MKS PAMP SA – Carbon Footprint of General Feed Gold Grains

Product Emissions Report

April 2025

Contents

1. Summary

1.1. Introduction

This report presents the results from the carbon footprint study of MKS PAMP SA's gold grain product(s).

This report conforms to the requirements for public disclosure of the life cycle GHG emissions of products laid out in the "Code of Good Practice for product GHG emissions and reductions". It aims to provide the basis to allow consistent information for product GHG emissions and reduction, assessed in conformity with the ISO 14067 Standard. The Product Emissions Report should be made available in the public domain

1.2. Background Information

Table 1: MKS PAMP SA Product(s) Carbon Footprint - Background Information

Category	Description
Company name	MKS PAMP SA
Company contact information	Prom. de Saint-Antoine 10, 1204 Geneva, Switzerland
Product name(s)	Gold Grains
Boundary	Cradle to gate
Standards, specifications and/or other documents used for footprinting methodology against which the company has been assessed for conformity	ISO 14067 Standard Carbon Trust Product Carbon Footprint - Requirements for Certification v3.0
Name of the independent, third-party verifier	Carbon Trust Assurance Ltd
Level of assurance achieved	Reasonable
Date of certification	01/04/2025
Functional unit	$kgCO_2e$ per kg

Data period	01/07/2023 – 30/06/2024
Product consistency criteria (PCC)	Product Category Criteria Form for Precious Metals (Unapproved)

1.3. Results

The overall emissions are reported in Table 2 below Please refer to the complementary MKS PAMP Footprint Expert FINAL.

Table 2: Footprinting Results Gold Grains (Cradle-to-Gate) – Global Market

Net Total Emissions (kgCO2e per kg of gold)	**9,729.93**
Fossil Emissions (kgCO2e per kg of gold)	9091.84
Biogenic Emissions (kgCO2e per kg of gold)	0.01
Land Use Change Emissions (kgCO2e per kg of gold)	638.08

1.4. Data

The data quality assessments were carried out based on a key developed internally at Carbon Trust. The overall data quality for the project was good, because of the primary data quality.

1.5. Key Assumptions

Table 5 in Section 2.4.2 outlines the key assumptions that have been made.

1.6. Interpretation of results

An overall breakdown of the emissions associated with the various products and process steps for each product are reported in **Table 8: Gold Grains (Cradle-to-Gate) – Global Market.** This table demonstrates that the highest emission process is that of the raw material (raw gold) which account for 93% of the total footprint and land use change which accounts for 7% of the total footprint.

The LUC methodology follows the 2019 IPCC Guidelines for National Greenhouse Gas Inventories. The equations and default constants used in the methodology are revised for specific land and biomes. To calculate LUC emissions, direct LUC equations and methodology were used. Indirect LUC has not been accounted for due to the lack of internationally agreed procedure.

Further details are recorded in section 2.4 Methodological Choices

1.7. Disclaimer on uncertainty

The emissions figures provided in this report have been calculated in accordance with the requirements of ISO 14067 standard, using the primary and secondary sources of data specified above. Based on ISO 14067 standard method of assessment, we believe that our assessment has identified 95% of the likely

GHG emissions associated with the full life cycle of the product(s) covered in this report. However, readers should be aware that even primary sources of data are subject to variation over time, and the figures given in this report should be considered as our best estimates, based on reasonable cost of evaluation.

2. Main Report

2.1. Goal of the study

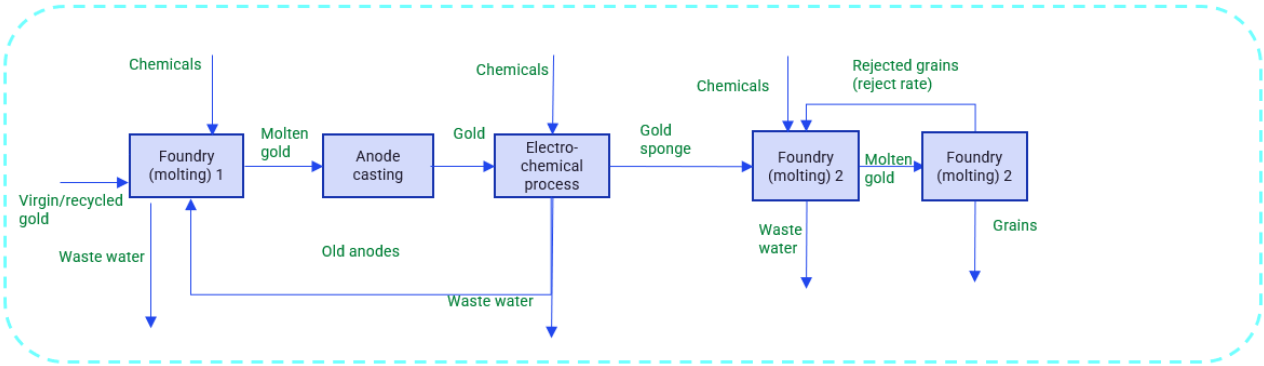
Table 3: Goal of the Study

Category	Description
Intended applications of study	Business to Business (or business consumer) with label license
Environmental footprint impact category	Climate change
Methodological or environmental footprint impact category limitations	Land use change implications
Reasons for carrying out the study	To calculate and verify the carbon footprints of the products
Target audience	Customers of the reporting company, MKS PAMP SA
Reference PEFCRs	N/A
Commissioner of the study	Tamara Jomaa-Shakarchi

2.2. Scope

The project scope involves calculating the carbon footprint of the gold grains within the general feed. These product(s) will be footprinted cradle-to- grave, using kgCO2e/kg as the functional unit.

2.3. Boundary



2.3.1. Raw materials

Gold inputs come from both virgin and recycled sources. The activity data provided by MKS PAMP SA was the total mass of the raw material inputs for each footprinted product over the reporting year.

The largest emission source within the raw materials was the gold input. The emission factors used for the gold were calculated using the EU Product Environmental Footprint Circular Footprint Formula (PEF CFF). The virgin emission factor for gold was calculated for specific suppliers provided by MKS PAMP SA. Recycled emission factors for gold were taken from the World Gold Council.

The Product Environmental Footprint (PEF) is a life cycle assessment (LCA) based method to quantify the environmental impacts of products established by the EU. The overarching purpose of PEF is to enable to reduce the environmental impacts of goods, accounting for supply chain activities (from extraction of raw materials, through production and use and to final waste management). This purpose is achieved through the provision of detailed requirements for modelling the environmental impacts of the flows of material/energy and the emissions and waste streams associated with a product throughout its life cycle.

The Circular Footprint Formula (PEF CFF) provides the approach that shall be used to estimate the overall emissions associated to a certain process involving recycling and/or energy recovery. These moreover also relate to waste flows generated within the system boundary.

The emission factor applied to the input gold material was calculated using the following two formulae which have been derived from PEF CFF below. An adaptation has been made in multiplying it with EvLUC to account for land use change from mining,

Pr = R2 x (1−A)MQL+R1A

EF = Pr x Er + (1-Pr) x Ev + Pr x Er + (1-Pr) x EvLUC

With respect to both the virgin gold and recycled gold, a 3-year rolling average emission factor has been applied and implemented into the PEF CFF. This allows MKS PAMP SA to obtain a supplier specific EF from each of their mines which may have varying yields over the years.

Pr is derived by calculating an average of the mine emission factors over the 3-year period.

Table 4: Explanation of PEF CFF formula

Parameter	Definition
Pr	The portion of the emission factor which can use Er (the recycled content)
Ev	Specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material, 3-year rolling average applied to this figure.
Ev LUC	Specific emissions and resources consumed (per functional unit) arising from land use change emissions caused by extraction of the virgin material.
Er	Specific emissions and resources consumed (per functional unit) arising from the recycling process of the recycled (reused) material, including collection, sorting and transportation process.
Er LUC	Specific emissions and resources consumed (per functional unit) arising from land use change emissions caused by the recycled material
R1	Proportion of material in the input to the production that has been recycled from a previous system. A three year rolling average has also been applied to R1.
R2	Proportion of the material in the product that will be recycled (or reused) in a subsequent system. R_2 shall therefore take into account the inefficiencies in the collection and recycling (or reuse) processes. R_2 shall be measured at the output of the recycling plant.
A	Allocation factor of burdens and benefits (jointly: "credits") between supplier and user of recycled materials. *For metals, this value is 0.2.*
MQL	The recycling process shall account for material quality loss during recycling, which is pre-defined for most materials. *For metals, this value is 1.*

Definitions from: Publications Office

For other chemical inputs, emission factors were taken from BEIS 2023 and EcoInvent 3.10. In the cases when the emission factors were not available in either database, an emission factor of a similar chemical was applied from EcoInvent.

2.3.2. Manufacturing

The raw materials were transported to MKS PAMP SA's manufacturing facility in Switzerland.

The activity data provided by MKS PAMP SA included the distance and mode of transport for each of the raw materials, as well as supplier location. Using these distances, the Carbon Trust's Road freight v4.5 calculator was used, whereas air freight and sea freight BEIS 2023 was used. This methodology calculators were used to find the emission factors for each raw material's upstream transport.

For manufacturing, electricity was the main energy source and 100% of the electricity was derived from hydroelectric power. Other energy sources used at the plant were natural gas and propane. This activity data was provided by MKS PAMP SA in MWh / year (for electricity) and m^3 / year (for natural gas and propane) for each process step. IEA 2023 emission factor was used for electricity as they use renewable energy. Emission factors from BEIS 2023 were used for natural gas and propane. For each process step a specific amount of $kgCO_2e$ emissions were associated with them, namely for example the first melting or the anode casting.

There were the following waste streams: black water, white water, non-precious metal waste, used crucibles. Waste activity data was derived from input data provided by MKS PAMP SA and BEIS 2023 was used for waste treatment emission factors.

2.3.3. Packaging

Packaging was carried out at MKS PAMP SA's facility in Ticino, Switzerland.

Gold grains are packaged into plastic boxes. Then 4 plastic boxes are packaged together in a cardboard box. Each product comes with a security label, warranty certificate and MKS PAMP label.

In terms of activity data, the mass of materials for one box or pallet was provided. These masses were then scaled up to account for the total production output for each product. Emission factors applied to these packaging materials came from the Carbon Trust's biogenic database.

2.3.4. Transport

Finished products are transported by road from MKS PAMP SA by road to customers in Switzerland.

For each country, the activity data was calculated using the specific mode and distance of the type of transport used. Using these distances, the Carbon Trust Road Freight Calculator v4.5 was used, whereas air freight and sea freight BEIS 2023 was used.

2.4. Methodology

2.4.1. Methodological choices

Significant methodological choices for calculating the product footprint of MKS PAMP SA's SKUs are listed below:

- Calculation models were based on templates available in Footprint Expert Multi SKU and Footprint Expert 5.1 (FPX). These were set out in the different life cycle stages of gold bar, from the raw materials entering the facility and going through the first round of the foundry, to the grain entering the bullion department, packaging, and sent to retailers.
- Global warming potential (GWP) factors were taken from the PEF CFF Calculator, Road Freight Calculator v4.5, EcoInvent 3.10 and BEIS 2023.
- Based on low materiality, emissions from upstream packaging of the raw material inputs, namely the chemicals and silver, and land use change for procured gold where the mine source could not be verified and accurately calculated, are being excluded.

- Land use change calculation tool follows the 2019 IPCC Guidelines for National Greenhouse Gas Inventories. Equations and default constants used in the methodology are revised for specific land and biomes.
- A 3-year rolling average has been applied to the virgin gold emissions factor and the percentage of recycled gold procured.

2.4.2. Key Assumptions

Table 5 outlines the key assumptions that have been made for this metal type.

Table 5: List of Assumptions

Process Step	Key Assumption
Inbound transport gold	To calculate the amount of gold transported per supplier, first the total amount transported was determined, then a percentage per supplier was calculated and consequently applied to the total amount (gold input allocation tab)
Emission factors	Where specific raw materials did not have an equal emission factor, a generic Ecoinvent 3.10 organic chemical emission factors were applied.
Allocation of input	The data received was for groups of products and not per SKU. Therefore an allocation key has been created to determine amount of gold produced per group, and calculate the amount of materials/utilities per group
Mass balance	MKS PAMP SA inputs include raw metals and chemicals. Due to inconsistency in the mass balance, to balance the inputs and output materials, it is assumed all chemicals are wasted as copper sulphates.
Helicopter transport	Assumption that a helicopter can fly 250km/h: https://www.helicentre.eu/en/faq/#:~:text=How%20fast%20do%20helicopters%20fly,on%20one%20tank%20of%20fuel.
Industrial by product - input gold	Have assumed the split from the WGC of virgin and recycled gold of 64.41% and 35.59%.
Recycled EF for gold	The WGC emission factor was used for the recycled gold as well as the investment gold.
Water	No water input data was provided; therefore, it was assumed that the sum of black and white water was that of input water.
Inbound transporta tion gold	To calculate exactly how much gold was transported per different supplier, the total amount transported was used to calculate the percentage per supplier and applied that to the total amount of gold used. This percentage split is included in the model.
SKUs	For the large bars, the LBMA and Swiss are the same finesse and hence product, the only difference is the engraving on the product, for it to be sold in specific areas.
Emission factors	For the raw materials where emission factors were not found, a generic Ecoinvent organic chemical emission factor was applied.
Allocation of inputs	The data received was for the family group of the product and not per different SKU, essentially it was for all the gold large bars produced, hence an allocation key was created which was then used to determine the amount of gold produced and consequently the amount of materials/utilities is used.

Raw Materials	The virgin emission factor for gold was provided by MKS PAMP SA for all its suppliers, where there were none, an emission factor taken from the world gold council study was used.
End of life	In terms of the PEF CFF, a 100% recycling rate of finished gold is assumed for finished gold products. Due to the nature of the value of the end product, we assume that this will not be disposed of through waste streams and will eventually be recycled. Furthermore, the products are sold branded and stored in vaults so unlikely that they are purchased for further processing.
LUC Calculation methodology	The LUC methodology follows the 2019 IPCC Guidelines for National Greenhouse Gas Inventories. Equations and default constants used in the methodology are revised for specific land and biomes. To calculate land use change, direct LUC equations and methodology were used. iLUC has not been accounted for due to the lack of internationally agreed procedure.
Assessment period	A 20 year assessment period is used, even though the mine life cycle can be over 20 years, a reputable source could not be found. Instead the IPCC's 2003 Good Practice Guidance for Land Use, Land Use Change and Forestry, and its default value of 20 years was used. The linear discounting method is used to allocated emissions over the assessment period.
Exclusion	Assume no land use change where land type is rocky or desert or where there has been no visible expansions or change to the landscape in the last 20 years.
Methodology	Using the gold procured by MKS PAMP SA, a percentage was calculated for the amount of gold MKS PAMP SA procures of total gold produced by the mine. The percentage is used to apportion the hectares of the mine for only the amount procured by MKS PAMP SA.
Unknown Mines	There are several gold sources which MKS PAMP SA procure from where the original source is not known as the gold is sourced from a refinery or an aggregator. In these cases, we have used mines that have sold similar quantities of gold as an assumption for the mine hectares and a 2014 start date.
Rolling average	Gold percentages for secondary data taken from WGC and are: recycled content 54% and virgin content 46%
Helicopter transport	Assuming a standard utility helicopter such as: https://www.airbus.com/en/products-services/helicopters/civil-helicopters/h145/h145-technical-information with a carrying load of 1905kg. Assumed standard capacity at 70% of this which is 1333.5kg. Helicopter model found here: https://www.ias-aviation.net/en/notre-entreprise/

2.4.3. Allocation of inputs

MKS PAMP SA produce several products at their facility. Raw materials, outputs and utilities were provided for each process step for all products within project scope. When modelling the individual product footprints, a calculation was made to identify the production inputs and utilities required for 1kg of each product and the associated outputs for 1kg of product. This was then multiplied by the total output of the product to determine the total input emissions associated with each SKU.

The inbound transportation file included the transportation information for all inbound gold. In order to allocate only the emissions related to the general feed gold grains, an allocation factor was required. Using the percentage of gold procured from each mine of the total gold procured, an allocation was calculated to determine the input gold transported from each mine for the general feed gold grains. An additional adjustment was made to the inbound gold to remove the inbound gold related solely to the provenance products. The client provided a percentage split of gold per product from each of these source mines.

The LUC emissions were also calculated using an allocation factor. The change in land use was calculated by drawing polygons on google earth of the developed land areas. The land use change in hectares was apportioned based on the percentage of gold procured by MKS PAMP SA for this product over the total metals production of the mine.

2.4.4. Allocation due to recycling

Recycling allocation allows products to use the generally lower, recycled material emissions factor, rather than exclusively using virgin material emissions factors, for a portion of some input materials — thereby reflecting the benefits of recycling in reducing GHG emissions. The methodology (PEF CFF) used, balances how much benefit is attributed to products that use recycled input materials and how much is attributed to products that are recycled and provided these materials

It was assumed that gold had a recycling rate of 100% due to the high value of the end product. The end-of-life fates for packaging materials were found at a country level.

Please refer to section 2.3.1 where further information is provided on the PEF CFF.

2.4.5. Grouping

This footprint includes the grouping of five SKUs into one final gold grains product. The reasoning behind the grouping is due to the similarity of the products. The difference in the footprint which would arise from this is considered immaterial due to the emission factor for silver being considerably lower than the emission factor for gold.

For each SKU group a global average has been calculated as the raw gold represents the majority of the footprint and the difference between SKUs is de minimis.

Table 6: ID Number

ID Number
ZAUGR00012
ZAUGR00016
ZAUGR00014
ZAUGR00013
ZAUGR00015

2.4.6. Methodological changes since previous report

The previous inventory reports were called Phase 1 MKS PAMP FPX Multi SKU V5.

Where there is a reduction assessment being made, this will only reflect reductions that are due to the actions of MKS PAMP SA (Product Carbon Footprints: Requirements for Assurance Part 2: Claims and Labelling, section 3.3). Where there have been changes to the data quality or improvements made to the calculation methodology, the baseline footprint has been re-baselined in order to also reflect those changes, so that the reduction assessment can be made with comparable footprints (Product Carbon Footprints: Requirements for Assurance Part 1: Technical, section 9.2).

The following changes in this section are all subject to re-baselining.

Input metal data granularity - Co-Product and Ex-Investment

Data granularity for input metals has improved so that supply can be defined as ex-investment or industrial by-product rather than only recyclate or virgin (doré).

To use the PEF CFF approach, inputs must be defined as virgin or recyclate so that credit can be allocated for recycling/use of recyclate.

Ex-investment metals are deemed to be recyclate. Industrial by-product metals are offcuts/scrap which the supplier cannot process, e.g. the remnants of a blank after some shape has been stamped from it. In GHG accounting terminology, this is a co-product, an output which is not the primary product but which is not a waste (i.e. it has value). Without knowing the supplier's own inputs, an assumption must be made on the content of that co-product metal with respect to virgin and recyclate percentage.

For this assumption, the World Gold Council's (WGC) guidance (2021 - Gold and Climate Change - Decarbonising investment portfolios) was followed, so that there is an assumed approximate 70:30 split of virgin:recyclate for these inputs.

Rolling Average for Co-Product

As the footprint applies a 3 year rolling average to the recycled content percentage, the footprint also extrapolates the above Co-Product assumption to the previous years. Those previous year datasets did not have the same granularity, i.e. all metal was grouped as either recyclate or virgin, and so any industrial by-product was previously grouped in with recyclate. Therefore, in order to re-baseline, the % of this year's input which is industrial by-product was subtracted from the previous year's recyclate percentage and was re-assigned to either recyclate or virgin according to the WGC recommended split. This means that the recyclate percentage of the previous year's decreases very slightly.

World Gold Council Emission Factor for Virgin Gold

This is not strictly a methodological change but is noteworthy for it's impact.

All mines which do not carry out their own footprinting use an average emission factor from the WGC. In previous footprints this number was ~38,000kgCO2e/kg, but the latest WGC guidance has re-stated their estimate at ~32,000kgCO2e/kg. Therefore, this has been updated in this footprint and in the previous years which are included in the 3-year rolling average.

Skarn Emission Factors

Skarn Associates is a mining-focused data analyst firm specializing in asset-level environmental and GHG emissions intelligence across the extractive sector.

Where mines do carry out their own footprints these are taken from the Skarn database and used in the footprinting. Where a mine is carrying out their own footprint now but was not doing so in the past (i.e. it was previously using the WGC average emission factor), the WGC emission factor is replaced with the more accurate, measured, Skarn emission factor in those past years.

This re-baselining of previous estimated footprints with the measured footprints can cause the emissions factor of the input virgin metal to be higher or lower than it was before, but this is an increase in accuracy of footprint, rather than a true increase or decrease of the footprint.

Harmonisation of Emission Factor Databases

In the previous set of footprints, End of Life emission factors for treatment of waste came from both the BEIS and EcoInvent databases. In order to harmonise the approach and to update to the latest best practice guidance from our Data Team, in this year's footprints, all end of life and waste emission factors have been taken from the BEIS database.

Biogenic Emissions

In the previous footprint, Carbon Trust used a biogenic calculator, separate to the CFF calculator, to calculate the biogenic emissions factors for the packaging material. This year, the biogenic emissions calculation has been incorporated into an improved tool.

2.5. Data

2.5.1. Data Collection and Validation

MKS PAMP SA provided all activity data used for the analysis. All the input data drivers are summarised in the footprint model under their relevant process sheet. The main point of contacts for the data was MKS PAMP SA ESG team members. The Carbon Trust provided MKS PAMP SA with a data collection template to be used.

2.5.2. Data Quality

The data quality assessments were carried out based on a key developed internally at Carbon Trust. The overall data quality for the project was medium, because of the quality of data that was provided for the chemicals and raw precious metals. Table 7 and 8 summarise the data quality assessment of the most material data points.

Table 7: Gold Grain Data quality assessment for material data points

Data point	Emission Factor Data Quality Indicator	Activity Data Quality Indicator	Application Data Quality Indicator
Raw materials	Good	Good	Medium
Packaging	Good	Good	Good
Manufacturing	Good	Good	Good

Downstream distribution	Good	Good	Good

2.6. Results

An overall breakdown of the emissions associated with the various products and process steps is reported in Table 6 below.

Table 8: Gold Grain Results - Global Average Market

Data Category	Emissions	Emissions	%
Process	*$kgCO_2e/kg$*	*Total tCO_2e*	
Input Materials (Gold)	9,714.30	25,062,885.19	99.84%
Input Material	2.00	5,164.84	0.02%
Transport	7.95	20,513.18	0.08%
Utility	5.52	14,229.29	0.06%
Packaging	0.07	174.93	0.001%
Output (Waste)	0.02	48.93	0.0002%
Downstream Distribution	0.08	206.31	0.001%
PRODUCT CARBON FOOTPRINT	**9,729.93**	**25,103,222.67**	**100%**

2.7. Conclusions

The two main hotspots within the carbon footprint of the gold grain are that of the raw materials, namely the raw gold and the land use change, driven by the carbon intensity surrounding the emission factors.

2.8. Recommendations

2.8.1. Emissions reductions

The main emissions hotspot of both products is the gold raw material input and land use change from the source mines. Sourcing raw materials with a higher percentage of recycled content would be the most impactful way of reducing the product footprint.

Moreover, switching to the use of low-carbon methods of transport, both upstream and downstream (business to business transport), will decrease this further. This might include alternative fuels, electric vehicles, or even more efficient delivery routes. For third-party logistics, (retailer to consumer) it is recommend that MKS PAMP SA engage with suppliers in switching to more sustainable transport options.

In addition to the procurement of recycled gold, MKS PAMP SA could work more with mines to understand what land rehabilitation projects they are involved and see where they could lower LUC emissions by sourcing from mines that are in not in expansion or increasing emissions through land use change.

2.8.2. Data quality improvements

There are several recommendations to improve future recertification and results:

Raw materials (Gold): MKS PAMP SA provided the gold sourcing data of the used mines and the emission factors from these mines. Obtaining more visibility not only on Dore but also on the recycled gold sources would help to derive a more accurate recycled gold emission factor.

Other inputs: Obtaining supplier-specific emission factors would increase the accuracy of the footprint as generic emission factors would no longer be required.

Inbound transportation and downstream distribution: Attaining more clarity over the transportation stages could improve footprint accuracy. For example, it may be that the suppliers use electric vehicles, or particularly efficient logistical practices.

Mine Data: For the calculation of land use change, a large amount of data research was required by the delivery team as the client did not hold specific data on the mines. Challenges such as, some mines not exclusively mining gold, unknowns around how much land has actually been changed and the age of the mines, difficulty accessing reports which disclosed development or production resulted in a number of assumptions and a lower data quality score for the LUC emissions. Gaining visibility on the expansion of mines and land use change due to gold exploration will help with the calculation of the land use change emissions.

2.9. Disclaimer on potential uses of this report

The results presented in this report are unique to the assumptions and practices of MKS PAMP SA. The results are not meant as a platform for comparability to other companies and/or products. Even for similar products, differences in unit of analysis, use and end-of-life stage profiles, and data quality may produce incomparable results. The reader may refer to the ISO 14067 standard for additional insight into the GHG inventory process.

3. Annex

Annex 1: Certification Details (Third Party Sign-Off)

This product footprinting study has been subject to an independent critical review to verify whether the methodology used for this LCA is compliant with ISO 14067 standard.

Category	Description
Name of the certifier	Rajul Shah
Date of certification	01 April 2025
Data valid until	31 March 2027

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