Product Environmental Footprint Supporting Study in the EF Pilot Phase: Henkel Gliss Kur Total Repair Shampoo

Product Environmental Footprint
Supporting Study
Gliss Kur Total Repair Shampoo

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1 Summary

This supporting study is part of Cosmetics Europe's PEF Project which follows closely the PEF guidelines of the European Commission, whose goals are:

- to test the "Study into the development of Product Environmental Footprint Category Rules for shampoo" (hereafter referred to as PEFCR);
- to validate the outcomes of the screening study.

The functional unit considered is as follows:

A hair wash carried out in Europe (EU 28 MS), on average length hair

The reference flow considered, i.e., the amount of product needed to provide the defined function, is 10.46 grams of shampoo.

The system boundaries of the study encompass the life cycle of the use of shampoo, from the materials extraction to the end-of-life of the shampoo and its packaging. Henkel provided primary data for the shampoo formulation (ingredients), packaging quantity and type, as well as manufacturing energy consumption, water use and waste generated. The remainder of the data were based on secondary data from the PEFCR. This includes data for transportation and distribution, use stage energy consumption and water use, packaging and product end-of-life. The main modelling limitations lie within the use stage. Since the use stage is highly dependent on consumer habits, which can vary significantly depending on the consumer, and for which little data are available, the modelling of this life cycle stage is considered to have a very high level of uncertainty.

Figure 1 presents the overall results contribution for the Gliss Kur Total Repair Shampoo life cycle. The use stage dominates or has a significant contribution for all indicators except freshwater ecotoxicity, which is dominated by product end-of-life. The production of the shampoo ingredients, as well as distribution and storage both have non negligible contributions for several indicators. Manufacturing as well as packaging production and end-of-life, relative to the other life cycle stages, do not have a large contribution to the overall results.

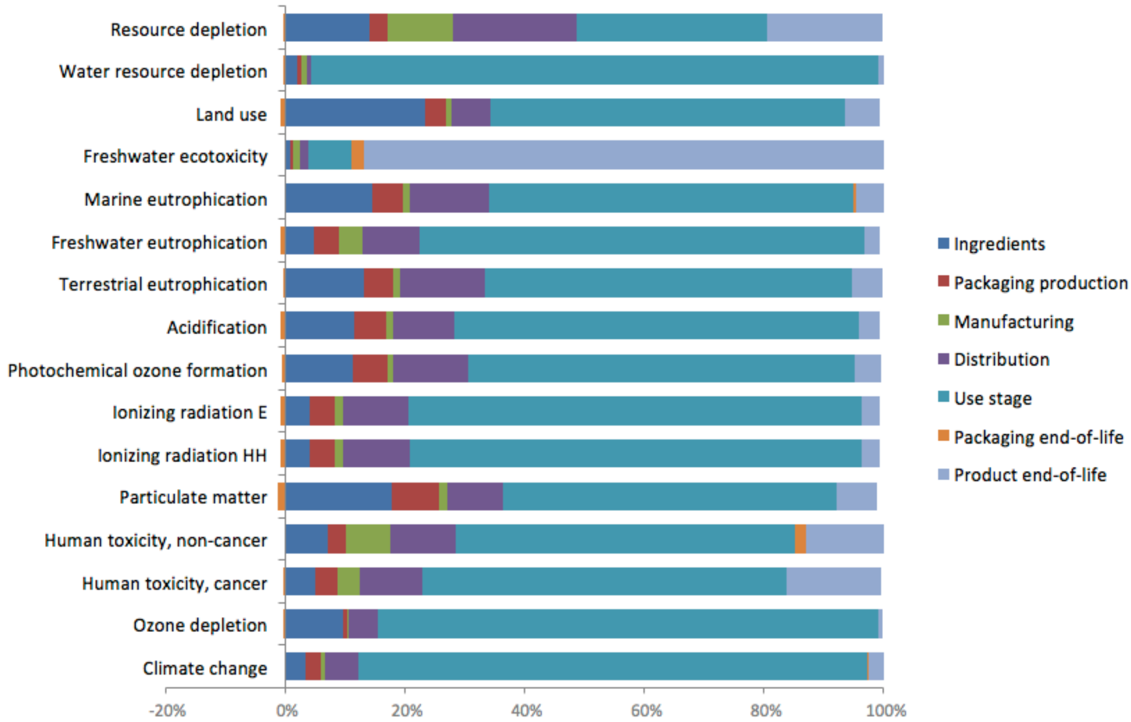

Figure 1. Overall results for one shampoo use per life cycle stage

The indicators evaluated as relevant for a shampoo are:

- Climate change
- Water resource depletion
- Mineral and fossil resource depletion
- Freshwater ecotoxicity (subject to the availability of appropriate methodology and data)

This selection was performed based on two normalisation approaches. The process and results to identify the most relevant EF impact categories are presented in Annex II: Normalisation.

The supporting study conclusions are consistent with those obtained from the representative product screening study.

2 General

The characteristics of the product under study are:

Product name: Gliss Kur Total Repair Shampoo

Product identification: FDH13DF0022\02

Product classification: C 20.42.16.30 “Shampoos”

Company: Henkel

Company location: Germany

Date of publication of the supporting study: April 2016

Geographic validity: Manufactured in Germany, distributed and used in Europe

Reference study: Study into the development of Product Environmental Footprint Category Rules (PEFCR) for shampoo, Final draft, April 2016

Critical review: This report has not undergone a critical review process

The current document endeavours to be compliant with the requirements of the ‘Product Environmental Footprint (PEF) Guide’ (Annex II to Recommendation (2013/179/EU), the “Guidance for the implementation of the EU PEF during the EF Pilot Phase” (version no. 5.0.) and the Study into the development of Product Environmental Footprint Category Rules for shampoo, Final draft, April 2016 (hereafter referred to as PEFCR). The latter document will be referred to throughout this report as PEFCR.

3 Goal of the study

This supporting study is part of Cosmetics Europe’s PEF Project which follows closely the PEF guidelines of the European Commission, whose goals are:

- to test the “Study into the development of Product Environmental Footprint Category Rules for shampoo” (hereafter referred to as PEFCR);
- to validate the outcomes of the screening study (such as the selection of relevant impact categories, life cycle stages, processes and elementary flows).

4 Scope of the study

4.1 Functional unit and reference flow

The functional unit considered is as follows:

A hair wash carried out in Europe (EU 28 MS), on average length hair

The reference flow considered, i.e., the amount of product needed to provide the defined function, is 10.46 grams of shampoo.

4.2 System boundaries

The system boundaries of the study encompass the life cycle of the use of shampoo, from the materials extraction to the end-of-life of the shampoo and its packaging. Figure 2 illustrates all life cycle stages included in the study as well as a description of the main activities considered in each life cycle stage. Henkel provided primary data concerning the shampoo formulation (ingredients), the packaging quantity and type, manufacturing energy consumption, water use and waste generated. The remainder of the data was based on secondary data from the PEFCR.

Life cycle stage	Description of activities included for each life cycle stage
1 Ingredients production	• Extraction of resources • Pre-processing of all material inputs to the studied product • Transportation from pre-processing facilities to the production facility
2 Packaging production	• Production of raw materials for packaging (plastics, cardboard, etc.) • Packaging manufacturing processes (blow molding, extrusion) • Transportation of packaging to shampoo manufacturing facility
3 Manufacturing	• Energy and water use for shampoo manufacturing • Packaging of the shampoo • Treatment of waste and wastewater • Manufacturing plant infrastructure
4 Product distribution and storage	• Energy inputs for warehouse lighting and heating • Distribution center infrastructure • Transportation from manufacturing plant to point of sale, to consumer's home
5 Use stage	• Energy use during shower • Water use during shower
6 Packaging end-of-life	• Transportation of packaging to treatment facilities • Recycling, incineration, landfilling of packaging
7 Product end-of-life	• Wastewater treatment (including infrastructure and sludge treatment) • Product end-of-life (aquatic environment)

Figure 2. System boundary diagram with the main activities included per life cycle stage

4.3 *Supplementary analysis*

No supplementary analyses were performed.

5 Life cycle inventory analysis

5.1 *Data collection and quality assessment*

Henkel provided primary data for the shampoo formulation (ingredients), packaging quantity and type, as well as manufacturing energy consumption, water use and waste generated. The remainder of the data were based on secondary data from the PEFCR. This includes data for transportation and distribution, use stage energy consumption and water use, packaging and product end-of-life. The main modelling limitations lie within the use stage. Since the use stage is highly dependent on consumer habits, which can vary significantly depending on the consumer, and for which little data are available, the modelling of this life cycle stage is considered to have a very high level of uncertainty.

Table 1 lists the shampoo ingredients, the associated dataset used for the modelling as well as the composition and data quality ranking. All datasets are based on ecoinvent version 2.2.

Table 1. Shampoo ingredients, modelling dataset, composition and data quality ranking (DQR)

Henkel name	Modelling dataset (ecoinvent v2.2)	Composition	DQR[1]
Sodium laureth sulfate (70%)	Fatty alcohol sulfate, mix, at plant/RER (w/o heavy metals)	]10-25%]	2
Cocamidopropyl betaine (40% cocamidopropyl betaine, 7% NaCl)	Fatty alcohol, mix (w/o heavy metals)	]1-5%]	2
Cocamidopropyl betaine (40% cocamidopropyl betaine, 7% NaCl)	Sodium chloride, powder, at plant/RER	]1-5%]	3
Disodium Cocoamphodiacetate	Fatty alcohol, from coconut oil, at plant/RER (w/o heavy metals)	]1-5%]	2
Sodium chloride	Sodium chloride, powder, at plant/RER	]1-5%]	3
Dimethicone + Laureth-4 + Laureth-23	Silicone product, at plant/RER	]0.1-1%]	2
PEG-7 Glyceryl Cocoate	Ethoxylated alcohols (AE7), coconut oil, at plant/RER (w/o heavy metals)	]0.1-1%]	2
Fragrance	Chemicals organic, at plant/GLO	]0.1-1%]	5
Citric acid	Acetic acid, 98% in H2O, at plant/RER	]0.1-1%]	2
Sodium benzoate	Benzoic-compounds, at regional storehouse/RER	]0.1-1%]	2
Cocamide MEA	Cocamide MEA[2]	]0.1-1%]	2
PEG-40 Hydrogenated Castor Oil, propylene glycol	Ethylene glycol, at plant/RER	]0.1-1%]	2
D-Panthenol (75%)	Chemicals organic, at plant/GLO	]0.1-1%]	5
Botanicals blend	Chemicals organic, at plant/GLO	]0.1-1%]	5
Hydrogenated Castor Oil	Chemicals organic, at plant/GLO	]0.1-1%]	5
Guar Hydroxypropyltrimonium Chloride	Chemicals organic, at plant/GLO	]0.1-1%]	5
Sodium hydroxide (50%)	Sodium hydroxide, 50% in H2O, production mix, at plant/RER	]0.1-1%]	3
Glycerin (99.5%)	Glycerine, from palm oil, at esterification plant/MY (w/o heavy metals)	]0.1-1%]	3
Mica : Titanium dioxide, 60:40	Titanium dioxide, production mix, at plant/RER	]0.1-1%]	3
Aqua, hydrolyzed keratin	Chemicals organic, at plant/GLO	[0-0.1%]	5
Cocodimonium hydroxypropyl hydrolyzed keratin	Chemicals organic, at plant/GLO	[0-0.1%]	5
Simmondsia Chinensis (jojoba) seed oil	Rape oil, at regional storage/CH (w/o heavy metals)	[0-0.1%]	2
Propylene glycol	Butane-1,4-diol, at plant/RER	]0.1-1%]	3
Water	Tap water, at user/RER	]50-75%]	3

[1] DQR: Data quality ranking, 1 = Excellent, 2 = Very good, 3 = Good, 4 = Fair, 5 = Poor
[2] Modelled as 23% monoethanolamine, at plant/RER + 77% Crude coconut oil, at plant/PH

Table 2 lists the packaging types and quantities per 250 ml bottle of shampoo, the associated dataset used for the modelling as well as the data quality ranking. All datasets are based on ecoinvent version 2.2.

Table 2. Packaging quantities, modelling dataset and data quality ranking (DQR)

Henkel name	Modelling dataset (ecoinvent v2.2)	Quantity/ bottle	DQR[1]
Primary packaging			
Shampoo bottle	Polyethylene, HDPE, granulate, at plant/RER Blow moulding/RER	0.021 kg	3
Shampoo bottle cap	Polypropylene, granulate, at plant/RER U Blow moulding/RER U	0.0069 kg	3
Shampoo labels and stickers	Polyethylene, LDPE, granulate, at plant/RER Extrusion, plastic film/RER	0.001 kg	3
Secondary packaging			
Corrugated board	Corrugated board, fresh fibre, single wall, at plant/RER	0.00875 kg	3
PP foil	Polypropylene, granulate, at plant/RER Extrusion, plastic film/RER	1.7E-4 kg	3
Tertiary packaging			
Pallet	EUR-flat pallet/RER	1.49E-5 p	3
Anti-slip film	Kraft paper, unbleached, at plant/RER	4.24E-4 kg	3
PP foil	Polypropylene, granulate, at plant/RER Extrusion, plastic film/RER	2.98E-4 kg	3
Packaging transport			
Truck transport	Transport, lorry 16-32t, EURO5/RER	0.0565 tkm	3

Table 3 lists the manufacturing data per functional unit, the associated dataset used for the modelling as well as the data quality ranking. All datasets are based on ecoinvent version 2.2. All data were provided by Henkel except for the infrastructure, for which the value is based on the PEFCR assumptions.

Table 3. Manufacturing data, modelling dataset and data quality ranking (DQR)

Henkel name	Modelling dataset (ecoinvent v2.2)	Quantity/FU	DQR[1]
Electricity consumption	Electricity, low voltage, at grid/DE	4.44E-4 kWh	3
Natural gas consumption	Natural gas, burned in industrial furnace >100kW/RER	2.57E-3 MJ	3
Water use	Tap water, at user/RER U - adapted flows Pfister, Germany	0.0116 kg	3
Infrastructure (manufacturing plant)	Chemical plant, organics/RER/I	4.18E-12 p	2
Wastewater treatment	Treatment, sewage, to wastewater treatment, class 3/CH	2.53E-6 m^3	3
Paper and cardboard waste incinerated	Disposal, packaging cardboard, 19.6% water, to municipal incineration/CH	2.50E-5 kg	3
Paper and cardboard waste landfilled	Disposal, packaging cardboard, 19.6% water, to sanitary landfill/CH	3.05E-5 kg	3
Solid waste incinerated	Disposal, municipal solid waste, 22.9% water, to municipal incineration/CH	4.80E-5 kg	3
Solid waste landfilled	Disposal, municipal solid waste, 22.9% water, to sanitary landfill/CH	5.87E-5 kg	3

For the distribution and use stage, the generic data from the PEFCR was used; refer to the PEFCR for the modelling details. For the packaging end-of-life stage, the 50:50 formula was used, as well as the default end-of-life treatment assumptions (see PEFCR).

Table 4 lists the ingredients' end-of-life modelling. The final quantity emitted to nature after wastewater treatment (or not) is omitted for confidentiality reasons. Wastewater treatment connectivity and efficiency data are based on the PEFCR, where the default values are 85% and 90% respectively. The substances for which wastewater treatment efficiencies differ from that of the default value are alpha-hexyl cinnamaldehyde (99.9%), dihydromyrcene (99.9%) and hexyl salicylate (99.8%).

Table 4. Ingredients end-of-life modelling

Henkel name	Simapro model	Comment
Sodium laureth sulfate (70%)	sodium laureth sulfate	70% sodium laureth sulfate, 30% water
Cocamidopropyl betaine	cocamidopropyl betaine	40% cocamidopropyl betaine, 7% NaCl, 55% water
	Sodium chloride	
Disodium Cocoamphodiacetate	cocamidopropyl betaine	39% Disodium Cocoamphodiacetate, 51% water, 10% NaCl
	Sodium chloride	
Sodium chloride	Sodium chloride	
Dimethicone + Laureth-4 + Laureth-23	dimethicone	50% Dimethicone, 3% Laureth-4, 3% Laureth-23, modelled as 57% dimethicone
PEG-7 Glyceryl Cocoate	Glycerin (6-17 EO) cocoate	
Fragrance	alpha-hexyl cinnamaldehyde	20% alpha-hexyl cinnemaldehyde
	Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-	10% beta-pinene
	dihydromyrcene	50% dihydromyrcenol
	hexyl salicylate	15% hexyl salicylate
	patchouli oil	5% patchouli oil
Citric acid	Citric acid	
Sodium benzoate	Sodium benzoate	
Cocamide MEA	Cocamide MEA	
PEG-40 Hydrogenated Castor Oil, propylene glycol	hydrogenated castor oil	
D-Panthenol (75 %)	dexpanthenol	
Botanicals blend	n/a	not modelled, 73% water
Hydrogenated Castor Oil	hydrogenated castor oil	
Guar Hydroxypropyltrimonium Chloride	hydroxypropyl guar hydroxypropyltrimonium chloride	
Sodium hydroxide (50%)	Sodium hydroxide	
Glycerin (99.5%)	Glycerol	synonym: glycerol
Mica, Titanium Dioxide 60:40	Titanium dioxide	mica:TiO2 (60:40), mica not modelled
Aqua, hydrolyzed keratin	n/a	not modelled, 83% water
Cocodimonium hydroxypropyl hydrolyzed keratin	n/a	not modelled, 69% water
Simmondsia Chinensis (jojoba) seed oil	n/a	not modelled, derived from the seeds of the desert shrub (USA)
Propylene glycol	1,3-Propanediol	
Water	n/a	not modelled

5.2 Data gaps

Please refer to the PEFCR for recommendations on the filling of data gaps.

5.3 Supplementary analysis

Please refer to the PEFCR for default assumptions and data sources.

6 Impact assessment results

6.1 PEF results

Figure 3 presents the overall results contribution for the Gliss Kur Total Repair Shampoo life cycle. The use stage dominates or has a significant contribution for all indicators except freshwater ecotoxicity, which is dominated by product end-of-life. The production of the shampoo ingredients, as well as distribution and storage both have non negligible contributions for several indicators. Manufacturing as well as packaging production and end-of-life, relative to the other life cycle stages, do not have a large contribution to the overall results.

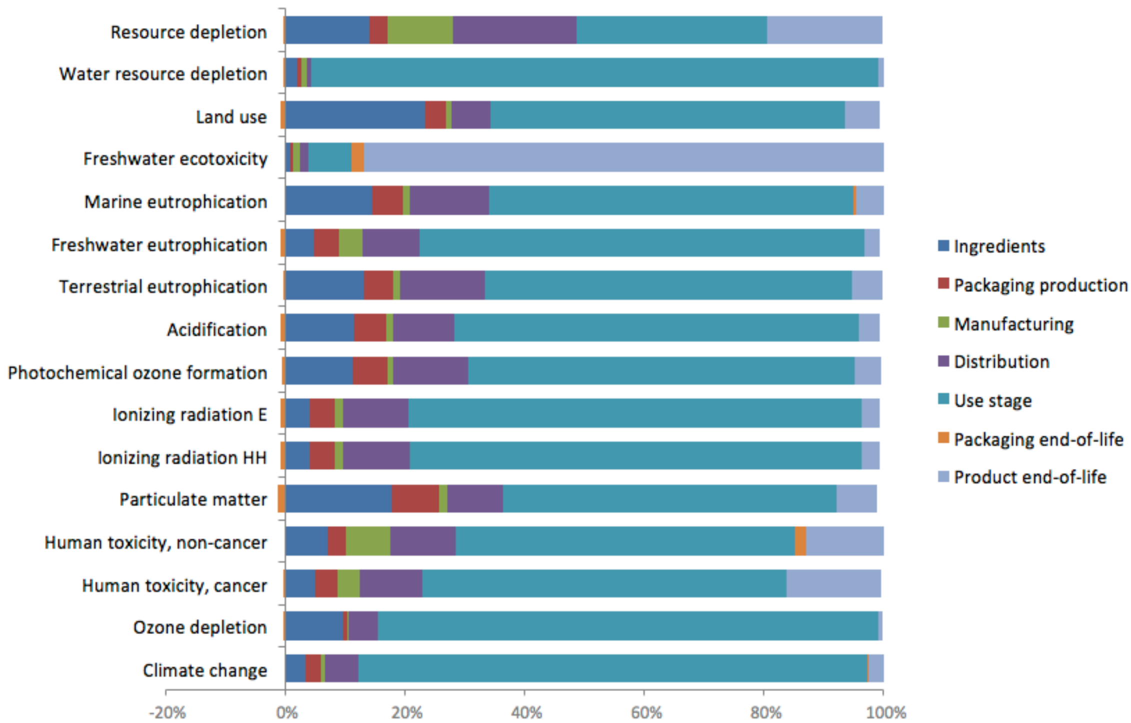

Figure 3. Overall results for one shampoo use per life cycle stage

The indicators evaluated as relevant for a shampoo are:

- Climate change
- Water resource depletion
- Mineral and fossil resource depletion
- Freshwater ecotoxicity (subject to the availability of appropriate methodology and data)

This selection was performed based on two normalisation approaches. The process and results to identify the most relevant EF impact categories are presented in **Error! Reference source not found.**.

The supporting study conclusions are consistent with those obtained from the representative product screening study.

Detailed results for the use stage are shown in Figure 4. For water resource depletion, tap water use in the shower is the main contributor. For all other indicators, the electricity and/or natural gas consumption, used to heat the shower water, are the main contributors. Note that the European (UCTE) grid mix was used as we assume product use on the European market.

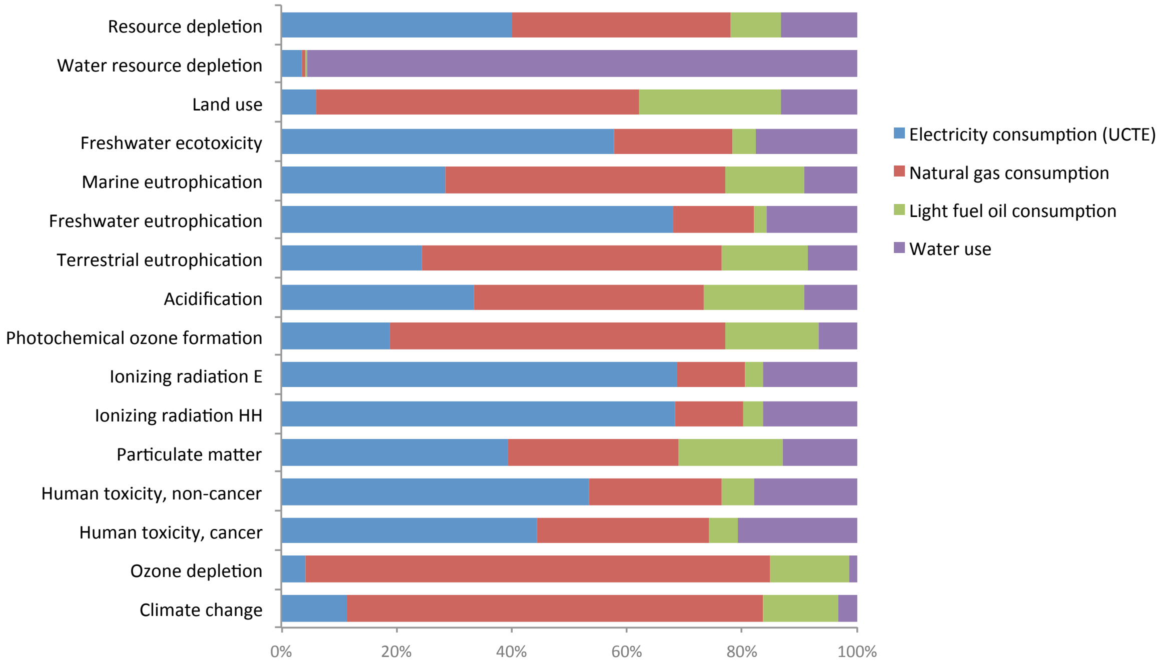

Figure 4. Detailed results for shampoo use stage

Detailed results for the product end-of-life are shown in Figure 5. Wastewater treatment dominates all indicators except for freshwater ecotoxicity, for which ingredients end-of-life is the main contributor. Processes responsible for the wastewater treatment impacts are mainly infrastructure related such as the sewer grid and the wastewater treatment plant. Sludge treatment is found to be negligible compared to wastewater treatment impacts.

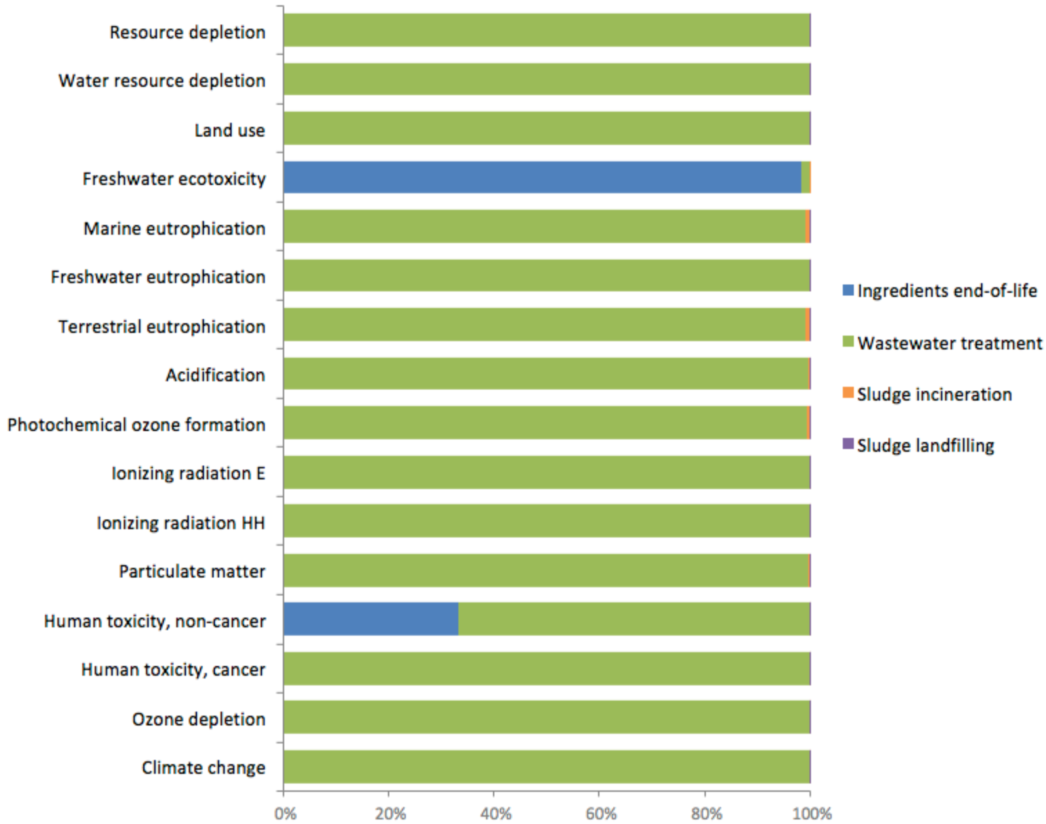

Figure 5. Detailed results for product end-of-life stage

Table 5 presents the ingredients freshwater ecotoxicity impacts and contribution after being emitted to nature. Sodium laureth sulfate is the main contributor, accounting for 85% of freshwater ecotoxicity impacts. The fragrance is the next most contributing ingredient, with 12% of impacts (9% alpha-hexyl cinnamaldehyde, 3% dihydromyrcene).

Table 5. Summary of freshwater ecotoxicity impact contributions of shampoo ingredients emitted to nature

General information		**Freshwater ecotoxicity**	
Henkel name		**CF[1] (CTUe/kg)**	**Ecotoxicity contribution (%)**
Sodium laureth sulfate		12'081	96%
Cocamidopropyl betaine		783.1	1%
Sodium chloride		3.87	0%
Cocamidopropyl betaine[2]		783.1	0.5%
Sodium chloride		3.87	0%
Sodium chloride		3.87	0%
Dimethicone, laureth-4, laureth-23		72	0%
PEG-7 Glyceryl Cocoate		1'645	0.9%
Fragrance			
alpha-hexyl cinnamaldehyde		110	0%
Bicyclo[3.1.1]heptane, 6,6-dimethyl-2- methylene-		4'200	0.2%
dihydromyrcenol		135	0%
hexyl salicylate		6'090	0.3%
patchouli oil		158	0%
Citric acid		22	0%
Sodium benzoate		146	0.1%
Cocamide MEA		177	0.1%
PEG-40 Hydrogenated Castor Oil, propylene glycol		1'680	0.4%
D-Panthenol (75%)		32.96	0%
Botanicals blend	not modelled	0	0%
Hydrogenated Castor Oil		1'680	0.3%
Guar Hydroxypropyltrimonium Chloride		35.23	0%
Sodium hydroxide (50%)		400.1	0%
Glycerin (99.5%)		0.213	0%
Mica, Titanium Dioxide 60:40		1028.3	0%
Aqua, hydrolyzed keratin	not modelled	0	0%
Cocodimonium hydroxypropyl hydrolyzed keratin	not modelled	0	0%
Simmondsia chinensis (jojoba) seed oil	not modelled	0	0%
Propylene glycol		1.47	0%
Characterization factor (CF) data source:			
USEtox default		Cosmede database	

[1] Characterisation factor
[2] Disodium Cocoamphodiacetate

Table 6 presents the ingredients emitted to nature and their associated human toxicity, non-cancer impacts and contribution. This is specific to the product end-of-life stage, which accounts for approximately 33% of the overall shampoo life cycle. Characterization factors are not available for several ingredients, thus the characterization factor for dimethicone was used as a proxy, as recommended in the PEFCR. Note that the characterization factors are considered to have a very high uncertainty and low robustness. Sodium laureth sulfate is the main contributor, accounting for 66% of human toxicity, non-cancer effects for this life cycle stage.

Human health, cancer and non-cancer effects are not considered to be relevant indicators (see Annex II: Normalisationfor more information).

Table 6. Summary of human toxicity, non-cancer effects contributions of shampoo ingredients emitted to nature

General information		Human toxicity, non-cancer	
Henkel name		**CF[1] (CTUh/kg)**	**Toxicity impact contribution**
sodium laureth sulfate		2.36E-06	66%
cocamidopropyl betaine		2.85E-07	1%
Sodium chloride		2.36E-06	2%
cocamidopropyl betaine[2]		2.85E-07	1%
Sodium chloride		2.36E-06	1%
Sodium chloride		2.36E-06	1%
Dimethicone, laureth-4, laureth-23		2.36E-06	3%
PEG-7 Glyceryl Cocoate		2.36E-06	5%
Fragrance			
alpha-hexyl cinnamaldehyde		2.36E-06	1%
Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-		2.36E-06	0%
dihydromyrcene		2.36E-06	1%
hexyl salicylate		2.36E-06	0%
patchouli oil		2.36E-06	0%
Citric acid		2.36E-06	3%
Sodium benzoate		2.36E-06	3%
Cocamide MEA		2.36E-06	3%
PEG-40 Hydrogenated castor oil, propylene glycol		2.36E-06	2%
D-panthenol (75%)		2.36E-06	1%
Botanicals blend	not modelled	2.36E-06	0%
Hydrogenated castor oil		2.36E-06	1%
Guar hydroxypropyltrimonium chloride		2.36E-06	1%
Sodium hydroxide (50%)		2.36E-06	1%
Glycerin (99.5%)		2.36E-06	1%
Mica, Titanium dioxide 60:40		2.36E-06	0%
Aqua, hydrolyzed keratin	not modelled	2.36E-06	0%
Cocodomonium hydroxypropyl hydrolyzed keratin	not modelled	2.36E-06	0%
Simmondsia chinensis (jojoba) seed oil	not modelled	2.36E-06	0%
Propylene glycol		2.36E-06	0%
Characterization factor (CF) data source:			
Custom calculated with USEtox model	Cosmede	Proxy – used CF for dimethicone	

[1] Characterisation factor, [2] Disodium Cocoamphodiacetate

6.2 *Supplementary analysis*

No supplementary analyses were performed.

7 Interpreting PEF results

7.1 PEF results

The results of the Henkel supporting study product are in line with those obtained from the representative product screening study. The same relevant impact categories, life cycle stages and processes were identified. The main contributing substance at product end-of-life is sodium laureth sulphate for both products (Henkel and representative product) however there are differences in the formulation of the two products therefore some of the other contributing substances are not the same.

The main areas of uncertainty in the study lie in the impact assessment methods. The impact categories for which the methods are currently not sufficiently reliable are human toxicity, cancer effects, human toxicity, non-cancer effects, freshwater ecotoxicity, water depletion, resource depletion, ionizing radiation and land use. The use stage modelling is also a large source of uncertainty. Since the use stage is highly dependent on consumer habits, which can vary significantly depending on the consumer, and for which little data are available, the modelling of this life cycle stage is considered to have a very high level of uncertainty.

7.2 Benchmark

Figure 6 shows a comparison of the Henkel shampoo vs the representative product from the screening study. The Henkel shampoo is in the same order of magnitude (less than 20% difference) for all indicators except for freshwater ecotoxicity for which the Henkel shampoo is approximately 28% lower. This is related to the product end-of-life impacts on freshwater ecotoxicity when the shampoo ingredients are emitted to nature.

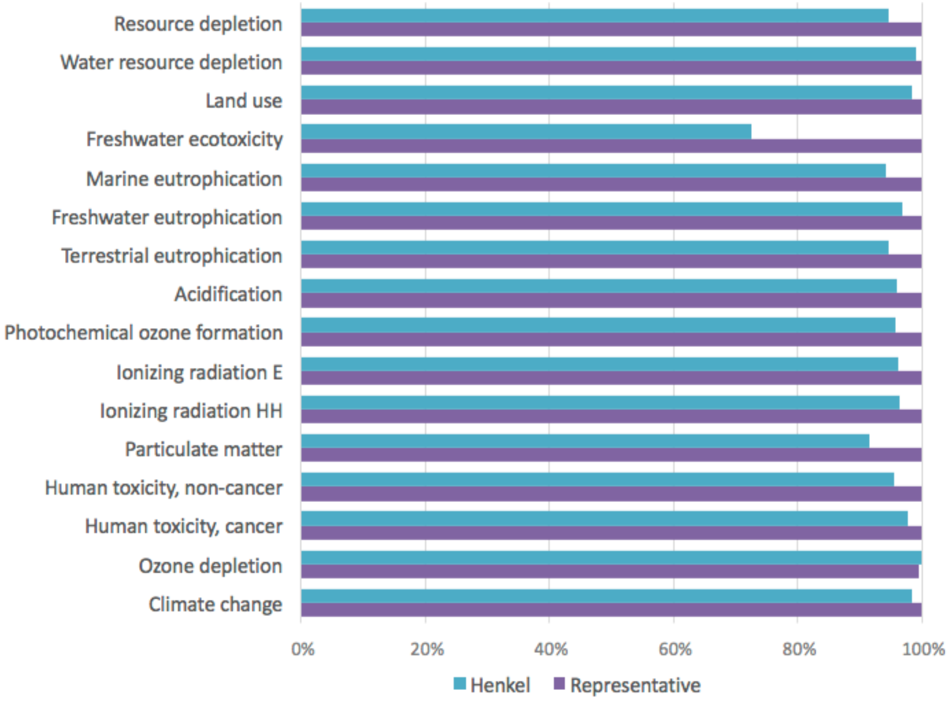

Figure 6. Benchmark comparison of Henkel shampoo vs representative product

The main freshwater ecotoxicity contributor for the Henkel and representative shampoo is sodium laureth sulphate (SLS). Product end-of-life impacts of SLS are 2.971 CTUe/FU and 3.86 CTUe/FU for the Henkel and the representative shampoo, respectively. This is simply because the representative shampoo contains more SLS per FU than the Henkel shampoo.

7.3 *Performance classes*

No performance classes are proposed based on the PEFCR.

8 Annex I: Bibliographic references

Author	Reference
AFNOR (2011)	AFNOR (2011-2012). BP X30-323-5 12/2011, General principles for an environmental communication on mass market product - Part 5: Methodology for the environmental impacts assessment of shampoos. → *New version will be published in 2014*
Arif	S. Arif, Technical Bulletin: hair shampoos, the science & art of formulation, Pilot Chemical; www.pilotchemical.com
de Schryver (2009)	De Schryver, A. M., Brakkee, K. W., Goedkoop, M. J., & Huijbregts, M. a. J. (2009). Characterization Factors for Global Warming in Life Cycle Assessment Based on Damages to Humans and Ecosystems. Environmental Science & Technology, 43(6), 1689–1695. doi:10.1021/es800456m
ecoinvent v2.2	ecoinvent centre, Swiss centre for life cycle inventories, version 2.2
Environmental Footprinting with USEtox	http://usetox.tools4env.com/substances, consulted 18.09.2014
European Commission (2006)	European Commission (2006). Integrated Pollution Prevention and Control, Reference Document on the Best Available Techniques for Waste Incineration. http://eippcb.jrc.ec.europa.eu/reference/BREF/wi_bref_0806.pdf
European Commission (2007)	Establishing the ecological criteria for the award of the Community eco-label to soaps, shampoos and hair conditioners. 2007/506/EC. OJ L 186, 18.7.2007, p.36
European Commission (2013)	Commission decision of 19 December 2013 amending the Decision 2007/506/EC in order to prolong the validity of the ecological criteria for the award of the EU Ecolabel to soaps, shampoos and hair conditioners
European Commission et al. (2012)	European Commission, Joint Research Centre (JRC), Institute for Prospective Technological Studies (IPTS) and LEITAT (2012). Revision of the European Ecolabel Criteria for Soaps, Shampoos and Hair Conditioners: preliminary results from the technical analysis. August 2012. 28-30.
European Commission et al. (2012a)	European Commission, Joint Research Centre (JRC), Institute for Prospective Technological Studies (IPTS) and LEITAT (2012). Revision of the European Ecolabel Criteria for Soaps, Shampoos and Hair Conditioners: background report including revised draft criteria proposal. August 2012. 81.
European Commission (2013)	European Commission (2013). 2013/179/EU: Commission Recommendation of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations. Annex II: Product Environmental Footprint (PEF) Guide. Official Journal of the European Union, L 124, Volume 56, May 4th, 2013. http://eur-lex.europa.eu/JOHtml.do?uri=OJ:L:2013:124:SOM:EN:HTML
European Commission (2013a)	European Commission, Joint Research Centre (JRC), Institute for Prospective Technological Studies (IPTS) (2013a). JRC Scientific and Policy Reports. Best Environmental Management Practice in the Retail Trade Sector. European Union, 2013.
European Commission (2014)	European Commission (2014). Guidance for the implementation of the EU Product Environmental Footprint (PEF) during the Environmental Footprint (EF) Pilot Phase. Version 3.4. January 15th, 2014.

Author	Reference
European Commission (2015a)	European Commission (2015), Humbert, S., Guignard, C. PEF / OEF : Default data to be used to model distribution, storage and use stage. Version a, January 13th, 2015
European Commission (2015b)	European Commission, Joint Research Centre (JRC), Saouter, E., Sala, S., Pant, R. USEtox: Potential issues and work proposal, TAB meeting (presentation), 29 September 2015
Eurostat (2011)	Environment and Energy, Waste statistics, Waste streams, Municipal waste generation and treatment, by type of treatment method, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database,
Frischknecht et al. (2005)	Frischknecht R., Jungbluth N., Althaus H.-J., Doka G., Dones R., Heck T., Hellweg S., Hischier R., Nemecek T., Rebitzer G. and Spielmann M., 2005, The ecoinvent database: Overview and methodological framework, International Journal of Life Cycle Assessment 10, 3–9.
Goedkoop et al. (2001)	Goedkoop, M., Spriensma, R. (2001). The Eco-indicator 99: A damage oriented method for Life Cycle Impact Assessment. Methodology Annex. Amersfoort, The Netherlands.
Hall et al. (2011)	Hall, B., Steiling, W., Safford, B., Coroama, M., Tozer, S., Firmani, C., McNamara, C., Gibney, M. (2011). European consumer exposure to cosmetic products, a framework for conducting population exposure assessments Part 2. Food and Chemical Toxicology, 49(2), 408–422. doi:10.1016/j.fct.2010.11.016
Henkel (2008)	Case study shampoo documentation, Case study undertaken within the PCF pilot project Germany. 2008
Hera (2004)	Human & Environmental Risk Assessment on ingredients of European household cleaning products, Alcohol Ethoxysulphates (AES) Environmental Risk Assessment. 2004 http://www.heraproject.com/files/1-E-04-HERA%20AES%20ENV%20%20web%20wd.pdf (consulted 18.07.2014)
Humbert (2009)	Humbert S (2009). Geographically differentiated life-cycle impact assessment of human health. Doctoral dissertation, University of California, Berkeley, USA.
Humbert et al. (2009)	Humbert, S., Loerincik, Y., Rossi, V., Margni, M., & Jolliet, O. (2009). Life cycle assessment of spray dried soluble coffee and comparison with alternatives (drip filter and capsule espresso). Journal of Cleaner Production, 17(15), 1351–1358. doi:10.1016/j.jclepro.2009.04.011
Humbert et al. (2011)	Humbert, S., Marshall, J. D., Shaked, S., Spadaro, J. V, Nishioka, Y., Preiss, P., … Jolliet, O. (2011). Intake fraction for particulate matter: recommendations for life cycle impact assessment. Environmental Science & Technology, 45(11), 4808–16.
Humbert et al. (2012)	Humbert, S., de Schryver, A., Margni, M., & Jolliet, O. (2012). IMPACT 2002+: User Guide - Draft version Q2.2 (version adapted by Quantis)
International Energy Agency (IEA) (2011)	Electricity and heat data, 2011, EU-27, http://www.iea.org/statistics/statisticssearch/
Jolliet et al. (2003)	Jolliet, O., Margni, M., Charles, R., Humbert, S., Payet, J., Rebitzer, G., & Rosenbaum, R. (2003). IMPACT 2002+: A new life cycle impact assessment methodology. The International Journal of Life Cycle Assessment, 8(6), 324–330.
Klaschka et al. (2013)	Klaschka, Ursula, et al. "Occurrences and potential risks of 16 fragrances in five German sewage treatment plants and their receiving waters." Environmental Science and Pollution Research 20.4 (2013): 2456-2471.
Making Cosmetics Inc.	Making Cosmetics Inc., How to make shampoos, www.makingcosmetics.com
Mottram et al.	F.J. Mottram, C.E. Lees (2000). Hair Shampoos. 2000. 289-306.

Author	Reference
(2000)	
Pfister et al. (2009)	Pfister, S., Koehler, A., & Hellweg, S. (2009). Assessing the environmental impacts of freshwater consumption in LCA. Environmental Science & Technology, 43(11), 4098–4104. doi:10.1021/es802423e
Research Institute for Fragrance Materials (2013)	Life Cycle Assessment of Selected Fragrance Materials, Final report, PE International and Five Winds Strategic Consulting
Sala et al. (2012)	Sala S, Wolf M, Pant R. (2012). Characterisation factors of the ILCD Recommended Life Cycle Impact Assessment methods. Database and Supporting Information. EUR 25167 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2012. JRC6825
Simonich et al. (2002)	Simonich,S, Federle, TW, Eckhoff, WS, Rottiers, A, Webb,S, Sabaliunas,D, de Wolf§, W. Removal of Fragrance Materials during U.S. and European Wastewater Treatment. *Environmental Science & Technology* 2002 *36* (13), 2839-2847
OECD (2011)	Wastewater treatment, % population connected, http://stats.oecd.org

9 Annex II: Normalisation

Based on the screening study results, Table 21 shows results obtained with the EU 27 normalisation factors and Table 22 illustrates results with the Quantis proposed conversion factors. The European Commission normalisation factors are applied at the midpoint level while the Quantis proposed conversion factors are applied at the endpoint level, which allows one to identify the relative contribution of midpoint indicators to the endpoints' results (areas of protection). These factors are taken from various LCA methodologies and publications.

Based on an analysis of both normalization methods, the impact categories evaluated as relevant for a shampoo are:

- Climate change
- Water resource depletion
- Mineral and fossil resource depletion
- Freshwater ecotoxicity (subject to the availability of appropriate methodology and data)

When considering the European Commission (EC) and Quantis proposed methods, the impact category Human toxicity, cancer effects, is also identified as being relevant, however, the main contribution for this impact category is from energy use during the use stage and this indicator is thus correlated with the Climate change indicator. When considering all the Human Health related indicators, global damage to this area of protection[1] linked to the use of shampoo appears to be negligible. Based on the previous analysis and considering that the positive impacts linked to personal hygiene cannot be adequately assessed in LCA, it is proposed not to consider Human Health in the final list of impact categories.

The safety of personal care products such as shampoos is guaranteed by toxicity risk assessment and thus differs from potential indirect impacts on human health (particulate matter impacts, toxicity of substances bioaccumulated in food, etc.). The environmental (LCA) evaluation of a shampoo attempts to provide information on what we could refer to as "Public health effects", meaning these impacts more globally highlight "indirect" effects on the population over the life cycle of a shampoo.

[1] Climate change (HH), Ozone depletion, Human toxicity, cancer and non-cancer effects, Particulate matter, Ionizing radiation, Photochemical ozone formation, Water resource depletion