Executive Summary

Product Carbon Footprint (PCF) of the MOECK & MOECK GmbH Reusable Lower Body Warming Blanket and a Conventional Single-use Lower Body Warming Blanket

Product Carbon Footprint (PCF) der wiederverwendbaren Unterkörper-Wärmedecke der MOECK & MOECK GmbH und einer konventionellen Einweg-Unterkörper-Wärmedecke

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GREEN ZERO

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1.1. Background and Objectives

This environmental assessment, prepared for MOECK & MOECK GmbH, evaluates the greenhouse gas (GHG) emissions as well as other environmental impacts of two types of lower body warming blankets: the reusable MOECK WARMING SYSTEM blanket and a conventional single-use blanket. The study aims to evaluate and compare the environmental impacts of these blankets with a focus on Global Warming Potential (GWP). This PCF is conducted in accordance with ISO 14067[1] standard, ensuring a robust and standardized approach.

PCF is an established framework for assessing the environmental impacts associated with all stages of a product's life cycle, from raw material extraction (cradle) to end-of-life disposal (grave). In this instance, the study adopts a cradle-to-grave approach for both the reusable and single-use blankets, covering production, usage, and disposal phases.

The primary purpose of this PCF is to answer the following question: What are the environmental impacts of the reusable MOECK WARMING SYSTEM blanket compared to a conventional single-use blanket, particularly in terms of GWP? This investigation includes:

- Quantifying the GHG emissions associated with each blanket throughout its life cycle.
- Identifying key differences in other environmental impacts

The secondary purpose of this study is to identify hotspots in the production, use, and disposal phases of both blanket types. This information is critical for MOECK & MOECK GmbH and other stakeholders in making informed decisions about product design, usage, and end-of-life management to minimize environmental impacts.

This PCF serves as a valuable resource for healthcare providers, policymakers, and other stakeholders by highlighting the environmental impacts of medical warming blankets and promoting sustainable healthcare practices.

1.2. Scope of the Study and Functional Unit

The scope of the study includes the following life cycle stages for both the reusable and single-use blankets:

- Production of Components: Analysis of the environmental impacts from raw material extraction and component manufacturing.
- Production of Packaging: Evaluation of the materials and processes used to produce packaging for the blankets.
- Inbound Logistics: Assessment of the environmental impacts from transporting raw materials to the manufacturing facility.

[1] ISO 14067:2018. Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification

- Manufacturing Processes: Analysis of the environmental burdens associated with the blanket manufacturing process.
- Outbound Logistics: Evaluation of the impacts from transporting finished products to customers.
- Use Phase: Examination of the environmental impacts during the usage of the blankets, including washing processes for the reusable blanket.
- End-of-Life (EoL) Disposal: Assessment of the impacts associated with the disposal of the blankets after their useful life.

The functional unit is defined as “200 applications (surgical procedures) for constant temperature control at 37°C per surgical unit”. This unit allows for a direct comparison between the reusable MOECK WARMING SYSTEM blanket and the conventional single-use blanket.

1.3. Data Sources and Data Collection

Primary data for the reusable MOECK WARMING SYSTEM blanket were sourced directly from MOECK & MOECK GmbH, ensuring high accuracy and relevance. This data encompasses all stages of the blanket's life cycle, including raw material extraction, manufacturing, distribution, usage, and end-of-life disposal. For the conventional single-use blanket, a theoretical model was created based on primary data for the weight of the components and specification of materials (if available) as well as industry average data (secondary data).

Assumptions were made where primary data were unavailable, particularly for the single-use blanket model. For both blanket types, secondary data were sourced from well-established life cycle inventory (LCI) databases, ensuring robust and reliable inputs such as ecoinvent (version 3.9).

1.4. Results

The assessment focuses on eight environmental impact categories according to the ReCiPe 2016 method (version 1.08), with a particular emphasis on the Global Warming Potential (GWP).

1.4.1. Reusable lower body warming blanket (MOECK WARMING SYSTEM)

The GWP for a baseline scenario is approximately 54 kg CO2 equivalents. The use phase is the most significant contributor to GWP due to the energy and water requirements for washing process (accounting for about 90% of CO2 equivalents). A further important contributor is the material manufacturing process (accounting for about 7% of CO2 equivalents).

1.4.2. Conventional single-use lower body warming blanket

The GWP for the conventional single-use lower body warming blanket is approximately 212 kg CO2 equivalents. The production phase dominates the GWP due to the raw materials and energy required for manufacturing each blanket (accounting for about 64% of CO2 equivalents). This phase includes emissions from material extraction, processing, and blanket production (accounting for about 30% of CO2 equivalents). Disposal impacts are substantial, given that each blanket is used only once before being incinerated.

1.4.3. Comparative Analysis

Taking the example of GWP the single-use blankets have 3.9 times higher greenhouse gas emissions compared to 200 applications MOECK WARMING SYSTEM reusable blankets (defined by the functional unit). The reusable blanket's GWP is concentrated in the use phase, specifically due to energy consumption for washing. However, over 200 uses, the total GWP is significantly lower than that of the single-use blanket (see Figure 1 and Table 1). The single-use blanket has a higher overall GWP due to the combined effects of production and disposal for each use. Each blanket's GWP accumulates rapidly with repeated use, making it less sustainable over time.

When comparing the reusable and single-use blankets over a functional unit of 200 uses, the reusable blanket demonstrates lower overall GWP. Key findings include:

- The reusable blanket's GWP is initially higher due to production impacts, but it becomes more favorable after multiple uses.
- The single-use blanket, despite its lower initial impact, accumulates a higher GWP over time due to the need for continuous production and disposal.

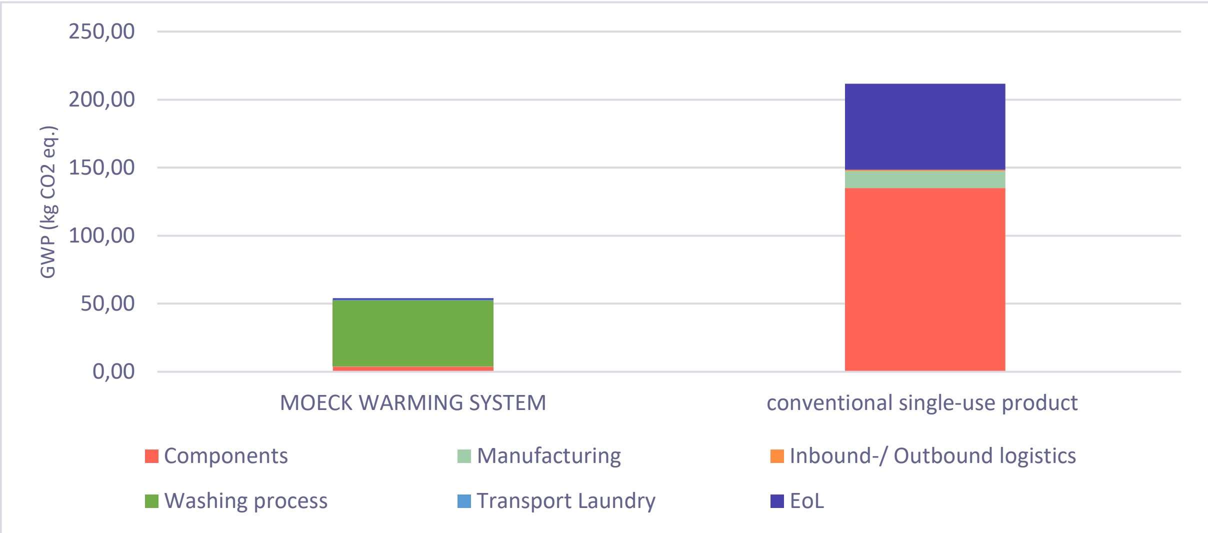

Figure 1 GWP results: MOECK WARMING SYSTEM and conventional single-use product for 200 applications (functional unit)

Table 1 Overview of absolute results: MOECK WARMING SYSTEM and conventional single-use product for 200 applications (functional unit)

Category	Unit	MOECK WARMING SYSTEM	Conventional single-use product
GWP	kg CO2 eq.	54,01	211,57
AP	kg SO2 eq.	0,11	0,46
FEP	kg P eq.	0,05	0,09
MEP	kg N eq.	0,010	0,008
POCP	kg NOx eq.	0,08	0,34
ODP	kg CFC11 eq.	3,60E-05	1,57E-04
LU	m2a crop eq	2,00	2,48
WU	m3	0,42	1,59

1.4.4. Sensitivity Analysis

A sensitivity analysis was conducted to evaluate the environmental impacts of the reusable lower body warming blanket (MOECK WARMING SYSTEM) by considering different scenarios involving various electricity mixes and transport distances. Given that electricity contributes to 63% of the GWP impacts for the washing process, which itself is the main contributor along the life cycle several scenarios are explored.

The analysis reveals significant reductions in environmental impacts, particularly in the Green Energy Scenario, which shows a substantial decrease in Global Warming Potential (GWP) and other impact categories (see Table 2 and Figure 2). The French and Austrian electricity mixes also demonstrate notable improvements, highlighting the influence of a low-carbon energy profile. In contrast, variations in transport distances (comparing zero, 30 km, and 200 km scenarios) have a relatively minor effect on the overall environmental impacts. This indicates that optimizing the electricity mix used for washing has a more profound impact on reducing the environmental footprint of the reusable warming blanket compared to changes in transport distances.

Table 2 Absolute results for scenarios regarding transport and electricity mixes

Cate-gory	Unit	1. Baseline (30km)	2. Scenario (0km)	3. Scenario (200km)	4. Scenario (100% Green energy)	5. Scenario (FR electricity mix)	6. Scenario (AUelectricity mix)	7. Scenario (NLs electricity mix)
GWP	kg CO2 eq.	54,01	53,54	56,68	27,93	28,86	41,48	58,49
AP	kg SO2 eq.	0,11	0,11	0,12	0,08	0,07	0,09	0,09
FEP	kg P eq.	0,05	0,05	0,05	0,01	0,01	0,03	0,02
MEP	kg N eq.	0,01	0,01	0,01	0,01	0,01	0,01	0,01
POCP	kg NOx eq.	0,08	0,07	0,08	0,06	0,05	0,06	0,08
ODP	kg CFC11 eq.	3,60E-05	3,58E-05	3,73E-05	2,78E-05	2,59E-05	3,11E-05	3,65E-05
LU	m2a crop eq	2,00	1,98	2,10	4,43	1,54	2,05	2,21
WU	m3	0,42	0,42	0,43	0,39	0,42	0,57	0,44

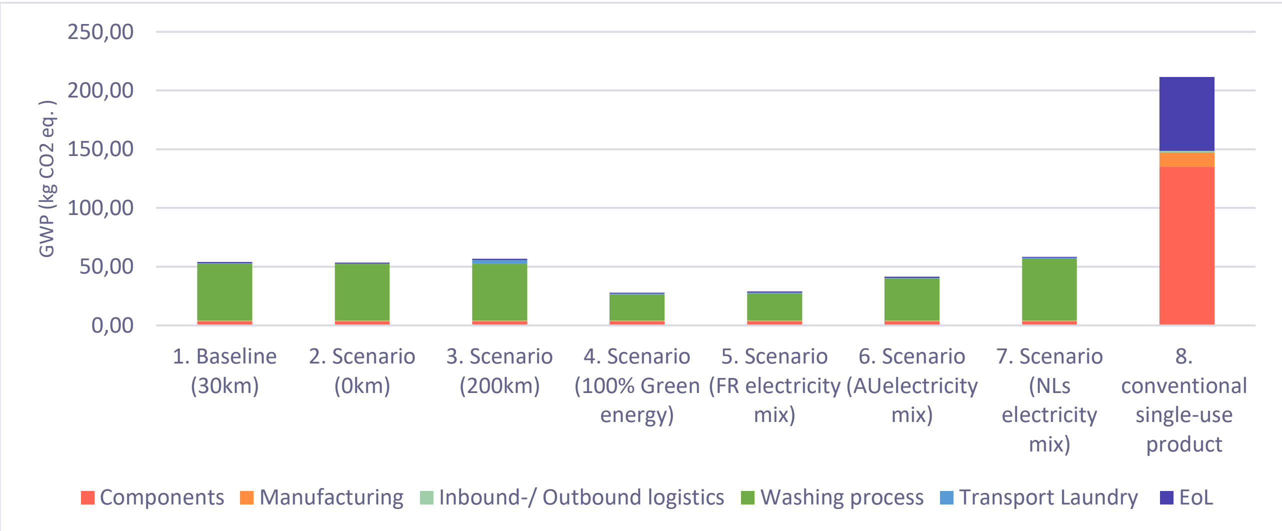

Figure 2 GWP results for scenarios regarding transport and electricity mixes and conventional single-use product

1.5. Conclusion

In the comprehensive life cycle assessment comparing the reusable lower body warming blanket (MOECK WARMING SYSTEM) to conventional single-use lower body warming blankets over 200 applications (surgical procedures), the reusable MOECK WARMING SYSTEM blanket demonstrates superior environmental performance across 7 out of 8 impact categories. The greenhouse gas potential (GWP) for the reusable blanket is approximately 54 kg CO2 equivalents.

Key Findings:

- Greenhouse Gas Potential (GWP): The reusable blanket shows a significant reduction in greenhouse gas emissions, with at least a 3.9 times lower GWP compared to conventional single-use blankets. Specifically, MOECK & MOECK's blanket proves more advantageous than 53 single-use blankets in terms of GWP.
- Lifecycle Hotspots: The main environmental impacts for the reusable blanket are attributed to the washing process (about 90% of CO2 equivalents) and material manufacturing (about 7% of CO2 equivalents).
- Optimization Potential: The choice of electricity mix used in the washing process offers significant optimization potential. For instance, using 100% green energy instead of the average German electricity mix can reduce CO2 equivalents by up to 47%

1.6. Critical review and appendices

The current report has undergone a critical review by an external expert to validate the methodology and findings. This ensures the robustness and credibility of the results. For a detailed breakdown of the LCA results, assumptions, and methodological specifics, refer to the full report. The appendices provide comprehensive data tables, sensitivity analysis outcomes, and additional context for the study's findings. This detailed information supports the conclusions drawn and offers a deeper understanding of the GWP assessed in this study.