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Comparison of Environmental Impacts of Body wash product in Life cycle: Korea and Europe

Hanbi Kim[1], Noh-hyun Lim[1], Chankyu Lee [2]
[1] IGSC Co., Ltd., Seoul, Republic of Korea
[2] Green management part, LG H&H Co., Ltd., Seoul, Republic of Korea

ABSTRACT: As the scope and standards of environmental regulations are expanding and strengthening, environmental impact assessment and carbon emission reduction activities for new product lines are spreading, and the environmental impact of Scope 3 is also gaining attention. Companies are disclosing environmental information through LCA and EPD results, but there are differences in environmental information results by country due to different standards for calculating environmental performance. Therefore, this study selected body wash products among cosmetics and compared the data collection and methodology in Korea and Europe and the results of applying them, and secondly, compared the carbon emissions of using recycled plastics in the containers of these products compared to the existing ones.

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CorrespondingAuthor: Noh-hyun Lim

KEYWORDS: Body wash, PCR, LCA, Carbon footprint, Environmental Impact, Recycled plastic

1 INTRODUCTION

The EU has set the Green Deal as a prioritized basic policy, introducing new regulations and systems and establishing detailed implementation plans with the goal of responding to climate change by reducing carbon emissions, achieving a circular economy by shifting to a sustainable industrial structure, and shifting to green consumption. [1]. Recently, the EU Commission announced a revised proposal to change the current Ecodesign Directive to the Ecodesign Regulation. The scope has been expanded from ErPs(Energy-related products) to include Physical products [2].

As a result, environmental impact assessment and carbon emission reduction activities are spreading to general consumer goods, and although they are not directly regulated compared to scope 1 and 2, interest in scope 3 emissions is also increasing as the demand for sustainability intensifies. As shown in Fig. 1, the environmental impact of indirect activities such as the use of sold products and end-of-life disposal has also come into focus. In addition, recycled plastics are being used not only for products but also for packaging containers used in products to achieve the goal of reducing carbon emissions and achieving a circular economy.

Along these lines, companies around the world are disclosing environmental information about their products through LCA and EPD results, but there are differences in environmental information results between countries due to differences in the application of system boundaries, emission factors, impact assessment categories and others between countries. For example, Europe has PCR (Product Category Rules) for Cosmetics and considers the use phase, while Korea applies Common guidelines for non-durable goods (Cosmetics included) and does not consider the use phase.

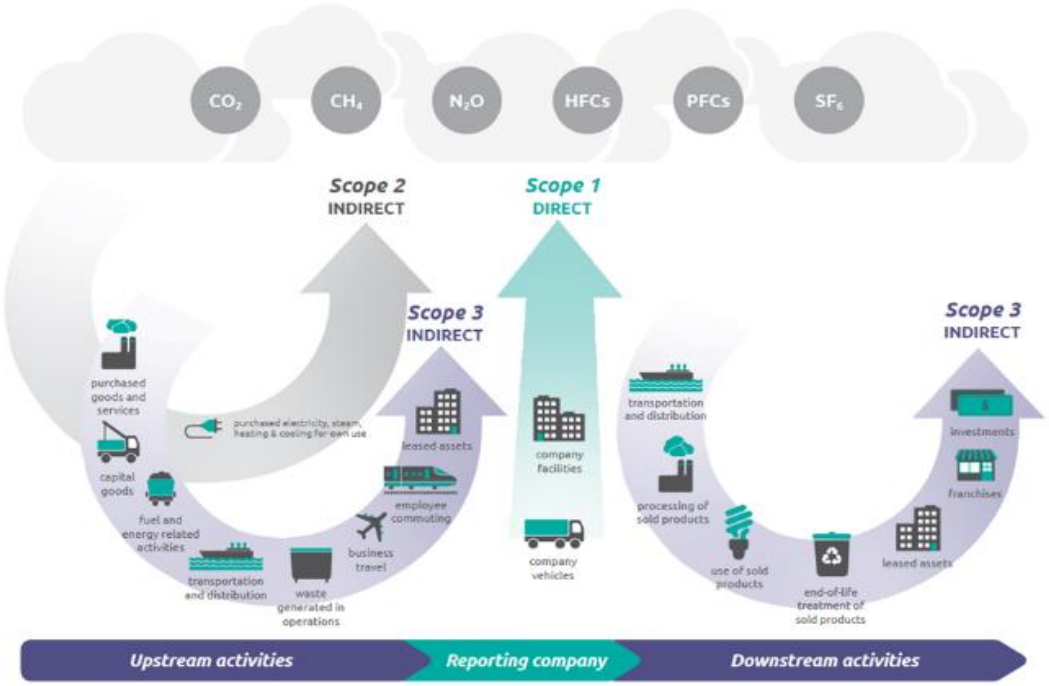

Fig. 1: Overview of GHG Protocol scopes and emissions across the value chain [3]

In this study, we first selected one Body wash product among cosmetics and compared the data collection methodologies in Korea (KEITI) and Europe (International EPD), particularly we compared the environmental impact results of the product with the use phase (Europe) and without the use phase (Korea). However, since it is difficult to directly compare methodology differences when LCIA results differ due to differences in environmental impact assessment methodologies, the comparison assumed that the Environmental Impact Indicator and LCI Database are the same.

Second, as the Circular economy model, which is gaining attention for realizing a sustainable society, is spreading around the world, we compared the carbon footprint of plastic containers used in the body wash products with the carbon footprint of virgin plastic and recycled plastic to determine the reduction in carbon emissions.

2 MATERIALS AND METHODS

First, we compared the methodology of data collection between PCR 2015:07 VERSION 2.0 [4] of the International EPD in Europe and the Common Guideline of the Korea Environment and Industrial Technology Institute (KEITI) in Korea [5], and compared the environmental impact result values of applying PCR 2015:07 VERSION 2.0 to LG Household &Health Care(BEYOND Body Wash 300ml) at the use phase.

The comparison of the environmental impact result values when the use phase is considered by applying 0 and when the use phase is not considered by applying the common guideline in Korea was conducted based on the difference in methodology in data collection of the two PCRs, excluding the difference in Environmental Impact Indicator and LCI Database.

The LCA calculation was performed using the ezEPD tool. The product information is as shown in Table 1, and the differences in data collection methods and scope of each PCR are as follows.

Table 1: Product Specification (BEYOND, LG H&H)

Category	Target product of the study
Product	Body wash
Volume (ml)	300
Container	PET
Annual Sales (EA)	38,024

2.1 Functional/Declared Unit

The Korean Common Guideline uses the Functional unit based on the unit product sold in the market, and if the unit of the product on the market is clear, it is based on the unit of product sales, such as one (1) product. The European PCR 2015:07 uses the Declared

Unit, which is the estimated daily use of a product based on the estimated daily exposure level for the product type and packaging. The applicable estimated daily use is shown in Fig. 2, according to the most recent data from authorized organizations.
For BEYOND Body Wash, the estimated daily usage of shower gel, 18.67 g/d (Declared Unit), was converted to the weight of one product, 306 g, and applied to the number of product usage days, 16.389 days (306/18.67).

2.2 Data collection and calculation

As shown in Fig. 3, the Korean Common Guideline does not include the use phase for non-durable materials of general products, and the environmental performance is calculated for all substances that contribute more than 95% of the cumulative mass of the substances inputs to the product manufacturing phase during data collection.
In addition, specific data is collected for materials that contribute 10% or more by mass of raw materials, auxiliary materials, and minimum packaging materials. However, specific data may be collected for substances that are not included in the scope of specific data collection but have a significant overall environmental impact.
For European PCR 2015:07 VERSION 2.0, only rinse-off products are considered in the use phase and shall include data for elementary flows to and from the product system contributing to a minimum of 99% of the declared environmental impacts shall be included (not including processes that are explicitly outside the system boundary)

2.3 Pre-manufacturing phase

In the Korean Common Guidance, pre-manufacturing data collection includes the raw material collection and manufacturing process and the manufacturing process of the product produced by the first-tier supplier. It also includes transportation from the first-tier supplier's manufacturing site to the product manufacturing site.
Pre-manufacturing in European PCR 2015:07 corresponds to Upstream and includes extraction and refining of raw materials, production of ingredients; auxiliaries; packaging, and scrap and waste the treatment of the upstream processes.

2.4 Manufacturing phase

The Korean Common Guideline includes the manufacturing process of a product, and the manufacturing phase can be subdivided into appropriate unit processes and includes the transportation of the product after the manufacturing phase. (However, production goods and services are excluded)
For European PCR 2015:07, this is the core stream and includes transportation of raw and auxiliary materials in the supply chain, manufacturing and packaging of the product, storage use of power and fuel, and disposal of scrap and waste from the core stream process.

2.5 Use phase

The use phase is the biggest difference between the two PCRs. The Korean Common Guideline does not include a use phase for body wash products. However, data on water use (e.g., amount of product usage per time, amount of water used, etc.) are collected to calculate the environmental performance of the use phase of water-using products. Data on emissions and waste from the use phase of water-using products are also collected.
For European PCR 2015:07, the use phase is considered downstream and includes the use phase only for rinse-off products. If specific data is not available, the following assumptions shall be made. For showering products, 100 liters of water use (20 liters/minutes for a shower of 5 minutes) 40% of the water used for showering products shall be considered to be heated up to 40°C; However, due to the different database and indicators connections.

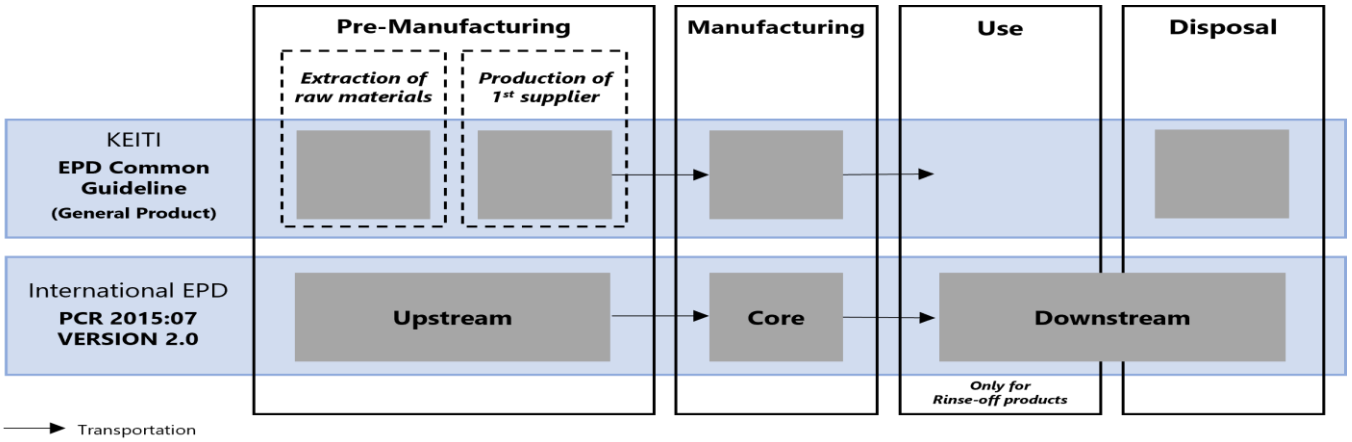

Fig. 3: System boundaries of EPD Common Guideline for General product and PCR 2015:07 VERSION 2.0

Product type	*Estimated daily amount applied* q_x *(g/d)*	*Relative daily amount applied*[1] q_x *(mg/kg bw/d)*	*Retention factor*[2] F_{ret}	*Calculated daily exposure* $E_{product}$ *(g/d)*	*Calculated relative exposure*[1] $E_{product}$ *(mg/kg bw/d)*
Bathing, showering					
Shower gel	18.67	279.20	0.01	**0.19**	**2.79**

1 The specific body weight of the persons involved in the study is used and not the default value of 60 kg.
2 The retention factor (Fret) was introduced by the SCCNFP to take into account rinsing off and dilution of finished products by application on wet skin or hair (*e. g.* shower gels, shampoos) (SCCNFP/0321/00); Fret has no units.

Fig. 2: Estimated daily amount applied for some products.

between the two PCRs, it was assumed that LNG gas hot water boilers were used in Korea, and calculations were made considering electricity, LNG, water (potable), sewage treatment, and air emissions (CO_2, NO_X, CO, NMVOC, CH_4, N_2O).

2.6 Disposal phase.

The Korean Common Guideline collects field data on how waste associated with the product is disposed of. If necessary, it applies disposal statistics by product component material, including wastewater treatment and water impacts based on the proportion of water. Collect data on the occurrence and composition of the top 95% or more by cumulative mass of the raw and auxiliary materials that comprise the product, including the minimum packaging and shipping packaging that is disposed of with the product. However, data is included for raw materials and auxiliary substances that are not among the top 95% of substances but have a significant impact on environmental performance and are included in the environmental performance calculation.

PCR2015:07 in Europe includes a disposal phase in Downstream and includes end-of-life treatment of product and packaging disposal scenarios. You should document a disposal scenario that complies with the current regulations in your region and includes key assumptions about the technically and economically feasible end-of-life phase.

2.7 Summary

To summarize the above comparison of methodologies for data collection in Korea and Europe, first, there are differences in units (Korea: functional units, Europe: declaration units), and then differences in each life cycle phase, as shown in Table 2.

There are differences in the cut-off criteria for the pre-manufacturing phase (Korea: 95%, Europe: 99%), differences in the percentage during the manufacturing phase (Korea: 95%, Europe: 99%), and differences in the inclusion of the use phase (Korea: not included, Europe: included). For the disposal phase, Korea uses disposal statistics, while Europe uses scenarios based on environmental conditions.

Table 2: Comparison of Data collection and method of KEITI and International EPD

Phase	KEITI	International EPD
Pre-manufacturing	95% (by weight)	99% (by Environmental impact)
Manufacturing	95% (by weight)	99% (by weight)
Use	Excluded	Included
Disposal	Statistical data	Disposal scenario (documented)

Second, when the raw material of the BEYOND Body Wash product container was changed from virgin PET resin to recycled PET resin, the product container specifications for comparing the difference in carbon emissions are shown in Table 3.

Table 3: Product container Specification

Category	Container	PCR Container
Ingredient	PET Resin	r-PET Resin
Weight(g)	35	35
Emission factor (kg CO2 -eq.)	2.370E+00	9.77E-01
Database name	polyethylene terephthalate production	polyethylene terephthalate production, granulate, bottle grade, recycled(1kg)
Reference	Domestic	Ecoinvent

3 RESULTS

The carbon footprint of the Korean methodology was compared to the European standard, and the results of the Korean and European LCAs are shown in Table 4.

Through all stage the total carbon footprint of one 300ml bottle of BEYOND Body Wash is 7.25E-01 kg in Korea and 7.34E-01 kg in Europe, and the carbon footprint of the European standard is about 1.3% higher than that of the Korean standard. In detail, comparing the carbon emissions due to the difference in data collected according to the cut-off criteria for each phase, the carbon emissions increased by 2.90E-03 kg in the pre-manufacturing phase, 6.50E-03 kg in the manufacturing phase, and 1.90E-10 kg in the disposal phase.

The carbon emissions of the use phase totaled 1.933E+01 kg, which is 25.5 times higher than the sum of the pre-manufacturing, manufacturing, and disposal phases. When comparing carbon emissions alone, the use phase accounts for 96.30% of the total, which is a high proportion of environmental impact. In addition, AP, EP, ADP, and WS also have a share of more than 90%. In this regard, the comparison of environmental impacts by impact category according to whether the use phase is considered is shown in Fig. 4 and Fig. 5.

Table 4: Comparison of Carbon footprint of KEITI and International EPD

Phase	KEITI	International EPD
Pre-manufacturing	4.231E-01	4.260E-01
Manufacturing	3.017E-01	3.082E-01
Use	-	1.933E+01
Disposal	3.474E-08	3.493E-08

Unit: kg CO2 eq./EA

In addition, the carbon footprint of the use phase of Beyond Body Wash is 1.934E+01 kg, which is 26.4 times higher than without the use phase. This is due to the high impact of electricity and sewage treatment of used water. In addition, AP increased by 23.5 times, POFP by 1.6 times, EP by 8.8 times, ADP by 11.8 times, and WS by 25.2 times. On the other hand, the impact of ODP on the usage phase was insignificant.

Next, the change in carbon emissions when recycled PET resin is substituted for the 300ml body wash bottle is shown in Table 5. The carbon footprint of the container with virgin PET resin is 7.60E-01 kg, while the carbon footprint of the container with 100% recycled PET resin is 7.10E-01 kg. As the percentage of recycled PET resin increased, the carbon footprint could be reduced by up to 6.57%. In addition, the carbon footprint of Beyond Body Wash 500ml product was reduced by up to 6.20% by using recycled PET resin.

Table 5: Carbon footprint based on percentage of Recycled PET resin content

Body wash Volume	Recycled PET resin content rate			
	0%	30%	50%	100%
300ml	7.60E-01	7.45E-01	7.35E-01	7.10E-01
500ml	1.08E+00	1.06E+00	1.04E+00	1.01E+00

Unit: kg CO2 eq./EA

4 CONCLUSION

In this study, we first compared the data collection methodologies of the Korean and European PCRs, and then selected a body wash product from among consumer products and compared the results of applying the Korean PCR, which does not consider the use phase, and the European PCR, which does consider the use phase, to the product, and concluded as follows.

First, as the environmental impact of raw materials and manufacturing, as well as the indirect emission area of Scope 3, is becoming more important, it is necessary to calculate environmental performance by applying PCR that reflects individual characteristics in the use phase of the product.

Second, we compared the reduction in carbon emissions when the material of the container used for BEYOND Body Wash was changed from virgin PET resin to recycled PET resin, and found that the change in container material reduced carbon emissions by up to 6.57% (300ml) and 6.20% (500ml) per product compared to virgin PET resin containers. The use of recycled PET resin in BEYOND products reduces carbon emissions by 7.065E+03 kg per year for about 120,000 products based on 2022 production. These products are flagship products of BEYOND and production will be increased in phases, which is expected to result in a proportional increase in carbon emission reduction.

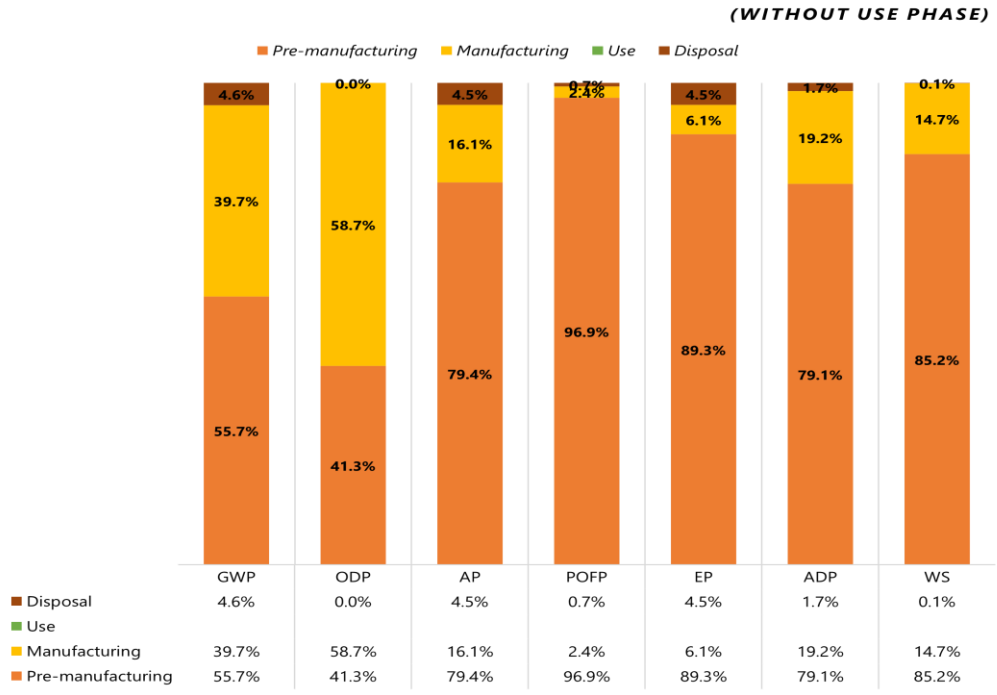

Fig. 4: Comparison of environmental impact of BEYOND body wash without Use phase (Applied KEITI PCR, Using Korean data base and method)

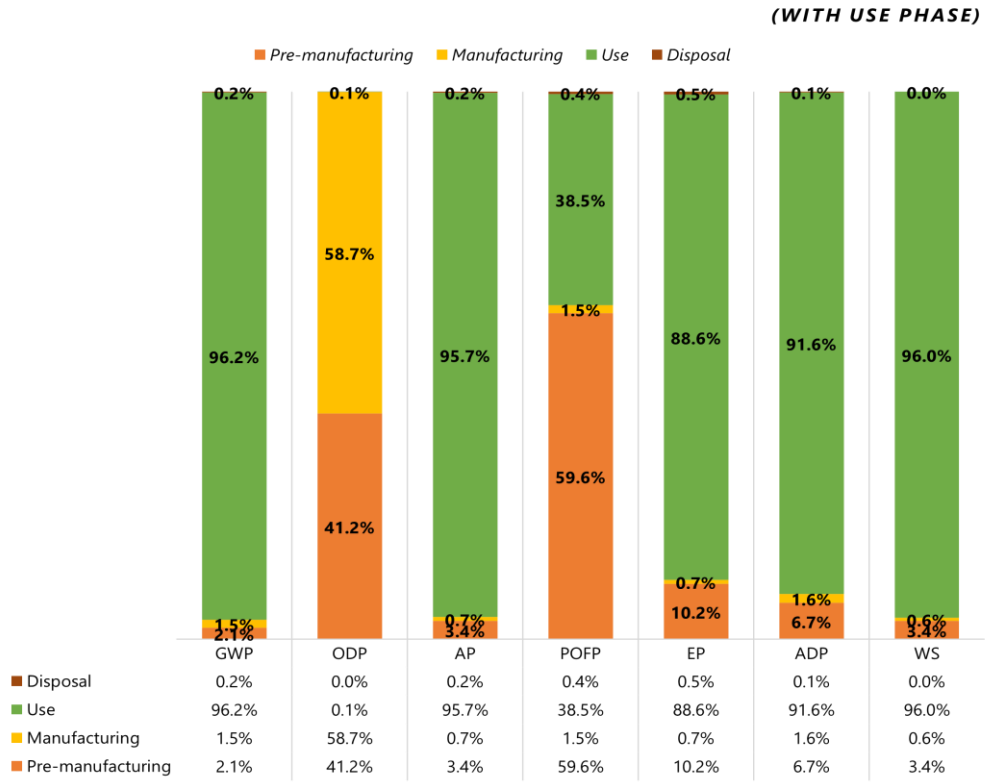

Fig. 5: Comparison of environmental impact of BEYOND body wash with Use phase (Applied International EPD PCR, Using Korean data base and method)

5 SUMMARY

In this study, first, we selected one body wash product among cosmetics and compared data collection methodologies based on the corresponding Product Category Rules (PCR) of Korea (KEITI) and Europe (International EPD).

The biggest difference between Korea and Europe was Use phase. Korean PCR does not consider us phase However, European PCR includes use phase. As a comparison result of carbon footprint, the carbon footprint of the use phase of Beyond Body Wash is 1.934E+01 kg, which is 26.4 times higher than without the use phase. This is due to the high impact of electricity and sewage treatment of used water.

Second, the study compared the carbon emissions of plastic containers used in the product with those of conventional containers when improved with recycled plastic.

The carbon footprint of the container with virgin PET resin is 7.60E-01 kg, while the carbon footprint of the container with 100% recycled PET resin is 7.10E-01 kg. As the percentage of recycled PET resin increased, the carbon footprint could be reduced by up to 6.57%.

6 ACKNOWLEDGEMENTS

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