Materials

Category 2: Undercounter one-tank dishwashers

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**	

- Stakeholder feedback on the data from the Lot 24 Task 4 report resulted in a **slightly lower weight** and a **different material composition** (substitution of stainless steel by 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.

Adjusted numbers

Product weight and Bills-of-Materials

Category 3: Hood-type dishwashers

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
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**	

- According to stakeholder input, a relatively **wide weight range** (100–200 kg) has been **confirmed**, 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 machines that can hold **two racks** at the same time and are therefore bigger and heavier.
- Hence it is **difficult to define a typical category 3 appliance**.

Adjusted numbers

Product weight and Bills-of-Materials

Category 6: Multi-tank conveyor-type dishwashers

Material / component	Weight in g	Weight in ratio %	Material category
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**	

- 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 the BoM.
- 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.

Assessment of the energy use of manufacturing

Adjusted numbers

Commercial dishwasher category	Energy use of manufacturing (kWh / unit)
Category 1: Undercounter water-change dishwashers	no data available
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

- Determining the energy use is **very labour-intensive**, which is why this data is generally unavailable.
- The energy use **depends** heavily on the manufacturer's level of **vertical integration**, i.e. whether components are produced in-house or sourced externally.
- **Data gap for category 1** could not be filled → approximation with figures from category 2
- **Contributions** to overall environmental impact are **marginal** (see MEErP Task 5)

Adjusted numbers

Packaging materials

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)

- 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.

Adjusted numbers

Volume and weight of the packaged product

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	57,5kg
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

Aspects for discussion

- **Bill of Materials** (of all categories):
  What is the **weight of ferrite** in permanent magnet motors and other components?
  - Stakeholders reported ferrite **contained in following components** (see Section 6.4.1.4):
    - Drain pumps contain 38.5 g
    - Sensors contain various magnets of approx. 1 g each
    - Cutlery lifting magnet contain approx. 5-10 kg
  - However, corresponding data is **currently missing in the BoM** of the different dishwasher categories
  - Ferrite is considered a **relevant material under the Critical Raw Materials Act** (see later discussion on MEErP Task 7)

12h00 – 13h30

Lunch break

Please note that there is unfortunately no canteen / cafeteria in CCAB anymore.

For lunch, you will need to go out and have a short lunch in the many places around CCAB.

Online participants are kindly requested to return at 13h30

MEErP Task 5 LCA & LCC of Base Cases

Mieke de Jager - Ecomatters

Understanding of the assignment

MEErP Task 5: Environment & Economics

- **Life Cycle Assessment (LCA)**: calculate the environmental impact of each base case of commercial laundry appliances
- **Life Cycle Costing (LCC):** calculate costs of each base case over the life cycle including possible repair/refurbishment actions
- This task is to provide insights on the environment impact and lifetime costs of commercial dishwashers
- This serves as input to Task 6, design options

LCA and LCC

Life Cycle Assessment (LCA)

- Calculates the environmental performance of a product or process over its entire life cycle
- Typically takes into consideration the full life cycle of a product, from material extraction through manufacturing, product use, and until end of life
- Impact categories are a way to quantify the potential negative effect on the environment, e.g. global warming (CO_2-eq. emissions) or water use

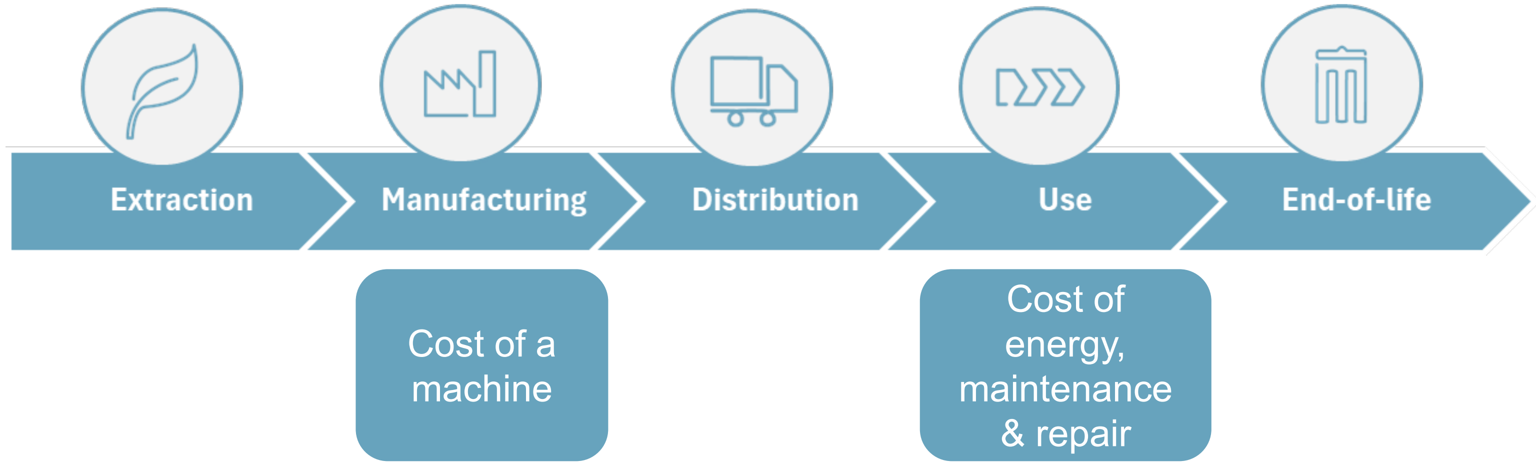
Impact category examples

Compared to a product with the same function, a more sustainable product has a smaller overall environmental impact

LCA and LCC

Life Cycle Costing (LCC)

- LCC calculates all costs (e.g., purchase, operation, maintenance) over the product’s life cycle
- LCA and LCC share the same life cycle stages, allowing integration for sustainability assessments that consider both environmental and economic factors



- LCA and LCC combined makes more informed decisions possible by balancing environmental and financial sustainability

Methodology

- The LCA /LCC will be conducted per Base Case of commercial dishwashers (Task 5) and the potential ecodesign options (Task 6)

- **The EcoReport tool** (ERT) is used: simplified tool to perform full LCA for all life cycle stages
  - Version 1.6 of the tool (2024): includes LCC and impact of repair/refurbishment actions;
  - Updated impact categories aligned with the 16 Environmental Footprint (EF) life cycle impact categories;
  - Updated database based on EF 3.1 datasets;
  - End-of-Life modelling updated according to the EF method by using the Circular Footprint Formula (CFF).
    - Formula allocates the environmental burdens and benefits of recycling/reuse of the machine components between the product and subsequent user of materials

Base Cases

- **Base Cases (BCs): average / representative product on the EU market**
  - Developed according to the MEErP
  - Not individual real-world products but combination of characteristics
  - BCs are defined to enable efficient market analysis and capture full technological diversity

Base Cases (2)

- **Six Base Cases** identified based on:
  - Insights from previous Preparatory Study (2011) as described in the Tasks 1-4
  - Stakeholder input

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

Data collection and quality

Data collection

- Data consultation rounds
  - 1st & 2nd Consultation: autumn 2024
- Consolidated in Task 1-4 report and discussed in SHM1

Data availability and quality:

- Most data from stakeholders (high quality)
- Limited datasets available in ERT (e.g. detergent)

Data quality assessment

Source	Data quality assessment
Stakeholder input, Scientific literature	High quality
Expert judgement, Literature, Previous study	Medium quality
Web research	Fair quality

LCA & LCC inputs (BC1) – Undercounter water-change dishwasher

Materials	Weight in kg
Stainless Steel	3.500
Steel Sheet galvanized	18.500
Polypropylene (PP)	10.210
Polyamid (PA)	0.818
Polymethylmetacrylate (PMMA)	0.012
Acrylonitrile Butadiene Styrene (ABS)	1.540
Polystyrene (PS)	1.050
Styropor expandable polystyrene (EPS)	0.082
Polybutylene Terephthalate (PBT)	0.072
Polyvinylchlorid (PVC)	0.826
EPDM-rubber	1.074
Polyoxymethylene (POM)	0.472
Polyethylene (PE)	0.383
Plastics others (assumed PP)	0.550
Aluminium	0.560
Cu wire	2.063
CuZn38 cast	0.047
Chrome	0.146
Bitumen	5.000
Cotton	0.927
Electronics (control)	2.167
Total net	**50.000**

LCA & LCC	Real life conditions
Production energy	30 kWh (assumed same as BC2)
Energy use / year	1,768 kWh
Water use / year	43,990 L
Detergent use	31 kg
Number of dishes per year	52,500
Dishes per cycle	50
Number of cycles per year / typical workload (%)	1,400 / 75 %
Unit value (€)	3,148
Repair/maintenance costs	44 % of purchase price
Estimated lifespan (y)	12
Lates annual sales (2023; units)	8,250
EU stock (calculated in ERT; in mln units)	0.078

- **BC1: Undercounter water-change dishwasher**
  - No dataset for cotton, excluded from modelling
  - Proxies: POM & PBT modelled with dataset for PET; PA modelled with Nylon-6; 'plastic others' modelled with polypropylene
  - Pumps modelled with stainless steel
  - Electronics modelled with dataset for 2-layer printed wiring board
  - Sales volumes available from 2008 – 2023; for EU stock calculations, average of these years applied for 1993 - 2007

LCA & LCC inputs (BC2) – Undercounter one-tank dishwasher

Materials	Weight in kg
Stainless steel	44.530
Polypropylene (PP)	4.733
Polyamide (PA)	0.500
Acrylonitrile Butadiene Styrene (ABS)	0.635
Pumps (copper)	2.447
Pumps (stack of sheets)	2.447
Pumps (stainless steel wave)	2.203
Pumps (Al)	2.203
Aluminium	0.350
Cable (copper)	1.200
Cable sheath (PVC)	0.300
Cable sheath (silicone, EDPM)	0.150
Electronics (control)	3.900
Gaskets (EDPM)	2.670
Total	**68.268**

LCA & LCC	Real life conditions
Production energy	30 kWh
Energy use / year	6,969 kWh + 94 kWh externally heated hot water
Water use / year	163,153 L
Detergent & rinsing agent use	183 kg & 16kg
Dishes per cycle	18
Number of cycles per year / typical workload (%)	16,500 / 80 %
Unit value (€)	5,659
Repair/maintenance costs	44 % of purchase price
Estimated lifespan	8
Lates annual sales (2023; units)	178,760
EU stock (calculated in ERT; in mln units)	1.19

- **BC2: Undercounter one-tank dishwasher**
  - Proxy: PA modelled with Nylon-6;
  - Pumps (stack of sheets) modelled with stainless steel
  - Electronics modelled with dataset for 2-layer printed wiring board
  - Sales volumes available from 2008 – 2023; for EU stock calculations, average of these years applied for 1993 - 2007

LCA & LCC inputs (BC3) – Hood-type dishwasher

Materials	Weight in kg
Stainless steel	112.045
Polypropylene (PP)	6.805
Polyamide (PA)	1.550
Acrylonitrile Butadiene Styrene (ABS)	0.635
Pumps (copper)	3.848
Pumps (stack of sheets)	3.848
Pumps (stainless steel wave)	2.957
Pumps (Al)	3.848
Aluminium	2.000
Cable (copper)	1.381
Cable sheath (PVC)	0.813
Cable sheath (silicone, EDPM)	0.406
Electronics (control)	5.000
Gaskets (EDPM)	3.543
Total	**148.678**

LCA &LCC	Real life conditions
Production energy	36 kWh
Energy use / year	14,066 kWh + 314 kWh externally heated hot water
Water use / year	154,977 L
Detergent & rinsing agent use	315 kg + 24 kg
Dishes per cycle / typical workload (%)	18 (80 %)
Number of cycles per year	33,000
Unit value (€)	8,662
Repair/maintenance costs	44 % of purchase price
Estimated lifespan (y)	8
Lates annual sales (2023; units)	66,004
EU stock (calculated in ERT; in mln units)	0.44

- **BC3: Hood-type dishwasher**
  - Proxy: PA modelled with Nylon-6;
  - Pumps (stack of sheets) modelled with stainless steel
  - Electronics modelled with dataset for 2-layer printed wiring board
  - Sales volumes available from 2008 – 2023; for EU stock calculations, average of these years applied for 1993 - 2007

LCA & LCC inputs (BC4) – Utensil / pot dishwasher

Materials	Weight in kg
Stainless steel	165.0
Polypropylene (PP)	3.0
Polyamide (PA)	4.0
Ethylene Propylene Dien M-class rubber (EPDM)	4.00
Acrylonitrile Butadiene Styrene (ABS)	0.0
Pumps (copper)	5.0
Pumps (stack of sheets)	4.0
Pumps (stainless steel wave)	3.0
Pumps (Al)	5.0
Cable (copper)	2.4
Cable sheath (PVC)	1.4
Cable sheath (silicone, EDPM)	1.1
Electronics (control)	2.1
Gaskets, etc. (EDPM)	6.0
Total	**206.0**

LCA & LCC	Real life conditions
Production energy	40 kWh
Energy use / year	12,115 kWh + 941 kWh externally heated hot water
Water use / year	116,700 L
Detergent & rinsing agent use	324 kg + 17 kg
Dishes per cycle	n.a.
Number of cycles per year / typical workload (%)	9,000 / 60 %
Unit value (€)	10,855
Repair/maintenance costs	44 % of purchase price
Estimated lifespan (y)	9
Lates annual sales (2023; units)	13,751
EU stock (calculated in ERT; in mln units)	0.10

- **BC4: Utensil / pot dishwasher**
  - Proxy: PA modelled with Nylon-6;
  - Pumps (stack of sheets) modelled with stainless steel
  - Electronics modelled with dataset for 2-layer printed wiring board
  - Sales volumes available from 2008 – 2023; for EU stock calculations, average of these years applied for 1993 - 2007

LCA & LCC inputs (BC5) – One-tank conveyor-type dishwasher

Materials	Weight in kg
Stainless steel	642.250
Polypropylene (PP)	55.500
Polyamide (PA)	6.140
Polyvinyl chloride (PVC)	4.600
Polystyrene (PS)	4.430
Acrylonitrile Butadiene Styrene (ABS)	5.000
Pumps (copper)	16.825
Pumps (stack of sheets)	15.625
Pumps (stainless steel wave)	12.335
Pumps (Al)	17.470
Condenser (AL)	4.720
Condenser (Cu)	7.080
Ventilator, fan (AL)	17.440
Ventilator, fan (Cu)	10.160
Drive motor (AL)	4.000
Drive motor (Cu)	5.000
Cable (copper)	16.300
Cable sheath (PVC)	8.640
Cable sheath (silicone, EDPM)	5.170
Electric contactor (copper)	10.000
Electronics (control)	9.800
Gaskets (EDPM)	12.800
Total	**891.285**

LCA & LCC	Real life conditions
Production energy	250 kWh
Energy use / year	109,463 kWh + 1,655 kWh externally heated hot water
Water use / year	820,512 L
Detergent & rinsing agent use	1,931 kg & 188 kg
Number of dishes per hour	1,800
Number of dishes per year / Typical workload (%)	3,801,600 / 80 %
Unit value (€)	13,394
Repair/maintenance costs	44 % of purchase price
Estimated lifespan (y)	11
Lates annual sales (2023; units)	5,500
EU stock (calculated in ERT; in mln units)	0.05

- **BC5: One-tank conveyor-type dishwasher**
  - Proxy: PA modelled with Nylon-6
  - Pumps (stack of sheets) modelled with stainless steel
  - Electronics modelled with dataset for 2-layer printed wiring board
  - Sales volumes available from 2008 – 2023; for EU stock calculations, average of these years applied for 1993 - 2007

LCA & LCC inputs (BC6) – Multi-tank conveyor-type dishwasher

Materials	Weight in kg
Stainless steel	980.00
Polypropylene (PP)	58.00
Polyamide (PA)	18.66
Ethylene Propylene Dien M-class rubber (EPDM)	12.00
Acrylonitrile Butadiene Styrene (ABS)	0.00
Pumps (copper)	39.02
Pumps (stack of sheets)	37.07
Pumps (stainless steel wave)	25.37
Pumps (Al)	44.88
Condenser (AL)	4.72
Condenser (Cu)	7.08
Ventilator, fan (AL)	17.44
Ventilator, fan (Cu)	10.16
Drive motor (AL)	4.00
Drive motor (Cu)	5.00
Cable (copper)	19.80
Cable sheath (PVC)	11.44
Cable sheath (silicone, EDPM)	8.36
Electric contactor (copper)	10.00
Electronics (control)	15.40
Gaskets, etc. (EDPM)	15.00
Total	**1,343.4**

LCA & LCC	Real life conditions
Production energy	300 kWh
Energy use / year	217,597 kWh + 3,449 kWh externally heated hot water
Water use / year	1,229,448 L
Detergent & rinsing agent use	2,753 kg & 251 kg
Number of dishes per hour	3,600
Number of dishes per year / Typical workload (%)	7,603,200 / 80 %
Unit value (€)	22,867
Repair/maintenance costs	44 % of purchase price
Estimated lifespan (y)	15
Lates annual sales (2023; units)	2,750
EU stock (calculated in ERT; in mln units)	0.03

- **BC6: Multi-tank conveyor-type dishwasher**
  - Proxy: PA modelled with Nylon-6
  - Pumps (stack of sheets) modelled with stainless steel
  - Electronics modelled with dataset for 2-layer printed wiring board
  - Sales volumes available from 2008 – 2023; for EU stock calculations, average of these years applied for 1993 - 2007

Assumptions & modelling choices

- Input data was obtained from Task 1-4
  - Raw material production: specific datasets for production of raw materials in the ERT
    - Proxies used in case no specific dataset was available (e.g. nylon production for polyamide)
    - Recycled content default value in tool: 0 % for all materials, except aluminium (30 %)
      - Impact of recycled content of aluminium calculated in ERT with a dataset for recycled aluminium
  - Distribution data based on PEF distribution scenarios (mode of transport and distances)
  - Use phase:
    - Energy, water, detergent and rinsing agent consumption taken from real-life conditions
      - Electricity modelled with an EU average grid mix dataset in ERT
      - Low pressure steam and hot water heated up externally modelled with boiler running on natural gas (dataset in ERT)
  - End-of-life: modelled with the Circular Footprint Formula (CFF) in the ERT
    - End-of-life impact of recycling and credit for recycling of all input Raw Materials
    - Recyclability of raw materials default value of ERT (85 % for (stainless) steel & aluminium; 50 % for electronics; 0 % for the rest of Raw Materials
  - LCC: yearly sales volumes available for 2008 – 2023, and average applied for 1993 - 2007 to calculate stock of machines in EU-27 (in ERT)
    - EU-27 rate for natural gas, electricity and water costs (see table)

Costs for resource consumption	
Electricity (EUR/kWh)	0.26
Natural gas (for heating; EUR/MJ)	0.02
Water (EUR/m3)	1.91
Detergent (EUR/kg)	4.20
Rinsing agent (EUR/kg)	3.90

LCA Results – Environmental Impact per base case product over its lifetime

Environmental impact per impact category and per Base Case over its entire lifetime

- Highest energy use and largest impact for **BC6** over entire life cycle and lowest impact for **BC1**
- Same results for the impact expressed per year of use (not shown)

Energy consumption	**unit**	**BC1**	**BC2**	**BC3**	**BC4**	**BC5**	**BC6**
Electricity	kWh						
Thermal energy	MJ						
PEF Impact categories	**unit**						
Climate change, total	kg CO2 eq						
Ozone depletion	kg CFC-11 eq						
Human toxicity, cancer	CTUh						
Human toxicity, non-cancer	CTUh						
Particulate matter	disease incidence						
Ionising radiation, human health	kBq U235 eq						
Photochemical ozone formation, human health	kg NMVOC eq						
Acidification	mol H+ eq						
Eutrophication, terrestrial	mol N eq						
Eutrophication, freshwater	kg P eq						
Eutrophication, marine	kg N eq						
Ecotoxicity, freshwater	CTUe						
Land use	pt						
Water use	m3 water eq. of deprived water						
Resource use, minerals and metals	kg Sb eq						
Resource use, fossils	MJ						

LCA Results – Environmental Impact per base case product per cleaned dish

Environmental impact per number of cleaned dishes per year

- BC4 excluded as only cycles are relevant
- Highest energy use and environmental impact per dish is for **BC1** (undercounter water-change dishwasher)
- Lowest impact per dish is for BC5 and BC6 due to large number of dishes cleaned per year

Energy consumption	unit	BC1	BC2	BC3	BC5	BC6
Electricity	kWh					
Thermal energy	MJ					
PEF Impact categories						
Climate change, total	kg CO2 eq					
Ozone depletion	kg CFC-11 eq					
Human toxicity, cancer	CTUh					
Human toxicity, non-cancer	CTUh					
Particulate matter	disease incidence					
Ionising radiation, human health	kBq U235 eq					
Photochemical ozone formation, human health	kg NMVOC eq					
Acidification	mol H+ eq					
Eutrophication, terrestrial	mol N eq					
Eutrophication, freshwater	kg P eq					
Eutrophication, marine	kg N eq					
Ecotoxicity, freshwater	CTUe					
Land use	pt					
Water use	m3 water eq. of deprived water					
Resource use, minerals and metals	kg Sb eq					
Resource use, fossils	MJ					

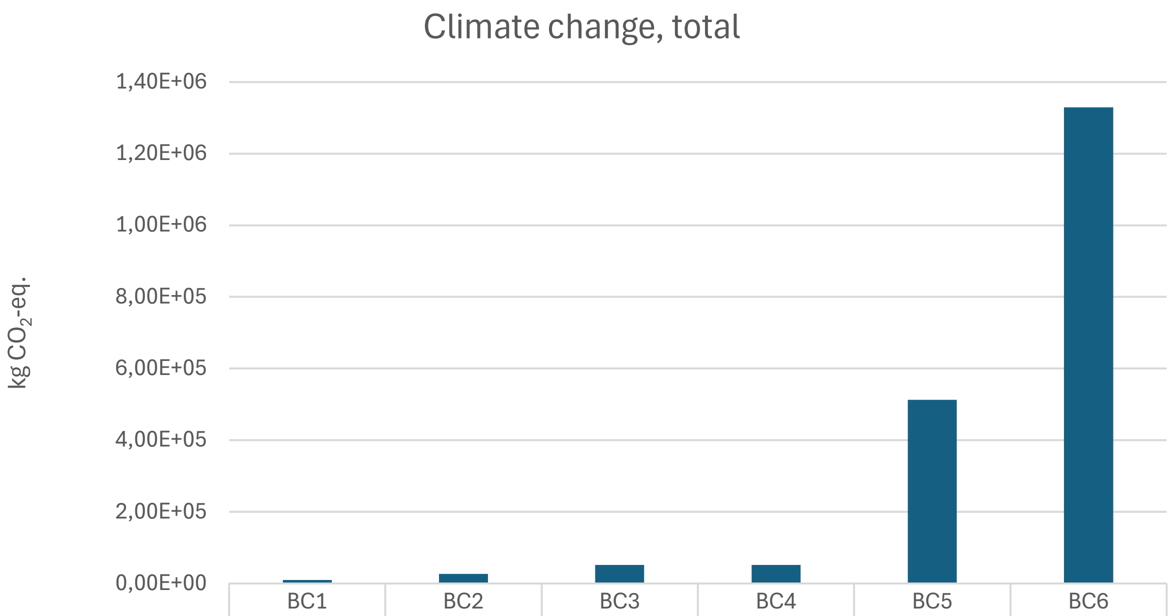
Base Case	# of cleaned dishes per year
BC1	52,500
BC2	237,600
BC3	475,200
BC4	*9,000(*)*
BC5	3,801,600
BC6	7,603,200

* For BC4, this is the number of cycles per year. Not included in figure

LCA results – Climate Change impact per lifetime

Climate change impact of all base cases

- Highest CO_2-eq. impact for **BC6** on product life cycle and per year of use (latter not shown)
  - **BC1** has the lowest impact per product and per year of use

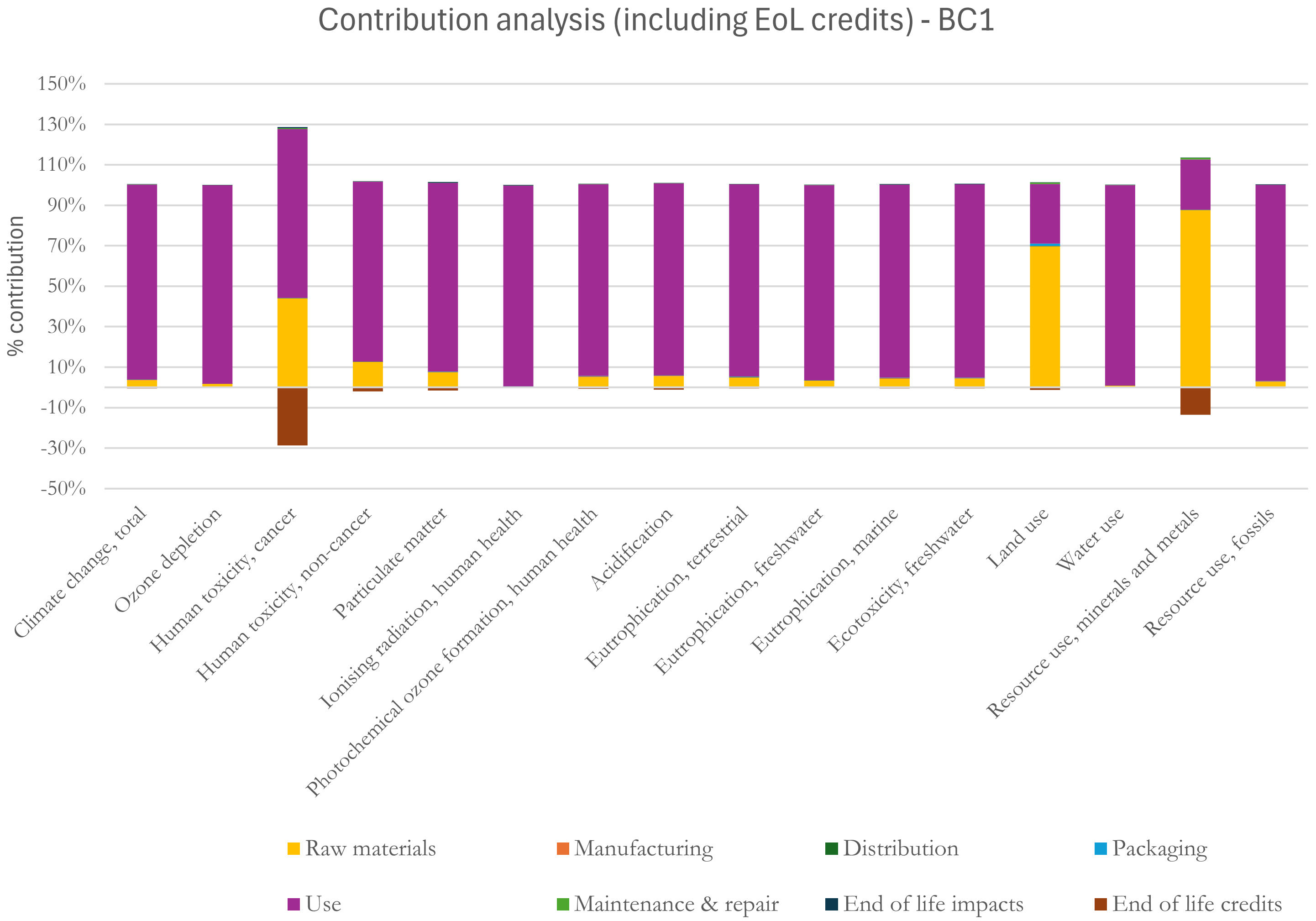


	BC1	BC2	BC3	BC4	BC5	BC6
Climate change, total	1,00E+04	2,65E+04	5,19E+04	5,16E+04	5,13E+05	1,33E+06

LCA Results – BC1: Undercounter water change dishwasher, contribution analysis over lifetime

Contribution analysis all life cycles

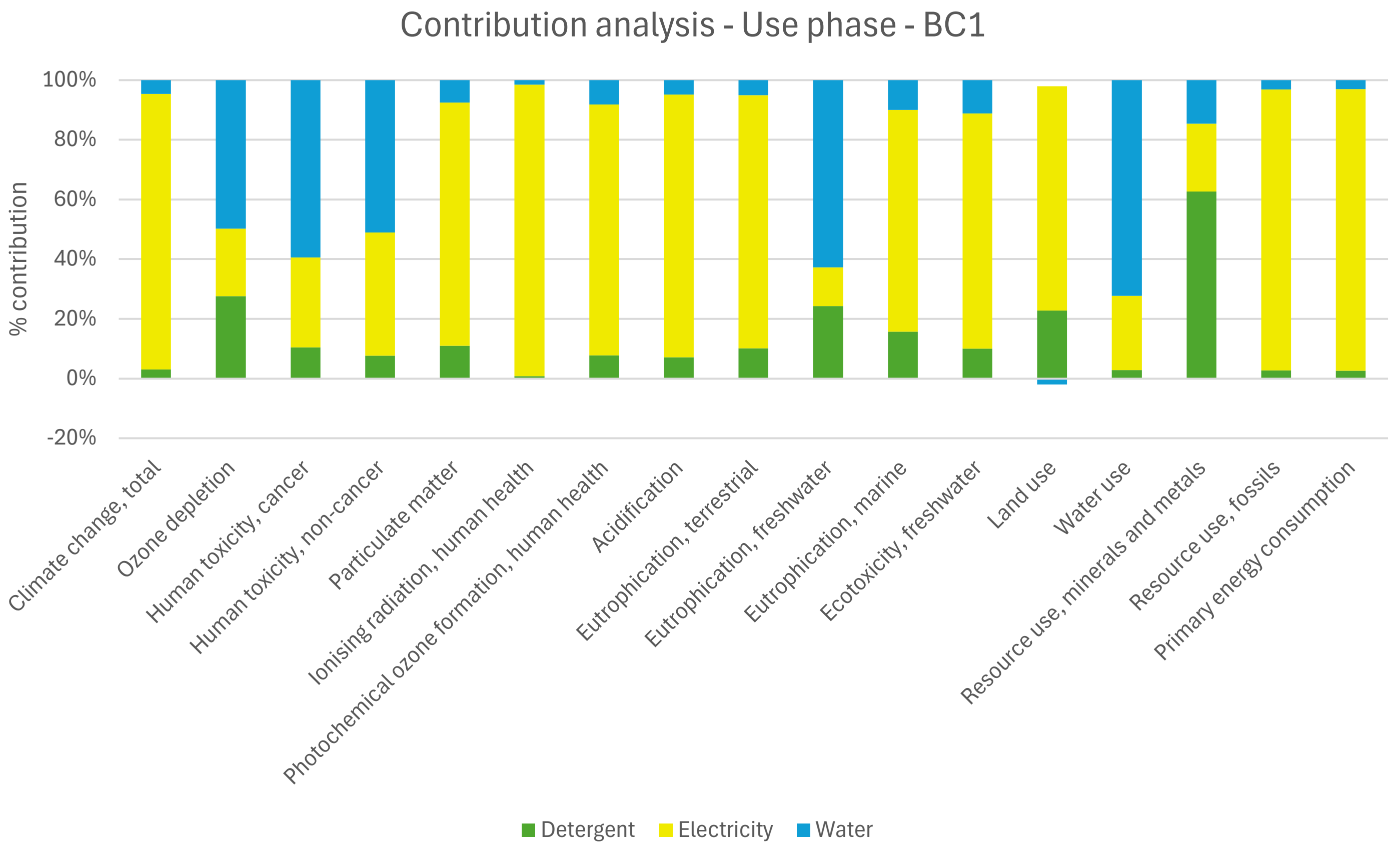
- Majority (>80 % per impact category) of the lifetime impact is from the **use phase** followed by the **raw materials** production for most impact categories
- Raw materials impact largest for some impact categories due to copper (Land use) or electronics (Resource use, mineral and metals)
- End-of-life modelling shows a credit for avoided impacts due to recyclability of certain raw materials
  - Stainless steel, galvanised steel, aluminium, printed wiring board (electronics)



LCA Results – BC1: Undercounter water change dishwasher, contribution analysis over lifetime

Contribution analysis Use phase

- Major contributor in the use phase is **electricity** use for most impact categories
- Detergent / water use are major contributors for several other categories

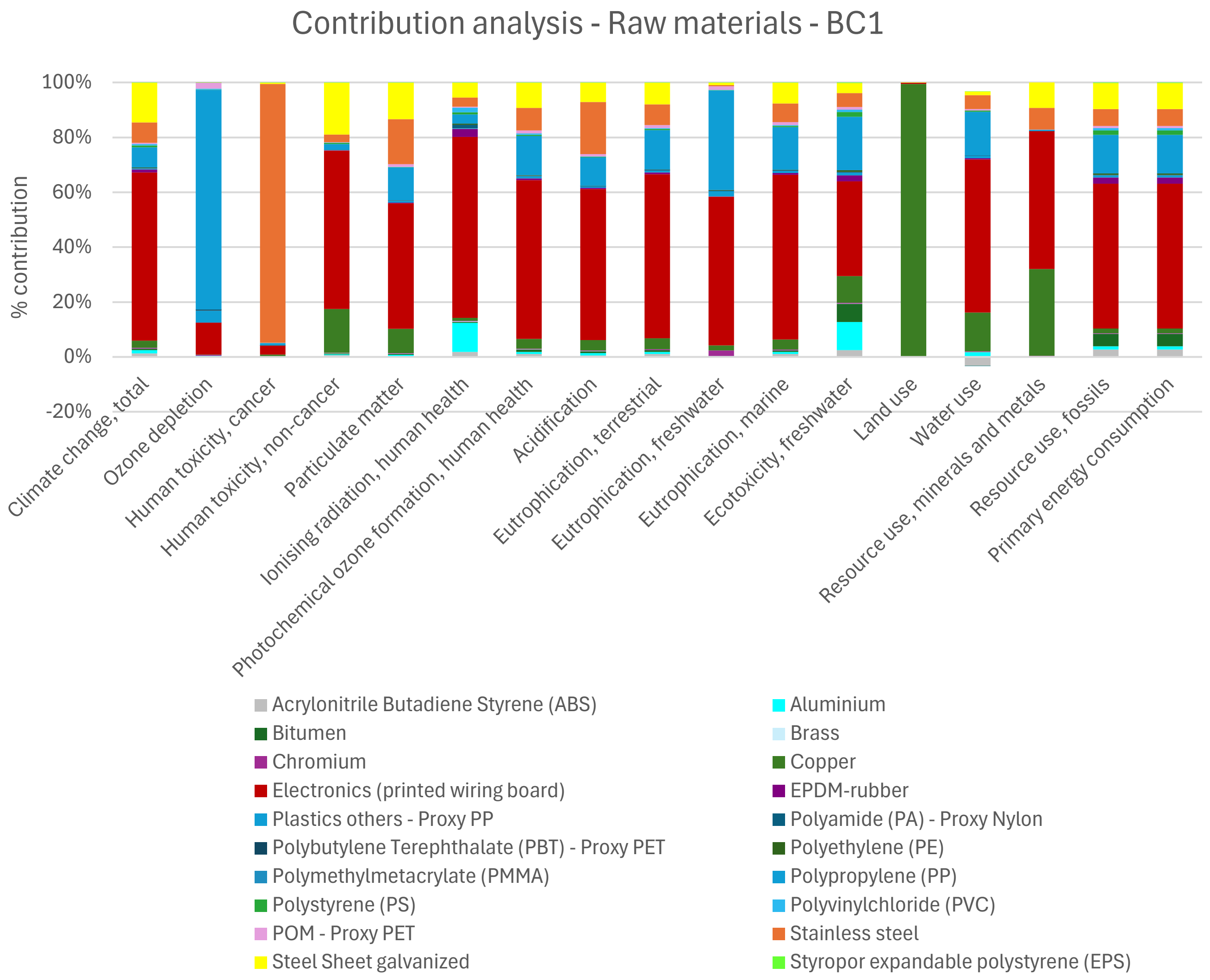


Note: The reason for the contribution of water use to the impact categories "Human toxicity, cancer" and "Human toxicity, non-cancer" is currently unclear to the study team and raised with the European Commission to seek clarification.

LCA Results – BC1: Undercounter water change dishwasher, contribution analysis over lifetime

Contribution analysis Raw materials production

- Major contributor of raw materials is the production of **printed wiring board**
- Additional high contributing raw materials are stainless steel (Human toxicity, cancer), polypropylene (Ozone depletion; Eutrophication, freshwater), and copper (Land use)



Results summary – Other Base Cases

LCA results all base cases

- As in BC1, all base case results show similar trends:
  - Majority (>90 %) of the lifetime impact is from the **use phase** followed by the **raw materials production** for most impact categories
  - End-of-life modelling shows a credit for avoided impacts due to recyclability of certain raw materials such as stainless steel, galvanised steel, aluminium, electronics (printed wiring board)
  - Major contributor in the use phase is **energy** use (mostly electricity) for most impact categories
  - Major contributor of raw materials are **electronics** (printed wiring board) and stainless steel
  - Additional high contributing raw materials are polypropylene, aluminium and copper depending on the impact category

- Full overview of results of all base cases in Annex

Life cycle costs (LCC)

Life cycle costs (LCC) methodology

- LCC calculated in the ERT for the full product lifetime and expressed in costs per year
  - Purchase price and repair/maintenance costs divided by lifetime
  - Costs for energy, water, detergent and rinsing agent (i.e. running costs) are discounted to their net present value (using escalation rate and discount rate values)

LCC Results per Base Case product over its lifetime

LCC results Base Cases

- Over the entire lifetime of the machine, **BC6** has the highest costs
  - Due to the capacity of the machine and the large volume of dishes cleaned per year
  - Majority of the costs (>61 %) for all Base Cases are the running costs (energy, water, detergent, rinsing agent)

Price aspect	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Product price	EUR	3,148	5,659	8,662	10,855	13,394	22,867
Natural gas (for heating)	EUR/year	0	7	23	86	910	2,540
Electricity	EUR/year	411	1,665	3,375	2,829	23,184	42,419
Water	EUR/year	76	290	277	207	1,435	2,096
Detergent	EUR/year	117	718	1,243	1,266	7,462	10,368
Rinsing agent	EUR/year	0	57	89	62	677	880
Repair & maintenance costs	EUR	1,385	2,490	3,811	4,776	5,894	10,061
Total	**EUR/year**	**982**	**3,861**	**6,566**	**6,187**	**35,422**	**60,498**
Running costs	EUR/year	604	2,738	5,007	4,450	33,668	58,303

LCC Results per Base Case product per cleaned dish

LCC results per cleaned dish

- Per cleaned dish, **BC1** has the highest total costs (1.9 euro-cents/dish)
  - Due to the lower number of cleaned dishes per year
  - Running costs of **BC2** is as high as **BC1** (1.1 euro-cents/dish) due to additional rinsing agent costs for BC2
  - BC4 is excluded from this figure as no dishes are available

Per dish cleaned		**BC1**	**BC2**	**BC3**	**BC5**	**BC6**
Product price	EUR					
Natural gas (for heating)	EUR/year					
Electricity	EUR/year					
Water	EUR/year					
Auxiliary material 1 (Detergent)	EUR/year					
Auxiliary material 2 (Rinsing agent)	EUR/year					
Repair & maintenance costs	EUR					
Total	**EUR/year**					
Running costs	EUR/year					
Number of cleaned dishes per year		**52,500**	**237,600**	**475,200**	**3,801,600**	**7,603,200**

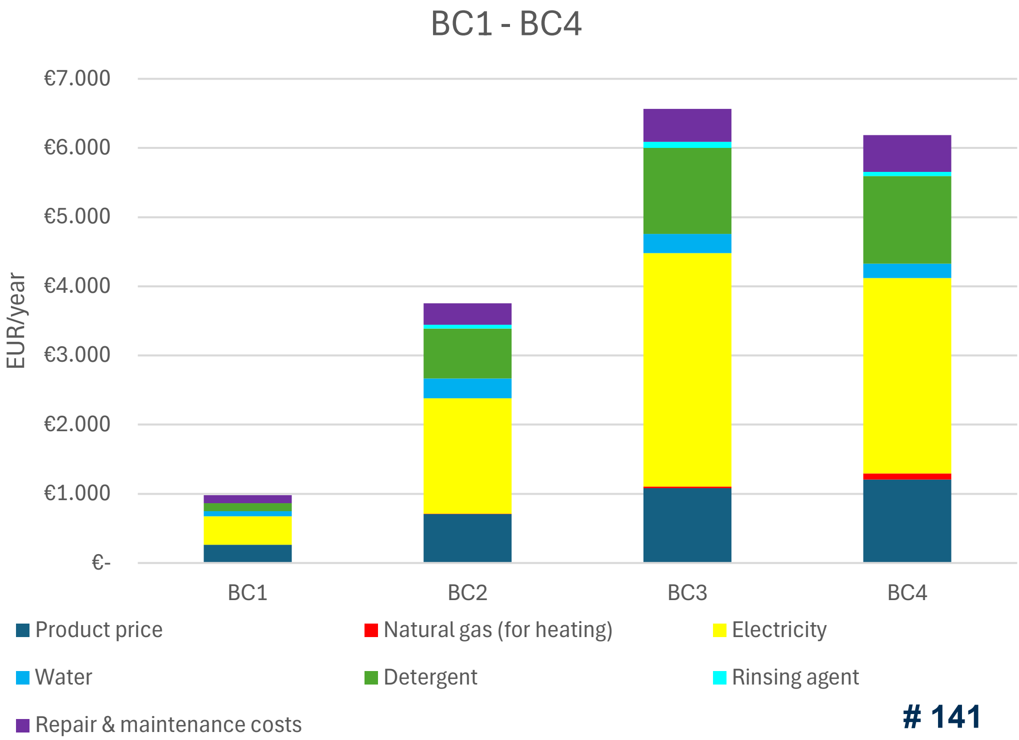
Base Case	**# of cleaned dishes per year**
BC1	52,500
BC2	237,600
BC3	475,200
BC4	*9,000(*)*
BC5	3,801,600
BC6	7,603,200

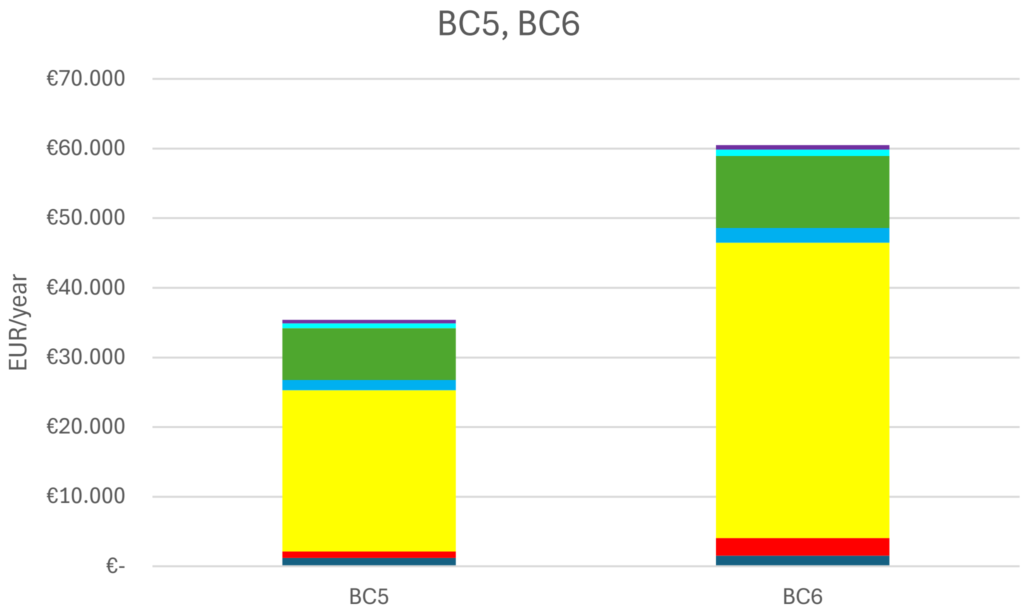
* For BC4, this is the number of cycles per year. Not included in figure

LCC Results – All Base Cases

Contribution analysis

- Majority of costs on a yearly basis are for energy (42 % - 74 %)
- Running costs of energy, water, detergent and rinsing agent together contribute to 62 % (BC1) – 96 % (BC6) of total costs





EU-27 Totals – LCA & LCC

Calculation methodology EU totals

- Environmental impact for total **EU-27** calculated (in ERT) for the lifetime of each Base Case
  - Both for new products sold in the latest year and the total stock of a Base Case
    - The per product impact is multiplied with the sales volume for a year (new products) and per product impact multiplied with the stock volume (last 30 years) for EU-wide impact of all machines

- LCC calculated for total EU-27 (in ERT)
  - Costs per year multiplied with stock volume of machines

EU totals – LCA results

Environmental impact on EU-27 level

- EU-27 **energy use** is largest for **BC6**
  - Although stock volume is the smallest for BC6, the total energy use is not fully compensated by lower stock volumes

- EU-27 wide **environmental impact** of machines in stock is largest for **BC2** and **BC6**
  - To different degrees depending on the impact category
  - Although the per product impact is largest for **BC6,** the sales volumes of BC2 are much higher than BC6, therefore contributing largely to the total EU environmental impact as well
  - For new products sold in 2023, **BC2** has higher impact than BC6, due to higher sales volume in 2023 (now shown)

Materials	**unit**	**BC1**	**BC2**	**BC3**	**BC4**	**BC5**	**BC6**
Energy consumption							
Electricity	kWh						
Thermal energy	MJ						
PEF Impact categories							
Climate change, total	kg CO2 eq						
Ozone depletion	kg CFC-11 eq						
Human toxicity, cancer	CTUh						
Human toxicity, non-cancer	CTUh						
Particulate matter	disease incidence						
Ionising radiation, human health	kBq U235 eq						
Photochemical ozone formation, human health	kg NMVOC eq						
Acidification	mol H+ eq						
Eutrophication, terrestrial	mol N eq						
Eutrophication, freshwater	kg P eq						
Eutrophication, marine	kg N eq						
Ecotoxicity, freshwater	CTUe						
Land use	pt						
Water use	m3 water eq. of deprived w						
Resource use, minerals and metals	kg Sb eq						
Resource use, fossils	MJ						
Total EU stock	units	78,102	1,190,610	439,610	101,328	48,278	31,376

EU totals – Results LCC

Total annual expenditure on EU total level

- EU-27 annual expenditure is highest for **BC2**
  - Due to the high sales volumes leading to high stock of BC2 machines in the EU
- Main contributor to the costs are running costs (energy, water and detergent; 57% - 96% for BC1 and BC6 respectively)

Price aspect	Unit	BC1	BC2	BC3	BC4	BC5	BC6
Product price	mln. EUR/year	26	1,012	572	149	74	63
Natural gas (for heating)	mln. EUR/year	0	9	11	9	48	89
Electricity	mln. EUR/year	30	2,131	1,588	309	1,222	1,491
Water	mln. EUR/year	7	371	130	23	76	74
Detergent	mln. EUR/year	10	919	585	138	393	365
Rinsing agent	mln. EUR/year	0	73	42	7	36	31
Repair & maintenance costs	mln. EUR/year	10	398	224	58	28	24
Total	**mln. EUR/year**	**83**	**4,912**	**3,152**	**694**	**1,877**	**2,136**
Running costs	mln. EUR/year	47	3,503	2,356	486	1,775	2,050
Stock volume	Units	78,102	1,190,610	439,610	101,328	48,278	31,376

Conclusions

Per product:

- **LCA**
  - **Use phase** followed by **raw material** stages are the most impactful phases
    - In the use phase, the main contributor is **energy** consumption
    - In the production phase, the main contributors are **electronics** (printed wiring board), **stainless steel, polypropylene** and **copper**
  - Impact is correlated to product resource consumption (energy, water, detergent, rinsing agent) and the capacity of the machines, with a higher impact over the full life cycle for the largest machines
    - However, per cleaned dish, smaller machines have a higher environmental impact, due to a lower number of dishes handled

- **LCC**
  - **Energy** use is the main cost driver for all Base Cases
  - Running costs exceed initial purchase costs

EU-27 level:

- **LCA & LCC**
  - Sales volume has a significant effect on stock-level impact, showing the highest effect for **BC2**, which has the highest sales volume and thereby stock accumulation
  - Running costs exceed initial purchase costs

MEErP Task 6 LCA & LCC of Design options

Martin Möller – Oeko-Institut
Mieke de Jager – Ecomatters

Task 6 Design options – background

Goal Task 6: identify and evaluate design options for the Base Cases

- Calculate environmental and economic performance of each design option to reach policy recommendations that are both environmentally beneficial and cost-effective

Methodology:

- Design options were identified from the Task 1-5 results and emerging technologies, components and processes that could deliver environmental improvements
- Potential design options were discussed with stakeholders to select a final set of design options
- For each design option, changes to input data were provided for:
  - Bill of Materials
  - Resource use (energy, water, detergent, rinsing agent)
  - Lifetime
  - Purchase price
- For each Base Case and design option, LCA and LCC results were calculated using the ERT

Design options – Overview

- Overview of design options, including all options combined (DO-08)
  - Note for BC1, only DO-04 is included; for BC2, DO-02 is excluded

Design option no.	Short title	Description of the design option – working hypothesis
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.
DO-04	Improved thermal insulation (double-walled design)	Improved thermal insulation through double wall design reduces heat loss by creating an insulating air gap between the inner and outer walls. This design option can improve energy efficiency and workplace comfort by minimising external heat radiation. However, the system increases the use of resources during manufacture as it requires additional materials such as stainless-steel sheets, insulation layers and sealing components.
DO-05	Further substitution of metals by polymers	Substitution of metal components with polymers (such as PP and ABS) reduces overall weight and *can improve durability* by providing superior chemical and corrosion resistance in harsh environments. This substitution offers environmental benefits, including a reduced carbon footprint due to the lower environmental impact of manufacturing polymer materials (compared to metals) and a *potentially longer service* life of the commercial dishwasher.

Design option no.	Short title	Description of the design option – working hypothesis
DO-06	Modular design and reuse of electronics	Modular design with replaceable electronic modules (e.g. control boards, power supplies) allows for targeted upgrades and repairs without replacing the entire dishwasher. This design option can reduce raw material consumption and the carbon footprint associated with manufacturing new electronics. In addition, standardised modules can simplify repairs and maintenance and potentially extend the life of the commercial dishwasher. However, initial implementation may require additional design effort and durable connectors to ensure long-term reliability.
DO-07	Energy recovery from drain water	A commercial dishwasher equipped with a drain water heat recovery system is designed to significantly reduce energy consumption by capturing thermal energy from hot wastewater. After each wash cycle, the hot drain water—often at temperatures around 60 °C—is routed through a heat exchanger, where it transfers its heat to the incoming cold freshwater supply. This process preheats the cold water (for example, from 15 °C up to approximately 40 °C) before it enters the dishwasher's internal heating system, thereby reducing the energy required to reach the necessary rinse temperature. This design option can reduce the energy needed to reach washing temperatures, thereby also cutting water heating costs.
DO-08	Combined options	This design option combines the features of all the aforementioned design options (DO-01 to DO-07).

Design options – input parameters

- Main input data changes:

Design option	Bill of Materials	Consumption	Lifetime	Purchase price
DO-01	More PP, cables, gaskets and electronics, inclusion of heat exchanger materials	15 % - 16 % less energy use	No change	15 % - 17 % more
DO-02	More PP, cables, gaskets, inclusion of heat pump materials	20 % - 25 % less energy use	2.5 % shorter	65 % & 75 % more for BC3 + BC4 38 % more for BC5 + BC6
DO-03	More stainless steel, PP, ABS*, cables, cable sheaths, gaskets and electronics	12 % less energy, water, detergent and rinsing agent use	10 % longer	28 % more for BC3 + BC4 50 % more for BC5 + BC6
DO-04	More stainless steel	10 % - 12 % less energy use	No change	3 % - 5 % more
DO-05	More PP, PA, ABS*, PS and copper; less stainless steel	No changes	27 % shorter	2 % - 5 % less
DO-06	More ABS*, cables, cable sheath, electric contactor, gaskets, electronics	No changes	10 % longer	5 % - 8 % more
DO-07	No changes	5 % - 10 % less energy use	No change	10 % - 15 % more
DO-08	Less stainless steel, more PP, PA, cables, electronics, gaskets, heat exchanger and heat pump materials	40 % - 60 % less energy use	10 % shorter	60 % - 75 % more

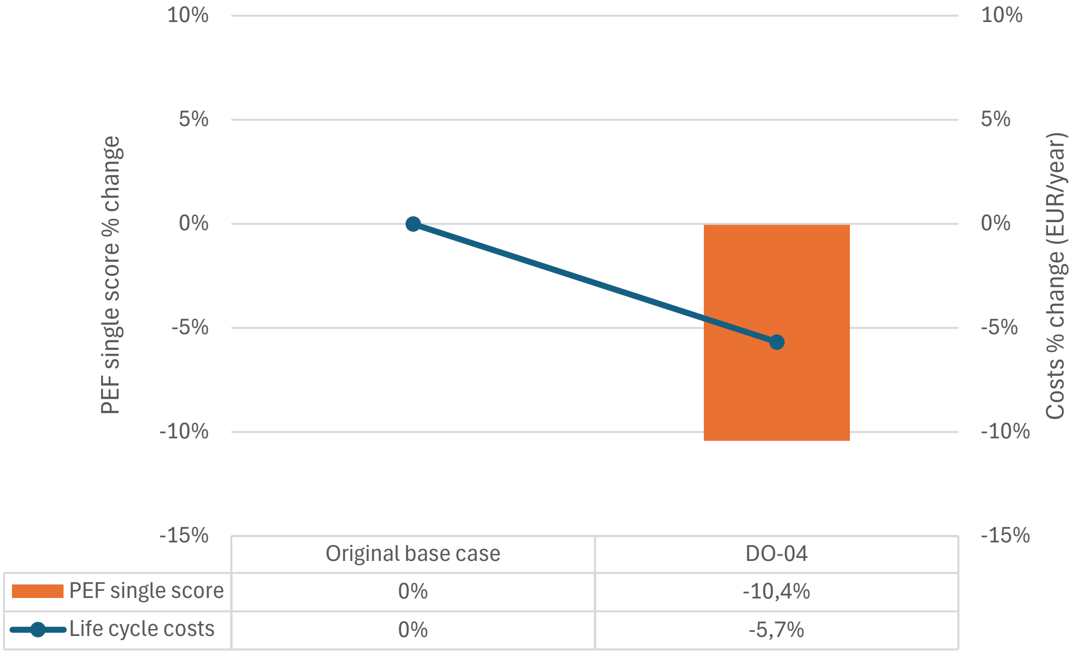
* Question to stakeholders: no ABS in BC4 and BC6: ABS expected to be in design options?

LCA Results – Methodology

- LCA and LCC results were calculated per Base Case and per Design Option
  - DO-08 was included with all design options combined (based on stakeholder data)
  - Sensitivity was performed for BC4 where the 40 % energy reduction of DO-08 (all DOs combined) was also applied to the energy needed to heat up water externally (outside of the machine)
- From the LCA results, the Product Environmental Footprint (PEF) single score was calculated
  - PEF single score developed by the JRC as part of its LCA methodology
  - Transforms the results of the 16 impact categories into a single, normalized and weighted factor
  - Design options with lower PEF single scores have more environmental benefits compared to the original Base Case
    - Note: PEF single score provides an indicative guidance, as not a full PEF-aligned LCA study was performed
    - PEF single scores in this study cannot be compared with products outside of this study
- PEF single scores are calculated per product lifetime (included lifetime shortening (DO-05, DO-02) or lifetime extension (DO-03, DO-06, DO-08) and per year of use
  - PEF single score divided by lifetime of the product
- PEF single score and total costs per year are plotted (see next slides)

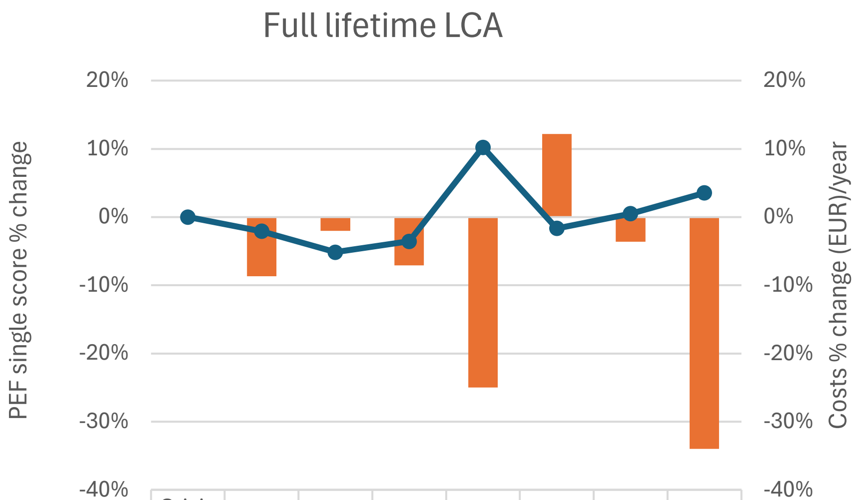
LCA Results – BC1

- Only one design option calculated for BC1 (DO-04; improved thermal insulation)
- DO-04 shows the environmental impacts (PEF single score) decreases with 10 % together with a 6 % cost decrease
  - The results per year of use are the same as the DO does not include a lifetime extension/shortening

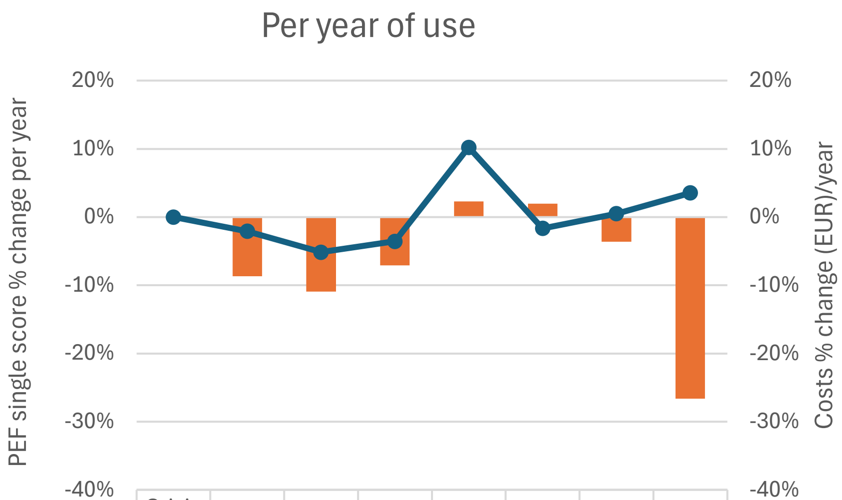


LCA Results – BC2

- For BC2, **DO-01**, **DO-03** and **DO-04** show a **decrease** in environmental impact associated with a **cost reduction**, both for the full lifetime of the product as well as per year of use
- For DO-07, the environmental impact reduces, while costs remain similar to the original Base Case results
- The full lifetime decrease in environmental impact of DO-05 is due to the lifetime shortening
  - Lower impact over lifespan, but increase in environmental impact per year of use, together with higher costs
- DO-06 environmental impact increase is spread over more years, leading to only a slight PEF score increase per year of use
- Large (27 %) environmental impact reduction of all DOs combined (**DO-08**), although with slight cost increase (per year of use)



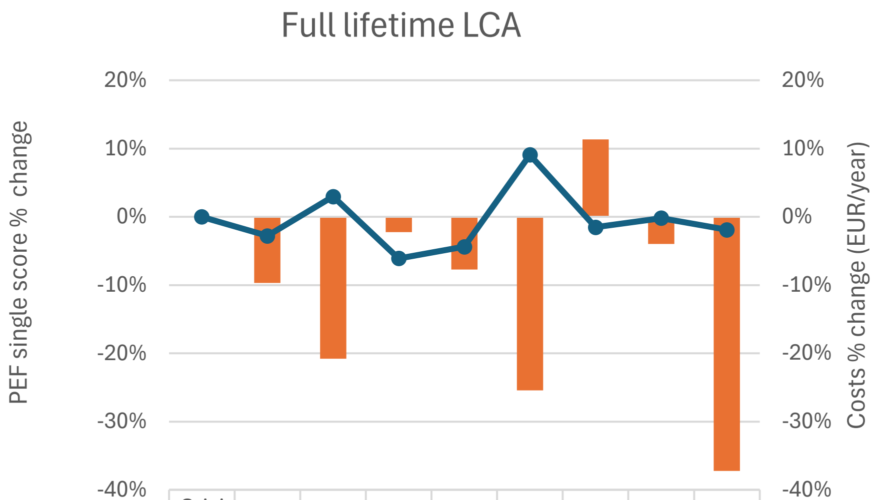
	Original base case	DO-01	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
PEF single score	0%	-8,6%	-2,0%	-7,1%	-25,0%	12,2%	-3,6%	-34,0%
Life cycle costs	0%	-2,1%	-5,14%	-3,55%	10,22%	-1,7%	0,5%	3,5%



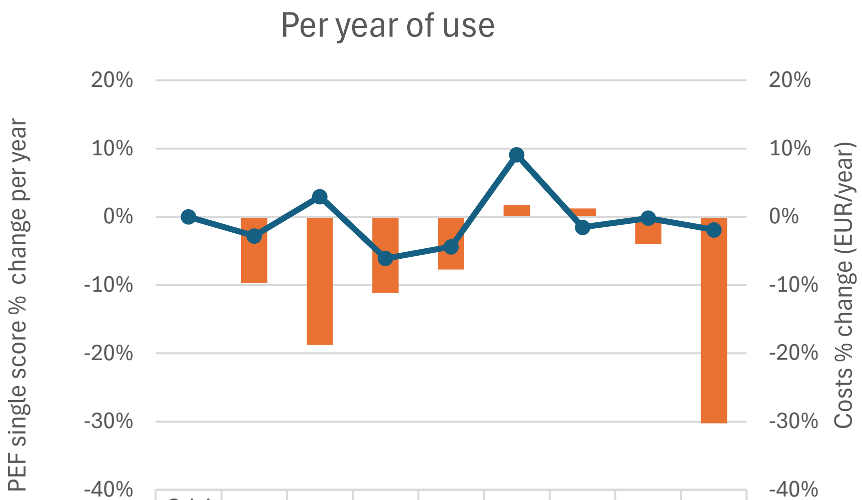
	Original base case	DO-01	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
PEF single score	0%	-8,6%	-10,9%	-7,1%	2,3%	2,0%	-3,6%	-26,6%
Life cycle costs	0%	-2,1%	-5,14%	-3,55%	10,22%	-1,7%	0,5%	3,5%

LCA Results – BC3

- For BC3, **DO-01**, **DO-03** and **DO-04** show a **decrease** in environmental impact associated with a **cost reduction**, both for the full lifetime of the product as well as per year of use
- For **DO-02** and **DO-07**, the environmental impact **reduces**, while costs remain similar or higher to the original Base Case results
- The full lifetime environmental impacts of DO-05 and DO-06 decrease and increase respectively, due to the lifetime changes, which is non-existent when expressed per year of use
- Large (30 %) environmental impact reduction of all DOs combined (**DO-08**), with slight costs reduction (per year of use)



	Original base case	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
PEF single score	0%	-9,7%	-20,8%	-2,2%	-7,7%	-25,4%	11,4%	-4,0%	-37,2%
Life cycle costs	0%	-2,8%	3,0%	-6,1%	-4,4%	9,1%	-1,5%	-0,2%	-1,9%

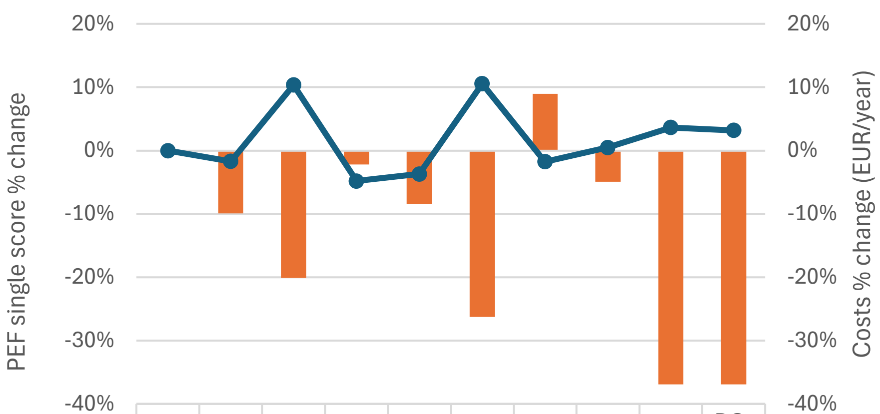


	Original base case	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
PEF single score	0%	-9,7%	-18,8%	-11,1%	-7,7%	1,7%	1,2%	-4,0%	-30,3%
Life cycle costs	0%	-2,8%	3,0%	-6,1%	-4,4%	9,1%	-1,5%	-0,2%	-1,9%

LCA Results – BC4

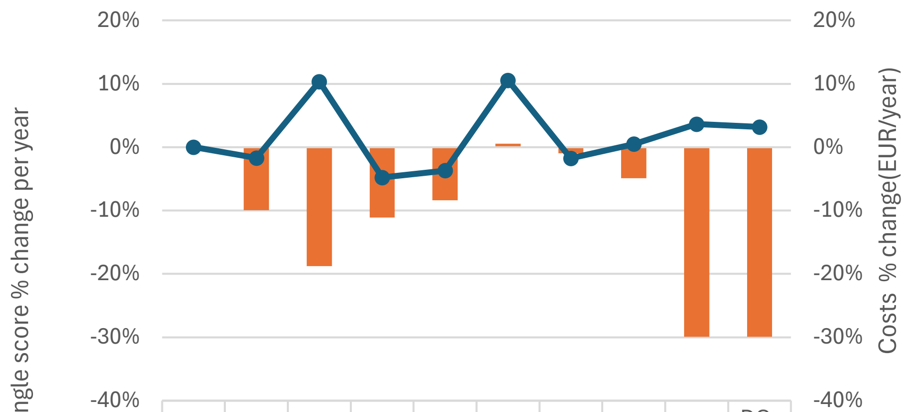
- For BC4, **DO-01**, **DO-03** and **DO-04** show a **decrease** in environmental impact associated with a **cost reduction**, both for the full lifetime of the product as well as per year of use
- For **DO-02** and **DO-07**, the environmental impact **reduces**, while costs remain similar or higher to the original Base Case results
- The full lifetime environmental impacts of DO-05 and DO-06 decrease and increase respectively, due to the lifetime changes, which is non-existent when expressed per year of use
- Large (30 %) environmental impact reduction of all DOs combined (**DO-08**), although with slight cost increase (per year of use)
- Sensitivity analysis shows similar results for DO-08 indicating only a minimal contribution to the overall impact and costs of external hot water input

Full lifetime LCA



	Original base case	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08	DO-08 Sensitivity
PEF single score	0%	-9,9%	-20,1%	-2,2%	-8,4%	-26,2%	9,0%	-4,9%	-36,9%	36,9%
Life cycle costs	0%	-1,7%	10,4%	-4,8%	-3,7%	10,6%	-1,7%	0,5%	3,6%	3,2%

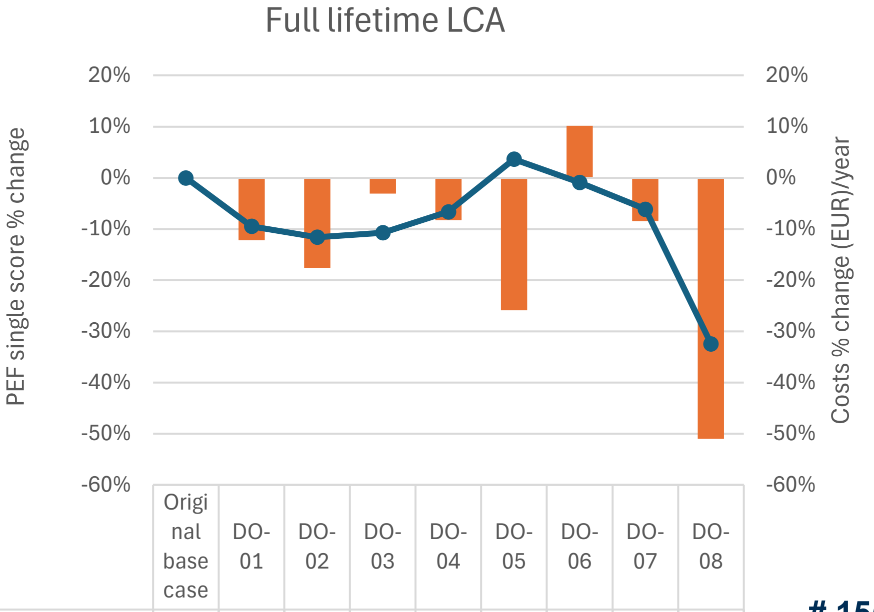
Per year of use



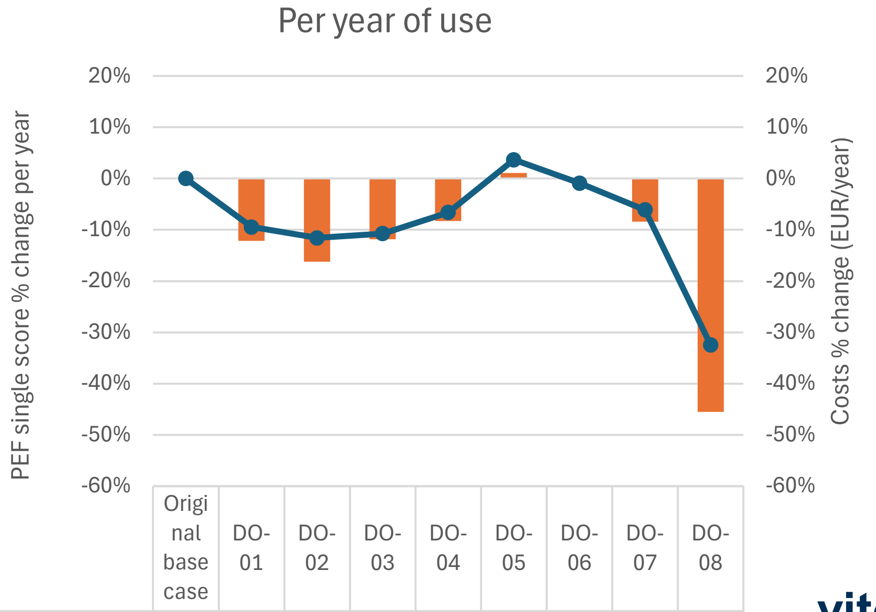
	Original base case	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08	DO-08 Sensitivity
PEF single score	0%	-9,9%	-18,8%	11,1%	-8,4%	0,6%	-0,9%	-4,9%	-29,9%	29,9%
Life cycle costs	0%	-1,7%	10,4%	-4,8%	-3,7%	10,6%	-1,7%	0,5%	3,6%	3,2%

LCA Results – BC5

- For BC5, **DO-01**, **DO-02**, **DO-03, DO-04** and **DO-07** show a **decrease** in environmental impact associated with a **cost reduction**, both for the full lifetime of the product as well as per year of use
- The full lifetime environmental impacts of DO-05 and DO-06 decrease and increase respectively, due to the lifetime changes, which is non-existent when expressed per year of use
- Large (46 %) environmental impact reduction of all DOs combined (**DO-08**), together with a large (32 %) cost decrease



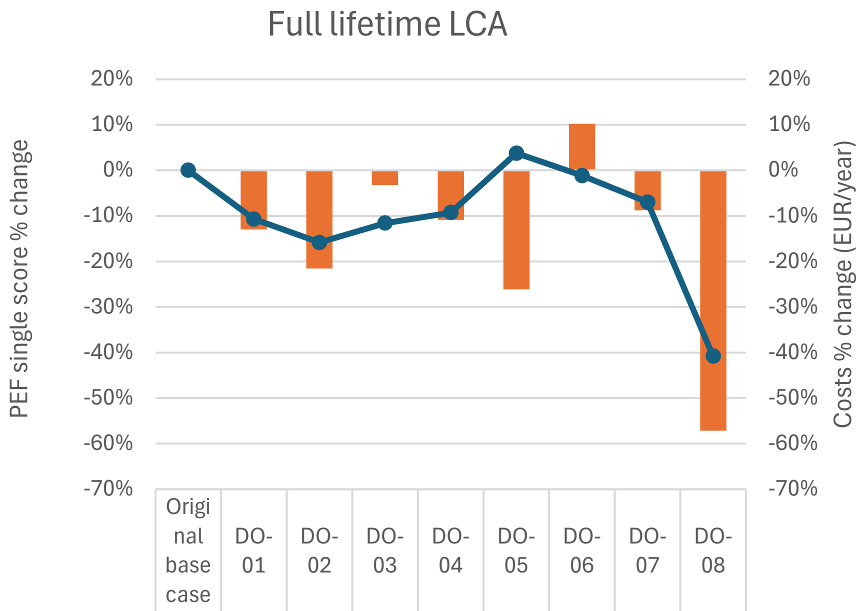
	Original base case	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
PEF single score	0%	-12,2%	-17,6%	-3,1%	-8,3%	-25,9%	10,2%	-8,4%	-51,0%
Life cycle costs	0%	-9,5%	-11,6%	-10,7%	-6,6%	3,6%	-0,9%	-6,1%	-32,4%



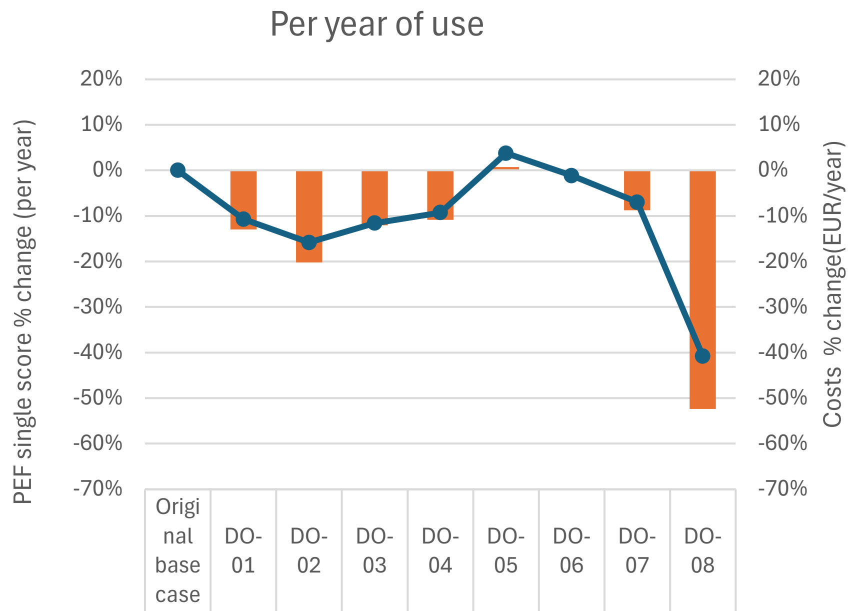
	Original base case	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
PEF single score	0%	-12,2%	-16,2%	-11,9%	-8,3%	1,1%	0,2%	-8,4%	-45,5%
Life cycle costs	0%	-9,5%	-11,6%	-10,7%	-6,6%	3,6%	-0,9%	-6,1%	-32,4%

LCA Results – BC6

- For BC6, **DO-01**, **DO-02**, **DO-03, DO-04** and **DO-07** show a **decrease** in environmental impact associated with a **cost reduction**, both for the full lifetime of the product as well as per year of use
- The full lifetime environmental impacts of DO-05 and DO-06 decrease and increase respectively, due to the lifetime changes, which is, however, non-existent when expressed per year of use
- Large (52 %) environmental impact reduction of all DOs combined (**DO-08**), together with a large (41 %) cost decrease



	Original base case	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
PEF single score	0%	-13,0%	-21,5%	-3,2%	-10,9%	-26,1%	10,2%	-8,8%	-57,2%
Life cycle costs	0%	-10,7%	-15,9%	-11,6%	-9,3%	3,8%	-1,1%	-7,0%	-40,8%



	Original base case	DO-01	DO-02	DO-03	DO-04	DO-05	DO-06	DO-07	DO-08
PEF single score	0%	-13,0%	-20,2%	-12,0%	-10,9%	0,7%	0,2%	-8,8%	-52,4%
Life cycle costs	0%	-10,7%	-15,9%	-11,6%	-9,3%	3,8%	-1,1%	-7,0%	-40,8%

Conclusions

- In most cases, the examined design options have the potential to generate environmental benefits, often with associated cost savings
- **Exhaust air heat pump (DO-02)** most promising design options in terms of environmental benefits
  - Slight increase in costs for the smaller machines (BC3, BC4)
  - In the largest dishwashers (BC5 and BC6), also **cost savings** are observed
- **Exhaust heat recovery (regenerator) (DO-01)** combines environmental benefits (9 to 13 %) with cost savings (2 to 11 %)
  - Although smaller environmental benefits than DO-02
  - Similar results for 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) with sometimes even lower environmental benefits and slight cost increases
- **Largest environmental benefit** with the combined design option **(DO-08)**
  - Only cost savings for largest machines (BC5, BC6)

Questions to stakeholders

- In general, confirmation/adaptation of the input data for each design option / Base Case would be appreciated.
- For all design options, the energy consumption reduction was modelled for the energy consumption of the machine used directly by the machine (electricity, low pressure steam). However, for some Base Cases, additional hot water, heated up outside of the machine, was included as well. Should the energy for this hot water production also be included in the energy reduction potential of the design options?
- Is design option DO-07 relevant for Base Case BC1?
- For Base Cases BC4 and BC6, Acrylonitrile Butadiene Styrene (ABS) was not included in the original Bill of materials; for the design options, this material was also not included, despite a percentage change compared to the original data of >100 %. Should ABS be included in the design options, and if so, at what quantity?

15h00 – 15h30

Coffee break

Online participants are kindly requested to return at 15h30

vito

MEErP Task 7 Scenarios

Antoine Durand – Fraunhofer ISI

vito

Context of the product group

Use phase input		Unit	BC1	BC2	BC3	BC4	BC5	BC6	All
Latest annual sale		mln. Units	0.008	0.179	0.066	0.014	0.006	0.003	0.28
		Share	2.9 %	64.9 %	23.9 %	5.1 %	2.2 %	1.1 %	100.0 %
Energy consumption		GWh/year	12	1,342	970	199	680	671	3,874
		Share	0.3 %	34.6 %	25.0 %	5.1 %	17.5 %	17.3 %	100.0 %
Water consumption		1000 m^3/year	352	29,204	10,229	1,634	4,923	3,688	50,030
		Share	0.7 %	58.4 %	20.4 %	3.3 %	9.8 %	7.4 %	100.0 %
Detergent consumption		t/year	248	32,757	20,790	4,536	11,586	8,259	78,176
		Share	0.3 %	41.9 %	26.6%	5.8 %	14.8 %	10.6 %	100.0 %

→ BC1: is a niche market compared to the other categories (market and consumption)

→ BC2 and BC3: are dominant (together: 89 % of the market, 60 % of the energy consumption)

→ BC4: low importance (5 % of the market and similar or less in terms of consumption)

→ BC5-6: low sales (together: <4 %) but large impact on environment due to the large capacity of the products.

Remark: in total over 200,000 units per year (which was the indicative threshold mentioned in Ecodesign Directive 2009/125/EC Art. 15 Point 2 (a) regarding market size for products to be regulated)

Ecodesign (for commercial dishwashers) under ESPR

Overview and first assessment based on Task 1-6

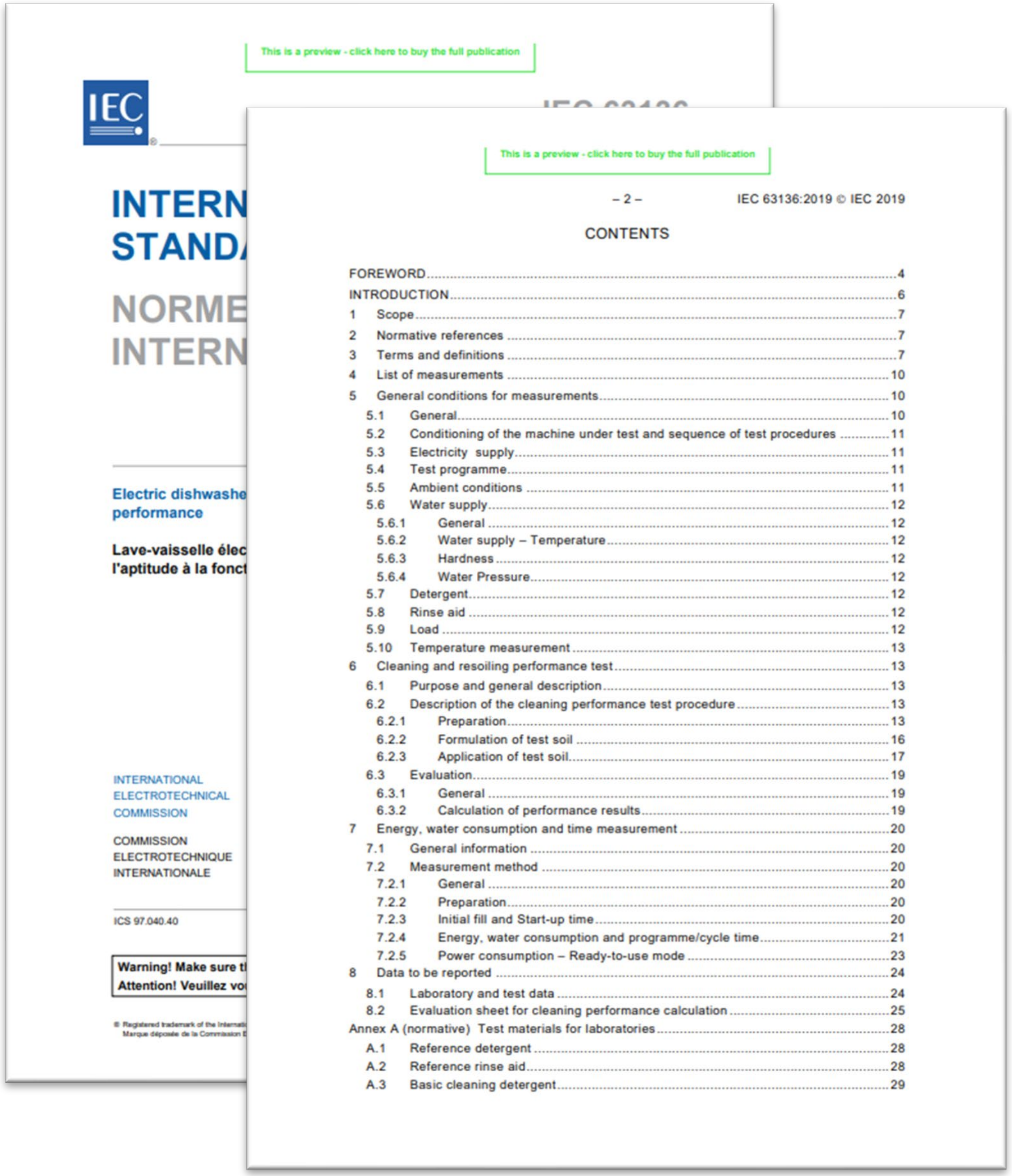
Ecodesign requirements (ESPR Article 5)	For commercial dishwashers
Durability, reusability, upgradability, reparability, and maintainability	Rather high number of repair/maintenance action (see Tasks 3 and 5). Reusability is not relevant (see Task 3)
Presence of substances that inhibit circularity	See „Substances of Concern“
Energy and resource efficiency	Use phase (in particular energy consumption): main hotspot according to Tasks 5
Recycled content	Sensitivity analysis shows limited impact (see Task 5)
Remanufacturing and recycling	See aspects related to CRM
Carbon and environmental footprints	To be discussed
Information requirements, incl. Digital Product Passport	DPP mandatory (or EPREL if available)

Energy and resource efficiency

Test standard:

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

Only BC2 and BC3 are covered by the standard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– 2 – IEC 63136:2019 © IEC 2019

CONTENTS

Energy and resource efficiency

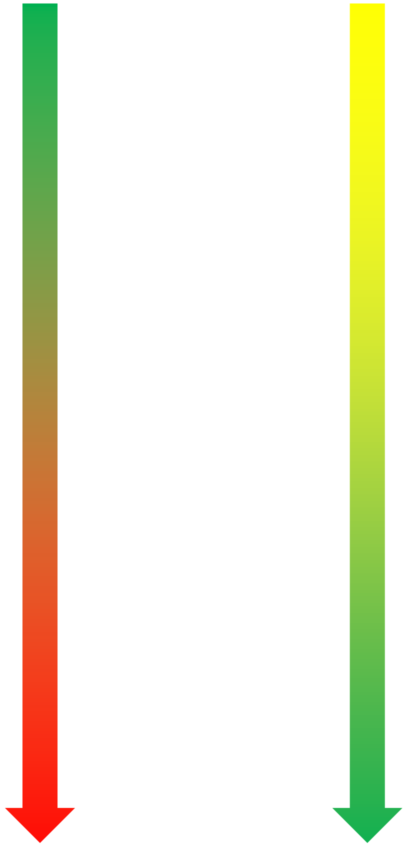
Test standard: make results comparable

Necessity to fully define a reference cycle for the purpose of a regulation.
While the EN IEC 63136:2019 delivers important elements of the reference cycle, the regulation should include following elements in order to make results comparable:

- Set a cleaning performance: e.g. $x_{clean} > 95\ \%$ (t.b.c.)
- Set a resoiling performance: e.g. $x_{res} < 1$ (t.b.c.)

Question to stakeholders: Are the requirements for a reference programme reasonable?

Energy and resource efficiency



Test standard: extend the scope

Possible approach for a test method based on EN IEC 63136:2019:

- **Cat 1**: it should be easy to elaborate a test method based on EN IEC 63136:2019, as parts (e.g. “7.2.3 Initial fill and Start-up time“) specific to tanks are not applicable.
- **Cat 4**: product is not designed to clean plates.
  - It might be meaningful to define a new „test dish“ for the test. If so, all sections specific to „test dish“ should be updated accordingly (e.g. section „6.2.1.1 Basic cleaning of plates“, 6.2.1.2 Basic cleaning of new plates)
  - However: check if „test dish“ could still be plates, as this would be the most pragmatic way to elaborate a test method
- **Cat 5-6**: similar measurement method as EN IEC 63136:2019, but higher number of racks and different timing probably necessary to better reflect the operation of such products.

Energy and resource efficiency

Test standard:

Consumptions per test dish

Relevant information (based on Table 3 of IEC 63136:2019):

Measured data	Value	Unit
Energy consumption for initial filling [1]	x.xxx	kWh
Water consumption for initial filling [1]	x.x	L
Initial filling time [1]	X	s
Water tank temperature when ready-to-use mode reached [5], [1], [3]		°C
Number of test dishes [2] per rack and cycle	x	(number)
Cleaning performance with the standard cleaning cycle (> *95%)*	x %	(per cent)
Resoiling performance in particles per plate x particles/test dish [2] (<*1)*	x	(particles / test dish)
Specific energy consumption per test dish [2]	x.xxx	kWh / test dish
Specific water consumption per test dish [2]	x.x	L / test dish
Specific detergent consumption per test dish [2],[3]	x.x	L / test dish
Average cycle time	x	s
Power left-on mode [3],[4]	x	kW
Power ready-to-use mode [1]	x	kW

[1] only applicable to product with tank (not for Cat 1)

[2] test dish = plate (potentially except Cat 4)

[3] currently no 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

Energy and resource efficiency

Approach to regulate energy efficiency:

- BC 2-3 (and BC1):
  - Regulation based on the test method from IEC 63136:2019 (to be slightly modified for BC1)
- BC 5-6:
  - Regulation based on a test method from IEC 63136:2019 (to be developed)
  - Alternative: performance requirements based on functional requirements
    → cost effective design options identified in Task 6 could directly be translated into requirements

    Legal caution: it should be checked if this complies with the ESPR framework, in particular with Article 5 Ecodesign requirements

    e) „Ecodesign requirements shall meet the following criteria: […] there shall be no proprietary technology imposed on manufacturers or other actors in the value chain.“
  - Important remark: While this alternative approach might be easier to implement (no product specific test standard), it wouldn‘t allow performance comparison of products from the same category, also: no min cleaning and resoiling performance being guaranteed
- BC 4:
  - To be discussed

Energy and resource efficiency

Level of requirement:

- Approach: requirements on **energy and water consumption** taking into account:
  - Design Options contributing to reduce the environmental impacts and the LCC/year, and
  - Design Options contributing to reduce the environmental impacts even if the LCC/year increase
  - **As long as the LCC/per year of the package of selected DOs are lower than in the baseline**

Cat	1	2	3	4	5	6
Requirements based on:	DO-04	DO-1 DO-3 DO-4 DO-7	DO-1 DO-2 DO-3 DO-4 DO-7	DO-1 DO-2 DO-3 DO-4 DO-6 DO-7	DO-1 DO-2 DO-3 DO-4 DO-7	DO-1 DO-2 DO-3 DO-4 DO-7

Energy and resource efficiency

Level of requirement:

- Key challenge:
  in order to elaborate concrete requirements on the energy and water consumption,
  the performance of a **reference machine for each Category of commercial dishwasher would be required**
- Alternative:
  Assess products which are on the market and for which test reports according to IEC 63136:2019 are available → use as benchmarks
  ➔ currently only possible for Cat 2 and 3

Energy and resource efficiency

Functional requirements for Cat 5-6:

- Functional requirements corresponding to the Design Options relevant for Cat 5 and 6:

  ➔ Here, instead of setting a requirement on the whole product (level in line with the selected Design Options), each selected Design Option is translated into a specific requirement.

Energy and resource efficiency

Functional requirements for Cat 5-6:

Design Option	Short description	Corresponding requirements
DO-01	Exhaust heat recovery (regenerator)	Exhaust heat recovery mandatory or “Heat recovery rate > x%”
DO-02	Exhaust air heat pump	Exhaust air heat pump mandatory
DO-03	Automatic programme for load and soil recognition	Automatic load and soil detection programme adjusting water, energy and detergent based on load size and soil level mandatory.
DO-04	Improved thermal insulation (double-walled design)	**U < x W/m²** for the elements of the envelop surrounding the hot zones of the machine
DO-05	*Further substitution of metals by polymers*	*“**min x % of recycled plastics** for the parts [list to be elaborated]”* *Remark: currently, not selected but to be confirmed (only 1 feedback from stakeholder until now)*
DO-06	*Modular design and reuse of electronics*	*Remark: currently, not selected but to be confirmed (only 1 feedback from stakeholder until now)*
DO-07	Energy recovery from drain water	Energy recovery from drain water mandatory

Durability, reusability, upgradability and reparability

Spare parts:

- Maintenance and repair actions seem to be 'business at usual' at commercial dishwashers (see Task 2 and 3)
- Few requirements suggested to make sure that all products on the market offer spare parts and allow easy repair and maintenance (based on other product groups):
  - Maximum delivery time of spare parts [x] of 5 days (see next slide)
  - For a minimum period of 10 years after placing the last unit of the model on the market
  - Information requirement: Provision of repair and maintenance information

Question to stakeholders:
Need / suggestions for 'design for repair' requirements (e.g. modular design on certain spare parts) to improve reparability of all products on the EU market?
Which usual delivery time / minimum period do you practice?

Durability, reusability, upgradability and reparability

Spare parts (based on Task 3)

Cat	1	2	3	4	5	6
List of spare parts	• Parts of the dosing system are maintenance parts. • Parts related to the water circulation system e.g. circulation pump, piping. • Electronics and dosing pumps.	• 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	• 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.	• 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.	• 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	• 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

Further topics

Design for recycling / Critical Raw Materials (CRM) ➔ Permanent magnets

- Dishwashers 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)

- No need to regulate under ESPR → information from this ESPR preparatory study might provide useful information for the elaboration of the forthcoming Delegated Act in accordance with the CRM Act:

  *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 post-consumer waste that must be present in the permanent magnet incorporated in the products referred to in paragraph 1.'*

Further topics

Green Public Procurement (GPP)

- 23.6 % of the market share of commercial dishwashers are in the public sector (estimate in Task 2) → GPP seems to be a relevant market
- ESPR Article 65 (Green Public Procurement): ‘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.’

Cat	1	2	3	4	5	6
Main GPP requirement	Two highest performance classes of the Energy Label	Two highest performance classes of the Energy Label	Two highest performance classes of the Energy Label	T.B.D.	On the best possible performance levels Issue: BAT = LCC = Tier 1!	On the best possible performance levels Issue: BAT = LCC = Tier 1!

Carbon and environmental footprints

Product Carbon Footprint (PCF)

- Relevance: to be discussed (might be helpful for public authorities to contribute to the national climate targets ➔ monitor the CO_2-impact of their procurement, e.g. Germany's 'Bundes-Klimaschutzgesetz'...)
- Calculation: simplified approach based on BOM and performance of the product according to the test method

Product Environmental footprint (PEF)

- Relevance: PEF is more meaningful as there are several impact categories beyond carbon footprint (see Task 5 results)
- Calculation: more complicated / would require more data

DPP (overview of the possibilities □ to be analysed)

Blue = DPP required

#	Stakeholder	Use-case (CE-goal)	BC1-3	BC5-6	Information to be provided	Feasible with EPREL?	Public data	Granularity
1	Customer	Sustainable purchase			CO_2 footprint, circularity indicators (e.g. reparability), recycled content	extended with sustainability information	Public	Model/Batch
2	Customer	Sustainable purchase			Environmental label	extended with label	Public	Model/Batch
3	Customer	Sustainable purchase			Technical specifications / documentation	yes	Public	Model/Batch
4	Customer	Prolong use (maintenance, repair)			Use, maintenance and repair instructions	extended with manuals	Public	Model
5	Customer	Resell & 2nd hand purchase			Usage history, repair history	No; DDP required	Confid.	Item
6	Customer	Proper disposal			Disposal and return options	extended with disposal information	Public	Model
7	Repairer	Professional (certified) repair			Dismantling instructions, spare part availability, etc.	extended with repair information	Confid.	Model/item
8	Reuser	Enable reuse			Usage history, repair history	No; DDP required	Confid.	Item
9	Refurbisher	Enable refurbishment			Dismantling instructions, usage & repair history	No; DDP required	Confid.	Item
10	Remanufacturer	Enable remanufacturing / repurposing			Dismantling instructions, usage & repair history	No; DDP required	Confid.	Item
11	Collection & Pre-sorting	Preparation for reuse			Energy efficiency, Usage/repair history, purchase date, original product price	No; DDP required	Confid.	Item
12	Collection & Pre-sorting	Component sorting			Dismantling instructions	extended with dismantling instructions	Confid.	Model
13	Collection & Pre-sorting	Separation of products/components with prohibited substances (WEEE, RoHS, REACH, etc.)			Prohibited / hazardous substances per component (incl. Batteries)	No; DDP required	Confid.	Model/Batch
14	Collection & Pre-sorting	Separation of products/components with valuable materials (CRMA, Battery Regulation)			Valuable materials, incl. CRMs (permanent magnets)	No; DDP required	Confid.	Model/Batch
15	Collection & Pre-sorting	Closed loop recycling			Application type, model	extended	Public	Model/Batch
~~16~~	~~Recycling~~	~~Material sorting~~			~~Material composition on shredded fraction~~		n.a.	n.a.

Conclusion

Main ESPR requirements proposed for commercial dishwashers

Requirements	BC2-3	BC5-6	BC1	BC4
Relevance	Very high	High	Low	Medium
Test standard and measurement data	Available Requirement (cleaning and resoiling performance) for a reference program in the regulation	EN update required	No major challenge to update the EN (to be checked)	No major challenge to update the EN (to be checked) if based on plates
Performance requirements (energy and water)	To be finalised	Very challenging in a short notice Functional requirements might be an alternative	Doable with a measurement campaign	Doable with a measurement campaign But: eventually same approach as for BC5-6
Label	Yes	No	Yes	?
DPP	EPREL as alternative	Yes	EPREL as alternative	?
GPP	Yes	Yes	Yes	Yes
Spare parts	Yes	Yes	Yes	Yes

Conclusion

Feasibility for a regulation covering all aspects e.g. by 2029 and required steps:

- BC2-3: possible
  - Need to define a reference programme and define a reference machine
  - Might be doable with already available products measured according to the EN standard
- BC5-6: possible
  - But likely based on functional requirements
  - Test standard approach might be mature only by the review of the regulation
- BC1 and BC4: might be possible
  - But a test method is needed first (could be done is a short notice, if the changes suggested here are reasonable for the stakeholders)
  - And would require a swift campaign of measurements to cover also energy efficiency aspects

MEErP Task 5
Substances of Concern

Eelco van IJken – Ecomatters

Substances of Concern (SoC) task

Objectives:

- Define information requirements and thresholds for substances meeting Art. 2(27) ESPR definitions (mandatory in ESPR legal text)
- Define exemptions from information requirements (when justified)
- Define if performance requirements for SoC negatively affecting reuse and recycling are relevant for this product group

Activities:

- Stakeholder consultation, literature review, consideration of stakeholder perspectives, and drafting of recommendations

SoC in ESPR Art. 2(27)

a) Appears in the Regulation on the registration, evaluation, authorisation and restriction of chemicals (REACH) (EC No1907/2006)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 (POP) (EU 2019/1021).

d) Negatively affects the reuse or recycling of materials in the product.

Stakeholder perspectives

- Complexity of data collection / limited window for data collection

- ESPR SoC should not duplicate what REACH, RoHS, CLP, POP or WEEE already covers
- Existing obligations for sharing information in place:
  - Waste Framework Directive: SCIP database for SHVC Art. 33(1) REACH obligation
  - WEEE: Art. 15(1) sharing information with waste treatment operators (I4R platform)

- Keep the 0.1 % w/w substance concentration threshold in articles from REACH Art. 33(1) as the single trigger for any ESPR reporting
- Non-Intentionally Added Substances (NIAS) should not be included

- Suggestion to identify recycling-hindering WEEE substances across product groups (consider waste-stream categories rather than product groups)
- Exemption mechanism is welcome, consider a REACH-style socio-economic evaluation

SoC Information requirements Art. 7(5)

Proposed to cover:
- Only Intentionally Added Substances (IAS)
- SoC present in the product (including its components and spare parts) (e.g. part of the bill of materials)

Proposed to exclude:
- Non-Intentionally Added Substances (NIAS)
- Substances used in the lifecycle of the product but not present in the product itself

Exemptions:
- No specific information/views gathered on substance specific exemptions

Required to share information
- The exact name or numerical identifier of each substance, location within the product, the concentration (concentration range/maximum value), clear instructions for safe use, and guidance on environmentally sound end-of-life treatment

Tracking thresholds for information requirements

Proposed tracking thresholds (derived from draft JRC guidance):

Art 2(27) SoC:

a) REACH Annex XIV SHVC: 0.1 % weight (w)/weight (w)
b) CLP hazard classes/categories:
   - UN Globally Harmonized System (GHS): generic contraction limits (GCL): 1.0 % w/w or 0.1 % w/w
   - CLP Annex I GCL: 1.0 % w/w or 0.1 % w/w depending on hazard class/category
c) POP: 0.1 % w/w
d) Negatively affects the reuse and recycling: 0.1 % w/w

In case of meeting multiple categories, the lowest threshold is followed

Implementation scenarios
To be assessed in the impact assessment

- **Highly ambitious scenario:** All SoC listed in Art. 2(27)(a–d) covered without exemptions
- **Intermediate scenario:** All Art. 2(27)(a–d) SoC be covered, but companies could justify substance-specific exemptions:
  - Supported by auditable (scientific) evidence demonstrating,
    - issues with technical infeasibility;
    - lack of analytical methods to detect or quantify;
    - irrelevance in the specific product; or
    - the need to protect confidential business information.
- **Limited scenario:** All Art. 2(27)(a–c) SoC would be covered, but companies could justify broader exemptions (groups of substances, hazard classes or categories, etc.)
  - Art. 2(27)(d) follow-up study with recyclers to identify which substances pose recycling challenges for this product group. Any problematic SoC could then be added to the Delegated Act.

SoC performance requirements (Art. 6)

Findings:

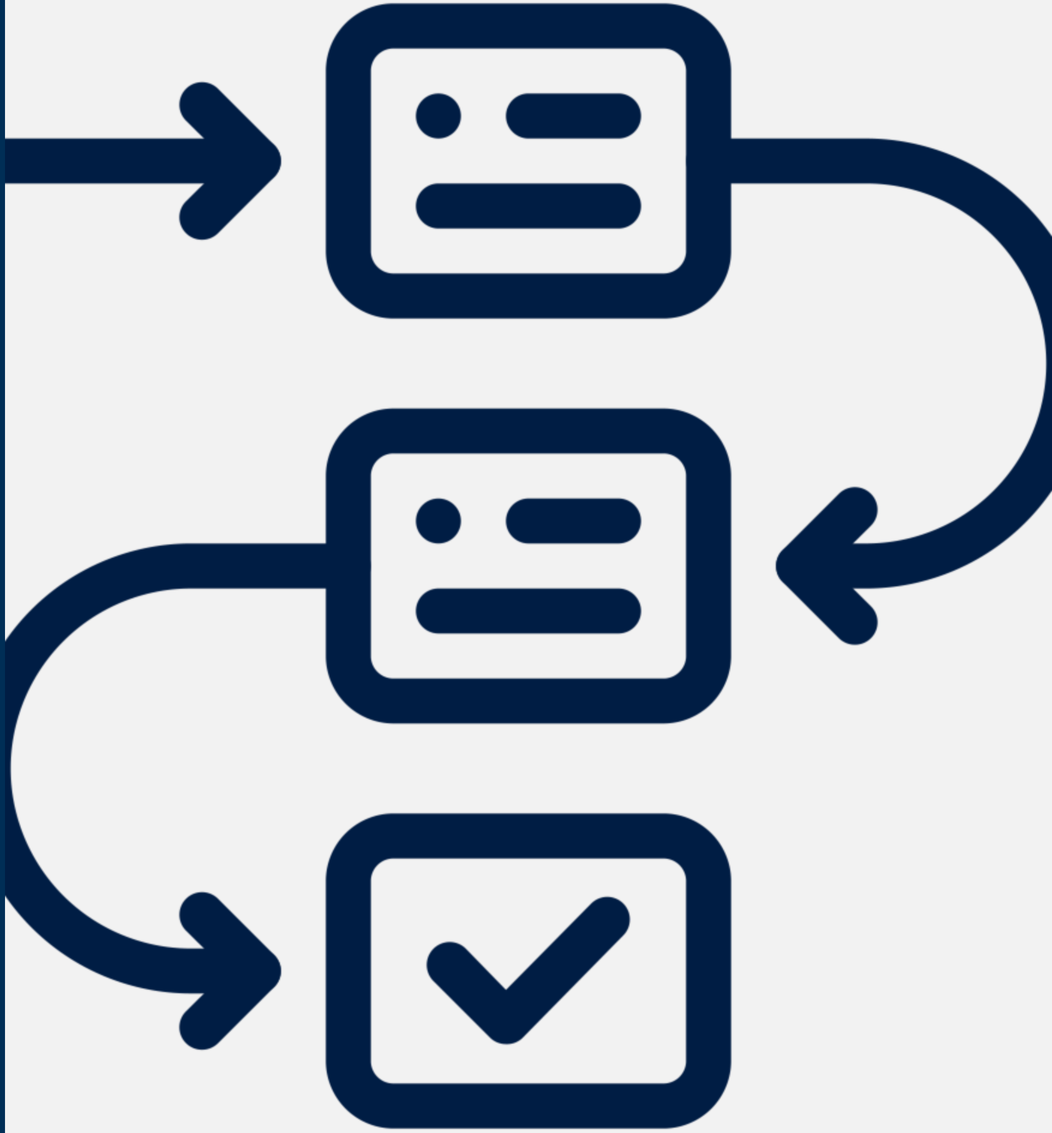
- Provided substance information mostly on SVHC/CLP SoC, with limited evidence for specific substances inhibiting recycling
- Lead concentration in brass/copper alloys was noted, but existing recycling practice is to dilute
- No views yet from recyclers and their representatives or from literature to determine specific performance requirements

Proposed:

- No substance specific performance requirements are proposed at this stage for the product group

Outlook:
Next steps

Kathrin Graulich, Oeko-Institut



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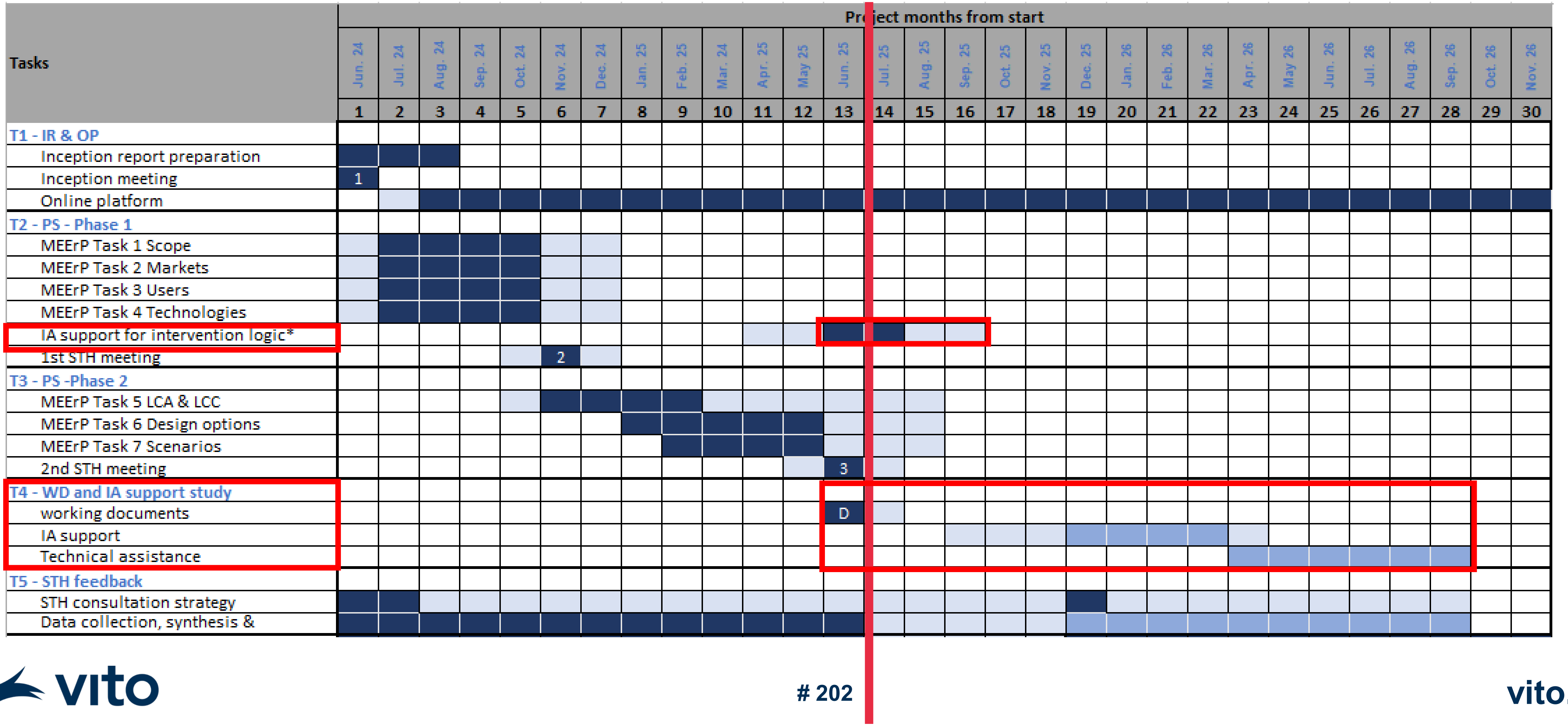
Next steps

- **Draft MEErP Task 1-7 report** available for download under https://ecodesign-commdishwashers.eu/en/documents
- **Stakeholder feedback to Draft final MEErP Task 1-7 report the latest by 15 August 2025**: Please send the **feedback template** (available on project website) back to ecodesign-commdishwashers@oeko.de.
- **Revised MEErP Task 1-7 report** by end of September 2025
- **Stakeholder registration** still possible, please inform your network: https://ecodesign-commdishwashers.eu/en/register

Study schedule

Overall project duration: 04.06.2024 – 03.12.2026



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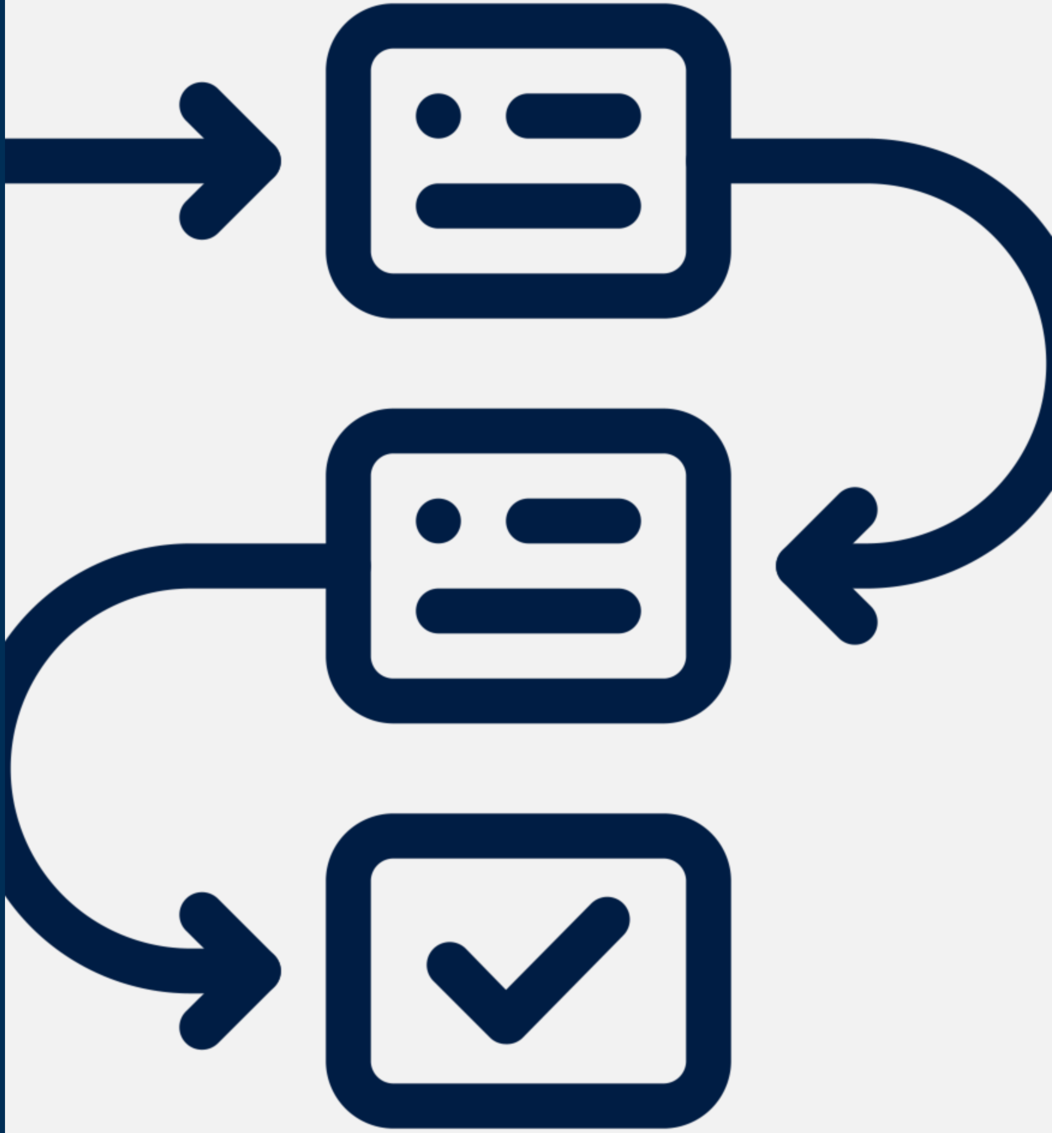
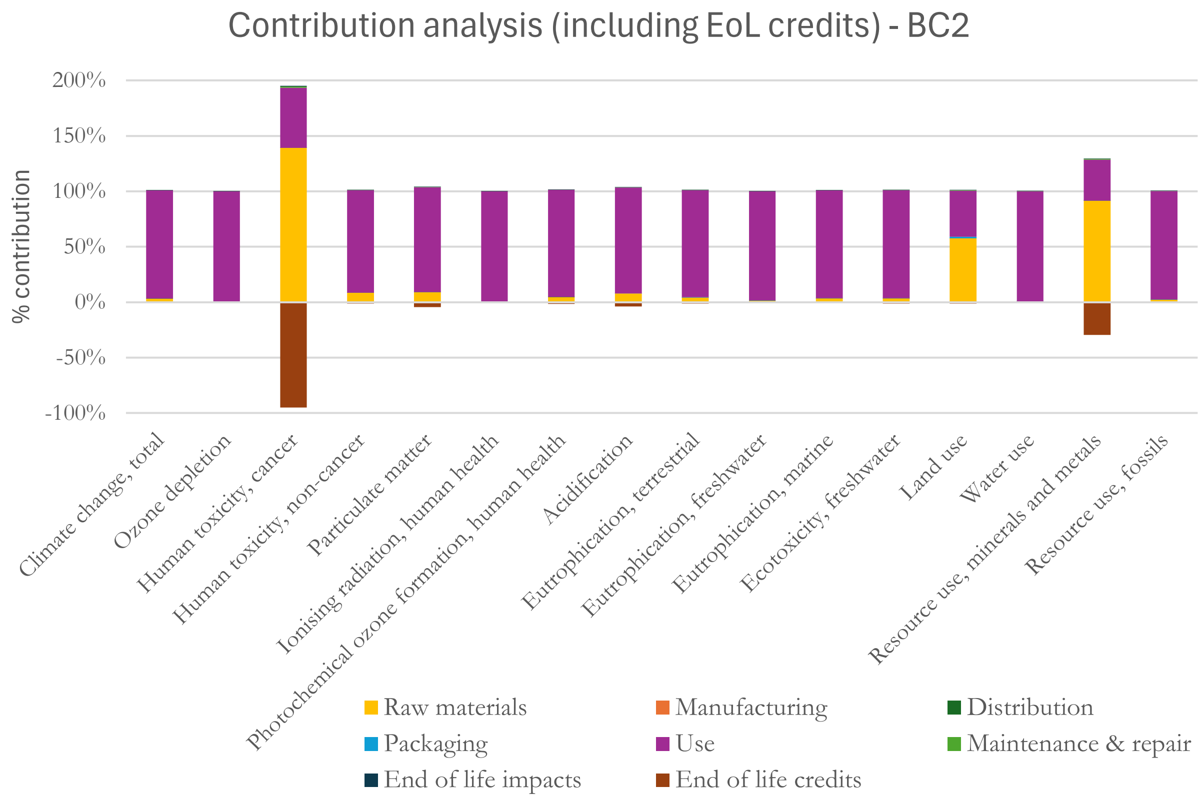
Annex



LCA Results – BC2: Undercounter one-tank dishwasher, contribution analysis over lifetime

Contribution analysis life cycles

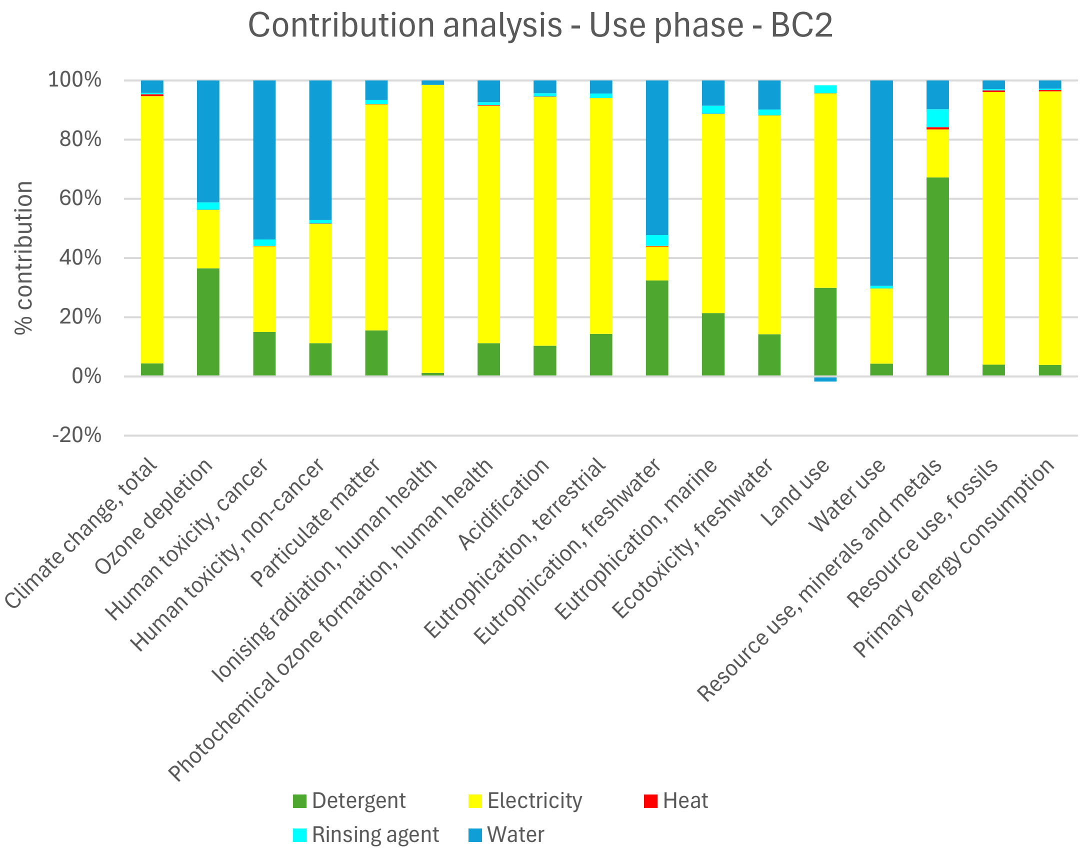
- Majority (>95% per impact category) of the lifetime impact is from the use phase followed by the raw materials production for most impact categories
- Raw materials impact largest for some impact categories due to stainless steel (Human toxicity, cancer), copper (Land use) or electronics (Resource use, mineral and metals)
- End-of-life modelling shows a credit for avoided impacts due to recyclability of certain raw materials
  - Stainless steel, aluminium, printed wiring board (electronics)



LCA Results – BC2: Undercounter one-tank dishwasher, contribution analysis over lifetime

Contribution analysis Use phase

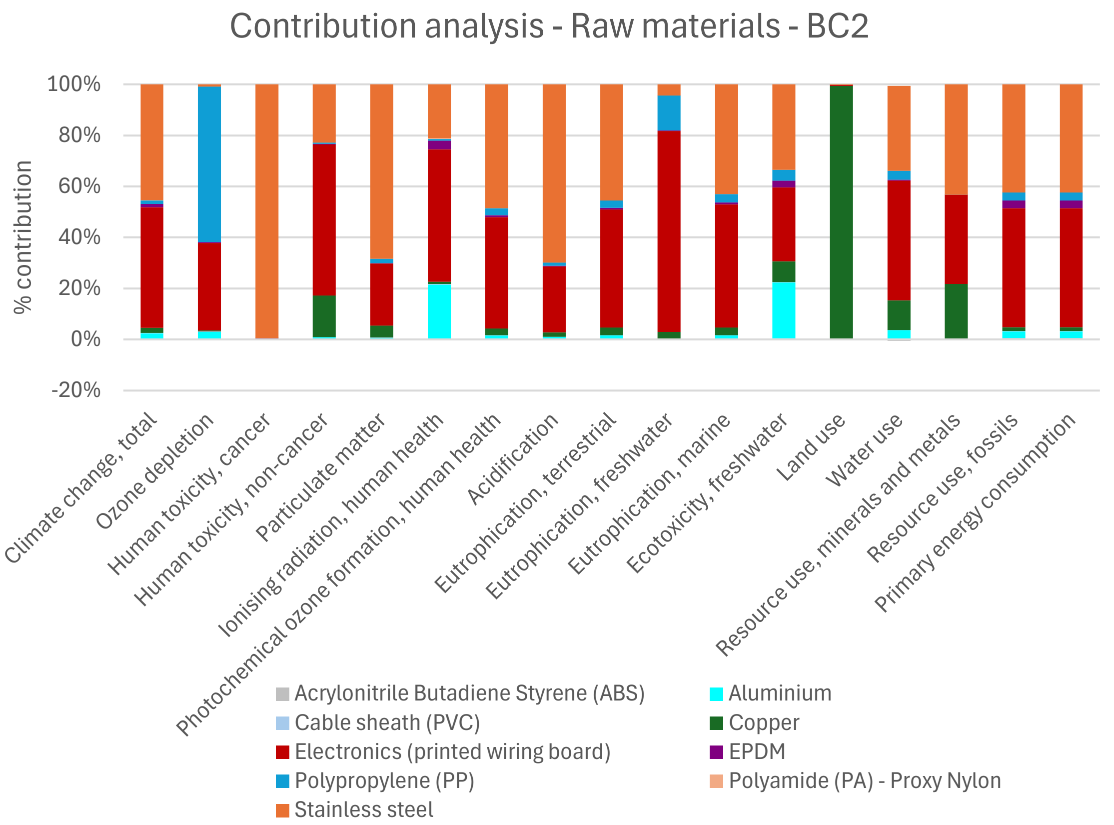
- Major contributor in the use phase is electricity use for most impact categories
- Water use is a major contributor for several other categories and detergent has a large impact on 'Resource use, minerals and metals'.



LCA Results – BC2: Undercounter one-tank dishwasher, contribution analysis over lifetime

Contribution analysis Raw materials production

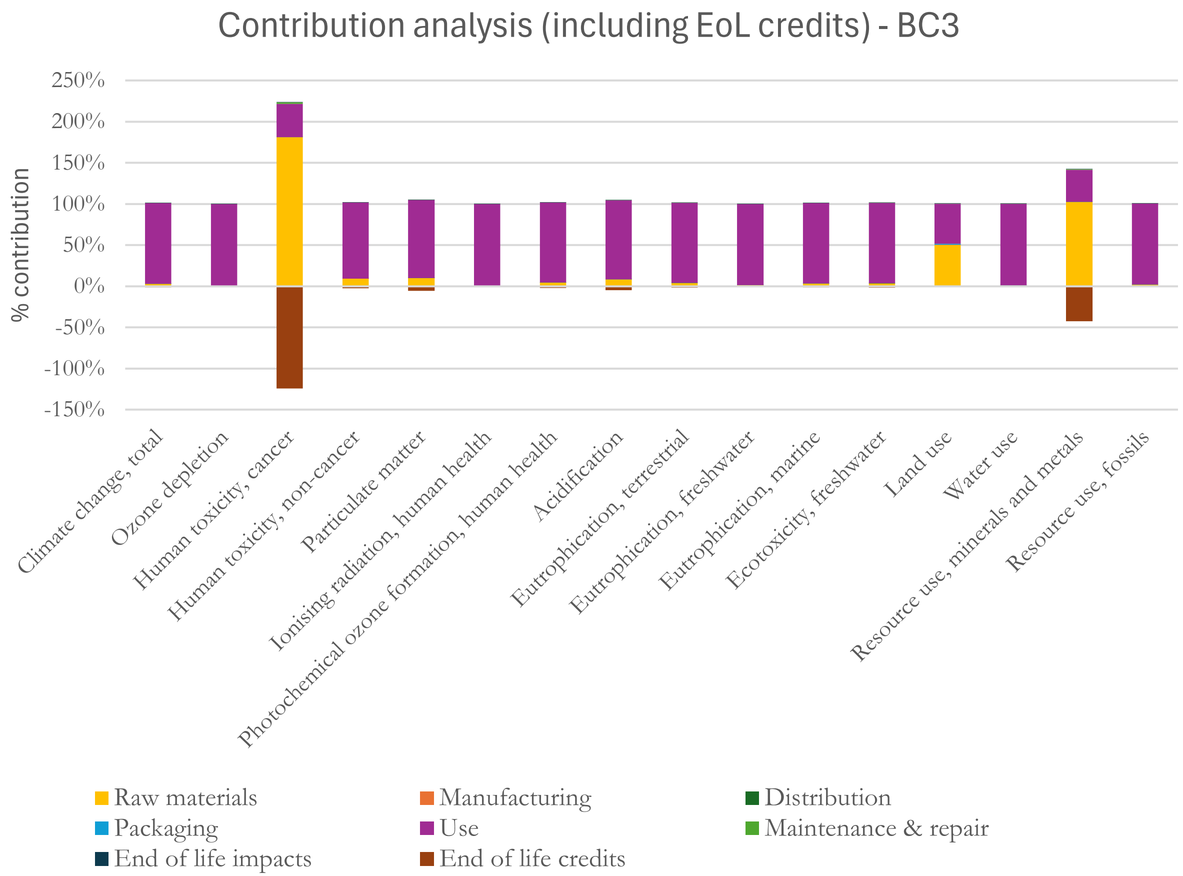
- Major contributor of raw materials is the production of printed wiring board and stainless steel
- Additional high contributing raw materials are polypropylene (Ozone depletion) and copper (Land use)



LCA Results – BC3: Hood-type dishwasher, contribution analysis over lifetime

Contribution analysis life cycles

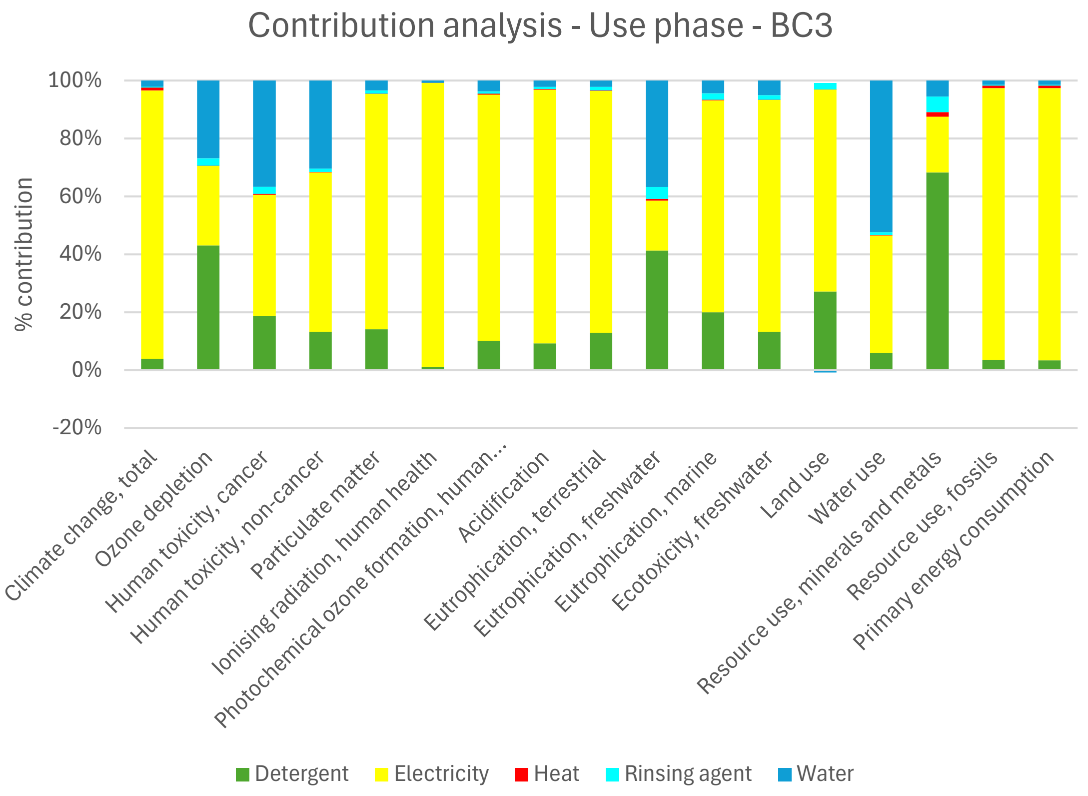
- Majority (>92% per impact category) of the lifetime impact is from the use phase followed by the raw materials production for most impact categories
- Raw materials impact largest for some impact categories due to stainless steel (Human toxicity, cancer, Resource use, mineral and metals), copper (Land use) and electronics (Resource use, mineral and metals)
- End-of-life modelling shows a credit for avoided impacts due to recyclability of certain raw materials
  - Stainless steel, aluminium, printed wiring board (electronics)



LCA Results – BC3: Hood-type dishwasher, contribution analysis over lifetime

Contribution analysis Use phase

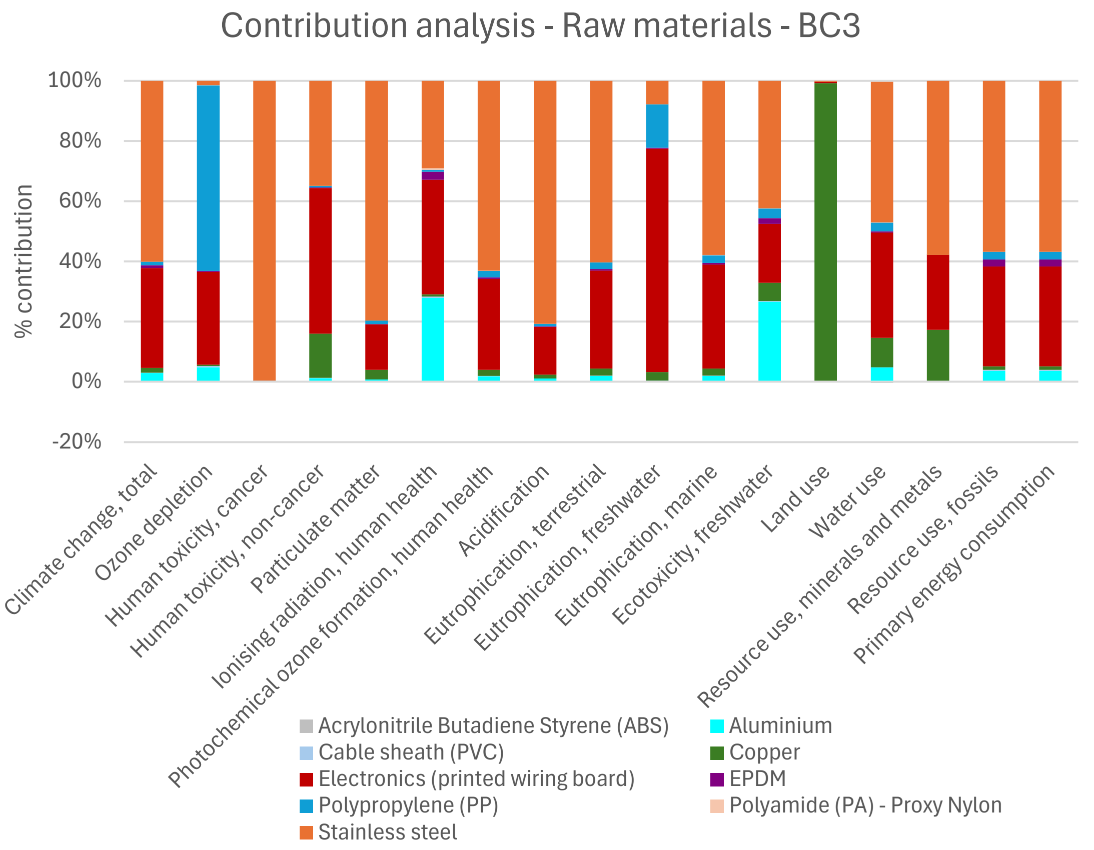
- Major contributor in the use phase is electricity use for most impact categories
- Water use is a major contributor for several other categories and detergent has a large impact on 'Resource use, minerals and metals'.



LCA Results – BC3: Hood-type dishwasher, contribution analysis over lifetime

Contribution analysis Raw materials production

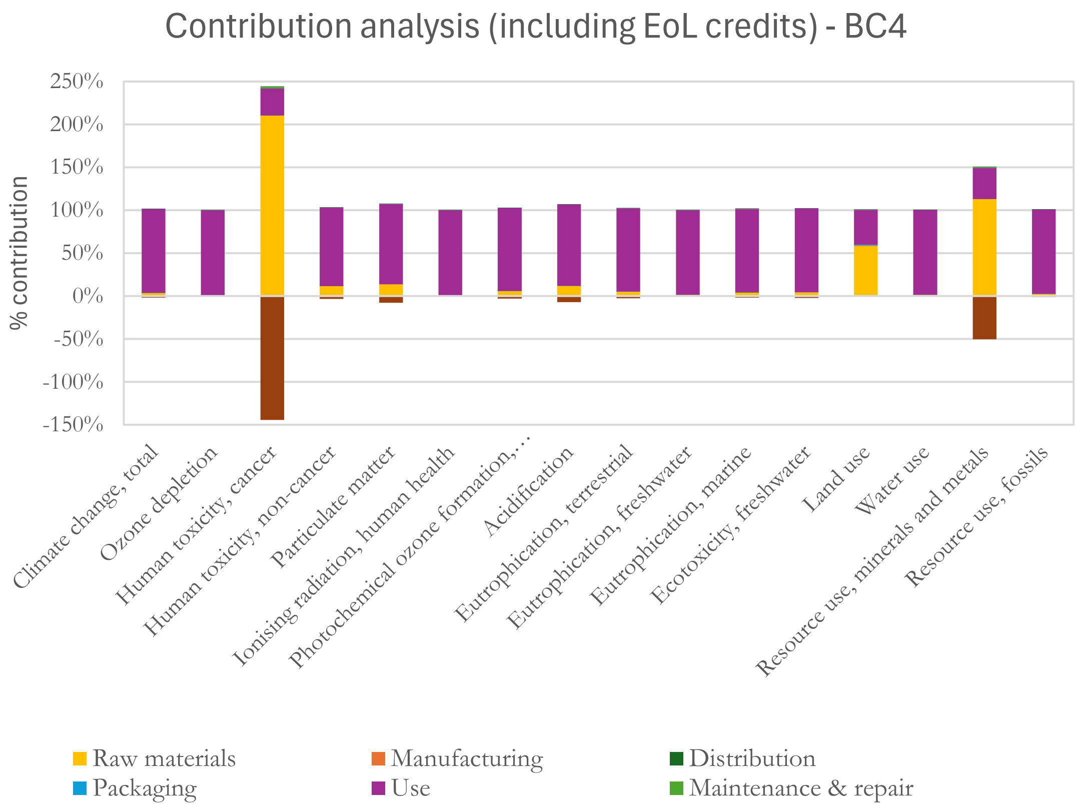
- Major contributor of raw materials is the production of printed wiring board and stainless steel
- Additional high contributing raw materials are polypropylene (Ozone depletion) and copper (Land use)



LCA Results – BC4: Utensils/pot dishwasher, contribution analysis over lifetime

Contribution analysis life cycles

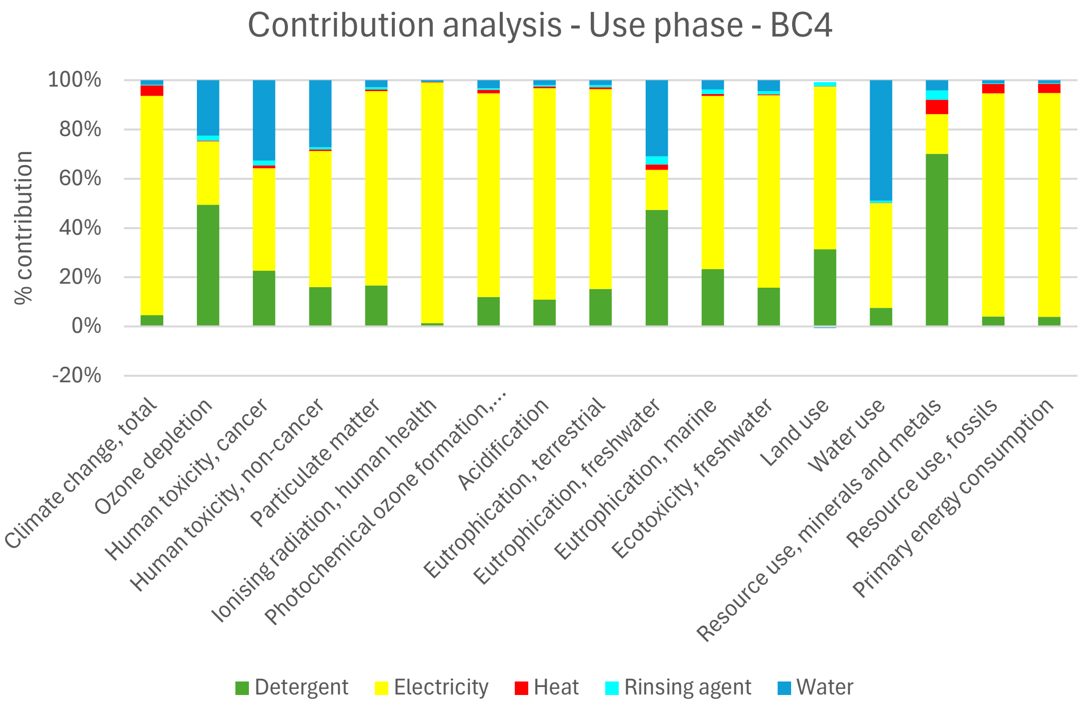
- Majority (>91% per impact category) of the lifetime impact is from the use phase followed by the raw materials production for most impact categories
- Raw materials impact largest for some impact categories due to stainless steel (Human toxicity, cancer, Resource use, mineral and metals) and copper (Land use)
- End-of-life modelling shows a credit for avoided impacts due to recyclability of certain raw materials
  - Stainless steel, aluminium, printed wiring board (electronics)



LCA Results – BC4: Utensils/pot dishwasher, contribution analysis over lifetime

Contribution analysis Use phase

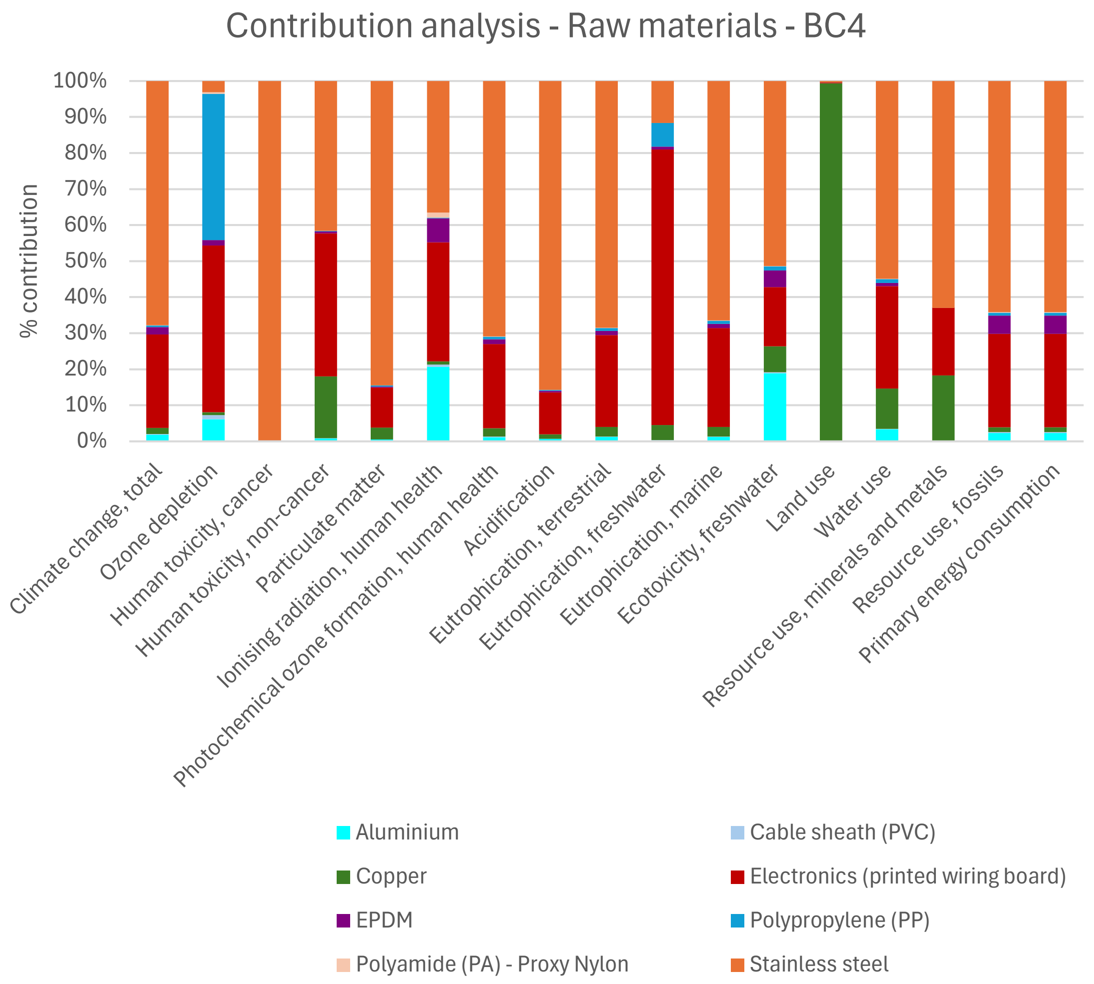
- Major contributor in the use phase is electricity use for most impact categories
- Detergent use is a major contributor for several other categories and water has a large impact on 'Water use'.



LCA Results – BC4: Utensils/pot dishwasher, contribution analysis over lifetime

Contribution analysis Raw materials production

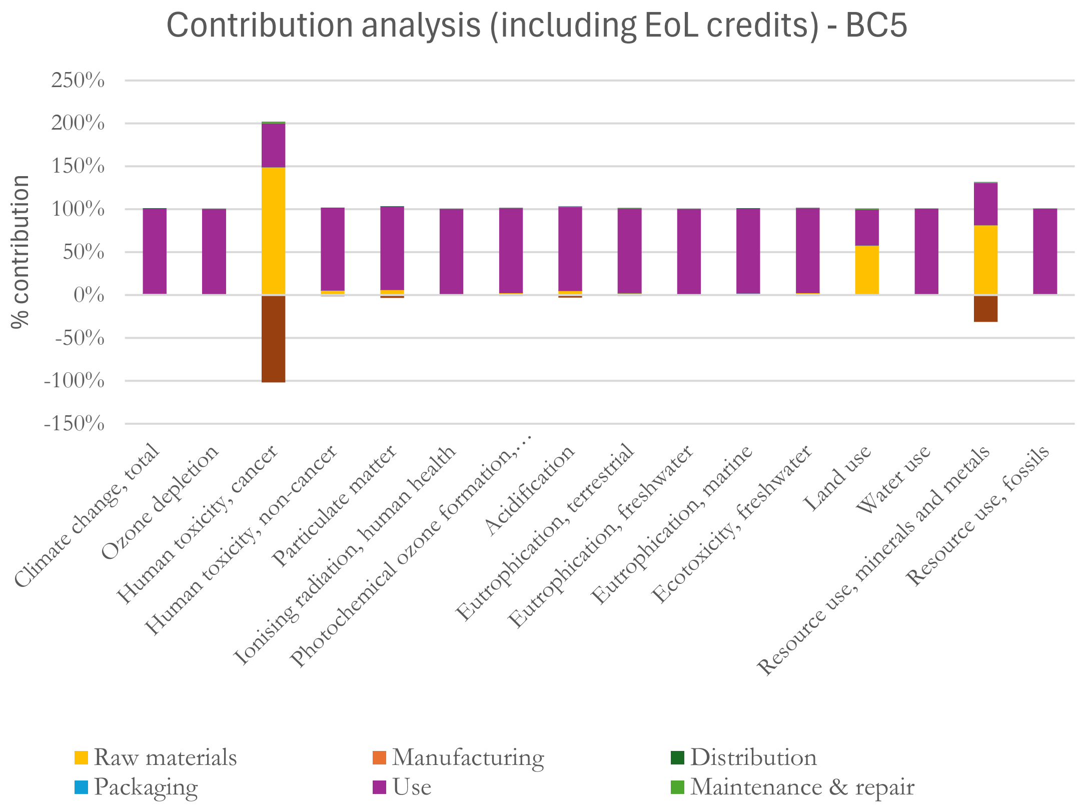
- Major contributor of raw materials is the production of stainless steel followed by printed wiring board
- Additional high contributing raw materials are polypropylene (Ozone depletion) and copper (Land use)



LCA Results – BC5: One-tank conveyor-type dishwasher, contribution analysis over lifetime

Contribution analysis life cycles

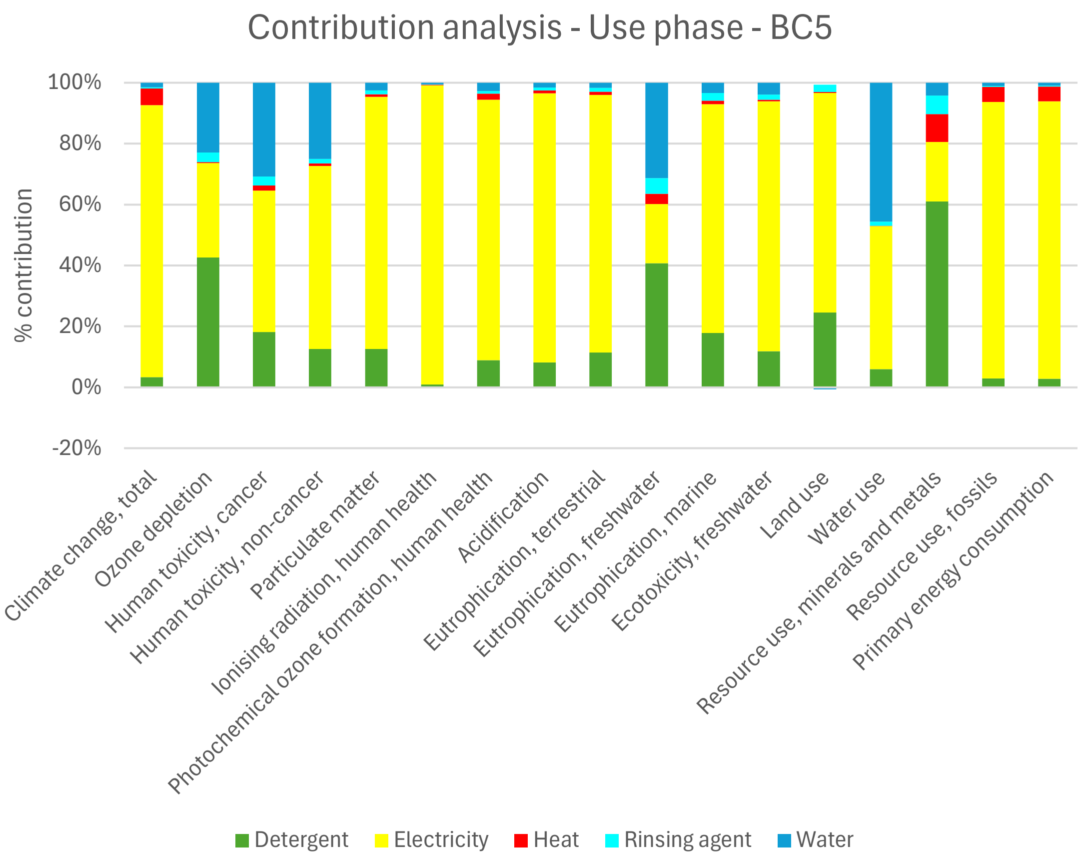
- Majority (>96% per impact category) of the lifetime impact is from the use phase followed by the raw materials production for most impact categories
- Raw materials impact largest for some impact categories due to stainless steel (Human toxicity, cancer, Resource use, mineral and metals) and copper (Land use, Resource use, minerals and metals)
- End-of-life modelling shows a credit for avoided impacts due to recyclability of certain raw materials
  - Stainless steel, aluminium, printed wiring board (electronics)



LCA Results – BC5: One-tank conveyor-type dishwasher, contribution analysis over lifetime

Contribution analysis Use phase

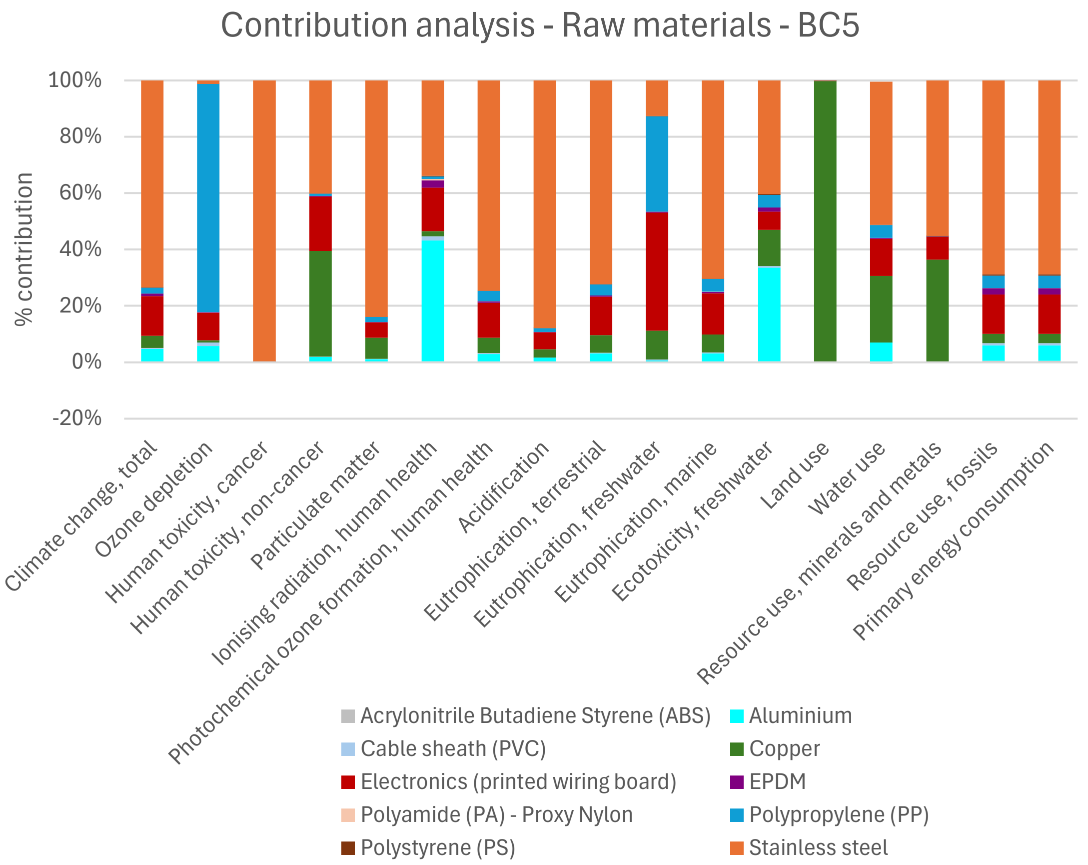
- Major contributor in the use phase is electricity use for most impact categories
- Detergent and water use have a major contribution to a few impact categories (e.g. Resource use, mineral and metals for detergent)



LCA Results – BC5: One-tank conveyor-type dishwasher, contribution analysis over lifetime

Contribution analysis Raw materials production

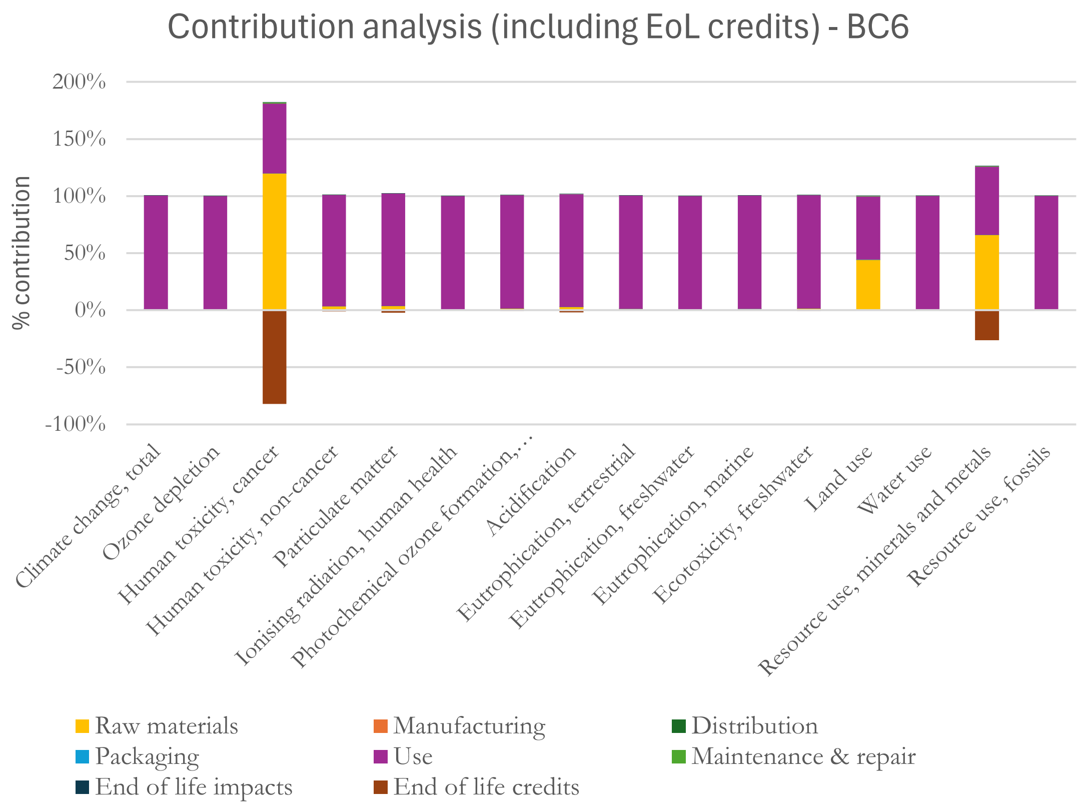
- Major contributor of raw materials is the production of stainless steel followed by printed wiring board
- Additional high contributing raw materials are polypropylene (Ozone depletion), copper (Land use) and aluminium (Ionising radiation, human health & Ecotoxicity, freshwater)



LCA Results – BC6: Multi-tank conveyor-type dishwasher, contribution analysis over lifetime

Contribution analysis life cycles

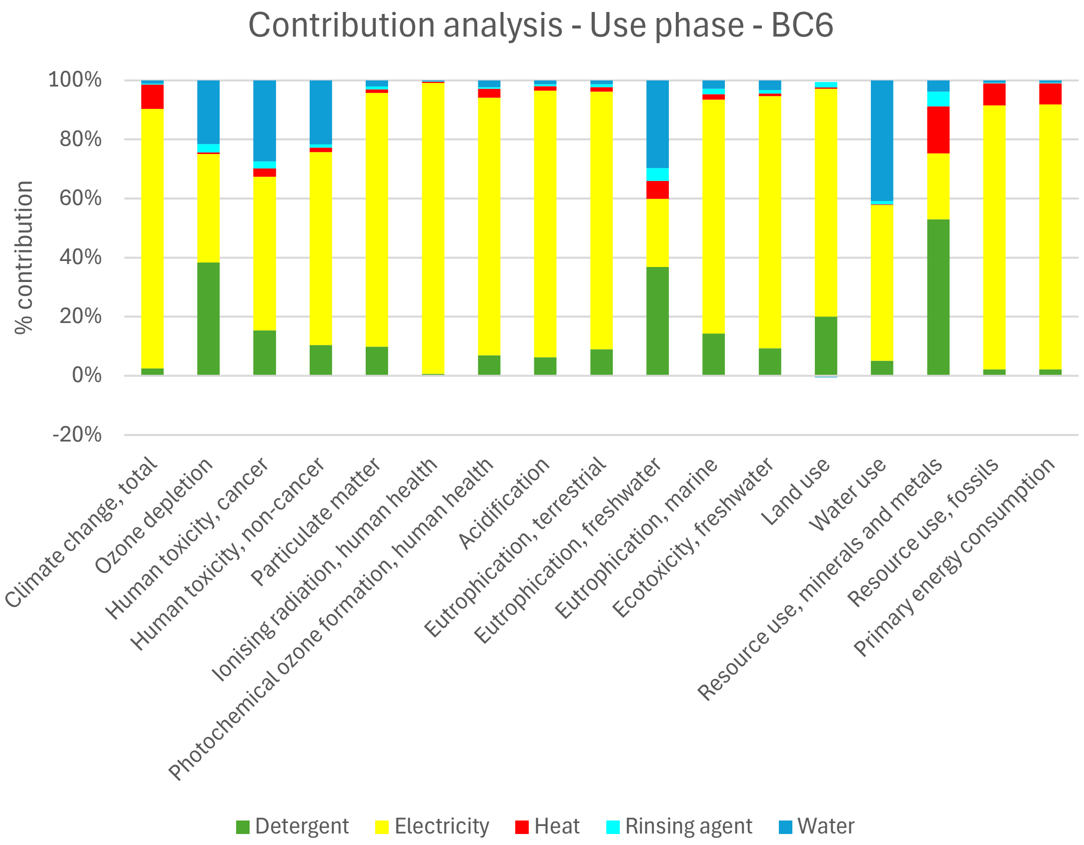
- Majority (>97% per impact category) of the lifetime impact is from the use phase followed by the raw materials production for most impact categories
- Raw materials impact contribution is large for some impact categories due to stainless steel (Human toxicity, cancer, Resource use, mineral and metals) and copper (Land use, Resource use, minerals and metals)
- End-of-life modelling shows a credit for avoided impacts due to recyclability of certain raw materials
    - Stainless steel, aluminium, printed wiring board (electronics)



LCA Results – BC6: Multi-tank conveyor-type dishwasher, contribution analysis over lifetime

Contribution analysis Use phase

- Major contributor in the use phase is electricity use for most impact categories
- Detergent and water use have a major contribution to a few impact categories (e.g. Resource use, mineral and metals for detergent)



LCA Results – BC6: Multi-tank conveyor-type dishwasher, contribution analysis over lifetime

Contribution analysis Raw materials production

- Major contributor of raw materials is the production of stainless steel
- Additional high contributing raw materials are printed wiring board ('Eutrophication, freshwater'), polypropylene (Ozone depletion), copper (Land use) and aluminium ('Ionising radiation, human health' & 'Ecotoxicity, freshwater')