openLCA 1.10.3

Case study compliant with - GHG Protocol Product Standard

GHG Inventory of a hammer

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Introduction

In addition to the accounting standards for companies and cities the Greenhouse Gas Protocol Initiative provides the “Product Life Cycle Accounting and Reporting Standard” (in short “Product Standard”). This standard is building on the framework and requirements of the ISO Life Cycle Assessment standards (14040,14044) with the intent of providing additional specifications and guidance. Therefore the compliance with the ISO 14040 requirements is immanent to a report compliant with the product standard.[1]

The purpose of this case study is to demonstrate the implementation of the Product Standard. This is done by calculating the greenhouse gas inventory of a hammer for usual households using openLCA 1.10.3 and reporting the results accordingly.[2]

The results presented are unique to the assumptions made for this study and are not meant as a platform for comparability to real products

Compliance to the Product Standard

The results of the case study are presented using the official “reporting template” of the GHG Protocol Initiative. The tabular structure of this documents facilitates the systematic implementation of the required steps.

During the conduct of the study, the documents required or recommended by the standard are also prepared. This includes in particular a process map and a data management plan.

Further a document is provided, that highlights certain additional requirements by the GHG Protocol Product standard in comparison to the “default” ISO 14040/44 approach. This document may serve as a first overview for those already familiar with the “default” approach but does not claim to be complete.

[1] https://ghgprotocol.org/product-standard

[2] https://www.openlca.org/

Greenhouse Gas Inventory Methodology

The study aims to calculate the greenhouse gas inventory of a “machinists’ hammer” with a head weight of 400g and a wooden handle according to DIN 1041. The tool is sold without packaging and designed for occasional use in usual household situations over a service life of 40 years. The exchange of the handle after 20 years is included.

The inventory is carried out using the database ecoinvent v.3.7.1, which was published in 2020.[3] Ecoinvent offers three different system models which apply different assumptions to determine the linking of impacts between producers and consumers (allocation and substitution). For this study the cut-off system model is used.

The inventory is calculated for the entire Life Cycle of the hammer. This includes all processes from cradle-to-grave as mapped in Figure 1.

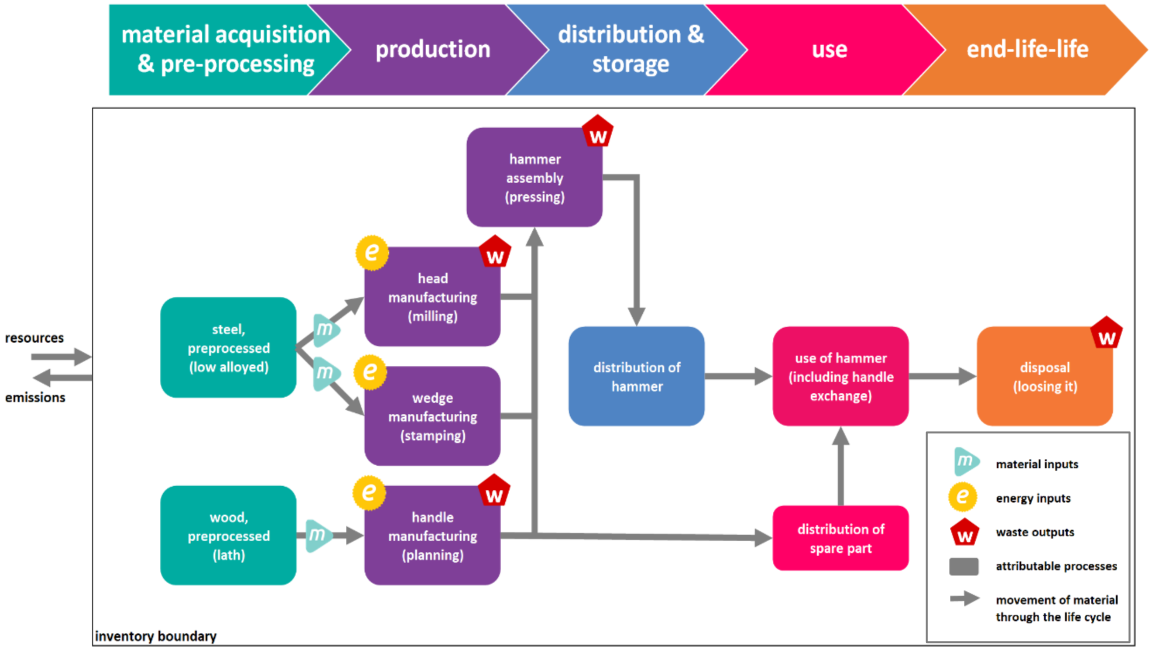


Figure 1: process map (process flow)

Further documentation is available in the following inventory reporting file according to GHG Protocol Product Standard.

[3] https://ecoinvent.org

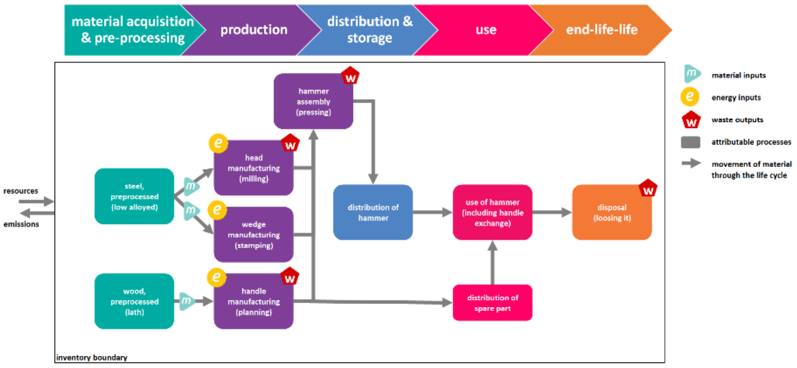
GHG Protocol Product Standard-Inventory Reporting

This report builds on the reporting template offered by the GHG Protocol Initiative. The GHG inventory was implemented in the openLCA software. It was implemented for illustrative purpose only.

General information and scope	
Contact information	GreenDelta GmbH
Studied product name	Machinists' Hammer, 400g
Studied product description	Machinists' hammer, head weight 400g, wood handle, sold without packaging (final product)
Unit of analysis 	Functional Unit: • Magnitude of the function: occasional use of hammer in usual household situations • Quality level: meeting DIN 1041, exchange of handle (after approx. 20 years) • Service Life: 40 years
Reference flow	1 item (1 head & fastening wedge, 2 handles)
Type of inventory	cradle-to-grave inventory
Additional GHGs included in the inventory	additional GHGs included beyond CO_2, CH_4, N_2O, SF_6, HFCs, PFCs: in insignificant quantities: $CHCl_3$; CFC-113
Sector guidance or product rules	n.a.
Inventory date and version	Oct. 2021 Version 1
Link to previous inventory reports and description of any methodological changes	n.a.

General information and scope	
Disclaimer	The GHG inventory was implemented in the openLCA software. It was implemented for illustrative purpose only. The results presented in this report are unique to the assumptions made for this study. 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 GHG Protocol Product Life Cycle Accounting and Reporting Standard (www.ghgprotocol.org) for a glossary and additional insight into the GHG inventory process.

Boundary setting	
Life cycle stage definition	**Material acquisition & pre-processing:** Resource extraction → components entering production site *Time period:* approx. 6 months
	Production: Components entering production site → finished product leaves gate of production *Time period*: approx. 1 month
	Distribution & storage: Finished product leaves gate of production → consumer takes possession of the product *Time period:* approx. 1 year
	Use: consumer takes possession of the product → production and distribution of spare handle→ product is discarded *Time period:* approx. 40 years (second handle after 20 years)
	End-of-Life: product is discarded → product is returned to nature or recycled *Time period:* approx. 100 years (for decomposition of wood)

<table>
<tr><th colspan="2">Boundary setting</th></tr>
<tr><td>Process map</td><td>


</td></tr>
<tr><td>Non-attributable processes included in the inventory</td><td>n.a.</td></tr>
<tr><td>Excluded attributable process, service, material, or energy flows</td><td>Internal transports in production (estimated as insignificant), transportation while use-phase (strongly dependent on individual user behavior and not part of the scope)</td></tr>
<tr><td>Justification for a cradle to-gate boundary</td><td>n.a.</td></tr>
<tr><td>Time period</td><td>In total: >100 years</td></tr>
<tr><td>Land use change impacts method(s) (when applicable)</td><td>The calculation of the attributable impact of land use change is estimated in the calculation but shows to be insignificant.</td></tr>
</table>

Allocation	
Methods used to avoid or perform allocation	The "Recycled content method (cut-off method)" is used. This method was chosen due to the long time period of the product's use stage. e.g. recycling of scrap steel from milling process (further efforts/benefits after collection for treatment are cut-off)
Displaced emissions and removals using the closed loop approximation method	n.a.

Data Collection and Quality	
A descriptive statement on the data sources, data quality, and any efforts taken to improve data quality	As this first study is not performed by a producing company, but for illustrative purposes only, there is no ownership or control of the processes involved. Otherwise, it would be mandatory to use primary data for these processes. The data quality of significant processes was assessed with the recommended indicator matrix system of the GHG standard. Results are accessible in the oLCA database. data-management-plan.xlsx

Source of uncertainty	Qualitative description
Scenario uncertainty	
Use profile	The studied product "hammer" (for occasional use in usual household situations) could alternatively be misused as a tool in the professional context. This would result in a shorter service life and higher number of spare parts necessary. Other use profiles are excluded as they would require a different quality of tool.
End-of-Life profile	The End-of-Life is assumed to be losing the hammer in nature. A realistic alternative scenario would be the communal waste treatment. Due to missing data, the choice was based on the assumed higher probability.
Allocation method(s) (co-product and recycling)	With a change of the end-of-life profile the recycling of the steel would become relevant. A switch from "recycled content method" to "closed loop approx." is not recommended by GHG

Source of uncertainty	Qualitative description
	standard as long as the amount of material recycled at the end-of-life is highly uncertain.
Parameter uncertainty	
Global Warming Potential factors	GWP factors according to IPCC 2013 GWP100a (incl. CO2 uptake). Quantitative uncertainty calculations (using GWP values from IPCC's Fourth Assessment Report and estimations for process data) are not performed.
Model uncertainty	
Model sources not included in scenario or parameter uncertainty	Model uncertainty arises from the limitations in the ability of modeling the decomposition of the steel into its chemical parts at the end of life. It is modelled as having no climate change impact. Further arises uncertainty from the use of generic process data, which does not model the conditions for this study in detail.

Inventory results: kg CO_2e /unit of analysis					
Total inventory results	Biogenic (when applicable)		Non-Biogenic (when applicable)		Land-use change impacts (when applicable)
	Removals*	Emissions*	Removals	Emissions	
2.024	-0.887	0.831	0	2.078	0.003 (insignificant)

Inventory results (continued): percent of total inventory results per life cycle stage	
Stage definition	Value (percent of total CO_2e)
Material acquisition and preprocessing	35.33%
Production	55.72%
Distribution and storage	00.64%
Use	00.94%
End-of-Life	07.36%

Inventory results (continued): carbon storage	
Embedded product carbon not released at the end of life	*The discrepancy of -0,056 is due to assumptions made for the waste treatment

Inventory results (continued): carbon storage	
	of wood and is seen as a deviation from reality.
Embedded product carbon leaving the gate of a cradle-to-gate inventory	n.a.
Amount of process emissions stored as a result of emission storage	n.a.

Inventory results (continued): cradle-to-gate and gate-to-gate	
Definition	Results (kg CO_2e /unit of analysis)
cradle-to-gate	1.843 (excl. spare handle)
gate-to-gate	1.128

Assurance	
Assurance type	First party
Level of assurance achieved or critical review findings	Reasonable assurance
Summary of the assurance process	“In the opinion of the assurance provider the reporting company’s assertion that the inventory product’s emissions are 2.024 kg CO2e is fairly stated, in all material respects, and is in conformance with the GHG Protocol Product Life Cycle Accounting and Reporting Standard."
Relevant competencies of the assurance providers	• Assurance expertise and experience using assurance frameworks • Knowledge and experience in life cycle assessment and/or GHG corporate accounting • Ability to assess the emission sources and the magnitude of potential errors, omissions and misrepresentations • Credibility, independence and professional skepticism to challenge data and information
Explanation of how any potential conflicts of interest were avoided	The assurance provider was not included in the project except for the assurance process. There is no disciplinary or economic dependence involved.

Setting reduction targets and tracking inventory changes (when applicable, not required to claim conformance)	
Base inventory and current inventory results	
Reduction target, if established	
Changes made to the base inventory, or if no change was made, the threshold used to determine that recalculation was not needed	
Appropriate context identifying and describing significant change/s that trigger base inventory recalculation	
The change in inventory results	
Explanation of steps taken to reduce emissions	

Highlighted Requirements for GHG Product Standard

The compliance with the ISO 14040 requirements is immanent to a report compliant with the GHG product standard. There is a high similarity of the product standard to the PAS 2050 standard.[4]

	GHG Product Standard	Comparison to "default" LCA (ISO 14040/44)
Data Quality	• Primary data for all processes under ownership or control of reporting company mandatory • For significant processes (rule of thumb >1%) report: data sources, data quality (indicator matrix available), efforts taken to improve quality	• No obligation for primary data • Data quality must be assed, but no specific quality scheme is defined
Allocation	• For allocation due to recycling: "recycled content (cut-off) method" or "closed loop approx."; standard includes guideline to choose one of them	• If allocation is necessary, physical relations are most recommended (if applicable)
Calculation	• Only calculate 100-year GWP factors, result in kg CO2e (strongly recommended to use most recent IPCC GWP values) • Including biogenic emissions (requires separate reporting)	• Several impact categories and methods • Weighting factors allowed

[4] https://ghgprotocol.org/sites/default/files/standards_supporting/GHG%20Protocol%20PAS%202050%20Factsheet.pdf

	• No weighting factors for delayed emission allowed	
Assurance/ Review	• "Limited" or "reasonable" assurance (by first or third party; definition and example wording included in standard)	• No certain assurance levels defined (review mandatory for publishing)
Reporting	• Recommended reporting template available • Specify additional GHGs beyond CO_2, CH_4, N_2O, SF_6, HFCs, PFCs in report • Process map with all attributable processes • Report time period (duration) of life cycle stages • Special focus on land use change impacts, report method • qualitative statement about uncertainty necessary with following elements: Use and end-of-life profile; Allocation methods (incl. recycling); Source of GWP values; Calculation models (if applicable) • impact results, report separately: total inventory, percentage by life cycle stages, Biogenic and non-biogenic emissions (if not sure, chose non-biogenic), land use change impacts, cradle-to-gate, gate-to-gate, carbon in product (not released at EoL), When using the closed loop approximation method, report displaced emissions and removals separately from end-of life stage inventory	• no template • Additional GHGs don't have to be reported separately • Not mandatory to include flow chart in report (but broadly used) • Reporting duration of life cycles stages is not mandatory • Not mandatory to explain land use change in detail in report • fewer specific requirements about how to report about uncertainty assessment and impact results
Setting reduction targets	• Not required to claim conformance with standard	• not applicable