ESTRADIOL 0.1 % TRANSDERMAL GEL SACHET/PUMP BOTTLE

Life Cycle Assessment Report

Abridged climate-impact summary | October 2026

This document describes an abridged version of the cradle-to-grave life cycle assessment (LCA) of estradiol 0.1 % transdermal gel (estradiol gel). This summary includes only climate-related impacts. The study was conducted according to LCA standards ISO 14040, ISO 14044, and ISO 14067. In this study, the Product Category Rules (PCR) for pharmaceutical products and processes (Siegert et al. 2019[1]) are also followed. For the use phase, the PAS 2090:2025 standard is followed. The results are reported for two bottle packaging sizes and two sachet packaging sizes.

Orion was the commissioner of this LCA study. The study was carried out by UseLess Company Oy based in Helsinki, Finland. The modelling was carried out using Sphera LCA for Experts software with the Managed LCA Content (MLC) database version 2025.2. The study was conducted between December 2025 and May 2026.

The functional unit used in this study is a daily dose of 1 g of the gel product, containing 1 mg of estradiol. It may also be referred to as a declared unit because the function of the gel is not assessed in this study. This functional unit was chosen because it enables a meaningful comparison between bottle and sachet packaging options on a use-equivalent basis (daily dose).

Estradiol gel is manufactured in Turku, Finland. The carbon footprint of the active pharmaceutical ingredient, estradiol hemihydrate, is based on manufacturer-specific data. Other raw materials are sourced from multiple international suppliers. Gel manufacturing includes the mixing and formulation of raw materials into the finished gel. Energy consumption for manufacturing is based on total facility energy use, allocated by floor area.

Estradiol gel is also packaged in Turku. The gel is packed in two different ways: bottle packaging and sachet packaging. Bottle packaging is available in two sizes: 107 ml and 58.5 ml. The corresponding delivered dose sizes are 1 g and 0.5 g gel per actuation, respectively. Life-cycle inventory data for packaging materials were modelled based on measured component weights and supplier-specific transport distances.

The distribution modelling for estradiol gel begins with transport from the manufacturing and packaging site in Turku to the dispatch facility. After dispatch, the global distribution is modelled using the share of sales based on unit sales of Orion's estradiol gel product, combined with representative transport routes.

The global warming potential (GWP, carbon footprint) of 1 g of estradiol gel ranges from 4.5 to 9.4 g CO_2e, depending on the packaging type and size. The results show that estradiol gel in sachet packaging consistently has a lower GWP than estradiol gel in bottle packaging. Within both packaging types, the 0.5 g option has a higher impact per gram of product than the corresponding 1 g option. The differences in carbon footprint between packaging options are primarily driven by how efficiently packaging material scales with product quantity. In the bottle options, especially the smaller bottle, a relatively large amount of material is needed to contain a small amount of product. This increases the emissions per gram considerably. In contrast, sachets require much less material per unit of product, which keeps their overall emissions lower. Bottles generate higher impacts at disposal, which further amplifies the total difference between packaging types and sizes.

[1] SIEGERT, M. W., LEHMANN, A., EMARA, Y., & FINKBEINER, M. (2019). HARMONIZED RULES FOR FUTURE LCAS ON PHARMACEUTICAL PRODUCTS AND PROCESSES. THE INTERNATIONAL JOURNAL OF LIFE CYCLE ASSESSMENT, 24(6), 1040-1057.

BOTTLE					SACHET				
LIFE-CYCLE PHASE	GWP per 1 g estradiol gel [gCO_2e], 1 g bottle	Share of total results [%], 1 g bottle	GWP per 1 g estradiol gel [gCO_2e], 0.5 g bottle	Share of total results [%], 0.5 g bottle	**LIFE-CYCLE PHASE**	GWP per 1 g estradiol gel [gCO_2e], 1 g sachet	Share of total results [%], 1 g sachet	GWP per 1 g estradiol gel [gCO_2e], 0.5 g sachet	Share of total results [%], 0.5 g sachet
API manufacturing	1.25	18.0%	1.25	13.4%	**API manufacturing**	1.25	27.8%	1.25	24.4%
Gel manufacturing	1.98	28.5%	1.98	21.1%	**Gel manufacturing**	1.98	43.9%	1.98	38.6%
Packaging	2.01	29.0%	3.37	35.9%	**Packaging**	0.55	12.2%	0.95	18.4%
Distribution	0.41	5.9%	0.50	5.3%	**Distribution**	0.28	6.2%	0.33	6.5%
Use phase	0.31	4.5%	0.57	6.0%	**Use phase**	0.26	5.9%	0.27	5.2%
End of life	0.98	14.1%	1.72	18.3%	**End of life**	0.18	4.0%	0.36	7.0%
TOTAL	**6.95**	100%	**9.39**	100%	**TOTAL**	**4.51**	100%	**5.14**	100%

Table 1. Climate impacts of estradiol gel in bottle and sachet packaging formats. Results are normalized per gram of finished gel product. Avoided burden credits from material and energy recovery are reported separately in the full LCA report and are not included in the total GWP values presented in this table.