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Study into the development of Product Environmental Footprint Category Rules (PEFCR) for Shampoo:

Explanatory Document

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Executive Summary

The Product Environmental Footprint (PEF) is a science-based method for measuring the environmental performance of goods or services throughout their entire life cycle (along the entire value chain). Its overarching goal is to identify opportunities for reducing the environmental impact.

Product Environmental Footprint Category Rules (PEFCR) provide specific guidance for calculating and reporting products' environmental impacts throughout their life cycle. The primary goal of defining such rules is the standardisation and harmonisation of the assessment process, in particular for those modelling assumptions which have a substantial impact on the results of calculations.

Cosmetics Europe (CE) completed a voluntary study into the development of PEFCR for shampoo, generally following guidelines and methodology developed by the European Commission (EC) for its own pilot projects. The study assessed the feasibility and relevance of establishing PEFCR for shampoo and many of the learnings are applicable to other rinse-off cosmetic products such as shower gels, liquid soaps, bath products and hair conditioners.

The study identified the use phase as the dominating contributor to the environmental footprint of a shampoo and climate change, water resource depletion, mineral and fossil resource depletion and freshwater eco-toxicity as the most relevant impact categories. For reasons explained in sections 2 and 3 of this document, the results of the study should be viewed with some caution. However, the findings of the study can be useful to companies in several ways. Specifically, the study defines a large number of modelling assumptions and default values relevant for shampoo (e.g. for the functional unit, the system boundaries, default transport distances, rinsing water volumes, temperature differences, life cycle

inventory data sources etc) that can be modified as appropriate, according to needs. Secondly the results of the study may be used to support internal decision-making (e.g. to identify 'hotspots' with high environmental impact and opportunities for improvement) or to meet information requests from commercial partners, consumers, media or authorities on product environmental characteristics.

The shampoo study also highlighted many of the challenges and limitations of the current PEF methodology, namely its complexity and resource intensiveness. It highlighted two areas where improvements are much needed: (1) data quality and availability and (2) impact assessment methodologies and robustness. The supporting studies provided few additional insights.

This document and its annexes are intended for CE's membership (cosmetics manufacturing companies and national associations), companies and associations of related sectors within the cosmetics value chain (e.g. suppliers of cosmetic ingredients or of packaging materials), academia and commercial service organisations which are offering product environmental footprint support to companies, as well as to official bodies such as regulators/legislators and their scientific advisors.

It should be noted that the PEF methodology is still under discussion and users of the findings of this shampoo PEFCR study are advised to monitor CE's publications for future updates.

1. Introduction

In May 2013 the EC launched a three-year multi-stakeholder pilot project on Product and Organisation Environmental Footprint (PEF and OEF, respectively)[1]. The PEF was intended to define a standard approach on how to measure the life cycle environmental footprints of products and to test the communication of their results.

The main objectives of the pilot were to (i) set up and test the process for developing Product/Organisation Environmental Footprint Category Rules (P/OEFCRs), (ii) set a cost-effective verification system, (iii) test different business to business or business to consumer communication vehicles, (iv) support the advancement and alignment of existing Life Cycle Assessment (LCA) based product claim standards and (v) facilitate the involvement of all interested stakeholders.

In July 2013, CE submitted an application for its participation in the PEF pilot in the product category 'shampoo'. Although the cosmetics pilot project was not selected by the EC, CE decided to carry out a voluntary study into the development of PEFCR for shampoo following the PEF Pilot guidelines[2], methodology and timings. By doing so CE's aim was to demonstrate its continuing commitment to sustainability and to advance the thinking on how PEF methodology could be applied to personal care products. CE conducted the project with an external consultant (Quantis) recognised for their expertise and experience in life cycle assessment.

2. Description of Cosmetics Europe's Shampoo study

2.1 What we did

A Task Force (TF) was created consisting of member companies and Quantis and managed by CE secretariat. In addition CE liaised with AISE (the International Association for Soaps, Detergents and Maintenance Products) who was participating in one of the EC pilots in the product category 'liquid detergent' to ensure, as far as possible, alignment and consistency of approaches. AISE was invited to all the meetings of the Task Force.

[1] Full information about the process can be found at: http://ec.europa.eu/environment/eussd/smgp/ef_pilots.htm
[2] Available at: http://ec.europa.eu/environment/eussd/smgp/pdf/Guidance_products.pdf

In line with PEF guidance, we defined a (virtual) representative product based on typical and commonly used shampoo ingredients at realistic concentrations. The composition of the perfume was based on available life cycle inventory data which restricted the number of fragrance components to five. On the basis of existing shampoo LCA studies and the PEF methodology, a draft shampoo PEFCRs was defined for the representative product. In addition to the definition of functional unit (one hair wash), shampoo functions (hair cleansing, hair conditioning, anti-dandruff activity and protection of sensitive target groups) and system boundaries (related processes included or excluded, e. g. towel cleaning), some key assumptions for the calculation of a shampoo PEF were proposed. In order to learn more about their potential impact on final calculation results, sensitivity analyses were performed on important assumptions such as water temperature and the volume of rinsing water.

We followed the basic steps for the PEF methodology: we modelled all processes and sub-processes involved into the product's life cycle down to a level of detail which allowed the mapping of the input (resource consumption) and output (emissions) values for each process to generate the so-called life cycle inventory. Depending on their nature, the inventory values were classified and assigned to the relevant impact category such as climate change, acidification or land use. In line with EC's PEFCR guidance and on the basis of our PEF screening results, we selected the 4 most relevant impact categories for shampoo from a set of 16 (15 from the EC guidelines plus the ionising radiation ecosystem quality proposed by Quantis) using normalisation and including an additional weighting step to that prescribed by the PEF. The latter was based on a standard LCA approach for impact assessment involving the assessment of potential damage to ecosystem and human health. We assessed the reliability and robustness of the modelling and results in order to assure the selection of the most relevant and appropriate impact categories.

Draft versions of the shampoo PEFCR study report were shared with CE's member companies and associations as well as with external stakeholders for comment. Although we received feedback from only a few organisations (BASF, EFfCI (the European Federation of Cosmetic Ingredient Suppliers), ADEME) a number of valuable comments were considered for PEFCR improvement.

Our efforts were predominantly targeted at checking the feasibility and relevance of establishing a set of PEFCR for shampoo. However, we believe that many of the assumptions and conclusions would be applicable to other rinse-off cosmetic products such as body wash.

Although we tried to follow the EC methodology and guidance (version 5.1 of September 2015), in some areas (representative product, packaging modelling, normalisation, PEFCR review and reporting, disclosure and communication) we had to deviate from it; all such deviations were recorded and justified in the study report (see its Annex 1).

2.2 What we found

In addition to some general and procedural aspects, the EC's PEF Guidance requires that a category rule document should include scope, input data (resource use and emissions), interpretation and reporting including communication.

As far as the **scope** of a PEF calculation is concerned, category rules should define the unit of analysis and the system boundaries, select relevant impact categories, propose reasonable assumptions (to bridge data gaps or make choices where reality is too complex) and address any possible limitations. Development of category rules should be supported by experience accumulated during a screening study. Learnings have to be derived from this model calculation for a "representative product", which should reflect all product (shampoo) technologies on the market in a systematic manner, e. g. weighted for market share. As the highly complex EU shampoo market is represented by hundreds of brands and an even larger number of product variants, we decided to define a virtual representative product. Almost each marketed product has a unique formula; however, shampoos in general have many common characteristics, e. g. they are ready–to-use preparations containing surfactants as cleansing actives. Thus, our representative product contains

the most widely used surfactants along with other essential or widely used secondary actives and excipients. As pack volumes vary largely, typically between 200 and 500 ml, this unit of analysis was excluded. Instead, the **unit of analysis** was "one hair wash", defined as 10.46 ml[3], the average volume of shampoo used daily by European consumers, together with the relevant proportion of packaging. The advantage of this functional unit definition is that it can easily be applied to other shampoo technologies which may come up in the future (e. g. concentrates) or with different approaches to achieving one of the benefits of hair cleaning such as shampooing, the elimination of grease, using "dry shampoo". In line with CE's commitment to life cycle thinking, we are recommending that modelling should cover all phases from production of raw materials (ingredients and packaging materials), manufacturing of the products, distribution and use up to disposal at consumer level as well as all logistics (transportation and storage) involved across the entire value chain. Excluded from the **system boundaries** are any capital goods beyond buildings for the production phase as well as other activities relating to hair cleaning namely hair drying (e. g. towel cleaning, energy used for blow drying).

Of the 16 **impact categories** which are mandatory for consideration in category rules development, we found the following four to be of highest relevance: (1) climate change, (2) water resource depletion, (3) mineral and fossil resource depletion and (4) freshwater ecotoxicity.

Regarding the recognised **limitations** of currently available concepts and methodologies, the USEtox model's input data and the proposed normalisation and weighting concepts are the most important elements which to date are not sufficiently mature and robust to be used for product comparison.

The objective of PEF calculations is **quantification of resource use and emissions** across the entire product life cycle. This project included four PEF calculations (one screening study plus 3 supporting studies of shampoos in the market). We identified the use phase as the dominant life cycle stage or, at least, a significant contributor to each shampoos' environmental footprint. This has been demonstrated for almost all impact categories except freshwater ecotoxicity, which is dominated by product end-of-life. Our results are consistent with those of published shampoo PEFs. Although we are proposing conservative (low) values for rinsing water volume and temperature as category rules (15 L, heated from 15 to 38°C), we found that rinsing of hair with heated water is the most critical process of the use phase. A sensitivity analysis revealed that even moderate changes of these parameters within a realistic range have a large impact on the PEF results. This is not only true for energy consumption, which is predominantly reflected in the impact category of climate change (carbon footprint), but also for water resource depletion associated with the tap water used for hair rinsing. In contrast to expectations of some stakeholders, only minor contributions come from manufacturing as well as packaging production and end-of-life.

The major issue concerning the **interpretation** of our findings is the question of the most efficient measures to reduce the PEF of shampoos. Whereas contributions from ingredients' production and distribution can, to a certain extent, be controlled by cosmetics companies (shampoo formulators) or their suppliers, consumers' showering habits cannot be directly influenced via product design. Because we can certainly assume a huge variability of individual showering habits, we consider communication to consumers as an essential success factor to achieve a more sustainable consumption behaviour with regard to showering products.

2.3 What we learned

Calculation of a PEF is a very complex, comprehensive, ambitious and challenging task. Whereas standards for the essential elements of PEF calculation have been defined via the respective ISO norms (e.g. ISO 14040 series and ISO 14025), the huge complexity of the task still requires substantial improvement (e. g. In terms of data quality) as well as more harmonisation and standardisation of methodology in order to

[3] B. Hall, S. Tozer, B. Safford, M. Coroama, W. Steiling, MC Leneveu-Duchemin, C. McNamara, M. Gibney, European consumer exposure to cosmetic products, a framework for conducting population exposure assessments, Food Chem Toxicol. *Volume 45, Issue 11*, *November 2007*, *Pages 2097-2108*

ensure that results are driven by the subject of investigation rather than the methodology used or data variability. However, like the EC, we are committed to comprehensive science-based assessment methodologies that take into account the full life cycle of products.

The vast majority of cosmetic products are composed of a fairly large number of ingredients from a variety of sources (both feedstocks and suppliers). Generally the data for key ingredients is made available as industry averages or is obtained from external databases such as Ecoinvent. There is very limited primary data for many chemicals and such data is expensive to generate and is updated infrequently. The development of a cost-efficient database of primary data, considering sourcing locations and manufacturing processes, is desirable.

3. How can the outcome of the study be used by cosmetics companies?

3.1 Review of current state of knowledge in PEF science

Conducting a PEF requires specific scientific expertise, access to relevant data related to the product/service under investigation and tailored software to handle and process further the huge data set. To date, only very few cosmetic companies have sufficient internal resources and adequate in-house expertise enabling them to conduct PEF calculations on their own. Interested companies can however rely on external service providers for most of these elements and have PEFs on their products conducted with a minimum of own contributions.

3.2 Category rules in the narrower sense

The primary goal of defining PEFCR is standardisation and harmonisation of the assessment process, in particular of those modelling assumptions which have significant impact on the results of PEF.

The choice of system boundaries and of the functional unit are important parameters with a huge impact on PEF results as are the modelling parameters for the use phase, such as the volume and temperature of the rinsing water. The documents produced in the shampoo PEF project provide a large number of modelling assumptions and default values which have been defined on the basis of robust evidence. Scientists in cosmetics companies can build on this work and just replace a small set of input data by values which are specific for the product under consideration, e. g. qualitative and quantitative information about product formula and packaging.

There may be different motivations and goals behind the intention of a company to have a PEF conducted. Basically, PEF results may either be used to support internal decision-making (identify easily achievable improvements or hot-spots with maximum environmental impact) or to satisfy information requests from external commercial partners, consumers, media or official (governmental) bodies.
For any target audience, PEF information may:

(i) be restricted to identified hotspots,
(ii) enable a comparison between different technologies providing a similar service on the basis of "order of magnitude" values (e. g. dry vs. conventional shampoo; deodorant stick vs. aerosol; leave-on vs. rinse-off hair conditioner) or
(iii) be used for a direct comparison of two products within the same category (which have similar characteristics) on the basis of precise figures (which is not the current situation).

Companies or other stakeholders interested in determining the calculated PEF of a shampoo product are the primary target user group of our PEFCR documents. They can directly apply the assumptions and values which we have established for the functional unit, the system boundaries, default distances for transport, volume of rinsing water and temperature difference, just to mention a few of the many assumptions to be made. Furthermore, the PEFCR documentation provides justifications for all choices made including references to important information sources. In addition, the most important outcome for this target group

is definitely the **selection of relevant impact categories** which helps to dramatically reduce the workload related to calculations and interpretation of data. On top of this, we have also looked into reliability/robustness of impact assessment models and input data behind all 16 impact categories proposed by EC guidance documents and have identified those which are still immature and thus should not be included in any PEF calculation. Finally, reference has been made to the most important sources for generic input, modelling and output data on many raw materials routinely used in cosmetic products. It should be mentioned, that the science behind PEF is in its elementary stage and thus subject to frequent changes.

3.3 Usefulness of knowledge acquired during the project

Aspects such as the impact of the data quality, the general level of precision of PEF calculations and the limitations regarding application of PEF results should enable users to avoid over-interpretation of results, false decisions on the basis of PEF calculations (e. g. product "optimisation" into the wrong direction) and inadvertent abuse of the results by direct comparison of footprint data for grading of similar products.

Large parts of the PEFCR study's outcome, such as the set of prioritised (selected) impact categories, may also be considered for related product categories. These include categories with comparable chemical composition and use conditions (e. g. shower gels, liquid soaps, bath products) or other rinse-off products with ingredients of different chemical characteristics (e. g. hair conditioners).

Those companies and industry associations which are involved in discussions with different stakeholders, as well as companies facing requests for PEF data from their customers, will appreciate the opportunity to make use of our conclusions about application domains and limitations of PEF results.

The impact of our work and conclusions could be maximised by having them acknowledged by the relevant services at EC level and/or by the wider scientific community. In order to achieve this, the PEFCR documentation will be shared with the EC; publication in a suitable scientific journal is also being considered.

3.4 Usefulness of results from screening and supporting studies

In the context of CE's shampoo PEFCR project, PEFs have been calculated and results reported on four different products (one virtual, which is the representative product investigated by the study, and three actual products in the supporting studies – see Annexes 3, 4 and 5). Because the results were very similar and a number of objectives can be satisfied by using "category footprints", this is valuable information for those companies that are not yet at a high level of ambition in terms of their sustainability strategy.

Information about hotspots - including the identified life cycle phase with the highest impact, i.e. the use phase - can also be used for communication purposes. Information to consumers about their important role in reducing the environmental impact of shampoos is one of the key messages.

There may also be benefit from using absolute figures such as the carbon footprint of a shampoo use for comparison with other routine daily activities of our consumers such as preparing a cup of coffee or a meal, driving a car over a particular distance, in order to put things into perspective.

4. Areas of improvement

The outcome of the PEFCR study on shampoo revealed little new knowledge or understanding of environmental hotspots for this product category but it confirmed, and in some cases identified new challenges in the application of LCA for the public comparison of products. Methodologically the current ISO standards for LCA are inadequate for supporting a harmonised and systematic approach for the

quantification of the environmental impacts of products and the services they deliver. The work of the EC in developing the International Life Cycle Database (ILCD), PEF methodology and category rules process has attempted to address the issue of harmonisation and systemisation of LCAs across various product sectors. By doing so, the PEF pilot process has highlighted many of the challenges and limitations of the current LCA methodology, which is a complex tool requiring significant data inputs and expertise to apply. The experience of CE through its work with the PEF methodology has specifically highlighted two general areas for improvement, which are outlined below.

4.1 Data quality and availability

There is very limited Life Cycle Inventory (LCI) data for many chemicals, packaging materials and processes associated with shampoo and related personal care products. For chemicals and packaging specifically, the available LCI data is often industry average (e.g. plastics) and non-supplier specific. There have been little or no efforts to understand the variability in LCI data of the same materials. The current lack of specificity of LCI data limits the relevance of LCA comparisons of very similar products. It is feasible to envisage how differences in LCI data for the same material or process could influence the PEF outcome in such a case. For example, the plastic polyethylene terephthalate (PET) is chemically the same irrespective of whether or not it is petroleum or bio-based. However, the types of impacts of bio-based PET and petro-PET are different. Other gaps in material LCI data relevant to shampoo include the wide variety of minor ingredients such as fragrances and polymers and our current inability to reflect the benefits of certification/sustainable sourcing for ingredients such as those derived from palm oil. The generation of LCI data is an expensive and time consuming activity and consideration must be given to the cost benefits of data generation and the intended use of the PEF and PEFCR.

In addition to the lack of specific data, there is a general lack of quantifiable information on domestic water heating, shower types and water usage by consumers. The consumer use phase is a key contributor to the footprint of shampoo and it is an area where there is a lack of understanding of variability. At a hotspot level this lack of information may not be an issue but it is relevant if the PEF data is used for product comparisons and consumer communications.

The third aspect relating to data highlighted in the study is the need for better and more comprehensive normalisation data and a better understanding of how to address material life cycles that include activities and emissions outside the boundaries of the EU.

4.2 Impact assessment methodologies

Many of the conventional impact methods and categories were developed for energy and fossil carbon-based systems. Appropriate impacts methods for some activities and processes relevant to the constituents of shampoo are lacking or are poorly developed. For example, bio-based materials are not currently considered by the models and impacts on biodiversity are not assessed. Some models are questionable (such as for land use and water consumption impact). There are international activities (e.g. at UNEP-SETAC level) to develop new methods for impact categories, e.g. AWARE for water consumption. Resource footprint models (for resources, water and land use impact categories) are being updated at EU level[4].

The PEF pilots have also highlighted the fundamental difference in philosophy between risk assessment and the way toxicological impacts of chemicals are assessed via a comparative approach in LCA. The EC has acknowledged the inadequacies in the current state of art of the USEtox approach for assessing human and environmental toxicological impacts for a product comparison purpose. ECETOC has conducted a scientific review of the subject of chemical impacts.

[4] Environmental Footprint - Update of Life Cycle Impact Assessment methods, draft 2.05.2016; http://ec.europa.eu/environment/eussd/smgp/ef_news.htm

Normalisation methodology was published by the EC and the recommendation for normalisation factors in the environmental footprint context currently relies on European domestic figures for 2010. Further developments to ensure robustness of the method are under consideration. A weighting approach involving the assessment of potential damage to ecosystems and human health such as the one initiated in this project[5] or the one investigated by the EC on the Planetary Boundaries [6] need to be developed in order to enable an accurate evaluation of multi-criteria damages.

[5] Quantis references, table 5, Screening Study Report (Annex 2 to this document)

[6] Valentina Castellani, Lorenzo Benini, Serenella Sala, Rana Pant, A distance-to-target weighting method for Europe 2020, International Journal of Life Cycle Assessment (2016) 21:1159–1169

Annexes:

I. List of abbreviations

AISE	International Association for Soaps, Detergents and Maintenance Products
CE	Cosmetics Europe
EC	European Commission
ECETOC	European Centre for Ecotoxicology and Toxicology of Chemicals
Ecoinvent	Life cycle inventory database for energy systems, materials, transports and chemicals
ILCD	International Reference Life Cycle Data System
ISO	International Standards Organisation
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
PEF	Product Environmental Footprint
PEFCR	Product Environmental Footprint Category Rules
OEF	Organisation Environmental Footprint
OEFCR	Organisation Environmental Footprint Category Rules
TF	Task Force
UNEP-SETAC	United Nations Environmental Program – Society for Environmental Toxicology and Chemistry
USEtox	A scientific consensus model endorsed by the UNEP/SETAC Life Cycle Initiative for characterising human and eco-toxicological impacts of chemicals.

II. Study into the development of Product Environmental Footprint Category Rules for Shampoo:

II.1 Final Report by Cosmetics Europe and Quantis, 8 April 2016

II.2 Screening study report, 14 November 2014

II.3 Supporting study report, Gliss Kur Total Repair Shampoo (Henkel), 28 April 2016

II.4 Supporting study report, Ultra Doux de Garnier Antidandruff Shampoo (L'Oréal), 28 April 2016

II.5 Supporting study report, Shampoo for Delicate Hair (Pierre Fabre), 28 April 2016