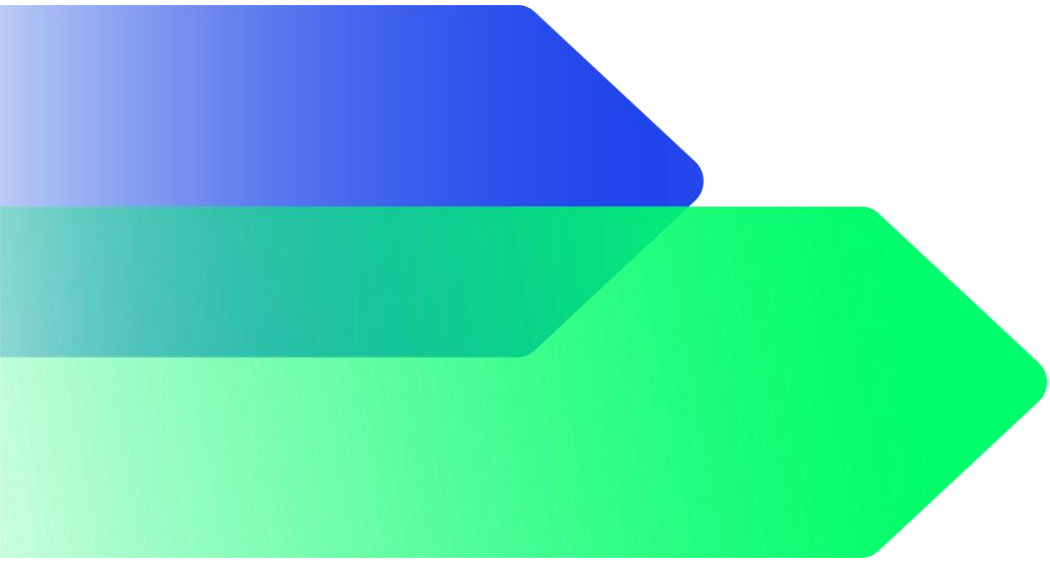
CARBON TRUST

PRODUCT CARBON FOOTPRINTS OF GOLD BARS (1KG AND 12.5KG)

MKS PAMP – Product Emissions Report

September 2022



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1. Introduction

This report presents footprinting study results calculated for MKS PAMP to measure the carbon footprints of their gold bars, namely 1kg and 12.5kg. FPX v4.5 (Footprint Expert) is a Carbon Trust developed and owned footprinting tool that was used to calculate the results.

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.

2. Background Information

Table 1: MKS PAMP Products Carbon Footprint - Background Information

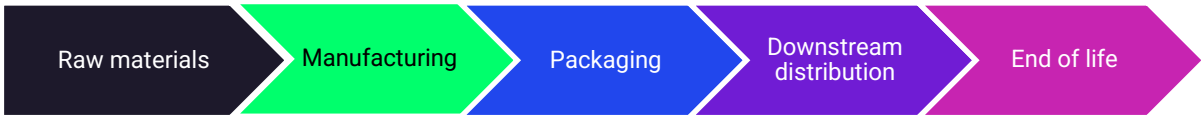
Category	
Company name	MKS PAMP
Company contact information	Prom. de Saint-Antoine 10, 1204 Geneva, Switzerland
Product names	Gold bars (1kg and 12.5kg)
Standards, specifications and/or other documents against which the company has been assessed for conformity	ISO 14067 standard Carbon Trust Product Carbon Footprint - Requirements for Certification
Name of the independent, third-party verifier	Carbon Trust Assurance Ltd
Level of assurance achieved	Reasonable
Date of certification	15th June 2022
Functional unit	kgCO_2e per kg
Data period	01-01-2020 to 31-12-2020

3. Scope and Boundary

3.1. Scope

The project scope involves calculating the carbon footprint, cradle-to-grave of gold bars, namely for the 1kg and 12.5kg bar.

The process map for the gold bars (1kg and 12.5kg) are as follows:



The diagrams below show a simplified process flow diagram for the manufacturing stage of each footprinted product.

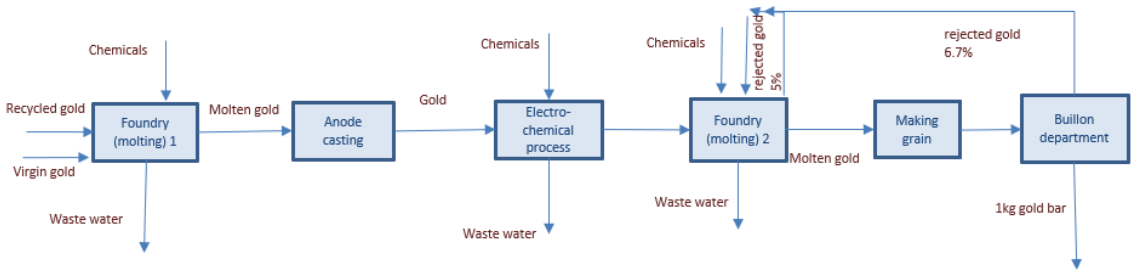


Figure 1: Gold Bar Process Map

For each activity data, a specific emission factor was assigned and multiplied with the activity data. This gave a value of the carbon emissions. This was conducted for each life cycle process and for each source, such as raw materials, electricity, waste streams, transport, etc.

3.1.1. Raw materials

Gold inputs come from both virgin and recycled sources. The activity data provided by MKS PAMP 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 and provided by MKS PAMP. Recycled emission factors for gold were taken from literature and averaged. The emission factor applied to the input material was calculated using the following formula which has been derived from PEF CFF:

$$Emission\ factor\ \left(\frac{kgCO_2e}{kg}\right) = P_r E_r + (1 - P_r)E_v$$

$$where\ P_r = R_2(1 - A)MQL + R_1 A$$

Parameter	Definition
E_v	Specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material.
E_r	Specific emissions and resources consumed (per functional unit) arising from the recycling process of the recycled (reused) material, including collection, sorting and transportation process.
R_1	Proportion of material in the input to the production that has been recycled from a previous system.
R_2	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: PowerPoint-Präsentation (europa.eu)

For other chemical inputs, emission factors were taken from the FPX v4.5 database (mostly BEIS 2020) or EcoInvent 3.7.1. In the cases when the emission factors were not available in either database, an emission factor of a similar chemical was applied from EcoInvent. If this also wasn't available, a generic emission factor was applied – 'chemical, organic' or 'chemical, inorganic' (also from EcoInvent).

3.1.2. Manufacturing

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

The activity data provided by MKS PAMP included the distance and mode of transport for each of the raw materials, as well as supplier location. Using these distances, the air freight, road freight and sea freight FPX v4.5 calculators were used to find the emission factors for each ingredient'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 in MWh / year (for electricity) and m^3 / year (for natural gas and propane) for each process step. The full lifecycle emission factor for hydroelectric power was taken from https://www.hydropower.org/factsheets/greenhouse-gas-emissions. Emission factors from BEIS 2020 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 molting 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 and BEIS 2020 was used for waste treatment emission factors.

3.1.3. Packaging

Packaging was carried out as MKS PAMP's facility.

1kg gold bars are individually packaged in protective plastic rolls with a paper certificate each. 25 bars are packaged in one plastic box for shipping. 12.5kg bars are packaged in wooden pallets, each containing about 500kg of gold.

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 FPX v4.5 database.

3.1.4. Downstream distribution

Finished products are transported by road from MKS PAMP in Switzerland to Zurich airport or to the final customers in Switzerland. For the 1kg gold bar, the products are flown to Malaysia, Thailand, USA, and India. From here, the products are transported to the end customer, by air and/or road.

For each country, the activity data was calculated using the specific mode and distance of the type of transport used. Emission factors were applied to these activity data which derive from Carbon Trust FPC v4.5 transportation calculator.

3.1.5. End-of-life

For the gold bars it is assumed 100% of the metal is recycled. The End-of-Life profile for packaging was calculated using the calculator already present in the FPX which considers different disposal methods.

3.2. Methodology

3.2.1. Methodological choices

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

- Calculation models were based on templates available in Footprint Expert 4.5 (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 buillon department, packaging, and sent to retailers.
- Global warming potential (GWP) factors were taken from the FPX Reference Database and EcoInvent 3.7.1.

- Materiality methodology and cut-off criteria: any process that constituted less than 1% of total emissions was excluded from the assessment.

3.2.2. Assumptions

Although comprehensive primary data was provided by MKS PAMP, Table 2 outlines the key assumptions that have been made.

Table 2: List of Assumptions

Process Step	Assumption
Raw materials	The virgin emission factor for gold was provided by PAMP for the top 78% of suppliers on a mass basis; the weighted average EF was applied to all virgin inputs.
Raw materials	Potassium fluoroborate EF was not reported in Ecoinvent 3.7.1 so the EF for sodium fluoroborate was used instead
Raw materials	For trimercaptotriazine and many chemicals in the minting department, a specific chemical could not be found in EcoInvent 3.7.1 so the 'chemical, organic//[GLO] chemical production, organic' was used instead
Raw materials	Black water and white water are outputs provided by PAMP. It is assumed that water consumption is the sum of these two.
Packaging	In the absence of specific information, it is assumed that raw materials used in packaging are virgin materials. Since packaging makes up a small proportion of the total footprint, this will have minimal impact.
End of life	In terms of the PEF CFF, a 100% recycling rate of finished gold is assumed for finished gold products. Products that are large, high purity metals (such as a solid gold bar), will usually be recycled. Products with metals in small amounts, especially where combined or alloyed with other materials, are unlikely to be recycled.
End of life	For packaging end-of-life, an EU average has been used due to the absence of global factors. However, this does not have a material impact on the footprint.

3.3.3 Allocation

MKS PAMP produce many more products at their facility than the products that are in scope. Therefore, MKS PAMP calculated raw material inputs, outputs, and energy usage for each process step for all products in scope.

3.2.3. Grouping

1kg and 12.5kg gold bars are packaged differently but have been grouped together since the footprint per kg has a difference of less than 0.5%. Gold bar results were based off primary data provided for the production of the 1kg gold bar.

4. Data Requirements

MKS PAMP 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 ESG team members. Primary data collected from the client is available in the project folder.

4.1. Data Management and Quality

The data quality assessments were carried out based on a key developed internally at Carbon Trust. Table 3 summarises the data quality assessment of the most material data points.

Table 3: Data quality assessment for material data points

Process step	Data point	Emission Factor Data Quality Indicator	Activity Data Quality Indicator	Application Data Quality Indicator
Raw materials	Gold	Medium	Good	Good
	Dextrose monohydrate	Medium	Good	Good
	Boric acid	Medium	Good	Good
	Borax	Medium	Good	Good
	Potassium fluoroborate	Poor	Good	Medium
	Sodium carbonate	Medium	Good	Good

	Calcium fluoride	Medium	Good	Good
	Caustic soda	Medium	Good	Good
	Hydrochloric acid	Medium	Good	Good
	Nitric acid	Medium	Good	Good
	Sulphuric acid	Medium	Good	Good
	Sodium borohydride	Medium	Good	Good
	Hydrogen peroxide	Medium	Good	Good
	Trimercaptotriazine	Poor	Good	Medium
	Sodium chloride	Medium	Good	Good
	Sodium sulphide	Medium	Good	Good
	Sodium metabisulphite	Medium	Good	Good
	Water	Medium	Good	Good
	Silicon carbide crucible	Medium	Good	Good
	Chemicals used in bullion department	Medium	Good	Medium
Inbound transportation	Inbound transportation of gold	Medium	Medium	Medium
	Inbound transportation of other raw materials	Medium	Good	Good

Manufacturing	Hydroelectric power	Medium	Good	Good
	Natural gas	Good	Good	Good
	Propane	Good	Good	Good
	Manufacturing waste	Medium	Good	Good
Packaging	Packaging	Medium	Good	Good
Downstream Distribution	MKS PAMP to airport or port (road)	Medium	Good	Good
	Air travel	Medium	Medium	Medium
	Shipping	Medium	Medium	Medium
	Port/ airport to final customer	Medium	Poor	Poor
End-of-life	Gold products	Medium	Medium	Medium
	Packaging	Medium	Medium	Medium

5. Results

An overall breakdown of the emissions associated with the various products and process steps for each product are reported in Table 4 below. This demonstrates that the highest emission process is that of the raw material which account for 99.6% of the total footprint, while the second largest is inbound transportation at 0.2%.

Table 4: 1kg Gold Bar Results (Cradle-to-Grave) – Global Market

Data Category	Emissions	Emissions	%
Process	*Total tCO_2e*	*$kgCO_2e/kg$*	
Raw materials - Gold	495,652.7	2,719.0	99.6%
Raw materials - Other inputs	323.9	1.8	0.1%
Inbound transportation	1,092.2	6.0	0.2%
Manufacturing	33.7	0.2	0.0%
Downstream distribution	781.2	4.3	0.2%
End-of-life	4.4	0.0	0.0%
PRODUCT CARBON FOOTPRINT	**497,888.1**	**2,731.2**	**100.0%**

6. Recommendations and Opportunities for Improvement

6.1. Emissions reduction

The main emissions hotspot of the SKUs is the gold raw material input. Sourcing raw materials with a higher percentage of recycled content would be the most impactful way of reducing the product footprint. In terms of other reduction initiatives, increasing procurement of recyclable packaging and incorporating more recycled content within the packaging will also assist in reducing emissions. Moreover, switching to the use of low-carbon methods of transport, both upstream and downstream, will decrease this further. This might include alternative fuels, electric vehicles or even more efficient delivery routes.

6.2. Data quality

There are several recommendations to improve future recertification and results:

Raw materials:

- Gold: MKS PAMP provided the gold sourcing data of the used mines, with the mines name anonymized due to pre-existing confidentiality provisions in contractual agreements between MKS PAMP and its clients. The certification team was thus, unable to provide the direct mapping to each individual used source, and the calculated figures are in consequence affirmed only at aggregated level. The plausibility check was conducted against industry data, per the requirement of ISO 14067

standard. MKS PAMP has taken measures to ensure that disclosures of mine-specific data including the name of the source will be available in the future, as it is a prerequisite for recertification.

- Other inputs: Obtaining supplier-specific emission factors would increase the accuracy of the footprint as generic emission factors would no longer be required.
- Increase percentage of recycled percentage within for example the packaging of the finished materials, this would decrease the overall emissions.

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.

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 products 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.

8. Disclaimer on potential uses of this report

The results presented in this report are unique to the assumptions and practices of MKS PAMP. 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.

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Published in the UK: 2022